

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE OHIO AGRICULTURAL EXPERIMENT  
STATION, CHAS. E. THORNE, DIRECTOR; E. R. ALLEN  
IN CHARGE SOIL SURVEY.

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# SOIL SURVEY OF MIAMI COUNTY OHIO.

BY

E. R. ALLEN, IN CHARGE, AND OLIVER GOSSARD, OF THE  
OHIO AGRICULTURAL EXPERIMENT STATION.

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W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

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



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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,

*Washington, D. C., September 21, 1917.*

SIR: During the field season of 1916 a soil survey was made of Miami County, Ohio. This work was done in cooperation with the Ohio Agricultural Experiment Station, and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1916, as provided by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

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

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Soil map, Miami County sheet, Ohio.



# SOIL SURVEY OF MIAMI COUNTY, OHIO.

By E. R. ALLEN, In Charge, and OLIVER GOSSARD, of the Ohio Agricultural Experiment Station.—Area Inspected by W. E. McLENDON.

## DESCRIPTION OF THE AREA.

Miami County lies in the southwestern part of Ohio. It is in the second tier of counties east of the Indiana State line and the fourth north of the Ohio River. It is bounded on the north by Shelby County, on the east by Champaign and Clark Counties, on the south by Montgomery County, and on the west by Darke County. It has an area of 408 square miles or 261,120 acres.

The general topography of Miami County is that of a broad, level to gently rolling plateau, cut by a number of valleys. That part of the county east of the Miami River is undulating to gently rolling, with the slopes to the streams, as a rule, rounded. Extending southwestward from the Shelby County line northwest of Piqua to a point north of Covington and through Bradford is a broad ridge known as the Union Moraine. This has a general level about 25 feet above the surrounding country. Its slopes are gentle except where it has been dissected by the Stillwater River, Greenville Creek, and Harris Run. North of this ridge the country is undulating except where dissected by the Stillwater River and its immediate tributaries.

Between the eroded areas along the Miami and Stillwater Rivers and south of the Union Moraine there is a broad, level area extending to the southern limits of the county. West of Tippecanoe City some broad hills rise 20 to 30 feet above the surrounding country. Smaller but similar level areas occur between the eroded regions along Ludlow and Greenville Creeks and in the southwestern corner of the county west of the Stillwater River and south of Ludlow Creek. Only in a few canyonlike valleys along the Stillwater River and its tributaries and in the old filled valley extending from a point southeast of Troy southeastward is the surface steeply rolling.

The Miami River Valley varies from a narrow gorge south of Piqua to a valley several miles in width near Troy. Some very dis-



FIG. 1.—Sketch map showing location of the Miami County area, Ohio.

tinct terraces occur in the broad part of this valley near and north of Piqua, and also near and south of Troy. The valley of the Stillwater River is narrow and in some places gorgelike. It contains only a few small terraces and the flood plains are narrow and unimportant agriculturally. The smaller streams of the county are bordered by flood plains varying in width from a few feet to one-half mile. The most important of these lies along Lost Creek.

The highest point in the county, 1,155 feet above sea level, occurs along the Champaign County line two miles north of Lena. From this point the slope is to the south and west, principally toward the south. The Miami River leaves the county at an elevation of 780 feet, which is the lowest point in the county.

Miami County is drained by the Miami and Stillwater Rivers and their tributaries. Spring Creek, Lost Creek, and Honey Creek drain that part of the county east of the Miami River, and Harris Run and Greenville and Ludlow Creeks drain that part west of the Stillwater River. The drainage system does not reach all parts of the county, and some large, flat areas are very poorly drained, artificial drainage being necessary here before the land could be farmed.

The early settlers of Miami County came from the Atlantic Coast States, mainly New Jersey, Pennsylvania, and Virginia. As early as 1798 settlements were made at Staunton and near the present site of Troy. In 1807 Miami County was formed from a part of Montgomery County. At first the county seat was at Staunton, but in 1808 Troy was laid out and the county seat moved to this place. The density of rural population of Miami County has been practically unchanged since 1880, averaging about 63 persons to the square mile. In 1910 the rural population amounted to 25,537. The urban population has steadily increased, rising from 9,834 in 1880 to 19,510 in 1910.

Piqua, with a population of 13,388 in 1910, is the largest city in the county. This is a thriving manufacturing city situated on the west bank of the Miami River about 3 miles south of the Shelby County line. Troy is situated on the west bank of the Miami River about 8 miles south of Piqua. It has a population of 6,122, and is the county seat. Tippecanoe City, with a population of 2,138, is 6 miles south of Troy, on the west side of Miami River. Covington, with a population of 1,848; Pleasant Hill, with 571; and West Milton, with 1,207, are thriving towns situated on the Stillwater River. Bradford, with a population of 1,844, is directly west of Covington. It lies partly in Darke County. Laura, Potsdam, Ludlow Falls, Fletcher, Conover, Lena, Casstown, Brandt, Phoneton, and Frederick are local trading centers.

Transportation facilities are provided by several steam and electric lines, and all parts of the county have good means of communi-

cation with Cincinnati, Chicago, Indianapolis, St. Louis, Columbus, Pittsburgh, Cleveland, Lima, Toledo, and other excellent markets. Good wagon roads are maintained in all parts of the county. Many of them have been improved with gravel and crushed limestone.

CLIMATE.

The climate of Miami County is favorable for agriculture. The mean annual temperature as recorded at Dayton, 20 miles south of Troy, is 52.7° F. The summer mean is 74° F. In the five months from May to September hot spells often occur, accompanied by high relative humidity. A maximum temperature of 108° F. has been recorded in July. The winters are moderately cold, the mean for this season being 30.7° F. From the latter part of November until March the temperature frequently falls below zero. A minimum of -28° F. has been recorded in February, and -22° F. in January.

*Normal monthly, seasonal, and annual temperature and precipitation at Dayton, Montgomery County.*

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1894).	Total amount for the wettest year (1907).	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	33.1	68	-16	2.64	3.07	3.08	4.1
January.....	28.9	75	-22	3.01	2.27	8.16	7.5
February.....	30.0	72	-28	2.76	3.31	.42	5.6
Winter.....	30.7	75	-28	8.41	8.65	11.66	17.2
March.....	40.3	84	-3	3.53	2.15	6.00	4.2
April.....	51.7	90	18	2.68	1.51	2.94	.8
May.....	62.9	97	28	3.83	4.17	3.17	T.
Spring.....	51.6	97	-3	10.04	7.83	12.11	5.0
June.....	72.2	100	41	4.04	3.75	3.98	0
July.....	76.2	108	45	3.25	.75	7.01	0
August.....	73.6	100	40	3.08	1.85	3.08	0
Summer.....	74.0	108	40	10.37	6.35	14.07	0
September.....	67.4	102	28	2.57	1.54	4.22	0
October.....	54.1	93	18	2.16	1.43	2.90	T
November.....	42.1	76	-1	3.00	1.77	2.56	.8
Fall.....	54.5	102	-1	7.73	4.74	9.68	8
Year.....	52.7	108	-28	36.55	27.57	47.52	23.0

Frosts occasionally occur at unseasonable times, particularly in the spring, causing damage to crops, especially fruits, vegetables, and tobacco. The growing season ordinarily, however, is of sufficient length to mature all crops, averaging 166 days. The average date of the last killing frost in the spring as recorded at Dayton is April 27, and that of the first in the fall, October 10. Killing frost has been recorded as late in the spring as May 21, and as early in the fall as September 21.

The mean annual precipitation of 36.55 inches is well distributed throughout the year. The rainfall is greatest during the spring and summer months, but droughts sometimes occur, resulting in greatly decreased yields. The average yearly fall of snow is 23 inches. Occasionally hailstorms cause injury to crops.

In the table on the preceding page are given the more important climatic data as compiled from the records of the Weather Bureau station at Dayton.

#### AGRICULTURE.

Miami County was settled very early in the development of Ohio. Some settlements were made at what are now Staunton and Piqua as early as 1797 and 1798, and after about 1800 there was a more or less steady influx of settlers.

The early agriculture was self-sustaining. The virgin soil was very productive, and crops were grown with little labor. Hogs were fattened in the woods, and corn was grown only for food. Hides and furs were the principal export products. The system of agriculture gradually became more extensive. Farming was stimulated by the completion in 1837 of the Miami and Erie Canal, which afforded cheap transportation to the markets at Dayton and Cincinnati. In 1846 several factories were in operation at Troy and Piqua. The growth of the population since 1880 has been largely due to manufacturing industries, which have afforded a steady local market for agricultural products.

The reclamation of the "black lands" (Brookston silty clay loam) by artificial drainage was begun at an early date and by 1850 considerable progress had been made in this work. By 1880 the county was well developed agriculturally. Ninety-two per cent of its area was in farms, and 79 per cent of the farm land was improved. In 1910, 94.8 per cent of the county was in farms, with an average of 89.5 per cent of improved land.

Miami County is one of the most highly improved counties in the State. The prevailing type of agriculture consists of general farming combined with stock raising and tobacco growing. In the level western part of the county, where there is much "black land," corn

and tobacco are the leading money crops, while in parts of the eastern section wheat and tobacco are the main money crops. In other places the income is about equally divided among corn, wheat, oats, and timothy hay. The value of the different classes of crops in 1909 is reported by the census as follows: Grains and hay, \$2,814,210; vegetables, \$199,842; fruits and nuts, \$84,172; and all other crops, largely tobacco, \$879,272. The income from animals sold or slaughtered amounted to \$881,326; from dairy products, \$340,653; and from poultry and eggs, \$347,140.

In 1909 corn occupied 71,226 acres, producing 3,481,762 bushels; oats 37,961 acres, producing 1,202,991 bushels; tame grasses 23,278 acres, producing 29,775 tons; wheat 22,311 acres, producing 276,376 bushels, and tobacco 9,224 acres, producing 8,199,498 pounds. Corn has been the most extensively grown crop in the last four census periods, except in 1899, when its acreage was slightly exceeded by that of wheat. The average yield of corn in the same time has ranged between 38 and 49 bushels; of oats between 31.6 and 37.8 bushels; and of wheat between 12.3 and 23.9 bushels. Corn has shown a considerable increase in yield since 1880, while wheat has shown a great decrease and oats a considerable decrease.

The widely varying acreage and yields of wheat are doubtless due to the effects of weather conditions and insect ravages. In some years the wheat is so unpromising in the early spring that it is plowed up and the land devoted to another crop. Wheat is at the present time, however, a very important money crop, and the acreage is probably well above that reported for 1909.

Tobacco is an important money crop. Tobacco was grown very early in the development of the county, but it was an unimportant crop until about 1885. The area in tobacco increased from 499 acres in 1879 to 1,358 acres in 1889, 4,740 acres in 1899, and 9,224 acres in 1909. In 1879 the average yield was 1,283 pounds per acre, and in 1909 only 889 pounds. Tobacco is not only a profitable crop, but it has the further advantage that considerable of the labor connected with its preparation for the market may be done during the winter months. Only 4 to 10 acres are devoted to tobacco on most farms and the crop is given a very disproportionate amount of attention, both in preparation of the soil and in fertilization.

In 1909 the combined production of timothy, clover, and alfalfa hay amounted to 29,551 tons. Timothy grown alone averaged 1.3 tons per acre, clover alone slightly more than 1 ton, and alfalfa 2.3 tons. Alfalfa has been introduced only very recently, and its acreage is steadily increasing. In 1899 only 12 tons of alfalfa hay was produced. In 1909 the production had increased to 673 tons. There are large areas of almost ideal alfalfa soils in the county, and as

the value of this forage crop is more fully appreciated and methods of growing it better understood the acreage is certain to increase materially.

Flax was once a fairly important crop. At one time a linseed-oil mill was operated at Piqua. In 1879 there were 58,926 bushels of flaxseed produced, but by 1889 the production had declined to 9,172 bushels, and by 1899 flax growing had practically been abandoned. Rye and barley also are almost negligible crops.

Irish potatoes are grown on a small scale. In 1909, 230,256 bushels were obtained from 2,521 acres. Sweet potatoes are grown to a very small extent. Considerable maple sirup was produced at one time, but the production declined from 7,058 gallons in 1879 to 3,024 gallons in 1899. The census does not report any production in 1909. The 1910 census reports 79,491 apple trees, 20,913 peach trees, and 7,688 grapevines in the county in addition to 32 acres of strawberries, 33 acres of blackberries, and 28 acres of raspberries.

In 1910, 8 per cent of the average value of all farm property in the county, including land, was made up of live stock. Hog raising is the main live-stock industry. It is developed for the most part in the areas where "black land" predominates and where corn is the dominant crop. Dairying is the next most important live-stock industry, but there are only a small number of strictly dairy farms in the county. In 1910 animals sold or slaughtered were distributed as follows: Calves, 4,698; other cattle, 5,804; hogs, 32,378; and sheep and goats, 2,320. Much of the live stock consists of grade animals.

The farmers recognize the natural adaptation of various soils to certain crops. The Clyde, Brookston, and Millsdale soils of the uplands and the Wabash and Genesee soils of the flood plains, locally included by the local name "black lands," are known to be best adapted to the production of corn. It is also recognized that the "black lands" and "sugar-tree lands," the Bellefontaine, Fox, and Milton series, are well suited to tobacco. The soils of the three last mentioned series are also recognized as the best wheat soils of the county. In the growing of alfalfa it has become more or less apparent that the crop does best also on these soils. However, the whole subject of crop adaptation has been studied far too little by the farmers, especially in view of the great diversity of the soils within the county, and the knowledge gained is not always used in practice.

In preparing the land for corn it is plowed, usually in the spring, to a depth of 5 to 7 inches and tilled with disk and spike-tooth harrows. The crop is cultivated three to five times with 2-horse, 1-row cultivators. A very large part of the crop is shocked in the field, after which it is husked and stored in cribs to be fed or sold on the local market. Oats are usually sown with a disk drill after the seed

bed has been prepared by disking or harrowing. Some of the oat land is plowed. Wheat and oats are frequently stored in barns before being thrashed.

Tobacco plants are started in beds having cloth covering, transplanted about June 1 by hand or by machine, and given very careful cultivation throughout the summer both by hand and with 1-horse cultivators. The plants are cut in the early fall, cured in barns, and stripped and prepared for market during the winter.

The farm equipment throughout the county is, in general, very good. Comfortable houses and large barns are common, the latter particularly in sections where tobacco growing is carried on. The implements used in the level areas, especially where there is much "black land," are modern and ample for properly tilling the soil and handling the crops.

In general, a crop rotation consisting of corn, oats, wheat, and clover is followed, but this is varied considerably according to the nature of the soil. In those parts of the county where "black-land" soils predominate, corn may be planted 3 or 4 years in succession and wheat omitted. In other sections a 3-year rotation consisting of corn, wheat, and oats may be followed. The acreage devoted to tobacco on any farm is too small to be considered in the planning of a general rotation.

The expenditure for fertilizers increased from \$1,994 in 1879 to \$31,181 in 1909 and \$37,880 in 1915. The most commonly used fertilizer is a complete mixture, with phosphoric acid the dominant constituent. The farmers are gradually recognizing, however, that acid phosphate alone is the most profitable fertilizer to use. Tobacco receives the heaviest application of fertilizer, with wheat probably next.

The farm labor is all white and largely American, and the supply is not abundant. Only one hand is kept on most farms. The wage paid is about \$30 a month, with board. As much as \$2.50 to \$3 a day is paid during the harvest season.

The farms range in size from 40 to 200 acres or more. The average size in 1910 was 74.4 acres. There has been a gradual decrease in the average size since the early history of the county.

The 1900 census reports the average value of farm land in Miami County as \$46.37 an acre, and the 1910 census as \$80.22. At the present time large areas are held for as much as \$175 an acre.

At first the farms were operated almost entirely by owners, but with the growth of agriculture the tenant system has developed until at present only 48 per cent of the 3,328 farms in the county are operated by the owner. Most of the leased farms are rented for a share of the crops. The leases are frequently for short periods, and the tenant system tends to discourage the building up of the soils.

## SOILS.

This region was covered by the ice sheet of the late Wisconsin glaciation, which left a surface mantle of drift varying from a few feet to over 100 feet in thickness. The weathering of this drift has given rise to the soils over the greater part of the county. The melting and recession of the ice sheet was accompanied by floods and the consequent formation of outwash plains, which are confined to the river valleys and exist at the present time as terraces. Along the streams there occur areas of alluvium of varying width which represent flood plains.

Although the glacial drift in general is very much influenced by the underlying rock and is composed quite largely of fragments of it, it contains in the terminal moraine much foreign material which is of extremely diverse origin. The term, ground moraine, is applied to the drift deposited by the central mass of the ice sheet. It results from the plowing and grinding action of the ice sheet and is distinguished from the terminal moraine in that the surface is much smoother, the rock fragments are less rounded, the underlying rock is nearer the surface, and the till is derived more largely from these underlying rocks.

These two classes of drift are distinctly developed in Miami County and give rise to decidedly different soils. Many of the differences in the soils may be accounted for by differences in the types of drift and in the underlying material.

The substructure of Miami County is made up of Niagara limestone, of Silurian age, consisting of a very nearly pure dolomite. To the north the lower Helderberg and Corniferous limestones and the Devonian shales occur, while much farther to the north, in Canada, crystalline rocks appear. These different formations over which the ice sheet traveled have influenced, in varying degree, the character of the soils of Miami County.

With the exception of the area between the Miami River and Spring Creek, which is intermediate in general characteristics between terminal and ground moraine, that part of the county east of the Miami River is covered by terminal moraine of the Miami lobe of the late Wisconsin glaciation. Rounded granite boulders are very common in this region, and the topography varies from rolling to steeply rolling. The rolling areas are characterized by broad swells or successions of knobs and sags, which might be described as subdued kame and kettle topography, while the steeply rolling areas have a very pronounced kame and kettle topography and occur in the filled interglacial valley extending from a point southeast of Troy to the county line near New Carlisle. The soils of the terminal-moraine region are better drained than those of the ground

moraine. They contain more foreign material in the till and more grit in the soil section, and are in general calcareous nearer the surface. These features are more prominent the more pronounced the morainic topography.

The broad, flat, poorly-drained area south of the Union Moraine and west of the Miami River is occupied largely by true ground moraine and the till is quite local in nature, being composed principally of rounded to subangular fragments of Niagara limestone. Few granitic boulders occur in this region. Much of this area for a long period consisted of a series of shallow lakes, and the resulting luxuriant growth of vegetation favored the accumulation of organic matter in the surface soil, resulting in dark-colored soils. The flat areas between the lakes were subjected to alternate wet and dry conditions, and there resulted here soils with very little organic matter in the surface layer, light-gray subsurface strata, and dense subsoils mottled in the upper part and streaked throughout with dark iron stains. The level, undissected ground-moraine areas of Miami County consist, therefore, of alternating areas of these light and dark soils, the intermingling in some cases being so intricate that the areas could not be shown separately on the map.

Extending southwestward from the Shelby County line northwest of Piqua to Covington and Bradford is the low, broad Union Moraine. The surface features of this moraine are entirely different from those of the terminal moraine which crosses the eastern and southeastern part of the county in being broadly rolling except where dissected by the Stillwater River and its tributaries, in being nowhere characterized by kame and kettle topography, and in showing no evidence of assorting action or of the presence of granitic material in the till. It was formed probably by a secondary advance of the ice sheet after it had receded considerably to the north. This is evidenced by the distinctly deeper drift underneath and to the north of the Union Moraine, the heavier and more shaly nature of the till, and by the smoother and heavier texture of the resulting soil as compared with the more silty soils in the remainder of the county.

In some parts of the county the drift is so shallow that the underlying rocks have exerted some influence on the soils. The largest area of shallow drift is around West Milton, but in other places, particularly in Monroe, Elizabeth, Bethel, and Concord Townships, there are areas, frequently quite large, which consist of limestone hills or elevations not planed down by the glacier, but left covered with a thin layer of drift. These hills are broad and smooth, without prominent ledges except where they border the bluffs of the Miami or Stillwater Rivers. Areas of shallow drift also occur south of Piqua and around and to the north of Pleasant Hill, bordering the narrow valleys of the Miami and Stillwater Rivers. The soils

formed in these areas of shallow drift are correlated separately from those in the regions of deeper drift.

Within the valleys of the Stillwater and Miami Rivers some areas of assorted material are underlain by rounded gravel rather than till. The soils in these areas of valley-filling deposits resemble those in the better drained, gravelly subsoil areas of terminal moraine, and are classed with them. The largest area of valley-filling material occurs just east of the Miami River, in Bethel Township. This area lies below the level of surrounding uplands and is defined on its eastern border by a distinct ledge which marks the margin of the old valley. The second largest area occurs in Brush Creek valley, extending from a point near Frederick almost to Nashville. This valley seems to be too large to have been formed by the stream which now flows through it, and it seems not unlikely that the Stillwater occupied it from its present channel northwest of Kessler. Smaller areas of valley-filling deposits are encountered along the Stillwater River southeast of Ludlow Falls, just north of Pleasant Hill, and south of Covington, and along the Miami River north of its junction with Spring Creek. All these deposits resemble the terminal-moraine areas in that they are underlain with rounded gravel and the soils are brown to reddish brown in color.

The outflow of water accompanying the melting of the ice sheet was apparently carried down the present valleys of the Stillwater and Miami Rivers, where it left benchlike deposits of gravel with but slight admixture of sand and earthy material. The rounded waterworn fragments in these deposits are composed of limestone and crystalline rocks, mainly the former. The weathering of this mass has given rise to reddish-brown soils with excellent under-drainage, which resemble somewhat the soils of the terminal-moraine areas, but are classed separately. Since the close of the glacial period the Miami and Stillwater Rivers have built up level flood-plain areas of varying width. Their tributaries likewise have carved out narrow valleys and deposited narrow strips of alluvium bordered by colluvial deposits. All the alluvial soils are dark colored, poor drainage having favored a luxuriant growth of vegetation and the accumulation of organic matter.

The glacial material that gives rise to most of the soils is quite finely ground and rock fragments and boulders are not numerous. The till in the smoother terminal-moraine area seems to be slightly more finely ground and to contain more rounded fragments than that in the true ground-moraine regions. The fragments in both areas, however, are composed almost entirely of Niagara limestone, showing the local nature of the material. This till is comparatively low in clay and quite friable. The till underlying the Union Moraine and that part of the county to the north is the heaviest and most

clayey and that underlying the terminal-moraine region the most gravelly and friable. That under the ground moraine is intermediate.

Since the retreat of the ice sheet the drift has been weathered under diverse conditions with respect to drainage and accumulation of organic matter, and with the differences in the original material a considerable variety of soils has been developed. Some of these are quite distinctly developed, but in many cases the transition from one type to another is very gradual, and the boundaries drawn may be only approximate.

In correlating the various soils of Miami County those which have a common origin and are similar in surface-soil color, subsoil color and structure, drainage, and topography are grouped into series. A type is a textural unit of the series.

The till soils of Miami County are classed in nine series, the Bellefontaine, Miami, Crosby, Conover, Brookston, and Clyde occupying areas of deep drift, and the Milton, Randolph, and Millsdale occurring in areas of shallow drift.

Where the surface drainage and deep underdrainage have been very good and the surface soils are brown and the subsoils reddish brown to chocolate brown the soils are included in the Bellefontaine series. This series occurs in the terminal-moraine region of the eastern part of the county and on the areas of valley filling along the Miami and Stillwater Rivers. The Bellefontaine loam occurs in the strongly morainic region and the silt loam in the smoother sections and in the areas of valley filling.

Where the drainage, particularly the underdrainage, is such that less oxidation has taken place in the 3-foot section, and the surface soils are yellowish gray to brownish gray, the subsurface material pale yellow to yellow and gray speckled, and the subsoil dull brown and mottled with dark iron stains, the soils are classed with the Miami series. This series occupies some of the smoother portions of the terminal moraine and the more rolling areas of the ground moraine. It is represented by the silt loam, silty clay loam, and clay types. The silt loam is formed from the weathering of till composed largely of Niagara limestone, while the silty clay loam comes from heavier shaly till in the northwestern corner of the county. The clay represents eroded areas where silt has not been able to accumulate.

Where the surface is level and the internal drainage poor, the types have gray topsoils, a gray subsurface layer, and an iron-streaked, dense, puttylike subsoil. These types are included in the Crosby series. This series is represented in Miami County by one member, the silt loam. It occurs in areas of ground moraine and results from the weathering of till composed largely, therefore, of Niagara limestone.

Soils with brownish-gray surface material, a similar or slightly lighter gray subsurface layer, and a dull-brown, iron-streaked subsoil, and underlain by calcareous till within 2 feet of the surface are classed in the Conover series. This series is confined to the smoother areas of the terminal moraine.

In the Brookston series, the surface soils range in color from dark gray to brownish black, and the subsoils are drab in the upper part and mottled yellow below. This series includes the dark soils of the ground-moraine region which are so intimately associated with the Crosby silt loam. In a few areas in the region of the terminal moraine the surface soils are brownish black to black and the subsoils drab. This soil is included in the Clyde series.

Where the bedrock lies within 3 feet of the surface and the soil is brown to reddish brown, indicating good drainage, it is classed in the Milton series. Where the soil is gray to yellowish gray and rock lies close to the surface it is included in the Randolph series.

The dark soils of the shallow-drift region, where bedrock occurs in the 3-foot section and where the surface soils are dark gray to brownish black and the subsoils drab, are included in the Millsdale series.

The well-drained soils of the terraces with reddish-brown surface soils and subsoils are included in the Fox series. The dark-gray to dark-brown alluvial soils are classed in the Genesee series, and the black soils in the Wabash series.

In the following pages of this report the soils of Miami County are described in detail and discussed in their relation to agriculture. The table below gives the name and the actual and relative extent of each type:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami silt loam .....	20, 736	23. 5	Fox silt loam .....	10, 496	4. 0
Shallow phase .....	36, 736		Milton silt loam .....	2, 368	3. 9
Level phase .....	3, 776		Deep phase .....	7, 296	
Crosby silt loam .....	36, 480	18. 2	Terrace phase .....	576	
Undulating phase .....	8, 704		Miami clay .....	6, 080	2. 3
Mixed phase .....	2, 368		Bellefontaine loam .....	4, 032	1. 6
Brookston silty clay loam .....	36, 736	14. 8	Millsdale silty clay loam .....	2, 880	1. 1
Mixed phase .....	768		Randolph silt loam .....	2, 624	1. 0
Heavy phase .....	768		Wabash silt loam .....	2, 624	1. 0
Terrace phase .....	384		Fox loam .....	1, 600	. 6
Bellefontaine silt loam .....	21, 504	8. 2	Clyde silt loam .....	1, 408	. 5
Genesee silt loam .....	19, 200	7. 4			
Conover silt loam .....	16, 320	6. 3			
Miami silty clay loam .....	14, 656	5. 6	Total .....	261, 120	.....

## BELLEFONTAINE LOAM.

The Bellefontaine loam to a depth of 10 to 12 inches typically consists of a yellowish-brown to brown, mealy fine-textured to distinctly gritty loam, which changes quite abruptly into gritty, gravelly, reddish-brown clay loam. This becomes calcareous at 18 to 22 inches, the gravel gradually increasing until below 27 to 30 inches the material is usually a friable, highly calcareous gravelly loam, reddish brown to yellowish brown and occasionally yellow in color. The surface soil when dry becomes grayish brown in some places, especially where the material is a fine loam. In other areas it may have a reddish tinge. The heavy subsoil shows some stickiness, which is more pronounced as calcareous material is approached.

There is no distinct natural boundary between this type and the Bellefontaine silt loam, the line as drawn being in most places more or less arbitrary. In general the silt loam occupies the gently rolling areas and the loam the steep and very hilly areas. The surface soil of the Bellefontaine loam varies from a few inches to over 1 foot in depth. The shallower areas are really Bellefontaine clay loam, while the deeper areas are more silty, resembling the Bellefontaine silt loam.

As mapped the Bellefontaine loam includes small areas of silt loam, sandy loam, gravelly loam, and clay loam. Where the gravelly areas are large enough they are indicated by means of symbols, but the areas of silt loam, which usually occur in situations protected from erosion; of clay loam, which are badly eroded; and of sandy loam are too small to show on the map.

The Bellefontaine loam is confined to the terminal moraine of the later Wisconsin glaciation. It has a pronounced morainic topography. Steep narrow ridges or kames, frequently gravel topped, alternate with deep, narrow valleys and kettle holes. Most of the land is so steep that erosion is excessive when cultivation is attempted. Drainage, both surface and internal, is excessive.

The type is only moderately important agriculturally. Approximately one-fourth of it is in the original forest, composed principally of sugar maple with some walnut and oak. The area south of Honey Creek is not so steep and broken and farming is carried on here without serious difficulty. The type is used for general farm crops. Where the land is not steep the yields of corn, wheat, oats, and clover are nearly as good as on the Bellefontaine silt loam. Corn, however, seems consistently to produce slightly lower yields, owing to the droughty nature of the subsoil. Much of the steeper land is in bluegrass pasture, to which the soil is very well adapted. Some alfalfa is grown and the crop is apparently successful.

As a rule only the lighter agricultural implements are used on this type, and tillage therefore is generally not as thorough as on the Bellefontaine silt loam. On the steeper areas little or no fertilizer is used, not much attempt being made to improve the soil. On the more undulating areas the farming practices are similar to those on the silt loam.

The more broken areas of the Bellefontaine loam can be bought for \$75 or less an acre. The less hilly land is held at \$150 an acre or more.

On the more undulating areas of this type the soil should be plowed deeper and treated with green manure. Wheat is a satisfactory crop on this soil. Where possible it should be followed by clover. The steeper areas should be used as pasture and orchard land and for the growing of alfalfa, clover, and timothy. The presence of lime in the open, permeable subsoil makes the type well suited to alfalfa where the subsoil is not too open and the surface soil therefore droughty. Alfalfa should be given a thorough trial on this soil. Tile drainage is needed on the Bellefontaine loam in places. On seepy slopes the reddish clay subsoil puddles and becomes refractory and unproductive.

The following table shows the results of the mechanical analyses of samples of the soil, subsoil, lower subsoil, and lower substratum of the Bellefontaine loam:

*Mechanical analyses of Bellefontaine loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271701, 271734, 271744.	Soil.....	2.4	5.8	4.0	15.5	8.9	48.0	15.3
271702, 271735, 271745.	Subsoil.....	2.7	7.0	4.1	13.0	7.9	36.5	28.8
271736, 271746.....	Lower subsoil..	2.4	4.5	2.8	15.4	12.2	34.1	28.7
271737.....	Lower substratum.	2.0	5.8	4.4	21.4	13.1	18.7	18.7

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>3</sub>): No. 271746, 3.70 per cent.

#### BELLEFONTAINE SILT LOAM.

The Bellefontaine silt loam consists of about 10 to 12 inches of slightly gritty silt loam, tinted with dull reddish brown, merging through a 3 or 4 inch zone into a dull reddish brown clay loam. This upper subsoil layer becomes slightly gravelly at 20 to 24 inches, and increases in friability and in gravel content with depth. Usually the lower part of the 3-foot section consists of a yellowish-brown, highly calcareous, gravelly loam. Owing to a small content of or-

ganic matter the surficial 7 or 8 inches of soil has a slightly brownish gray color which tends to obscure the reddish-brown and chocolate-brown tints, but in moist tilled fields the surface soil always shows a rich brown color, which is more pronounced at a slight distance than upon close examination of a boring. The type is sometimes spoken of as "red land" or "red clay," but in classification it is really to be considered a brown soil.

The gravelly material in the lower part of the 3-foot section is very largely limestone, but considerable granitic material is present. Most of the fragments are small, and the soil can usually be penetrated with the auger. At greater depths the material is usually composed of a mixture of sand, gravel, and rounded bowlders, relatively low in fine, earthy material. In some places the deeper material is really a gravelly till. The most characteristic feature of this type is its rich brown color; this, together with the complete absence of gray mottling in the subsurface and of dark iron streaks in the lower subsoil, serves to distinguish it from the corresponding member of the Miami series.

As mapped the Bellefontaine silt loam varies considerably. The surface silt loam ranges from 8 to 16 inches in depth. In the shallower areas the change from the silt loam surface soil to the clay loam subsoil takes place within 2 or 3 inches, while in those areas where the silt is approximately 16 inches deep there is a 4 or 5 inch zone of friable silty clay loam or light clay loam between the true surface soil and the subsoil. The areas of shallow and deep silt, which depend upon differences in topography and resultant erosion, are associated with areas of shallow and deep gravelly material, respectively. In the less eroded areas calcareous material may not be encountered in the 3-foot section. The areas in which the surface silt loam is 8 inches or less deep really constitute a shallow phase, but this occurs so intimately associated with the typical soil, as a result of the sudden transitions characteristic of morainic topography, and frequently in such small areas that its separation in mapping is not warranted.

The Bellefontaine silt loam is intimately associated with the Bellefontaine loam, Miami silt loam, and Miami silt loam, shallow phase. It is very difficult to separate from the Miami soil in places. As mapped it includes small areas of Bellefontaine loam and Miami silt loam. The Bellefontaine silt loam occurs quite extensively within terminal-moraine areas and in areas of valley filling along the Miami and Stillwater Rivers and Brush Creek. Typical areas are mapped in central Staunton Township, in Elizabeth Township south of Cass-town and south of Alcony, and north of Brandt in Bethel Township. Less typical are the small areas in Monroe Township and the large area in western Bethel Township.

The glacial material giving rise to the Bellefontaine silt loam is generally quite deep, although in some places the bedrock is only about 4 feet below the surface. The topography is for the most part gently rolling. Several areas are very nearly level, while others are so distinctly morainic or so rough as to be subject to considerable erosion. Drainage, both surface and internal, is excellent. Only on some level areas and seepy ridge slopes is artificial drainage necessary.

The Bellefontaine silt loam is an important soil. It is practically all cleared and in a high state of cultivation. A small part of the type is forested, largely with sugar maple and walnut. The soil is frequently called "sugar-tree land." It is considered one of the most valuable general-farming soils of the county, aside from the dark-brown and black soils. The principal crops grown are corn, wheat, oats, and tobacco, with considerable clover and timothy and some alfalfa. The type is one of the best wheat and tobacco soils of the county, and it is also well suited to clover and alfalfa. The yields of corn vary from 40 to 60 bushels per acre, wheat from 15 to 25 bushels, oats 30 to 50 bushels, and tobacco 1,200 to 1,600 pounds.

On most farms the Bellefontaine silt loam is tilled with modern implements. With proper care an excellent seed bed is prepared, especially with the aid of double disks, spring-tooth harrows, and straight-tooth harrows. The soil is plowed to a moderate depth.

Commercial fertilizers are used to a considerable extent on this soil, especially in growing wheat and tobacco. Complete fertilizers have been used for the most part, but there is a tendency at the present time to use more acid phosphate. Applications range from 100 to 200 pounds per acre.

Farms composed largely or entirely of the Bellefontaine silt loam sell for \$150 to \$200 an acre, depending almost entirely on the nearness to towns. Practically all the farms are provided with good buildings and are in a high state of improvement.

This soil is in a high state of productiveness at the present time, but its limit has not been reached. Artificial drainage would be beneficial on the more nearly level areas and on seepy slopes. The lower part of the 3-foot section is nearly everywhere calcareous, but it must not be assumed from this that liming would not be beneficial, especially in growing such crops as clover and alfalfa. Both of these crops grow well without treatment, but the surface and sub-surface material is not calcareous and alfalfa reaches its maximum development only when calcium carbonate is present in both surface soil and subsoil. With the use of ground limestone this soil, with its excellent natural drainage and calcareous lower subsoil, is almost ideally suited to alfalfa, and a much larger acreage should be devoted to this profitable crop.

This soil is low in organic matter, which should be added by the use of green-manure crops, preferably the legumes. In the areas

where the silt is 10 inches or less in depth, deeper plowing should be tried, especially in connection with green manuring. The gradual incorporation of organic matter and subsoil material into the surface soil is an experiment well worth trying, especially in view of the splendid yields of corn, wheat, and other crops frequently obtained on eroded areas.

#### MIAMI SILT LOAM.

The surface soil of the Miami silt loam is a yellowish-tinted, brownish-gray silt loam, 7 to 9 inches deep, underlain by a slightly more compact, pale-yellow and gray mottled silt loam which becomes slightly heavier at 15 to 16 inches and merges through a 3 or 4 inch zone of friable silty clay loam into a stiff, dull-brown clay loam, well streaked with dark iron stains. The subsoil at 27 to 30 inches becomes more friable and calcareous, and the extreme lower part of the 3-foot section consists of slightly weathered, loose, friable till.

Over a large part of the type the silt loam is only 12 inches deep and the till is encountered slightly below 20 inches. These areas represent a gradation toward the shallow phase, while other areas represent gradations toward Conover silt loam and Crosby silt loam. In the areas in Newberry Township north of the Union Moraine the subsoil is almost identical with that of the Miami silty clay loam, being too heavy for typical Miami silt loam. Some areas represent a gradation toward the Bellefontaine silt loam, especially those in Elizabeth and Bethel Townships.

The Miami silt loam occurs in small areas widely distributed over the county, occupying smoother areas of the terminal moraine and slightly rolling areas of the ground moraine near streams, where erosion has not been rapid enough to remove the silt perceptibly faster than it has accumulated by weathering. The surface of the type is gently rolling, with little variation, since the soil-forming material gives rise to the Crosby silt loam in the level areas and to the shallow phase of the type or to the Bellefontaine silt loam where the topography becomes sharply to steeply rolling.

The Miami silt loam has good surface drainage but only moderately thorough internal drainage. This lack of internal drainage is probably responsible for the slight degree of maceration that has taken place, as evidenced by the localization of mineral matter in the soil, giving rise to mottling, precipitates, streaking, and concretions. In some way, at present little understood, these factors very distinctly lower the producing power of the soil.

The Miami silt loam is relatively unimportant agriculturally. It is quite extensive, but it occurs in small areas, and a type of agriculture especially adapted to the soil has not been developed. Nearly all of the type is under cultivation, but numerous isolated patches of

the original growth of beech, sugar maple, oak, and elm remain. The cultivated areas are in a fair state of improvement, and some of the farms are highly improved. The type is well suited to general farming, and the yields are quite satisfactory, although they average lower than those obtained on good areas of Bellefontaine silt loam. Clover does well and is quite generally included in the rotation with corn, oats, and wheat.

Land values on the Miami silt loam vary from \$100 to \$150 an acre, depending upon the nearness to shipping points and markets.

The more extensive use of lime on this soil would result in a more luxuriant growth of clover and would render possible the growing of alfalfa, provided seepy areas were previously tile drained. The liberal use of green manures would also be beneficial.

*Miami silt loam, shallow phase.*—The surface soil of the Miami silt loam, shallow phase, is a brownish-gray to yellowish-gray, slightly gritty, very friable silt loam, 7 to 9 inches deep. On the average it contains more yellow and brown than the surface soil of the typical Miami silt loam, but it is distinctly less brown than the surface soil of the Bellefontaine silt loam or loam, and beaten fields frequently appear light gray. The surface material typically contains an appreciable amount of sharp grit and is very low in clay, so that it is more friable than the surface soil of the typical Miami silt loam. The surface layer rests directly on the subsoil of brown to dull yellowish brown, slightly gritty clay loam. This is tough and stiff, but less plastic than that of either the true Miami silt loam or the Bellefontaine silt loam. The tough clay loam gives way quite suddenly at 17 to 20 inches to a friable, highly calcareous, gritty and gravelly clay loam to loam, yellow to bright brassy yellow in color. This till material is composed largely of rounded and subangular fragments of limestone, but granitic material is also present in appreciable quantities. The material is unusually well ground up, and it can nearly everywhere be penetrated to the depth of 36 inches with the soil auger. No slabs of rock are encountered. There appears to be more granitic material than in the case of the Crosby silt loam and less than in the case of the Bellefontaine loam or silt loam. The gravelly fragments are on the average smaller than those under the Bellefontaine soils.

The changes from surface soil to subsurface layer and thence to subsoil are quite abrupt. The surface material is texturally a silt loam, but it approaches a loam in properties. It contains as much sand as many loams, but the proportion of clay is so low that the silt constitutes over 50 per cent. The surface soil is sometimes less than 7 inches deep where the topography is quite steep and erosion has been active. This is the case on the morainic knobs and on the dissected areas near the streams. In other places where the topog-

raphy is distinctly morainic the soil and subsoil are brownish, representing a gradation toward the Bellefontaine silt loam. In some of the more nearly level areas the surface soil is quite gray and the upper subsoil is slightly mottled, with more extensive iron streaks below. This is true of some of the phase in south-central Lost Creek and north-central Elizabeth Townships and in part of the area northwest of Brandt. The areas along the streams in the ground-moraine region of the county owe their topography to stream erosion and are frequently less gritty than the areas of the terminal-moraine region.

The shallow phase of the Miami silt loam is intimately associated with the typical Miami, the Conover, and the Bellefontaine silt loams. It is usually distinct from the first two soils since they occupy smoother areas, but the line of separation from the Bellefontaine silt loam is indistinct in places, particularly just north of Casstown, in north-central Staunton Township, and between Nashville and Frederick. Here the tough subsoil frequently has a reddish tinge, but it contains dark iron streaks and lacks the rich chocolate brown plastic clay loam of the Bellefontaine series.

The phase is extensively developed throughout the eastern part of the county and in scattered areas near streams. In the latter situations it represents eroded areas resulting from stream action, and in the former it shows the knob and sag topography characteristic of morainic regions. In many cases low knobs alternate with shallow kettle holes so intricately that the surface may be designated as subdued kame and kettle topography. In many of these areas the thin veneer of friable silt is surprisingly uniform in depth over depressions, slopes, and knolls. This phenomenon, together with the fact that some areas are so nearly level that very little erosion could have taken place, makes it seem that the soil is not in every case an erosional phase of the Miami silt loam, but that more probably the soil-forming material for some other reason has not been weathered to ordinary depths. The phase is distinguished by five criteria, viz, its morainic topography, shallow and friable surface soil, tough subsoil, shallow and friable till, and grittiness throughout surface soil and subsoil.

The shallow phase of the Miami silt loam is an important soil. It is used for general farming, with wheat perhaps the leading money crop. The original forest growth, which consisted of widely varying combinations of sugar maple, oak, hickory, beech, and ash, has been largely removed, and only scattering woodlots remain. Many of the farms are in only a moderate state of improvement. Corn is not produced extensively, and tobacco on only a few farms. The type of farming practiced has not been such as to get the best results from this soil and, as a result, it is frequently undervalued. Owing to the fact that the shallow, friable, mellow, surface soil is

directly underlain by the tough clay loam subsoil, farmers have neglected deep plowing, and a well-defined plowsole has been formed.

Under the present methods of farming, corn on this phase yields 35 to 40 bushels per acre, oats 30 to 40 bushels, wheat 10 to 20 bushels, and hay three-fourths to 1½ tons. The farming methods are not the best, cultivation being done with the lighter tools. Plowing is done almost entirely with 2-horse plows. The seed bed is easily prepared and is usually worked up into good condition. Fertilizers are used to some extent.

Better tillage methods should be used on this phase. The soil should be plowed deeper and the plowsole already formed broken up. The subsoil, while tough, is not refractory. It is not especially high in clay and contains enough grit to impart some friability, but, most significant, it is underlain at very shallow depths, 17 to 20 inches, by a loose, friable, and highly calcareous stratum. Deeper plowing, subsoiling, and possibly very deep tiling should be tried in an effort to make the roots penetrate the lower subsoil. It is an interesting fact that yields are highest on the eroded areas, provided there has been sufficient weathering after the erosion. Erosion and weathering has resulted in a breaking up of the clay loam subsoil, permitting penetration by roots. With good farming methods alfalfa should prove successful. More legumes should be included in the rotation, and rotations should be more systematically planned and adhered to than is done at present. It is possible that alfalfa started with the aid of a light application of limestone might be able to penetrate the present subsoil and improve the structure of the phase without preliminary deeper tillage.

*Miami silt loam, level phase.*—The surface soil of the level phase of the Miami silt loam consists of a brownish-gray, smooth, friable silt loam, about 8 inches deep, underlain by a pale-yellow to yellow and gray mottled, rather compact silt loam extending to a depth of about 16 inches. This subsurface material is quite different in appearance from the surface soil. In general the upper part of it is pale yellowish, while the lower part contains light-gray mottlings and dark streaks. These gray mottlings are small and rather indistinct as compared with the large ashy-gray mottlings in the lower part of the subsurface layer of the Crosby silt loam. The surface soil is quite low in organic matter and tends to become compact and clod. Moist plowed fields appear light brown to brownish gray, but beaten fields have a light-gray to almost white appearance. Occasionally the surface soil is tinted with yellow.

The subsoil is very similar to that of the typical Miami silt loam, consisting of a dull-brown, stiff, plastic clay loam well streaked and mottled with dark iron stains. It is underlain at 27 to 34 inches by friable, gritty, slightly gravelly, calcareous clay loam which becomes more friable with depth and grades from dull brown to yellow. The

extreme lower part of the 3-foot section is frequently a yellow, incoherent mass of subangular gravel, sand, and clay. In some cases till is not encountered in the 3-foot section. The level phase is very similar to the typical Miami silt loam, but the surface silt loam is deeper and the calcareous till is encountered at lower depths, owing to the comparative absence of erosion.

The level phase of the Miami silt loam occurs for the most part on the broad divide between the Miami and Stillwater Rivers in Monroe Township. The phase occurs in level areas which in other sections are ordinarily occupied by the Crosby silt loam, and it seems probable that the bedrock, which here is only 6 to 8 feet below the surface, has provided sufficient underdrainage to prevent the type of weathering that gives rise to the Crosby silt loam. The second most extensive development of the phase is northeast and southeast of Cass-town, and in part of this region, at least, the bedrock occurs at depths of 7 to 8 feet.

This phase is of rather minor importance agriculturally. It is a good general-farming soil, and satisfactory yields of wheat, corn, oats, clover, and timothy are obtained. Some tobacco is grown, and 900 to 1,500 pounds per acre are obtained. Wheat, one of the principal money crops, yields 10 to 20 bushels per acre. Modern machinery is used on most farms, and some commercial fertilizer is applied. Land values range from \$125 to \$175 an acre, depending on the nearness to markets and shipping points and the state of improvements.

This soil responds readily to good management. The methods suggested for the typical Miami silt loam would prove equally profitable on this phase.

The results of the mechanical analyses of samples of the soil, subsoil, lower subsoil, and substratum of the typical Miami silt loam, and of the soil, subsoil, and lower subsoil of the shallow phase, are shown in the following table:

*Mechanical analyses of Miami silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
<b>Typical:</b>		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271772.....	Soil.....	0.6	1.9	1.6	6.2	8.6	67.3	13.7
271773.....	Subsoil.....	.7	2.0	1.6	5.6	8.0	64.5	17.5
271774.....	Lower subsoil..	.9	2.0	1.8	7.0	8.0	53.4	27.1
271775.....	Substratum.....	1.7	4.4	3.2	14.0	14.9	40.6	21.3
271776.....	.....do.....	1.0	3.0	2.2	10.6	9.6	39.9	33.5
<b>Shallow phase:</b>								
271728.....	Soil.....	1.0	3.4	2.5	10.6	10.6	58.4	13.1
271729.....	Subsoil.....	2.0	3.5	2.1	10.2	10.7	40.9	30.4
271730.....	Lower subsoil..	3.2	6.0	3.6	12.7	12.6	40.4	21.6

The following samples contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>2</sub>): No. 271730, 37.09 per cent; No. 271775, 26.34 per cent.

## MIAMI SILTY CLAY LOAM.

The surface soil of the Miami silty clay loam consists of a smooth, heavy, yellowish-gray silt loam to light silty clay loam, 7 to 8 inches deep. In beaten fields it appears light gray, but close inspection reveals more or less yellow. The surface soil is low in organic matter. It becomes heavier in the lower part, and grades into a dull-brown, light silty clay loam which below 10 inches is smooth and plastic but not sticky. Some mottlings occur in the more nearly level areas, but they seldom extend below 10 inches. The subsurface layer becomes heavier with depth, and at an average of 15 inches the material is a heavy, plastic silty clay loam or silty clay streaked with dark iron stains. In the more rolling areas the subsoil is dull brown, but in the more nearly level areas, where the upper part of the subsurface layer is mottled, the subsoil color is a mingling of dull brown and lead gray. The plastic silty clay loam layer gives way gradually at 24 to 27 inches to a clayey till containing fragments of limestone and shale and varying from yellowish brown to slate yellow in color. This unweathered layer is high in clay and shows a striking contrast to the friable till underlying the silt loam soils of the county. The rock fragments are small and the material is readily penetrated with the soil auger.

The Miami silty clay loam is, on the whole, quite uniform. Its general outer boundary east of the Stillwater River is coincident with that of the Union Moraine. East of Bradford, where Harris Run and Stillwater River have badly dissected this moraine, the subsoil material on the slopes resembles the friable till of the Miami silt loam, shallow phase, and the boundary between these two soils is arbitrarily drawn. The larger content of limestone and friable material in the subsoil in these areas may be due to the fact that the streams have cut through the layer of the heavier boulder clay into material which is of the same origin as that in the principal ground-moraine area, but which was buried by the heavier boulder clay of the Union Moraine. In sections 35 and 36, east of Bloomer, where the type is interspersed with areas of the heavy phase of the Brookston silty clay loam, the topography is almost level and the surface soil closely resembles that of the Crosby silt loam, but the subsurface and subsoil layers and the lower till partake so much more of the nature of the Miami silty clay loam that the soil is classed with this type. Numerous other nearly level areas represent a similar variation from the type. In sections 7 and 12 north of Clayton and in section 14 southeast of Blind Corners the yellowish-gray silt loam is quite friable and extends to a depth of 10 or 11 inches, but because of the resemblance in the subsoil it seems better to include these areas with the silty clay loam than with the silt loam. The presence

of the slick, slightly brittle, dull-brown subsurface zone, underlain by heavy, plastic silty clay loam to silty clay, is considered a criterion of sufficient importance to cause the soil to be classed with the heavier member of the series.

The Miami silty clay loam is confined to the northwestern corner of the county. It occurs on, and to the northwest of, the Union Moraine. The surface is typically undulating, but some included areas are quite rolling and others nearly level. The more nearly level areas represent a gradation toward the Crosby silt loam, and the more rolling areas a gradation toward the Miami clay. Surface drainage is fairly good, but the dense, rather impervious subsoil causes internal drainage to be insufficient.

The Miami silty clay loam is an extensive type. In the region occupied by this type the farm improvements are of moderate cost (Plate I, fig. 1) and the land is recognized as having a relatively low agricultural value. Most of the type is cleared and farmed, hay (clover or timothy), wheat, corn, and oats being the principal crops. Some tobacco is grown. The soil is not very well adapted to corn, and cattle and hog raising is not extensively carried on. Corn yields 30 to 40 bushels per acre, oats 30 to 40 bushels, and hay three-fourths to 1½ tons. Considerably lower yields are often obtained, due to the puddling or ill handling of the soil when wet.

This soil is heavy and rather difficult to work, especially below a depth of 6 inches, and there is a tendency to plow rather shallow. The attempt to prepare a good seed bed is sometimes abandoned if plowing and adverse weather conditions have caused cloddiness. Commercial fertilizers are used at the rate of 100 to 200 pounds per acre. Land of the Miami silty clay loam ordinarily sells at \$65 to \$125 an acre. Only the very highly improved farms sell at higher prices. Improved roads traverse the type, and it is nowhere far from shipping points.

One of the main needs of this type is more thorough pulverization of the seed bed. This requires care in plowing the soil at the proper moisture content. Deeper plowing would no doubt be beneficial, but because of the heavy nature of the subsurface material it can be done only at considerable expense. On account of the tendency of the freshly exposed material to puddle, deeper plowing would have to be done gradually and in the fall, preferably in connection with green manuring. Clover does quite well on this soil, and it would no doubt grow more luxuriantly with moderate liming. The rank growth of sweet clover near the limestone roads indicates that this class of legumes could be grown with applications of lime. The use of green manuring with legumes is highly advisable. Better drainage is needed over much of the type.

The results of the mechanical analyses of samples of the soil, subsoil, lower subsoil, and substratum of the Miami silty clay loam are shown in the following table:

*Mechanical analyses of Miami silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271777.....	Soil.....	0.9	2.7	1.7	8.9	8.8	56.0	20.8
271778.....	Subsoil.....	.7	1.8	1.4	6.9	6.1	43.9	38.9
271779.....	Lower subsoil...	.9	2.1	1.4	7.8	8.6	39.4	39.7
271780.....	Substratum.....	2.3	3.6	2.0	9.2	8.8	44.5	29.4

The following samples contained more than one-half of 1 percent calcium carbonate ( $\text{CaCO}_3$ ); No. 271779, 4.43 per cent; No. 271780, 3.21 per cent.

#### MIAMI CLAY.

The Miami clay consists of a dull-brown, stiff, heavy clay loam, about 7 inches deep, changing quite abruptly into a dull-brown, plastic silty clay, which in turn gives way at 17 to 18 inches to a more friable clay loam containing fragments of limestone. The surface material is heavy and on drying breaks into small cubes. The type represents areas of weathered limestone till, in which erosion has been so active that little or no silt has accumulated on the surface. Where the type represents eroded Miami silt loam the till is nearer the surface than in the areas bordering the Miami silty clay loam. In fact, in the former areas the material is sometimes calcareous at the surface. In the latter areas the till material is not as heavy as that under the Miami silty clay loam, probably owing to the fact that the streams have cut down through the heavier till material so that the present steep slopes are covered with a mingling of the two kinds of drift.

The Miami clay occupies steep and eroded areas next to the large streams. Some of these narrow valleys, such as those west of Pleasant Hill, are almost canyonlike. Agriculture can be carried on only with difficulty. Washing and gullyng are quite active, and little effort is made to prevent erosion. Probably less than one-half of the type is cleared and farmed. Only the lighter agricultural implements are used.

It is doubtful whether cultivation is profitable on this type. Where the type is cultivated contour plowing and other means of preventing erosion should be followed. Alfalfa could probably be grown if care were used in preparing the seed bed and in supplying the nurse crop. The soil should never be plowed except when at the best moisture content. If very moist it is somewhat sticky, and when slightly dry it becomes very hard and cloddy.

In the following table are shown the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Miami clay:

*Mechanical analyses of Miami clay.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271781.....	Soil.....	1.0	2.5	2.4	13.4	11.0	34.5	34.9
271782.....	Subsoil.....	.6	2.4	2.0	12.4	10.0	33.3	39.1
271783.....	Lower subsoil...	4.6	4.9	2.8	10.6	10.9	38.4	28.0

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 271782, 7.52 per cent; No. 271783, 29.15 per cent.

#### CROSBY SILT LOAM.

The 3-foot section of the Crosby silt loam includes four zones. The surface soil is a light-gray, friable, smooth silt loam, with an average depth of about 7 inches. When moist it has a peculiar dull leaden gray shade. Its content of organic matter is very low and in plowed fields it appears almost white. Some small iron concretions are present. The surface material is a light-gray to ashy-gray compact silt loam, streaked with dark iron stains and frequently tinted or speckled with pale yellow. This gray layer usually extends to a depth of 12 inches and rarely varies more than 1 inch in either direction. The upper subsoil consists of a dense puttylike, plastic silty clay loam of a peculiar dull-yellow or yellowish-slate color throughout most of its section, but containing large gray mottlings in its upper  $1\frac{1}{2}$  to 2 inches, which represents the transitional zone from silt loam to silty clay loam. Dark iron streaks and small iron concretions are also present. This dense silty clay loam layer gives way abruptly at 27 to 30 inches to a friable, highly calcareous clay loam or heavy loam. This contains fragments, chiefly limestone, varying from coarse sand to subangular gravel, the latter seldom reaching a diameter of three-fourths inch.

There are some areas in which the gray layer is almost negligible and where the subsoil is dull brown. These represent a gradation toward the undulating phase, and they are so classed where large enough to map. In macerated soils the extremely poorly drained areas generally have a heavier gray layer, but this is not the case in the Crosby silt loam, since the surface soil turns dark very readily, and even in slight depressions the Brookston silty clay loam is developed. The more poorly drained areas of Crosby silt loam have a steel-gray surface soil, a mottled yellow and gray subsurface soil, and a yellow and drab mottled, silty clay loam subsoil. These areas repre-

sent a gradation toward the Brookston silty clay loam. The beaten surface here appears nearly white, but an examination of the material from borings does not reveal the peculiar dull-gray characteristic of the typical soil.

The Crosby silt loam occurs widely distributed throughout the ground-moraine section of the county. It is very closely associated with the Brookston silty clay loam, and includes numerous areas of that type too small to show on the map. The surface is distinctly flat; in some previous surveys the Crosby silt loam has been mapped as a flat phase of the Miami silt loam. Only very faint undulations occur on the typical areas. Drainage, both surface and internal, is very poor throughout the type. Water stands on the surface after heavy rains, and the subsoil is so dense and plastic that air and water movement is very much hindered. During the spring months the soil has a peculiar mushy structure when water-soaked, giving rise to the local name of "slush land."

The Crosby silt loam is one of the most important soils of the county. Its level surface permits farming on an extensive scale, and it is almost entirely cleared and cultivated. Only scattering woodlots of the original timber growth of beech, elm, oak, and ash remain. The original growth was predominantly beech, and this has given rise to the local name of "beech land."

This soil is so closely associated with the Brookston silty clay loam that the type of agriculture and the crops grown are largely adapted to meet the requirements of both these soils. General farming is carried on, with corn, oats, tobacco, hay, and wheat as the principal crops. Tobacco and corn are important money crops. The tobacco is cut in September, cured in large barns, and stripped and prepared for market during the winter. Much of the corn is sold direct to local dealers. Some farmers have taken up hog raising and use corn for feed. Clover grows quite satisfactorily and the acreage sown to this crop in rotation is steadily increasing. Considerable timothy is grown, but owing to the included small areas of Brookston soil the quality is not always first class.

The type of agriculture practiced on the level areas of Crosby silt loam and on the Brookston silty clay loam is quite profitable, and this is reflected in the general appearance of the buildings.

Corn on this type yields 35 to 50 bushels per acre, oats 25 to 40 bushels, wheat 10 to 15 bushels, and tobacco 900 to 1,200 pounds. These yields are only estimates, owing to the intermingling of the type with the Brookston silty clay loam. A small but increasing amount of commercial fertilizer is used on this soil. Two hundred pounds of ready-mixed product per acre is an average application, made generally on wheat or tobacco.

Farms composed of a mixture of this type and the Brookston silty clay loam are valued at prices ranging from \$150 to \$250 an acre, depending upon highway facilities, improvements, and tile drainage. The higher figures apply only to those farms in which the Brookston is the dominant type. Farms occupied only by the Crosby silt loam, as east of the Miami River, are valued at \$125 to \$150 an acre.

The Crosby silt loam responds readily to fertilization and the growing of legumes. The home mixing of fertilizers, with careful study of the response to different mixtures, would be very beneficial. Clover gives fair yields on this soil in its present condition, and no doubt much better results would be obtained with the use of ground limestone, large quantities of which are available at several quarries. Probably the most difficult problem in the improvement of this soil is the installation of artificial drainage. The question of how far apart and how deep the drains should be placed in order to obtain best results has not been determined. The fact that the deeper subsoil consists of moderately loose, highly calcareous material, sealed off by the dense upper subsoil, has an important bearing on this question. The dense subsoil probably would slowly loosen up with the drainage, permitting deeper rooting. The fact that all the areas of Brookston soil are tilled renders possible the tiling of the intervening areas of Crosby silt loam at a much lower figure than would otherwise be the case. Whether or not deeper plowing would encourage deeper rooting is uncertain. The reports of farmers as to the results of deeper plowing are conflicting, but in general it is agreed that no benefit is obtained. However, the varying conditions under which such trials have been made render definite conclusions impossible.

*Crosby silt loam, mixed phase.*—In some areas of the Crosby silt loam the patches of Brookston silty clay loam are so prominent that the soil has a different agricultural value from that of the typical Crosby soil, notwithstanding the developments of Brookston soil are too small to show separately on a map of the scale used. These areas are therefore shown as a mixed phase of the Crosby silt loam. The two types are quite distinct in topography, the higher land being occupied by the Crosby silt loam. In some places as a result of low swells the drainage is sufficient to make the soil resemble the undulating phase of the Crosby silt loam more than the typical soil.

*Crosby silt loam, undulating phase.*—The undulating phase of the Crosby silt loam consists of a brownish-gray to light-gray silt loam, 7 to 8 inches deep, underlain by a compact, ashy-gray to light-gray and yellowish mottled silt loam which extends to a depth of about 12 inches and changes to a dull-brown, plastic silty clay loam, mottled with dark iron stains. The subsoil is underlain at about 24 inches by friable, gravelly, calcareous till, similar to that underlying the typical Crosby silt loam.

The phase differs from the typical Crosby silt loam in that its surface is undulating to gently rolling, its gray layer frequently less ashy colored and less prominent, and its lower subsoil dull brownish and less dense. It is not so closely associated and interspersed with Brookston silty clay loam as is the typical soil, the slightly rolling topography having prevented the development of an extensive system of lakes such as has given rise to areas of Brookston soil.

The undulating phase of the Crosby silt loam is most extensively developed in the large area east of Piqua between the Miami River and Spring Creek, which is intermediate between terminal and ground moraine. Smaller areas are scattered throughout the true ground-moraine section of the county.

The agricultural value of the phase is higher than that of the typical soil, but the general selling value of the farming land is lower, for the reason that the phase contains less Brookston silty clay loam, or "black land."

#### CONOVER SILT LOAM.

The Conover silt loam consists of a slightly gritty, gray silt loam, 7 to 8 inches deep, underlain by a slightly lighter colored silt loam, which rests directly on the subsoil at 14 to 16 inches. The subsoil is a tough, dull-brown clay loam marked with dark iron stains, giving way abruptly at approximately 22 inches to a yellow, friable, calcareous gravelly loam. The surface material in some places extends without perceptible change to 16 inches, while in other places the subsurface material is lighter than the surface soil, being pale yellowish gray or slightly speckled with gray and streaked with iron stains. These latter areas represent a gradation toward the Crosby silt loam, and areas with a distinct gray subsurface layer are separated and mapped with either the typical Crosby silt loam or its undulating phase.

The surface soil of the Conover silt loam differs from that of the Crosby silt loam in that it is darker, does not pack together so firmly, contains more grit, and fewer iron concretions and more gravel are present. Calcareous till is encountered at less depth than in the Crosby soil. The Conover silt loam is really a gray, slightly acid, unmacerated soil, whereas the Crosby silt loam is a gray, macerated soil distinctly acid in the surface and subsurface layers.

The Conover silt loam is closely associated with the Crosby silt loam, Miami silt loam, and Miami silt loam, shallow phase, and it grades into each of these soils. It occupies the smoother areas of the terminal-moraine region of the northeastern part of the county. Its surface is undulating to gently rolling. As the surface becomes flatter the type almost invariably grades into the Crosby silt loam; where it

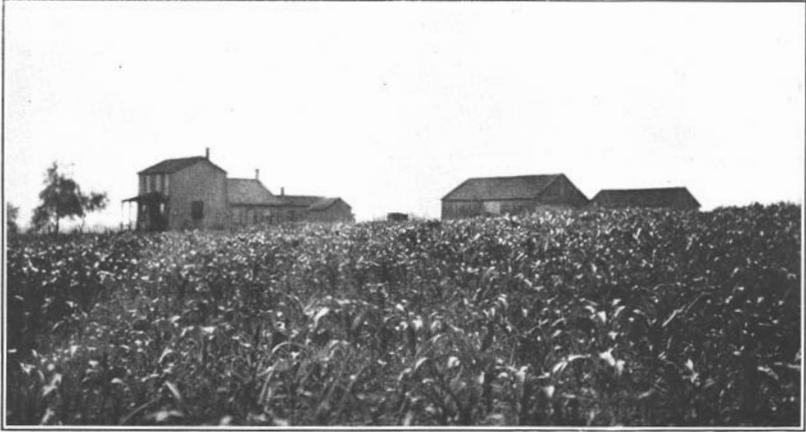


FIG. 1.—TYPICAL FARM BUILDINGS ON MIAMI SILTY CLAY LOAM.

Improvements of moderate cost are found in the poorer farming section of Miami County.

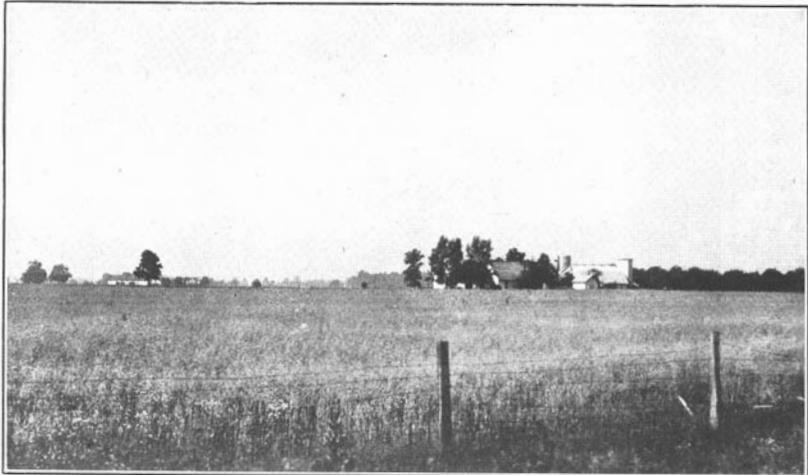


FIG. 2.—FARM BUILDINGS ON THE LEVEL AREAS COMPOSED OF CROSBY SILT LOAM AND BROOKSTON SILTY CLAY LOAM.

Improvements of this character are typical of the best farming sections of Miami County.

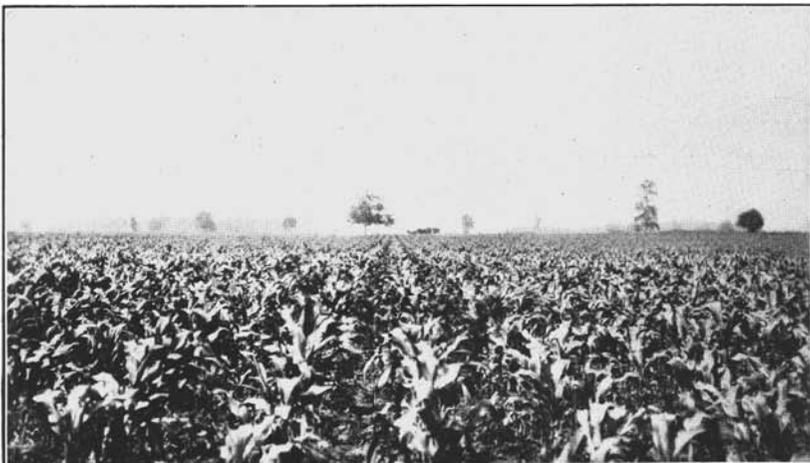


FIG. 1.—CORNFIELD ON BROOKSTON SILTY CLAY LOAM.

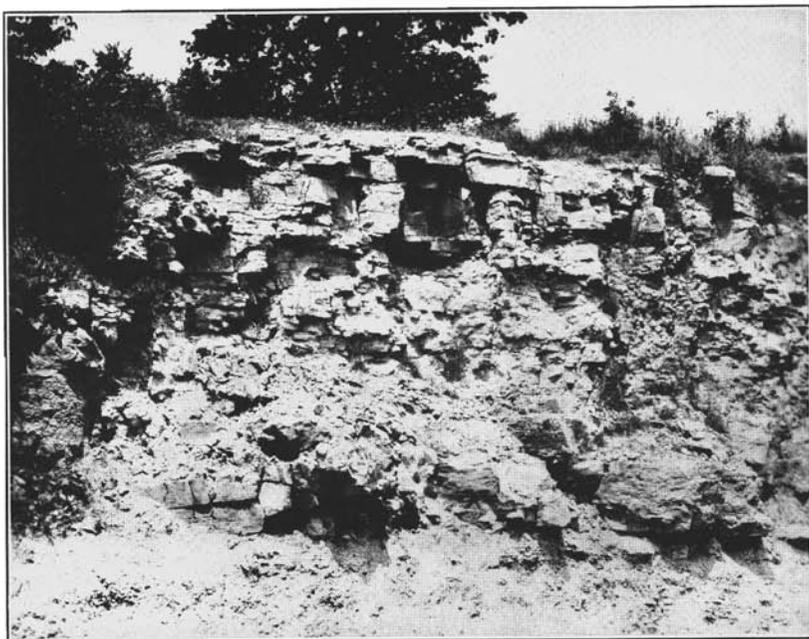


FIG. 2.—OUTCROP OF NIAGARA LIMESTONE.

The cracked and, therefore, pervious rock furnishes good underdrainage.

becomes sharply rolling or bumpy the surface silty material is more shallow and the soil is classed as Miami silt loam, shallow phase. Even here, however, there are encountered fairly distinct rolls and ridges on which the gray material is of sufficient thickness to warrant the classification of the soil as Conover silt loam. The surface runoff and underdrainage of this type are only fair.

The Conover silt loam is an important type agriculturally. It occupies extensive areas in Lost Creek, Brown, and Spring Creek Townships. Most of the type is cleared and in a moderate state of improvement. The original forest growth consisted largely of beech, with some oak, elm, and ash. Corn, wheat, oats, and timothy are the principal crops grown. Corn and oats are extensively grown in Brown Township. Timothy gives very good yields of a very high quality of hay. Corn yields 30 to 40 bushels per acre, oats 25 to 35 bushels, wheat 12 to 20 bushels, and hay 1 to 1½ tons.

Farms composed of this type sell for \$100 to \$150 an acre, depending largely on the improvements, nearness to pikes, and distance from markets.

One of the principal needs on this type is a better system of crop rotation. Corn and oats or corn, wheat, and oats are grown entirely too much in rotation without a legume. By the use of lime, clover could be satisfactorily grown; in fact, it grows fairly well without any soil treatment. The turning under of green crops would be beneficial.

#### BROOKSTON SILTY CLAY LOAM.

The surface soil of the Brookston silty clay loam is a dark-gray to brownish-black, heavy silt loam to light silty clay loam, 8 to 9 inches deep. Its black appearance when well moistened has given rise to the term "black lands." In most places dried plowed fields appear dark brown. The subsoil is a bluish-gray, plastic, silty clay loam with an indistinct streaking of yellow. This becomes more pronounced and the material more friable below 20 to 24 inches, and this lower section may be characterized as a golden-yellow and bluish-gray, mottled clay loam. Small gravel particles occur throughout the subsoil and become more prominent in the lower part of the 3-foot section.

The surface soil varies considerably in depth but comparatively little in texture, although in some borings it shows the properties of a silt loam. In many of the virgin areas the dark surface soil is barely 7 inches in depth. In other places it may be as deep as 15 inches, especially in the smaller areas of the morainic section east of the Miami River, where the type frequently occupies slight basin-shaped depressions. There is considerable color variation in the

subsoil. The subsurface layer may have prominent yellow streakings. In a few borings it has a bluish-black color and gives way gradually to a dark bluish gray deeper subsoil with little or no mottling of yellow. These areas with a bluish-black subsurface layer are associated with a deeper and darker surface soil. In some places the dark surface material, 15 inches deep, rests directly on a golden-yellow, bluish-gray streaked subsoil. As mapped the type includes every possible gradation between these different variations. In some places the surface soil is shallower in the large areas and deeper in the basinlike depressions; frequently the opposite is the case. The central part of an area may be drab in the subsurface layer and the outer part yellow, or vice versa.

The Brookston silty clay loam is very closely associated with the Crosby silt loam, but the boundaries between the two soils are, as a rule, quite distinct. As mapped, however, the Brookston silty clay loam unavoidably includes small areas of the Crosby soil. The type occurs principally in the ground-moraine section of the western and southwestern parts of the county. It occupies shallow depressions which at one time were a series of lakes and swamps. It lies at a slightly lower level than the Crosby silt loam, but the difference in topography is very slight. The Brookston silty clay loam also occupies scattered depressions throughout the terminal-moraine section of the eastern part of the county. The surface drainage and underdrainage of this type are very poor, and few attempts are made to farm it without improving the drainage by means of large open ditches or tile drains or both. Practically all the farmed area is tile drained.

The Brookston silty clay loam is one of the most important soils of the county, if not the most important. It is the most desirable extensive soil for general farming, and it is practically all cleared and in a high state of improvement. (Pl. I, fig. 2.) The original forest growth consisted of beech, elm, ash, oak, and some sugar maple. The predominance of elm has given rise to the local name of "elm ground." Corn is the principal crop grown on this soil. (Pl. II, fig. 1.) Tobacco is also extensively grown, being exceeded by corn alone as a money crop. Wheat, oats, clover, and timothy are also included in the rotation. Clover grows very well and the yield of timothy is high, but the hay is not of first-class quality in wet seasons. Hogs are raised in considerable numbers, and dairying is carried on in a small way. Corn yields 50 to 75 bushels per acre, and tobacco 1,500 to 2,000 pounds. Yields do not decline in dry years to the same extent as on the lighter-colored or "clay" soils. Yields of wheat and oats are variable, as the growth of straw is somewhat heavy and the grain sometimes chaffy. This is not the rule, however, and 30 to 50 bushels of oats and 15 to 25 bushels of

wheat may be taken as fair ranges of yields. Clover yields 1 to 2 tons and timothy 1 to 1½ tons per acre.

Modern implements are used on this soil, and the cultivation is quite thorough. Care is generally taken to cultivate under the proper moisture conditions. The surface soil cracks upon drying and clods somewhat if stirred while wet, but under ordinary conditions the soil is not hard to handle. Some fertilizer is used, and the quantity is steadily increasing. Most of the fertilizer is used on tobacco.

Land values on this type average nearly \$200 an acre. Some farms are held at prices as high as \$250 an acre. Graveled roads pass through the areas of this soil at short intervals, and it is all within fairly easy reach of markets and shipping points.

This soil is tile drained when farmed, but many of the drainage systems are not extensive enough to give maximum results. With more thorough underdrainage a better root system of crops could be developed and the feeding area of the roots increased. More care should be exercised in the preparation of the seed bed, and shallow cultivation should be given in times of drought to prevent drying and cracking of the surface soil and injury to the root systems. More organic matter, in the form of roughage or green manure, should be incorporated in the soil.

*Brookston silty clay loam, mixed phase.*—In addition to the typical Brookston silty clay loam, which includes some small unmappable areas of Crosby silt loam, it has been necessary to recognize a mixed phase, which includes much of the Crosby silt loam, but the Brookston silty clay loam is the dominant type. In this place the Brookston soil itself is frequently lighter colored than typical, representing a gradation toward the Crosby silt loam. In some places the Brookston silty clay loam is typical, but the areas of typical soil are too small to map separately.

*Brookston silty clay loam, terrace phase.*—The Brookston silty clay loam, terrace phase, is a brownish-black to black, rather heavy silty clay loam, 7 to 12 inches deep, underlain by a heavy, yellow and bluish-gray streaked silty clay loam or silty clay which merges into a friable, golden-yellow clay loam at 18 to 22 inches. It is underlain by friable sand and gravel. In the area south of West Milton and that northeast of Troy the surface soil is deeper and more silty than in the areas near Tippecanoe City. Borings of black silt loam, 24 inches deep, underlain by a bluish to dark bluish-gray subsoil were obtained in the small area northeast of Troy, indicating that it was originally very swampy and has received accumulations of wash from the surrounding higher lying areas.

This phase occupies poorly drained areas on gravel terraces. Its surface is level to basinlike, and the drainage therefore poor. The

phase is unimportant because of its small extent, but it is all cleared and farmed and highly prized.

This soil is heavy and difficult to work. Care must be exercised to plow at the proper moisture content, in order to obtain a good seed bed. One of the foremost needs is adequate tile drainage. Some tile has been laid, but there are some areas that have not been sufficiently tiled and are producing abnormally low yields.

*Brookston silty clay loam, heavy phase.*—The heavy phase of the Brookston silty clay loam consists of a dark-gray to brownish-black, heavy silty clay loam, 7 to 8 inches deep, underlain by a dark bluish gray, very plastic silty clay which extends to a depth of 36 inches with slight changes in color and texture. The lower foot is slightly more friable and more grayish, with occasional mottlings of yellow. The phase is distinguished from the typical Brookston silty clay loam by its heavier texture throughout the 3-foot section and by the almost complete absence of yellow in the subsoil.

This phase occurs within the region occupied by the Miami silty clay loam and represents the swampy accumulation mingled with heavier material which, under better drainage conditions has given rise to the Miami silty clay loam. The heavy phase occupies only very small areas, and has practically no effect on the agriculture. It is not as desirable as the typical soil, since it is more difficult to work, and requires more extensive tiling to effect adequate under-drainage. It is well suited to the production of corn, for which it is principally used.

The following table shows the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Brookston silty clay loam, and of the terrace phase and heavy phase of that type:

*Mechanical analyses of Brookston silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271731....	Soil.....	0.4	2.2	1.8	8.3	8.0	53.7	25.3
271732....	Subsoil.....	.6	2.2	1.8	7.4	6.8	53.2	28.1
271733....	Lower subsoil...	.6	2.3	2.0	8.6	7.4	48.8	30.1
Terrace phase:								
271791....	Soil.....	.8	2.4	2.0	8.2	7.8	51.4	27.4
271792....	Subsoil.....	1.4	3.2	2.2	9.0	8.2	48.9	27.0
271793....	Lower subsoil...	2.6	4.2	2.4	11.9	10.5	42.6	25.9
Heavy phase:								
271784....	Soil.....	.4	1.6	1.6	7.0	7.0	50.5	32.3
271785....	Subsoil.....	.4	1.4	1.0	6.4	7.4	48.0	35.4
271786....	Lower subsoil...	.4	1.8	1.2	7.0	8.2	47.4	33.7

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>3</sub>): No. 271731, 0.54 per cent.

## CLYDE SILT LOAM.

The surface soil of the Clyde silt loam consists of a black, friable silt loam, about 12 inches deep, underlain by a bluish-black, plastic silty clay loam to silty clay, which becomes bluish gray and somewhat more friable below 23 or 24 inches and is frequently marly. The sub-surface layer is in places black rather than bluish black. Occasionally it is bluish gray. The area of this type mapped in section 24, east of Tippecanoe City, is more nearly a clay loam.

The Clyde silt loam occurs in the eastern or morainic section of the county and is confined to those regions where the general topography is distinctly morainic. The soil has accumulated in swampy, basinlike areas and has received a considerable amount of rather highly calcareous wash from the surrounding ridges. The topography is flat to basinlike and drainage is extremely poor. The bluish color indicates that little oxidation of the iron compounds has taken place in the lower subsoil. Owing to its high organic matter and clay content the surface soil cracks badly in time of drought. The soil clods if stirred when wet, but when under proper moisture conditions a mellow seed bed is readily prepared.

This type is very inextensive and unimportant. It is all cleared and cultivated and used largely for the growing of corn, to which it is well adapted. Most of the type at the present time is underlain with some tile, but not all of it is sufficiently drained for the best development. Its very high natural productiveness would justify extensive drainage systems.

In the following table are shown the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Clyde silt loam:

*Mechanical analyses of Clyde silt loam.*

Number	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271747.....	Soil.....	0.4	1.2	1.0	5.6	8.9	61.8	21.2
271748.....	Subsoil.....	.9	2.1	1.4	8.7	10.4	54.4	22.0
271749.....	Lower subsoil...	2.4	4.4	3.0	12.6	12.9	46.6	18.0

The following samples contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 271748, 10.45 per cent; No. 271749, 2.65 per cent.

## MILTON SILT LOAM.

The surface soil of the Milton silt loam consists of 8 to 12 inches of brown, smooth silt loam assuming a chocolate tint when moist. It is low in organic matter and very high in silt, but it does not pack as much as the surface soil of the Crosby or even the Miami silt

loam. In plowed fields it appears somewhat grayish, but a faint reddish-brown tint serves to distinguish the type from the Crosby or Miami series. The subsoil is a reddish-brown, sticky, plastic silty clay, 20 to 30 inches deep, overlying bedrock. A few fragments of till are usually encountered in the lower part of the 3-foot section. Some decomposed rock fragments usually occur just above the bedrock.

Between the silt loam surface soil and the true subsoil there is in places a transitional layer of friable silty clay loam, usually 2 or 3 inches thick but in some cases ranging up to 12 inches in thickness. Aside from this variation and the varying depth to bedrock, the soil is very uniform. Small areas of the deep phase and of the Randolph silt loam are included in the type. Throughout the soil section there is a complete lack of the mottling and iron streaking characteristic of the more poorly drained types. The subsoil is one of the most characteristic features of this type. It is peculiarly sticky and plastic, this characteristic becoming more pronounced as the bedrock is approached, and portions from this part of the soil section are removed from the soil auger with difficulty. This reddish-brown subsoil where exposed in cuts presents a chocolate appearance, and on drying it cracks into small cubes.

The Milton silt loam occurs principally in the southwestern part of the county, near the Stillwater River in Union Township, where for some reason the deposit of glacial drift was very thin. Smaller areas occur on the rock hills of Monroe Township. The thin deposit of drift originally present here has almost entirely weathered away, and the present soil is in fact residual.

The surface of the Milton silt loam is nearly level, with just enough relief to give fair surface drainage. As the color of the soil indicates, underdrainage is good, owing no doubt to the cracked and broken nature of the bedrock. (Pl. II, fig. 2.) The regions occupied by this type abound in springs, and underground streams are common.

This type is not very extensive, but it is very productive and is one of the most highly prized soils of the county. The original heavy tree growth, consisting of sugar maple, with some oak and walnut, has nearly all been removed, and the farms are in a high state of improvement. The heavy virgin growth of sugar trees has given rise to the local name of "heavy sugar land." The type is used for diversified farming, with wheat, tobacco, corn, oats, clover, and timothy as the leading crops. Some alfalfa is grown successfully. Wheat and tobacco are the main money crops. Clover produces a very luxuriant growth and is quite generally included in the rotations. The range of average yields reported on this soil are: Wheat 15 to 30 bushels, tobacco 1,200 to 1,400 pounds, corn 40 to 60 bushels, and

oats 30 to 40 bushels. The soil is easily cultivated, and no special effort is necessary to obtain a good seed bed. Fertilizers are used to a small extent on tobacco and wheat.

Land values on this type range from \$125 to \$175 an acre, depending almost entirely on the improvements.

The Milton silt loam responds readily to the application of fertilizers and the use of green manures, preferably the legumes, which grow so luxuriantly on this soil. Alfalfa does well and its more extensive growth should be encouraged. Although the Milton silt loam is spoken of correctly as limestone land, it must not be concluded that the use of ground limestone would not be beneficial, especially in connection with such sensitive crops as alfalfa, which reaches its maximum development only when calcium carbonate is present throughout the soil section. In no place did any part of the soil section tested show effervescence with dilute mineral acid except in the rock fragments just above the bedrock.

Included with the Milton silt loam are a few small areas of Milton stony clay loam, which are indicated on the map by means of stone symbols. The Milton stony clay loam consists of a heavy, brown to chocolate-brown clay loam or silty clay loam, 7 to 8 inches deep, underlain by a reddish-brown, heavy, plastic silty clay. Rock fragments and slabs are so abundant that it is usually not possible to penetrate below 20 inches with the soil auger. The fragments are a serious hindrance to cultivation. This type occupies steep slopes next to the larger streams. The largest areas occur along the Stillwater Valley below West Milton. Smaller areas occur along the Miami River bluffs south of Tippecanoe City and where its tributaries have cut through the ledges farther back. The land is steep and broken, and unfit for agricultural use. It is largely forested and used for pasture.

*Milton silt loam, deep phase.*—To a depth of 12 or 14 inches the Milton silt loam, deep phase, consists of a smooth, brown silt loam, somewhat brownish gray in the surface 7 or 8 inches but becoming rich brown to reddish brown in the subsurface layer. The subsoil is typically a reddish-brown, slightly sticky clay loam, underlain at 27 to 30 inches by a reddish-brown, calcareous clay loam which becomes more friable and calcareous and sometimes more yellow with depth. The bedrock is frequently encountered in the lower part of the 3-foot section, but in many cases it is just below the 3-foot limit.

The cracked, open nature of the underlying rock is responsible for the thorough underdrainage and consequent high oxidation of this phase, whereas in the Bellefontaine silt loam underlying gravelly material causes the thorough underdrainage. This difference, together with the lack of morainic topography and the absence of grittiness in the surface layer, constitutes the main differences between

this soil and the Bellefontaine silt loam. Occupying as it does a position intermediate between the Bellefontaine silt loam and the typical Milton silt loam the phase varies in places toward those types. On the occasional small, low morainic swells throughout the phase, where the bedrock is 4 feet or more below the surface, the soil is true Bellefontaine silt loam. Other areas, where the rock is within the 3-foot section, the subsoil, somewhat sticky and plastic, and till only moderately abundant, represent gradations toward the typical Milton silt loam.

The Milton silt loam, deep phase, occupies the broad, low rock hills in Elizabeth, Bethel, and Monroe Townships; occasional strips just back of the ledges facing the Miami and Stillwater Valleys; and areas rising slightly above the level of the typical Milton silt loam in Union Township. The rock hills rise 10 to 20 feet above the general level of the surrounding country, while the areas facing the river valley are slightly lower than the surrounding country. The areas west of the Stillwater River in Union Township are faintly morainic and represent slightly heavier deposits of till than in near-by areas of Randolph, Millsdale, and Milton soils. This glacial material is rather coarse in places, resembling the true Bellefontaine lower subsoil, and this combination of gravelly till over the open, porous, rock has resulted in a color slightly more reddish than that typical of the Bellefontaine series.

The surface of this phase is level to undulating. In no place is there sufficient relief to interfere with agriculture or to cause serious erosion, but there is sufficient slope to induce good surface drainage. The porous bedrock causes good underdrainage.

The Milton silt loam, deep phase, is a fairly important soil agriculturally. Practically all of it is in a high state of cultivation. Only occasional patches of the original forest, consisting principally of sugar maple, remain. About the same crops are grown as on the Bellefontaine silt loam. The phase is an excellent wheat and tobacco soil, and alfalfa does satisfactorily. Yields do not differ essentially from those obtained on the Bellefontaine silt loam. The farming system is essentially the same as that on the Bellefontaine soil. Land values are a little higher, owing to the smoother surface.

As the silt loam surface soil of this phase is quite deep and the calcareous material is well buried, deeper plowing would apparently not be as profitable as on the Bellefontaine silt loam. However, this calcareous layer can be reached by the roots of lime-loving, deep-rooted crops, especially alfalfa. A much larger area should be sown to this crop than is the case at the present time. The use of green-manure crops, especially the legumes, which grow so luxuriantly, should be encouraged.

*Milton silt loam, terrace phase.*—The Milton silt loam, terrace phase, consists of a brown silt loam, about 10 inches deep, underlain by a brown to reddish-brown, sticky, plastic silty clay loam which rests directly on the bedrock at 18 to 24 inches. Some gravel and rock fragments usually occur just above the bedrock, indicating a mingling of glacial till and rock débris. In some places there is a suggestion of mottling in the subsurface layer, but in general the soil section is very similar to that of the typical upland Milton silt loam. This phase occupies a few small areas on the terraces along the Miami and Stillwater Rivers. The material has weathered under good drainage conditions and has received little or no wash from surrounding areas.

In the following table are shown the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Milton silt loam, and of the deep phase of the type:

*Mechanical analyses of Milton silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
<b>Typical:</b>		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271767....	Soil.....	0.2	1.2	0.9	3.4	6.2	70.6	17.8
271768....	Subsoil.....	.9	1.8	1.4	6.0	7.5	43.3	39.2
271769....	Lower subsoil...	1.0	1.8	.9	4.9	27.8	36.5	27.3
<b>Deep phase:</b>								
271738....	Soil.....	1.0	2.4	1.8	7.9	8.6	60.9	17.6
271739....	Subsoil.....	1.2	1.9	1.7	7.9	7.6	43.0	37.0
271740....	Lower subsoil...	.1	1.3	1.2	6.2	5.6	34.2	51.3

The following sample contained more than one-half of 1 per cent calcium carbonate ( $\text{CaCO}_3$ ): No. 271769, 61.45 per cent.

#### RANDOLPH SILT LOAM.

The surface soil of the Randolph silt loam consists of a light-gray, pulverulent silt loam, 7 to 8 inches deep. The material is gray or brownish gray when moist, but in dried, beaten fields it appears almost white. The organic-matter content is low, as the color indicates, and the silty material compacts when wet, in which respect the type differs from the Milton silt loam. The subsurface material is a compact, yellow and ashy-gray mottled and iron-streaked silt loam, extending to a depth of 11 or 12 inches. This zone corresponds to the gray layer of the Crosby silt loam, but contains more yellow. The upper subsoil is a dense, yellowish-drab silty clay loam, resembling that of the Crosby silt loam but being, as a rule, sticky. The deeper subsoil, encountered at 22 to 30 inches, is yellowish, friable till, highly calcareous, usually only a few inches in thickness above the solid bedrock.

The bedrock is encountered at any depth from 22 to 36 inches. In a few cases it is nearer the surface, as northwest of West Milton, in which case the subsoil is more sticky, the till almost entirely absent, and the soil droughty and very low in agricultural value. In some places, particularly north of West Milton, the bedrock averages about 36 inches deep, but these areas have the subsoil characteristics peculiar to the Randolph silt loam.

The surface of this soil is level, but the run-off is fair. Under-drainage is very poor, owing to the dense subsoil and probably also to the massiveness and imperviousness of the underlying rock.

The Randolph silt loam is relatively unimportant. Its total area is not large and it is of rather low productiveness. Most of it is cleared and farmed and in a moderate state of improvement. The original tree growth was largely beech, with some oak, elm, and ash. Wheat, corn, and oats, and some clover are grown. Timothy hay does quite well. Wheat yields 15 to 20 bushels per acre, oats 20 to 30 bushels, and corn 30 to 40 bushels. Land values vary from \$75 to \$100 an acre. This type is hardly extensive enough to have an independent selling value.

The Randolph silt loam is not readily improved. Its gray surface soil and slightly ashy subsurface soil indicate an acid condition and lime should be applied. Green manuring would tend to prevent the surface soil from becoming compact. Although the underdrainage is very poor, the nearness of the bedrock to the surface almost prohibits tile drainage.

In the following table are shown the results of the mechanical analyses of samples of the soil, subsoil, lower subsoil, and substratum of the Randolph silt loam:

*Mechanical analyses of Randolph silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271753.....	Soil.....	1.5	3.8	2.0	6.9	7.5	61.2	16.9
271754.....	Subsoil.....	1.0	3.4	2.0	6.8	6.0	58.6	22.2
271755.....	Lower subsoil.....	1.4	2.6	2.0	8.4	6.6	43.4	35.6
271756.....	Substratum.....	3.8	5.2	3.2	14.0	13.2	37.1	23.7

MILLSDALE SILTY CLAY LOAM.

The Millsdale silty clay loam consists of a dark-gray to brownish-black, friable silty clay loam, 7 to 9 inches deep, underlain by a dull bluish gray, plastic clay loam or silty clay loam which becomes yellowish streaked or yellow below 20 to 22 inches. At depths varying from 24 to 30 inches friable, calcareous till is encountered, and the

bedrock is reached at 30 to 36 inches. The bedrock is usually at sufficient depth to have little effect on the agricultural value, its principal effect being to render the soil wetter and more swampy, particularly in the lower foot. Even in times of drought this portion of the 3-foot section is usually water-logged. This type differs from the Brookston silty clay loam in that it is more poorly drained and consequently more bluish in the subsurface layer. The till is much wetter than the corresponding layer of the Brookston soil.

In the area northwest of West Milton the bedrock is encountered at 12 to 16 inches, and the surface soil is not as dark as typical. This area is much below the average in productiveness. In the large area south of West Milton the type in places is characterized by 12 or 14 inches of black soil resting directly on the bedrock. These patches are very productive. In the areas north of West Milton the rock in some places is not encountered in the 3-foot section.

The Millsdale silty clay loam is confined to swampy situations in the areas of shallow drift in the southern part of the county. The largest area is in Union Township near West Milton. Scattered developments occur in Monroe and Bethel Townships. The land is flat to slightly basinlike, and surface drainage and underdrainage are very poor.

The Millsdale silty clay loam is of rather minor importance, owing to its small extent. It is very productive, and most of it is cleared and farmed. The original forest growth was composed of elm, beech, and ash. The type is recognized as a good soil for corn, and this is the principal crop. Oats, wheat, and tobacco are also grown, with some clover and timothy. The agricultural value in general is about the same as that of the Brookston silty clay loam.

Where the soil is of sufficient depth tile drainage should be more extensively developed. This would permit a more diversified and profitable system of farming. The type responds readily to applications of commercial fertilizer and barnyard manure.

Four small areas of a terrace variation are included with the Millsdale silty clay loam. They consist of a brown to black silty clay loam, 8 to 15 inches deep, underlain by bedrock at 8 to 24 inches. Where the bedrock is within 15 inches of the surface the black soil rests directly on it, but where the rock is deeper there is a bluish-gray to yellowish silty clay layer and frequently a layer of till above the rock. This variation occupies terracelike areas in the Miami and Stillwater Valleys, where water-deposited material was removed by the glacier and a thin deposit of till left. The present soil owes its origin to the weathering of this till and the bedrock under swampy conditions, and to accumulations of wash from the surrounding higher land. The area west of Clayton is very high in organic matter, and the black surface material rests on the bedrock at 8 to 12

inches. The area west of Pleasant Hill is slightly sloping, and for the most part the dark surface material rests directly on the bedrock. Considerable stony fragments are scattered through this area.

In the following table are shown the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Millsdale silty clay loam:

*Mechanical analyses of Millsdale silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271760.....	Soil.....	0.7	2.2	1.6	8.4	9.2	55.4	22.6
271761.....	Subsoil.....	1.0	2.2	1.6	8.1	9.5	55.8	21.9
271762.....	Lower Subsoil..	1.8	3.0	1.9	8.8	10.8	51.6	22.2

The following sample contained more than one-half of 1 per cent calcium carbonate (CaCO<sub>3</sub>): No. 271761, 16.5 per cent.

#### FOX LOAM.

The surface soil of the Fox loam is a reddish-brown, rather fine textured, slightly gravelly loam, 8 to 10 inches deep. The gravel fragments are rounded to subangular and rather prominent, being much more prominent than in the surface soil of the Fox silt loam. The surface material grades into a reddish-brown gravelly clay loam which usually shows some stickiness at 17 to 20 inches and becomes more tenacious for about 6 inches more, where it changes to a yellowish, highly calcareous, friable gravelly loam. This continues throughout the 3-foot section. As in the case of the silt loam of this series, the soil is underlain by stratified sand and gravel.

The Fox loam is closely associated with the Fox silt loam. It occupies terrace areas along streams. It lies at slightly lower levels than the silt loam, and differs also in being more gritty and gravelly in the surface soil. The topography is level to faintly undulating. Some depressions, probably representing old stream channels, occur in places. The surface drainage is fairly good and the underdrainage excellent.

The Fox loam is of small importance agriculturally, although it is valuable for farming and practically all cleared. The crop value is slightly lower than that of the silt loam. However, as in the case of the silt loam, the abundance of limestone gravel in the subsoil and the thorough underdrainage make the type well suited to alfalfa. Some alfalfa is grown at present.

The following table shows the results of the mechanical analyses of samples of the soil and upper and lower subsoil of the Fox loam:

*Mechanical analyses of Fox loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271750.....	Soil.....	2.2	8.5	4.0	9.6	7.2	50.3	18.2
271751.....	Upper subsoil...	4.0	9.0	3.4	7.5	5.0	34.6	36.8
271752.....	Lower subsoil...	4.2	9.6	3.5	7.	8.0	36.6	31.0

## FOX SILT LOAM.

The surface soil of the Fox silt loam consists of a slightly gritty, brown to faintly reddish brown silt loam, 10 to 15 inches deep, with an average depth of about 12 inches. As in the Bellefontaine silt loam the material below 7 inches is more reddish than above. The surface soil in few places contains an appreciable amount of gravel. The subsoil is a reddish-brown clay loam containing grit and gravel. It frequently becomes quite sticky when wet. The gravel becomes more prominent and the interstitial material more reddish and more sticky below 22 or 24 inches. The calcareous gravel increases so rapidly with depth that the lower part of the 3-foot section consists of a friable, calcareous gravelly loam. This gravelly material varies in color from reddish brown to brassy yellow. It is penetrated with difficulty with the soil auger. Stratified beds of sand and rounded gravel 5 to 25 feet deep underlie the soil proper.

In some places the surface soil is a loam, and a considerable part of the type as mapped is intermediate between a loam and silt loam in texture. This is particularly true of the area southeast of Troy and that southeast of Tippecanoe City, but the lack of gravel in the surface soil and the higher position as compared with the typical Fox loam made it seem more consistent to class these areas with the silt loam. This soil, which is formed from glacial-outwash material, is confined to the Stillwater and Miami valleys, the largest areas occurring in the latter. It occupies distinct terraces lying 15 to 25 feet or more above the level of the streams and is not subject to overflow. The surface is, in the main, level to undulating, but some areas are billowy in places. The topographic variations are greater than those characteristic of true alluvial deposits.

The surface drainage of this type is sufficient and the underdrainage excellent. The presence of gravel beds at depths of 3 feet or less might seem to indicate that the soil is inclined to suffer in times of drought, but the reddish-brown loam subsoil appears to be very retentive of moisture and the type is not droughty.

The type is not extensive, but it is so productive that it exerts an appreciable influence on the agriculture of the county. It is practically all cleared and in a high state of improvement. The scattered

areas of virgin timber that remain consist of sugar maple, oak, and walnut. Wheat and corn are the most important crops on this soil. Some tobacco is grown, and the diversified agriculture that is practiced includes also oats, clover, and timothy. Wheat yields 20 to 25 bushels per acre, corn 40 to 50 bushels, oats 30 to 40 bushels, and tobacco about 1,500 pounds. The soil is friable and easily worked. Modern machinery is employed almost exclusively. Some commercial fertilizer is used, principally on wheat and tobacco.

Farms composed of this type of soil are valued at \$175 to \$200 or more an acre. This high valuation is due to the productiveness of the soil, to the high state of improvement of the farms, and to the piked roads which pass through or near the areas. Some of the earliest settled farms in the county are on this type. As other parts of the county have developed the improvements on these terrace areas have kept ahead of those on the other soils.

This type is well suited to general farming. It is a splendid soil for alfalfa. In growing this crop a light dressing of ground limestone would doubtless prove profitable. Green manuring should be done more extensively, preferably with legumes, which grow so abundantly on this soil. Green manuring should be combined with a careful use of fertilizers, to which this soil readily responds.

In the following table are shown the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Fox silt loam:

*Mechanical analyses of Fox silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	<i>Per cent.</i>
271757.....	Soil.....	0.3	1.9	2.6	16.0	15.6	50.4	13.1
271758.....	Subsoil.....	.2	1.	2.	15.1	15.9	25.5	21.9
271759.....	Lower subsoil..	2.9	7.6	5.6	18.6	8.8	24.6	32.1

GENESEE SILT LOAM.

The Genesee silt loam consists of 12 to 18 inches of dark-gray to brownish-black, heavy silt loam, changing very gradually into a slightly lighter colored material of slightly heavier texture. The division into zones or layers is not as sharp as in the upland soils, and in many borings there is little visible change in the material within the 3-foot section. The surface soil is quite dark when moist, but it becomes brownish or even grayish on drying. There is considerable variation in the type as mapped. It is most typical in the broader bottoms along the larger streams, where the material has been derived from diverse sources. The narrow strips along the

smaller streams are of much more local origin and vary somewhat from typical, the soil having been deposited in more rapidly moving water, resulting in a slightly coarser texture. In the morainic region of the eastern part of the county the type is nearly a loam in texture, owing to the swiftness of the depositing current and to the gritty nature of the silt on the adjoining uplands. There is usually a more distinct difference between surface soil and subsoil in the smaller areas than in the larger, the subsoil of the former tending to be steel gray in color. Some of the better drained areas of this type have a chocolate tint suggestive of the Fox soils. Along the larger streams the material is frequently more sandy near the channel, where it was deposited by more rapidly moving water. There are several gravelly areas, deposited by very swift waters, sometimes as the result of the breaking of a dike. Gravelly areas were observed along Lost Creek south of Casstown, along the Miami River south of Troy, and along the Stillwater River south of Covington and just north of the point where this stream leaves the county. The upper ends of the narrow strips of Genesee silt loam are frequently largely colluvial rather than alluvial.

The Genesee silt loam is most extensively and most typically developed in the broad flood plains of the Miami River, with smaller areas along the Stillwater River. Numerous narrow areas occur along the smaller streams, but these are less typical. The drainage of this type is poor, and in most places has been improved by tiling. The type is a splendid corn soil, and it is largely devoted to this crop. Yields of 50 to 75 bushels per acre are often obtained, but the crop is sometimes a total loss owing to floods. Oats, wheat, and clover are successful under normal conditions. The type is easily cultivated and worked into an excellent seed bed. In periods of drought it cracks to a considerable extent, suggesting a rather large content of clay and organic matter.

The value of this land is much less than that of upland of equal productiveness, owing to the fact that inundations sometimes cause loss of crops.

The great need of this type is protection from overflow and more adequate drainage. Some steps have been taken in this direction, but much remains to be done. With these improvements this soil would produce excellent crops almost indefinitely.

#### WABASH SILT LOAM.

The Wabash silt loam consists of a black, heavy silt loam to silty clay loam, 12 to 18 inches deep, underlain by a bluish-black silty clay loam to silty clay which becomes bluish gray and sometimes more friable in the lower part of the 3-foot section. The surface soil is

high in organic matter and cracks to a considerable extent in dry weather. The area northwest and south of Grayson really approaches a clay loam in texture. The type in places, especially in the Honey Creek bottoms, includes numerous areas of Genesee silt loam. The boundaries between these two types are more or less arbitrarily drawn.

The Wabash silt loam occupies parts of the flood plains of the Stillwater River and Honey Creek. In the Honey Creek bottoms the type owes its origin to the accumulation of highly calcareous material washed from the surrounding morainic hills. The surface is flat and the drainage very poor. The type is of minor importance owing to its small extent. It is naturally a splendid corn soil, but owing to the poor drainage the crop often fails to develop properly. Wheat has a tendency to make an excellent growth of straw and produce a "chaffy" grain.

The great need of this type is better drainage. This can be accomplished only by systematic tiling, and, in order to make tile drainage possible, it will be necessary to deepen and straighten the stream channels.

#### SUMMARY.

Miami County, situated in southwestern Ohio, has a total area of 408 square miles or 261,120 acres. The surface is level to rolling, with a few small steeply rolling areas. The eastern part of the county consists of undulating to rolling terminal moraine, while the western portion is a flat ground moraine. The surface of this latter section is broken by the valleys of the Stillwater and Miami Rivers.

The county is drained by the Miami and Stillwater Rivers and their tributaries. Artificial drainage has been found necessary in the level western part.

Miami County was organized in 1807. The early settlers came from Pennsylvania, New Jersey, New York, Virginia, and the New England States. The farming lands were soon taken up, and the rural population has remained practically stationary since 1880. In 1910 the rural population numbered 25,537, and the urban 19,510.

Good transportation facilities are provided by numerous steam and electric roads, and excellent markets are within easy reach of all parts of the county.

The mean annual temperature is 52.7°, and the mean annual precipitation 36.55 inches. The average length of the growing season is 166 days.

Practically all of the county is cleared and in a high state of improvement. In 1910 the average size of the farms was 74.4 acres, of which 66.5 acres were improved land. Tenants operated 51.7 per cent of all the farms.

Corn, oats, wheat, clover and timothy hay, and tobacco are the leading crops. Tobacco is grown most extensively in the western part of the county, where it is an important money crop. The agriculture consists of general grain farming and tobacco growing, combined with live-stock production and dairying. Some alfalfa is grown, and the acreage is steadily increasing.

In 1910 over \$31,000 was spent for commercial fertilizers. The amount of fertilizer used is gradually increasing, but there is a growing tendency to mix the preparations at home from relatively low-priced materials.

The soils of Miami County are chiefly of glacial origin. The underlying rocks are limestone, and the soils have been formed from these rocks and other formations to the north over which the glacier passed. Some shaly material transported from the north, mixed with ground-up limestone, has given rise to the heavier soils of the north-western corner of the county. The glacial material of the greater part of the ground moraine is more friable, and composed largely of ground-up Niagara limestone, while that of the terminal-moraine region contains an appreciable admixture of granitic material. These differences in the original material have given rise to important differences in the soil.

The glacial-till soils of Miami County are classed in nine series. The soils occurring in areas of deep drift are classed in the Bellefontaine, Miami, Crosby, Conover, Brookston, and Clyde series. Where the surface drainage and underdrainage are good, brown to reddish-brown soils have resulted. These soils occur largely in the moraine region and are included in the Bellefontaine series. Where either the surface drainage or the underdrainage, particularly the latter, has been only moderate, the resulting soils have a yellowish-gray surface layer, a pale-yellow to faintly grayish mottled subsurface layer, and a dull-brown iron-stained subsoil. These soils are included in the Miami series. Where the surface drainage and underdrainage have been poor the soils have a light-gray surface layer, an ashy-gray subsurface layer, and a dense, plastic, puttylike subsoil, iron streaks being more or less prominent throughout the 3-foot section. These soils are included in the Crosby series. Some soils in the smoother part of the terminal-moraine region have a brownish-gray surface layer, a similar or slightly lighter colored subsurface layer, and a dull-brown, iron-streaked subsoil. They are included in the Conover series, which is quite extensively developed. Where the surface material is dark gray to brownish black, the subsurface layer drab, and the deeper subsoil yellow, the soil is included in the Brookston series. Where the surface material is brownish

black to black, and the subsoil bluish gray, the soil is included in the Clyde series.

Three series of dark-colored shallow-drift soils, in which the bedrock lies within 3 feet of the surface, are recognized. Where the underdrainage has been good the surface soil is brown and the subsoil reddish brown and plastic. This soil is classed in the Milton series. Where the underdrainage has been poor, gray to yellowish-gray surface soils with compact dull bluish-gray, iron-streaked subsoils have resulted. The soil here is included in the Randolph series. The black soil in which the bedrock is usually within 3 feet of the surface is classed in the Millsdale series.

The terrace soils are included in the Fox series. The alluvial soils are divided into two series, the Genesee including the dark-gray to brownish soils, and the Wabash series the black soils.



[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

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



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