Soil Survey of Marion County, Indiana.

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DESCRIPTION OF THE AREA.

Marion County is located approximately in the center of the State of Indiana and is bounded on the north by Hamilton and Boone counties, on the west by Hendricks, on the south by Morgan

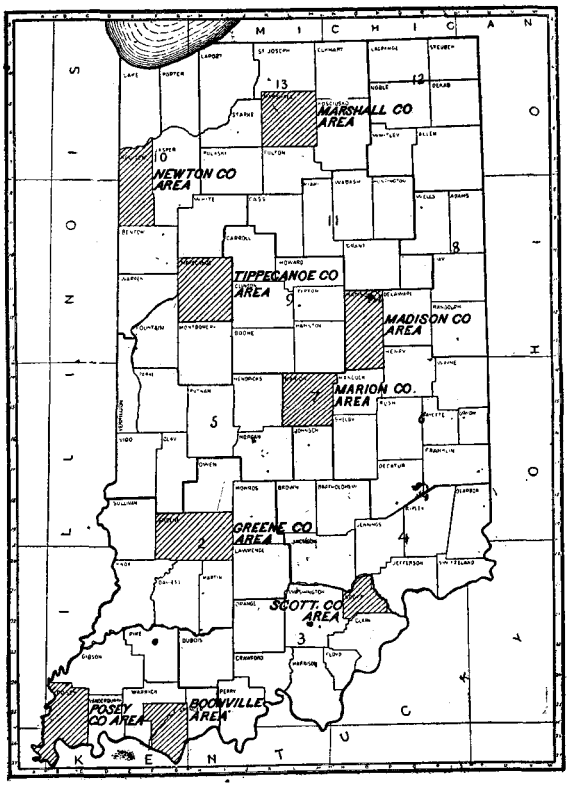

Fig. 1.—Sketch map showing location of the Marion County area, Indiana.

and Johnson, and on the east by Shelby and Hancock counties. It has an area of 248,704 acres, or about 389 square miles.

In topography the surface varies from level to gently rolling or

rolling. That portion of the area which lies within the bottoms along White River is level, with only here and there slight undulations, and about one-third of the remainder of the area is also level or undulating. The level stretches in the upland, which vary in size from one to four or five square miles, are surrounded by and gradually grade into gently rolling and rolling lands. The roughest portion is found along Eagle Creek in the northwestern corner of the county. Here a few of the slopes are too steep to be cultivated. Other limited areas of broken land are found at intervals along Eagle and Fall creeks and White River. One very conspicuous hill lies in the southwestern part of the county on the west side of the White River, about one and a half miles from the county line. It can be readily seen for miles, as it reaches an elevation of nearly 100 feet above the surrounding country. Another prominent hill or short ridge lies immediately northeast of Glen Valley.

The average elevation of the county above sea level is 860 feet, and occasionally an elevation of 900 feet is reached. The mean elevation of the land above the valley of White River is 175 feet.

The White River, running in a tortuous course 20° east of north and south of west, divides the county unequally, the western portion being a little more than one-half as large as the eastern, or one-third of the whole area. After crossing Marion County the White River continues in a southwesterly course until it is joined by the east fork of the White River, and thence it flows into the Wabash River and later into the Ohio.

The drainage of practically the entire county is directly into the White River. Eagle Creek enters the area near the northwest corner, flows southerly, and empties into the White River a few miles below Indianapolis. Fall Creek enters the northeast corner of the county, flows southwest, and empties into the White River within the city limits. Several other smaller streams traverse portions of the county and join the river. Buck Creek, which crosses the southeast corner of the county, flows into the east fork of the White River.

Throughout those portions of the county where the surface is gently rolling or rolling, or where there are gravel beds within four or five feet of the surface, the natural drainage is good. Where the surface is level, however, as is frequently the case throughout the uplands and always in the bottoms, the natural drainage is

often deficient. There are also numerous small depressions, formerly swamps, in which the natural drainage is poor. Tile drains and open ditches have been employed with marked success where the natural drainage is deficient. Practically all the swamps, none of which were of great extent, have been reclaimed, and the value of these formerly cold and wet lands has been greatly increased.

The first settlement within the limits of the present survey was made on the site of Indianapolis in 1820. Marion County was organized by act of the Legislature in 1821. The central and western portions were settled first, but it was not long until settlers were scattered over the entire area. The early settlers came from Kentucky, Ohio and Pennsylvania, and a few from Virginia and the Carolinas. At the present time the population throughout the rural districts is evenly distributed.

Indianapolis, the capital of Indiana and the county seat of Marion County, is located in the central part of the area, as well as in the center of the State. From the completion of the first railway, in 1847, to the breaking out of the Civil War there was a decided quickening of the city's energy and development. More railroads were constructed and business expanded. Railroad building continued with Indianapolis as a center, and the population increased rapidly. The growth of the city has been and still is steady and permanent. The industries of the city have a wide range, and include the manufacture of farm implements, carriages, and farm machinery. The most important villages are Southport, West Newton, Valley Mills, Bridgeport, Clermont, Broad Ripple, Lawrence, Oaklandon, Cumberland, New Bethel, and Acton.

The transportation facilities for this county and the surrounding country are excellent. Radiating from Indianapolis like the spokes of a wheel, there are fifteen steam railways and twelve electric lines. So completely do these roads traverse Marion County that no point is more than four miles distant from a steam or electric railroad. Within the area there are approximately 175 miles of steam railways and 135 miles of electric lines.

The dirt roads of the county are kept in excellent condition, and owing to the numerous deposits of gravel there is an abundance of excellent road-building material. There are about 350 miles of free gravel roads within the area and more are being improved each year. All toll roads have been abolished.

Indianapolis, with its population of 230,000, affords an excellent market for the products of Marion and the adjoining counties.

Large quantities of hay, grain, dairy and poultry products and vegetables are shipped in from the surrounding country to supply the city markets.

CLIMATE.

There are no marked peculiarities in the climatic conditions of the area. Extreme temperatures seldom occur and the rainfall is well distributed throughout the year. The following table, compiled from the records of the Weather Bureau station at Indianapolis, shows the mean monthly, annual, absolute maximum and minimum temperature, and mean monthly and annual precipitation, as well as the total amount for the driest and wettest years, and also the average depth of snow:

NORMAL MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION, ETC., INDIANAPOLIS.

MONTH.	Temperature.			Precipitation.			
	Mean. ° F.	Absolute Maximum. ° F.	Absolute Minimum. ° F.	Mean. Inches.	Total Amount for the Driest Year. Inches.	Total Amount for the Wettest Year. Inches.	Snow, Average Depth. Inches.
January	28	69	—25	2.8	1.6	4.9	6.9
February	31	72	—18	3.3	1.6	4.6	4.4
March	40	82	0	3.8	4.1	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
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
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
December	33	68	—15	3.0	4.1	0.9	5.1
Year	53	106	—25	41.9	30.3	56.7	22.9

As will be seen from the foregoing table, the average annual precipitation is 41.9 inches. The greatest amount of rainfall occurs in May, June, and July, and the smallest in October and January. The average annual temperature is 53° F.

The following table gives the dates of the last killing frosts in the spring and the first in the fall, for the period of seven years:

DATES OF FIRST AND LAST KILLING FROSTS.

YEAR.	Indianapolis.		YEAR.	Indianapolis.	
	Last in Spring.	First in Fall.		Last in Spring.	First in Fall.
1899	Apr. 9	Sept. 30	1904	Apr. 21	Oct. 23
1900	Apr. 13	Nov. 6	1906	Apr. 23	Oct. 19
1901	Apr. 9	Oct. 18			
1902	Apr. 8	Nov. 23	Average	Apr. 13	Oct. 24
1903	Apr. 5	Oct. 24			

It will be seen from this table that the average date of the last killing frost in the spring is April 13, and of the first in the fall is October 24, thus giving a growing season of over six months.

AGRICULTURE.

As stated elsewhere in this report, the first settlement in Marion County was made in 1820, prior to which time little was known of this immediate locality, except the information gained by early hunters and traders. The Indians who occupied this portion of the State before the advent of the white settlers had cleared small patches of ground here and there in the forest, and small quantities of corn were raised.

At this time the entire county was covered with forests of oak, beech, maple, walnut, ash, elm, hickory, and sycamore, and the clearing of fields was a difficult task. The timber, which would now be very valuable, was cut down and burned. The first crop was usually corn, and there was more of this staple grown than any other in the early days. Wheat was also grown, and hay was made from the wild grasses. By 1850 there were in Marion County 82,525 acres of improved land in farms, the cash value of which was $3,461,545. During this year there were 1,123,860 bushels of corn; 110,334 bushels of wheat; 89,318 bushels of oats; 21,831 bushels of potatoes, and 7,485 tons of hay produced within the county.

The methods of culture followed were somewhat crude. Cultivation was never as thorough as at the present time. The ground was turned with a breaking plow, harrowed once, sometimes not at all, and the seed planted. Though the cultivation was deficient, the soil was new and strong and good yields were obtained. Corn was often grown upon the same field for twenty consecutive years, and the same was true of wheat. Practically no attention was paid to the rotation of crops. The bottoms were recognized as being better adapted to corn, while the uplands were known to be better suited to small grain crops.

Corn, which was the leading staple in early days, is still the first crop of importance. Probably the largest acreage was devoted to corn in 1880, when there were 60,937 acres, which yielded 2,227,537 bushels, or about 37 bushels to the acre. A larger yield was obtained in 1900, when 56,759 acres produced 2,431,640 bushels, or an average of 43 bushels per acre. In 1906 the acreage was 42,845, with an average of 45 bushels per acre. The average for 1905 was 45¼ bushels per acre. Yellow corn is grown almost en-

tirely, and it is of good quality. While portions of the area produce as high as 70 bushels per acre, a conservative estimate places the average yield at 40 bushels. Much more care is being taken now than formerly in selecting seed and in cultivating the crop.

The extensive growing of wheat has been continued longer in this part of the country than in many other sections, for the reason that the soil is fairly well adapted to the production of this grain and a comparatively small amount of labor is required. Only winter wheat is grown. In 1880 there were 34,527 acres in wheat, which produced 729,330 bushels, or an average of 21 bushels per acre. In 1900 there were 49,791 acres, which yielded 848,980 bushels, or 18 bushels per acre. In 1906 there were 27,944 acres, which yielded 707,583 bushels, or 25 bushels per acre. This last was an exceptional yield and the largest in the history of the county. For the years 1903, 1904, and 1905 the averages were, respectively. 13, 11, and 16 bushels per acre. For the entire county 16 bushels per acre is considered an average crop. The acreage of wheat is decreasing, as is also the yield per acre. Continuous cropping of wheat on the same fields has reduced the productivity of the soil until under present conditions wheat growing is not as profitable as formerly.

The acreage of oats in Marion County has always been comparatively low, but it has been on the increase for the last few years. In 1880 there were 6,275 acres; in 1900, 6,071 acres; and in 1906, 15,786 acres devoted to this crop. A yield of 35 to 40 bushels per acre is considered an average for this section.

The soils of the county are well adapted to the production of grasses, and the yields of hay are from $1\frac{1}{4}$ to $2\frac{1}{2}$ tons per acre. Timothy and clover both yield well. These are usually seeded with wheat, there being but little of either sown without a nurse crop. Hungarian and German millet are also grown to a small extent, and a few patches of sorghum are seen. Little attention has been given to alfalfa. A few small fields occur, but do not give satisfactory yields. With careful attention alfalfa could be profitably grown.

Considering the excellent market afforded by Indianapolis, it would seem that more Irish potatoes could be profitably grown in the area. In 1900 there were 2,421 acres in the county, which yielded an average of 73 bushels per acre. In 1905 there were 2,052 acres, with an average yield of 104 bushels per acre, and in 1906 the average was 70 bushels per acre. Within the last few years the growing of tomatoes and peas for canning purposes has

received some attention. In 1906 there were 1,230 acres of tomatoes and 1,379 acres of peas in the county. The yield of tomatoes varies from 125 to 225 bushels per acre, and the price paid thus far averages about 22 cents per bushel. An average crop of peas is expected to net about $40 an acre.

There is but one canning factory in the area, but another is located a few miles south of the county line. These factories contract with the farmers to grow a certain acreage. The factory grades the peas and pays a stated price for each grade. A large percentage of the vines are fed to stock. Substations or branch factories should be established at various points throughout the county.

Strawberries are grown to some extent, and 250 crates of 24 quarts each is considered an average yield per acre. The vines are allowed to bear for two years, when the beds are plowed up. Currants, raspberries, blackberries, cabbage, lettuce, radishes, and other truck crops are also grown, but the trucking industry has never been extensively developed in the vicinity of Indianapolis. Apples, peaches, and pears are grown only to a limited extent. There are a few pear orchards of commercial size. Almost every farm has a few apple trees and sometimes a few peach trees, but these fruits are not especially adapted to this section. A few grape vines have been planted and do fairly well. It is thought that the grape and pear industry could be profitably extended.

Owing to the large quantity of dairy products consumed in Indianapolis, dairying has developed into an important industry in the surrounding country. A number of farmers make a specialty of dairying, while many others practice general farming and engage in dairying to some extent. Most of the cows are turned out to pasture during the summer. By employing soiling crops, much larger herds could be supported upon the same acreage. Comparatively few silos are found in the area. Judicious planting of such crops as oats, peas, millet, corn, and sorghum will provide a continuous supply of good forage until the time of killing frosts in the fall, and sufficient silage for the remainder of the year. There is at present a predominance of Jersey blood in the dairy stock, but there are also many of the so-called dual-purpose cows. It would be more advisable for the dairyman to make a specialty of the dairy breeds.

Approximately 20,000 gallons of milk and 8,000 gallons of cream are delivered daily to patrons in the city of Indianapolis.

Only one-sixth of this quantity is produced in Marion County, the remainder being shipped in on the electric and steam roads from the surrounding country for a distance of 50 to 60 miles. The county produced in 1906 719,424 pounds of butter. Much creamery butter is shipped in from various parts of Indiana, Illinois and Wisconsin. There are only a few creameries within the county.

The number of beef cattle is much less than the number of dairy cattle. There were in the county in 1905-6 about 3,000 head. The number of hogs on hand over three months old was 17,337. Only a few sheep are kept at the present time. Taking the statistics of the State agricultural report for 1906 and reckoning the number of horses, cattle, sheep and swine in the county, it is found that there are approximately three acres of improved land for each animal. By more intensive farming the number of live stock should be greatly increased.

There are large stockyards in Indianapolis to which local stockmen can easily deliver their fat stock directly. The nearness of this market tends to encourage the raising of fat stock, as freight charges and commissions are saved. There are several farms in the area which make a specialty of raising horses, mostly racing stock.

In the matter of crop adaptation, it has been recognized for many years that the soil along the bottoms of White River and its tributaries is better adapted to corn, and that the upland soils are better suited to the small grain crops. The closer adaptation of crops to soils has not been worked out. The following rotation is practiced: Corn, oats, wheat, and grass. Hay is usually cut from a field for two years, after which the field may be pastured for one or two years longer.

All the stable manure produced on the farms is applied to the fields, but this supply is insufficient to meet the needs of the soil. Large quantities are also brought from Indianapolis. The manure from the stockyards can be obtained for 25 cents a load. This is very rich and contains but little straw or litter of any kind. Loss is frequently incurred by stacking the manure in the field and allowing it to remain for considerable time. It should be spread upon the field as soon as hauled.

Throughout this county, as in many other sections, the farmers experience some difficulty in securing labor for the farm. To obtain good help the farmer must be willing to pay as much as the factories or other industries of the city. When such wages are paid,

sufficient labor can be secured. On the farms $1.50 a day with board is usually paid for ordinary work, though it is sometimes necessary to pay $2 a day during harvesting or other busy periods.

Many of the larger farms are being divided into smaller holdings and more intensive methods of cultivation are being followed. The average size of farms in the county in 1900 was 70.6 acres. The census of 1900 states that 48.4 per cent of the farms of the county were operated by the owners. As the average size of farms decreases the proportion of those who operate their own farms increases. The rental price of farm land is high, ranging from $4 to $7 an acre, and even as high as $10 an acre. The highest rent is paid for the trucking land near the city. Only a few farms are rented on shares, but when this system is followed the renter furnishes everything and gives the landowner one-third of the crop, or each may furnish half and divide the crop equally. The cash rental is preferred.

The value of farm lands in the county is constantly increasing. The price ranges from $75 to $300. There are few farms for sale in the county for less than $100 an acre.

Considering the high price of land and the low yields of wheat, the acreage of that crop should be reduced and the land be devoted to more intensive farming. The yields of corn can be increased by careful selection of seed, thorough cultivation, and proper fertilization. A careful study should be made of the needs of the soil, so that fertilizers may be applied intelligently. In Indianapolis it is no uncommon thing for the customer to pay $1 or more a bushel for Irish potatoes, and the price seldom falls below 50 cents. It can not be too strongly urged on the attention of the farmers of this section that there is a good opportunity for the growing of this crop.

There is also splendid opportunity for the higher development of the dairy industry, since so small a percentage of the dairy products consumed in Indianapolis are produced in Marion County. Milk sells for seven cents a quart, and the price of creamery butter seldom falls below 30 cents a pound.

SOILS.

Marion County includes three distinct geological formations. The eastern portion of the area is underlain by Carboniferous limestone 60 to 100 feet below the surface. Two miles west of the city of Indianapolis the limestone is underlain by black Genesee shale,

which has a thickness of 40 feet. In the extreme southwest corner of the county the Genesee shale is overlain by the Knob sandstone. These rock formations are covered to a depth of from 50 to 100 feet by a deposit of drift which forms the surface of the county and determines the character of soils. This drift is foreign in character and general in distribution. It is not a promiscuous deposit of clay, sand, and water-worn pebbles and bowlders like much of the eastern glacial drift. Such materials are found in it, but with not nearly as much regularity and order as is usually found in stratified rocks. At the base of the drift formation is usually found a compact lead-colored clay. Occasionally may be found thin deposits of very fine gray or yellow sand. Between the clay and the rock on which it rests is generally interposed a layer of coarse gravel or small siliceous bowlders. Sometimes this is wanting and the clay lies directly on the rock. In Marion County this clay bed ranges from 20 to 100 feet in thickness and is very uniform in character throughout, except where the light strata of fine sand occur. Above this is generally found a few feet of coarse sand or fine gravel and on this gravel from 20 to 30 feet of true glacial drift of more promiscuous character. In and upon the drift are a few glacial bowlders of granite, gneiss, and trap, which rocks are not found in place nearer than the Lake Superior region, whence they have been carried. In the upper drift are the glacial terraces and beds of gravel from which is obtained the best available material for road construction. The most of it is yellow or orange colored clay with considerable quantities of sand and lime. The gravel terraces are generally found in a succession of small mounds or ridgelike elevations from 10 to 15 feet above the surrounding country and usually rest on a compact clay.

The lower blue clay represents an earlier glaciation (probably Illinoisan) than the overlying softer drift of late Wisconsin Age. The material is fine and very much harder and more compact than the drift forming the present surface. The glacial debris which covers this entire region has been influenced since its deposition by weathering and the action of water until at the present time there are seven distinct though closely related soils within Marion County.

Excluding the Muck these soils represent two series—the Miami and the Huntington. The Miami series, which is by far the more extensive, gives rise in the present survey to five soil types, namely, Miami clay loam, Miami loam, Miami sandy loam, Miami gravelly loam, and Miami black clay loam. The Miami clay loam, the most extensive type in the county, embraces nearly all of the upland soil,

It has been formed directly from the unmodified drift and is therefore very uniform in texture. The Miami loam, which is closely related to the clay loam, though coarser in texture and containing a higher percentage of sand and fine gravel, has been formed from drift which has been modified to some extent by the action of water, and much of it occurs as a terace soil lying between the bottoms and the upland. The Miami sandy loam contains a high percentage of sand and some fine gravel and occurs as low ridges or patches adjoining the bottom land. The Miami gravelly loam also occurs as low ridges or hills. The Miami black clay loam occupies depressions in the upland where swampy conditions formerly prevailed and where large amounts of organic matter have accumulated.

The Miami soils occur throughout Indiana, Ohio, Michigan, Illinois, Wisconsin, Iowa, and Minnesota. They are all of glacial origin, and owing to the fact that the organic matter content is low, they are, with one exception, light in color.

The Huntington series, which comprises the alluvial soils lying along the water courses throughout this region, is represented in the present survey by only one type, the Huntington loam.

The Muck represents accumulations of organic matter in advanced stages or decomposition. Only a very limited amount of Muck was encountered in the area.

The following table gives the names and areas of the several soil types shown in the accompanying map:

AREAS OF DIFFERENT SOILS.

SOIL.	Acres.	Per Cent.	SOIL.	Acres.	Per Cent.
Miami clay loam	188,672	75.9	Miami sandy loam	512	0 2
Huntington loam	31,040	12 5	Muck	256	.1
Miami loam	24,768	10 0			
Miami black clay loam	2,880	1.1	Total	248,704	
Miami gravelly loam	576	.2			

MIAMI CLAY LOAM.

The surface soil of this type consists of a light-brown or ash-gray fine loam or silty loam extending to a depth of 8 to 12 inches. The color varies considerably with the moisture conditions. Immediately after a rain when there is the maximum amount of moisture present the soil is of a brown color, but when the surface becomes dry the soil is ashen-gray, or frequently whitish in color. In the small depressions where organic matter has accumulated the surface is always darker than on the higher places. The texture may vary slightly in different localities, but there is always present a high percentage of silt which imparts to the soil a smooth feel.

The subsoil to a depth of 36 inches consists of a brown, yellow or mottled, stiff, tenacious clay loam. There is frequently present in the subsoil below 24 inches a sufficient amount of angular gravel to impart a slightly gritty feel. This gravel content sometimes increases with depth, and the size and proportion of gravel may increase until a gravel bed in a clay matrix is encountered. The gravel is often lacking when the subsoil grades into bowlder clay. The areas under which gravel beds may be encountered are small when compared with the extent of the entire type.

Some difficulty is occasionally experienced in securing a good seedbed if cultivation is not carried on under proper moisture conditions. Clods sometimes form, and considerable time is required to pulverize them. If plowed when moisture conditions are favorable, however, there is but little difficulty in putting the soil in good tilth.

The Miami clay loam is the most extensive type, occupying nearly 76 per cent. of the area of the entire county. The same soil extends for many miles beyond the limits of the present survey. It occurs with remarkable uniformity in different parts of the county, with the exception of such changes as attend the varying drainage conditions in local areas. Occupying the uplands, its elevation is greater than that of any other soil in the area. The White River, which is bordered on both sides throughout most of its course by the Huntington loam and Miami loam, divides the survey into two parts of unequal size. The continuity of the two extensive areas of Miami clay loam is broken only by the bottom land along the small streams and the small areas of Miami black clay loam which occupy the depressions where large amounts of organic matter have accumulated.

The surface of the Miami clay loam varies from level to gently rolling, becoming more rolling and broken along some of the streams. The roughest portions are found in the northwest corner of the county along Eagle Creek and in the northeast corner along Fall Creek. There is a sharp descent from the upland to the streams, and here some of the slopes are too steep to be cultivated. The broken areas are of small extent, however, and the gently rolling surface is again encountered at a distance of from one-fourth to one-half mile from the streams. Between the areas of Miami clay loam and the White River the steep descent found along portions of Fall and Eagle creeks is absent, but there is usually a gradual descent to the bottom lands. Sometimes there is a well-defined terrace where a drop of 8 to 20 feet occurs. The gradation

from the Miami clay loam into the Miami loam is frequently so gradual that it is difficult to establish a boundary.

Where the surface of the type is rolling or where there is gravel underneath, the natural drainage is good, but where the surface is level or nearly so, and in the small depressions, the drainage is poor. In these places tile drains and open ditches have been constructed and their use has proved very profitable. The extension of these drains would further increase the value of the land in many instances.

The material from which the Miami clay loam is derived consists of glacial drift which was laid down by the great ice sheet. The depth of the younger glacial drift is usually from 20 to 30 feet, while the depth to the underlying rock is from 50 to 150 feet. A few glacial bowlders occur upon the surface, but not in sufficient numbers to interfere with cultivation. These are of granite, gneiss, and trap.

The original timber growth on this type consisted of beech, oak, hickory, maple, elm, ash, and walnut. The entire county was originally covered with timber, but the forests have gradually disappeared until only a few scattered wood lots of 5 to 15 acres are to be seen.

The Miami clay loam is considered a good general farming soil, and such crops as wheat, corn, oats, and hay are grown successfully. In the early days wheat was grown extensively and often on the same field year after year. The acreage of corn is greater now than formerly, though this crop was always extensively produced. Instances were found where fields have been cropped continuously to corn for twenty years. This custom has been greatly improved upon, but even at the present time it can not be said that a systematic crop rotation is practiced upon this type. The most common practice is to have wheat follow corn. Clover and timothy are seeded with the wheat and the meadow is left for two years, after which the field may be pastured for one or two years, when it is planted again to corn. When oats are grown this crop usually follows the corn. Corn and wheat are frequently grown for two years in succession in the same field. It will thus be seen that there is little regularity in the system of cropping.

The yields of wheat vary considerably, but an average for ten years is placed at 16 bushels per acre. Forty bushels is considered an average yield of corn and oats. Hay yields from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Irish potatoes do fairly well upon this type and yield an average of 100 bushels per acre. Tomatoes and peas are grown

for canning purposes, and the acreage is increasing. Tomatoes yield 200 bushels per acre and an average price for the last few years has been 22 cents a bushel. Forty dollars is considered a fair average net return from an acre of peas.

Near Indianapolis some trucking is carried on, and this industry could be profitably extended. Strawberries do very well; also currants and raspberries. Grapes, though not grown to any extent, could be profitably produced on a commercial scale. The acreage of wheat should be reduced and a more intensive system of agriculture practiced. A greater number of live stock should be kept and there is a good opportunity for the extension of the dairy industry.

All the stable manure produced on the farm is used upon the fields and considerable amounts are brought from the city. Commercial fertilizers are also used, and their use is considered profitable.

Farms in the Miami clay loam range in value from $75 to $250 an acre, depending on the location.

The following table shows the average results of the mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI CLAY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17620 17624.....	Soil.....	1.1	6.6	3.9	13.9	9.2	50.6	14.1
17621 17625.....	Subsoil.....	.5	5.1	4.3	14.4	10.3	44.4	20.4

MIAMI LOAM.

The surface soil of the Miami loam consists of a mellow brown loam of medium to fine texture extending to an average depth of 12 inches. There is frequently present on the surface and mixed with the soil a small amount of gravel, but this is never sufficient to interfere with cultivation or to affect the agricultural value. The subsoil to 36 inches consists of a heavy loam or light clay loam which contains sufficient fine, angular gravel to make it decidedly gritty. The gravel content usually increases with depth, and a bed of gravel is sometimes encountered at three to four feet. Small ridges of gravelly loam occur at intervals and where these are of sufficient size they have been indicated on the map. On the slopes between this type and the Huntington loam there is often found a narrow band of gravel, but it is usually too small to be indicated.

The Miami loam differs from the Miami clay loam in that the surface is darker in color and coarser in texture. There is much less silt present in the surface soil; the subsoil contains a much larger percentage of fine gravel than the Miami clay loam, which makes the natural drainage conditions somewhat better. The Miami loam is easy to cultivate and a mellow seed bed can be secured more readily than on the clay loam.

The Miami loam is frequently spoken of as second bottom land, and throughout a portion of its extent it appears as a terrace soil between the Huntington loam and the Miami clay loam. The largest area lies directly west of Indianapolis, between White River and Eagle Creek, and extends south on the west side of Eagle Creek to two miles below Maywood. Another area of considerable size lies between Lick Creek and the south county line bordering the bottom land along the river. Other areas of smaller extent occur along the White River to the north of Indianapolis and along Fall and Eagle creeks.

The surface varies from level to gently rolling. Where level, as is more often the case, the areas of this soil have the appearance of being a broad terrace. The boundary between this and the Huntington loam, or first bottom, is often very distinct, there being a sharp descent of 5 to 20 feet, with a distance of a few rods. The boundary between the Miami loam and the clay loam, however, is not so marked. There is occasionally a sharp rise, but it is more often a gradual slope, so that the two soils grade into each other, making it difficult to establish a dividing line. Where the surface is gently rolling the appearance is practically the same as the surface of the clay loam, and there is no suggestion of its being a terrace or second bottom.

Owing to the gravel present in the subsoil, the natural drainage is good. Over portions of the type, however, where the surface is level, tile drains greatly improve the physical condition and the productivity of the soil. The Miami loam has been derived from the glacial drift which covers the region. The presence of beds of water-worn gravel at depths of from three to five feet indicates that portions of the type at least have been influenced by the action of water to a greater extent than the Miami clay loam, in which the gravel is more angular.

The Miami loam is a good general farming soil and produces fair yields of wheat, oats, corn, and hay. The system of cropping is the same as on the Miami clay loam, no definite crop rotation being followed from year to year. Potatoes, tomatoes and peas

are also grown, and the trucking industry has been developed to a greater extent than on any of the other soils of the county.

Wheat yields an average of 15 bushels per acre, corn 45 bushels, oats 45 bushels, and hay from one and a half to two tons per acre. Corn and oats seem to do a little better on this soil than on the heavier type, but all things being considered they are of about the same value for general farm crops. The loam is better adapted to truck crops than the clay loam and it should be devoted more extensively to this industry, as much greater returns per acre could be secured than are now obtained by general farming. Stable manure is used extensively and commercial fertilizers are also applied to this soil.

Farms on this type of soil range in value from $100 to $300 an acre.

The following table shows the average results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17614 17616.....	Soil.....	1.3	9.1	11.6	16.5	8.3	39.9	13.3
17615 17617.....	Subsoil.....	2.3	12.9	12.7	11.4	5.5	41.5	14.1

HUNTINGTON LOAM.

The surface soil of the Huntington loam to a depth of 10 to 16 inches consists of a mellow, brown to dark-brown loam of medium to fine texture. There is usually sufficient silt present to impart a smooth feel to the soil. In small depressions and for a short distance back from some of the streams the soil is often nearly black in color, owing to the excess of organic matter accumulated in these places.

The gradation from soil to subsoil takes place gradually, and frequently there is little change to a depth of 20 inches. The subsoil becomes slightly heavier with increased depth until at 24 inches it is a heavy loam. The color is a dark brown, usually becoming lighter with depth. The subsoil contains considerable silt to a depth of 36 inches, where a bed of sand is sometimes encountered. Lenses of sand are scattered throughout the type, but these are not of sufficient size to be indicated in the map. This type is comparatively easy to cultivate, and a mellow seed bed is readily secured.

The Huntington loam occurs as first bottom along the White River and all of the smaller streams within the survey. The most extensive area lies along White River from Indianapolis south to the county line. Throughout this distance it varies in width from one to two miles. The type continues north of the city, but is scarcely ever more than one-half mile in width. The bottoms along Eagle and Fall creeks are also of this type, and there is a narrow strip along practically all of the smaller streams within the county. The soil in these smaller bottoms is frequently influenced by the wash from the higher lands, and therefore there are some differences in this soil in the more extensive bottoms. This variation, however, is never of sufficient importance to warrant the establishing of a new type.

The Huntington loam is an alluvial soil, being composed of glacial material which has been reworked and redeposited by the action of the streams, along which it is now found. The surface is level, with only here and there slight undulations and small depressions. Owing to this topography and the low-lying position, the natural drainage is poor. The soil lying close to the river is frequently overflowed, and as a result crops are damaged. Levees have been constructed in some places, and these now keep the river within its banks for a portion of its course. Tile drains and open ditches have been constructed, and at present almost the entire type is under cultivation. When the river overflows a sediment is left upon the surface, which is very beneficial to the soil.

The original timber growth on this soil consisted of ash, elm, and sycamore, with some hickory, oak and beech. The land is used for general farming, although corn is grown more extensively than any other crop and is better adapted to the soil than grass or grain crops. While wheat and oats are grown to some extent, the grain often lodges badly and does not properly mature. Hay makes a rank growth and may also lodge before it matures.

On that portion of the type subject to overflow the yield of corn is about 70 bushels per acre, while on that not overflowed 50 bushels is considered a good average crop. This difference is due to the sediment deposited, which proves to be a very valuable fertilizer. Oats average 40 bushels and hay from $1\frac{1}{2}$ to 2 tons per acre.

Stable manure is used to some extent on a portion of this soil which is not overflowed, but commercial fertilizers only sparingly. Upon some of the areas near the city trucking is followed with good results. Tomatoes, peas, lettuce, cabbage, onions, radishes, straw-

berries, and potatoes are grown with profit. This industry should be extended.

Farms range in value from $125 to $400 an acre, depending on the location.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

MECHANICAL ANALYSES OF HUNTINGTON LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17626	Soil	0.0	0.8	1.1	13.0	31.1	44.2	9.0
17627	Subsoil	.6	1.8	1.0	16.4	22.2	48.4	9.6

MIAMI BLACK CLAY LOAM.

The soil of the Miami black clay loam consists of a heavy, black loam or light clay loam extending to an average depth of 14 inches. The depth varies somewhat, being greater in the center of an area than near the outer margin. The soil contains a high percentage of organic matter, and to this may be attributed the black color. With increased depth the color becomes lighter. The soil is cohesive, with a tendency to puddle, and if cultivated too wet large clods are formed which are difficult to pulverize. On drying, cracks an inch wide and a foot deep are often formed on the surface. If cultivated at the proper time little difficulty is experienced in securing a good seed bed. The soil gradually becomes heavier with increased depth; below 14 to 16 inches it grades into a clay loam of drab or grayish color, and at 24 to 30 inches it may have a yellowish or mottled appearance.

The Miami black clay loam occupies only a small percentage of the area surveyed. It occurs in small basinlike depressions throughout the upland, and is occasionally found along some of the smaller streams. These bodies vary in size from 5 to 160 acres. They are most numerous in the southern part of the county in the vicinity of Southport, but small patches may be encountered in any part of the survey.

The material composing the Miami black clay loam is of glacial origin, but since its deposition it has been modified to considerable extent. Prior to the construction of drainage systems sufficient to carry off the surplus water these small areas were covered with swamps and marshes. Through the growth and decay of vegetation

large amounts of organic matter have been added to the soil, the rapid oxidation of which was prevented by the excessive moisture. Some of the finer particles of soil have been washed into these depressions from the surrounding higher land, and this has had considerable influence on the texture of this soil.

Though of limited occurrence, the Miami black clay loam is very good soil, especially for the production of corn. When well drained and under favorable climatic conditions it produces 50 bushels per acre. Although there is danger of lodging, the average yield of oats is estimated at from 35 to 40 bushels per acre. It is also well adapted to clover and timothy, the latter yielding from one to two tons per acre. Only the best drained areas are suited to clover, because in the wet places the soil heaves badly and the plants are killed.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI BLACK CLAY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17618	Soil	0.2	3.1	3.7	12.5	12.5	56.3	12.1
17619	Subsoil	.0	2.1	2.7	11.8	10.5	56.0	17.6

MIAMI GRAVELLY LOAM.

The surface soil of this type consists of a heavy brown sandy loam or loam of medium texture extending to an average depth of 12 inches. There is present on the surface and mixed with the soil from 10 to 20 per cent. of gravel usually less than one-half inch in diameter. The subsoil is a brownish, light clay loam usually containing a higher percentage of gravel than the soil, and frequently grading into a bed of gravel at two to four feet.

The soil is of small extent. The largest area is found in the extreme southern portion of the county just northeast of Glen Valley. Here the soil occurs as a ridge 40 to 50 feet higher than the surrounding country, and extends for 1½ miles from northwest to southeast. Another gravel hill of considerable size lies adjacent to the west side of the White River, one-half mile north of the south county line. Other small bodies are scattered about the county, but most of them are found near White River or one of its tributaries. These small divisions occur as low, narrow ridges

or nearly level areas. The largest area somewhat resembles a moraine. The entire type is of glacial material, portions of which have been influenced by the action of water.

The greater proportion of the type is under cultivation and, while it frequently suffers from drought, fair yields are obtained. The crops grown are the general farm crops, corn, oats, wheat, and grass, which are common to this section of the country.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

MECHANICAL ANALYSES OF MIAMI GRAVELLY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17610	Soil	3.4	16.1	14.0	8.5	7.8	39.6	11.4
17611	Subsoil	6.4	9.3	18.1	9.3	3.9	21.5	31.9

The following samples contained more than one-half of 1 per cent. of calcium carbonate ($CaCo_3$): No. 17610 2.41 per cent., No. 17611 8.80 per cent.

MIAMI SANDY LOAM.

The surafce soil of this type, to an average depth of 10 inches, consists of a light, brownish sandy loam of medium texture. There is present on the surface and mixed with the soil a small amount of fine gravel. The subsoil is a light-brown or yellowish loamy sand of medium to coarse texture, containing varying amounts of fine gravel and frequently grading into a gravel bed at three feet.

This type is of very small extent, occupying only about one square mile. Four small patches, which constitute the greater part of the Miami sandy loam, are found about seven miles southwest of Indianapolis, lying adjacent to the bottom land along White River. There are a few small areas scattered about the county, but all are of little importance. The usual occurrence of this soil is in the form of low ridges, knolls, and small terraces. The material is derived from glacial débris, much of which has been modified to some extent by the action of water.

The natural drainage is excellent and the type is somewhat droughty at times. At present the soil is used for general farming, but as it is earlier and more easily worked than the other soils of the county, it should be devoted to the trucking industry. The yields obtained are slightly below those from the heavier soils.

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

MECHANICAL ANALYSES OF MIAMI SANDY LOAM.

NUMBER.	Description.	Fine Gravel. Per Cent.	Coarse Sand. Per Cent.	Medium Sand. Per Cent.	Fine Sand. Per Cent.	Very Fine Sand. Per Cent.	Silt. Per Cent.	Clay. Per Cent.
17612	Soil	4.3	34.2	19.4	19.0	2.4	13.6	6 5
17613	Subsoil	3.7	34.4	21.6	18.0	2.6	12.9	5.8

MUCK.

Only two areas of Muck were mapped in the survey of Marion County, and those are of a very limited extent. The material consists of vegetable matter in advanced stages of decomposition. Fine earth from the higher surrounding land has been mixed with this type. In color the Muck is black and extends to a depth of 18 inches to four or five feet, usually resting upon a bed of clay.

One of the areas lies five miles due west of Southport, while the other is about the same distance northwest. The former is now in a condition of swamp, but could be easily drained; the latter is cleared, drained, and under cultivation. Corn and grass are grown, but the type is better adapted to celery, and as there is an excellent market for this vegetable in Indianapolis the soil should be entirely devoted to its production.

SUMMARY.

Marion County lies in the central part of Indiana and comprises an area of approximately 389 square miles. The surface varies from level to gently rolling, becoming broken near some of the streams, especially in the northwestern part along Eagle Creek and in the northeastern part along Fall Creek. The average elevation above sea level is 860 feet.

The first settlement in the area was made in 1820. Indianapolis, population 230,000, the capital of the State and the county seat of Marion County, is located in the center of the area. Fifteen steam and 12 electric railways enter the city. There are over 350 miles of free gravel road within the county. All toll roads have been abolished.

The climate does not differ materially from that of other Middle States in the same latitude. Extremes of temperature seldom occur and the rainfall of 41.9 inches is well distributed throughout the year.

Corn is the principal crop. The average yield for the county is 40 bushels per acre. The soils are well adapted to wheat, but continuous cropping has reduced the yield, the average yield being 16 bushels per acre. The acreage is also decreasing at the present

time. The acreage of oats has always been comparatively small, but it is increasing slowly. Irish potatoes do fairly well and yield an average of 90 bushels per acre. All trucking crops suited to this climate do well, although the trucking industry has not been extensively developed. Considering the excellent market afforded by Indianapolis, there is a good opportunity for the truck farmer.

Dairying is not followed as extensively as would be expected near a large city. Approximately 20,000 gallons of milk and 8,000 gallons of cream are consumed by the city daily, and of this only about one-sixth is produced within Marion County. There is a fine opportunity for the extension of the dairying industry.

In 1900 the average size of farms was 70.6 acres, and at the same time 48 per cent. of the farms were operated by their owners. The size of farms is decreasing, while the proportion of farms being worked by the owner is increasing.

The soils of the area belong to the Miami and Huntington series. The Miami soils have been derived from the glacial material which covers this entire region to a depth of from 50 to 150 feet. The Huntington soils are alluvial in origin. Seven types, including muck, were mapped.

The Miami clay loam, the most extensive soil in the county, occupies about 76 per cent. of the area surveyed. The surface is level or gently rolling, except near some of the streams, where it is broken. It is considered a good general farming soil, and farms upon this type vary in value from $75 to $250 an acre.

The Miami loam is also a good general farming soil and somewhat better adapted to truck crops than the Miami clay loam. Farms on this type range in value from $100 to $300 an acre.

The Huntington loam occurs as an alluvial soil along the White River and its tributaries. It is especially adapted to corn, and frequently produces 70 bushels per acre. Portions of it are subject to overflow. It has practically the same value as the Miami loam.

The Miami black clay loam occupies the depressions in the upland. It contains a very high percentage of organic matter and is very productive. It produces an average of 50 bushels of corn per acre.

The Miami sandy loam and Miami gravelly loam are types of very small extent and little consequence.

The Muck comprises two areas of decaying vegetable mold in advanced stages of decomposition. Both areas are small and of little importance.