Issued May 2, 1914.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF INDIANA, DEPARTMENT OF GEOLOGY;
EDWARD BARRETT, STATE GEOLOGIST.

SOIL SURVEY OF BOONE COUNTY, INDIANA.

BY

W. E. THARP, OF THE U. S. DEPARTMENT OF AGRICULTURE,
AND E. J. QUINN, OF THE INDIANA DEPARTMENT
OF GEOLOGY.

J. E. LAPHAM, INSPECTOR IN CHARGE NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1912.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1914.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 24, 1913.

SIR: In continuation of the cooperative work in Indiana, one of the projects of the field season of 1912 was the survey of Boone County. The selection of this area was made after conference with State officials, with whom the bureau is cooperating.

I have the honor to transmit herewith the manuscript report and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1912, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

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

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MAP.

Soil map, Boone County sheet, Indiana.

SOIL SURVEY OF BOONE COUNTY, INDIANA.

By W. E. THARP, of the U. S. Department of Agriculture, and E. J. QUINN, of the Indiana Department of Geology.

DESCRIPTION OF THE AREA.

Boone County is located in the central part of Indiana, being bordered on the north by Clinton, on the east by Hamilton, on the south by Marion and Hendricks, and on the west by Montgomery County. Its general altitude is from 850 to 950 feet above sea level, with a few hills exceeding the latter height by about 100 feet. The total area of the county is 427 square miles, or 273,280 acres.

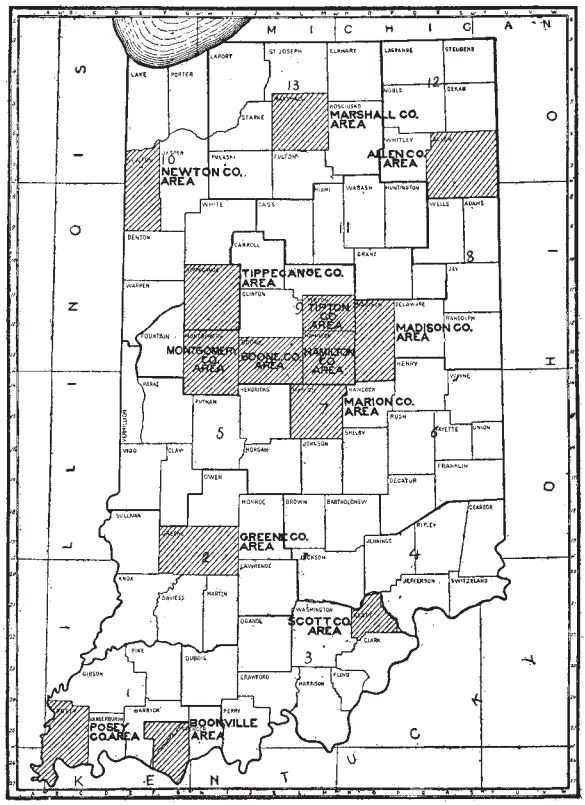

FIG. 1.—Sketch map showing areas surveyed in Indiana.

The surface of the greater part of this county is undulating to very moderately rolling. In general it consists of innumerable broad, low ridges, or divides, extremely irregular in outline and absolute elevation, although the local relief, except near the streams, is usually less than 50 feet, and apparently not this great, on account of the very easy slopes that usually prevail. The depressions are equally irregular in size and outline. The smaller ones range from mere kettle holes to swales a few rods or a fraction of a

mile in the greater diameter, and most of them have no very definite connection with others in the vicinity. The surfaces of the larger ones are flat, or nearly so, and constitute the only level areas in the uplands proper.

Conspicuous features of the landscape in nearly all parts of the county are the numerous moundlike elevations and occasional isolated hills of considerable height. Some of the latter rise 100 feet or more above the surrounding country, and the slopes on all sides are rather steep. More frequently these elevations are ridges, one side standing in clear relief, while the other declines very gradually to the average surface level, which may be much above that on the opposite side. Many of the smaller mounds are mere "bumps," a few feet high and a few rods across, while the larger ones are from 10 to 50 feet high and from one-eighth to one-half mile in length along the major axes. These local elevations have a pronounced relief, but the slopes are usually mild and in very few instances too steep to prevent the convenient use of farm machinery.

In the northwestern part of the county, along Sugar Creek, or, more frequently, for some distance on each side of its southern tributaries the surface is rolling, with some short, abrupt slopes along the streams. On the northern side of Sugar Creek the general decline of the uplands is almost imperceptible to within a short distance of the valley; then it flattens into a nearly level terrace The outer margin of this terrace drops abruptly to the bottom land, the height of the glacis, or sloping part, ranging from 25 to 50 feet. Similar topography prevails along the lower course of Eagle Creek, but the terraces in general are higher than those on Sugar Creek, and the uplands adjoining are rolling to moderately hilly. The untillable portion of these hilly areas includes very little ground other than the gravelly slopes immediately bordering the trenchlike valleys.

All the Eagle Creek drainage and that of Fishback and Whitelick Creeks represents the extreme extension of a part of the White River system, while that of Sugar Creek is similarly related to the Wabash River. The watershed between these two systems is a broad belt extending across the county from northeast to southwest. Here the natural drainage is very poorly developed, although the average elevation is something like 100 feet above the major streams at Zionsville and at Mechanicsburg. The upper branches of Eel River in this area are little more than artificial ditches that follow structural depressions. This is also true of much of the drainage in the northeastern, central, and southwestern townships. The innumerable lines shown on the map are mostly artificial waterways. The larger ones are dredged ditches 10 to 15 feet deep, straightening the former ill-defined and obstructed course of natural channels, while the smaller ones are outlets for depressions that had little or no connection with one another or with the creeks.

All the creeks and the larger ditches maintain their flow the year round. Many of the small ditches carry more or less water throughout the entire summer, since so many tile drains open into them. Excellent water for domestic use can usually be obtained on the higher lands at depths of 20 to 60 feet.

With the exception of a few grassy swamps, all this region was originally forested. On the well-drained land walnut, sugar tree, hickory, poplar, and oak were the dominant varieties, while beech, elm, ash, and white oak were more commonly found on the lands deficient in natural drainage. The present shallow muck beds, or "chaffy lands," and the central portions of most of the larger areas of black land were then ponds or swamps in which aquatic plants and water-loving grasses constituted most of the vegetation. Willow, cottonwood, and buttonwood bushes followed as fast as the processes then in operation increased the area of ground partially free from water.

All that now remains of the once dense deciduous forests are numerous open woodlots, very few of which include more than 20 acres. Many of these are merely groups of trees around farm buildings, but there still remain many beautiful groves, usually free from undergrowth, and the ground covered with bluegrass. Possibly 10 but certainly not more than 20 per cent of the total area has as yet escaped tillage.

The present price of well-improved farms, desirably located, ranges from $150 to $175 an acre. Those at a greater distance from a town or electric railway command about $125. These are very general estimates. The total value of land and improvements, exclusive of buildings, according to the Thirteenth Census returns, was $27,280,190; of buildings $4,485,470.

About 33 per cent of the farms are operated by tenants. A common rate of rent is two-fifths of all grain and cash payment for hay and pasture ground. In many cases all the rent is paid in cash, the rates varying from $7 to $9 an acre.

Nearly all the public roads are well graded and surfaced with gravel. Practically all the bridges are most substantial structures of iron, concrete, or stone. Thirty delivery routes insure daily delivery of mail to almost every farmhouse. Two steam roads and three interurban electric lines connect Lebanon, the county seat, with outside points. Most of the farmhouses are well built, with good barns and outbuildings.

The high tone of rural improvements is due in part to the generally prosperous conditions that have prevailed during the last two or three decades, in which period thousands of acres of highly productive black lands have been reclaimed, and in larger measure to the fact that this is an area of small holdings. The average size of farms is

about 80 acres, but in each township there are many holdings of 10 to 60 acres each. In the county there are 61 farms embracing between 260 and 500 and only two that contain 500 or more acres.

CLIMATE.

The following table, compiled from the records of the weather bureau at Indianapolis, gives the normal monthly seasonal and annual temperature and precipitation for that station:

Normal monthly, seasonal, and annual temperature and precipitation at Indianapolis.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	33	68	−15	3.0	4.1	0.9	5.1
January	28	69	−25	2.8	1.6	4.9	6.9
February	31	72	−18	3.3	1.6	4.6	4.4
Winter	31	.....	.....	9.1	7.3	10.4	16.4
March	40	82	0	3.8	4.2	7.4	3.6
April	52	87	19	3.4	3.2	2.3	1.2
May	63	96	31	4.0	2.4	5.1	0.1
Spring	52	.....	.....	11.2	9.8	14.8	4.9
June	72	100	39	4.4	3.5	7.5	0.0
July	76	106	48	4.2	0.8	7.5	0.0
August	74	101	46	3.2	3.6	5.9	0.0
Summer	74	.....	.....	11.8	7.9	20.9	0.0
September	67	98	30	3.3	0.7	3.9	0.0
October	55	89	22	2.8	3.5	4.4	Trace.
November	42	76	−5	3.7	1.2	2.3	1.6
Fall	53	.....	.....	9.8	5.4	10.6	1.6
Year	55	106	−25	41.9	30.4	56.7	22.9

It will be observed that the mean rainfall of 3 to 4 inches for each of the spring and summer months is ample for most crops, but that the total amount in the driest year is too low to meet the requirements of a heavy crop of corn and grass. Short periods of deficient rainfall will occur in most seasons, their effect upon a particular crop depending largely upon the stage of growth when the shortage in precipitation occurs. For this reason the moisture relations of the several types have been set forth with some care, and the tillage operations necessary to minimize injurious effects of exceptionally wet or dry periods have been suggested. In this respect, however, neither the soils nor the climatic conditions differ from those of the adjacent sections of the State.

The fall of snow is extremely variable from year to year, but the average is 22 inches. Since there is so little forest and most farm land is almost free from obstructions like hedge rows or lines of weeds along the wire fences, the snow drifts more than formerly. This is frequently the cause of injury to fall-sown grains.

The average date of last killing frost in the spring is April 16 and of the first in the fall October 19. The earliest killing frost in recent years occurred on September 21 and the latest reported for the spring months was May 21.

AGRICULTURE.

Since in the earlier stages of the agricultural development of this county only land with good natural drainage could be utilized, the greater part of the black lands, or Clyde silty clay loam, remained in nearly its original condition for many years. Some small areas were reclaimed by individual efforts of farmers and others later, as a result of the construction of road ditches and cooperation of owners of low lands within short distances of natural outlets, but most of the larger bodies of black land have been brought under cultivation within the last 25 or 30 years. Within this period the deep dredged ditches that form the upper part of Eel River, Prairie Creek, and a number of other streams have been brought to their present high degree of efficiency and thus afford an adequate outlet for the hundreds of branches since constructed.

Practically all the black land has been relieved of standing water or of any liability to injury from this cause. Nearly every field consisting entirely or in part of the black clay loam has tile drains, but in many instances a greater number are needed to insure a prompt lowering of the level of the ground water after heavy rains. This is particularly true of those large areas having a substratum of heavy clay instead of gravel.

The next stage in the development of this artificial system will be the extension of the tile drains into the flat phase of the Miami silt loam. As suggested in the description of that phase, such an improvement is now almost as much of a necessity, considering the advancing price of land and cost of producing crops, as was the surface drainage of the black land some years ago.

The comparatively late development of so large a portion of the arable lands has had the effect of conserving the virgin fertility of the black lands until a period when improved machinery, accessibility to markets, and the generally high price of grain rendered their cultivation extremely profitable. Fortunately, the occurrence of this type is so common throughout the county that the increase in average crop yields and the enhancement of land values has been shared by the owners of hundreds of small farms.

The general trend of agriculture may be seen in the following table, compiled from census returns:

Production of leading crops in Boone County.

Census.	Corn.		Wheat.		Oats.	
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Bushels.
1910	91,080	4,572,233	19,742	317,758	38,867	1,213,582
1900	81,472	3,912,050	34,900	266,710	3,297	119,330
1890	60,048	1,783,060	40,067	464,972	7,810	191,869
1880	63,087	2,280,742	33,679	623,289	4,285	117,070

Corn, oats, wheat, and clover are the chief crops. With regard to cash value they rank in the order named, and in late years the acreage of grain is in the same order with the clover acreage as a rather changeable member of the group. Farmers no longer consider wheat a profitable crop. The average net returns from oats are more favorable, but neither of these crops would be so generally grown were it not for the necessity of frequently seeding the ground to grass or clover. This is recognized by all farmers having soil types other than the Clyde or Genesee as absolutely indispensable in good farm management. In most instances the problem of maintaining fertility is considered chiefly in its relation to the production of corn. The steadily increasing demand for this grain is stimulating interest in every means that promises greater average yields. In the last few years many farmers have used commercial fertilizers, and the probable result of their more extensive employment is becoming a matter of great interest.

In a report of this kind it is quite impracticable to go into detail regarding commercial fertilizers or their probable effect upon crop yields. Local conditions enter so largely into the problem that specific directions or statements to be of any value whatever must be based upon field experiments extending over a term of years. But some principles of soil fertility and their application to local conditions in this county may be considered.

The Miami soil requires more thorough preparation for planting than is usually given on the average farm. Whether by deeper plowing, subsoiling, or frequent changes to deep-rooted crops like the clovers, the subsurface soil ought to be loosened and made as highly absorbent of moisture as possible. Instead of getting rid of excess rainfall by a rapid surface discharge into the natural drainage lines, more of the water should be held in the soil and upper subsoil until it is absorbed by the lower subsoil and the underlying stratum. The structure of

the latter, a sandy clay, is highly favorable to such storage of moisture, but the compact layer between the depths of 12 to 25 inches in the flat phase of the Miami silt loam, and to a less marked degree in the typical silt loam, prevents as effective absorption of heavy rainfalls as is desirable, and tends to increase the surface run-off, or at least to render the latter necessary in order to prevent undue saturation of the surface soil.

The frequent occurrence of periods of deficient precipitation in the months of July and August and consequent reduction in yields of corn or other late maturing crops, emphasize the need of conserving as far as practicable the excess of rainfall that usually occurs earlier in the season. Of course the average level of the ground water must be held below 20 or 30 inches, but there is no danger of its standing for any length of time above this height in the types mentioned, or in any others where tile drains have been installed.

The necessity of an increase of organic matter in the Miami soil is discussed in the type description. It is needed to improve the physical condition and to insure a sufficient supply of nitrogen for good crops of grain, which require a liberal supply of this element, whose development in a soil is dependent largely upon the presence of humus, or of decaying vegetable matter.

Except to meet the requirements of some special crop, or to hasten profitable yields on previously mismanaged land where the results of a crop rotation with clover can not be awaited, the use of complete fertilizers does not seem advisable. Certainly none of the expensive element, nitrogen, should be purchased, and chemical analyses[1] show that there is no lack of potash if the soil is handled in a way to render it available.

[1] Chemical determinations for the total amounts of lime, potash, and phosphoric acid in a composite sample of Miami silt loam collected about 3 miles southwest of Thorntown gave the following results:

Depth.	Lime.	Potash.	Phosphoric acid.
Inches.	*Per Cent.*	*Per Cent.*	*Per Cent.*
0 to 12	0.0030	0.0126	0.0013
12 to 30	.0051	.0129	.0015
30 to 36	.0070	.0097	.0008

An analysis by similar methods of a sample of the Clyde silty clay loam taken 3½ miles southwest of Lebanon gave the results indicated below:

Depth.	Lime.	Potash.	Phosphoric acid.
Inches.	*Per Cent.*	*Per Cent.*	*Per Cent.*
0 to 6	0.0120	0.0103	0.0023
6 to 18	.0090	.0138	.0020
18 to 36	.0096	.0126	.0016

As to the profitable use of phosphatic fertilizers no definite statements can be made. It is a problem to be worked out by field experiments.[1]

In the last few years considerable quantities of commercial fertilizer have been used, and their use is rapidly increasing. With the exception of the potash used on the "chaffy lands," the most of the brands have about the following composition; from 1 to 2 per cent of nitrogen, 2 to 4 per cent of potash (K_2O), and from 6 to 8 per cent of phosphoric acid (P_2O_5). The results reported by farmers are variable, but in the main an increase of both corn and wheat has usually followed the application of fertilizers. Wheat has generally been improved both in quality and yield.

In many instances the increased yield was due to the presence of immediately available plant food where the natural sources of supply were locked up through lack of organic matter and otherwise bad physical condition of the soil. The very light colored types, in such a wet spring as that of 1912, remain cold and inert after the black ground has become warm and in good condition for corn.

The following 4-year rotation is practicable under present conditions on most farms: First year, corn; second year, oats or wheat; third year, clover with timothy and the hay harvested; fourth year, land used for pasture. The elimination of the small grain is favored by many farmers, were it not for the advantage these crops afford of seeding the land to clover. Winter rye may be substituted for oats or wheat and is a better nurse crop than the latter. Rape has also been used for the same purpose, and furnishes excellent pasture for hogs. Since the latter form so large a proportion of the live stock on most of the small farms, and also on many of the larger ones, it is very desirable to reduce the acreage of small grain and increase that of corn and forage crops.

With regard to maintenance of fertility, dairying affords opportunity for the best methods of soil management. In the northeastern part of the county many farmers are engaging in this business to a greater or less extent, since there is a milk-condensing plant at Sheridan which takes all the product the surrounding country offers. In all parts of the county an increasing number of farms are shipping milk or cream to Indianapolis. This business is causing much attention to be given to the problem of securing cheaper feed. Several hundred silos have been constructed, chiefly to afford better feed for dairy cows, but also for other stock, as the advantages of the method have become better known.

Much interest is taken in the cultivation of alfalfa, but so far efforts to establish this valuable forage plant have not been entirely successful. The best observed results were on well-drained bottom

[1] See Bulletin No. 155, Ind. Expt. Station.

land. This is probably due to the rather high degree of fertility, abundant moisture supply at moderate depths, and freedom from acidity in the soil. On the Miami silt loam, flat phase, there are a few small fields that have stood a number of years, but in many instances on this soil the roots of the plant turn brown and die. Bluegrass usually spreads into fields of alfalfa in a few years and so thins the stand that it is no longer profitable.

Alfalfa requires a fertile soil in which the drainage and aeration to a depth of several feet are excellent, i. e., suitable for the best growth of corn. It also needs much water during practically the entire growing season, so that a good reserve of moisture in the lower subsoil, or at somewhat greater depths, is almost a necessity. Another prime requisite is lime. The soil and subsoil of normal types can hardly contain too large a percentage of this material. If the soil is not inoculated with the bacteria necessary to this plant, no very long-continued growth will be made. These soil conditions must be assured, and in addition a very thorough preparation of the seed bed is necessary, and freedom from competition of grass or weeds during early growth must be assured.

In this county the Miami series is too deficient in humus and lime to suit alfalfa. After becoming established the large amount of carbonate in the lower subsoil might prove sufficient for the plant requirements, but in its early stages the acidity of the surface soil is decidedly unfavorable. Well-drained Clyde silty clay loam should prove satisfactory, especially if a permanent supply of water is within 8 to 10 feet of the surface. Those phases where lime nodules or slightly calcareous clay occur in the subsoil should be selected, other conditions being favorable. But liming of the soil and also inoculation doubtless are necessary in all cases.

Tomatoes are the only truck crop grown to any extent in this county. There is a canning factory at Lebanon, and several of the smaller towns are shipping points from which canneries at Indianapolis secure their stock. The crop in 1912 was generally poor on account of the unfavorable season. The previous years' yields of 8 to 10 tons per acre are secured in good seasons, and the contract price is about $9 per ton. The black soils usually make the heavier yields.

On both Prairie Creek and Eel River there are locations where the Clyde silty clay loam affords good sites for the cultivation of celery and onions, these crops requiring very loose, rich soils and an abundant water supply. It seems possible that supplemental irrigation on a scale practicable to assure success with small acreages of these crops could be successfully practiced in certain locations along these deep dredged ditches.

The same observations apply to the cultivation of strawberries near the streams. The fruit could be successfully grown almost anywhere except on the Muck and on the heaviest phase of the Miami silt loam. The local markets are very poorly supplied with this or other small fruits of desirable quality.

Little attention is paid to the production of apples or pears on a commercial scale. The orchards are generally small and in most instances not well cared for. The opportunity for fruit culture here is quite as good as in most sections in the adjoining States. The typical Miami silt loam affords most excellent sites for orchards, and the proximity to Indianapolis assures a ready market for all that could be grown. Besides the well-recognized requirements of pruning, spraying, and proper cultivation, a cooperative plan of marketing would be necessary. Since most farmers are able to make fair returns from their land without such an effort, it is not probable that fruit growing will become a business of great importance.

SOILS.

The surface formations of this county consist of glacial material known geologically as the early Wisconsin drift. The thickness of the drift is quite variable, ranging from less than 50 to more than 150 feet. The average, at a very rough estimate, may be placed at less than 100 feet. The older drift sheets and the sedimentary rocks are thus buried so deeply that they exert no influence upon the soils.

In general the first 10 to 15 feet of the Wisconsin material is a very light brown or pale-yellowish mixture of fine sand, silt, and clay carrying a large proportion of gravel and small stones. The latter consist largely of granites and various kinds of hard, dark-colored rocks apparently as resistant to decay as quartzitic gravel, with some schistose and gneissic fragments. As a rule, there is not much sandstone or shale, but pieces of limestone are usually abundant from within 4 to 5 feet of the surface downward. The matrix in which these are embedded varies in composition, but there is almost everywhere a rather high percentage of fine sand, so that the material is porous. The surface of artificial exposures usually weathers to a loose, friable silty or fine sandy loam of light color. With few exceptions, it contains sufficient lime to react freely with hydrochloric acid.

The above description is applicable to the glacial material or till of the uplands in general, but along the creek valleys and in many of the depressions that were formerly lakes the light-colored bowlder clay gives place to beds of gravel. The substrata of the terraces on Sugar and Eagle Creeks are irregularly stratified sand and gravel, and pockets or streaks of this material occur along many of the small branches forming the substratum of the black soils.

But neither the bowlder clay nor the gravel beds directly form the soils, except in areas of very limited extent. Almost everywhere the glacial material is covered with a silt or silty clay layer having an average depth of about 30 inches. Its mechanical composition and general appearance, as well as its relation to the topography, is strongly suggestive of a loess, for notwithstanding the fact that bowlders and coarser material are scattered through this silty material near the surface, it is thought by some geologists that it represents a reworked glacial deposit transported to its present position by wind action. Over practically all the uplands and on all the higher terraces of the larger streams this silty material forms an almost unbroken surface mantle. On the short, steep slopes near the creeks and on the apex of the sharper ridges and mounds it is either very thin or has been modified through loss of its finest particles by erosion and through admixture with the underlying till. On all the wider divides and wherever the surface is but moderately rolling or undulating the silty surface stratum is present. Its rather uniform depth and the persistence with which it invests all the major topographic irregularities is remarkable. To this fact must be attributed the wide extent of fertile, relatively stone-free soils of this and adjoining counties.

Through the various agencies of weathering, as erosion, oxidation, and effect of vegetable covering, there has been more or less modification of the silty layer, and several distinct soil types have thus been formed.

On the gently undulating uplands and on the wider terraces there has been least change in depth and composition of the silty stratum. In such locations the depth is seldom less than 2 feet and very rarely exceeds 5 feet. In the first 10 or 15 inches silt particles usually form as much as 50 to 60 per cent of the soil, with very fine sand as the next highest component. Between the depths of 15 to 30 inches there is a rapid increase in the percentage of clay, so that this zone is usually a stiff, silty clay loam, not quite so favorable to good moisture conditions as if the texture were a little coarser. At 30 or 40 inches there is usually a fairly well marked contact between the silty clay and the underlying glacial material, which at this depth is reddish-brown clay, with more or less sand and gravel.

The light color of the silty surface soil is due to lack of organic matter. The coloration of the middle and lower subsoil is determined chiefly by drainage conditions, or may be taken as an indicator of the average moisture content. Owing to the somewhat imperfect internal drainage and aeration that are characteristic of most of the silty material, where it exceeds 2 feet in depth, light-gray and pale-yellowish tints prevail, with more or less mottling. As a rule there has not been much segregation of the iron content, so that "buckshot" or small concretions are seldom abundant.

Wherever such general conditions as these prevail the soil type locally known as "clay land" has been developed. In this survey the name Miami silt loam, flat phase, is used and has been given wider application than the local term. The latter is often restricted by farmers to the heaviest and deepest areas of this soil where its inability to endure wet weather occasions considerable difficulty in tillage.

Wherever the surface inclination is quite pronounced, as on the flanks of the innumerable morainic mounds and in the vicinity of the larger creeks, the silty layer is not only thinner than elsewhere, but it is also coarser in texture. This is due to erosion, whereby much of the silt and clay have been removed, leaving the fine sand, or coarsest constituents, as permanent soil material, usually a silty fine sand. In most instances there is more or less gravel scattered over the surface and stones from the bowlder clay beneath are frequently exposed. In such locations the comparatively coarse texture of the surface soil and the presence of the sandy bowlder clay within a foot or two of the surface induce so much better circulation of soil water and air to a depth of several feet that a distinct soil type has been developed. It has been correlated with the typical Miami silt loam, but is generally known throughout the section of the States as "sugar-tree land." It is distinguished from the flat phase by rolling topography, coarser texture of soil grains, and the uniformly brown tints that prevail in soil and subsoil. These physical properties are very favorable to the maintenance of equitable moisture conditions, a factor of highest agricultural importance. It is also probable that the total quantity of available mineral plant food is somewhat higher in the 3-foot soil section, including as it does more or less of the glacial material, than in more thoroughly leached and weathered silt. This is the case with regard to lime and doubtless applicable in some measure to other essential minerals.

The Clyde silty clay loam, or the "black land," is distinguished from the preceding type by the high content of organic matter. The latter is chiefly in the form of carbonaceous material, or vegetable tissue, in the condition which it acquires when decomposed under water, or where air is mostly excluded. It is doubtless less active as an element of soil fertility than the brown humus which results from the decay of plant remains upon the surface, or in the first few inches of a well-drained soil. The abundance of this black humus, which often extends to a depth of 18 or 20 inches, imparts a fine physical structure to a soil that would otherwise be a heavy clay or clay loam.

The type owes its origin primarily to lack of surface drainage and to the character of vegetation such conditions imposed. While most of the "black lands" were forested when the first settlers entered the region, up to a comparatively recent period the low areas were illy

drained prairies or marshes in which grassy vegetation prevailed. Indeed many areas of limited extent were in the latter condition until artificially drained. It was during the prairie stage that the black humus accumulated, with lesser accretions, perhaps, after the encroachment of the forest from the adjoining higher ground.

In some of this type there is still such an excess of vegetable matter in the surface soil that the latter is "mucky," or, as it is locally called, "chaffy" ground.

A few areas of true Muck are found, but its depth seldom exceeds 15 or 20 inches. The subsoil of some of the Muck is a highly calcareous clay, a marl in some instances. The rather high percentage of lime in the Clyde silty clay loam is probably due to the former abundance of this mineral in the subsoil, when the latter was in the same condition as the clay under the present Muck beds. As the natural drainage improved the lime was removed, but there is still a sufficiently high percentage to affect favorably the fertility of the soil.

The alluvial soils consist of material from both the glacial deposit and its silty covering. The latter has doubtless contributed the more on account of its greater surface exposure. As a rule fine sand and silt are the chief components of the bottom-land types. Coarse surface material does not usually occur, except in the immediate vicinity of the larger streams, although sand and gravel commonly form the substratum. With one exception, the Genesee loam, there is a remarkably low content of organic matter in the alluvial types. This is true of virgin land, as well as that which has been cultivated many years. The prevailing color of both soil and subsoil is a shade of brown that may be described as a medium brown in contradistinction to the darker brown of the soils having a moderately high percentage of vegetable matter. This is principally owing to the good drainage and aeration that most of these soils enjoy, induced by their elevation above the stream channels, their open structure, and the presence of a gravelly substratum. Notwithstanding their deficiency in humus, these brown soils are very productive and show few signs of exhaustion, although cropped almost continuously to grain for many years.

The following table gives the names and extent of the various types mapped in the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami silt loam	28,480	71.2	Genesee loam	2,240	0.8
Flat phase	166,080		Genesee silt loam	2,176	.8
Clyde silty clay loam	60,928	22.3	Muck	960	.3
Fox silt loam	4,864	1.8	Fox sandy loam	832	.3
Genesee sandy loam	3,456	1.3			
Meadow	3,264	1.2	Total	273,280	

CLYDE SILTY CLAY LOAM.

The surface soil of the Clyde silty clay loam to a depth of 8 or 10 inches is a black silty clay loam having a high content of silt. The organic-matter content is high and consists almost entirely of black humus, rather than the brownish-black vegetable mould commonly occurring in upland soils or in land where the organic matter is of more recent origin. The relatively high percentage of humus imparts a friable or mellow property to the soil very apparent in cultivated fields. The "crumb structure," or tendency to assume a finely granular condition, so desirable in all soils, is remarkably well developed in most of this type. This property, being a function of the humus content, is dependent upon the amount as well as the condition of vegetable débris present. Where there is a very high percentage of organic matter the soil is somewhat spongy and approaches Muck, while in other places the organic content is not more than sufficient to impart a black color and good physical properties to what would otherwise be a heavy, compact soil.

Below the surface soil and to a depth varying from 15 to 25 inches the material is a silty clay loam of black to dark-drab color. This part of the material is usually quite compact, in many instances rather gummy. It would be much more resistant to penetration to any implement and less pervious to water were it not that the organic matter it contains gives it a well-developed, granular structure. Exposures in ditches of this layer usually show it to have a coarsely cubical or blocky structure that greatly facilitates aeration and sub-drainage.

The lower part of the 3-foot soil section is usually a smooth, plastic, silty clay of yellowish-gray color, mottled faintly with brown iron stains. In places the subsoil is a yellowish-brown silty clay where immediately underlain by gravelly material. It seldom has the granular structure characteristic of the middle soil stratum. It is less pervious, as a rule, although varying considerably in this respect, often within a few rods or even in the same boring. The coloration usually indicates the natural drainage conditions.

In many places a gravelly clay is found a little below the subsoil proper, at depths of 30 to 40 inches. In such instances its presence is indicated by numerous small pebbles upon the surface, or by the proximity of a gravel pit in which loose sand and gravel are found at less than 5 or 6 feet. Such land is in condition for tillage sooner after a rain than those larger areas where clay is the basal material to a considerable depth.

The above description is applicable to most of the black land in this county. The greater portion of all the larger tracts consists of soil having essentially these characteristics. The smaller areas, the

more or less isolated bodies of less than 40 acres and the innumerable narrow and rather illy defined swales found almost everywhere in the uplands present variations of this type ranging from very black, loose soils to those but slightly darker colored and nearly as firm as the adjoining flat phase of the Miami silt loam. As a rule the central part of the small areas corresponds very well with the type description, but the outer portion, or in many instances all of the body of black land, has a firm, silty soil, very black, but never approaching a "muck" condition. In such places the subsoil is usually a dull-yellow or yellowish-brown clay or clay loam. The latter is not generally so heavy, nor inclined to be so "gummy" as the subsoil of some of the larger areas of the type, the color being indicative of the better underdrainage. The soil has a well-developed, granular structure, with a consequent tendency to a grainy, friable condition that is highly favorable to easy tillage.

Such comparatively light-colored developments of the type occur everywhere in intimate association with the typical soil, but in Jefferson, Jackson, Clinton, and Marion Townships this phase is the most commonly found. In many instances it simply represents the condition which the type assumes after many years of cultivation. The small areas were generally drained years before the larger ones were reclaimed. The latter still have, in most cases, a very large content of organic remains that has not yet been reduced by long-continued cultivation or thoroughly mixed with mineral matter from the subsoil by plowing and other operations of tillage.

Along the upper course of the drainage lines, where the obstructed drainage of the ponds and sloughs begins to take some definite direction and forms a channel, the Clyde silty clay loam resembles an alluvium. There is more or less sand in the soil and the subsoil is usually a mixed material, quite heavy but admitting of an easier movement of water through it than is possible in the light-colored clay subsoil of most of the type.

These various phases of the type are important chiefly with respect to convenience of tillage and economy in drainage. Some of this land that has been in cultivation for many years has lost so much of its original high percentage of organic matter that the ground is inclined to become cloddy unless carefully managed. This is the first stage in the gradual decrease of the black organic matter consequent upon continued tillage. In all the larger bodies, and often in those that are mere "pot holes" or sharp depressions in the uplands, there are some places where the soil still has such an excessive proportion of vegetable matter that the surface is "chaffy" or resembles Muck. All of these will improve in course of time. Deep plowing, in order to mix the loose material with the gummy clay subsoil, is to be recommended, and the admixture of silt and sand from the

surrounding land may be encouraged. Such places may be profitably treated with potash, as suggested for the cultivation of corn on the Muck.

It is impracticable to represent these variations in the type on a map of the scale used in this survey, because two or more fairly well defined phases are usually involved in every area, however small. In many of the larger ones in the southern part of the county every gradation may be found from a brown silt loam at the margin to a mucky soil in the lowest places.

Limited areas of the type were grassy marshes when the first settlers came to this county, but most of the type was heavily forested. Excepting the places where the soil was practically Muck or essentially a permanent swamp, the growth consisted chiefly of swamp white oak, pin and bur oak, silver maple, black ash, and elm. Hickory was abundant on those areas of this type which approach the Miami silt loam, flat phase. All of these species are still seen in woodlots where the black soil is found. In small ponds where water stood the most of the year buttonwood bushes, willow, and occasionally cottonwood were the characteristic varieties.

With the exception of a very few small ponds or an occasional slough, all this black land has been artificially drained. In the central townships thousands of rods of 4 to 8 inch tile have been laid in recent years. The main line and principal laterals of the several extensive drainage systems are complete, but more branch lines could be profitably installed. Most of the areas in the remainder of the county are well drained, both open and tiled ditches being employed. As a rule few landowners consider any further ditching necessary than what is required to provide prompt relief from excess water. The suggestions concerning the advantage of installing tile drains in the flat phase of the Miami silt loam apply equally well to parts of this type. Where there is a heavy, compact subsoil, better aeration would be secured if tile drains were laid a few rods apart. As the surface soil becomes more compact through exhaustion of its present liberal supply of humus the advantage of the improvement suggested will become more apparent. In most instances the average level of the ground water in all flat or markedly depressed areas is only a little below the bottom of the ditch or tiles.

The average yield of corn on the Clyde silty clay loam may be placed at about 50 bushels per acre. On most well-managed farms 60 to 70 bushels is a common yield and returns of 80 and 100 bushels are not uncommon. The quality in most instances is not so good as that of the lighter colored soils. Practically all of this land endures continuous cropping to this grain remarkably well. Some fields have had little change to other crops for 20 years and still give good average yields.

Oats fall down, or lodge, badly in wet seasons. On the firmer ground in dry years the returns are satisfactory, from 40 to 60 bushels being commonly obtained. The yield of wheat is most variously reported, indicating the varying effects of drainage, time of seeding, and seasonal conditions. In most years yields of 25 bushels are above the average, although this is quite frequently exceeded. In the winter of 1911-12 this crop suffered great injury by accumulation of ice in the low places.

Timothy and bluegrass make a vigorous growth on this soil, but the quality in each case is somewhat below that of the grasses on lighter soils. Clover also makes a vigorous growth. The soil is seldom acid, and in many instances lime nodules are found in the lower subsoil. Alfalfa should do well on well-drained ground where corn does well without potash. A phase that is neither very chaffy nor exceptionally gummy just below the plow line should be selected. Since this plant requires much water, location where the water table is about 3 or 4 feet from the surface should prove most suitable in this respect. It is probable that lime and stable manure, if free from weed and bluegrass seed, would be beneficial. In places the litmus-paper test showed the soil to be slightly acid. To favor the proper inoculation soil from an alfalfa field should be scattered on the ground.

The following table shows the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Clyde silty clay loam:

Mechanical analyses of Clyde 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.*	*Per cent.*
281126	Soil	0.2	1.2	2.2	6.7	7.0	58.0	24.5
281127	Subsoil	.2	1.4	2.2	6.8	7.9	62.1	19.4
281128	Lower subsoil	.0	.4	.9	3.2	4.9	68.4	22.0

MIAMI SILT LOAM.

The soil of the Miami silt loam is a light brownish gray silt loam. In many instances, as on the tops of the slight elevations that are a characteristic feature of the type, the soil is a brown sandy loam. On the hillsides there is a considerable textural variation, but silt and fine sand are the chief components, there being but a small percentage of clay and seldom any coarse sand. The organic-matter content is everywhere low, and, therefore, the surface when dry has a grayish color, but not so light a shade as the dry surface of the flat phase of the type. The moist soil invariably has a pronounced brownish tint approaching reddish brown on gravelly slopes. There is usually a little gravel scattered through the soil and occasionally some small stones, but such material is not very abundant except upon the

crests of some of the mounds and on a few small spots on comparatively level ground.

The subsoil from 10 to 15 inches below the surface to a depth of 3 or 4 feet is usually a brown or dull reddish brown clay. It is rather heavy and compact, and these qualities would be more pronounced were it not for the coarse angular sand and small bits of gravel that it contains. This coarse material, with some fine sand, increases the porosity and imparts a degree of friability that would otherwise be lacking. The sand and gravel usually increase with depth, so that at 4 or 5 feet the material is a clay loam, or in many instances a sandy clay. In some places the underlying stratum is comparatively loose gravel, and the total thickness of soil and clay subsoil may not exceed 4 or 5 feet, but such conditions are not of common occurrence and are usually limited to areas of a few acres. The clay substratum is evidently of sufficient thickness to be a good moisture reservoir and the capillary movement of the soil moisture is not affected, with regard to average crop requirements, by beds of gravel, even where the latter are known to be present at moderate depths.

This type is the prevalent soil in the rolling to moderately hilly sections of the uplands. The largest tract is a few miles southeast of Whitestown. The surface consists of mounds and rather narrow ridges, quite irregularly disposed and of unequal height. The local relief—that is, the difference in elevation in any 20 or 40 acre field—is usually less than 30 to 40 feet; but the difference in elevation of the higher hills near the railroad and the slopes near Fishback Creek is much greater. All the land is tillable and very little is so rolling as to erode seriously. The higher ground is in part gravelly and is somewhat stony. The lower slopes of the larger ridges have a more silty soil than the higher ground, but the variation in this respect is not of great importance, for the clay or sandy clay subsoil largely determines the physical conditions with regard to drainage, aeration, and average moisture content.

The areas east of Jamestown have somewhat similar topography, but most of this land is less gravelly than that near Whitestown and the soil varies from a fine sandy loam to a silt loam.

These small areas are most numerous in the western and southwestern parts of the county, and there are some very conspicuous elevations a few miles east and north of Lebanon having a sandy phase of this soil. Those in the northeastern townships have but slight elevations above the surrounding land. All the morainic hills or innumerable small elevations occurring throughout the county have in general this type of soil. In many instances the surface soil, even to the crest of the elevation, is a silt loam, but as a rule the slightly reddish sandy clay subsoil prevails, insuring good aeration and under-

drainage. The mound and ridge areas whenever of sufficient size have been indicated on the map. In many such cases the extent of the fine sandy loam is exaggerated, for on the flanks of the mounds there is frequently a whitish silt loam with a dense silty clay subsoil to a depth of 2 to 3 feet. This close structural subsoil imparts to these places about the same physical properties as distinguish the "clay spots" in the flat phase of the type. Aside from the small areas of morainic origin the type is derived from eroded areas of till lying adjacent to valleys.

These knolls and ridges are favorite sites for farm buildings. It is noticeable that apple trees on such locations average larger and evidently are longer lived than those on lower grounds. In some measure this may be due to the earlier improvements made as compared with those on the flat phase of the Miami silt loam, but the soil in general is well adapted to the apple. This tree prefers a moderately loamy or friable surface soil with well-drained clay or clay loam subsoil. The air drainage in orchards on the morainic hills is also a factor of importance in the average productiveness of the trees.

In the areas of Miami silt loam, embracing the rolling to moderately hilly lands along the creeks, the surface features have been determined in large measure by erosion. These include the low bluffs that form the sides of the valleys of Sugar and Eagle Creeks and the limited areas of broken ground on ravines breaking through these bluffy hills. In a few instances elsewhere short, steep hillsides form a considerable part of the fields through which small drainage lines extend; but with these exceptions this land is easily tilled with the usual farm implements. The soil on the crests of the broader ridges approaches the Miami silt loam, flat phase, while on the steep slopes it is more sandy and gravel and stones are usually numerous, but never so abundant as to interfere with cultivation.

As a rule land in the immediate vicinity of the "bluff lines" is quite broken. In some instances, however, the uplands extend with comparatively little relief almost to the crests of the escarpments, such topography being found on the south side of Sugar Creek, west of Thorntown, and in the upper curves of the stream. Most of the areas on the southern tributaries of Sugar Creek are rolling, with but little ground too rough to be farmed.

In the vicinity of Zionsville much of the type is quite hilly, and farther north it has in general a rather mild topography and the boundary between the typical silt loam and the flat phase is more or less arbitrary.

The average yields of corn, wheat, and oats on the typical Miami silt loam are somewhat higher than those on the flat phase of the type. The inherent fertility with regard to the mineral elements may be a

little higher than that of the silt loam, because erosion has removed the surface materials, which may be assumed to have lost some of the valuable elements through long-continued leaching and weathering and brought within the zone commonly occupied by plant roots the comparatively unchanged bowlder clay beneath, for the latter is undoubtedly rich in the mineral elements, consisting as it does of a heterogeneous mixture of rock débris. Throughout most of the type free lime is found in the lower subsoil. The physical condition of the soil and subsoil insures good drainage and aeration. The pronounced brownish tints usually prevailing and the rare occurrence of mottling are due to the relatively free circulation of air and good capillarity that exist throughout the entire soil section. As stated elsewhere, the underlying glacial material is a reservoir of soil moisture, and in this type the capillary connection between this substratum and the surface soil leaves little to be desired. There are many variations in this respect, but as a rule the reddish-brown sandy clay subsoil, or layer between the depths of 10 to 36 inches, has good capillarity and is seldom so compact as to prevent a comparatively free downward movement of excess water in wet seasons. In general, crops on the typical Miami silt loam do not suffer so much from seasonal extremes as on the heavier flat phase of the type.

Clover and bluegrass find this a congenial type, owing in part to lack of acidity in the soil and the presence of lime at such comparatively shallow depths in the subsoil. The yields, however, are not generally so great as on the Clyde soils. Timothy does best on the lightest colored or more silty phases of the soil. The quality of all these crops is good, there being no tendency toward slow maturity of grain or coarseness of fiber in straw and grass such as is observable in soils with high organic-matter content and a tendency to be wet.

In common with all the upland soils, this one is deficient in humus.

On account of the former abundance of hard maple and black walnut this type is popularly termed "sugar-tree land." Practically all of it has long since been cleared and is now in cultivation. It is held in high esteem by farmers, chiefly because it is less susceptible to either wet or dry weather than the heavier soils and in less measure because of the easy tillage of its somewhat sandy surface soil. The areas mapped as Miami silt loam include only the more pronounced development of the type, phases of the soil approaching this type but not distinctly characteristic of it having usually been referred to as the Miami silt loam, flat phase.

Miami silt loam, flat phase.—The Miami silt loam, flat phase, is the light-colored upland soil commonly called "clay land." It is the dominant soil in the county, forming 60.8 per cent of the total area. To a depth of about 10 inches the soil is a light-gray silt, variations in shade ranging from ashy gray when dry to a pronounced brownish

gray as the characteristic color under usual moisture conditions. Silt and very fine sand constitute the greater part of the material, but there is usually a little medium sand present and in most instances a few pebbles. A hand sample, if dry, has a rather fine, floury feel, with a little coarse grit, and there is a noticeable lack of granulation, or the "crumb" structure, so often discernible in the black soils. There is usually very little humus, even virgin soil containing no visible quantity of vegetable matter below 5 or 6 inches.

The subsoil to a depth of 25 or 30 inches is a stiff clay, technically a silty clay loam, since silt and clay, the smallest grade of soil particles, make up most of the mass. The upper part of the subsoil is generally a mottled gray and yellow silty loam, only a little less friable than the surface soil, but with slight increase in depth the physical properties of a clay are very apparent. As a rule the material has a rather high degree of plasticity if wet and is so tenacious as to offer considerable resistance to penetration by any implement. With the usual moisture content it is stiff and crumbly, but there is not the marked development of granular structure noticeable in clayey subsoils of types having much organic matter in the surface soils. This stratum is not impervious, but the heaviest phases admit of a slow downward movement of excess water and of rather poor aeration.

The color is variable, but in most instances the upper part of this substratum is light gray, more or less mottled with pale-yellowish streaks. In the lower portion brown or reddish-brown tints more commonly prevail, but not infrequently brown and grayish mottlings occur throughout the entire stratum, with some very light colored streaks due to unequal oxidation and suggestive of ineffective subdrainage. Soft, black iron concretions sometimes are numerous in poorly drained places, occurring chiefly in the soil and upper subsoil.

The lower portion of the 3-foot section is usually a brownish clay or clay loam containing considerable sand and gravel. This coarse material gives it a comparatively open, porous structure, and the difference in physical character between this stratum and the silty clay above is very marked. The line of contact is fairly well defined and usually occurs between 25 and 40 inches below the surface. At a little greater depth the clay is more sandy, with gravel and stones forming an appreciable proportion of the entire mass. The brownish coloration due to oxidation and other processes of weathering extends a few feet farther down and then gives place to the light-yellowish tints of the comparatively unaltered glacial material.

The Miami silt loam, flat phase, almost everywhere in this county has this characteristic structure, a gray silty surface soil grading downward to a mottled silty clay subsoil that at 25 or 30 inches is underlain by brown sandy gravelly clay. There are departures from this type

with respect to the depth and color of the soil and thickness of the middle subsoil, as well as variations in the relative proportions of sand, silt, and clay in each, that cause some difference in the moisture relations and tillage requirements. As a rule all such variations are toward the Clyde soil on the one hand or the so-called "sugar-tree land" on the other; and their occurrence is generally indicated by surface configurations similar to the topography characteristic of one or the other of these soils. On local elevations and the short, steep slopes or banks near ditches the soil is essentially the Miami silt loam and corresponds to this type description. In depressions the darker color is due to a greater content of humus, and the loaminess is further increased in most old fields by material washed from adjoining higher grounds.

The surface of most of the flat phase of the Miami silt loam is undulating to very moderately rolling. On some of the pronounced slopes that are concave rather than arched or convex, the silty clay is deeper than the average elsewhere, causing rather poor underdrainage. This is very often evident in the light-gray color of soil and the presence, in some instances, of small, brown iron concretions. The upper subsoil is usually a whitish, puttylike silt, with abundant pale-yellow mottlings. The lower subsoil is often a tough, bluish clay and the sandy substratum is not found at less than 4 feet. These "clay spots" are also found on land that is nearly level, but the poor drainage is due to the structure of the subsoil rather than lack of surface inclination. Fortunately such phases are limited to small spots, seldom more than an acre or two in one body, but approaches toward this heavy phase are very common in all sections of the county, possibly a little more in the western and southwestern townships than in the eastern ones, on account of the slightly greater average depth of the silt. They are more frequently found in large bodies of the soil than in small areas, and on low swells rising but a few feet above adjoining black lands than on divides that have a pronounced decline toward a well-defined drainage line. In many instances the light color of the soil and its tendency to a puttylike consistency when wet are due to exhaustion of the humus through long-continued cultivation. On account of their small size and lack of pronounced structural or textural differences when compared with the normal type, it is impracticable to outline these areas. For the same reason it is impossible to show the hundreds of small mounds, ranging in size from a few square rods to a few acres, where the soil approaches the typical Miami silt loam in color and texture.

All of this soil was originally forested. The forest was a mixed growth of hardwoods, with less tendency toward the dominance of certain species than obtained upon the black soils or the "sugar tree land." While on the latter hard maple and black walnut were the character-

istic varieties, they also formed much of the forest on the flat phase of the Miami silt loam, and the woodland pastures on this type usually include specimens of these trees. On the heavy phase described in the preceding paragraphs beech was the most abundant species, and "beech land" is a local term often applied to these soils. In depressions inclined to be "seepy" and where the surface drainage is poor, ash, elm, and hickory were more common. The originally meager supply of humus was due to this forest cover, for well-drained forest lands accumulate but little vegetable remains below the immediate surface soil. There were formerly many bowlders of various size, but most of them have been removed to fence lines or used in farm buildings. Small stones are usually found on the slight elevations and slopes near streams.

With the exception of woodlots, practically all this phase is cultivated. Taking the soil as a whole, the average yield of corn is probably less than 40 bushels, certainly not much above this estimate. On many farms where frequent changes to clover have been practiced the ordinary yield is from 50 to 60 bushels per acre, or even more in favorable seasons.

The average yield of wheat has declined during the last 20 years. Formerly returns of 25 to 30 bushels were frequently secured, but in recent years from 15 to 20 bushels are more commonly reported. This decrease is doubtless due in part to causes not attributable to the soil, but the flat phase of the Miami silt loam seems to have suffered a greater decline than other soils in yields of this grain.

Oats do best in seasons of abundant rainfall. They will make a good growth and usually stand up well. In 1912 about 50 bushels per acre were matured, though not subsequently saved in good condition. Oats require much moisture in a comparatively short period. The heavier areas of this soil have too dense a subsoil to admit of as rapid delivery of water as seems necessary for the best development of the oat plant, except in seasons of very frequent rains. In dry seasons the crop is usually poor on the heavier areas or on land that is in bad condition through long tillage to corn.

Timothy does well on this phase and the quality of hay is better than that from the Clyde soils. This is also true with respect to corn. Clover does not, in most years, make so rapid a growth or produce so much hay as on the Clyde silty clay loam. Since the surface soil is so generally acid, it is somewhat remarkable that so little difficulty is experienced in getting a stand or maintaining it for several years. In most cases failure to secure a stand may be attributable to seasonal conditions or improper management.

Tomatoes, potatoes, and garden crops are successfully grown on the flat phase of the Miami silt loam. The difference in yields, other conditions being equal, coincides pretty closely with observable variations

in the humus content of the soil and to a less degree in the character or structure of the subsoil. This, of course, is true regarding all crops, but is most in evidence with those that are more exacting in their requirements than corn or small grains.

The origin of this phase of the Miami silt loam and its general mineralogical composition, as well as some chemical determinations are discussed in a preceding page. There is no evidence of a marked deficiency in the mineral elements of fertility. Lime is needed in the surface soil to correct acidity, but in the lower subsoil there is a relatively large quantity of this mineral. To the deficiency of organic matter is due the lack of available nitrates so often indicated in the slow growth of the corn. The bad physical condition of the soil is also caused chiefly by the low content of humus. The mechanical composition is highly favorable to easy and effective tillage, but without some vegetable matter there will be a decided tendency to pack after rains and to remain cold and wet in the spring after darker soils are in good condition. Whether these undesirable conditions are improved by applications of barnyard manure or by a return to the soil of green crops is a matter of farm management. The effects on the soil are essentially the same. In most cases, however, not enough vegetable matter is returned to the fields. There should always be enough to give the soil a darker color and a noticeable increase in the granulation, or "crumb" structure, when compared with the ashy-gray soil of fields that have long been subject to tillage with few changes to grass. Clover and alfalfa are especially beneficial to this type. Besides adding available nitrogen, the deep penetration of their roots and their subsequent decay render the subsoil much more permeable to air and water.

Deep plowing should be practiced, but this does not mean that the yellowish silty clay of the subsurface soil should be turned up, with the highly probable result of forming clods or packing to a close crust, as it is likely to do under the usual conditions of spring plowing. The depth should be increased as the effects of previous tillage and influence of the humus is apparent. Subsoiling, or any process that renders the subsoil more permeable to air, will give direct and lasting benefit.

While not practicable to loosen up or otherwise materially alter the structure of the middle subsoil by tillage, its physical condition, or rather its influence upon the moisture content of the entire soil section, may be changed by tile drainage. The surface drainage is good, but the dense subsoil, as previously stated, is too retentive of moisture. The water movement, both downward and laterally, is rather slow. Tile drains would facilitate this movement, thus hastening relief after heavy rains. In dry periods the soil moisture would be increased by the more rapid circulation of the air through the sub-

soil, because there is considerable condensation of moisture upon the soil grains by this process. During critical periods in crop development such increase in the total amount of soil water may prove of greatest value. This is doubtless the chief cause of corn making a steadier growth in dry weather over tile drains. In a number of instances a rather incomplete system has been installed, the results of which are very apparent, and the owners of the land state that the increased returns soon pay for the improvement.

All the heavier areas of this soil, regardless of local elevation, need tile drainage, and all would be benefited by the extension of the laterals that have already been laid in the adjoining Clyde soils. The size of the tile and the distance apart of the lines should be governed by the surface configurations of the fields and also by the character of the subsoil. Where the clay is especially dense and the depth to the brownish sandy clay is 4 or 5 feet ditches a few rods apart are needed. In the more sandy phase and where the subsoil is more porous the lines need not be so close together.

With the improvement suggested above, deeper tillage, and an increase in the humus supply this soil would prove very nearly as valuable for corn as the Clyde soils, while its adaptability to other staple crops would be enhanced and the average yields less dependent upon seasonal conditions.

FOX SILT LOAM.

The surface soil of the Fox silt loam to a depth of about 12 inches consists of a gray or grayish-brown silt loam. Upon drying out it has a decided grayish cast, but when wet the brownish color is very pronounced. Silt is the chief constituent, but there is enough fine sand present to render the material quite friable. Coarse sand is almost entirely lacking, except along the margins of the terraces and upon the occasional slight elevations that occur in the larger areas of the type. In such places the surface soil may be a fine sandy loam, with more or less gravel and some small stones, but not enough to interfere with cultivation. Beginning at about 12 inches the subsoil is a stiff, firm, brownish silty clay, not nearly so friable as the surface soil. Between the depths of 15 to 30 inches the subsoil is generally a clay, with enough coarse and medium sand to give a moist hand sample a most decidedly gritty feel. If dry the material is coarsely granular, checking into blocky fragments on exposure to the atmosphere. Vertical exposures, as in gravel pits, usually show this middle zone to be a reddish-brown, crumbly clay, frequently mottled with dark chocolate brown iron stains. In the lower portion pebbles are generally quite abundant and at 25 to 36 inches there is such a rapid increase in the proportion of coarse sand and gravel that it is difficult to penetrate below 30 inches with a soil auger. The basal part of

the 3-foot soil section is often a clayey gravel or very gravelly clay, while at a somewhat greater depth, usually less than 5 feet from the surface, relatively clean gravel or sand is found extending to an unknown depth. In general a representative section of this type consists of about a foot of grayish silty loam resting upon a reddish-brown clay or a very heavy silty clay loam that in many places is underlain by a deep bed of gravel.

This type is found on the comparatively level terraces or high second bottoms of Sugar and Eagle Creeks. The elevation above the first bottoms ranges from 20 to 50 feet. The outer margin or terrace line is generally an abrupt declivity, more or less stony or gravelly, while for a few rods back from its crest the soil is a brownish sandy loam of variable depth. Along the margin of the terraces the clay subsoil is thinner or may consist chiefly of gravelly sandy clay, grading to unconsolidated gravel. An approach to rough topography anywhere means coarser surface soil, with much gravelly or sandy clay at comparatively shallow depths. As a rule the greater part of the surface is nearly level or but slightly undulating and the immediate surface conditions closely resemble those of the somewhat lighter and best drained areas of the Miami silt loam, flat phase.

Usually in depressions in the surface of the terraces the soil is very similar to that of the higher ground surrounding them, for the gravelly substratum induces such thorough underdrainage that no semi-swampy condition ever existed. In some places, however, where there were formerly shallow ponds a black soil with a high content of organic matter has been developed. Several small areas of this kind are found on the terrace northwest of Thorntown. In such areas there is enough coarse sand in the soil to be easily observable, and pebbles are usually abundant. It is more crumbly than the lighter colored soil adjoining and may be reduced to a deep, mellow seed bed with less labor than is generally necessary on the black soils of the uplands. In a few places a "gummy" clay stratum lies just below the plow line, but such a condition is not commonly found. The subsoil is a dark-colored clay or clay loam free from the mottling usually observable in the subsoil of types of similar origin. At a depth of about 40 inches reddish-brown gravelly material is generally found. This doubtless favors good underdrainage but the close structure of the stratum between 20 and 30 inches necessitates artificial drainage in some places.

Practically all of this type is cultivated, a very small proportion being forested. The soil yields easily to tillage, and, on account of the slightly higher percentage of very fine sand, is less inclined to pack than the Miami silt loam, flat phase. Except in the depressions, the humus content, even of virgin soil, is low, owing in large measure to almost continuous cropping to grain.

The substratum of gravel insures thorough drainage and aeration. The terrace lands may be cultivated sooner after heavy rains than the upland silt loams. For the same cause crops show the effects of continued dry weather, especially near the outer margins of the terraces and on some of the gravelly knolls. The stratum of heavy material over the gravel is essentially the moisture reservoir and in normal seasons most of the type maintains a good moisture content, except in places where loose gravel is found at 3 to 4 feet from the surface.

The largest bodies of this type are found on the north side of Sugar Creek near Thorntown. The elevation of the southern edge of the terrace is from 20 to 40 feet above the creek bottoms. In most places the elevation very gradually increases toward the north, and the comparatively level surface of these areas merges almost imperceptibly into the undulating flat phase of the Miami silt loam along the somewhat arbitrary line on the map that indicates the approximate boundary between the two types. The areas on the south side of the creek are better defined topographically. The soil of the small bodies of Fox silt loam in general is more sandy than that in the larger areas, and a relatively greater proportion of the surface consists of steep slopes with more or less exposure of the underlying clay or gravel. The small areas near Zionsville have in general so much local relief that the original silty covering has been largely reduced by erosion to a fine sandy loam or shallow silty loam. A considerable part of each area is underlain by gravel and is somewhat susceptible to drought.

The average crop yields on all the heavier phases of this type are about the same as on the Miami silt loam, flat phase, except such variations in wet seasons as would be expected on account of the somewhat better drainage the terrace land enjoys. The interior portions of some of the larger bodies, however, would be benefited by tile drainage, although the absolute need of such improvement is limited to occasional flat spots having exceptionally light-colored soil. The latter are usually acid, but elsewhere the soils are generally free from such trouble.

In the vicinity of Thorntown farms that consist largely of this type are now valued at $150 to $200 an acre. The convenience of tillage the level surface affords and the generally recognized adaptability of the type to endure seasonal extremes, as well as the desirability of location, have much to do with this high valuation. The smaller areas are usually considered about equal to the typical Miami silt loam and are locally rated at about the same price.

FOX SANDY LOAM.

On all the larger creeks small areas of second-bottom land are found. In most instances they are fairly well defined terraces of moderate

elevation, usually less than 20 feet above the overflow land. While most of the surface rises to about the same level, it is generally more or less uneven and no very well defined separation may be made between it and the adjoining upland slopes, except that the latter rise, at some distance back from the creek, to a greater altitude. The approximate extent of a number of these rather illy defined terraces has been indicated upon the map and the soil classified as Fox sandy loam.

The basic material of the areas near Zionsville is stratified sand and gravel, or at least gravelly material. The original capping of silt or silty loam has suffered much erosion, on account of the uneven surface and the relatively larger extent of slope the outward margins of the individual areas usually present. On such uneven ground the soil is quite variable, ranging from a gravelly sandy loam, too loose and open to be of much agricultural value, to brown fine sandy loam having a depth of about 6 to 12 inches. The subsoil is a brown or faintly reddish brown clay that is very similar to the Miami silt loam. On the nearly level portions the soil is usually a silty loam with sufficient depth of silty clay substratum to have good moisture-holding properties. The surface is generally gravelly, with a good many small stones on the more broken ground. Exposures of the underlying gravel are generally numerous.

The small areas on Sugar Creek and its tributaries have generally a brown silty or fine sandy soil, with a relatively heavy subsoil.

With such diversity in soil texture and structure, no statements relative to actual agricultural value are applicable to the type as a whole or even to the different parts of the same area. Nearly all is regularly cultivated, and, except in unusually dry seasons, the crop yields on the most of this ground are very satisfactory. On nearly all of it clover does well and bluegrass makes a good growth, but, of course, does not remain green so long in summer as on the soil holding moisture better.

GENESEE SANDY LOAM.

A considerable portion of the first-bottom land on the lower courses of Eagle and Sugar Creeks consists of rather coarse textured material ranging from a brown loamy sand to a moderately heavy sandy loam. The latter represents the more common development, for drifts of loose sand occur for the most part only in the channel, and very light sandy soils are seldom found except on the immediate banks and the inner sides of short curves. Most of the areas mapped as Genesee sandy loam have a surface soil in which sand of various grades is the chief component, but there is usually enough silt and clay to give more or less coherency and favorably affect the moisture-holding properties. There is usually but little humus, except in depressions.

The characteristic color is brown, suggestive of iron-stained particles, but slightly affected by organic matter. In most instances there are but few stones or pebbles.

The subsoil is exceedingly variable in texture. It ranges from a stiff sandy loam of brown color or slightly mottled with rusty iron stains to a light-brown sand that at a few feet below the surface may be loose and coarse.

The substratum in most places is sand and gravel. The water table fluctuates with the rise and fall of the stream, but it seems that it usually stands well up toward the bottom of the 3-foot soil section. For this reason, most of the type maintains a fair degree of moisture, except in unusually dry seasons. In normal seasons and during usual stages of the streams corn does well and other crops make very satisfactory yields. Nearly all the type is subject to overflow, but the inundations seldom last more than a few hours. The fertility of this rather coarse, open soil is thus frequently renewed, which accounts in large measure for the excellent returns almost invariably secured on some low-lying and very sandy phases of the type. Much of this type is well adapted to melons, sweet potatoes, and other crops requiring a light soil.

GENESEE SILT LOAM.

The Genesee silt loam consists of a brown silty loam to a depth of 8 to 12 inches. The proportion of fine sand is usually so high that the surface is very friable and has in general the properties somewhat characteristic of a fine sandy loam, rather than those of a heavier soil. It yields easily to tillage, and only in the very heaviest phases becomes cloddy or is inclined to pack after rains. The subsoil is a light-brown silt loam, being a little heavier in texture and more compact than the surface foot, but it is not difficult to penetrate with a soil auger. As a rule it has a texture and structure highly favorable to the maintenance of good moisture conditions. Except in local depressions or in the occasional sandy mounds, saturation or extreme dryness seldom occurs. This is due to the average elevation, which ranges from a few feet to as much as 10 to 15 feet above the adjacent portion of the stream channel, and is also favored by the presence of a rather coarse, sandy substratum that is frequently reached with a 40-inch soil auger.

The color in what may be considered the typical development of this soil is a pronounced brown, suggestive of a dull shade of ochre, rather than the dark-brown coloration usually associated with soils in which there is more or less humus. In this type there is a noticeable lack of organic matter, the surface soil differing slightly in this respect from the subsoil. This observable deficiency in humus and the brown color, which is undoubtedly due to a rather high degree of

oxidation of the iron content and uniform distribution of this ferruginous material throughout the soil mass, help to differentiate this soil from the Genesee loam. The difference between these soils is quickly seen when the average material of the Genesee silt loam is compared with a sample of the Genesee loam.

This type is of alluvial origin and is found along Sugar and Eagle Creeks and their larger tributaries.

The surface is generally free from stones and gravel and there are comparatively few abandoned channels or deep depressions of any sort. The slight moundlike elevations found in some of the larger areas are more sandy than the lower ground. The immediate banks of the streams and lines of "cut-off" for the current during floods are also quite sandy and in places gravelly.

The water table is not generally more than a few feet below the surface, so that the moisture content seldom falls below that necessary for a growing crop. Exceptions to this occur along the channel, where coarse sand may be found a little below the surface, or in spots in the interior of the fields where the structure is similar, but these are limited to a very small proportion of the total area anywhere. The equitable water supply is doubtless the chief factor in the excellent average yields of grain and grass.

Practically all of this type is now cultivated. Clover, timothy, and bluegrass do especially well on this land, but as a rule it is so generally devoted to grain that alternations with grass or clover are not frequently made. It is quite apparent, however, that some of the higher lying areas are in need of more frequent change to crops that tend to increase instead of diminishing the organic matter. On one rather heavy phase of this type near Thorntown yields of 80 to 90 bushels of corn have been secured, but the ground has been frequently manured and otherwise well cared for.

Oats do not generally grow so rank as on the Clyde soils. Rye and wheat do better than on the average upland soil, returns of 30 to 40 bushels of the latter having been reported in favorable seasons.

Notwithstanding its deficiency in humus, the type has a high value as a corn soil. The short inundations to which much of it is subjected almost every year and the rare overflows that sometimes extend over all but the highest parts deposit much fine material, and the fertility is thus renewed to an extent that compensates for the temporary loss sustained when floods come, as they sometimes do, in the growing season.

The higher lying portions of this alluvium are well adapted to alfalfa. The short overflows are not liable to cause much injury, except in the quantity of weed and bluegrass seed thus scattered on the land.

GENESEE LOAM.

The Genesee loam embraces those black alluvial soils found along the smaller streams and in some of the widest parts of the valleys of the larger creeks. In the former locations the surface soil is usually a dark-brown or dark-drab silty loam with enough sand to render it rather friable and loamy. Where it approaches in texture a clay loam the surface is crumbly and the subsoil usually less compact than that of the other black lands. The organic-matter content is moderately high and affects the color to a depth of 15 to 18 inches.

The subsoil is a clay or clay loam and ranges in color from gray, mottled with yellow or yellowish brown, to dark brown or drab, with many rusty-brown iron stains in the lower portion. In the lower part of the 3-foot section there is considerable coarse sand and fine gravel. The lighter tints indicate poor aeration and a rather high average level of the water table. On the other hand, the darker colors are found where the natural drainage is better, a condition usually prevailing in most of the type. It is a little more compact than the surface soil but seldom "gummy" or containing a semi-impervious layer. It is generally so open in structure that it admits of comparatively good underdrainage and aeration. The exceptions to this are generally confined to low places where the average level of the ground water is close to the surface.

The Genesee loam on Sugar Creek generally occurs on the outer margin of the wider parts of the flood plain, where there is little sedimentation, except from the backwater of the highest floods. Since the burden of these is mostly silt and clay particles, comparatively heavy soils have been developed. At the foot of some of the hillsides narrow strips of Muck are often found, due to seepage from the higher ground. In some of these places the subsoil contains so much bog iron that it is very yellow and sticky. Near the stream channel the texture is coarser and there is less organic matter in the surface soil.

This soil has a high degree of fertility and possibly is as nearly inexhaustible with regard to the elements of mineral plant food as any soil can be, but the organic-matter content in some of the higher lying areas is decreasing. The soil is slowly assuming a higher color and the physical conditions are possibly less satisfactory than when the land was cleared. Such ground would be benefited by more frequent change to clover or to pasture grasses. Lower ground subject to more inundations is thus rejuvenated, but the well-drained higher valley lands will in time, at least, show the effects of almost continuous cropping to corn.

The yields of corn on this type are frequently as high as 80 to 90 bushels per acre. Wheat usually gives better returns than on the Miami silt loam, flat phase, but the possibility of injury by flood is,

of course, a serious menace. On the highest locations, where floods of even a few hours' duration seldom occur, alfalfa would do well, the fertility of the soil and the permanency of the water supply being especially favorable to this crop.

MUCK.

In soil classification Muck is a term applied to those deposits consisting chiefly of vegetable remains where the decomposition occurred in part under water or, at least, under conditions of almost constant saturation. The earlier stage of the process usually forms peat, a brown, fibrous mass, in which the plant tissues are still discernible, but further change, with more or less exposure to atmospheric agencies, generally gives a very black, finely divided carbonaceous material, loose and porous when dry and very soft and spongy if wet. All these cumulative deposits are in a later stage of decomposition and many of them have so far changed under the influence of artificial drainage and admixture of silt and clay from adjoining cultivated land that they are now essentially a soil, with an abnormally high content of organic matter. This is frequently the case in the lowest portions of the Clyde silty clay loam.

The Muck areas indicated on the map are as yet true Muck. From a depth of about 4 inches to a foot or more the material is black, finely divided plant tissue, with comparatively little earthy material. In artificially drained and well-cultivated fields the surface is loose and offers but little resistance to any implement. Its general physical properties are indicated by the local name "chaffy" land, but it is in too fine a state of division to render this term correctly applicable.

In the smaller areas the Muck is usually but a few inches deep, and as a rule more or less earthy material is mixed with it. The upper subsoil is generally a black, granular clay or silty clay loam, grading with increase of depth to a yellow or mottled yellowish and gray clay. In many cases the subsoil is identical with that of the Clyde silty clay loam.

In the larger areas along the Eel River ditches the Muck has a depth of 10 to 20 inches, the lower part of which is often quite compact and invariably contains much moisture. Beneath the vegetable material is often found a close, heavy, dark-drab clay, in many instances so sticky and gummy as to be very difficult to penetrate with a spade. This layer is not usually more than a foot or so thick but changes at a depth of 15 to 20 inches to a brown marly clay that at 36 inches is a light-gray marl, with many small shells. In this material the lime carbonate may be so high that it is rather friable and chalky. Four or five feet below the surface there is generally a clay. In no instance was this substratum found to be sand or gravel.

Practically all of this type, which is locally termed "chaffy" soil, is now drained and in cultivation. Bluegrass and timothy make a rank growth, but the quality of the hay is not so good as that made from grass on normal soils. On all this type corn fails to thrive so well as on the Clyde silty clay loam. The plants when from 2 to 3 feet high are very liable to turn yellow, the lower leaves being affected first. The stalk ceases to grow, and even if it does not die it fails to mature any grain. The extremities of the roots die and in many instances are shriveled and brown nearly to the base of the stalk. This trouble, common to many Muck and Peat soils throughout northern Indiana, may be remedied by the application of potash. From 100 to 200 pounds of muriate of potash per acre should be used. It is better to distribute the potash over the surface, or, at least, to drill in the hill. This soil is also improved for corn by applying several loads of manure per acre. It is probable that the manure introduces bacteria that are necessary to the growth of corn but are not present in the Muck. The latter is generally acid, as indicated by the litmus-paper test.

The Muck soils will improve in physical character and lose the "chaffiness" with continued cultivation. The black carbonaceous subsoil will yield to atmospheric agencies wherever drained and gradually assume a granular structure similar to that of the other black soils. In the management of this soil deep plowing of those areas where the mucky material is but a few inches deep will hasten the process, rendering the soil more firm and of better texture. Whenever practicable it should be done in the fall, so that the stiff gummy clay may be frozen and thawed as many times as possible. This will render it less troublesome to cultivate later.

The deeper Muck is easily cultivated and by the use of potash or stable manure the production of corn should be attended with little chance of failure. Yields of 70 to 80 bushels have been secured under favorable conditions or when the soil was more or less loamy. The quality of corn is invariably improved by the potash, but it is not generally so good as that on a normal soil.

Some of the tracts near the large ditches could be utilized advantageously for truck, such as onions, cabbage, and celery. It also seems possible that a limited acreage could be thus used and profitably irrigated by means of pumps.

MEADOW.

Meadow embraces those narrow strips of alluvium on the small branches and upper courses of several of the creeks. The conditions of deposition prevent the development of any well-defined type. As a rule most of the material is rather fine textured, varying from a silty loam to a fine sandy loam, and generally there is but little coarse

sand or gravel, except near the channel of the stream. The surface in most places is more or less uneven and in the wider developments low, seepy spots frequently occur on the margin. There is usually a low, blufflike bank on one or both sides of the Meadow where the stream is a short tributary of one of the larger creeks. On the heads of small branches this topographic feature is lacking and the distinction between this type and the Clyde silty clay loam is not well defined. In nearly all cases the width of the alluvium on the small drainage lines is considerably exaggerated upon the map.

Practically all of this type has been cleared of the original forest, wholly or in part, so that it is now mostly set to bluegrass. Some of the widest portions of these little valleys are cultivated, the soil usually being a very fertile, dark-colored fine sandy loam, but crops are liable to injury by overflows.

SUMMARY.

Boone County is located in the central part of Indiana and has an area of 427 square miles, or 273,280 acres. The surface is undulating, becoming more rolling and hilly along the larger streams. There is very little land unsuitable for tillage and practically all is included in well-improved farms. The public roads are excellent, and several steam and electric lines afford most convenient transportation facilities.

Corn, oats, wheat, and clover are the principal crops. Comparatively few cattle are fattened, but dairying is carried on quite extensively. Some attention is given to sheep and many draft horses are raised, but hog raising is the principal live-stock industry.

All the upland soils are the derivatives of a thin surface deposit of silty material overlying glacial material. The alluvial types are of limited extent and generally consist of brown sandy loams.

The Miami silt loam, or "sugar-tree land," embraces most of the rolling lands and the local elevations of the uplands. The soil contains more fine sand than that of the Miami silt loam, flat phase, and the subsoil is more open in structure. On account of its more effective underdrainage and aeration, this type is less susceptible to seasonal extremes than the heavier soils and the average yields of grain are somewhat higher.

The Miami silt loam, flat phase, or "clay land," is the most extensive soil in the county. It is a light-colored silt loam, with a rather heavy silty clay subsoil. It is deficient in humus and on this account requires rather careful management. Clover does well on it and it is excellent timothy and bluegrass land. The ordinary yields of corn are about 40 bushels per acre; of wheat 15 to 20 bushels; of oats from 30 to 40 bushels.

The Clyde silty clay loam, locally termed black lands, owes its origin to the semiswampy conditions formerly prevailing in practically all the depressions of the uplands. Under artificial drainage it is an ideal corn soil, the average yield in favorable seasons being 80 bushels per acre. Wheat does well and timothy, clover, and bluegrass make heavy yields. Limited areas of this type have an excess of vegetable matter in the surface soil and are called "chaffy" land. A few small areas of true Muck occur in association with these black lands.

The Fox silt loam occurs on the level bench lands of Sugar and Eagle Creeks. It is similar to the Miami silt loam, flat phase, but the smooth surface and generally good natural drainage render it somewhat easier of management. On those terraces that have an eroded surface the soil is quite variable in depth and texture, but most of it is a sandy loam. This variable condition is represented by the Fox sandy loam.

The Genesee silt loam embraces most of the larger areas of alluvium. It is a brown silty or fine sandy loam, rather low in organic matter, but the physical structure and topographic position insure good moisture conditions. Most of this type has a very high agricultural value.

The Genesee sandy loam is a soil of rather limited areal extent. In normal seasons and during usual stages of the streams corn does well and other crops make very satisfactory yields.

The Genesee loam represents black alluvial soils found along the smaller streams and in some of the widest parts of the valleys of the larger creeks. Corn frequently yields as high as 80 to 90 bushels per acre. Wheat usually gives better returns on this soil than on the flat phase of the Miami silt loam.

The narrow strips of alluvial soil on the branches are represented by Meadow. The texture, structure and drainage conditions are quite variable, and most of this land has little present agricultural value except for pasture.

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[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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