

SOIL SURVEY OF MARSHALL COUNTY, INDIANA.

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LOCATION AND BOUNDARIES OF THE AREA.

Marshall County lies in the north-central part of the State of Indiana, only one county—St. Joseph—separating it from the Michigan line. It is bounded on the east by Kosciusko and Elkhart counties, on the south by Fulton County, and on the west by Starke and St.

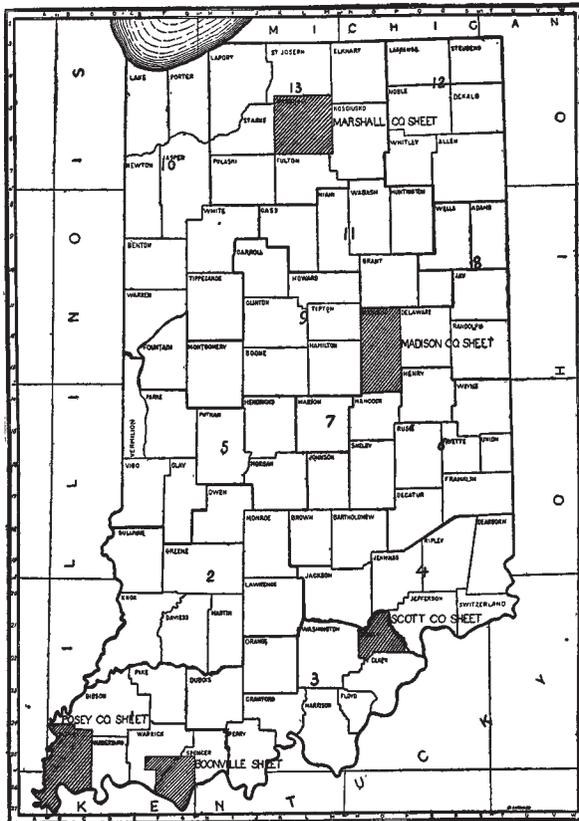


FIG. 28.—Sketch map showing location of the Marshall County area, Indiana.

Joseph counties. It contains about 445 square miles. Plymouth, the county seat, situated a little to the west of the center, is 84 miles southeast of Chicago by rail, and 108 miles north of Indianapolis.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

Prior to the organization of Marshall County this region was inhabited almost exclusively by Potawatomi Indians, who were very numerous here. The first cession of lands now embraced in Marshall County was made by the Indians at a treaty near Rochester, whereby they gave up a strip of land 1 mile in width through the present limits of the county to enable the whites to establish the Michigan road, a highway extending from Indianapolis to Michigan City via Logansport and South Bend. These road lands were offered for sale in 1832 and the proceeds were devoted to the building of the Michigan road, which extends through the center of the county in a north and south direction, following the boundary between the level and the rolling topography of the county.

A few years after the sale of the Michigan road lands most of the lands within the present limits of the county were given up by the Indians, who, after 1838, ceased to be an important factor in the history of Marshall County.

At this time immigrants from Ohio, Pennsylvania, and other Eastern States were rapidly coming into the county, and as the Michigan road was the first one opened, they naturally established themselves in its vicinity. Many of the settlers were Germans, some of whom came direct from the mother country.

The greater part of the county was originally covered with a heavy growth of timber, consisting principally of walnut, oak, and poplar. This timber, except the little that was used for building material, was either burned or destroyed in any possible way to clear the land. As the country became more thickly settled and transportation facilities improved, the lumber business became an important industry in the development of the county. The period from 1860 to 1870 was the most prosperous for this industry.

The first crops grown in Marshall County were corn, wheat, oats, rye, and beans. The soil was prepared by what was known as a "jumping plow" or "breaking shovel," drawn by several yoke of oxen. Grain was sown broadcast and dragged in with a brush. Corn yielded from 25 to 50 bushels per acre. Wheat was frequently a failure, but in favorable years produced from 14 to 18 bushels. Oats were not a great success. Rye was used principally for feed and pasture, rarely being thrashed. Potatoes gave a large yield, and seemed to be of better quality than those produced at the present time. The sandy soils were best adapted to this crop. The early settlers grew a little tame hay, but depended mostly upon marsh hay or corn fodder for their stock feed. When hay was scarce the stock often lived on the buds of the basswood for long periods. Flax was also grown for many years and manufactured into homespun clothing.

About 1865 the farmers began to realize that the soils were becoming less productive, and began to grow clover to maintain their productiveness. Timothy was also introduced about the same time.

When first settled a large part of the county comprised swampy areas, but as it became more thickly settled some attention was given to drainage, though no well-planned system was inaugurated until 1876. Since that time more or less drainage work has been in progress every year, and a great many open ditches and tile drains have been constructed, while the Yellow River, in the northeastern part of the county, has recently been dredged. Many open ditches, into which tile drains empty, are seen in the eastern and northeastern parts of the county. Some of the most productive lands in the county have been made available for agricultural purposes by artificial drainage, and at the present time there is little land that is not well drained, aside from the Muck areas, and in some of the latter drainage work is now in progress.

CLIMATE.

The following table, taken from the records of the Weather Bureau stations at Syracuse and South Bend, shows the mean normal monthly and annual temperature and rainfall. South Bend is about 24 miles north and Syracuse 26 miles northeast of the center of the county.

Normal monthly and annual temperature and precipitation.

Month.	Syracuse.		South Bend.		Month.	Syracuse.		South Bend.	
	Tem- pera- ture.	Precipi- tation.	Tem- pera- ture.	Precipi- tation.		Tem- pera- ture.	Precipi- tation.	Tem- pera- ture.	Precipi- tation.
	°F.	Inches.	°F.	Inches.		°F.	Inches.	°F.	Inches.
January	25.2	2.47	29.2	2.90	August	72.4	3.19	72.8	3.12
February ...	24.0	2.32	22.8	2.14	September ..	63.8	2.76	65.7	2.90
March	34.2	4.00	35.6	2.99	October	54.8	3.55	54.2	2.44
April.....	50.7	1.98	50.4	1.77	November ..	40.2	3.74	39.7	3.12
May.....	62.6	3.77	60.8	3.09	December ..	27.4	3.07	27.8	3.07
June	69.3	3.60	70.5	2.45	Year	50.0	39.11	50.3	33.65
July.....	75.4	4.71	74.1	3.57					

The figures show a fairly uniform distribution of rainfall throughout the year, with the maximum during the growing season. The temperature is characterized by sudden changes during the period from October to April, and by alternate freezes and thaws, which sometimes seriously damage crops.

The average date of the last killing frost in spring is April 20, and of the first in fall October 10, giving a growing season of approximately 172 days.

PHYSIOGRAPHY AND GEOLOGY.

The entire area of Marshall County is covered to a great depth by the deposit of drift of the Glacial period. No outcrops of stratified rock are seen, nor have they been reached by any of the many borings. The character of the surface material varies with the topography.

Generally speaking, a line running north and south through the center of the county separates the sandy soils from the clay soils. What are known as the "clay soils" have been mapped as the Marshall loam, which is found principally east of this line. The sandy soils include the Marshall sandy loam, Miami sand, and Marshall sand, and occur west of the dividing line. The topography of the western part of the county is quite rolling, with intervening depressions or slight valleys. Going westward from central points in the county the country assumes a more rolling topography, the boulder clay being found at greater depths, while the amount of sand increases until finally the "sand barrens" are reached. These barrens, which have been mapped as the Miami sand, seem to be wind-blown deposits and to have some of the characteristics of sand dunes, though in a few places they have the appearance of old beach lines. Some of this sand at the present time is subject to wind action. This sandy region is said to be very similar to that bordering Lake Michigan. The topography of the country along the Yellow River and the lakes is usually very rolling, very little marsh and bottom lands being found. That part of the county lying east of the line above described is level or gently rolling, though there are small areas of a more rolling topography.

There are many basins or depressions in all parts of the county that are locally known as marsh, and have been represented on the map as Muck.

The beds of the streams are usually in the gray or the bluish till, and are covered by a stratum of washed gravel, sand, and boulders. In many parts of the county boulders are scattered over the surface. These are chiefly of granite, gneiss, and other metamorphic rocks. From the borings made these rocks seem to be more abundant on the surface than at lower depths.

Many rounded knolls, composed of both stratified and unstratified drift material, appear in different parts of the county. These are most numerous in the Marshall sandy loam.

In many of the gravel pits the stratification is clearly outlined, the material being rounded gravel, clay, and sand, which is extensively used for road construction. Good tile and brick clays are plentiful.

There are many lakes in Marshall County, which are fed from springs that may either flow from the lake basins or along the shore

line. The largest and most important of these are Lake Maxinkuckee and Lake of the Woods. The lake bottoms consist of an impervious blue clay, and below this is a mass of sand and gravel from which the springs flow. Marl is sometimes found in the lake beds. There is a large number of flowing wells in the county, these being especially numerous around Lake Maxinkuckee. These have the same source as the springs, being fed from the sand and gravel underlying the blue or gray clay.

The county is drained principally by the Yellow River, which flows across it in a general southwesterly course, though it flows directly west for a distance of about 7 miles just before it leaves the county. Yellow Bank and Pine creeks drain the northwestern corner, while the Tippecanoe River drains the southeastern corner.

SOILS.

The soils of Marshall County have been classified into nine types, including Muck and Meadow. They range in texture from sand to clay loam, and thus offer opportunity for the production of a diversity of crops.

The following table shows the extent of each type, and the map accompanying this report gives the distribution graphically by means of different colors:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall loam.....	121,216	42.7	Meadow.....	6,784	2.5
Marshall sandy loam.....	77,184	27.3	Miami clay loam.....	3,392	.8
Miami sand.....	27,840	9.8	Miami black clay loam.....	1,536	.5
Muck.....	24,768	8.7	Miami gravelly sandy loam.....	1,216	.3
Marshall sand.....	20,672	7.4	Total.....	284,608	-----

MARSHALL LOAM.

The Marshall loam, to a depth of 14 inches, consists of a brown loam containing much sand, underlain to a depth of 18 inches by a yellowish-brown loam, which is slightly more tenacious than the surface soil. The subsoil, from 18 inches to 3 feet, is a yellow sticky sandy loam, often containing some gravel.

A few boulders, sometimes measuring 3 or 4 feet in diameter, and some smaller stones are occasionally scattered over the surface, but the greater part of these has been removed. Large piles are often seen in the fields, and they are sometimes used in constructing fences.

The soil is often heavy enough to form clods, but these are easily broken by the harrow and roller. When put in a good state of tilth the soil becomes a very mellow loam.

There are some small areas where the soil is heavier in texture and darker in color than the typical phase, and often extends to a depth of 18 or 20 inches. The subsoil in such places is a yellowish-drab sandy clay. A small portion of this phase had to be artificially drained before cultivation was a success.

The Marshall loam occupies the largest and most uniform areas of any soil type in the county, though frequently small areas of the other types are found scattered through it. It occupies the greater part of the eastern half of the county, while west of the central dividing line it occurs in comparatively small areas, except in the extreme north-western corner, where a spur of the main body of the type extend beyond the line.

The Marshall loam is generally level or undulating in topography, though it is found to a slight extent upon rounded knolls and narrow ridges, in which position the soil is often quite gravelly, and stones are scattered here and there over the surface, while the subsoil is a mass of gravel, sand, and clay, which is often used for road material. This phase is not so productive, nor is the soil so deep as that found occupying a more level topography. The average depth of the soil would probably not exceed 8 inches. These knolls and ridges are found chiefly in the small areas of the type occurring in the south-western part of the county.

In many places along the boundary line between the Marshall loam and the Marshall sandy loam the former has a tendency to become more rolling.

The level areas frequently contain a small amount of gravel, but in no case in sufficient quantities to cause any serious trouble in cultivation. This was most noticeable in German township. Along the northern boundary of this township, which forms part of the county line, the soil had the lightest color of any of the types encountered in the area, and had the survey extended farther north it might have developed into some other type.

The Marshall loam was originally covered with a heavy growth of black walnut, and is still locally known as the "black walnut land." Occasionally a small patch is seen with its original timber, which has been kept as a small forest reserve.

All of this type at the present time has adequate drainage, though tile drainage and other artificial aids were necessary before some of it could be cultivated. The small forest reserves or woodlots are about the only spots not at present under cultivation.

The Marshall loam is generally recognized as the best soil in the county for general farming, being well adapted to nearly all crops grown in the area, and producing larger yields than any other soil type. It is especially adapted to corn, wheat, clover, and timothy.

Corn yields from 35 to 70 bushels per acre, clover and timothy from 1 to 2 tons, and wheat from 15 to 18 bushels.

The following table shows the results of mechanical analyses of typical samples of the fine earth of the Marshall loam :

Mechanical analyses of Marshall loam.

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11970	SE. 40 of NE. $\frac{1}{4}$ sec. 7, T. 33 N., R. 4 E.	Brown light loam, 0 to 12 inches.	1.1	5.4	9.8	27.6	11.0	28.8	16.2
11972	SE $\frac{1}{4}$ sec. 19, T. 33 N., R. 3 E.	Brown light loam, 0 to 14 inches.	1.4	12.5	14.9	26.2	4.1	21.6	19.2
11971	Subsoil of 11970	Yellow sticky sandy loam, 12 to 36 inches.	1.9	5.2	8.4	31.1	11.3	25.2	16.5
11973	Subsoil of 11972	Yellow sticky sandy loam, 14 to 36 inches.	2.2	12.5	15.2	27.4	4.5	19.3	18.9

MARSHALL SANDY LOAM.

The soil of the Marshall sandy loam to a depth of 10 inches is a dark or light-brown sandy loam, underlain by a yellow sand to a depth of 20 inches. Immediately below this is found a yellow sandy clay, or in some cases gravelly clay.

This type has usually a rolling topography and generally occurs as irregular ridges composed of rounded knolls. The soil in the intervening depressions is a heavy, black sandy loam, often 18 inches deep, while the subsoil is darker in color than that found on the higher elevations and contains less gravel. Occasionally the subsoil, from 18 to 36 inches, is a heavy, bluish-gray sandy loam. On the rounded knolls the soil is often quite gravelly, and there are many spots of only a few acres which would have been classed as a gravelly loam had they been large enough to represent on the map. The subsoil in these cases often contains such a high percentage of gravel that it is very difficult to make a boring 3 feet deep, and in other places it is almost pure sand and gravel. A few comparatively level areas are seen near the streams, where both the soil and subsoil become quite gravelly. Boulders, chiefly of granite, are found scattered on the knolls and ridges, and to some extent over all the type, but they are much more plentiful on the knolls. Many small spots of the Miami sand are also found, usually occupying the tops of the ridges, similar to the position of the gravelly phase just described. These spots of sand and gravel are clearly defined during the growing

season, as the crops upon them frequently suffer from lack of moisture. The most typical Marshall sandy loam is found on the sides or slopes of the ridges, where the topography is only gently rolling.

The depth to the clayey subsoil varies somewhat, being often 25 inches, which of course accounts for some variation in crop yields.

Probably three-fourths of the Marshall sandy loam is found west of the line heretofore described. The largest area of the type extends north and south through the town of Plymouth, and touches the western boundary of the county in only one place. In the eastern half of the county the greater part of the type lies along the Yellow River and in the southeastern corner of the county.

The Marshall sandy loam, while occurring in broad and somewhat uniform areas, is frequently spotted with the other soil types. It also occurs in small areas in the Marshall loam, which are easily detected by their slight elevation above the adjacent soil.

This type occupies about one-fourth of the area surveyed and is next in importance to the Marshall loam. It is especially adapted to the growing of cucumbers for pickles, and to beans, pease, Irish potatoes, and small fruits. The average yield of cucumbers is about 100 bushels, though 200 bushels per acre have been produced. Corn yields from 25 to 55 bushels, wheat from 12 to 18 bushels, and potatoes from 80 to 170 bushels per acre. Clover and timothy also give fair yields, especially the former.

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

Mechanical analyses of Marshall sandy loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.		Coarse sand, 1 to 0.5 mm.		Medium sand, 0.5 to 0.25 mm.		Fine sand, 0.25 to 0.1 mm.		Very fine sand, 0.1 to 0.05 mm.		Silt, 0.05 to 0.005 mm.		Clay, 0.005 to 0 mm.	
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.				
11962	SW. 40 of NW. ¼ sec. 11, T. 32 N., R. 2 E.	Dark light sandy loam, 0 to 15 inches.	0.5	5.3	17.4	48.0	8.8	11.7	7.8							
11968	SW. ¼ sec. 29, T. 32 N., R. 1 E.	Brown sandy loam, 0 to 12 inches.	1.7	8.5	14.4	32.2	8.4	21.0	13.6							
11963	Subsoil of 11962	Yellow sticky sandy loam, 15 to 36 inches.	2.1	7.0	13.0	37.5	12.2	14.1	13.6							
11969	Subsoil of 11968	Yellow sandy clay, 12 to 36 inches.	1.4	5.6	7.3	21.0	9.8	28.5	25.8							

MIAMI BLACK CLAY LOAM.

The soil of the Miami black clay loam, to a depth of 8 inches, is a black clay loam having the characteristics of a clay when wet. It is apt to break up into large clods, but unless handled when too wet or

too dry can be put into a good state of tilth, becoming quite loamy. The subsoil, from 8 to 36 inches, is a stiff, mottled yellow and blue, or blue clay. Occasionally a considerable amount of sand is found in both soil and subsoil, and a few small gravel are sometimes seen scattered over the surface.

The greater part of the type is under cultivation, though most of it had to be artificially drained to a certain extent before it could be farmed, and there still remains a small portion too wet to give good crop yields. The soil is heavy in texture, and is one of the last to warm up in the spring, yet when well drained it is probably the best corn-producing soil in the county.

The Miami black clay loam is quite limited in extent in Marshall County. It is found only in Bourbon and German townships, most of it in the former, and is distinctly level in topography. Though especially adapted to corn, it is used to some extent for hay and pasture. In good seasons corn yields from 40 to 75 bushels, and hay from 1 to 2 tons, per acre.

The following table shows the results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Miami black clay loam.

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
11984	SE. 40 of NW. $\frac{1}{4}$ sec. 2, T. 34 N., R. 3 E.	Black loam, 0 to 12 inches.	P. ct. 0.7	P. ct. 8.4	P. ct. 19.8	P. ct. 30.2	P. ct. 5.0	P. ct. 14.7	P. ct. 20.7
11986	NW. 40 of NE. $\frac{1}{4}$ sec. 35, T. 34 N., R. 3 E.	Black clay, 0 to 8 inches.	.1	2.2	4.6	12.2	4.3	36.0	40.6
11985	Subsoil of 11984	Gray sandy clay, 12 to 36 inches.	.4	9.5	19.7	27.8	4.6	12.5	24.9
11987	Subsoil of 11986	Mottled clay, 8 to 36 inches.	.3	2.8	6.2	12.2	2.9	24.5	50.6

MIAMI CLAY LOAM.

The soil of the Miami clay loam, to a depth of 10 inches, is a yellowish-white loam containing between 30 and 40 per cent of sand and the same quantity of silt, underlain to a depth of 16 inches by a yellowish loam containing a lower proportion of sand, beneath which is a yellow silty, sandy, or gravelly clay. The material from 10 to 16 inches is usually somewhat more tenacious than the surface soil. When dry the soil is almost white in color, but when damp it becomes a dark gray.

Most of this type has more or less gravel scattered over the surface

and through both soil and subsoil, and in some places it partakes of the nature of a gravelly loam.

The type occupies narrow ridges, usually near lakes or around Muck areas, and is rather rolling in topography, though occasionally a comparatively level area is found. Near the lakes both soil and subsoil are more silty in character, and as a rule there are fewer stones than is the case farther away.

The Miami clay loam occurs in small areas in the western part of the county, only one area being found in the eastern half, near the southern boundary. Erosion has been greater on this soil than on any other within the area.

The type at present is of low agricultural value, but on account of its physical properties it should produce fair crop yields. Some of the more level areas, when carefully cultivated, produce from 25 to 40 bushels of corn per acre, from 14 to 18 bushels of wheat, and good yields of hay. The more hilly portions should produce good bluegrass for pasture and would very likely prove excellent for fruit.

The following table shows the results of mechanical analyses of the fine earth of typical samples of the Miami clay loam:

Mechanical analyses of Miami clay loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
11976	SW. $\frac{1}{4}$ sec. 13, T. 33 N., R. 2 E.	Gray silty loam, 0 to 10 inches.	1.6	4.8	6.9	22.9	8.0	36.2	19.1
11974	$\frac{1}{4}$ mile S. of Lapaz	Gray silty loam, 0 to 15 inches.	1.9	5.4	5.3	19.7	10.3	34.9	21.6
11977	Subsoil of 11976	Yellow silty clay, 10 to 36 inches.	1.4	3.5	3.3	12.0	7.4	39.0	38.0
11975	Subsoil of 11974	Yellow silty clay, 15 to 36 inches.	1.4	3.0	3.4	18.0	7.6	32.4	34.1

MIAMI SAND.

The Miami sand, to a depth of 9 inches, is a slightly loamy grayish or yellowish sand of medium texture. The subsoil, from 9 to 36 inches, is a yellow or orange-colored sand of about the same texture as the soil. Practically the only difference between soil and subsoil lies in the organic matter, which gives the former a darker color and more loamy texture, but there are places on the tops of some of the hills where even this difference does not exist. In the depressions the soil is more loamy, much darker, and extends to a greater depth, hence is more productive, than that on the hills.

Practically all of this type is found in the western half of the county, and most of it along the central western border and along the Yellow River and Lake Maxinkuckee. The few small spots found in the eastern half do not cover more than $1\frac{1}{2}$ square miles.

The Miami sand is very rolling in topography, and much of it resembles sand dunes in form and appearance. In all probability a large portion was formerly old sand dunes on which plants have obtained a foothold and checked the action of the wind. Some of it is even now shifted about by the winds.

Probably one-third of the Miami sand is not under cultivation, and some that was once cultivated has apparently been abandoned and left to grow up in weeds. It is the most unproductive soil in the county, but the smaller areas scattered through the more productive types do fairly well, as they have received more attention than the farmers were able to give to the broader areas. Heavy applications of barnyard manure and a careful rotation of crops are absolutely necessary to secure even fair yields from this soil.

More of this type is covered with timber, in proportion to the total area, than of any other soil type in the county. The trees are chiefly scrub oaks, with a few other trees of fair size scattered here and there. The type is locally known as the "sand barrens," and in its extreme phases little agriculture is attempted.

The following table shows the results of mechanical analyses of the Miami sand:

Mechanical analyses of Miami sand.

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11978	NE. $\frac{1}{4}$ sec. 9, T. 33 N., E. 1 E.	Gray sand, 0 to 8 inches..	0.4	6.5	25.2	56.6	5.5	2.1	4.4
11980	SW. $\frac{1}{4}$ sec. 21, T. 33 N., E. 1 E.	Gray sand, 0 to 10 inches.	.8	5.8	18.6	59.9	4.7	4.5	5.0
11981	Subsoil of 11980	Yellow sand, 10 to 36 inches.	.4	5.3	18.9	65.0	4.1	2.7	2.9
11979	Subsoil of 11978	Yellow sand, 8 to 36 inches.	.6	6.2	23.0	59.1	5.3	1.8	3.7

MIAMI GRAVELLY SANDY LOAM.

There is a great variation in the material that forms the Miami gravelly sandy loam, though the soil to a depth of 8 inches is generally a light or dark brown sandy loam, containing a high percentage of gravel and frequently small stones. The subsoil is a gravelly or sandy clay with numerous small stones scattered through it.

The type is found bordering lakes or old lake basins as a chain of rounded knolls or hills, which are generally composed of stratified and unstratified sands, clays, and gravel. One of these knolls may consist almost entirely of sand and gravel, while another near by may be composed of loam or clay; but the brown sandy loam described above predominates, and along the slopes and slight depressions it is comparatively uniform.

The Miami gravelly sandy loam covers only a small portion of the county, the largest area being on the eastern side of Lake Maxinkuckee. Its surface is very rolling and often badly washed. A considerable portion is not cultivated, and on the remainder the crop yields are only fair.

The following table gives the mechanical analyses of the fine earth of this soil:

Mechanical analyses of Miami gravelly sandy loam.

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11954	SW. $\frac{1}{4}$ sec. 23, T. 32 N., R. 1 E.	Brown gravelly sandy loam, 0 to 10 inches.	4.2	13.4	17.9	35.6	7.5	9.8	11.3
11952	SE. $\frac{1}{4}$ sec. 30, T. 33 N., R. 3 E.	Gray gravelly sandy loam, 0 to 9 inches.	2.2	10.3	12.7	32.4	9.7	19.2	13.2
11953	Subsoil of 11952	Yellow gravelly sandy loam, 9 to 36 inches.	3.5	11.9	13.1	26.5	7.7	17.4	19.3
11955	Subsoil of 11954	Brown gravelly sandy loam, 10 to 36 inches.	6.5	17.3	15.7	28.2	4.9	7.0	20.2

MARSHALL SAND.

The first 10 inches of the Marshall sand varies from a gray to an almost black loamy sand underlain, usually to a depth of 3 feet or more, by an orange-colored sand or, in places, a sand of lighter color.

Gravel often occurs in both soil and subsoil, and was found in greater quantities in the areas in the southeastern and northwestern corners than in other parts of the county. In the former instance, where the type borders the Tippecanoe River, the presence of gravel has probably been influenced to a certain extent by the river, though at the present time the soil is elevated above all danger of overflow.

The Marshall sand occurs in five comparatively large areas and a few smaller ones. In extent it is about equally divided between the eastern and western sides of the county, and does not occur through the central portion at all. Some spots of the Miami sand, too small to represent on the map, are found in areas of this type, usually as

small knolls or sand mounds elevated a few feet above the surrounding soil. A few areas are seen in this type of soil that are lower and flatter than the general type, and here the soil is deeper, darker, and usually more loamy and more productive than the more elevated portions. The subsoil in these cases rests on almost white sand. Frequently at a depth of 8 or 10 feet a blue clay is encountered. As the topography becomes more rolling the soil assumes a lighter color and is of lower agricultural value. The most productive portion of the type is that found in the northwestern corner of the county, but this is more likely due to better cultivation, to more liberal applications of manure, and to a more careful rotation of crops than to any natural difference in the soil itself.

In the western part of the county the type is found associated with the Miami sand, and the line between the two is at times rather indefinite. There is not a great deal of difference between the Miami sand and the Marshall sand so far as texture is concerned, but the latter occupies a more level topography, and there is more organic matter in the soil, making it darker and more loamy. The crop yields are from 10 to 25 per cent higher. The Marshall sand is always lower lying than the Miami sand, and does not have such excessive drainage as the latter; consequently there is less leaching, and the organic matter is retained longer. It is nearly always possible to find water at from 6 to 12 feet below the surface.

The greater part of the Marshall sand is under cultivation. It is best adapted to cucumbers for pickles, beans, and Irish potatoes, though corn, timothy, and wheat are extensively grown, but with only fair yields. Corn yields from 25 to 35 bushels per acre, Irish potatoes from 80 to 150 bushels, and other crops in proportion.

The following table shows the results of mechanical analyses of typical samples of the Marshall sand:

Mechanical analyses of Marshall sand.

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11958	NW. $\frac{1}{4}$ sec. 28, T. 33 N., R. 1 E.	Brown loamy sand, 0 to 12 inches.	0.4	8.6	30.7	47.4	1.3	5.5	5.8
11956	NW. $\frac{1}{4}$ sec. 8, T. 34 N., R. 1 E.	Gray medium sand, 0 to 10 inches.	.7	10.7	28.5	45.1	4.2	3.4	6.9
11957	Subsoil of 11956	Yellow medium sand, 10 to 36 inches.	.4	11.7	27.4	48.7	4.6	2.5	4.1
11959	Subsoil of 11958	Yellow sand, 12 to 36 inches.	.2	6.4	28.9	54.9	1.3	1.8	6.1

MUCK.

The Muck in this area usually represents deposits of partly decayed organic matter, sometimes mixed with particles of earth. The Muck areas occupy low, wet places, and are locally spoken of as "marshes." As a rule the Muck is more than 3 feet deep, and there is little change to that depth. Sometimes, however, the surface soil has reached a higher state of oxidation and is a deep black in color, with few, if any, fibers distinguishable, which material gradually changes to a reddish-brown mass, in which the fibers and sometimes the forms of leaves can be made out. In other cases there is no change to a depth of 3 feet. Sometimes the surface is red, especially before cultivation, but becomes black after being plowed and exposed to the air for some time. A few spots are seen in which the mass is very compact or peaty. Around the edges and in other shallow places a whitish sand or sandy clay is found underlying the Muck, but most of that mapped in this county is more than 3 feet deep, though the sand or clay may be found at greater depths.

This type is found in spots from a few acres up to 2 or 3 square miles in extent. It is also seen in narrow strips along streams or at the head of streams, and is always lower than the adjacent soil types, and comparatively level. These small areas of Muck occur in various parts of the county, but the greater portion of the type is seen in the eastern half.

Owing to the position of some of the Muck areas, it is supposed that they are old lake beds, which have gradually become filled with decaying organic matter. A few instances are seen where Muck entirely surrounds a lake, which is much smaller now than it was at one time. Sometimes where the ground is springy and wet on the slopes the Muck extends a short distance up the slopes; otherwise it is very level. It is naturally covered with swamp grass, goldenrod, huckleberry bushes, and cottonwoods, with occasional larger trees. Before cultivation small mounds about 1 foot in height are often seen thickly scattered over the surface.

In its natural condition water is always near the surface, and artificial drainage is necessary before cultivated crops can be grown, except in some instances around the edges. Drainage has been accomplished to some extent by constructing large, open ditches into which tile drains empty, and much work is being done at the present time along this line. About 75 per cent of the type is yet undrained.

Until drained the Muck can be used only for pasture and for hay, but when drained it is an almost ideal soil for onions and celery, and good crops of corn can also be secured. Some onions are grown at the present time. Corn is the most common crop on the drained areas, the yields ranging from 40 to 75 bushels per acre. Marsh and timothy

hay are the chief crops on the undrained areas, yielding from 1 to 3 tons per acre, generally of a poor quality. The greater part of the type is used chiefly for pasture.

MEADOW.

The term Meadow represents poorly drained areas along streams and in depressions, which are not usually cultivated. The soil may consist of a heterogeneous mass of material, though it is usually a heavy black sandy loam, rich in organic matter. The subsoil varies from a tenacious blue clay to a white sand.

The material composing the type is much more variable along streams than in depressions, this being due to stream action. The soil bordering the streams is often almost pure sand and gravel, but in other places the first few inches is muck. When found in depressions, the soil is rather uniform and usually has the characteristics of the sandy loam described above.

Most of the cultivated areas of Meadow are found in these depressions, which have been wholly or partially drained. Corn is the principal crop, but these areas are rarely cultivated, except around the edges. The type is used mostly for grazing or hay.

AGRICULTURAL CONDITIONS.

The farmers of Marshall County are in a fairly prosperous condition. In the eastern half of the county, which is largely occupied by the Marshall loam, nearly every acre of which can be cultivated, the farmers as a rule are more prosperous than those living on the sandy soils in the extreme western portion. The houses, though often small, are nearly always painted, and the barns are of sufficient size to shelter all the live stock and machinery. Many silos are also seen. As a rule, the houses are smaller and not quite so good on the more sandy soils, and a good dwelling with no barn is frequently seen.

The value of farm land ranges from \$20 to \$100 an acre. The Marshall loam is generally held at from \$65 to \$100, the Marshall sandy loam at from \$65 to \$75, the Marshall sand at from \$30 to \$40 when in cultivation, and other lands at from \$20 to \$60 an acre. Muck undrained sells at from \$20 to \$30, and when drained at from \$40 to \$70 an acre.

About 75 per cent of the land in this county is under cultivation or in a condition to be cultivated. The remainder consists of sand, marshes, timber land, and rough broken land, and, aside from the marshes, the greater part of this land lies in the western half of the county. Much of this uncultivated land can be used for pasture, so that there is comparatively little land in the county from which some returns can not be secured.

About \$2,000,000 in mortgages is held against the farms of Marshall County, which is between 15 and 25 per cent of their value. While these farm mortgages apply generally throughout the county and are not confined to any one soil type, yet they are fewer in proportion to the total number in the northern and northeastern parts of the county than in other sections. A great many German farmers live in those parts of the area, and, being of industrious and prudent habits, they have maintained a better financial standing.

About 60 per cent of the farms are operated by the owners. The remainder are cultivated by tenants, who pay a rental of from two-fifths to one-half of the crop made, or, very rarely, a cash rent, which ranges from \$3 to \$4.50 an acre. The proportion of grain paid varies in different sections. For corn lands one-half of the crop is more often paid, while for wheat and rye either two-fifths or one-half is paid, according to the amount of seed furnished and the proportion of the thrashing bill paid by the owner and tenant, respectively.

About 90 acres is the average size of farms in this county. Where onions and potatoes are grown the farms are below the average in size, but where much live stock is kept they are usually larger. There are several farms of 640 or more acres, but as a rule these large holdings are divided up and rented in smaller tracts.

The smaller farms are generally operated by the owner or tenant and his family, assisted to some extent by labor hired by the day or week during harvest and other pressing seasons. The wealthier farmers usually hire by the month, paying from \$20 to \$25 and board, and employing the men from the 1st of March to the 1st of November. The harvest season is from June 15 to August 15, during which time there is a great demand for laborers, and efficient men receive from \$1.75 to \$2 a day. At other times day laborers receive \$1.25 a day and dinner. During the corn-husking season labor is much in demand, and at times farmers find difficulty in getting the crop out as fast as they desire. The labor is exclusively white and is usually efficient, but the supply is often inadequate.

Corn and wheat are the principal products of Marshall County. From 15 to 25 per cent of the cultivated lands is planted to each of these grains. The average yield of corn in the county is 35 bushels per acre and of wheat 10 bushels. Winter wheat only is grown. Owing to severe damage to wheat by freezing and by the Hessian fly, there has been a tendency in recent years to reduce the acreage somewhat and to give more attention to the growing of rye, but as yet rye is an unimportant crop. The corn is planted in checked rows and cultivated with two-horse machinery. A great part of it is cut for fodder, both by hand and by corn binders and binders and shockers.

The fodder is sometimes shredded, and thus prepared it may be substituted for hay. A part of the crop is put into the silo and utilized in that way. Wheat is generally sown in drills, and is thrashed either in the field or at the barn. Clover is an important crop, about 15,000 acres being cut every year. It is generally sown with wheat or oats, and produces two crops, one of hay and one of seed, a considerable proportion of the seed being shipped out of the county. Timothy is grown on all soils except the sand, and will thrive in low, damp places where clover or corn does not do well. Both clover and timothy hay are baled and shipped to eastern markets. Oats are grown largely for home use, but some are shipped.

Among the minor crops cucumbers are probably the most important. They are grown chiefly on the more sandy soils and are sold at the salting stations, of which there are seven within the area. The managers of these stations contract with the farmers, giving them 60 cents a bushel and providing the seed. Cucumbers are rarely grown in large fields, the patches ranging from 2 to 5 acres. Onions are grown chiefly on the muck and potatoes on the more sandy soils. On nearly every farm there is an orchard, which supplies the needs of the owner. A great many apples are made into cider, to be sold later as vinegar.

Except on the most sandy land every farmer keeps one or more milch cows. A great many sell milk to the creameries, of which there are several within the area. According to the census of 1900 the value of dairy products in Marshall County was \$163,028. A great many beef cattle, hogs, and sheep are kept also, this being more particularly true in the eastern half of the county. The Shorthorns, Angus, and Herefords are the chief breeds of cattle, and the Chester Whites, Poland Chinas, and Berkshires are the breeds of hogs most in favor. Almost the entire grain crop produced in some sections of the Marshall loam is consumed upon the farm. The raising of live stock is to be commended, for the more manure produced the more productive the lands should become. Increased interest is being shown in the live-stock industry.

The farmers of Marshall County have a fair understanding of the adaptation of soils to crops. The Marshall loam is generally recognized as the best soil in the county for general farming and the more sandy soils as best for the special crops. The possibilities of the Marshall sandy loam and the Marshall sand for Irish potatoes, however, are not fully appreciated, especially in the case of the latter type of soil, which produces fair yields of corn and rye, but is excellently adapted to potatoes, which, with liberal applications of manure, give very large yields. It is suggested that where the type lies near Muck areas a dressing of the Muck would prove very beneficial.

Marshall County is well supplied with railroad facilities. The Baltimore and Ohio crosses the northern part of the county in an east and west direction; the Pittsburg, Fort Wayne and Chicago the central part; the New York, Chicago and St. Louis the southern part; the Lake Erie and Western the western half in a northwest and southeast direction, and the Logansport division of the Terre Haute and Indianapolis passes through the southwestern, central, and northern parts of the county. Few points in the area are more than 7 miles by wagon road from a station. The three east and west lines are trunk lines from Chicago to the East, so that all produce can be quickly shipped either way from any point in the county.

Good dirt roads are found on nearly every section line, and many of them have been graveled. Except in the most sandy areas there is rarely any difficulty in getting products to market.

Plymouth, the largest town in the county, had a population in 1900 of 3,656. Other smaller towns are Bremen, Bourbon, Argos, and Culver. Only a comparatively small portion of the produce can be consumed within the county, so that it is necessary to seek larger markets. Plymouth is only 84 miles from Chicago by rail; but as this large western market is supplied with enormous shipments from all over the northern part of the Mississippi Valley, the farmers of Marshall County find better markets elsewhere. Some of the products are shipped to the larger towns around the State, while a great deal of live stock, hay, etc., is shipped to Pittsburg and Buffalo. Nearly every railroad station in the county has an elevator, and the exceptionally good railroad facilities enable the farmers to send their products wherever they may desire.

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