

U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS—MILTON WHITNEY, Chief.

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SOIL SURVEY OF CALHOUN COUNTY,  
MICHIGAN.

BY

R. F. ROGERS, IN CHARGE, AND WILLIAM G. SMITH.

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W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

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[Advance Sheets—Field Operations of the Bureau of Soils, 1916.]



WASHINGTON:  
GOVERNMENT PRINTING OFFICE,  
1919.

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## LETTER OF TRANSMITTAL.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., August 23, 1918.*

SIR: I have the honor to transmit herewith the manuscript report and map covering the survey of Calhoun County, Michigan, and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1916, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

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

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### MAP.

Soil map, Calhoun County sheet, Michigan.



# SOIL SURVEY OF CALHOUN COUNTY, MICHIGAN.

By R. F. ROGERS, In Charge, and WILLIAM G. SMITH.—Area Inspected by  
W. E. McLENDON.

## DESCRIPTION OF THE AREA.

Calhoun County is situated in the central-southern part of Michigan, about 85 miles west of Detroit and 150 miles northeast of Chicago. It is bounded on the north by Barry and Eaton Counties, on the east by Jackson County, on the south by Branch and Hillsdale Counties, and on the west by Kalamazoo County. It has an area of 693 square miles, or 443,520 acres.

Calhoun County is traversed by a series of northwest-southeast belts, varying in width from belt to belt and also from place to place in the same belt. There are some seven belts extending across or occurring partly in the county, constituting three types of surface relief. In geological nomenclature the three types are designated as outwash plains, moraines, and till plains. All three are products of glacial deposition. The outwash plains consist normally of smooth plains produced by the deposition of gravel, sand, and silt from running water, spreading the material out so as to bury all inequalities and leave a smooth plain surface. The moraines are hilly belts in which the hills have no systematic arrangement as to position nor uniformity of elevation or of shape. Among them are many basins without drainage outlet and often filled with water, forming lakes and ponds. The till plains are gently undulating to rolling, having a surface intermediate between that of the unmodified outwash plain and that of the moraines.

In Calhoun County there are three rather well-defined outwash plain belts, three morainic belts, and one well-defined till-plain belt or area.

The southwestern part of the county is occupied by an outwash plain almost perfect in the development and preservation of its typical features. Narrow valleys very shallow in depth traverse it at intervals so wide that its essential features are scarcely modified by them. A few low isolated hills rise above its smooth surface, representing probably patches of an old surface, the rest of which



FIG. 1.—Sketch map showing location of the Calhoun County area, Michigan.

was buried by the covering of gravel and sand-plain deposits. It is a smooth area, seemingly flat but with a gentle slope southward. Its northern boundary enters the county in Sec. 18, T. 3 S., R. 8 W., and extends eastward passing half a mile south of Joppa and the same distance north of Abscoda by way of Burlington and southward across the county line in Sec. 32, T. 4 S., R. 6 W.

North of this plain lies a morainic belt varying in width from one to four or five miles, being narrowest in the south-central part of the county and widest in the southeast corner and the central west side. Its surface is undulating to rolling with a few small areas that are hilly. The most striking of the latter lies 2 miles east of Burlington. While its surface features are not rough, except locally, they are distinct from the uniformly flat surface characteristic of the outwash plains on both sides of it.

North of this morainic belt lies another outwash-plain area extending from the county line at the northwest corner of T. 2 S., southeastward in a continuous belt to the central part of the county where it makes a southward bend to the St. Joseph River. Here it merges into the belt followed by this stream, the northeastern end of which extends across the county line 5 miles east of Homer. Throughout its extent it has a smooth surface, except for occasional shallow valleys that have been cut below its surface and a few low hills that stand above it. Its width varies from 1 to 3 or 4 miles. Immediately north of this belt lies a morainic belt, somewhat discontinuous and quite irregular in width. From the west line of the county southeastward to the central part of T. 3 S., R. 6 W., its width varies from a few hundred yards to a mile or more. East of this point, after an interruption by a north-south connecting belt of outwash plain it loses its belt-like form and spreads out over a considerable area in the east-central part of the county. In the western part of its course it lies against the south bluff of the valley occupied by the Kalamazoo River where it forms a narrow belt of pronounced relief. Eastward it becomes smoother and in the broad eastern end it consists of a rolling plain interspersed with swamps and lakes.

North of this belt lies the broadest and most continuous outwash plain belt in the county. Where it enters the county in the north-western corner it is about 4 miles broad. This width remains rather uniform southeastward to Marshall where it breaks up into four narrower belts, one extending southward to join the belts previously described, one slightly southeastward up Kalamazoo River, and two others slightly northeastward up Rice Creek and its north branch. A narrow belt also leaves this broad belt at Battle Creek, extending northeastward up the valley of Battle Creek. East of the longitude of Ceresco these plains are all smooth excepting a few shallow val-

leys. West of that line its surface is as a whole much less smooth than that of the outwash plains already described. It includes several areas, the most important one lying along Sevenmile and Wabasacon Creeks, that are fully as rough as the morainic belts lying farther south, the roughness consisting in all cases of valleys and basins lying below the general level of the plain. On rising to this level and standing on one of the areas of unbroken plain surface the plainlike character of the surface is evident. There is no such irregularity of elevation as is found in the morainal belts.

North of this belt lies the broadest, roughest, and most continuous morainal belt in the county. West of Battle Creek its topography is rough, considerable areas being too rough for cultivation. East of the creek the roughest part is confined to a narrow belt along its southern margin, though the greater part of this rougher strip is much smoother than the rougher parts west of the creek. Northward from the southern margin and east of Battle Creek it becomes smoother. A large area in the northeastern part of the county consists of a gently rolling and undulating till plain.

The streams of Calhoun County flow westward, their waters finally reaching Lake Michigan. The northern and central parts are drained by the Kalamazoo River, and the southern part by the St. Joseph River. These streams have considerable fall, and afford valuable water power. Battle Creek, the most important tributary of the Kalamazoo River in this county, joins the latter stream at the town of Battle Creek. It affords some water power. The chief tributary of the St. Joseph River is the Nottawa Creek, which drains the south-central and southwestern parts of the county. This stream is rather sluggish throughout most of its course, and it is of little value as a source of power. The drainage from Duck Lake and the extreme northeastern corner of the county finds its way into the Grand River, which flows northwestward into Lake Michigan.

Almost all the upland of the county is sufficiently well drained for farming. In the plainlike or gently undulating situations, however, there are areas, some of them comprising several thousand acres, in which scarcely any drainage lines have been developed but where the soil may be so thoroughly underdrained that it is well suited to farming. Swamps and marshes are most numerous or extensive on the borders of the streams and lakes. The soils of the county are porous, except in certain areas of heavy loam or clay loam, and they absorb a large part of the rainfall. On many of the steep hillsides the water is so rapidly absorbed that gullies have not been developed.

Within Calhoun County there are many small bodies of standing water. Some of these are without outlets, and others are connected with streams through bordering swamps with no definite channel of discharge, but the greater number have well-defined outlets, and

some stand in the course of streams. The larger lakes include Duck Lake, Goguac Lake, Nottawa Lake, Beadle Lake, St. Marys Lake, Graham Lake, and Wabasacon Lake.

Calhoun County was organized in 1833. Settlers came into the county in large numbers in 1833 and 1834, but most of the land was taken up in 1835 and 1836. Most of the settlers were from New York. The remainder came largely from Ohio and Pennsylvania. The population in 1850 was about 11,000. According to the census of 1910, the county has a population of 56,638, of which 37.6 per cent is reported as rural. The rural population, the density of which is 30.7 persons to the square mile, is rather evenly distributed over the county. The population consists chiefly of native Americans, but within recent years there has been a considerable influx of foreigners, chiefly Greeks and Austrians, who have settled mainly in Battle Creek and Albion.

Battle Creek, the largest city in Calhoun County, had a population of 25,267 in 1910. It is situated in the northwestern part of the county, is a railroad junction point and an important manufacturing city, with a variety of industries. Marshall, the county seat, with a population of 4,236 in 1910, is situated near the center of the county. It has a number of industrial plants. Albion, a manufacturing city in the eastern part of the county, had a population in 1910 of 5,833. Homer, a town of about 1,000 inhabitants, is situated on the Kalamazoo River in the southeastern part of the county. Tekonsha, Burlington, and Athens are towns of local importance.

Calhoun County has excellent transportation facilities. The first railroad, the Michigan Central, was completed to Battle Creek in 1845. Railway lines traverse the county in all directions, giving direct communication with all parts of the Middle West. Only in the sections northeast and southwest of Marshall are any farms as much as 8 miles distant from a railroad station.

Most of the country roads have been in comparatively poor condition until four or five years ago, since which time extensive improvements have been made. During the last year a large mileage of roads was graveled or otherwise improved. All parts of the county are reached by rural mail routes.

Calhoun County has excellent markets for all farm products. Marshall is 110 miles from Detroit and 177 miles from Chicago. Grand Rapids, South Bend, Toledo, and various large cities of northern Indiana and Ohio are easily accessible. The cities and towns within the county also afford a market for a large quantity of produce.

#### CLIMATE.

The climate of this region is characterized by short summers and long, though not always severe, winters. There are sudden changes

in temperature and rather wide extremes, as the Great Lakes are too remote to modify the climate to any great extent. There is a wide range between summer and winter temperatures. Occasionally in the summer the temperature rises to 95° F. or falls to 30° F. In the winter it may fall to 20° or more below zero. The mean

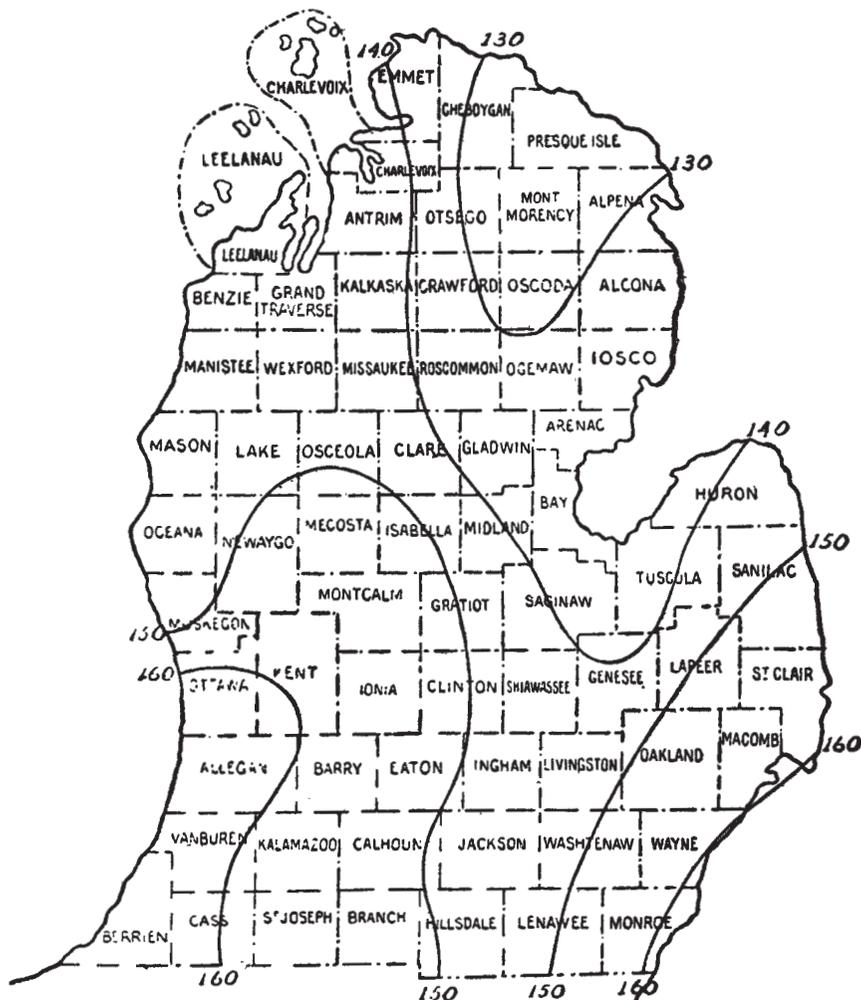


FIG. 2.—Average length of growing season.

annual temperature as recorded at Olivet, in southwestern Eaton County, is 46.5° F.

The average date of the last killing frost in the spring, as recorded at Olivet, is May 7, and that of the first in the fall October 5, giving an average growing season of about 151 days. (See figure 2.) The grazing season is considerably longer. The latest killing frost in the spring occurred May 21 and the earliest in the fall on September 14.

The mean annual precipitation at Battle Creek is reported as 33.33 inches. The rainfall is evenly distributed throughout the year. The annual snowfall varies greatly.

The data in the following table are compiled from the records of the Weather Bureau stations at Olivet and Battle Creek. Olivet is only about 5 miles north of Calhoun County, and the climatic conditions are similar to those in the area surveyed.

*Normal monthly, seasonal, and annual temperature and precipitation.*

Month.	Temperature at Olivet.			Precipitation at Battle Creek.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1879).	Total amount for the wettest year.
	<sup>° F.</sup>	<sup>° F.</sup>	<sup>° F.</sup>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
December.....	26.9	60	-10	2.48	2.04	1.15
January.....	23.0	62	-13	2.08	3.26	2.84
February.....	21.9	62	-19	2.80	1.65	6.10
Winter.....	23.9	62	-19	7.36	6.95	10.09
March.....	32.3	75	-5	2.41	1.22	3.69
April.....	45.4	85	15	1.95	0.80	1.93
May.....	56.6	87	25	3.01	0.57	4.65
Spring.....	44.8	87	-5	7.37	2.59	10.27
June.....	66.3	91	30	4.28	2.50	8.00
July.....	70.6	96	41	3.59	1.60	5.95
August.....	68.0	95.	40	2.97	1.40	4.75
Summer.....	68.3	96	30	10.84	5.50	18.70
September.....	61.5	92	28	2.74	2.22	3.75
October.....	48.9	85	15	2.70	0.85	1.92
November.....	36.6	70	7	2.32	0.42	1.78
Fall.....	49.0	92	7	7.76	3.49	7.45
Year.....	46.5	96	-19	33.33	18.53	46.51

#### AGRICULTURE.

The oldest settled section of Calhoun County has been under cultivation for about 85 years. Development was slow at first because of the heavy forest cover. Lumbering was carried on very extensively in the early days. Comparatively little merchantable timber remains, although there is considerable second-growth hardwood scattered over the county. The first farmers settled near streams and in open, level areas. General farming has been practiced throughout the county since its earliest settlement. Wheat, corn, and hay were the principal crops grown at first, and wheat continued to be the most important money crop until about 10 years ago.

It was often grown on the same field year after year, but, despite this exhaustive practice, many of the heavier textured soils have maintained their productiveness remarkably well. At first the hay crops consisted only of the wild grasses which grew abundantly on the prairies and in the low, marshy places, but later clover and timothy became important. Recently alfalfa has received some attention.

According to the census, the leading cereal crops of the county in 1879, named in the order of their importance, were wheat, corn, oats, barley, buckwheat, and rye. There were 36,989 acres in hay, producing 40,320 tons, and 2,930 acres in potatoes, producing 272,209 bushels. The orchard products produced in 1879 were valued at \$108,010, market-garden products at \$11,088, and forest products at \$150,730. The chief crops at present, named in order of acreage, are corn, hay, wheat, oats, rye, potatoes, beans, barley, and buckwheat. The chief subsistence crops are corn, wheat, oats, and hay. Corn and wheat are the principal money crops, but oats and hay are marketed to some extent. Timothy and clover are the most important hay crops. On the lighter soils a small acreage is devoted to strawberries, grapes, raspberries, and other small fruits, and near cities and towns the growing of onions, cabbage, and other vegetables is assuming some importance. Orchard fruits, principally apples, are grown on a commercial scale in a few cases, but every farmstead, except those recently established, has a small apple orchard, usually large enough to produce a surplus of fruit. Cattle raising has never been a prominent industry, but many hogs and some sheep are raised. Dairying is developing into an important industry.

The census reports 51,286 acres in corn in 1909, with a production of 1,996,456 bushels. The acreage in corn is increasing each year, and the yields are improving as more care is taken in seed selection and cultivation. Corn is grown in all parts of the county and on all the soil types.

Wheat, the second most important money crop, is grown to some extent on practically all the farms. Most of the wheat produced is shipped out of the county. The census shows a gradual decrease in the wheat area from 82,775 acres in 1879 to 38,811 acres in 1909. In the latter year there was a production of 896,157 bushels, or an average of 23 bushels per acre. There has been a gradual decline in yields on most of the soils, but a marked improvement has taken place in recent years, owing to scientific management. Formerly much land was used for wheat that is now known to be better adapted to other crops. The largest average yields are obtained on the Miami loam, the Bellefontaine loam, the Coloma loam, and the Fox loam. These soils, particularly the Miami loam, frequently yield 25 to 40 bushels per acre, and occasional yields of 45 bushels are obtained.

Yields on the other soils range from 8 to 35 bushels, with occasional yields of 40 bushels.

The census reports a production of 1,219,747 bushels of oats in 1909, from 34,695 acres, the yield averaging about 35 bushels per acre for the county. On the best grain soils oats frequently yield 40 to 75 bushels per acre under favorable conditions. A large proportion of the oat crop is used on the farms. With few exceptions oats follow corn in the rotation. The crop is seeded between the latter part of March and May 1. Clover and timothy, or clover alone, is sometimes seeded with the oats. The crop is cut in July, and cured in shocks in the field.

The census reports 12,780 acres in rye in 1909, producing 207,351 bushels, or an average of 16 bushels per acre. Rye does better on poor soils than oats or wheat. It responds readily to good farming methods; and on a productive soil, with careful seed-bed preparation, yields of 30 to 35 bushels per acre are not uncommon. The crop is seeded and harvested in practically the same way as wheat. It can be sown at almost any time of the year, even late in the season. Rye is a valuable winter cover crop for some of the soils, especially those of lighter texture, and it is usually grown on the light soils, the heavier types being considered more valuable for some other crop. Rye is used occasionally as a nurse crop when seeding some of the lighter soils to grass and clover, since it makes less demand on the supply of soil moisture than either wheat or oats. Much of the rye produced is shipped out of the county.

Barley was grown on 1,480 acres in 1909, and gave an average yield of about 25 bushels per acre. Where weather and soil conditions are favorable barley yields 35 to 45 bushels per acre, and yields of 70 bushels per acre occasionally are obtained on the Miami loam, Coloma loam, and Bellefontaine loam. Barley usually takes the place of oats in the rotation. Buckwheat is often sown on wet ground or where corn has failed, and is sometimes plowed under as green manure. The census of 1910 reports 1,132 acres in buckwheat, with an average yield of 14.5 bushels per acre.

Hay ranks next to corn in acreage, occupying 49,109 acres in 1909 and producing 59,919 tons, an average of nearly  $1\frac{1}{4}$  tons per acre. There were 22,588 acres in timothy alone, 22,017 in timothy and clover mixed, and 3,402 acres in clover alone. Timothy and red clover are often sown together, either in the spring with oats or in the fall with wheat. Some farmers sow the seed broadcast on wheat in the spring and harrow it in. Timothy usually is seeded at the same time the small grain is sown, while clover is sown the following spring on the young grain. In some cases the hay crop is seeded in August in a well-prepared field, without a nurse crop. In sowing timothy and clover the seed is mixed in equal quantities. The clover seldom lasts

longer than one year, and the timothy is then allowed to remain for one or two years or as long as a profitable crop can be cut. June grass (Kentucky bluegrass) thrives on many of the soils, especially those containing considerable lime, and affords excellent pasturage.

Alfalfa has received considerable attention within recent years and has proved a profitable crop. It is grown mainly in small patches scattered throughout the county, but there are a number of good fields containing 60 acres or more. The alfalfa acreage has increased considerably since 1909, when the crop occupied 81 acres and produced 111 tons. Alfalfa has been tried on nearly all the soils of the county, with varying results. The best and older stands frequently yield 4 to 5 tons per acre a season. Three cuttings are usually made. Alfalfa is a particularly valuable crop on light soils when a good stand is once obtained. It should follow some clean-culture crop, such as potatoes or corn. The productiveness of the very light soils must be increased before good results can be expected. Alfalfa should prove highly profitable on many of the soils of the county. The average yields are much greater than for any of the other hay crops. The chief soil requirements are<sup>1</sup> "a deep, fertile, well-drained soil rich in lime and reasonably free from weeds." Liming and inoculation are advisable in most cases. Alfalfa is valuable as a hay crop, as pasturage for hogs, and as a perennial legume to be mixed with clover and grasses for both hay and pasturage.

Potatoes and beans are the most important special crops of the county. Potatoes are grown in small fields in all parts of the county. The crop is grown commercially in a small way on practically all the lighter, well-drained soils, and occasionally on the heavy loam types. The census of 1880 reported 2,930 acres in potatoes, producing 272,209 bushels, or an average of about 92 bushels per acre. The census of 1910 reports 4,199 acres in potatoes, producing 532,788 bushels, or an average of about 126 bushels per acre. Yields of 225 to 250 and occasionally even 300 bushels per acre have been obtained on sandy loam and light loam soils in favorable seasons. With the use of good seed, the incorporation of organic matter, and frequent shallow and thorough cultivation the average yield for the county could probably be doubled. Fertilizers are sometimes used, especially on the early potato crops. Sulphate of potash is said to give best results. At present many farmers either make heavy applications of well-rotted manure on land intended for potatoes or plant the crop on land that has previously been green manured or otherwise fertilized. Potatoes frequently are harvested in the large fields with diggers, but sometimes a fork is used. Blight and other potato diseases have at times greatly lowered the yields, and unfavorable weather conditions have caused almost complete crop failures in some years.

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<sup>1</sup> See Bul. No. 396, Bureau of Plant Industry, U. S. Dept. of Agr.

Beans have proved a profitable crop ever since they were introduced, about 40 years ago, and the acreage has steadily increased. The census reports 2,308 acres in beans in 1909, producing 29,267 bushels, or an average of  $12\frac{1}{2}$  bushels per acre. Beans are grown for sale in a small way on nearly all the soil types of the county.

Onions are grown commercially in a few patches in different parts of the county. It is reported that this can be made a very profitable crop on well-drained Muck and Peat. Best results with onions are obtained where the soil is fine in texture, well drained, and free from weeds. Applications of well-rotted stable manure are said to give excellent results, especially on old land. Lime should not be used unless the soil is distinctly acid. Muriate of potash, acid phosphate, and bone meal seem to give best results where commercial fertilizers are necessary.

Fruit has never been grown extensively in Calhoun County, although a number of the soils are well suited to the production of fruit, especially apples. Increased interest is being taken in fruit growing; many new orchards are being set out and old ones improved. There are a few small commercial orchards, largely of apples, scattered over the county, the most important being near Marshall, Albion, and Battle Creek. Peaches rank next to apples in importance. In growing peaches it is necessary to select a site with sufficient elevation and slope, and most of the favorable locations are on sandy soils. The climatic conditions are not so favorable for peaches as in the counties bordering Lake Michigan. Most of the apple and peach orchards are poorly cared for, and only a few farmers give them proper cultivation, fertilization, and spraying. Strawberries and raspberries are produced quite extensively on the well-drained sandy soils near Battle Creek and some of the other large towns. Grapes are grown in a small way.

Vegetables are grown on nearly every farm for home use and to some extent for local markets. Truck is grown quite extensively near Battle Creek, Albion, Marshall, and some of the other large towns. A considerable acreage of Muck land is devoted to trucking near Battle Creek. The principal vegetable crops are cucumbers, tomatoes, onions, cabbage, Irish potatoes, lettuce, beans, peas, cauliflower, radishes, beets, and celery.

Stock raising and dairying are becoming increasingly important in Calhoun County. Many silos are being erected. Nearly every farmer keeps a few head of cows and sheep. A large number of hogs are raised each year, and the industry is increasing as a result of the rising prices of pork products and the increased production of corn in the county. Many farmers ship in a few head of young cattle each year for fattening. These are sold to local dealers, who ship them mainly to Chicago and near-by cities. Sheep formerly

were brought into the county in large numbers for feeding the roughage of the farm and for fattening through the winter, but this practice has been discontinued on account of the prevalence of the parasitic nodular disease. Many farmers still keep small flocks of sheep. The animals are mainly of the improved coarse-wool breeds.

Dairy farming is developing into a very important industry. There is a steady local demand for milk, butter, and cream. There are several herds of pure-bred Holsteins, the most popular dairy breed in the county, in addition to a considerable number of Guernseys, and Jerseys. The principal beef breed is the Shorthorn (Durham). Most of the dairy and beef animals are grade Holsteins. The census reports \$1,342,599 worth of animals sold or slaughtered in 1909, and \$528,561 worth of dairy products, \$362,583 worth of poultry and eggs, and \$94,221 worth of wool produced in that year. In 1910 there were 15,877 dairy cows in the county.

Insect pests have done considerable damage to certain crops in past years. The Hessian fly has frequently damaged the wheat crop, and is still a source of some loss each year. It is controlled to some extent by seeding after September 15 or 20. The potato blight has caused considerable loss in some years, and the potato bug frequently gives trouble. Bordeaux mixture is commonly used for controlling the potato blight and many other potato diseases. Hog cholera has been known in the county, but no serious epidemics have occurred in recent years.

Soil adaptation seems to have little influence on the types of farming carried on in different parts of the county. General farming is engaged in on practically all the soils. Most farmers have given considerable study to the adaptation of soils to crops, however, and since nearly every farm comprises more than one soil type, it is often possible to use different parts of the farm for the most suitable crops. The reclaimed swamp and Muck areas are well suited to such staple crops as corn and hay, and these are commonly grown on such lands. Corn, however, is more likely to be injured in these areas by early fall frosts than on the upland. The farmers recognize that well-drained Muck land is admirably suited to peppermint, celery, onions, cabbage, carrots, beets, and other special crops. The light sandy soils are known to be well suited to truck, small fruits, and berries. The heavier soils are best suited to corn. The Miami loam, Fox loam, Bellefontaine loam, and Coloma loam give best results with both corn and wheat. The Homer and Clyde soils give good yields of corn in many cases. Flat areas are often not well adapted to wheat, on account of the excessive moisture content during the winter. Hay crops give the largest yields on the heavier soils, particularly the Miami loam, Bellefontaine loam, Fox loam, Coloma loam, and Homer loam. Even the poorly drained types like the Clyde and Wabash

soils and Muck and Peat are good hay soils where properly handled, yielding from 1 ton to 2½ tons per acre. Clover does best on soils having a high lime content, such as the Miami loam. The Coloma soils lack lime and are not well suited to red clover, but alsike succeeds on them. Alfalfa seems to give best results on well-drained, medium-textured types having rather open and moderately calcareous subsoils.

Beans do best on fairly productive, well-drained soils, such as the Miami, Bellefontaine, Coloma, and Fox loams and sandy loams. Muck and Peat land is not suitable for beans, as the crop tends to produce vines instead of seed. Beans do not thrive on low, wet, poorly drained soils. On heavy soils the underground drainage must be thorough for best results. The light and even fine gravelly soils give very good results with beans if they contain sufficient organic matter.

Improved Muck is considered ideal for the production of onions. This crop has been grown successfully for home use on nearly all the various types of soil in the county, but good Muck land seems to produce onions best and cheapest. The heavy loam and clay loam soils are not suitable for onions. Black, compact Muck extending to a depth of 3 feet or more and underlain by marly clay, clay, or clay loam, is considered the best onion soil. This kind of Muck land supports a growth of black ash, maple, and elm, while the poorer grades of Muck and Peat have a cover of tamarack and huckleberry bushes and other shrubs.

The sandy or sandy loam soils are best used for early market gardening. The productive gravelly sandy loam or sandy loam soils seem best adapted to peaches, but peaches and apples grow on all the well-drained soils. Many of the light-textured, well-drained soils are well suited to small fruits. The lighter soils of the county are much better suited to fruit growing than to the production of staple farm crops.

The farms of Calhoun County are in general well equipped. The best improved farms are on the heavier soils. The machinery on the small farms, containing 40 to 80 acres, usually includes 1-horse and 2-horse cultivators, and plows, mowers, and binders. Most of the better farms of 160 acres or over are also equipped with a disk plow, gasoline engine, hay loader and rake, cream separator, riding plow, spike drag, spring-tooth harrow, and manure spreader. Horses are used for most of the farm work. Many farms use engines for such work as filling silos, pumping water, and running separators. Windmills are often employed for pumping water. The 1910 census reports the average value of all farm property per farm as \$6,831, of which the land represents 56.9 per cent, buildings 26.6 per cent, implements 4.1 per cent, and domestic animals 12.4 per cent.

The methods followed in growing corn vary to some extent in different parts of the county and on different soils. The crop usually is grown on sod land, broken in the spring. Land that has been fall plowed generally is disked and harrowed well before the corn is planted. The available barnyard manure is generally applied, but ordinarily no commercial fertilizer is used. Corn is planted between May 10 and June 10. Most farmers drill the seed, but some plant in hills or use the checkrow method, which has the advantage of permitting cross cultivation.

In growing wheat the usual practice is to plow the oat stubble in August or early September and drill in the wheat before the 15th of September. The seed bed usually is carefully prepared. The earlier and better the seed bed is prepared the later the seeding may safely be delayed. All volunteer wheat should be destroyed in order to destroy breeding places for the early fall brood of Hessian fly. The seed bed should be thoroughly pulverized and compacted, and the wheat sown not earlier than September 15 or 20. In some cases a phosphate fertilizer is drilled in with the seed, at the rate of 150 to 200 pounds per acre. It is reported that this helps to start the plant growth and to fill the heads. Winter wheat does best if there is just enough moisture to germinate the seed and force a strong root growth. An excess of moisture causes "heaving," surface rooting, and inability to withstand cold and drought.

Well-rotted stable manure frequently is applied as a top dressing on land to be used for beans. A potash and phosphate fertilizer is sometimes used. The crop usually is planted in the latter part of May with a grain drill. Planting in rows is said to produce better yields than planting in check rows or hills, but the last method is very common. The rows are spaced 28 to 36 inches apart and the hills placed at intervals of 18 to 20 inches. The best results have followed very shallow but thorough cultivation. The crop is harvested late in August or early in September with a bean puller or cutter, piled in small shocks, and allowed to dry in the field. Continued wet weather at this time is disastrous, as the beans rust and often sprout. The thrashing is done with machines, and the beans are marketed as they come from the thrasher. The cleaning, grading, and picking usually is done at the elevator.

The two principal causes of failure in alfalfa growing<sup>1</sup> are poor seed-bed preparation and failure to inoculate the soil. Among other important causes are the use of acid soils, light, infertile soils, or poorly drained soils, the use of a nurse crop, and, in case of late seedings, winter killing. In seeding alfalfa late spring or early summer is a favorable time on the medium or heavy types of soil, and early or middle spring on the lighter types.

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<sup>1</sup> See Bul. No. 271 Mich. Agr. Expt. Sta. "Alfalfa Growing in Michigan."  
66735°—19—3

The crop rotation commonly practiced throughout the county consists of corn, oats, wheat and grass. The land usually remains in sod one or two years, but in some cases as long as a profitable hay crop can be cut. The general practice is to harvest one crop of clover the first year in sod, one crop of timothy the second year, and then to plow the sod land for corn. Clover and timothy usually are seeded with the wheat. Rye or some other crop occasionally takes the place of wheat and sometimes barley is substituted for oats. Beans and potatoes frequently are introduced into the rotation. Potatoes sometimes follow a hay crop and hay occasionally is followed by wheat, in which case it is seeded with oats.

Comparatively little commercial fertilizer is used in Calhoun County. Only 97 farms reported the use of fertilizer in 1909, with an average expenditure of \$31.79 each. The census reports \$10,740 spent for fertilizer in 1899 and \$19,835 in 1879. Fertilizers have been found beneficial on certain soil types, but results indicate that ordinary brands usually do not produce a sufficient increase in crop yields, especially on the heavier types, to justify their use. The universal opinion is that the soils can best be permanently built up by good agricultural methods. Many of the soils are permanently benefited by the application of burnt lime or ground limestone. The widespread occurrence of sorrel, especially on the light-colored soils of the county, indicates an acid condition and a need of lime. Lime is essential for good results with clover, alfalfa, bluegrass, and many other crops, and the yields of grain and other crops are often greatly increased by its use.

There has been a scarcity of farm labor throughout the county in the last few years, owing to the higher wages and other inducements offered by large manufacturing enterprises. The farm laborers are mainly white and of American birth, but there is a large number of foreign-born laborers in some sections, especially near Battle Creek and the other cities. The ordinary monthly wage for farm hands is \$25 to \$40 with board. Day laborers are paid \$2 to \$2.50 with board during haying and harvest time or whenever extra men are needed. Married men often receive a monthly wage of \$40 to \$50, with the use of a house, a cow, and a garden patch. The census reports \$453,283 paid for farm labor during the year 1909, and the expenditure undoubtedly has increased within recent years. In 1909, 64.7 per cent of all the farms in the county used hired labor, at an average expense of \$186.15 each.

The average size of farms increased from 103 to 109.5 acres between 1880 and 1910. The total number of farms decreased from 3,940 to 3,761 within the same period. The farms vary in size from about 40 to 320 acres or more. A large percentage are near 160 acres in size. Over 75 per cent of the farm land is improved.

Farm land is rented almost entirely on a share basis. Usually the landlord furnishes one-half the seed, and receives one-half the crop. The 1910 census reports 73.4 per cent of the farms operated by the owners, and practically all the remainder by tenants. In 1880 owners operated 88 per cent of the farms.

The average assessed value of farm land in Calhoun County in 1910 was \$35.49 an acre, an increase of 34 per cent over that reported in 1900. Prices of farming land range from \$15 to \$125 or more an acre. As much as \$200 an acre is asked for particularly desirable farms near the larger cities, while an occasional outlying farm in poor condition can be bought for \$30 to \$40 an acre. Probably the greater part of the good farm land ranges from \$60 to \$75 an acre. The well-drained heavy soils sell for \$50 to \$100 or more an acre, the better grades of drained lowland for \$50 to \$75 or more, the lighter soils for \$25 to \$40 or more, and the undrained swamps, Peat bogs, and Muck lands for \$15 to \$30 or more.

#### SOILS.

The soils of Calhoun County have been formed largely from materials accumulated by glacial action modified slightly by erosion and wind action and by the accumulation of partially decayed vegetable matter. The underlying rocks, chiefly sandstone and shale, were covered to varying depths, in many places hundreds of feet, by glacial debris and outcrop in very few places within the county. Most of the glacial drift was derived from igneous and metamorphic rocks such as granite, diorite, diabase, dolomite, gneiss, schist, and quartzite, and has been transported great distances. Part of the material, however, has come from sedimentary rock, such as limestone, sandstone, and shale. Although the underlying rock is sandstone and shale, such material is not abundant in the glacial drift unless it constitutes a considerable part of the silt and clay, the immediate origin of which can not be determined. In a few places the sandstone material is abundant, however; the predominant rock material seen within the upper two or three feet of the soil occurring in fragments large enough for identification is granitic, or at least crystalline. Below that depth limestone fragments constitute from 5 to 50 per cent or more of the identifiable material. In the northeastern part of the county, within the area mapped as Miami, the limestone material is abundant.

The glacial material was deposited in the form of terminal and ground moraines, kames, eskers, and nearly level outwash plains, till plains, gravel plains, and aprons. Areas of Muck and Peat mark the beds of former lakes and ponds.

The drainage conditions attending the melting of the ice and the subsequent presence of lakes and ponds were important factors in

determining the texture of the material that was laid down by the glacial waters. Where the water had free escape from the melting ice and flowed with a strong current the deposited materials were coarse in texture and the resulting soils are loose and either sandy or gravelly. Where the flow was slower the soils are finer textured, being in places quite heavy. There is also more or less intergradation in texture. The characteristics of the different soils depend upon several processes, including deposition under and at the border of the ice sheets, deposition by flowing glacial waters, deposition in glacial lakes and ponds, deposition by streams in first-bottom and terrace positions, and the accumulation of decomposed vegetable matter in depressions.

The soils derived from morainic material are identified as members of the Bellefontaine, Coloma, Miami, and Crosby series. The Clyde soils were developed under poor drainage conditions in basins and swamps, the material consisting of locally redeposited glacial material. The Griffin and Wabash soils consist of alluvium deposited by streams along their courses. The Waukesha, Fox, Plainfield, and Homer series include soils deposited in broad, filled-in valleys or on terraces or outwash plains by glacial streams or lakes.

A study of the soils of the county as a whole shows that their most striking and persistent features are essentially independent of the processes by which the soil materials were accumulated and to a slightly less extent of the petrographic or chemical character of those materials.

These characters persist with striking uniformity over morainic and outwash areas. The color of the soil, the soil profile, and its general chemical characteristics so far as content of organic matter and lime carbonate are concerned are strikingly persistent over the well-drained and much of the larger portion of the whole county.

However much the characteristics of the soil horizon may have varied with the variation in character of material when originally accumulated, such differences have been greatly diminished by the forces of weathering since that time. There has been a progressive unifying process persistently at work and the results are evident. The predominant soil differences at the present time are those of texture and differences in drainage conditions. To these must be added, in weighing the natural conditions which have controlled the course of agricultural development in the county, the wide differences in topography. Pronounced variations in texture are features inherited from the original soil materials but they do not change with the change from morainic to outwash deposits. Morainic materials may be sandy or argillaceous. Outwash materials may likewise be sandy as well as finer in texture, though taking the morainic material as a whole it has two textural characteristics that differentiate it from

the outwash as a whole. The former is somewhat more argillaceous and it is marked by the presence of glacial bowlders often very abundant, while the outwash material is essentially free from them.

Leaving out of consideration the broad textural differences just mentioned, the soils of the county may be grouped broadly under two heads—(1) those developed under conditions of good drainage and (2) those developed under conditions of poor drainage. The latter soils cover a very small part of the county.

The soils of the first group were developed, with the exception of two small areas, under a rather heavy cover of mixed hardwood forest, consisting predominantly of red oak with a relatively scant undergrowth. Their true soil profile, down to a depth to which the forces of weathering have been working for a sufficient length of time and with sufficient vigor to determine the soil character, in this case about 30 inches, consists of an inch or two of dark-colored surface, underlain by a horizon of light-brown material 10 to 16 inches in thickness, usually becoming slightly heavier with depth. This is underlain by and grades into a deeper brown to rusty reddish brown heavier horizon, ranging from a sticky sand in the very lightest soils to a heavy rusty brown clay in the heavier types. This horizon varies in thickness from 3 to 12 inches, varying usually with the texture of the original material, and grades downward into a brown, lighter textured material, which finally passes into the unweathered parent material either of glacial till or of outwash. In the latter case the material consists of gray sand and gravel, and the change from the rusty reddish fourth horizon, described above, is abrupt. In the soils derived from heavy glacial till the development of the various members of this general soil profile below No. 2 is less perfect than in the outwash material. They are also less well developed in the extremely sandy areas of both till and outwash than elsewhere.

That this profile down to the parent rock is a product of weathering, and therefore produced subsequent to the original deposition of the material and independent of the processes of deposition, is shown with striking clearness in many exposures in the outwash plains. The line of separation between the base of horizon 4 and the gray gravel beneath is extremely irregular, narrow tongues of horizon 4 project downward as wedges into the gravel and tongues of gravel extend up into No. 4. The width of this zone will reach a maximum of at least 3 feet, and the number of alternations in a horizontal distance of 10 feet may reach 10 in number. Since such alternations of texture as these could not possibly be produced by deposition and the line of division is discordant entirely with the stratification lines of the gravel, there seems to be no escape from the conclusion that the features above the division line are the product of forces operating since deposition.

While exposures in the glacial till do not show such a sharp line between the weathered zone or true soil, and the parent rock, yet the existence of the same features in the profile from the surface downward, even though the expression is weaker than on the outwash plains, leaves a strong presumption in favor of its development under the influences of forces acting subsequent to the deposition of the glacial till.

The two exceptional areas referred to above consist of dark-colored soils to a depth of about 8 inches from the surface, with a profile below this depth essentially the same as that described above. These soils were developed under grass rather than timber cover and hence the much darker and thicker surface horizon. One area lies a mile southwest of Battle Creek and the other immediately south of Athens.

The soils developed under imperfect drainage conditions have a dark-colored surface horizon varying greatly in thickness passing gradually or abruptly into gray or gray and brown mottled material. The grayness of the material expresses its unoxidized and unaerated or even its deoxidized condition.

There are therefore two broad groups of soils in the county which may be designated as the brown group and the black group, or, better, as the light-colored group and the dark-colored group. They could be designated also as the group developed under good drainage conditions and that developed under poor drainage conditions. The former group includes such a large proportion of the soils of the county that it may be described as an area of light-colored or brownish soils, with well aerated and oxidized subsoils from which the carbonates have been removed to a depth varying from 12 inches to 5 or 6 feet. The parent rock has usually a considerable percentage of lime carbonate in the form of limestone fragments, boulders, and pebbles.

The soils of each of the main soil groups are further subdivided according to the processes by which the soil materials were accumulated, the petrographic character of that material, and the color of the various soil horizons, this being the combined result of drainage conditions and the percentage of organic matter in the soil.

Twenty-three soil types, including Muck and Peat, are mapped in Calhoun County. The types are grouped into series on the basis of similarity in origin, color or range of color of the surface soils, and color and structure of the subsoil.

The series is divided into types on the basis of texture.

The soils of the well-drained, or brown, group have been separated into 17 types belonging to 8 series.

The soils of the Miami series are light grayish brown to gray, with a brownish or yellow shade, and are underlain by yellowish-brown, heavier textured subsoils. The subsoils may be slightly gray

and streaked or specked with iron stains. The lower subsoil and the substratum are calcareous, the latter consisting of till which is only slightly weathered. These are upland soils occupying gently undulating to hilly areas. The surface drainage usually is good, but the heavier types can be improved by artificial drainage.

The Crosby series is characterized by light-gray to light brownish gray surface soils, a light-grayish, mottled to ashy-gray subsurface layer, and a mottled yellowish-brown and gray, tough subsoil which becomes friable and calcareous at a depth of 2 to 2½ feet. The Crosby soils are flat to gently undulating, and have rather poor natural drainage.

The soils of the Bellefontaine series are light brown to brown or reddish brown, and underlain by brown to reddish-brown subsoils. The subsoils of the finer textured types are heavier and more compact than the surface soils, ranging from a sandy clay loam to a compact clay, and usually extend to a depth of 2½ to 3 feet. The substratum is a lighter colored, coarser, calcareous material. The topography is rolling to rough and hilly, representing terminal and ground moraines. The Bellefontaine soils have been formed largely through the weathering of glacial drift containing a relatively large proportion of limestone material.

The soils of the Coloma series are light brown to brownish gray, with yellow or yellowish-brown subsoils, little if any heavier than the soils, and noncalcareous to a depth of 3 feet or more. These soils are undulating to rolling in topography and have good to rather excessive drainage.

The Waukesha series includes types characterized by dark-brown surface soils and yellowish-brown subsoils, resting upon beds of calcareous gravel and sand at shallow depths. The dark color is the result of development under prairie conditions. The Waukesha soils typically are more productive than the Plainfield and Fox soils, on account of their higher content of organic matter and their greater power to hold moisture.

The soils of the Fox series are grayish brown to brown, with yellowish-brown to reddish-brown, heavier and more compact subsoils. The underlying stratified beds of gravel and sands carry a high percentage of limestone material. The topography is level to gently undulating or gently rolling, and natural drainage is good.

The surface soils of the Plainfield series are brownish gray to light grayish brown. The subsoils are yellow to yellowish brown, and have the same texture as or are lighter than the soils. The Plainfield types differ from the Fox mainly in having light subsoils and in the absence of any appreciable quantity of calcareous material in the substrata, which are gravelly and sandy. The surface is level

to gently undulating and the drainage is good to excessive in the lightest, sandy members.

The surface soils of the Homer series are light gray or ashy gray, and in forested areas mottled with brown and yellow. The subsoils are light gray, mottled with yellow, brown, and rusty colors. The deposits giving rise to these soils are thick, and in the case of lake and stream terraces there has been some deposition and reworking since glacial times. The topography is flat, and the drainage is poor.

The soils belonging to the dark-colored or poorly drained group include the Clyde, Griffin, and Wabash series and Muck and Peat.

The Clyde series is characterized by very dark brown to black surface soils, and gray, drab, or mottled gray and yellowish subsoils. The dark color of the surface soils is due to the high percentage of organic matter resulting from the decay of plants under swamp conditions. These soils are derived from calcareous glacial material in areas where poor drainage has prevailed for long periods. The Clyde soils grade into Muck and Peat on the one hand and into such glacial soils as the Homer on the other, without very sharp boundaries. The topography is flat, and the soils are naturally poorly drained.

The Griffin series consists of brown to dark-brown soils, with brown to mottled gray and rusty-brown subsoils. These soils are composed of recent alluvial sediments and are subject to overflow.

The Wabash series is characterized by dark-brown to black soils, high in organic matter content, underlain by drab or gray to dark-gray subsoils. These soils are of alluvial origin and subject to frequent overflows. They are characteristically poorly drained. The soil-forming material is derived from the glacial uplands.

In following pages of this report the individual soils of Calhoun County are described in detail, and their relation to agriculture discussed. The following table gives the name and the actual and relative extent of the several types:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Coloma loam.....	73,600	16.6	Coloma loamy sand.....	12,352	2.8
Fox loam.....	67,520	15.2	Wabash loam.....	11,712	2.6
Muck and Peat.....	55,616	12.5	Plainfield fine sandy loam.....	8,064	1.8
Bellefontaine loam.....	50,048	11.3	Coloma fine sandy loam.....	4,736	1.1
Plainfield sandy loam.....	27,968	6.3	Fox fine sandy loam.....	2,752	.6
Fox sandy loam.....	22,720	5.1	Waukesha loam.....	2,112	.5
Bellefontaine sandy loam.....	21,184	4.8	Coloma fine sand.....	2,048	.5
Miami loam.....	18,112	4.1	Wabash clay loam.....	1,920	.4
Clyde loam.....	14,528	3.3	Crosby loam.....	1,792	.4
Clyde clay loam.....	14,528	3.3	Homer clay loam.....	1,472	.3
Homer loam.....	14,336	3.2	Griffin loam.....	704	.2
Bellefontaine fine sandy loam.....	13,696	3.1			
			Total.....	443,520	.....

## MIAMI LOAM.

The Miami loam to a depth of 6 to 8 inches consists of a light grayish brown to gray friable loam, underlain by a light-brown or grayish-brown loam which becomes heavier with depth and grades at 12 to 16 inches into a dull-brownish tough clay loam or silty clay, usually streaked with gray and other shades of brown. The soil on slight elevations when dry has an ashy-gray appearance and in depressions where more organic matter is present a darker color. Fields thus have a patchy appearance. Below a depth of 18 to 24 inches the subsoil is slightly to moderately calcareous, except in some of the lighter-textured areas, where nearly all the lime to a depth of 4 or 5 feet has been leached out. The substratum usually is gray. Limestone fragments occur in the lower depths. The heavy, compact subsoil may extend to a depth of 5 to 15 feet or more, except in some areas near the zone of contact with other soils. Stones, gravel, and occasional large bowlders of various crystalline rocks occur on the surface and throughout the soil section, but not in sufficient quantity to interfere seriously with cultivation. Many of the larger stones have been removed. The type in many places contains considerable very fine sand, and in some included patches it has a silt loam or clay loam texture. It is locally known as "clay land."

The Miami loam occurs only in the northeastern part of the county, where it occupies gently undulating to rolling uplands. Natural drainage is good over most of the type, considering the heavy nature of the subsoil, but some areas could be improved by artificial drainage, particularly for the growing of such crops as alfalfa.

This is one of the best soils in the county for general farming and dairying, and it is adapted to a wide range of crops. It produces good yields of all the staple crops and many special crops commonly grown in this part of the State. The type originally supported a heavy growth of forest trees, including several species of oak, hickory, several varieties of maple, ash, rock elm, some beech, and black and white walnut. The greater part of it is under cultivation, corn, wheat, oats, and hay being the chief crops. Buckwheat, rye, and barley are grown to some extent, but the soil is considered more valuable for the crops first mentioned. The yield of corn ranges from 30 to 75 bushels per acre, the ordinary yield being between 30 and 40 bushels. As much as 100 bushels per acre has been produced under favorable conditions. Wheat yields 12 to 40 bushels per acre, with an average of about 22 bushels. Oats yield 35 to 75 bushels, averaging about 45 bushels. Potatoes yield from 75 to 250 bushels per acre. The principal hay crop is red clover and timothy mixed. The yield ranges from 1½ to 4 tons per acre, averaging about 2 tons. Bluegrass thrives on this soil and affords good pasturage. Alfalfa

has been grown in an experimental way and yields as high as  $4\frac{1}{2}$  to 5 tons per acre are reported, but much of the type will require artificial drainage and other treatment before the crop can be successfully grown on a large scale. Apples, grapes, strawberries, raspberries, and many other fruits and berries are grown, as well as a wide variety of vegetables. Sugar beets of good quality have been grown on this soil in Genesee County.

The Miami loam retains its natural productiveness under proper cultural methods and readily responds to good treatment. Most of the farmers practice the crop rotation common to this section of the State. The soil is easy to maintain in good tilth when plowed and cultivated under proper moisture conditions, but if plowed when too wet it forms clods which are difficult to pulverize. Very little commercial fertilizer is used, but barnyard manure is often applied. A crop of clover occasionally is turned under.

The agricultural conditions over this type are particularly good. Farms range in price from \$60 to over \$100 an acre.

This soil is in need of organic matter, and where there is not a sufficient supply of stable manure green manure should be used to a greater extent. Deeper plowing would probably prove beneficial in favorable years and fall plowing would give good results in many cases. Tile drainage would be advisable where alfalfa is to be grown, and artificial drainage of some sort would doubtless prove beneficial for other crops in the flatter areas. The subsoil and substratum are well supplied with lime, but the surface soil is sometimes deficient in this material. The use of heavier horses and heavier machinery is needed. The universal opinion is that this soil can be kept in a productive condition without the use of commercial fertilizers.

#### CROSBY LOAM.

The Crosby loam to a depth of 8 to 15 inches is a gray to grayish-brown loam, often mottled with yellow and brown. In some places the soil is nearly white and chalky. The subsoil is a gray or grayish-brown loam to clay loam, mottled with yellow and rusty brown. Particles of iron oxide occur in the subsoil and occasionally in the surface soil. Both soil and subsoil may contain more or less fine sand and gravel, and a few boulders occur on the surface and embedded in the soil in places. The lower subsoil in places contains enough lime to effervesce slightly with hydrochloric acid.

The Crosby loam is widely distributed throughout the southern half of the county. It usually occurs in narrow strips along the contact of the upland with the lowland. Many such areas are too small to be shown on a map of the scale used in this survey. The largest area lies 2 miles south of Burlington. The surface is nearly

level to very gently rolling. Drainage usually is satisfactory under normal seasonal conditions, but much of the type would be benefited by tile drainage, especially in wet years.

Most of this type is under cultivation, but it is not important agriculturally, owing to its small extent. The chief crops grown are corn, oats, and wheat. These produce fair yields in favorable seasons. Corn yields 25 to 55 bushels per acre, averaging about 35 bushels; oats 25 to 50 bushels; wheat 12 to 25 bushels, with an average between 15 and 18 bushels; and hay an average of about 1½ tons per acre. Buckwheat frequently is sown where the soil is too wet for other crops, or where corn has failed, and the yields are fairly high. Areas too wet for safe cultivation are pastured. Little or no commercial fertilizer is used, but lime and barnyard manure frequently are applied. This land is valued at \$55 to \$75 an acre.

Much of this type is in need of tile drainage, especially the flatter areas, as crop failures often occur in excessively rainy years. Liming has proved beneficial, especially where a leguminous crop was grown.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Crosby loam:

*Mechanical analyses of Crosby loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
301105.....	Soil.....	1.9	7.7	7.1	23.6	10.1	35.7	13.7
301106.....	Subsoil.....	1.8	6.4	6.7	29.6	12.7	27.3	15.8

BELLEFONTAINE SANDY LOAM.

The Bellefontaine sandy loam, to a depth of 6 to 10 inches, is a brown to grayish-brown sandy loam. The subsoil, to a depth of 30 to 36 inches or more, consists of brown to reddish-brown sandy loam, some strata, between 20 and 30 inches, containing sufficient clay to have a sandy clay texture, and to be quite sticky when wet. The proportion of clay throughout the subsoil is large enough to cause the soil to stand up well in cuts and to influence its agricultural value. Gravel in varying quantities and sizes occurs in both the soil and subsoil, and there is a scattering of gravel and large stones on the surface. In a few places these are so abundant as to interfere with cultivation. The type at a depth of 4 to 6 feet is underlain by gray sand and gravel, frequently stratified, and occasionally showing a strong alkaline reaction. In some included areas the subsoil is a loamy sand instead of a sandy loam. As a rule this is an easy soil to cultivate.

Where the fine material predominates it clods to a slight degree, but the clods are readily pulverized.

The Bellefontaine sandy loam occurs mainly in irregular areas scattered throughout the western and central parts of the county. It is typically developed in the northwestern part, where it occupies continuous areas several square miles in extent. Some areas are too small to represent on the map. This soil grades into the Bellefontaine loamy sand, and in some places it is difficult to separate it from that type. It is a gradational soil between the Bellefontaine loam and loamy sand, and is, therefore, subject to considerable variation.

The surface of the Bellefontaine sandy loam ranges from rolling to rough and hilly, being characteristic of terminal moraine deposition. Because of the surface relief and the gravelly and sandy nature of the subsoil the drainage tends to be excessive, and crops frequently suffer during ordinary periods of drought.

This is not an important agricultural type. It is adapted to special crops rather than to general farming, but fair yields of some of the staple crops frequently are obtained in favorable years with the best management. Over 70 per cent of the type is cleared and under cultivation. The tree growth consists chiefly of several varieties of oak, with some hickory, elm, beech, walnut, and hard maple, and scattered softwoods. The type is fairly well suited to rye and Irish potatoes, but it does not give good results with corn and wheat. Several varieties of grasses do fairly well, but the yields of hay are generally light. Vegetables give fair results under proper cultural methods. Apples, grapes, and many other fruits are well suited to this soil, but peaches do not thrive, on account of climatic conditions. Truck crops, strawberries, raspberries, and other berries and small fruits are successfully grown on this soil near Battle Creek. The condition of the apple orchards indicates that more of the type could profitably be devoted to winter apples if market conditions were satisfactory.

Crop yields in general are intermediate between those obtained on the Bellefontaine fine sandy loam and those on the Coloma loamy sand. Corn yields 12 to 25 bushels, averaging between 15 and 20 bushels, but occasionally reaching 35 bushels per acre; oats, 20 to 45 bushels, averaging about 25 bushels; rye, 10 to 25 bushels; wheat, 8 to 20 bushels, with an average of probably less than 12 bushels; beans, 8 to 15 bushels; and hay three-fourths to 1½ tons. Potatoes yield 75 to over 125 bushels per acre in good seasons. Alsike and June grass succeed, but red clover does not thrive. Alfalfa is grown in a few experimental patches. The gravelly and sandy clay nature of the subsoil insures good drainage and favors proper root development, and yields range as high as 5 tons per acre for the season.

This soil is handled in about the same way as the other light upland types. Some farmers cultivate thoroughly in dry seasons, in order to conserve the moisture supply. The soil is kept in good tilth with a moderate expenditure of labor, and in only a few places does it contain sufficient clay to clod when plowed in a wet condition.

Some commercial fertilizer is used on this type. A fertilizer containing phosphate of lime is said to be beneficial. A bone preparation is sometimes used. Good results have followed the use of lime, and liming has been found essential for the successful growing of alfalfa and clovers. All the manure is saved and applied to the land, and green-manure crops, such as clover, are used by many farmers.

Farm land on the Bellefontaine sandy loam is valued at \$35 to \$60 an acre, depending largely on the location and improvements.

Agricultural conditions on this type are only fair. The soil shows the effects of overcropping, and is in need of organic matter. Systematic crop rotations, including legume crops, and a careful selection of crops adapted to the soil are beneficial. The rougher areas are better adapted to forestry and pasture than to crop production.

#### BELLEFONTAINE FINE SANDY LOAM.

The surface soil of the Bellefontaine fine sandy loam consists of a light-brown to brownish-gray fine sandy loam to sandy loam, 8 to 15 inches deep, usually carrying a small proportion of fine gravel and having a scattering of stones and bowlders on the surface. The subsoil is brown to reddish brown and ranges from a compact loam to a sandy clay loam. It contains some fine gravel and in places a considerable percentage of fine to medium sand. Where the soil is of medium texture, as is often the case, it is comparatively loose and mellow, but where the texture is fine the surface material is often compact, giving the soil the appearance of being much heavier than it really is. The subsoil at 20 to 30 inches grades into lighter material, and at a depth of 4 to 6 feet this passes into a bed of grayish gravel and sand which often shows some stratification. The soil clods if plowed in a wet condition, but ordinarily it works into a good tilth.

A variation of the type, practically free from gravel and stone occurs in section 19, Battle Creek Township; sections 14 and 23, Leroy Township; and in sections 5, 6, 7, 8, 15, and 22, Athens Township. In these areas the soil is a smooth, fine to very fine sandy loam, 6 to 8 inches deep, underlain by a yellowish-brown to slightly reddish brown fine to very fine sandy loam which at 20 to 24 inches gives way to a reddish-brown, compact clay loam.

The Bellefontaine fine sandy loam is distributed throughout the northeastern and southwestern parts of the county. Its surface varies from rolling to hilly, and the run-off is thorough. The light

character of the subsoil insures good to excessive underdrainage, and in dry seasons crops sometimes suffer from drought.

This is the most extensive and most important upland soil of medium texture in the county, and the greater part of it is cleared and under cultivation. The forest growth consists chiefly of maple, oak, hickory, elm, beech, ash, walnut, and scattered softwoods. General farm crops give fairly good yields. Apples, grapes, strawberries, raspberries, and other orchard fruits and berries give good results under favorable conditions. The soil is fairly well adapted to peaches, but the climatic conditions are not so favorable as in the counties nearer Lake Michigan.

Corn ordinarily yields 20 to 50 bushels per acre, with an average of about 25 bushels; wheat 10 to 25 bushels per acre, averaging about 15 bushels; oats 25 to 70 bushels; hay 1 to 2 tons; rye 10 to 25 bushels; and beans 8 to 18 bushels. Potatoes average over 100 bushels per acre under favorable conditions, and yields of 250 bushels have been obtained on land heavily manured and otherwise properly handled. Alfalfa is grown in a small way by a few farmers, and is reported to yield 3 to 5 tons per acre per season.

Less cultivation is required on this type than on the heavier soils. Very little commercial fertilizer is used, but all the stable manure produced is applied to the fields, and on some farms a green crop is occasionally turned under.

Land of this type of soil is valued at \$50 to \$100 an acre, depending upon the nearness to towns and railroads, and the state of improvement.

The Bellefontaine fine sandy loam in many places shows the effects of overcropping, especially to wheat and other cereals. Much of the type is deficient in organic matter and in need of lime. It is difficult to obtain a good stand of red clover, alfalfa, and certain other leguminous crops without liming.

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

*Mechanical analyses of Bellefontaine fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
301109.....	Soil.....	1.4	11.3	13.9	39.7	6.5	20.8	6.1
301110.....	Subsoil.....	2.1	9.1	11.2	38.3	8.9	16.6	13.7

BELLEFONTAINE LOAM.

The surface soil of the Bellefontaine loam is a brown to grayish-brown, mellow loam, 8 to 10 inches deep, containing more or less fine to coarse sand. The soil in depressions may be quite dark brown

in color and often a silt loam in texture, but such areas are not large enough to be mapped satisfactorily. The subsoil is a brown to reddish-brown silty clay, sandy clay, or clay. It is rather compact and contains more or less gravel. In some places sandy material occurs in the lower part of the 3-foot section, but usually the heavy subsoil extends to a depth of 3 feet. The substratum is sandy and gravelly, gray in color, and moderately to highly calcareous. It may show cross-bedding or other forms of stratification. Large and small stones occur on the surface and in the soil mass. In many cases these stones, where they interfere with cultivation, are removed from the fields.

The Bellefontaine loam is widely distributed through the northern and western parts of the county. In the eastern part its relative position is occupied chiefly by soils of the Coloma and Miami series. The type often occurs in areas several thousand acres in extent. It occupies terminal and ground moraines and the surface is undulating to hilly. The slopes, however, are seldom so steep that ordinary farm machinery can not be used. The surface relief insures good run-off and most of the type has good underdrainage. Many included depressions an acre or two in extent have insufficient drainage outlets. Where such areas are large enough they are mapped as a separate type.

The Bellefontaine loam is the most extensive type of the series, and it dominates the agriculture of a large part of the county. It is the fourth most extensive type mapped, and nearly all of it is under cultivation. The heavy native hardwood forest consisted principally of oak, hickory, maple, beech, walnut, and rock elm.

This is one of the strongest soils in Calhoun County for general farming. It is well suited for grains and grasses. Beans and Irish potatoes are grown on a considerable acreage. Apples, cherries, and other orchard fruits succeed. Bush fruits and berries thrive. The soil is well adapted to wheat, which yields 12 to 40 bushels per acre, averaging about 22 bushels under favorable conditions. Corn yields range from 25 to as much as 100 bushels per acre in very favorable seasons; the average is about 37 bushels. The yield of oats ranges from 30 to 70 bushels per acre, with an average of about 35 bushels. As much as 100 bushels per acre have been reported. Barley yields 20 to 70 bushels per acre, beans 10 to 30 bushels, rye 18 to 20 bushels, and potatoes 75 to 275 bushels. The yield of hay ranges from  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons per acre, the average being about  $1\frac{3}{4}$  tons. The hay consists of timothy and red clover mixed. Some difficulty is experienced in getting a stand of red clover, but alsike does fairly well. Alfalfa is grown in a few scattered patches. Yields have ranged as high as 4 to 5 tons per acre per season. June grass and bluegrass are grown to some extent.

A rotation is followed by most farmers on this soil, the land remaining in sod for one or more years. Some farmers turn under a crop of clover for green manure. Good stands of alfalfa can be obtained only where the soil is properly prepared, inoculated, and limed. Very little commercial fertilizer is used, but all the available barnyard manure is applied to the soil. The land responds well to such applications. Lime is used to some extent, especially in seeding to alfalfa. Liming is said to increase the yields of most other crops. Potatoes are sometimes affected by blight and potato bugs. Wheat is often injured by the Hessian fly, and many farmers plant the crop late, so that the damage by the fly may be curtailed by frost and cold.

Land of this type is held at prices ranging from \$50 to \$100 or more an acre, depending upon the improvements, location, and present condition of the soil.

The Bellefontaine loam responds readily to good cultural methods, and seems to maintain its natural productiveness indefinitely under good treatment. A rotation which includes use of the land as pasture gives good results. Liming and the keeping of live stock are beneficial. Much of the type is deficient in organic matter. A marked increase in crop yields has followed thorough pulverization of the soil and the plowing under of green crops, such as the clovers.

In the following table the results of mechanical analyses of samples of the soil and subsoil of the Bellefontaine loam are given:

*Mechanical analyses of Bellefontaine loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
301107.....	Soil.....	1.2	5.5	6.2	19.9	10.5	46.0	10.7
301108.....	Subsoil.....	1.1	4.0	4.7	17.9	11.0	37.4	23.7

COLOMA FINE SAND.

The Coloma fine sand consists of a light-brown to grayish-brown fine sand to loamy fine sand, 6 to 10 inches deep, underlain by a yellow to reddish-brown fine sand to loamy fine sand which is loose and open in structure, and extends to a depth of 3 feet or more. The type is characterized by the almost complete absence of boulders and gravel.

Soil of this type occurs only in the western part of the county, and is mapped in a few scattered areas which vary in size from a few acres to 1,000 acres or more. The largest areas occur near Penfield, and in the west-central part of Emmet Township. A small area is mapped in the central part of Athens Township.

This type has a rolling surface, with rounded hills and undulating areas, and is so thoroughly drained that crops suffer in dry seasons. It is subject to wind erosion.

The Coloma fine sand is unimportant, but most of it is cleared and farmed. The native tree growth is about the same as on the other sandy upland soils. The type is best adapted to forestry, stock raising, and the growing of special crops, such as vegetables, small fruits, and berries. It differs from the Coloma loamy sand mainly in the finer texture of the sand constituents and in freedom from stone and gravel. In point of crops grown, yields, land values, and farming methods it is similar to the sand type.

#### COLOMA LOAMY SAND.

The surface soil of the Coloma loamy sand, extending to a depth of 7 to 10 inches, consists of a yellowish-brown to grayish-brown loamy fine sand to loamy sand, containing varying, though usually small quantities of fine gravel. The subsoil to a depth of 36 inches or more consists of a yellowish-brown or brown to reddish-brown, loamy, medium-textured sand to coarse sand, usually containing more or less gravel. Gravel and occasional boulders are scattered over the surface. In a few places there is sufficient clay in the lower subsoil to make the sand slightly sticky, and here the type resembles the Bellefontaine sandy loam. In some places the type is free from gravel. The substratum consists of cross-bedded gray sands and gravels. The organic-matter content usually is small.

The Coloma loamy sand is not very extensive, but it is fairly well distributed, usually in small areas, over a considerable part of the county. The largest areas occur in Bedford, Penfield, and Convis Townships. The surface varies from rolling to steeply rolling and rough, as in the northwestern part of the county. Drainage is good to excessive, and crops suffer considerably during long dry periods.

This is not an important type in the general agriculture of the county. It is best adapted for use as forest and pasture land. It is better suited to the growing of special crops, such as small fruits and vegetables than to the general farm crops. Between 60 and 75 per cent of it is cleared and under some form of cultivation. It was originally covered with forest, consisting chiefly of several species of oak, with a scattering of other hardwoods and softwoods. Where the land is not farmed a second growth of timber, largely oak, has sprung up.

Corn, oats, hay, and some wheat and rye are grown. The yields vary greatly, depending upon the topography and the season. In moist seasons and in favorably situated areas many of the earlier fruits and vegetables give good results. Corn yields 12 to 20 or even 30 bushels per acre, oats 15 to 35 bushels, rye 10 to 20 bushels,

hay three-fourths ton to 1½ tons, beans 8 to 15 bushels, and potatoes 50 to 100 bushels or more. There are a few experimental patches of alfalfa on this soil. Clover succeeds where the soil is well supplied with lime. The farming methods are practically the same as on the Bellefontaine sandy loam. Areas near markets have been profitably devoted to the growing of light truck crops, berries, and other small fruits. Some commercial fertilizer is used, and all available barnyard manure is applied. Applications of lime have proved beneficial.

Land of this type sells for \$25 to \$50 or more an acre, depending upon the improvements, the present condition of the land, and the nearness to Battle Creek and other large cities.

A considerable part of this type is well suited to the production of certain special crops. The rough and hilly areas suffer from erosion where cleared and are best suited to stock raising and forestry. The type requires the same methods of improvement as the Bellefontaine sandy loam. The Coloma loamy sand, however, requires more care to control leaching.

The results of mechanical analyses of samples of the soil and subsoil are given in the following table:

*Mechanical analyses of Coloma loamy sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
301115.....	Soil.....	7.0	19.2	20.6	37.0	2.5	9.9	3.6
301116.....	Subsoil.....	5.9	22.2	22.9	36.9	2.1	6.4	3.8

COLOMA FINE SANDY LOAM.

The Coloma fine sandy loam consists of a grayish-brown to gray fine sandy loam, 6 to 12 inches deep, underlain by a yellowish-brown, slightly compact fine sandy loam to loam. Yellowish sandy material usually is encountered at about 30 inches, and at 5 to 10 feet a bed of gravel and sand, gray in color and usually somewhat calcareous, occurs in places overlying a sandstone formation. On the surface and throughout the soil there occur varying quantities of gravel and a few large stones, but these are not sufficiently abundant to interfere seriously with cultivation. Some areas approach the Bellefontaine fine sandy loam in texture and color. When dry and compact the soil is rather difficult to break, but the clods pulverize readily when rolled and harrowed.

The Coloma fine sandy loam is of small extent. It occurs in the eastern and southern parts of the county, in association with the Coloma loam. The largest and most typical areas lie north of Albion. The undulating to hilly surface and the open structure of the subsoil insure thorough drainage. Crops often suffer from drought.

This is not an important type in the agriculture of the county, but nearly all of it is under cultivation. The native forest growth is chiefly oak, hard and soft maple, hickory, and elm. The type is farmed to the same crops as the Bellefontaine fine sandy loam, and the same crop rotations and farming methods are followed. Practically the same yields are obtained.

This land has a selling value of \$40 to \$65 an acre, depending on the improvements and nearness to markets. When sold in connection with other soils it brings as much as \$75 to \$100 an acre.

#### COLOMA LOAM.

The Coloma loam, to a depth of 8 to 12 inches, consists of a yellowish-brown or grayish-brown to gray light-textured loam. The subsoil to a depth of 18 to 20 inches is a yellowish-brown or grayish-brown loam to light fine sandy clay loam, below which depth it grades into pale-yellow or yellowish fine sandy loam or sandy loam, often mottled with iron stains in the lower part of the 3-foot section. The soil and subsoil contain varying quantities of gravel and angular sandstone fragments, and sometimes rests upon sandstone rock at a depth of 3 or 4 feet, and the entire type is doubtless underlain by a sandstone at some depth. The substratum consists of gray, moderately calcareous gravel and sand.

The Coloma loam, as mapped, includes some areas which have a brown to reddish-brown clay loam to sandy clay subsoil. Were such areas large enough to warrant separation they would be mapped with the Bellefontaine series.

The Coloma loam does not contain sufficient clay to cause it to clod badly unless worked when very wet. If properly handled it breaks up into a friable condition.

This is the most extensive type in Calhoun County, covering one-sixth of its area. It occurs principally in the eastern and southeastern parts, where it occupies areas varying in size from a few acres to nearly an entire township.

This type is derived from glacial drift deposited in the form of moraines, and it has the typical rolling to hilly surface of such deposits. The slopes are smooth and seldom steep enough to interfere seriously with the use of farm machinery. The natural drainage is good, owing to the open character of the subsoil and substratum and the surface relief. Kettleholes occur throughout the type, and these have no surface outlet, but the water is carried off through the soil, and crops suffer but little from excess moisture. The larger depressions frequently are occupied by a different soil, but all such areas of sufficient size are mapped as a separate type.

On account of its large extent this is the dominant agricultural type of Calhoun County. It originally supported thick forests of

nearly all the trees native to the upland, including several species of oak, hickory, elm, ash, sugar maple, walnut, beech, and some softwoods. Probably over 75 per cent of it is cleared and either under cultivation or used for pasture.

This soil has a considerable range in adaptation, being used for all the staple and some of the special crops common to this section. It is not so productive as the Miami loam, and on the whole is considered less productive than the Bellefontaine loam, but some areas are equally as desirable as the best areas of the Bellefontaine soil. Corn ordinarily yields 25 to 50 bushels per acre, and in favorable seasons 75 to 100 bushels have been obtained on heavily manured and limed land; wheat yields 12 to 35 bushels per acre, averaging about 17 bushels; oats 30 to 60 bushels, with an average of about 35 bushels; barley 20 to 40 bushels, and as much as 70 bushels under favorable conditions; beans 10 to 30 bushels, with an average of about 15 bushels; rye 18 to 20 bushels; and hay  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons, averaging about 2 tons. Potatoes range from 75 to over 275 bushels per acre, the yields being greatly affected by weather conditions and the damage suffered from potato bugs and blight. On properly prepared land, potatoes have produced an average of 225 bushels per acre. Alfalfa is successfully grown where the soil has been limed and otherwise properly handled, and yields of 4 to 5 tons per acre per season are not unusual. Difficulty is sometimes experienced in obtaining stands of red clover. Alsike, which is not exacting, does fairly well, but is not grown extensively. There are some well-kept and productive apple orchards on this soil.

Land of the Coloma loam type, without improvements such as houses and barns, is held at \$40 to \$55 an acre. Improved land has sold for \$60 to over \$100 an acre.

The Coloma loam is fairly productive, and it requires only proper cultural methods to maintain it in that condition. Liming has proved beneficial, and is especially necessary in growing such crops as alfalfa and red clover. Continuous cropping has impaired much of the type.

Areas where the sandy, lower subsoil material approaches the surface require special treatment. Increased crop yields have invariably followed the turning under of a green-manure crop, such as clover, and the application of lime or barnyard manure. A crop rotation in which pasture has a place gives good results. The development of apple orcharding apparently would be profitable.

#### WAUKESHA LOAM.

The Waukesha loam consists of a dark-brown to black loam, 10 to 20 inches deep, underlain by brown or yellow material which ranges in texture of fine earth from a sandy loam to a sandy clay loam.

Gravel usually is present in the subsoil. Some areas have a clay loam subsoil to a depth of about 30 inches, below which stratified beds of sand and gravel occur. In dry seasons the subsoil assumes a condition described locally as hardpan.

The Waukesha loam is of small extent. The principal areas occur on Goguac Prairie near Battle Creek, and at Athens, in the southwestern corner of the county. The type occupies flat to slightly undulating, plainlike areas. These formerly were known as prairie, but supported originally a scattering of bur oak. Drainage in most places is thorough on account of the underlying sand and gravel, and in a few places it is excessive. In some cases, however, the drainage is slow.

All the Waukesha loam is under cultivation or used as pasture. The type is devoted to general and dairy farming. The chief crops are corn, oats, hay, and wheat. Corn yields 40 to 75 bushels per acre, oats 40 to 65 bushels, wheat 12 to 30 bushels, and mixed hay 1½ to 2 tons. Potatoes are grown in a small way, and large yields have been obtained on heavily manured fields. Alfalfa is grown experimentally with varying results. Where the sand and gravel occur near the surface the type is less productive than in areas of heavier subsoil. Very little commercial fertilizer is used on this soil, but all the stable manure available is applied. Liming has increased yields of the staple crops and has proved essential for the successful growing of alfalfa and clover.

Land of the Waukesha loam ranges in price from \$75 to over \$200 an acre, depending upon the improvements and nearness to towns. Most of the type is near cities.

The prevailing system of crop rotation is practiced on this soil. Fall plowing is considered beneficial. Some farmers have produced a fair yield of certain crops, including corn, in dry seasons simply by thorough cultivation. Clover and other green-manuring crops invariably increase yields. Winter wheat is sometimes damaged by freezing and thawing.

The following table gives the results of mechanical analyses of the soil and subsoil of the Waukesha loam:

*Mechanical analyses of Waukesha loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
301103.....	Soil, 0 to 15 inches.....	<i>Per cent.</i> 0.9	<i>Per cent.</i> 8.3	<i>Per cent.</i> 10.2	<i>Per cent.</i> 25.6	<i>Per cent.</i> 7.3	<i>Per cent.</i> 29.2	<i>Per cent.</i> 18.3
301104.....	Subsoil, 15 to 36 inches.....	2.0	8.3	11.0	32.9	10.3	21.7	13.7

## FOX SANDY LOAM.

The Fox sandy loam to a depth varying from 8 to 16 inches consists of a grayish-brown to brown sandy loam or loamy sand. There is some admixture of gravel in places, and occasionally a few cobblestones occur on the surface and in the soil mass. The subsoil is a yellowish-brown or brown to reddish-brown, moderately compact sandy loam to heavy loam, grading into coarser material at 24 to 30 inches. It also contains varying quantities of gravel, and gray, calcareous sand and gravel beds are encountered at depths of  $\frac{1}{2}$  to 6 feet. In some areas the heavy upper layer of the subsoil has a sandy clay loam texture. Occasionally the surface soil is compact and approaches a light loam in texture. The soil is friable and easily maintained in good tilth under a wide range of moisture conditions.

The Fox sandy loam is not extensive. It occurs on outwash plains, in old stream valleys of glacial origin, and on stream and lake terraces. The areas range in size from a few acres to 500 acres or more. The surface in general is flat to gently undulating, and often broken and hilly near streams. Kettleholes occur throughout the type, but the underdrainage in such depressions usually is sufficient to carry off all surplus water. The type in general is well drained. It is not eroded to any appreciable extent.

The Fox sandy loam originally supported a tree growth similar to that on the Fox loam. Practically all the type is now under cultivation. It is a fairly good agricultural soil, but is not quite so valuable as the loam. The staple crops are grown successfully, including Irish potatoes, beans, small grains, and hay crops such as timothy, clover, and alfalfa. The acreage in alfalfa is not large, but sufficient to indicate the possibility of successful production. The crop has yielded as much as 4 to 5 tons per acre per season. The Fox sandy loam is well suited to truck gardening, and a part of it is devoted to garden crops, strawberries, and bush fruits. It is a good Irish-potato soil, the yield ranging from 100 to 200 bushels per acre and occasionally reaching 250 bushels on manured land. Corn yields from 20 to 60 bushels per acre, with an average of about 38 bushels; oats 30 to 50 bushels, averaging about 35 bushels; wheat 12 to 20 bushels; rye 10 to 20 bushels; beans 10 to 15 bushels; and mixed hay (timothy and clover) 1 ton to  $2\frac{1}{4}$  tons, with an average of  $1\frac{1}{2}$  tons.

Practically the same cultural methods are employed as on the Fox loam, but less labor is required to produce a mellow seed bed. Some commercial fertilizer, ordinarily of low grade, is used. Liming is becoming more popular. All available stable manure is applied, but the quantity is generally insufficient to keep up the supply of organic matter in the soil.

This land is valued at \$50 to over \$75 an acre. The average price is about \$55 an acre.

Much of the Fox sandy loam shows the effects of overcropping, and where the supply of barnyard manure is not sufficient green-manure crops, such as clover, cowpeas, and buckwheat are needed. Crops on the Fox sandy loam often suffer from drought, and methods for conserving moisture, such as intensive cultivation, are beneficial in dry seasons. The soil forms a good mulch.

#### FOX FINE SANDY LOAM.

The surface soil of the Fox fine sandy loam is a light-brown or grayish-brown fine sandy loam, which may be slightly sticky when wet. It is underlain at 8 to 10 inches by a brown to reddish-brown material which varies in texture from a heavy loam to a sandy clay loam or sandy clay, and becomes heavier with depth. The subsoil grades into sandy material in the lower part of the 3-foot section. Some fine gravel usually is present in the subsoil and sometimes also in the surface soil. The substratum consists of gray, calcareous, stratified gravel beds. The soil is friable and easily maintained in good tilth under a wide range of moisture conditions.

This type occurs on glacial outwash plains and on stream and lake terraces. It is less extensive than the Fox sandy loam. It occupies comparatively small areas, the largest occurring  $3\frac{1}{2}$  miles northwest of Athens. The surface is mainly level but in some places gently rolling, as a result of erosion. The gravelly substratum insures good underdrainage.

Owing to its small extent, the Fox fine sandy loam is of little agricultural importance. It is adapted to the same crops as the Fox sandy loam. Ordinary yields range between those obtained on the Fox sandy loam and those on the Fox loam. The type produces fairly good yields of general farm crops, as well as of vegetables and some fruits, especially in moist seasons. It is handled in the same way as the Fox sandy loam, and can be improved by the same methods. It has practically the same value as the sandy loam.

#### FOX LOAM.

The Fox loam, to a depth of 8 to 10 inches, consists of a grayish-brown to brown, light to heavy loam. The subsoil is a rather compact, yellowish-brown, grayish-brown, or brown to reddish-brown, heavy loam to clay loam, with more or less gravel in the lower part. At 20 to 30 inches the subsoil often grades into yellowish or brown, loose sandy material, which is often sticky. At 3 to 5 feet gravel and sand beds carrying large quantities of lime-bearing material are encountered. In some areas the heavy subsoil continues to a depth of

3 feet or more, but these are not typical. Usually there is only a scattering of gravel and stones on the surface or in the surface soil, and most of the type is almost entirely free from bowlders. There is often present in the subsoil, especially in dry seasons, a hard layer which is commonly spoken of as hardpan.

The Fox loam is widely distributed throughout the county. It occurs on terraces along the larger streams and around lakes, and on extensive outwash plains. The largest areas lie along the Kalamazoo and St. Joseph Rivers and Nottawa Creek. The surface varies from level to slightly undulating or gently rolling, the latter condition occurring near streams. The natural drainage in most places is thorough, the underlying strata of sand and gravel favoring free internal movement of moisture. Where the heavy subsoil extends to unusual depths artificial underdrainage would be beneficial, and some depressed areas are wet enough to require drainage before they can be used for cultivated crops.

The Fox loam is one of the most important soils of the county, and nearly all of it is under cultivation. It originally supported a forest growth consisting chiefly of hardwoods, principally oak, hickory, ash, beech, elm, and walnut. There still remain some prairielike areas where the chief tree growth is a scattering of bur oak. The type is well adapted to general and dairy farming. The principal crops are corn, oats, hay, and wheat. Wheat is not grown so extensively as in the past. It was formerly grown almost continuously in the same fields, which greatly reduced the yields. The Fox loam is a good corn soil, and it is also well adapted to oats and hay. Some alfalfa is grown, the yield ranging from  $4\frac{1}{2}$  to 5 tons per acre per season. This crop is increasing in popularity. Potatoes are grown to some extent, with yields in favorable years ranging from 100 to over 200 bushels per acre. Beans are sometimes grown, and yield 10 to 20 bushels per acre. Corn yields 40 to 100 bushels per acre, with an average of about 50 bushels; oats 35 to 60 bushels, averaging between 40 and 45 bushels; wheat from 10 to 35 bushels, the average being about 22 bushels; and hay 1 to  $2\frac{1}{2}$  tons, the average being about  $1\frac{1}{2}$  to  $1\frac{3}{4}$  tons. The soil is less productive in those areas where sand and gravel beds lie near the surface.

The Fox loam has a fair content of organic matter, and is easily cultivated. If plowed when comparatively dry it readily works up into a mellow bed, but if it is plowed when wet and allowed to dry out in the furrows large clods frequently are formed. These pulverize easily under the roller, immediately after a light rain, and after harrowing the soil is in good physical condition.

The Fox loam is valued as highly as any soil in Calhoun County. It is relatively free from stone and lies well for cultural operations.

It sells at prices ranging from \$50 to \$100 an acre, with an average between \$60 and \$75.

This soil is not subject to destructive erosion. It can be maintained in a productive condition with reasonably good cultural methods. Clover succeeds where the soil is well supplied with lime, and this crop might advantageously be used for green manure where a good supply of stable manure is not available. Care in maintaining the supply of organic matter is necessary for continued success with crops. Commercial fertilizers are not generally used. Liming has increased yields and has been found helpful in producing and maintaining a profitable stand of alfalfa or clover. The type usually is plowed to a depth of about 6 inches, but the depth is sometimes varied in order to prevent the formation of a plow sole, the so-called "hardpan."

#### PLAINFIELD SANDY LOAM.

The Plainfield sandy loam to a depth of 6 to 10 inches consists of a light-brown or grayish-brown to gray loamy sand to sandy loam. The soil contains variable, though usually small quantities of organic matter. The subsoil is a yellowish-brown to brown fine to medium sand, somewhat less loamy than the surface soil and of more open structure. A scattering of fine gravel often occurs on the surface and throughout the soil mass. The type is sometimes gravelly near streams and potholes. The subsoil in some places is a little heavier than the soil, containing enough clay to be somewhat sticky. The substratum consists of grayish-yellow and gray sand and gravel, stratified and calcareous. The type can be cultivated under nearly any moisture condition.

The Plainfield sandy loam occurs in some rather large areas, but it is not nearly so extensive as the Fox loam. It is developed on lake and stream terraces and on glacial outwash plains. The principal areas occur on terraces along the Kalamazoo River and Battle Creek. The surface is flat to gently undulating, becoming rolling to hilly near streams and lakes, where potholes frequently occur. Drainage is likely to be excessive, and in dry seasons crops suffer from lack of moisture because the loose nature of the subsoil allows the moisture to drain away.

The Plainfield sandy loam is relatively unimportant, but most of it is farmed or used for pasture. The remaining tree growth consists largely of oak and soft maple, with some hickory and elm. The type is adapted to early truck crops, including potatoes, melons, and strawberries, and to small fruits and bush fruits. These crops are grown in a small way near Battle Creek and Albion, but most of the type is used for general farming, corn, oats, rye, hay, and wheat

being the principal crops. Yields vary widely with the rainfall, and even in very favorable seasons the yields are lower than those obtained on the Fox loam. Corn ordinarily yields 15 to 35 bushels per acre, oats 20 to 40 bushels, rye 10 to 20 bushels, mixed hay three-fourths ton to 1½ tons, wheat 8 to 15 bushels, potatoes 75 to 175 bushels, and beans 8 to 15 bushels. The land is valued at \$40 to over \$60 an acre.

The Plainfield sandy loam is inclined to be droughty and leachy. The effects of commercial fertilizer are not lasting, but the soil responds readily to the application of barnyard and green manures. Clover succeeds and is a good crop to turn under. Liming has proved profitable. The type declines in productiveness more rapidly than the heavier members of the Fox series. It can be improved by deep plowing and frequent manuring. The incorporation of organic matter not only adds plant food but increases the power of the soil to hold moisture.

#### PLAINFIELD FINE SANDY LOAM.

The Plainfield fine sandy loam, to a depth of 6 to 8 inches, is a light-brown to grayish-brown or gray, loamy, fine sand to fine sandy loam, free from gravel and stones. The subsoil consists of a yellowish-brown to brown, loose, incoherent, fine to medium sand, often becoming pale yellow with depth. The lower foot of the 3-foot section usually contains a small quantity of fine gravel, and occasionally shows some stratification. The subsoil in some areas contains sufficient clay to be slightly sticky.

The Plainfield fine sandy loam is of small extent. The largest area occurs near Beadle Lake, in Emmet Township. Like the other members of the Plainfield series, this type occurs in glacial outwash areas and on stream and lake terraces.

The surface in general is level, becoming either pitted or gently rolling near streams and lakes. The type is well or even excessively drained, owing to the open nature of the subsoil.

This is a comparatively unimportant type. It resembles the Plainfield sandy loam in all respects, except that it is finer in texture. It can be worked under a wide range of moisture conditions, is easily kept in good tilth, and gives practically the same yields as the sandy loam. The suggested means for improving the sandy loam apply as well to the fine sandy loam.

#### HOMER LOAM.

The Homer loam, to a depth of 8 to 10 inches, consists of a chalky-white to gray or grayish-brown, friable loam, usually mottled with brown and yellow. The subsoil is a gray, heavy loam, silty clay loam,

or sandy clay, mottled with yellow and brown, grading into sandy coarser material at a depth of 24 to 30 inches. This lighter material is brown or yellowish brown, mottled with gray. Fine to medium gravel is present in the subsoil in variable quantities, and sometimes also in the surface soil. The substratum consists of gray, stratified gravel and sand; it is similar to the substratum of the Fox series. In some areas the upper 3 or 4 inches of the surface soil is dark brown to black, owing to the large percentage of organic matter present. The subsoil of the type in the northeastern part of the county frequently contains calcareous layers, and these give a strong lime reaction in some cases. This calcareous subsoil variation is quite noticeable near areas of the Miami loam.

The Homer loam is distributed throughout the county in areas which vary in size from 5 to 10 acres to 1,000 acres or more. The type occurs largely on low lake and stream terraces, which may have been overflowed to some extent when the streams and lakes were at higher levels. It also occupies flat and slightly depressed portions of outwash plains, filled-in valleys, and high lake and stream terraces. It is typically and extensively developed on terraces along the Not-tawa Creek and St. Joseph River. The surface is level or flat, and the soil is not thoroughly drained. The type frequently occupies slight depressions within areas of the Fox soils. Some of this land after being cleared appears to be well drained, but it is probable that the water table is not far below the surface.

As mapped the Homer loam includes some small areas of the Homer fine sandy loam and of a darker gray fine sandy loam which is intermediate in color characteristics between the light Homer soils and the black Clyde soils. The typical Homer fine sandy loam consists of gray fine sandy loam, 6 to 10 inches deep, underlain by gray, heavy fine sandy loam to heavy loam, mottled with yellow and brown. The subsoil becomes coarser in the lower part of the 3-foot section, where it may be yellowish-brown to brown, with gray mottling. In the darker colored areas the soil to a depth of 6 to 8 inches is a dark-gray fine sandy loam, resting upon a gray fine sandy loam subsoil like that of the typical Homer fine sandy loam. The crops grown and the farming practices on the Homer fine sandy loam are about the same as on the loam. The most important areas occur on the south side of the St. Joseph River, 3 miles southwest of Clarendon.

The Homer loam is a fairly good agricultural type when well drained, but at present much of it is used for pasture. A small part of the type is forested, principally with swamp oak, several other species of oak, black and white ash, elm, maple, hickory, and walnut. The principal crops are corn, oats, and hay, and pasture grasses. Wheat, rye, beans, and buckwheat are grown to some extent. Where sufficiently drained, the type is well suited to general farm crops,

especially corn and hay. Red clover, alsike, and June grass succeed where the soil is well supplied with lime. If the soil is plowed when too wet and allowed to dry, it forms clods which are difficult to pulverize, but when plowed under proper moisture conditions it can be maintained in fair tilth with a moderate expenditure of labor.

Corn yields 25 to 100 bushels per acre, with an average of about 43 bushels; oats, 35 to 50 bushels, and occasionally 60 or 70 bushels; mixed hay,  $1\frac{1}{2}$  to 3 tons; buckwheat, 10 to 35 bushels, averaging about 15 bushels; rye, 10 to 20 bushels; wheat, 15 to 30 bushels, with an average of 22 bushels; and beans, 15 to 20 bushels. Crop yields vary widely with the season. In very wet years crops may be unprofitable, but in years of moderate rainfall good yields are obtained. A five-year rotation usually is followed on this soil.

Land of this type ranges in value from \$40 to \$65 an acre, depending upon the drainage, improvements, and nearness to towns and shipping points. When the type is sold in connection with other soils, as is often the case, as much as \$75 to \$100 an acre is sometimes obtained.

The chief need of the Homer loam is better drainage. Much of the type already is drained by open ditches, but little tile has been laid. Tile drainage is certain to result in marked improvement. Commercial fertilizers are not commonly used on this type. Liming has proved beneficial, especially for the staple crops and crops like red clover. All the manure produced is returned to the land. More stock should be kept to supply manure and to utilize certain crops to the best advantage. It is necessary to conserve and increase the supply of organic matter in the soil. The type apparently is well suited to late cabbage, sugar beets, and other late truck crops, as well as to certain canning crops and small fruits.

#### HOMER CLAY LOAM.

The Homer clay loam consists of a light-gray to grayish-brown silt loam or heavy loam, 5 to 8 inches deep, underlain by gray clay loam or silty clay mottled with brown and yellow. The subsoil frequently becomes heavier with depth. At 20 to 30 inches sandy and gravelly layers are frequently encountered, brown or yellowish-brown in color with gray mottling. Iron-oxide particles are often abundant in the soil section. When dry the soil and upper subsoil often appear white and chalky, but there are some included areas in which the upper 3 or 4 inches of the surface soil is dark brown to black, owing to a large content of organic matter. The substratum consists of stratified gravel and sand and is quite similar to that of the Fox series.

The Homer clay loam is not extensive. In general distribution and topographic position it is similar to the Homer loam. The under-

drainage is not so thorough as in the loam type, on account of the heavier subsoil.

Practically all the Homer clay loam is under cultivation or used for pasture. The original tree growth included swamp oak, elm, white and black ash, soft maple, hickory, and linden. The soil is not difficult to cultivate, but if plowed when too wet and allowed to dry it forms clods which are hard to reduce. The soil is rather strong and productive, and is well adapted to general farming where the drainage is satisfactory. The chief crops grown are corn, oats, and hay and pasture grasses, and these crops do well, especially corn and hay. Buckwheat, rye, wheat, and barley are grown to some extent. Ordinarily corn yields 35 to 100 bushels per acre, averaging about 45 bushels; oats, 40 to 50 bushels, occasionally reaching 70 bushels; and hay,  $1\frac{1}{2}$  to 3 tons. Yields may be quite high in moderately dry years, while in wet years they are likely to be low. The uncertainty as to yields can be eliminated to a large extent by installing tile drainage.

The methods of handling this soil, the fertilizer requirements, and land values are about the same as in the case of the Homer loam. The clay loam is more difficult to keep in good tilth. On account of the heavier texture of both soil and subsoil it requires a somewhat different method of treatment, and it probably has a slightly different crop adaptation. It should prove well suited to late truck crops, including late cabbage and sugar beets, as well as to certain canning crops and small fruits.

#### CLYDE LOAM.

To a depth of 8 to 15 inches the Clyde loam consists of a dark-gray or dark-brown to black, moderately friable, mellow loam to compact, heavy loam; in many places containing a small quantity of fine waterworn gravel. The subsoil to a depth of 20 to 30 inches is a gray, dark-gray, or drab heavy loam to silty clay loam or sandy clay, somewhat streaked and mottled with iron stains. It grades into lighter-textured material. The upper subsoil frequently contains a sandy layer, with more or less gravel, and sometimes so-called "quicksand" material is encountered relatively near the surface. The substratum consists of gray, stratified gravel and sand, or in places grayish loamy till. It shows a strong lime reaction. The Clyde loam includes some small areas of Muck and Peat which can not satisfactorily be separated on the map.

This type formerly was poorly drained and in a semiswampy state, resulting in a relatively large accumulation of organic matter. Much of it is still puddled and compact, being sticky and impervious when wet and very hard and cloddy when first brought under cultivation. In drained areas the soil works up into a mellow loam and

the subsoil becomes more friable and pervious to water. The mucky areas of the type are naturally loamy and mellow.

The Clyde loam occupies nearly flat areas, with occasional low knolls and swells and intervening shallow depressions, and is naturally poorly drained. The type occurs throughout the county in areas ranging in size from a few acres to 1,000 acres or more. It is developed in basinlike depressions, in old glacial stream channels, in low areas bordering swamps, ponds, and lakes, and in other situations where the drainage is poor.

Most of the Clyde loam is still in a wet condition and used for pasture, but some large and important areas have been drained and put under cultivation. A part of the type is forested, the growth including poplar, slippery elm, soft maple, black and white ash, linden, swamp hickory, shagbark hickory, oak, and some sugar maple. Nearly all the merchantable timber has been removed. Tamarack and willow grow in the more poorly drained depressions, where the mucky and peaty accumulations may be thick.

The Clyde loam is best adapted to general farming, and it is used mainly for that purpose. The principal crops are corn, oats, and hay. Rye, buckwheat, barley, beans, and wheat are grown to a small extent. The soil is considered desirable for late cabbage, celery, onions, and certain other late truck crops and for some small fruits. Where it is properly drained and cultivated large yields are often obtained, corn producing 25 to 75 bushels per acre and occasionally, under exceptionally favorable conditions, reaching 100 bushels. From 40 to 60 bushels per acre is frequently obtained on well-drained and properly cultivated tracts. Oats yield from 25 to 60 bushels per acre, and mixed hay  $1\frac{1}{2}$  to 3 tons. Cabbage, celery, onions, and other truck crops are grown on some areas.

Undrained areas of the Clyde loam are valued at \$20 to \$40 an acre. Land drained by open ditches is valued at \$50 to \$70 an acre, and tile-drained land at \$75 to \$125 an acre. The type usually is farmed and sold in connection with other soils.

A considerable number of county drains have been opened through this and other poorly drained soils. Tile drains have not been installed to any considerable extent. The soil is unfit for cultivation without artificial drainage. The application of lime is beneficial after the soil is drained. In other parts of Michigan this type of soil has proved well suited to sugar beets, giving an average yield of 10 to 12 tons per acre.

#### CLYDE CLAY LOAM.

The Clyde clay loam, to a depth of 6 to 15 inches, consists of a dark-brown or black loam to clay loam, containing a considerable proportion of organic matter. The subsoil is a gray or drab silty clay or

clay, streaked with yellow and brown iron stains. A blue clay often occurs in the subsoil. The lower part of the 3-foot section may be quite yellow or yellowish brown, with gray and bluish mottlings. The clay subsoil is plastic and sticky when wet and so compact as to be nearly impervious to water. Sandy and fine gravelly layers often occur in the lower part of the 3-foot section, especially near streams. As in the case of the Clyde loam the surface soil is often very mucky and peaty. As mapped the Clyde clay loam contains some small bodies of the Clyde loam.

The Clyde clay loam is well distributed over the southern part of the county, only a few small areas being mapped north of the Kalamazoo River, and has the same extent as the loam. It has a nearly level surface, with slight elevations and depressions, and as a result is poorly drained. Over much of the type the soil is in a puddled condition and difficult to maintain in good tilth, as it has a tendency to clod and crack. When drained and plowed under proper moisture conditions it can be handled with a reasonable expenditure of labor, especially in the mucky areas.

The Clyde clay loam is an important soil where properly drained. It is naturally strong and productive. Most of it at present is used for pasture, a smaller proportion being in forest. The original tree growth consists of slippery elm, soft maple, poplar, hickory, oak, ash, and linden. In the mucky and peaty depressions tamarack and willow constitute the chief tree growth. The type is best adapted to general farming. Corn, oats, and hay do well, and these are the principal crops. Corn yields from 35 to 75 bushels per acre, averaging about 50 bushels. Yields of 85 to 100 bushels per acre have been obtained under favorable conditions. Oats yield from 35 to 65 bushels, averaging about 40 bushels, and hay 1½ to 3 tons per acre. Rye, buckwheat, barley, and wheat are grown to a small extent.

Undrained land of this type is valued at \$25 to \$40 an acre, depending largely upon the character of the pasturage. Land drained by open ditches ordinarily is valued at \$50 to \$75 an acre. A higher value usually is placed on tile-drained land.

The principal need of the Clyde clay loam is better drainage. Several county drains have been opened through this soil, but to insure success with crops the greater part of the type requires tile drainage. Drainage makes the soil easier to cultivate, lengthens the growing period, aids soil aeration, and allows deeper root development. The application of lime is beneficial after the land is drained. In other counties in Michigan this soil has given good results with cabbage and sugar beets. Sugar beets yield 5 to 20 tons, averaging 12 tons, and cabbage produces an average of 12 tons per acre. Onions, celery, and certain other truck crops also do well on this type.

## GRIFFIN LOAM.

The Griffin loam consists of a friable, mellow, brown to dark-brown loam to silty loam, 10 to 15 inches deep, underlain by yellowish-brown loam to sandy clay loam. Sandy layers with gravel are encountered between depths of 18 and 30 inches, generally at about 20 inches, and the material becomes sandy and gravelly in the lower part of the 3-foot section. The lower part of the section is stratified and shows considerable variation. In low, wet areas gray mottling occurs in the lower subsoil. On small knolls or slight elevations the soil is frequently a brown sandy loam.

This type is not extensive. It occurs only in the first bottoms of the Kalamazoo and St. Joseph Rivers near the county boundary. The surface is generally level, with occasional knolls and slight depressions. The lower lying areas are subject to frequent overflows, and artificial drainage is necessary to insure best results with crops. Areas not subject to overflow are generally well drained.

The Griffin loam is inextensive and unimportant agriculturally. About 60 per cent of it is under cultivation or used for pasture. The native tree growth is chiefly black walnut and black ash, with some elm, oak, and hickory. The type supports a luxuriant growth of grasses suitable for grazing and much of it is used for pasture. The chief crops are corn, oats, hay, and wheat. Corn yields from 40 to 75 bushels per acre, oats 20 to 60 bushels, hay  $1\frac{1}{2}$  to  $2\frac{1}{2}$  tons, and wheat 15 to 20 bushels.

Land of this type in well-drained areas free from overflow brings about \$60 an acre.

## WABASH LOAM.

The Wabash loam, to a depth of 10 to 15 inches, typically is a dark-brown to black, light to heavy loam, often containing some gravel, especially near the streams. The surface soil has a high content of organic matter, and in very wet depressions is mucky or peaty. The subsoil consists of a dark-gray or dark-brown to black, heavy loam to clay loam, containing fine gravel and sand layers and often mottled with yellow and brown. It grades into stratified sandy and gravelly material. The subsoil sometimes contains calcareous layers and fragments of limestone. As a rule the type is high in organic matter. Owing to its origin as alluvium washed from soils of different texture, this type varies considerably from place to place.

The Wabash loam occurs in the first bottoms along the major streams of the county, such as the Kalamazoo and St. Joseph Rivers, and Battle and Nottawa Creeks. Its areas vary in width from 250 feet to about one-half mile. The surface is flat, with occasional slight elevations. The type is subject to frequent overflows, and even

in very dry years water stands on the surface in places. Wet conditions have resulted in the accumulation of large quantities of organic matter. When drained the soil usually works up into a mellow, friable structure, but if plowed when too wet it forms clods which are difficult to break down.

The Wabash loam is of little agricultural value at present. Most of it is still in forest, from which nearly all the merchantable timber has been removed. The original tree growth consisted chiefly of slippery elm, black ash, yellow or black oak, swamp white oak, linden, hickory, beech, soft maple, poplar, and some black walnut. Where drained and protected from overflow this soil is best adapted to the staple farm crops, such as corn, oats, and hay. A small acreage is cultivated in dry years, but the type where the forest growth is open is mainly used for pasture.

The Wabash loam ordinarily is valued at \$15 to \$25 an acre. It is sometimes held for a higher price. Land values depend on the timber growth, the character of the pasturage, and other local factors.

In places the soil is strongly acid and here lime would be beneficial. Applications of potash and phosphoric acid fertilizers have proved profitable in the mucky areas.

#### WABASH CLAY LOAM.

The surface soil of the Wabash clay loam is a dark-gray or dark-brown to black, heavy loam to silty clay loam, 10 to 15 inches deep, containing a relatively large proportion of organic matter. The subsoil is a gray to grayish-brown or dark-brown silty clay, mottled with yellow and brown. It is plastic and sticky when wet. The subsoil is often strongly calcareous. In some places the type has a clay loam subsoil, with sandy layers in the lower part, and occasionally the soil may approach the Wabash loam in texture and structure. Often, however, the typical soil extends over a considerable area without any marked variation.

The Wabash clay loam commonly occurs in the widest bottoms along the largest streams of the county. A typical and extensive area lies along the St. Joseph River, southeast of Clarendon. Smaller areas occur along the Kalamazoo River and other large streams. The type occupies flat first-bottom land, occasionally marked by small mounds rising 1 to 3 feet above the general level. On these mounds the soil is often of lighter texture, and frequently the soil in the wet depressions is quite mucky. The type requires artificial drainage before it can be cultivated, and owing to the compact nature of the soil, the flat topography, and the low-lying position, it is difficult to provide good drainage in many places.

In its present undrained condition this soil is best used as pasture or forest land. Much of it is still forested, but most of the marketable timber has been cut. The tree growth is about the same as that on the Wabash loam. With drainage and protection from overflow this is a valuable soil, well suited to general farm crops such as corn, hay, and oats. The soil tends to form hard clods unless plowed and tilled under proper moisture conditions.

This land is valued at \$25 to \$40 an acre. It is generally sold in connection with adjoining upland types.

#### MUCK AND PEAT.

Muck and Peat include soils composed largely of organic matter. Peat is composed almost entirely of vegetable matter, consisting of roots and leaves of water-loving plants and trees in various stages of decomposition. The first stage in the formation of the deposit consists of raw, brown Peat, fibrous in structure, and held together in felty masses in which the plant forms are still recognizable. The soil below this vegetation is dark in color, occasionally being black. It is generally saturated with water at no great depth below the surface, and is nearly or quite devoid of visible mineral matter. It extends to depths ranging from a few feet to 20 feet or more. Brown Peat of felty, fibrous nature can rarely be used for crop production, on account of its unfavorable physical condition. Huckleberry and tamarack are a common growth on such land. As the mineral or earthy matter increases and traces of the original vegetation begin to disappear, the material assumes a finer texture and darker color, finally becoming a Muck soil.

Muck consists of an accumulation of vegetable remains in a more advanced state of decay than Peat, mixed with variable, though usually small quantities of clay, sand, and silt carried into the depressions by wash from higher surrounding areas or by the wind. Muck is dark brown to black and mellow. The deposits vary in depth from a few inches to 10 feet or more. Typical Muck is quite uniform in color, texture, and structure to a depth of 30 inches or more. In some places sufficient earthy matter is present to give it a dark-gray or gray color and a firmer structure.

The underlying material of Muck and Peat varies from a gray sand or sand and gravel to a gray or drab silty clay. The agricultural value of the land depends largely upon the character of the subsoil material and its depth below the surface. The greater part of the Muck and Peat land is underlain by sandy and gravelly loam or clay. The substratum consists of gray, stratified gravel, sand, and clay, often showing a strong lime reaction. Layers of bog lime or marl occasionally occur in the subsoil, but usually not in sufficient quantity to affect noticeably the upper soil.

Muck and Peat occur in all parts of the county in areas which range in size from less than 10 acres to several thousand acres. Many of the bodies are too small to be mapped separately. All the areas occupy naturally poorly drained depressions, in which swampy conditions have prevailed over long periods of time. In this region the deposits have been formed in glacial depressions since the last ice sheet withdrew. The areas support a luxuriant growth of tamarack, poplar, willow, reeds, rushes, flags, mosses, sedges, and huckleberry, with elm, soft maple, and other trees in the better drained places.

Areas of Muck and Peat have a flat surface and often lack outlets, and it is sometimes difficult to provide good drainage, which is necessary to fit them for cultivation. Areas in which the subsoil consists of sand are considered less desirable than those having a heavier subsoil. In such areas the underdrainage is likely to be excessive following the installation of tile. A gravelly and sandy clay subsoil is considered the best subsoil.

A number of county drains have been constructed through Muck and Peat areas, but only a comparatively small proportion of the land is under cultivation. Much of it has been cleared of trees and bushes and is used for summer pasture. Nearly all the general farm crops succeed on good Muck land. The chief crops in this county are corn and hay. Small grains grow well, but have a tendency to produce a rank growth of straw and are likely to lodge. This is especially true of wheat. Certain varieties of oats and barley succeed, but probably the best crop of all is hay. Alsike and timothy are successful crops. They are usually sown together, although timothy generally does well alone. Yields of 2 to 3 tons of hay per acre are common on properly drained land. Corn and certain other crops do not do well on newly broken areas.<sup>1</sup> Some farmers use the land for hay or pasture the first few years. Quite often the difficulty in growing crops is overcome by applying stable manure and practicing thorough cultivation. Corn in new areas is often brown in color and stunted. The yields on old fields ordinarily range from 35 to 55 bushels per acre, and yields of 60 or even 75 bushels per acre have been obtained under particularly favorable conditions. Oats yield 20 to 35 bushels, and occasionally 40 to 55 bushels per acre.

This soil is well adapted to many special crops, including celery, onions, cabbage, lettuce, carrots, parsnips, horse-radish, spinach, tomatoes, sugar beets, and peppermint. Peppermint, however, has not proved so profitable as in certain other parts of Michigan, and the crop is grown in only a small way. Onions have, as a rule, proved very profitable throughout the county. Near Battle Creek a considerable acreage of Muck is profitably devoted to truck crops. Huckle-

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<sup>1</sup> See Bul. 273, Mich. Agr. Expt. Sta., "The Utilization of Muck Lands."

berries grow wild in the Peat bogs, and are a source of income in many places.

A considerable number of farmers formerly burned over their Muck and Peat lands, but this practice is now less common and is considered injurious. Fertilizers are used on Muck land to some extent and many farmers apply barnyard manure, with good results. The Michigan Agricultural Experiment Station has published information regarding the fertilizer requirements of Peat and Muck lands. The interested reader should consult this report.<sup>1</sup>

A conservative estimate places the value of undrained Muck and Peat land at \$15 to \$30 an acre. Some areas sell for higher prices, depending on the natural drainage conditions, the location, possibilities of future development, the pasturage, and other factors. Land drained by main ditches sells for \$40 to \$70 an acre, depending largely upon the drainage. Tile-drained lands are valued at higher prices. Some desirable drained Muck land in small areas near Battle Creek is held at \$400 or \$500 an acre.

The first steps necessary in the improvement of Muck and Peat is proper drainage. It probably is best to use the open ditches at first, and to install tile drains later, after the soil settles and becomes compact. Rolling and compressing of the seed bed are necessary for the best results. Crops do best in the areas of black deposits, with a relatively large proportion of earthy or mineral materials and of close texture, such as exists where the organic material has reached an advanced stage of decomposition.

#### SUMMARY.

Calhoun County, Michigan, is in the south-central part of the State. It has an area of 693 square miles, or 443,520 acres. Its surface is typical of a glaciated region, with rolling to hilly morainic belts and intervening strips of level to gently undulating country.

The county is drained mainly by the Kalamazoo and St. Joseph Rivers and their tributaries, but the run-off from the northeastern corner is into the Grand River. The upland is in general well drained, but there are many swampy areas in the county, and numerous ponds and lakes.

Calhoun County was organized in 1833. Settlers came into the county in large numbers between 1833 and 1836, largely from New York, Ohio, and Pennsylvania. The population in 1910 was 56,638, of which 21,302 was rural. The rural population is evenly distributed throughout the county. Marshall, the county seat, has a population of over 4,000. Battle Creek is the largest city, with 25,267 inhabitants in 1910. Albion is the second largest town, with

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<sup>1</sup> *Ibid.*, p. 29.

a population of 5,833. Homer, Tekonsha, Burlington, and Athens are towns of local importance.

The county has excellent transportation facilities. Many good county roads have recently been provided, and good markets for all farm products are easily accessible.

The climate is characterized by sudden and extreme changes. The mean annual temperature is reported as 46.5° F. at Olivet, and the mean annual precipitation as 33.33 inches at Battle Creek. The average length of the growing season is 151 days.

The agriculture of Calhoun County consists chiefly of grain and hay farming, though dairying is becoming an important industry. The principal products are corn, wheat, oats, hay, potatoes, beans, garden truck, live stock, and dairy products.

The average price of good farm land is about \$60 an acre. The range in price ordinarily is from \$15 to \$125 or more an acre.

The soils of Calhoun County are chiefly of glacial origin. Most of the soils are gravelly. The soils have been grouped in the Bellefontaine, Coloma, Fox, Miami, and Clyde series, which occupy the greater part of the county, the Crosby, Griffin, Waukesha, and Wabash series, of very small extent, the Homer soils, which are not extensive, but are fairly well distributed over the county, and Muck and Peat, of which a considerable area exists.

The Miami loam is a rolling upland soil, well drained, and adapted to general farming and stock raising. The subsoil is calcareous and such crops as clover thrive.

The Crosby loam is a level to very gently sloping, upland soil. It is a fairly good agricultural type, but is not developed to any important extent. Some areas are in need of drainage.

The Bellefontaine series includes upland soils of rolling to rough and hilly surface. Drainage is good to excessive. These soils give good yields of the staple crops.

The Coloma soils have a rolling to hilly topography and good to excessive natural drainage. They are devoted to general farming. The loam is extensive and is a very desirable type. The sandy loam is of minor importance. The fine sand and loamy sand are probably best adapted to forestry and to growing fruits and truck crops.

The Waukesha loam occurs in level to slightly rolling areas, but drainage usually is adequate, as the substratum consists of stratified sand and gravel, and this material lies near the surface. The type is used for general farming and dairying.

The Fox soils occupy level to gently undulating terrace or outwash plain areas. The underdrainage is generally good, being favored by the gravelly and sandy substratum. The loam is the most important type. The Fox soils are well suited to general crops.

The Plainfield series is represented by two light sandy types which are used for general farming, but are better suited to growing truck and other special crops.

The Homer soils typically have a flat surface and are not well drained. They are cultivated in favorable seasons, but in years of heavy rainfall are too wet for satisfactory farming. These soils are well suited to corn, hay, and oats.

The Clyde loam and clay loam are level and naturally poorly drained, but when reclaimed are valuable for corn, hay, oats, and special crops, such as sugar beets, onions, and cabbage. These are good hay and corn soils, but wheat does not seem to do well.

The Griffin loam is of small extent and of little importance. It is an alluvial soil lying largely above overflow.

The Wabash soils are of alluvial origin and occur in the first bottoms of large streams. They are poorly drained, but afford some pasturage. With drainage and protection from overflow they are valuable general-farming and pasture soils, especially adapted to corn and hay.

Muck and Peat, which term includes several grades of organic soils, have a flat surface and are naturally poorly drained. Large areas have been reclaimed by ditching. The more thoroughly decomposed black Muck makes good agricultural land; the partly decomposed and fibrous Peat is of little value at present. Reclaimed Muck produces good yields of corn, hay, and many other crops, especially certain truck crops, among them onions and cabbage.



[PUBLIC RESOLUTION—No. 9.]

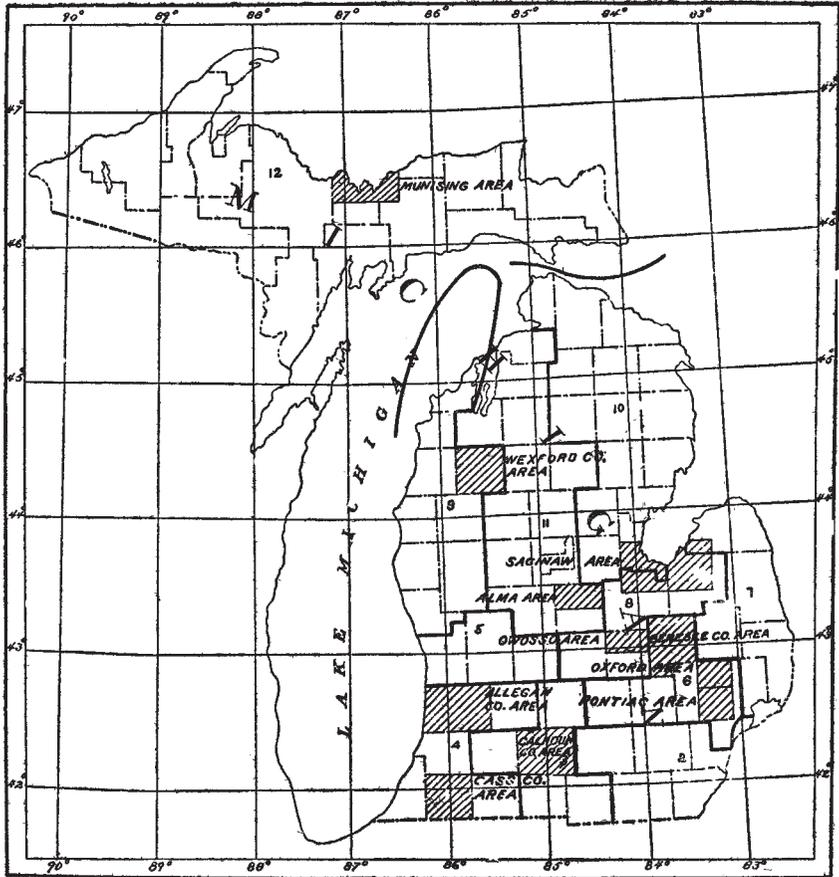
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report of field operations of the Division of Soils, Department of Agriculture."

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

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

Approved March 14, 1904.

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



Areas surveyed in Michigan.

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