U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS
IN COOPERATION WITH PURDUE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

SOIL SURVEY OF MONROE COUNTY INDIANA

BY

T. M. BUSHNELL, PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION, IN CHARGE, AND EARL D. FOWLER
U. S. DEPARTMENT OF AGRICULTURE

PART II. THE MANAGEMENT OF MONROE COUNTY SOILS

BY

A. T. WIANCKO AND S. D. CONNER, DEPARTMENT OF AGRONOMY
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

[Advance Sheets—Field Operations of the Bureau of Soils, 1922]

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[PUBLIC RESOLUTION—No. 9]

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

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

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

Approved, March 14, 1904.

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

PREFACE

This report consists of two parts. Part I is designed to be descriptive and in a measure technical in the discussion of the soils. The general discussion of the soils of the county in the chapter on Soils in Part I was written by C. F. Marbut. Part II is intended to furnish information to county agents, farmers, and others more directly interested in the use of the soil. The soil map serves both parts of the report.

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PART I. SOIL SURVEY OF MONROE COUNTY, IND.

By T. M. BUSHNELL, Purdue University Agricultural Experiment Station, in Charge, and EARL D. FOWLER, U. S. Department of Agriculture

COUNTY SURVEYED

Monroe County is in the south-central part of the State of Indiana, about 30 miles southwest of Indianapolis. Morgan and Owen Counties bound it on the north, Owen and Greene Counties on the west, Lawrence County on the south, and Jackson and Brown Counties on the east. The outline of the county is nearly rectangular, the irregularities consisting of a small projection at the southeastern corner and a truncation by West Fork White River of the northwestern corner. It has an area of 416 square miles or 266,240 acres. The principal features of this county are (1) the Norman upland, (2) the Mitchell plain, and (3) the Crawford upland.[1]

FIG. 51.—Sketch map showing location of Monroe County, Ind.

The Norman upland is a severely dissected plain in the eastern part of the county, extending westward nearly to Harrodsburg, Smithville, Unionville, and Douston. The main divides are small flats and long narrow ridges, the crests of which represent remnants of old plains into which the creeks and their tributaries have cut V-shaped valleys from 200 to 400 feet deep. As a rule the stream bottoms are narrow and the gradient rather steep.

The Mitchell plain lies just west of the Norman upland and extends a short distance west of Harrodsburg; thence north and northwest along an irregular boundary to the county line west of Ellettsville. This generally smooth and level plain is locally very irregular, owing to numerous sink holes and some rough dissected areas along streams.

The Crawford upland includes the remainder of the county west of Mitchell plain. Like the Norman upland it is a dissected plain, but the ridge tops are broader and more rounding, the hillsides more gentle, and the valleys broader. The drainage is not so complete, and some streams which rise in the hills disappear in sink holes when they reach the valleys. Kirksville Ridge forms the eastern margin of this upland, rising as a distinct escarpment above the Mitchell plain.

The northern border of Monroe County is in the glaciated section of the State, but the glacial action here was too feeble to modify the preexisting physiographic features to any great extent. One effect

[1] The Handbook of Indiana Geology, published by the State department of conservation, gives a complete discussion of the physiography of the State, and it is the source of names and some statements in the description of the physiography of Monroe County.

of the glaciers was the formation of terraces beyond the limits of the ice sheets, where the glacial waters escaped through the valleys of Bean Blossom and Salt Creeks. West of Ellettsville is a large, rather flat area called "Glacial Lake Flatwoods" which was formed at the margin of the glacier.

In the Norman uplands dissection in some places has proceeded so far as to lower the divides from level-topped ridges to a series of high points or knobs with intervening low gaps. The hillsides have a slope varying from 10° to 30°.

Sink holes are the most striking surface features of the Mitchell plain. These depressions range from slight sa and water-tight basins to huge hollows 50 or more feet deep. -called "swallow holes" into which creeks disappear occur here and there. In the eastern portion of Mitchell plain the sink holes are few, and the country is gently undulating without distinct gullies along the smaller streams. However, some of the larger streams have cut below the general plain level as rocky, steep-sided, gorgelike valleys. Some of the roughest land in the county occurs where there is an almost continuous descent in a comparatively short distance from the top of Kirksville Ridge to the Clear Creek valley. The flattest land in Monroe County is on the lake and river terraces and bottoms and on a part of the Mitchell plain west of Bloomington.

The average elevation of Monroe County is about 760 feet above sea level. The highest elevation is 1,006 feet and the lowest is 490 feet. The maximum local relief is about 500 feet. The Kirksville, Stanford, and Unionville Ridges rise to an elevation of about 900 feet and Mitchell plain between 700 and 800 feet.

Monroe County lies between the two forks of White River, which receive all the drainage waters of the county. Although the west fork touches the northwestern corner of the county and is the outlet for Bean Blossom Creek, the greater portion of the area drains through Salt and Indian Creeks to East Fork White River. The crest of the divide between these forks lies close to the route of the Illinois Central Railroad across the county. Both Salt and Bean Blossom Creeks meander in rather deep channels through flat, overflow lands from one-fourth to 1½ miles wide and several hundred feet below the adjoining uplands. The lower course of Bean Blossom Creek has been narrowed by a glacial bar across its valley, and the actual stream channel becomes very deep as it cuts through the high White River bottoms. Moores Creek is typical of the small streams of the Norman upland, in having many branches and steep draws extending in all directions and steep gradients near their heads. The upper reaches of Clear and Indian Creeks are comparatively shallow draws in gently undulating country, and the gradients are more uniform and gentle. Clear Creek has underground tributaries which drain the sink-hole country and issue as springs, and similarly some small streams west of Bloomington pass underground to outlets in the Richland Creek Valley.

Monroe County was organized January 14, 1818. The original settlers drifted in from the East and Southeast. Indiana University was established at Bloomington, the county seat, in 1820. The rural population reached a maximum of 14,588 in 1910 and decreased to 12,924 in 1920, whereas Bloomington, the only city in the county, quadrupled in size in 40 years, having a population of 11,595 in 1920. The rural population has an average density of 31 persons per square mile and is fairly evenly distributed over the county. Practically all the farming population is white, and 97 per cent of the people in the county are native born.

Besides being the county seat and site of the State university, Bloomington has several large limestone quarries, stone mills, a furniture factory, and other industries. Other towns in the county are Ellettsville with a population of 721; Harrodsburg, 389; Stinesville, 299; Smithville, 375; Unionville, 125; Clear Creek, 94; Stanford, 120; Sanders, 41; and Dolan, 36.

Monroe County is traversed from north to south by the Chicago, Indianapolis & Louisville Railway, with numerous branches serving the stone quarries, and from east to west by the Illinois Central Railroad. It is similarly intersected by the Dixie Highway and a coast-to-coast highway. Several good roads radiate from Bloomington. That part of the county called the Mitchell plain is very well supplied with good roads, but in other sections roads occur at greater intervals, and they are not so well kept up, especially in the eastern hilly section. In the rougher country, roads follow natural routes along the ridges and valleys, and some trails follow the rocky beds of streams.

Telephone service is general in the better farming sections.

Bloomington is the chief local market for butter, milk, eggs, poultry, other agricultural products, and hardwood timber. Livestock and grain are shipped to Indianapolis or more distant cities.

CLIMATE [2]

The climate of Monroe County is characteristic of southern Indiana and the humid, temperate belt at elevations of less than 1,000 feet above sea level. (Fig. 52.) The mean annual figures of the Weather Bureau station at Bloomington are: Temperature, 53.2° F.; precipitation, 37.63 inches; and snowfall, 26.1 inches.

Spring and autumn temperatures approach the annual mean, but there is a difference of nearly 44° between the means of winter and summer. During fall, winter, and spring the ground frequently freezes by night and thaws by day, which loosens the soil and causes more rapid erosion of bare lands and also injures the growth of wheat and clover by "heaving," thus exposing or breaking the roots. The average frost-free season is 175 days, from the average last killing frost in the spring (about April 24) to the average first killing frost in the fall (about October 16), which is sufficient for maturing all of the common crops. The rough surface of Monroe County causes many local variations in frost occurrence. Crops are more likely to suffer from frosts on the bottom lands than elsewhere. The hilly lands are considered safer for orchard sites because of better air drainage. The latest recorded killing frost in the spring occurred on May 25, and the earliest in the fall occurred on September 14.

The rainfall is well distributed through the year, the least occurring in the fall. September, the driest month, has an average rainfall

[2] See Handbook of Indiana Geology, pp. 16–32, for a complete discussion of the climate of the State.

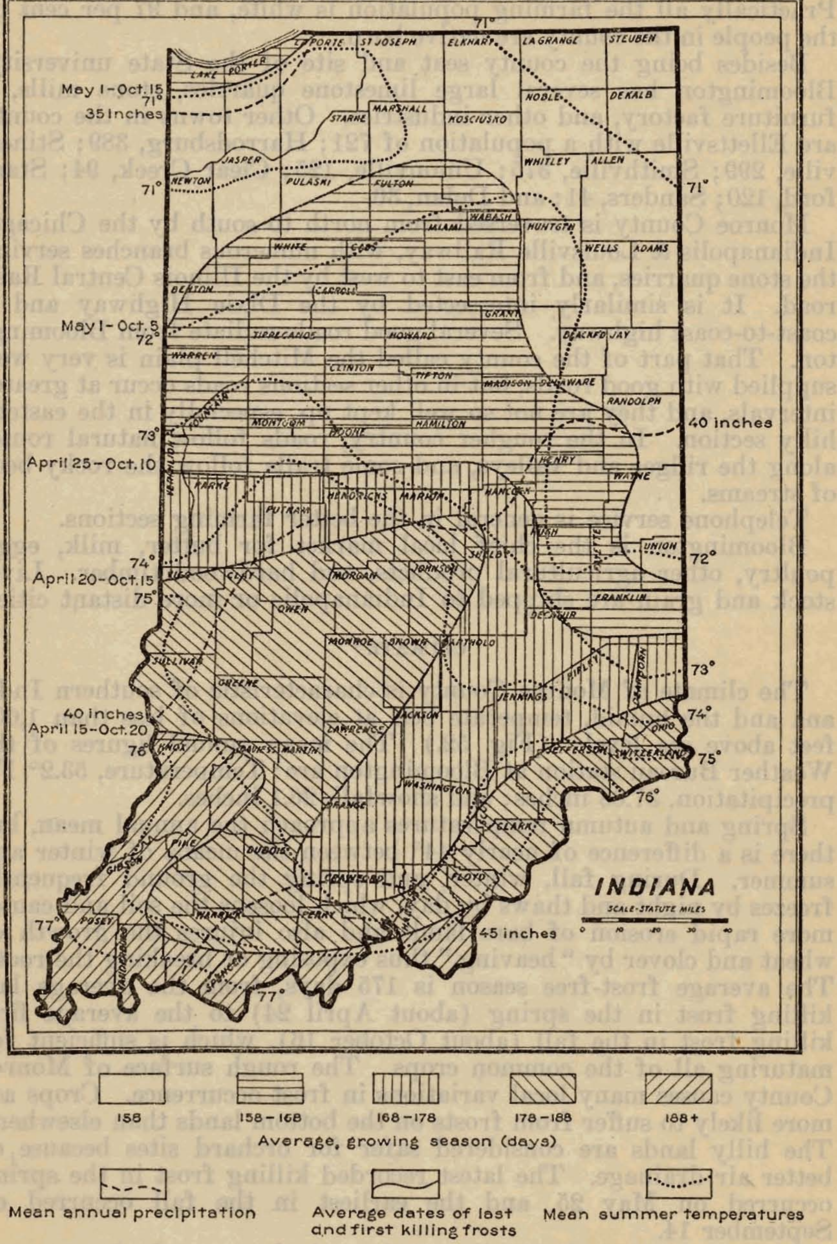

FIG. 52.—Sketch map showing climatic data

of 2.45 inches; and March, the wettest month, averages 4.13 inches. When the moisture is properly conserved it is more than sufficient for the crops.

The following table compiled from the records of the Weather Bureau station at Bloomington gives the more important climatic data for Monroe County:

Normal monthly, seasonal, and annual temperature and precipitation at Bloomington

[Elevation, 744 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1914)	Total amount for the wettest year (1921)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	31.9	71	−11	2.90	3.49	4.77	4.8
January	29.5	70	−20	3.37	2.35	3.16	8.7
February	29.4	70	−20	2.75	3.50	2.10	7.3
Winter	30.3	71	−20	9.02	9.34	10.03	20.8
March	42.3	86	0	4.13	2.68	7.04	3.9
April	51.4	88	20	3.03	4.66	5.05	.7
May	63.7	97	29	3.48	.96	3.15	Trace.
Spring	52.5	97	0	10.64	8.30	15.24	4.6
June	71.8	103	36	3.26	.44	3.18	.0
July	76.2	108	46	3.68	3.29	2.78	.0
August	74.6	103	41	3.26	5.38	5.81	.0
Summer	74.2	108	36	10.20	9.11	11.77	.0
September	67.8	103	28	2.45	3.27	10.17	.0
October	56.6	92	22	2.80	1.43	2.14	.1
November	43.6	79	5	2.52	1.50	7.07	.6
Fall	56.0	103	5	7.77	6.20	19.38	.7
Year	53.2	108	−20	37.63	32.95	56.42	26.1

AGRICULTURE

During a century of occupation by white men, Monroe County has passed through three stages of agricultural development. The pioneer stage was marked with scattered settlements in the most favorable situations, usually along the main streams. Then followed a second period during which time the land was all taken up and rapidly cleared or the best timber cut out. During that period lumbering was almost as important as farming, although the virgin soils are said to have produced excellent crops, and virgin land was always available. In the third period, which includes the 40 years covered by census data, the changes have not been so great. Most of the land sufficiently smooth for cultivation has been farmed more or less continuously until some fields have become "worn out." The land has been further subdivided, as the tendency has been toward more and smaller farms and a smaller acreage of improved land per farm. There has been a decrease in density of the rural population, because farm wages can not compete with the wages paid in the cities and quarries. As in other hill counties of Indiana, only about one-fifth of the farms are operated by tenants, whereas over half of the farms in Jasper County, in the northern part of the State, are operated by tenants.

Land values in Monroe County have always been low, and they have doubled in value only in recent years. The better farm lands of the State have increased from five to ten times the original value in the same period. The crops commonly grown have been limited to corn, hay (timothy, or mixed timothy and clover), wheat, and oats, which have in former years been several times more valuable than all the animal products. The most remarkable change in recent years has been the great increase in the value of poultry, eggs, milk, and butter which now constitutes the source of over one-fifth of the farm income. Although orcharding seemed promising and many peach and apple trees were set out, results have not proved very satisfactory, since few of the farmers have studied fruit growing to any great extent.

The following figures from the 1920 census show the agricultural condition of Monroe County: The 2,232 farms, averaging 102.2 acres, comprise 85.7 per cent of the total area of the county, and 62.6 per cent of the farm land is classed as improved land. The average value of all farm property is $5,766, or $56.50 an acre, and the average value of the land alone is $34.26 an acre. In 1919, 29.2 per cent of the farms expended an average of $187.77 for labor; 56.5 per cent of the farms expended an average of $274.96 for feed; and 61.9 per cent of the farms used an average of $60.68 worth of fertilizers.

The total value of the agricultural products by classes, in 1919, is shown in the following table:

Value of all agricultural products, by classes

Product	Value	Product	Value
Cereals	$1,648,550	Livestock and products—Continued.	
Other grains and seeds	10,722	Dairy products, excluding home use	$382,260
Hay and forage	751,030	Poultry and eggs	408,910
Vegetables	188,247	Wool	11,254
Fruits and nuts	37,839		
All other crops	45,347	Total	5,112,339
Livestock and products:			
All domestic animals	1,628,180		

The following table shows the acreage, total yield, and the yield per acre of the principal farm crops for the year 1919:

Acreage and production of principal crops, 1919

Crop	Area	Total yield	Yield per acre
	Acres	*Bushels*	*Bushels*
Corn	29,736	812,124	27.31
Oats	7,671	137,147	17.88
Wheat	12,902	160,182	12.41
Rye	1,115	8,867	7.95
Potatoes	478	17,642	36.91
		Tons	*Tons*
Timothy alone	10,497	9,634	.92
Timothy and clover mixed	5,852	8,539	1.46
Clover alone	1,698	2,296	1.35
Alfalfa	187	366	1.96
Other cultivated grasses	1,015	754	.74
Grains cut green	1,944	1,674	.86
Silage crops	1,399	9,667	6.91
Coarse forage	12,945	12,057	.93

Minor crops mentioned in the census are barley, beans, vegetables, tobacco, sorgo for sirup, grapes, strawberries, raspberries, and blackberries. The census reports 97,888 fruit trees of bearing age and 49,846 trees of nonbearing age in the county, principally apples and peaches, with some pears, plums, and cherries. Sudan grass, soy beans, and cowpeas are used for forage.

The foregoing data indicate that the average farm in Monroe County is of moderate size and value and that the usual Corn-Belt type of farming is followed. A number of men who work at least a portion of the year in quarries, mills, and factories maintain small homes in the rural districts. The production of dairy and poultry products is increasing in popularity, and in this connection an effort is being made to increase the acreage of legumes. Some farm homes among the hills are so isolated and on such rough roads as to be almost inaccessible.

The surface relief of Monroe County largely determines the location of the arable land and its susceptibility to erosion, and is probably the most important factor affecting the value of farm lands. Bottom land subject to overflow is devoted to corn and hay, since such land can not be used for wheat and red clover. The soils which have gray and mottled subsoils usually are too acid to grow clover without lime, and even with applications of limestone they would probably not become good alfalfa soils on account of their poor drainage.

The " red-clay " limestone soils are generally recognized as the best upland soils for clover and for general farming. The brown bottom-land soils are best for corn, and the ridges and hillsides are the most favorable locations for orchards.

The usual Corn-Belt farming methods are followed. Corn is grown for feed for work animals, for fattening hogs and cattle, for silage, rough forage, bedding, and as a cash crop. Wheat is a cash crop; it also protects the land during the winter. Oats are grown in rotation as a nurse crop for timothy and clover. Clover is grown for soil improvement and for hay, usually with timothy. Hay is fed to farm animals and sold as a cash crop. A few hogs are fattened on every farm for home use or for market. Dairy cows are more common than beef cattle in this county.

The farmhouses range from one-room log cabins to modern farm homes; and the outbuildings, from pole sheds to first-class barns. The average farm equipment is neither so complete nor so good as in the better farming sections of the State. Most of the implements are horse drawn, although some tractors are used on the larger and more level farms.

The common practice is to break some stubble or meadowland in the fall for corn and the larger part in the spring. The land for corn is pulverized by disking, harrowing, rolling, or dragging. Most of the corn is planted in checkrows and given several cultivations each way. It is harvested by shucking from the row or cutting, shocking, and husking from the shock, or by shredding. Part of the crop is used for silage. Corn land is frequently seeded to wheat in the fall or it is disked and harrowed and seeded to oats in the spring. Timothy and clover are seeded in the small-grain crops in the spring and are allowed to remain for two or three years.

The use of commercial fertilizer has increased in recent years, since the small quantity of manure produced and returned to the land is not sufficient to maintain the fertility on the average farm. About two-thirds of the farms of the county report the use of commercial fertilizer, which is chiefly acid phosphate or mixed goods which contain a high percentage of phosphoric acid. Two or three tons per year are applied to 20 or 30 acres of land, more being used on wheat than on corn.

Farm labor is usually drawn from local sources and it is scarce and high priced on account of the competition with the quarries and factories. Labor, other than the farmer's family, is hired principally during harvest and threshing time and on dairy farms.

Over half of the farms in the county range in size between 50 and 174 acres, about 600 contain less than 50 acres, and slightly more than 300 contain over 174 acres.

According to the 1920 census 77.1 per cent of the farms are operated by owners, 21.8 per cent by tenants, and 1.1 per cent by managers. Tenants usually give from one-third to one-half of the crops as rental.

The current value of farm land in Monroe County ranges from the amount of the taxes against it to several hundred dollars an acre. The better land averages about $100 an acre, the rolling land ranges from $25 to $50, and the hilly land from $5 to $25.

SOILS

The soil map of Monroe County shows three rather poorly defined north-south belts, each characterized by the predominance of a particular group of soils.

The most easterly belt is made up largely of Tilsit silt loam and Muskingum stony silt loam. Associated with them are Muskingum silt loam and Lawrence silt loam. This soil belt corresponds to that part of the Norman upland which lies within the county.

The central belt is made up mainly of Bedford silt loam and Hagerstown silt loam.

The soil in the western belt consists mainly of Tilsit silt loam, with considerable Hagerstown silt loam and Frederick silt loam. Cincinnati, Gibson, Vigo, and Robinson silt loams occur within a small area in the northwestern part of the county. Small areas of soils other than those mentioned are also found in the county.

All the soils of the county have developed under the cover of forests similar to those of the mid latitudes of the eastern part of the United States, consisting of mixed hardwoods. The well-drained soils are light in color, except for a thin dark-colored surface layer in the areas still covered with forest. The organic matter is not thoroughly incorporated with the mineral material and the dark color disappears in cultivated fields when mixed, in plowing, with the much thicker layer of light-colored, usually pale yellowish-brown or grayish-brown, material which lies below it.

However, not all the light-colored soils have developed under condition of good drainage. Some of them are poorly drained, but they have been subjected to excessive moisture for comparatively short periods each year. Lawrence silt loam is an example.

In color the soils of the county are similar to the soils of the original timber-covered region of the mid latitudes of the United States. The normally well-drained soils throughout this part of the United States are light in color, rarely gray, but never black, excepting the 1 or 2 inch layer of dark-colored material immediately beneath the layer of leaf mold which covers the surface soil in the forests. This dark color disappears when it is mixed in cultivated fields with the light-colored, usually pale yellowish-brown or grayish-brown material which lies below it and which continues to a depth somewhat below the usual depth of plowing, except where considerable sheet erosion has taken place. Although the immediate surface of the timber-covered soil is dark, this layer is so very thin that the comparatively light-textured topsoil, or horizon A, must be described as light colored. The fact that the surface organic matter is not usually thoroughly incorporated with the mineral portion of the soil, so that it consequently disappears rather rapidly when the soil is subjected to cultivation, is another reason for not basing the color description of these soils on the thin dark-colored surface material.

Some of the soils in Monroe County have developed in place from unconsolidated material derived from decayed sandstones, and others from limestone material. Notwithstanding this fact, none of the soils contain lime carbonate at any depth. Even the soils developed from highly calcareous glacial drift, such as the Cincinnati and Gibson silt loams, contain no lime carbonate above the unweathered, highly calcareous glacial drift which lies 5 or more feet beneath the surface.

Mature Upland Soils

The fully developed soils of Monroe County, soils having the same general characteristics as those developed on the smooth, well-drained areas common to the region of which this county forms a part, are the Hagerstown, Cincinnati, Bedford, Elk, and Princeton soils and one member of the Muskingum series, or Muskingum silt loam. These soils may be described as those whose characteristics are the results of the activity of the soil-forming forces of the region under conditions which have not limited their operation.

These mature soils are generally fine grained, and the predominant soils have silty surface layers and heavier subsoils, usually consisting of silty clay loam material or clay. The characteristics common to representative bodies of mature virgin soils may be described as follows, according to the layers from the surface downward:

(1) A thin layer of leaf mold, from 1 to 3 inches thick.

(2) A layer of dark-colored material, coarsely granular and also from 1 to 3 inches thick.

(3) A layer of grayish-brown or yellowish-brown material from 6 to 15 inches thick, with laminated structure. The more gray or lighter the color of the material the more definite are the laminations. In some cases the material is faintly granular; the granules are almost as large as those in the fourth layer, but are flattened. The texture is similar to the material composing the second layer.

(4) A layer from 10 to 20 inches thick of heavier textured material than that of the layers above and of deeper color, varying from faint reddish brown to brown. It breaks into angular structural particles,

varying in diameter from 1 to 10 millimeters. Usually the outside of the particles has a deeper color than the inside, except in the upper part of the layer, where light-colored material washed from the third layer coats the particles. In this layer are a number of tubes filled with the same material as the rest of the layer or with material from above, also nests and pockets of dark-colored, rounded particles, probably insect casts.

(5) A layer of material varying in texture according to the character of the underlying rock. It also varies greatly in color, and also is highly mottled with gray, yellow, and reddish brown. It is usually structureless or imperfectly cloddy or banded, corresponding to the banding or stratification of the rock from which it was derived through decomposition.

The substratum is sandstone, shale, limestone, and unconsolidated deposits. The mature upland soils are differentiated partly on the basis of their derivation and partly on differences in the features of their successive layers. The Hagerstown soils have developed from limestones, the Muskingum soils from shales and sandstones, the Cincinnati soils from glacial drift containing a high percentage of calcium carbonate, the Bedford soils from limestone, the Elk soils from old river deposits, and the Princeton soils from calcareous wind-deposited material.

There is one soil that is less fully developed than those which have been named, namely, the Frederick silt loam. This soil differs from the Hagerstown soils mainly in having a more yellowish color.

The other soils of the county may be classed into two other groups, one including those soils which have developed an unusually heavy layer in the subsoil, and the other including those soils in which layers have not developed or have only faintly developed.

Soils with Imperfectly Developed Profiles

The imperfectly developed soils, those having the very heavy layers, are unusual because their parent materials are no heavier in texture than the materials from which the mature soils of the county have developed. The heavy layer in the subsoil is a feature which can not be ascribed to the texture of the original parent material. A full discussion of the probable forces which have caused its development would require more space than can be devoted to it in this report. This group of imperfectly developed soils includes the Tilsit, Lawrence, Gibson, Robinson, Calhoun, Vigo, Lickdale, and McGary soils.

Of this group, Tilsit silt loam and Lawrence silt loam, which occur on the flat tops of ridges, are among the most important. Because of the apparent relationship between these two types of soil, they will be described in detail, the latter soil being described first.

Lawrence silt loam profile.—The succession of layers developed in virgin Lawrence silt loam may be described, from the surface downward, as follows, as based on a typical profile:

(1) A thin layer, in places 2 inches thick, consisting of a mixture of dark-colored organic matter and gray silty material having a somewhat granular structure.

(2) Between depths of 2 and 9 inches, a laminated layer of pale-yellowish silt loam, having a single-grained structure and containing small dark-colored iron concretions.

(3) Between depths of 9 and 16 inches, a laminated layer of gray, friable silt loam, which is slightly heavier in texture than layer No. 2 and having an admixture of yellowish material which appears as spots or streaks without definite boundaries.

(4) A gray layer which below a depth of 16 inches, becomes heavier in texture and which, between depths of about 24 and 36 inches, consists of moderately plastic clay loam or silty clay loam material colored a variegation of yellow, gray, and reddish yellow.

The substratum consists of material more friable than that composing layer No. 4 and is somewhat lighter in texture. At depths varying from 5 to 6 feet it grades downward into red clay. This red clay layer seems to be the product of the weathering of the underlying limestone and presumably represents the material from which the soil has developed.

Tilsit silt loam profile.—The successive layers of virgin Tilsit silt loam from the surface downward may be described as follows, based on a typical profile:

(1) A thin layer of dark-colored material like that of Lawrence silt loam.

(2) Between depths of 2 and 12 inches, a laminated layer of friable silt loam which varies in color from pale yellow to pale yellowish brown and which has a single-grained structure.

(3) Between depths of 12 and 22 inches, a yellowish-brown layer consisting of heavier-textured material, commonly silty clay, which is usually uniformly oxidized and which breaks into angular particles, typical of the true subsoil or horizon B of the well-drained timbered soils of the humid part of the mid latitudes of the United States. The particles range up to one-half inch or more in diameter and they have a deeper brown color on the outside than on the inside.

(4) Between depths of 22 and 30 inches, a layer of material similar in texture to layer No. 3, but which contains gray streaks and spots, and the structural particles are coated with gray, structureless silty material. The quantity of this gray material increases with depth, and usually it forms a thin structureless gray layer.

(5) A 6-inch brownish layer heavier in texture than layers Nos. 3 or 4, the transition from layer No. 4 being abrupt. This material breaks into well-defined columns about 2 inches in diameter. The outside of the columns at the top, over the end and halfway down the side, is coated with gray material which appears to have been carried down from the gray layer above. The material inside of the columns is colored with a variegation of brown, yellow, and gray. The columns decrease in size with depth and the material becomes lighter in texture until, at a depth of about 36 inches, the columnar structure disappears.

The substratum consists of friable silty clay material mottled with brown, yellow, and gray, and not so heavy in texture as layer No. 5. This represents the parent material of Tilsit silt loam, the material having originated from the weathering of sandstones and shales, mainly from shales.

Layer No. 3 of the Tilsit soil is not represented in the Lawrence silt loam, and layer No. 5 of the former soil appears to be what may be called a degenerated representative of layer No. 4 of the Lawrence soil.

Tilsit silt loam occurs on the smooth tops of narrow ridges in the eastern and western parts of the county. These ridge tops are the remnants of what were formerly much wider areas which are being obliterated by erosion now in process on two sides. In the eastern part of the county the areas of the Tilsit soils lie at a somewhat lower level than the areas of Bedford silt loam on the Mitchell plain, whereas in the western part the areas of Tilsit soils lie at a higher level than the areas of Bedford silt loam of the Mitchell plain.

It is apparent that the areas of Tilsit silt loam have been reduced to such narrow limits that the features of the soil, which have developed originally under conditions of poor drainage, have been considerably modified by the better drainage resulting from the reduced size of the areas. Probably the profile, or succession of layers, in what is now Tilsit silt loam was originally very similar or possibly exactly like that of the Lawrence silt loam. Since areas of Lawrence silt loam are also being reduced to smaller and narrower areas by erosion, some of the more narrow areas are now subjected to the same forces which have developed the existing characteristics of the Tilsit silt loams. Many narrow areas of Lawrence silt loam are now as narrow as the average area of Tilsit silt loam, and on these narrow areas the soil profile is probably very similar to that of the Tilsit soil.

Gibson silt loam.—On smooth upland areas east and west of Bean Blossom Creek, in the northwestern part of the county, occur Gibson silt loams. This type of soil is practically the same, in its succession of layers, as Tilsit silt loam. The principal difference is that the substratum of the Tilsit soil consists of clayey material derived from sandstone and shale—mainly shale—whereas that of the Gibson soils consists of glacial till.

Robinson silt loam.—In a nearly level basin, formerly a lake, in the northwestern part of the county, occurs Robinson silt loam, a forest soil developed from the materials which had accumulated by sedimentation in the old lake. A typical profile of this soil in its virgin state may be described as follows:

(1) A thin surface layer, in places 3 inches thick, consisting of a mixture of organic matter and silty material.

(2) A layer of gray silt loam, nearly white when dry and containing a few iron concretions. In texture, the silt loam composing the lower portion of this layer is heavier than that of the upper 3 inches.

(3) A layer of heavy silty clay rather firm or compact.

The substratum, consisting of more friable and lighter-textured material than that of layer No. 3, represents the parent material. The upper portion of this substratum material is more leached of its carbonate than at greater depths.

Calhoun silt loam.—On old river or creek deposits which now exist as terraces or benches in the valleys have developed the Calhoun soils. The profile of Calhoun silt loam is very similar to that of Lawrence silt loam, minor differences occurring in the various layers.

Vigo silt loam.—On flat or very gently sloping, poorly drained areas in the northwestern part of the county occur Vigo silt loams, soils which appear to be related, though rather distantly, to the Lawrence silt loams. The former soils have developed from calcareous glacial drift, whereas the latter have developed from material which had accumulated in place through the weathering of limestones.

The distinguishing characteristics of virgin Vigo silt loam, based on a typical profile and described according to its successive layers from surface downward, are as follows:

(1) A thin layer, in places about 2 inches thick, consisting of a mixture of silty material and organic matter, which may be slightly granular.

(2) Between depths of 2 and 22 inches, a layer of silty material, usually laminated, but on drying it falls into white or light-gray powder. It contains yellowish-brown spots which have no definite boundaries.

(3) Between depths of 22 and 35 inches, a grayish layer of heavy clay, mottled with yellowish and reddish brown. The gray color is not so pronounced as in layer No. 2.

The substratum consists of lighter-textured and more friable material than that composing layer No. 3. It is glacial material leached of carbonates and represents the parent material. Below this, calcareous glacial drift may or may not be found.

The flat or very smooth areas on which Vigo silt loam has developed appear to be the remnants of what originally constituted a plain covering a very large area of southwestern Indiana and on which had developed soils very closely similar to Vigo silt loam. The invasion of this plain region by drainage ways has resulted, by erosion, in the removal of the original Vigo soil, and a new soil, such as the Cincinnati silt loam, has developed on areas from which the original Vigo soils were completely removed. On narrow areas, however, from which the original soil has not yet been removed the Vigo soil now present has been modified by the development of a normal yellowish-brown subsoil, or B horizon, in what was originally the gray layer over the heavy layer. This modification is the result of the better drainage which has been afforded by the deeper drainage ways. In this modified Vigo soil, mapped as Gibson silt loam, the heavy grayish layer still persists, but it has become columnar in structure.

Lickdale silt loam.—On some very flat or in slightly depressed, poorly drained upland areas in bench positions in the southwestern part of Monroe County occur Lickdale silt loams. Here the upper soil layers are similar to those which occur in Lawrence silt loam, and the lower clay layer is not so heavy as layer No. 4 in the Lawrence soil.

McGary silt loam.—On flat or nearly flat terraces near the mouth of Bean Blossom Creek in the northwestern part of the county occur McGary silt loams. The profile of this type of soil is similar to that of Lawrence silt loam, except that the soil layers are slightly heavier in texture than the corresponding layers of the latter soil. The parent material of the McGary soils is highly calcareous, whereas that of the Lawrence soils is noncalcareous, to the extent that it does not effervesce on treatment with hydrochloric acid.

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YOUNG OR UNDEVELOPED SOILS

The soils of the third group, including those soils in which layers have not yet developed or which have not yet reached a mature state of development, are composed of materials which have recently accumulated. The alluvial soils are good examples. Among these soils are the Montgomery, most of the Muskingum stony silt loams, the Huntington, Holly, and Waverly soils, many of which are poorly drained bottom lands along streams. These soils and others not mentioned in the foregoing discussion are described in subsequent pages of this report.

TYPES OF SOIL

In the following pages are described the types of soil occurring in Monroe County, and also their agricultural values are discussed. The names of the types of soil are given in the following table; also the acreage and proportionate extent of each.

Extent of different soil types in Monroe County

Soil	Acres	Per cent	Soil	Acres	Per cent
Hagerstown silt loam	17,088	7.0	Guthrie silt loam	704	.3
Shallow phase	1,472		Vigo silt loam	832	.3
Hagerstown stony silt loam, shallow phase	16,896	6.3	Lickdale silt loam	128	.1
Frederick silt loam	12,032	15.2	Huntington silt loam	6,720	2.5
Eroded phase	28,608		Huntington very fine sandy loam	12,288	4.6
Bedford silt loam	36,096	13.6	Huntington fine sandy loam	448	1.0
Tilsit silt loam	23,552		Colluvial phase	2,176	
Eroded phase	7,360	11.8	Holly silt loam	11,776	4.4
Flat phase	640		Waverly silt loam	6,592	2.5
Muskingum silt loam	3,520	1.3	Waverly silty clay loam	1,344	.6
Muskingum stony silt loam	53,120	20.0	Dark-colored phase	192	
Cincinnati silt loam	1,216	1.1	Princeton fine sandy loam	448	.2
Steep phase	1,792		Genesee silt loam	640	.2
Gibson silt loam	1,920	.7	Genesee fine sandy loam	192	.1
Elk silt loam	4,608	1.7	Montgomery silty clay loam, gray phase	128	.1
Elk fine sandy loam	256	.1	Rough stony land	5,632	2.1
Lawrence silt loam	1,216	.4	Stone quarries	256	.1
McGary silt loam	192	.1			
Calhoun silt loam	2.368	.9	Total	266,240	-----
Robinson silt loam	1,792	.7			

HAGERSTOWN SILT LOAM

In its virgin state Hagerstown silt loam has a surface layer of leaf mold an inch or two thick, overlying a layer of dark-brown silt loam, about 2 inches thick, which contains considerable vegetable matter. Moist, new ground has a dark-brown color, whereas dry cultivated fields have a brown or light-brown cast with a suggestion of red eroded spots. To plow depth the material consists of medium-brown, friable silt loam. The subsurface, between depths from about 7 to 20 inches, consists of a yellowish-brown or light brownish-yellow silt loam which is friable when moist and floury when dry. The subsoil, between depths of 20 and 40 inches, is a yellowish-brown silty clay loam material having a faint reddish cast, friable when dry, but somewhat plastic when wet. In the lower part of the subsoil faint markings of gray and speckles of red may appear. Deeper down the material is a dull-red heavy clay which is stiff and plastic when wet and hard and compact when dry. In road cuts this clay, on drying, breaks into small, hard, angular fragments, and in only a few places may be seen any mottlings which would indicate that it is impervious to water. The red clay rests on pure limestone, which only in a few places is disintegrated more than a fraction of an inch, although there are large seams and crevices where the red clay has washed down into the underground drainage channels. The limestone is of the Salem and Harrodsburg formations, but in the soil the carbonates have been leached to the extent that a moderate degree of acidity has developed in the subsoil.

Hagerstown silt loam is the principal soil in a belt of country from 2 to 4 miles wide extending north and south through the center of the county. Other small areas occur in a narrow zone near the eastern border of the county. It occurs as more or less continuous broad areas which are generally lower than contiguous areas on the west and higher than other areas on the east. The surface relief of areas of this soil is gently undulating or gently rolling, and the areas are comparatively free from any minor irregularities which might interfere with cultivation.

The surface drainage is effected by a network of small draws which removes all rain water rapidly. Sufficiently rapid removal of the absorbed water through underground channels takes place, so that there is little subsoil mottling as a result of poor underdrainage. Sink holes are far less common on areas of this soil than on areas of Bedford silt loam.

Hagerstown silt loam is one of the most important soils in Monroe County, because of its productivity and rather large extent. It is estimated that 85 per cent of it is under cultivation, and the remainder is thickly forested with oaks, beech, maples, and other trees. Some of it is in bluegrass pasture. The principal crops and average yields are: Corn, 30 bushels; wheat, 15 bushels; timothy, 1 ton; oats, 20 bushels; and mixed hay, 1½ tons an acre. Crops of minor importance are clover, rye, alfalfa, and the usual garden vegetables. A number of hogs, and some cattle and sheep are fed on this land. Milk and eggs also add considerable to the farm income.

All the available manure is used on wheat and corn, and mixed fertilizers high in phosphorus, or acid phosphate alone, are applied at the rate of 100 or 200 pounds per acre for these crops.

The present average value of farms consisting largely of Hagerstown silt loam is about $100 an acre, but varies more or less according to location and improvements.

Hagerstown silt loam, shallow phase.—The surface soil of Hagerstown silt loam, shallow phase, consists of a brown or medium dark-brown silt loam which is friable when wet and light brown and floury when dry. In cultivated land the darker layer extends through plow depth, whereas in virgin areas there is an inch or two of vegetable mold covering a lighter-brown material. Between depths of 6 and 20 inches the material is a yellowish-brown or brownish-yellow, compact silt loam or silty clay loam, which has a slightly reddish cast and some plasticity when moist. The subsoil consists of a heavy red clay which is plastic when moist and rather tough and compact when dry. The soil is free from carbonates, although the red clay, at a depth of about 30 inches, rests directly upon a light-gray massive limestone sufficiently porous to allow water to pass through it. It is only slightly weathered and cracked. This limestone is chert free, and analyzes about 98 per cent calcium carbonate. The principal variations of this phase occur where erosion has resulted in a shallower soil with a reddish cast, or where the various horizons become thicker, as they do near areas of typical Hagerstown silt loam.

Hagerstown silt loam, shallow phase, is developed chiefly around the headwaters of Clear Creek south of Bloomington, where it occurs on the shoulders of slopes. It is associated with typical Hagerstown silt loam, Hagerstown stony silt loam, shallow phase, and rough stony land. Areas of it are dissected by small drainage ways, which carry off surface water very rapidly. In places this land is damaged by erosion. The substratum is apparently sufficiently porous to allow aeration and good underdrainage.

Hagerstown silt loam, shallow phase, is mapped in only a few small areas in Monroe County, but there are numerous small patches of it included in areas of typical Hagerstown silt loam. Probably 80 per cent of this shallow Hagerstown soil is cleared, and the remainder is in woods pasture which still retains some of the original forest growth, including black and white oak, beech, hickory, sugar maple, walnut, tulip poplar, and other trees.

A considerable acreage of this shallow soil is in hay meadows which are devoted principally to timothy, timothy and clover, or clover alone, and some of the most productive alfalfa fields in the county are to be found on it. Mixed hay averages over 1½ tons and alfalfa over 2 tons an acre. It is good bluegrass land. Wheat is an important crop, averaging about 15 bushels, and corn yields about 30 bushels an acre. When oats are grown the yields average less than 20 bushels. The general practice is to grow some kind of a cover crop on the land to protect it from erosion during the winter.

Farmers use some acid phosphate on wheat, or a mixed fertilizer containing a large quantity of phosphorus, less potassium, and a little nitrogen. Some of the land has been limed for alfalfa and clover, with good results. Some of the Hagerstown silt loam, shallow phase, has a high value, on account of its location near towns, but for farming purposes its current value ranges from $50 to $100 an acre.

HAGERSTOWN STONY SILT LOAM, SHALLOW PHASE

Hagerstown stony silt loam, shallow phase, is very similar to Hagerstown silt loam, shallow phase, and has nearly the same profile, although the layers are generally thinner than in the latter soil. In many places the friable silty surface soil is only a few inches deep and the land plows as a silty clay loam. Outcrops of limestone occur in many places both as ledges and as large fragments embedded in the soil. The soil on some areas which are not so stony might be considered an eroded phase of the silt loam. A few areas of Muskingum stony silt loam and rough stony land too small to map are included in mapped areas of this soil.

This soil occurs through the central limestone belt in association with Hagerstown silt loam, rough stony land, and other soil types on the steeper parts of the hills. The slopes are cut by many large and small drainage ways; but there is little sheet erosion. This type of soil is locally extensive, though its total area in the county is not large. It has been largely cleared of the original forest, and on most farms where it occurs it affords good bluegrass pasturage. Hay on this soil returns fair yields. The current value of this land ranges from $10 to $40 an acre.

FREDERICK SILT LOAM

Frederick silt loam is a brown or light-brown silt loam, about 8 inches deep, underlain by yellowish-brown, brownish-yellow, or slightly reddish yellow, friable silt loam. Beneath this layer, at a depth of about 22 inches, is a slightly reddish yellow, friable or semiplastic silty clay loam material, which is more or less mottled with gray and brown. This layer in turn is underlain by a plastic red clay resting on the bedrock. Chert fragments or "flint rock" are plentiful in this soil, and though few occur on the surface of virgin soils, they are exposed in great numbers in road cuts or eroded fields. This soil is derived from impure, cherty limestone of the Mitchell formation and the lower Harrodsburg layer. It is somewhat similar to Hagerstown silt loam, but differs from that soil in being more mottled in the subsoil, with many chert fragments, and in having a more impervious substratum. It is thoroughly leached of carbonates and is acid in all layers except the surface layer, which is usually neutral in reaction.

Frederick silt loam is confined to the central and western belts of the county where it occurs on undulating or rolling plains and ridges, being associated with its eroded phase on the rougher land and the Bedford silt loam on the smoother land. Areas of it contain numerous sink-hole depressions which facilitate surface drainage. The underdrainage is good, but not so good as in the Hagerstown silt loam, because the underlying Mitchell limestone is close grained and the red clay subsoil seems to be more impervious to water.

This soil is not extensive in Monroe County, but it is considered good farm land. About 75 per cent of it is used for cultivated crops, and the remainder for pasture and wood lots. Practically the same crops are grown on this soil as on Hagerstown silt loam, and average yields are about the same or slightly less. The general farming practices are also similar, but more care is needed to protect this land from erosion.

Frederick silt loam, eroded phase.—Frederick silt loam, eroded phase, is practically the same as the typical soil. Much of this land is badly eroded, and is bare of grass and even weeds, where the surface soil has been washed away on broad areas. Some areas are dissected by sharp V-shaped gullies several feet deep; in other areas numerous deep sink holes are so close together as to render the land unfit for ordinary farming, and in still other places steep hillsides cut up by large draws or stream heads occur. Although some of the land is not actually eroded, it might easily become so in one season of clean cultivation. In fact much of it is land which has been cultivated and allowed to wash. Some of the better areas are now in crops, returning fair yields of small grains and giving good results with timothy, clover, and alfalfa. There is some bluegrass pasture, and much waste land which produces principally weeds, briers, and sassafras bushes. The current value of land of this kind ranges from $10 to $30 or more an acre.

The following table gives the results of mechanical analyses of samples of the surface soil and subsoil of Frederick silt loam:

Mechanical analyses of Frederick silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283378	Surface soil, 0 to 8 inches	0.4	0.1	0.1	0.4	10.2	69.9	18.9
283379	Subsoil, 8 to 26 inches	0	0	0	.5	7.6	65.4	26.5
283380	Subsoil, 26 to 36 inches	0	0	0	2.2	7.8	67.4	22.6
283381	Subsoil, 36 to 48 inches	1.0	.8	.4	8.7	7.1	58.0	24.0

BEDFORD SILT LOAM

The surface soil of Bedford silt loam consists of a light grayish-brown, friable silt loam, about 6 inches deep, underlain by a light brownish-yellow, friable silt loam. At a depth of about 20 inches the subsoil is a pale-yellow, light-gray, or rust-brown, semiplastic, silty clay loam material, which usually is slightly more friable and mottled between the depths of about 30 inches and 4 or 5 feet. Immediately below this is a plastic, red clay which continues to bedrock, 8 or 10 feet below the surface. Angular chert fragments are common in the soil. This soil type is associated with Frederick, Lawrence, and Guthrie silt loams. The narrow, long-branching areas which are surrounded chiefly by Muskingum stony silt loam, represent practically all the arable land on the ridge tops and nearly always include border zones of Frederick silt loam too small to indicate on the map.

Areas of Bedford silt loam are scattered over the county, except along the eastern and western borders, the largest bodies being in the general vicinity of Bloomington. It occurs on the smoother portion of the Mitchell plain, and such areas have a gently undulating surface. Sink holes and small draws or sags which afford fair surface drainage are local topographic features. The underdrainage is evidently retarded by the zone of compaction in the subsoil and by the rather impervious red-clay substratum.

About 56 square miles of Bedford silt loam are mapped in Monroe County, of which about 75 per cent is devoted to corn, wheat, and hay, principally timothy. A small acreage is in oats, which is not a very successful crop in southern Indiana. Yields range from 25 to 35 bushels of corn, from 12 to 18 bushels of wheat, and a little more than a ton of hay an acre. Farmers use some commercial fertilizer, and a little limestone for clover.

The current value of Bedford silt loam ranges from $25 to $85 an acre.

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

Mechanical analyses of Bedford silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283382	Surface soil, 0 to 7 inches	1.2	1.2	0.6	1.8	10.7	68.7	15.9
283383	Subsoil, 7 to 16 inches	.2	.8	.4	1.0	6.4	65.2	25.8

TILSIT SILT LOAM

Tilsit silt loam is a light grayish-brown, friable silt loam about 8 inches deep, underlain by a light brownish-yellow, friable, silt loam material. Some light-gray mottlings appear at a depth of about 20 inches, and continue through the heavier layer, which consists of yellow, light-gray, and rust-brown, semiplastic, silty clay loam material. Below depths of 24 or 32 inches the subsoil material is slightly more friable and pervious, and becomes gritty or gravelly, owing to the partly weathered rock fragments, as it approaches the bedrock from 5 to 10 feet below the surface. The soil and parent rock are noncalcareous, the soil showing slight acidity near the surface and reaching a maximum at or near the heavy layer. This soil has developed in place from the sandstones and shales of the Chester, Mansfield, and Knobstone geologic formations. Some rock fragments occur on the surface and throughout the soil.

This type of soil occurs in the western and eastern portions of Monroe County, where it is associated with its eroded phase, with the Muskingum silt loam, Muskingum stony silt loam, and with the eroded phase of Frederick silt loam. It constitutes the smoother portion of the " freestone " hill lands, and areas of it have undulating surfaces. Small areas on narrow ridges usually include a border zone of Muskingum silt loam, which is a common development in the eastern part of the county, but such areas do not constitute such good land as that in the southwestern part where the hilltops have a plainlike appearance.

Surface drainage is effected by gentle slopes. The underdrainage is rather sluggish on account of the almost impervious heavy layer and substratum.

From 60 to 70 per cent of the Tilsit silt loam land is under cultivation. It is of large extent in Monroe County, being one of the more extensive soil types of southern Indiana. The common crops are corn, which yields from 25 to 30 bushels an acre; timothy, yielding more than one ton; and wheat, yielding about 12 bushels. Minor crops are clover, rye, and fruits, such as peaches, apples, and pears. A rather common practice among farmers is to use about 150 pounds of commercial fertilizer per acre on wheat, and a smaller quantity on corn. Lime has been used effectively for clover and alfalfa on some small fields.

Farms consisting largely of this kind of soil are valued from $15 to $50 an acre.

Tilsit silt loam, eroded phase.—Tilsit silt loam, eroded phase, is similar to typical Tilsit silt loam, and it represents old fields which have been seriously injured by erosion, which in many places have become waste or idle land. In places, the soil has been washed away to a depth of nearly 2 feet, leaving the subsoil exposed over patches of several square rods, and in some places narrow V-shaped ravines are yearly cutting deeper, and farther up the slopes. A few areas are still in forest and are, to a very slight extent, eroded but would rapidly become more so if cleared. Other fields have been well handled and kept under grass which greatly arrests erosion. On idle land the usual vegetation consists of poverty grass, briers, bracted plantain, cinquefoil, sassafras, and other weeds and brush. Some fields on areas of this soil include patches of typical Tilsit silt loam.

The current value of this kind of land ranges from about $5 to $20 an acre.

Tilsit silt loam, flat phase.—The flat phase of Tilsit silt loam has a surface soil consisting of light grayish-brown or brownish-gray, friable silt loam which contains some iron concretions and which becomes very light gray on the surface when dry. Between depths of 8 and 18 inches the material is light-gray, friable silt loam, stained with brown by soft iron concretions. This layer in turn is underlain by light-gray, yellow, or brown, compact, silty clay loam material, which becomes more friable with depth and more gritty as it approaches the bedrock. The largest area of this soil is in the southeastern part of Monroe County, on the Brown County line; but this does not represent a typical development of this flat-phase soil. Here it has the appearance of a sloping terrace in a valley. It is not an alluvial formation, but has developed in place from impervious, hard shales which occur at rather shallow depths. Here surface drainage is better than in the few small, flat areas which occur on the hilltops in the western portion of the county, but the underdrainage is equally poor.

This kind of soil is inextensive in Monroe County, and makes comparatively unproductive land, though it is used for hay, pasturage, and wheat. It is not so well suited to corn or legumes. Poverty grass, briers, and cinquefoil form part of the vegetation on old fields. The original growth consisted of black oak, white oak, and other trees. Land of this phase is worth from $10 to $30 an acre.

MUSKINGUM SILT LOAM

Muskingum silt loam has a topsoil consisting of a light brownish-gray or yellowish-brown friable silt loam, which is underlain, at a depth of about 6 inches, by a light brownish-yellow friable or crumbly silt loam. Beneath this layer, at a depth of about 24 inches, the subsoil consists of a more compact, yellowish-brown, heavy silt loam or silty clay loam material. These layers in places are slightly reddish yellow and may have faint gray markings along the joint planes. Below a depth of 32 inches the subsoil becomes more friable and more or less marked with yellow, gray, and brown, owing to the presence of unweathered rock fragments which increase in size, number, and hardness until the rotten rock is reached at depths of 5 or 10 feet. The bedrock is usually a fine-grained, shaly sandstone, belonging to the Knobstone and Chester formations. The surface soil is slightly acid and the subsoil highly so. Although the parent rock contains little or no free carbonate, in its unweathered state it is neutral in reaction.

Muskingum silt loam occurs both in the eastern and western belts of Monroe County on ridge tops and the shoulders of slopes. The crests are level in many places, but the land drops off sharply on each side, affording very good surface drainage. Underdrainage is also good. This type of soil is associated principally with Muskingum stony silt loam, which occurs on the adjoining steep hillsides, and Tilsit silt loam, which occurs on the smoother parts of the ridges. The arable land in many places on some small ridges consists of Muskingum and Tilsit silt loams, so that areas mapped as one type usually contain some patches of the other soil.

Muskingum silt loam is inextensive in Monroe County. Probably less than one-third of it is under cultivation. Part of the remainder is in forest of black, white, and chestnut oaks, hickory, and other trees. Most of the large trees have been cut, but some are still cut for railroad ties each year. Some of the soil is on waste land grown up to weeds, sassafras, and briers. Corn, wheat, and oats are the most common crops, and produce yields about equal to those obtained on Tilsit silt loam. Fruit trees, chiefly peaches and apples, have been planted on this soil and they do fairly well, although no very well kept or productive orchards were observed during the survey.

following table gives the results of mechanical analyses of samples of the surface soil and subsoil of Muskingum silt loam:

Mechanical analyses of Muskingum silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
2833108	Surface soil, 0 to 7 inches	0.2	0.2	0.2	0.6	13.6	69.2	15.7
2833109	Subsoil, 7 to 28 inches	.3	.1	0	.2	17.4	58.6	23.5
2833110	Subsoil, 28 to 36 inches	.6	.4	0	.7	30.0	52.4	15.7

MUSKINGUM STONY SILT LOAM

Muskingum stony silt loam has a topsoil consisting of a light grayish-brown or yellowish-brown, friable silt loam, about 8 inches deep, underlain by a light yellowish-brown or slightly reddish brown friable silt loam. At a depth of about 15 inches mottling appears in the subsoil, owing to the presence of small weathered fragments of rock which grade into only slightly decomposed rock within 2 or 3 feet of the surface. In many places small and large rock fragments are numerous on the surface and in the soil. They are particularly noticeable in eroded areas. Large, hard sandstone fragments are more in evidence where the soil is derived from rocks of the Chester or Mansfield formations, whereas small stones and gravel are more common in the soil which has developed from the Knobstone sandstone.

This soil predominates in the eastern third of Monroe County and is rather extensive in the western part. It occurs on the steepest hillsides, where the run-off is very rapid and where there is no tendency for the subsoil to be seepy. The slopes range from moderate to very precipitous and may be locally smooth or rough and dissected by many small draws. The boundary lines between areas of this soil and that of the eroded phase of Tilsit silt loam have been arbitrarily drawn in many places.

It is also associated with the eroded phase of Frederick silt loam, with Muskingum silt loam, and with rough stony land.

Most Muskingum stony silt loam land is in forest, brush, or is waste land. The original growth consisted of black, white, and chestnut oaks, beech, maple, hickory, and other trees, the largest of which have been removed. The best stands of the younger trees in Monroe County occur on this soil. Some areas have been so denuded and burned over that they appear almost worthless. A small acreage of the better, smoother land grows corn, oats, peaches, and other crops. The yields are small.

The current value of this land ranges from $5 to $20 an acre and at times some is sold each year for the taxes charged against it.

CINCINNATI SILT LOAM

Cincinnati silt loam, to a depth of about 6 inches, is a light-brown, friable silt loam, underlain by a light yellowish-brown or brownish-yellow, friable silt loam. Below 18 inches the material is yellowish brown or slightly reddish brown in color, semiplastic, and of a silty clay loam texture. The latter layer may be very slightly mottled with gray and brown in its lower portion, though the subsoil generally has an appearance suggestive of good drainage and aeration. The deep substratum consists of glacial till. The virgin surface soil is practically neutral, but the subsoil is fairly acid.

This type of soil occurs in the northwestern portion of the county, on the best-drained portions of the glacial deposits. Most of this land is used for growing corn, wheat, timothy, and oats, the yields being about the same as those obtained on Frederick silt loam, which soil it resembles in appearance.

The current value of Cincinnati silt loam varies from $50 to $75 an acre.

Cincinnati silt loam, steep phase.—Cincinnati silt loam, steep phase, is much the same as typical Cincinnati silt loam, but occurs on much steeper and rougher areas, which render it unfit for ordinary cultivation. Much of it occurs on steep gullied hillsides of the glacial-till deposits at the mouth of Bean Blossom Creek valley and elsewhere along the border of the unglaciated country. On such areas no well-defined soil type has developed, and more or less of the residual material outcrops on the slopes.

This steep-phase soil is nonagricultural land, and it is covered with forest and brush. It is used for pasture and wood lots, and its value depends largely on the quantity and quality of the timber which grows on it.

GIBSON SILT LOAM

The surface soil of Gibson silt loam is a light-brown or light grayish-brown silt loam about 7 inches deep. When wet the surface is brown in color, and when dry it becomes grayish. Between depths of 7 and 18 inches the subsoil consists of light brownish-yellow or yellowish-brown, friable silt loam material, and between 18 and 28 inches it is a compact, light yellowish-brown and gray silty clay loam.

At lower depths the material is somewhat looser and grades downward into the Illinoian till. This soil is acid in its lower layers, but only slightly acid in the uneroded surface soil.

This soil is mapped only in the northwestern corner of the county, where it occurs on some of the smoother uplands east and west of the mouth of Bean Blossom Creek. The surface of this land is gently sloping and slightly dissected by small stream ways which afford good drainage. In a few places there are indistinct sink holes, and underdrainage is somewhat sluggish.

Gibson silt loam closely resembles Bedford silt loam in appearance, and it is used for growing the same crops, with similar results. Probably 75 per cent of it is under cultivation and the remainder is in pasture and woodland. The native forest growth consisted principally of white and black oak, beech, hickory, and tulip poplar. The current value of this land ranges from $25 to $75 an acre.

The following table shows the results of mechanical analyses of samples of the surface soil and subsoil of Gibson silt loam:

Mechanical analyses of Gibson silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283348	Surface soil, 0 to 7 inches	0.0	0.6	0.4	1.0	9.8	70.8	17.6
283349	Subsoil, 7 to 16 inches	.1	.2	.1	.4	9.6	69.8	19.9
283350	Subsoil, 16 to 22 inches	0	0	0	.4	7.8	67.4	24.6
283351	Subsoil, 22 to 36 inches	0	0	0	.4	8.8	64.7	26.0

ELK SILT LOAM

Elk silt loam has a surface layer of light grayish-brown, friable silt loam which grades downward into a light yellowish-brown, friable silt loam 15 inches below the surface. The subsoil consists of a light yellowish-brown or brownish-yellow, compact, silty clay loam material, mottled with gray and brown at a depth of about 26 inches. Below 36 inches the subsoil is somewhat more open. The deeper substratum consists of rather heavy, stratified deposits, apparently of both local and glacial origin. Although the parent material is mostly silty clay loam or silty clay in texture and is noncalcareous, it also includes some beds of plastic or "soapy" calcareous clay, which contains small foreign rocks and pebbles. The soil material is moderately acid in its lower layers.

This soil occurs on the deposits which constitute the second bottoms along the main streams of Salt and Bean Blossom Creeks, which undoubtedly accumulated during glacial times. It is associated with Calhoun silt loam. A few small areas occur along Clear Creek. The land is all above overflow.

Elk silt loam includes the better-drained lands of the terraces. The surface is rolling, and in most places the land is suitable for cultivation, though in some places it is badly dissected by small stream channels. The total area of this soil in the county is not large, and barely half of it is cultivated, the remainder being in forest, brush, and pasture. Corn, wheat, and timothy are the main crops. Some tobacco has been grown successfully on this soil. The current value of this kind of land varies from $10 to $50 an acre.

ELK FINE SANDY LOAM

Elk fine sandy loam is a brown or grayish-brown fine sandy loam 8 inches deep which in places is rather dark colored when wet. The subsurface soil material to a depth of 16 inches consists of a light-brown fine sandy loam, grading downward into a light yellowish-brown or brownish-yellow, friable or compact, fine sandy clay loam material, the true subsoil. In places the subsoil may be slightly mottled with gray and brown in its lower portion, and is underlain by stratified, moderately calcareous material.

This soil has developed on the heavy backwater deposits of the West Fork White River, which are covered with a veneer of wind-laid or water-laid sand. It is mapped only in the northwestern corner of the county where it is associated with other second-bottom soils near the mouth of Bean Blossom Creek. This land has a smooth, nearly flat surface, but is fairly well drained. The soil is only slightly acid. Most of it produces good crops of corn, clover, and wheat. It is currently valued at about $100 an acre.

LAWRENCE SILT LOAM

The surface soil of Lawrence silt loam is a dull grayish-yellow or yellowish-gray, friable silt loam which contains some soft and hard, brown or black iron concretions. In a moist condition the surface soil is often puttylike and tends to run together, but it is floury when dry. Between depths of about 9 and 16 inches the subsurface consists of a mottled, pale-yellow and light-gray, friable silt loam material which becomes more plastic and heavier with depth. Between 24 and 34 inches the subsoil consists of heavy, semiplastic silty clay loam material, mottled with light gray, yellowish, and rust-brown. Iron concretions are fewer and softer in this layer than in the layers above. The lower portion of the subsoil is more friable and mottled, and below depths of 4 or 6 feet a red clay occurs. The subsoil and substratum contain more or less angular chert fragments, and a cherty limestone bedrock probably occurs within 10 feet of the surface. Mapped areas of this soil include some patches of soils which vary from the type, since this soil represents a transitional stage between the better drained and oxidized Bedford silt loam and the more poorly drained and oxidized Guthrie silt loam.

Lawrence silt loam occurs in a few scattered areas on the flatter portions of the Mitchell plain, the largest areas occurring about 3 miles west of Bloomington. It is found on the flats or very gentle slopes which are barely reached by the natural drainage ways, so that the rain water is not rapidly removed. The impervious layers of the subsoil and substratum and the general absence of sink holes cause poor underdrainage. This soil is locally called "crawfishy" or hardpan land.

Lawrence silt loam is inextensively developed in Monroe County. It is below the average as an agricultural soil, although it is all smooth, arable land. Comparatively little corn is grown on it, but more timothy and wheat. Clover is usually not successful, because the surface soil is somewhat acid and the subsoil very acid.

The current value of this land ranges from $20 to $50 an acre.

The following table shows the results of mechanical analyses of samples of the surface soil and subsoil of Lawrence silt loam:

Mechanical analyses of Lawrence silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283304	Surface soil, 0 to 7 inches	0.0	1.0	0.3	1.4	14.6	66.2	16.6
283305	Subsoil, 7 to 26 inches	.1	.2	.2	.7	6.4	70.6	21.9
283306	Subsoil, 26 to 36 inches	.8	.4	.2	1.4	8.4	61.7	27.2

M'GARY SILT LOAM

The surface soil of McGary silt loam, about 6 inches deep, consists of a light grayish-brown or brownish-gray, heavy silt loam which grades downward into a light-gray, heavy silt loam with rust-colored streaks. At a depth of about 10 inches the material is mottled with yellowish brown and gray, and has a silty clay loam texture. This is underlain by a heavy, plastic silty clay of the same color. At a depth of about 30 inches the substratum may consist of a yellowish-brown or yellow and gray, friable, silty clay loam material. The upper layers of this soil are somewhat acid, but the deep, friable subsoil material contains sufficient lime carbonate to effervesce freely with hydrochloric acid. The deeper substrata, also calcareous, consist of layers of clay, silt, and sand, which probably are backwater deposits of West Fork White River, which were probably laid down during the Wisconsin glaciation.

This soil type is mapped only in the northwestern corner of the county, where it is associated with Elk soils on the terraces near the mouth of Bean Blossom Creek. The surface of these areas is flat or gently sloping and sufficiently elevated to be above the river overflow. The underdrainage is imperfect because of its tough clay subsoil. Soil of this type is of small extent in the county. About 80 per cent of it is devoted to corn, wheat, clover, oats, and timothy, which produce fair yields. Where land of this kind is included in farms, its current value ranges from $25 to $100 an acre.

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

Mechanical analyses of McGary silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
2833111	Surface soil, 0 to 6 inches	0.4	1.8	0.9	2.2	6.7	69.8	18.1
2833112	Subsoil, 6 to 10 inches	.8	1.4	.8	1.8	8.2	48.2	39.0
2833113	Subsoil, 10 to 16 inches	0	.4	.2	1.3	9.0	61.0	28.2
2833114	Subsoil, 16 to 30 inches	0	.2	.4	1.2	4.6	51.6	42.0
2833115	Subsoil, 30 to 36 inches	.4	.2	0	.4	2.8	61.3	34.9

CALHOUN SILT LOAM

The surface soil of Calhoun silt loam is a light-brown or brownish-gray friable silt loam, about 6 inches deep, which may become very light colored when dry. It contains black and brown iron concretions. This surface layer is underlain by a light-gray, friable silt loam to a depth of about 14 inches. Between 14 and 28 inches the subsoil consists of a light-gray, yellow, or brown, compact, silty clay loam material. The deeper substratum is composed of stratified clay and silt, as in the case of Elk silt loam. Calhoun silt loam represents the flatter, less eroded and the more poorly drained portions of the old terraces, so that it is not an extensive soil in the county.

In places the land is gently sloping, but the impervious subsoil makes it wet and "late." This soil is acid even in its surface layer. It is not so good for corn as the better-drained land, but produces good crops of timothy and fair yields of wheat. The current value of land of this kind varies from $10 to $40 an acre.

ROBINSON SILT LOAM

The surface soil of Robinson silt loam is a light-gray or light brownish-gray, friable silt loam, which becomes very white on the surface when dry. It contains a few iron concretions. The subsoil, between depths of 6 and 26 inches, is a heavier light-gray and yellow silt loam material, and deeper down it consists of a compact, plastic, silty clay loam material which becomes more friable at a depth of about 35 inches. Heavy material continues to a depth of several feet, and according to well records the substratum consists of stratified, lacustrine deposits as deep as 100 feet in places.

Areas of Robinson silt loam are mapped in the northwestern part of Monroe County, where they represent the beds of old lakes which were formed along the border of the Illinoian glaciation. Here the surface is flat, or very slightly sloping, and the land is cut only by very shallow drainage ways. The subsoil does not allow rapid movement of all soil moisture. The land was originally covered with a forest growth that is characteristic of wet, "hardpan" soils. Probably 60 per cent of this land is cleared, however, and is now devoted to the growing of the ordinary farm crops. It is considered slightly more productive than the other very light colored soils of this section. Its current value ranges from $30 to $50 an acre.

The following table gives the results of mechanical analyses of samples of the surface soil and subsoil of Robinson silt loam:

Mechanical analyses of Robinson silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283365	Surface soil, 0 to 6 inches	0.4	0.9	0.4	3.3	10.8	65.6	18.4
283366	Subsoil, 6 to 26 inches	.4	.6	.4	2.6	11.6	61.1	23.3
283367	Subsoil, 26 to 36 inches	0	.6	.3	1.0	12.1	53.7	32.1

GUTHRIE SILT LOAM

The surface soil of Guthrie silt loam consists of a light-gray silt loam which is slightly brownish to a depth of 5 inches when wet, but almost white when dry. Numerous black and dark-brown iron concretions occur on the surface and in the soil, but they decrease in number and hardness with increasing depth. Between the depths of about 5 and 26 inches the subsurface consists of a friable or puttylike silt loam which is slightly marked or mottled with brown and yellow. Below this layer is a zone of semiplastic, silty clay loam material which is light gray in color and mottled with brown and yellow. Between depths of about 5 and 10 feet the material consists of a plastic, red clay which contains angular fragments of chert. The bedrock is cherty limestone.

This soil occurs on the very flattest portions of the Mitchell plain, west of Bloomington and northwest of Ellettsville. It is not reached by the surface drainage ways, and in some places it occurs in shallow sinks which have imperfect underground outlets. The surface of this land is flat or depressed.

This is not an important soil type in Monroe County, because it is not extensive and is unsuited for corn and clover, owing to poor drainage and rather high degree of acidity. Timothy and wheat, the principal crops grown on it, give moderate returns. Many pastures contain considerable poverty grass. The current value of this land varies from about $20 to $50 an acre.

VIGO SILT LOAM

The surface soil of Vigo silt loam consists of a light-gray or light brownish-gray friable silt loam, which contains some small iron concretions. When dry it is nearly white. The subsurface is a very light gray silt loam, mottled with yellow and brown. At a depth of about 22 inches the subsoil consists of a light-gray, yellow, and rust-brown compact or semiplastic silty clay loam material, becoming a little more open in structure below a depth of 34 inches. The deeper substratum consists of glacial drift to depths varying from 10 to 25 feet. In appearance this soil resembles Guthrie and Robinson silt loams.

Soil of this type occurs in the northwestern part of the county, associated with Gibson and Cincinnati silt loams. The land is either very flat or gently sloping, so that it is poorly drained. The soil is very acid from the surface down.

Only a small acreage of Vigo silt loam is mapped in Monroe County, but it is extensively developed in the southwestern part of Indiana. The virgin forest growth, consisting of white and pin oaks, beech, hickory, and sweet gum, has been cut, and the land produces wheat, timothy, corn, and other crops. Crop yields are usually less than on the better drained soils. The current value of this land ranges from $20 to $50 an acre.

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

Mechanical analyses of Vigo silt loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283374	Surface soil, 0 to 6 inches	0.6	1.0	1.0	3.2	11.8	64.6	17.9
283375	Subsoil, 6 to 26 inches	1.0	1.0	.8	2.8	7.3	69.6	17.5
283376	Subsoil, 26 to 36 inches	.4	.8	.4	1.9	10.8	60.0	25.8
283377	Subsoil, 36 to 60 inches	1.4	1.8	1.4	8.2	12.0	45.6	29.7

LICKDALE SILT LOAM

The surface soil of Lickdale silt loam is a light-gray silt loam which has a slight brownish tinge when wet, but is almost white when dry. It contains numerous hard, black iron concretions which decrease in number and hardness with depth. The subsurface, to a depth of 18 inches, is a friable, light-gray silt loam, slightly marked with brown. At a greater depth the subsurface consists of gray, rust-brown, or black, plastic silty clay loam or clay. Below a depth of about 36 inches the subsoil is less compact but is rather heavy and rvious down to the parent rock.

mall areas of this soil are mapped in the southwestern part of Monroe County on very flat or slightly depressed areas on the hilltops. The surface drainage and underdrainage are both poor. Land of this kind is used principally for growing timothy and wheat and for pasturage. The yields are low. This land is currently valued from $10 to $30 an acre.

HUNTINGTON SILT LOAM

The surface soil of Huntington silt loam is a brown loam or silt loam, a little heavier in texture at a depth of about 15 inches. This soil in different areas varies somewhat in color and texture. Ordinarily it does not contain sufficient lime to effervesce with acid. It is developed on alluvial deposits of limestone origin.

The principal areas of Huntington silt loam are mapped along Clear Creek and other creeks in the limestone belt of the central part of the county. Although it is first-bottom land, subject to overflow, and is generally level, it occurs on the higher portions of the bottoms, so that it is effectively drained by the streams.

The total area of this soil in the county is not large. However, about 80 per cent of it is utilized for crops, it being probably the best natural corn land in the county. Yields ranging from 50 to 75 bushels an acre are reported. Clover does well, also timothy and bluegrass, but wheat is seldom grown.

The original forest consisted of elm, oaks, hickory, sycamore, walnut, and other deciduous trees, but most of the original timber has been cut.

The current value of this land may be as high as $100 an acre, according to location and the character of associated soils.

HUNTINGTON VERY FINE SANDY LOAM

Huntington very fine sandy loam consists of brown or light-brown, friable very fine sandy loam which grades downward into a lighter and somewhat yellowish brown, friable very fine sandy loam or loam. The deeper material may be slightly mottled with gray at a depth of about 30 inches. The substratum consists of sand, gravel, and silt. In some places this soil is rather silty and in other places it contains some coarser sandy material.

Areas of this soil are mapped along most of the streams in the eastern half of Monroe County. The surface of such areas is nearly flat, but may be cut by old and new stream channels. The land is subject to overflow, but is well drained during most of the growing season.

This type of soil includes some of the best land in the hill section of the county, and it is largely cleared and cultivated. Corn, timothy, alsike clover, and oats are the crops commonly grown, and very good yields are obtained, although fields are usually small and irregular in shape. The land is currently valued from $20 to $60 an acre.

HUNTINGTON FINE SANDY LOAM

Huntington fine sandy loam is usually a brown fine sandy loam representing recent alluvial deposits. The surface portion is somewhat darker in color than the deeper material. The texture is variable, but usually it is sandy, and the lower layers of areas near stream channels are gravelly. The soil shows no acidity but contains practically no free lime carbonate. It is derived from recent alluvium washed from sandstone, shale, and limestone uplands.

This soil occurs in small areas along the small stream valleys in the western part of the county. Drainage conditions are good, as the smooth, sloping land is dissected by old stream channels. Although this type of soil is inextensive, it is the most important soil on some farms, because the adjoining hilly land is too rough for cultivation. It is used chiefly for corn and hay, and produces good yields. The current value of this kind of land varies from $20 to $50 an acre.

Huntington fine sandy loam, colluvial phase.—Some of the land mapped as the colluvial phase of Huntington fine sandy loam resembles the typical Huntington fine sandy loam, as in small, narrow valleys where it includes all the arable land. Little of this land is subject to overflow from the main streams, but the small tributaries from the hills are constantly washing in new material. Other areas of such land occur near small draws, where distinct alluvial fans have been formed from sediments washed into some of the large valleys during heavy rains. This material may include silt and clay from limestone soils, and sand, gravel, and rocks from the sandstone uplands. A combination of such materials usually makes a productive soil. This kind of land is used for growing corn, hay, wheat, and garden products. Although this soil occurs in small areas, it is highly valued because it is more fertile than most of the adjoining soils.

HOLLY SILT LOAM

Holly silt loam is a grayish-brown or light grayish-brown, friable silt loam, from 6 to 10 inches deep, underlain by a light-gray, yellow, or brown, puttylike, silt loam material. The subsoil is somewhat acid. The deeper substratum is stratified alluvium of much the same appearance as the upper layers, which has been washed from sandstone and shale uplands.

This soil occurs on most of the small stream bottoms of Monroe County, between the browner, richer, and better drained Huntington silt loam and the grayer, poorer, and wetter Waverly silt loam. However, most of it is sufficiently well drained for farming, and the greater portion of it is used for corn, timothy, alsike clover, and Sudan grass. When the season is not too wet the crop yields on this soil nearly equal those on Huntington silt loam.

This land is currently valued from $20 to $60 an acre.

WAVERLY SILT LOAM

Waverly silt loam consists of a 5-inch layer of light-gray or light brownish-gray, friable silt loam, underlain by lighter-colored material, mottled with rust-brown. The subsoil, at a depth of 18 inches, consists of a slightly more compact, silt loam or silty clay loam material, which becomes looser again at a depth of about 28 inches. The deeper substratum consists of much the same kind of material. This soil is acid in its surface layers and very acid in the subsoil. The greater portion of the parent material was derived chiefly from sandstone and shales, and the lesser portion from glacial and limestone materials.

Comparatively extensive areas of Waverly silt loam are mapped on the broader bottoms along Salt and Bean Blossom Creeks. Here the land surface is flat and a little lower than the banks of the streams, so that drainage is very slow. The land is subject to severe inundation in rainy seasons. Over two-thirds of this soil has been cleared of its original forest growth and is devoted to corn, timothy, alsike clover, and Sudan grass. Corn does poorly in wet seasons, but it may yield from 20 to 40 bushels in favorable years. Some very heavy yields of timothy and alsike clover hay were observed on this land in 1922, and in the same year the Sudan grass, which was seeded very late, yielded a good crop of hay. The current value of this land varies from $20 to $60 an acre.

WAVERLY SILTY CLAY LOAM

Waverly silty clay loam consists of light-gray, friable silty clay loam, about 5 inches deep, underlain by light-gray and brown, silty clay loam material, which becomes slightly heavier and more compact at a depth of about 24 inches. The deeper substratum consists of alluvium, chiefly of sandstone and shale origin. This type of soil is slightly acid.

Waverly silty clay loam is mapped in Bean Blossom Creek and Salt Creek valleys. This land is level or depressed and is poorly drained, as it is lower than the land near the streams. This soil was originally forested with swamp varieties of trees and other vegetation, some of which remain. The principal crops are timothy, Sudan grass, and alsike clover, yields of which are good. The current value of this land is equal to that of Waverly silt loam.

Waverly silty clay loam, dark-colored phase.—The dark-colored phase of Waverly silty clay loam is a dark grayish-brown or dark brownish-gray, heavy, sticky silt loam or silty clay loam about 8 inches deep. The subsoil between depths of 8 and 20 inches is a dark-gray, plastic, silty clay loam or silty clay material marked with rust-brown. At lower depths the material is lighter-gray, drab, and rust-brown alluvium, consisting of silt and clay.

This soil is mapped as a few small areas in Bean Blossom Creek and Salt Creek valleys where it may represent old abandoned stream channels or it may include the lowest land on the bottoms, where the finest sediments of the flood waters have settled. On some areas near the foot of the hills, the dark color of the soil may be caused by the springs or by "seeps" from the limestone bluffs. In many places there is a surface veneer of lighter silt which has been washed over the darker soil. Such flat areas are usually poorly drained and difficult to drain. In favorable seasons, however, the land is very productive and returns large yields of corn, timothy, and alsike clover. A portion of it is still covered by a lowland forest growth. The current value of this land ranges from $25 to $60 an acre.

PRINCETON FINE SANDY LOAM

The topsoil of Princeton fine sandy loam consists of about 10 inches of brown fine sandy loam underlain by light-brown or yellowish-brown fine sandy loam which grades downward into yellowish-brown or slightly reddish brown, heavy fine sandy loam or fine sandy clay loam material. The subsoil is usually looser at a depth of about 36 inches, and in places it is a rather loose sand. This soil has evidently been formed by sands blown from river bottom lands and deposited over upland soils. It shows very little acidity at any depth and is calcareous in the substratum.

Princeton fine sandy loam is mapped in several small areas in the northwestern corner of Monroe County, on the hills adjoining the bottoms of West Fork White River. Several variations, owing to differences in slope, state of erosion, or looseness of the sand, are included in mapped areas of this soil. The surface of this land varies from smooth to somewhat broken, and the surface drainage varies from good to excessive. Underdrainage is usually good, but where the subsoil consists of loose deep sand the land is droughty.

Though very limited in extent, this soil is practically all used for crops such as corn, wheat, hay, and rye. It is well adapted to cantaloupes and watermelons, which are grown on some farms. Crop yields are good in seasons of well-distributed rainfall. Since land of this type is associated with good alluvial lands and is located near towns it has a rather high value in Monroe County.

The results of mechanical analyses of samples of the surface soil and subsoil of Princeton fine sandy loam are given in the following table:

Mechanical analyses of Princeton fine sandy loam

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283355	Surface soil, 0 to 12 inches	0.1	2.0	9.0	51.6	8.2	21.8	7.4
283356	Subsoil, 12 to 24 inches	0	1.8	8.8	50.5	6.4	22.6	9.9
283357	Subsoil, 24 to 36 inches	0	1.9	10.0	60.7	3.4	14.6	9.4

GENESEE SILT LOAM

Genesee silt loam consists of a brown or dark chocolate-brown topsoil, about 8 inches deep, of friable, or slightly gritty silt loam, underlain by a lighter-brown material which is slightly mottled with shades of brown at a depth of about 2 feet. This soil is not acid even in its lower layers. The substratum material consists of stratified recent alluvium, derived principally from till of the Wisconsin glaciation of central Indiana, and it is moderately calcareous.

This soil type is mapped only in the West Fork White River bottoms in the northwestern corner of the county. It is high, first-bottom land subject to occasional overflow. The surface is level, or gently undulating, owing to the occurrence of old stream channels. Although little of this kind of soil occurs in the county, it is representative of much of the bottom land in the State, and it is high-priced, productive land. Corn is the main crop and yields from 40 to 70 bushels or more an acre. Wheat is also grown, and it does well if it is not injured by high water. The same is true of red clover.

GENESEE FINE SANDY LOAM

Genesee fine sandy loam is a brown fine sandy loam, which is underlain by layers of brown materials which vary in texture from sandy loam to silt loam. This soil includes the first-bottom land which is nearest the channel of West Fork White River, where the greatest wash and deposition of sand takes place during times of overflow. These deposits are subject to change in composition, and they increase in area each year. The material is sufficiently rich in lime to effervesce with hydrochloric acid. Except for a few spots where coarse sand and gravel are deposited several feet deep, this land is productive and will produce large yields of corn in normal seasons. Idle land of this character grows up in jungles of horseweed, cocklebur, and other lowland vegetation.

Land of this kind is currently valued at about $100 an acre.

MONTGOMERY SILTY CLAY LOAM, GRAY PHASE

Montgomery silty clay loam, gray phase, is a dark-brown or dark-gray somewhat plastic, silt loam or silty clay loam, underlain, at a depth of about 7 inches, by a dark-brown or dark-gray, plastic, silty clay which is mottled with drab and reddish brown at a depth of about 24 inches. This soil is not calcareous, and shows practically no acidity at any depth in some areas, but is moderately acid in other places. It occurs in small depressions or on nearly flat areas on the old lake plains, associated with Robinson silt loam.

The natural drainage of this gray-phase soil is poor, its subsoil being almost impervious. When drained, this land is productive and adapted to corn, clover, timothy, wheat, and oats. Its total area in this county is very small, but most of it is cultivated. Its current value is estimated to range from $50 to $75 an acre.

The results of mechanical analyses of samples of the surface soil and subsoil of Montgomery silty clay loam, gray phase, are given in the following table:

Mechanical analyses of Montgomery silty clay loam, gray phase

Number	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
283368	Surface soil, 0 to 7 inches	0.2	0.8	0.4	1.6	7.4	62.4	27.0
283369	Subsoil, 7 to 24 inches	.4	.4	.4	1.4	8.2	60.8	28.6
283370	Subsoil, 24 to 36 inches	1.0	.6	.4	1.0	8.4	58.8	29.8

ROUGH STONY LAND

Rough stony land includes the roughest parts of Monroe County, such as the land which marks the boundary between the Harrodsburg limestone and the underlying Knobstone formation. Areas also occur where there are precipitous bluffs of Riverside sandstone, and where the land is considered too rough, steep, broken, and stony for farming. Most of it would not make good pastures if cleared, so that it should be left in forest to protect it from erosion, and to provide firewood, railroad ties, and saw logs.

SUMMARY

Monroe County, Ind., situated about 30 miles southwest of Indianapolis, has an area of 416 square miles.

The eastern portion is part of the highly dissected Norman upland, the central belt includes the limestone, sink-hole country called the Mitchell plain, and the western portion is a part of the rolling Crawford upland. The elevations of the county range from 490 to 1,006 feet above sea level. The county is thoroughly drained by tributaries of the east and west forks of White River.

The climate of Monroe County is humid and temperate, the rainfall well distributed, and the average frost-free season 175 days.

Four-fifths of the farms are operated by owners. Improved farm land includes less than 60 per cent of the area of the county. The 1920 census gives the average land value as $34.26 an acre.

Corn, timothy and clover, wheat, and oats are the most important crops. Poultry, eggs, dairy products, and hogs are important sources of income.

Monroe County has light-colored, timbered silt loams on the uplands and old terraces. According to the stage of development, the soils of the county may be classed into three major groups, namely, mature, imperfectly developed, and young soils.

Of these three groups, the mature soils are the most extensive and important agriculturally. The Hagerstown, Frederick, Bedford, Tilsit, Muskingum, Cincinnati, Gibson, Elk, and Princeton soils comprise this group.

The imperfectly developed soils, including the Tilsit, Lawrence, Gibson, Robinson, Calhoun, Vigo, Lickdale, and the McGary soils, have a very heavy layer developed in the subsoil.

The young or undeveloped soils include those soils in which layers have not yet developed or which have not yet reached a mature stage of development. The alluvial soils or those occurring along streams are good examples, as the Huntington, Holly, Waverly, and Genesee soils.

PART II. THE MANAGEMENT OF MONROE COUNTY SOILS

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INTRODUCTION

The farmer should know his soil and have a sound basis for every step in its treatment. Building up the productivity of a soil to a high level in a profitable way and then maintaining it is an achievement for which every farmer should strive. The business of farming should be conducted as intelligently and as carefully as any manufacturing business. Every process must be understood and regulated, from the raw material to the finished product, in order to be uniformly successful. The farmer's factory is his farm. Different soils present different problems. It is important, therefore, that soils be studied and understood in order that the production of crops may be most satisfactory and profitable.

It is the purpose of the following discussion to call attention to the deficiencies of the several soils of the county and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory that does not in the long run bring profitable returns. Some soil treatments and methods of management may be profitable for a time, but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in this country. A properly balanced system of treatment will make almost any soil profitably productive.

CHEMICAL COMPOSITION OF MONROE COUNTY SOILS

The following table gives the results of chemical analyses of the different types of soil in Monroe County, expressed in pounds of elements per acre, based on 2,000,000 pounds as the weight of the surface soil of an acre, representing the plowed surface of the mineral soils.

Three groups of analyses are given; total plant-food elements, elements soluble in strong (specific gravity, 1.115) hydrochloric acid, and elements soluble in weak (fifth-normal) nitric acid.

Chemical composition of Monroe County soils

[Elements in pounds per acre (2,000,000 pounds)]

Element	Hagerstown silt loam	Hagerstown silt loam, shallow phase	Frederick silt loam	Muskingum silt loam	Muskingum stony silt loam	Bedford silt loam	Tilsit silt loam	Tilsit silt loam, flat phase	Elk silt loam	Lawrence silt loam
Phosphorus [1]	960	1,050	1,140	960	610	960	1,400	1,480	960	1,400
Potassium [1]	3,700	5,050	4,540	2,690	2,520	3,870	2,690	2,350	4,880	2,860
Calcium [1]	4,000	6,710	3,570	3,140	2,140	2,570	4,430	3,860	2,140	3,430
Magnesium [1]	5,190	2,170	4,580	4,340	2,530	5,310	3,500	4,340	3,620	4,820
Manganese [1]	1,580	580	580	430	290	580	1,150	1,580	1,870	430
Aluminum [1]	43,600	53,200	44,100	41,000	32,600	45,700	44,300	42,000	41,600	41,500
Iron [1]	35,600	33,500	46,300	27,800	19,200	42,800	42,800	57,100	25,500	56,300
Sulphur [1]	640	320	480	400	240	480	320	720	480	640
Phosphorus [2]	55	96	26	79	18	38	79	79	35	52
Potassium [2]	219	319	202	202	101	101	185	84	135	151
Nitrogen [3]	2,600	2,000	2,700	2,300	2,200	2,200	2,600	2,000	2,600	2,200
Potassium [3]	20,350	25,050	25,400	26,230	21,690	25,050	21,190	19,840	24,380	20,350
Element	**Calhoun silt loam**	**Guthrie silt loam**	**Lickdale silt loam**	**Robinson silt loam**	**McGary silt loam**	**Cincinnati silt loam**	**Gibson silt loam**	**Vigo silt loam**	**Princeton fine sandy loam**	**Elk fine sandy loam**
Phosphorus [1]	700	1,140	1,050	790	1,840	790	700	610	700	440
Potassium [1]	2,020	2,860	1,850	4,200	4,040	4,370	2,860	2,190	2,350	1,850
Calcium [1]	1,860	2,290	3,140	2,140	4,290	2,000	1,860	2,140	1,710	2,570
Magnesium [1]	3,740	4,340	3,140	2,050	1,690	2,410	3,620	2,900	2,170	2,410
Manganese [1]	580	290	2,450	720	1,440	1,010	720	720	580	1,590
Aluminum [1]	35,700	33,000	34,100	46,000	43,600	55,200	45,400	39,200	21,200	23,200
Iron [1]	37,500	44,900	44,200	25,500	42,700	33,500	25,500	24,400	13,400	16,800
Sulphur [1]	320	560	640	400	400	320	400	320	240	160
Phosphorus [2]	18	70	44	52	56	61	26	35	61	18
Potassium [2]	68	135	68	235	118	235	135	84	185	85
Nitrogen [3]	2,400	2,000	2,400	2,000	2,800	2,000	2,800	2,000	1,800	2,000
Potassium [3]	21,360	19,170	16,820	23,710	25,220	25,560	25,390	20,180	16,820	19,670
Element	**Montgomery silty clay loam, gray phase**	**Waverly silty clay loam, dark-colored phase**	**Waverly silty clay loam**	**Waverly silt loam**	**Holly silt loam**	**Huntington silt loam**	**Genesee silt loam**	**Genesee fine sandy loam**	**Huntington very fine sandy loam**	
Phosphorus [1]	1,220	1,220	1,140	700	870	790	1,310	870	520	
Potassium [1]	5,040	3,360	6,890	5,550	4,200	2,690	5,210	1,680	3,360	
Calcium [1]	12,570	7,430	6,710	2,140	1,710	19,800	21,200	68,700	1,000	
Magnesium [1]	4,820	4,580	6,760	7,000	4,580	4,340	12,060	13,270	4,705	
Manganese [1]	1,730	1,300	720	1,440	1,590	1,150	860	1,440	430	
Aluminum [1]	82,900	45,200	96,600	46,800	49,400	46,900	42,400	27,300	44,000	
Iron [1]	39,800	24,500	45,500	35,400	38,500	42,500	35,400	25,500	26,500	
Sulphur [1]	400	560	480	320	240	400	480	320	480	
Phosphorus [2]	131	79	87	79	26	44	148	52	35	
Potassium [2]	252	118	252	404	151	151	270	67	118	
Nitrogen [3]	4,400	3,600	4,800	2,600	2,000	2,400	2,400	1,600	1,800	
Potassium [3]	18,830	29,930	26,900	25,220	25,220	19,500	23,200	23,540	20,850	

[1] Soluble in strong hydrochloric acid (specific gravity, 1.115).
[2] Soluble in weak nitric acid (fifth normal).
[3] Total.

The total plant-food content is more valuable in indicating the origin of a soil than its fertility. This is particularly true in case of potassium. The quantity of total potassium in a soil is seldom an indication of its need of potash. Some Indiana soils have over 30,000 pounds of total potassium per acre in the 6-inch depth of topsoil, yet they fail to grow corn without potash fertilization, because so little of the potassium is available.

Total nitrogen is generally indicative of the needs for nitrogen, although some soils with little nitrogen may have a supply of available nitrogen sufficient to grow a few large crops without the addition of nitrogen. Soils having a low total nitrogen content soon wear out, in so far as that element is concerned, unless the supply is replenished by legumes or the use of nitrogenous fertilizers.

The quantity of total phosphorus in ordinary soils is usually about the same as that shown by a determination made with strong acid. For this reason a separate determination of total phosphorus has been omitted. A low supply of total phosphorus usually indicates the need of a soil for phosphate fertilizers, although there are exceptions to this. The quantity of phosphorus soluble in weak acid is considered by many authorities as a still better criterion of the phosphorus needs of a soil. The depth of a soil may modify its need for phosphates. Everything else being equal, the more soil phosphorus that is soluble in weak acid the less it is apt to need phosphate fertilizers. Whenever the phosphorus soluble in weak acid runs less than 100 pounds an acre phosphates are usually needed.

The quantity of potassium soluble in strong or weak acid is to some extent significant. This determination, however, is not so reliable as an indicator as that of phosphorus, particularly with soils of high lime content. Sandy soils and muck soils are more often in need of potash than clay and loam soils.

The use of strong or weak acid in the analysis of a soil has sometimes been criticized as having little or no value, yet analyses made with strong or weak acids more often can be correlated with crop production than can analyses made by methods which determine the total quantities of the elements of the soil. For this reason acid solutions have been used in these analyses.

It must be admitted, however, that no one method of soil analysis will surely indicate the deficiencies of a soil. For this reason these chemical data are not intended to be the sole guide in determining soil needs. The depth of the soil, the physical character of the subsoil and the surface soil, and the previous treatment and management of the soil are factors of the greatest importance and should be taken into consideration.

In interpreting the soil survey map and analyses it should be borne in mind that a well-managed, well-fertilized, and manured soil which is naturally low in plant-food elements will produce larger crops than a poorly-managed soil that is naturally high in the nutrient elements. The better soils, including those having large quantities of plant-food elements, will endure continuous cropping much longer than the less fertile soils.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity. Soils whic are very acid will not produce well, even though there may be no lack of the elements of plant food. Though the application of nitrogen, phosphorus, and potassium is of some value on acid soils, these elements will not be fully effective where lime is deficient. The following table shows the percentages of volatile matter and nitrogen, and the acidity of the various soils in the county, the acidity being expressed in terms of pounds of limestone needed per acre. Samples were taken from the surface soil (0 to 6 inches), from the subsurface soil (6 to 18 inches), and from the subsoil (18 to 36 inches). It is important to know the reaction not only of the surface soil, but of the lower layers as well.

Volatile matter, nitrogen, and acidity of Monroe County soils

Type of soil	Depth	Volatile matter	Nitrogen	Acidity, pounds of limestone[1]
	Inches	*Per cent*	*Per cent*	*Per acre*
Hagerstown silt loam	0- 6	4.22	0.13	240
	6-18	3.80	.07	640
	18-36	4.20	.05	5,000
Hagerstown silt loam, shallow phase	0- 6	4.37	.10	140
	6-18	4.65	.10	160
	18-36	5.35	.05	1,100
Hagerstown silt loam, shallow phase (virgin)	0- 6	6.70	.22	200
	6-18	5.50	.12	140
	18-36	6.95	.07	2,800
Frederick silt loam	0- 6	4.63	.14	220
	6-18	4.40	.07	160
	18-36	3.97	.05	2,000
Muskingum silt loam	0- 6	4.32	.12	200
	6-18	3.92	.06	3,800
	18-36	3.70	.03	7,300
Muskingum stony silt loam	0- 6	4.40	.11	900
	6-18	4.10	.07	3,100
	18-36	4.00	.05	6,000
Bedford silt loam	0- 6	4.25	.11	300
	6-18	3.70	.06	4,200
	18-36	3.55	.03	8,000
Tilsit silt loam	0- 6	4.96	.13	220
	6-18	3.65	.05	2,400
	18-36	3.42	.03	10,000
Tilsit silt loam, flat phase	0- 6	4.50	.10	440
	6-18	3.10	.04	6,400
	18-36	4.00	.03	15,000
Elk silt loam	0- 6	3.85	.10	500
	6-18	3.50	.03	3,600
	18-36	3.65	.02	9,600
Do	0- 6	4.40	.13	500
	6-18	3.80	.06	260
	18-36	4.20	.04	340
Do	0- 6	4.40	.14	360
	6-18	3.67	.09	280
	18-36	3.52	.05	2,300
Lawrence silt loam	0- 6	4.42	.11	1,440
	6-18	3.15	.05	4,800
	18-36	3.50	.04	11,400
Calhoun silt loam	0- 6	3.63	.12	900
	6-18	2.90	.05	3,900
	18-36	3.45	.05	8,400
Guthrie silt loam	0- 6	3.93	.10	400
	6-18	3.35	.04	4,600
	18-36	3.67	.04	10,200
Lickdale silt loam	0- 6	4.40	.12	600
	6-18	3.27	.05	3,200
	18-36		.03	11,200
Robinson silt loam	0- 6		.10	1,100
	6-18	3.35	.05	4,200
	18-36	4.25	.04	7,800
Do	0- 6	4.10	.10	1,760
	6-18	3.55	.08	5,100
	18-36	4.50	.04	7,200
McGary silt loam	0- 6	4.77	.14	160
	6-18	4.12	.08	300
	18-36	6.17	.06	alk.
Cincinnati silt loam	0- 6	3.95	.10	560
	6-18	4.42	.05	5,600
	18-36	3.80	.03	6,400
Gibson silt loam	0- 6	4.46	.14	800
	6-18	3.60	.06	3,100
	18-36	3.90	.03	7,000
Vigo silt loam	0- 6	3.95	.10	300
	6-18	3.50	.04	7,800
	18-36	3.30	.02	9,000
Princeton fine sandy loam	0- 6	2.36	.09	240
	6-18	2.25	.07	100
	18-36	2.17	.02	100

[1] Hopkins method.

Volatile matter, nitrogen, and acidity of Monroe County soils—Continued

Type of soil	Depth	Volatile matter	Nitrogen	Acidity, pounds of limestone
	Inches	*Per cent*	*Per cent*	*Per acre*
Elk fine sandy loam	0–6	2.85	0.10	340
	6–18	2.35	.09	700
	18–36	2.75	.05	480
Montgomery silty clay loam, gray phase	0–6	8.37	.22	200
	6–18	5.85	.10	80
	18–36	4.70	.03	60
Waverly silty clay loam, dark-colored phase	0–6	5.74	.18	100
	6–18	4.50	.07	100
	18–36	4.70	.05	60
Waverly silty clay loam	0–6	7.91	.24	200
	6–18	6.25	.15	100
	18–36	4.75	.07	80
Waverly silt loam	0–6	4.20	.13	1,000
	6–18	3.62	.06	1,800
	18–36	3.37	.05	1,700
Holly silt loam	0–6	3.65	.10	2,200
	6–18	3.55	.06	4,400
	18–36	3.22	.04	4,400
Huntington silt loam	0–6	5.02	.12	60
	6–18	4.85	.11	60
	18–36	4.00	.08	60
Genesee silt loam	0–6	5.26	.12	alk.
	6.18	4.10	.11	80
	18–36	4.55	.09	80
Genesee fine sandy loam	0–6	6.00	.08	alk.
	6–18	6.62	.04	200
	18–36	7.00	.04	140
Huntington very fine sandy loam	0–6	3.24	.09	1,360
	6.18	2.80	.06	2,400
	18–36	2.67	.04	3,300

As a general rule, a soil which is only slightly acid or neutral in reaction, and which contains organic matter and nitrogen in its subsurface layers is more fertile than a shallow acid soil. Given two soils of the same acidity in the surface layer, the soil with the greater acidity in its subsurface layer is in greater need of lime. Also the more organic or volatile matter and nitrogen a soil contains, and the greater the depth at which the organic matter can be found in the subsoil, the less will be the need for lime.

SOIL MANAGEMENT

For convenience in discussing the management of the several soils of the county they have been arranged into groups according to certain important characteristics with respect to which they require similar treatment. For example, several of the upland soils, having practically the same requirements for their improvement, may be conveniently discussed as a group, and thus avoid the repetition that would result if each soil were discussed separately. Where different treatments are required, they are specifically pointed out. *The reader should study the group including the soils in which he is particularly interested.*

UPLAND AND TERRACE SILT LOAMS

The upland and terrace silt loams include the silt loam members of the Bedford, Lawrence, Hagerstown, Frederick, Tilsit, Elk, Cincinnati, Gibson, Robinson, Calhoun, Lickdale, Guthrie, Muskingum, Montgomery, and McGary series. The practical problems in the management of these soils are very similar, regardless of their topographic position. Important differences in natural productivity exist and are fully recognized, but these differences are in degree and do not require separate groupings for the purpose of this discussion. In the discussion which follows these differences will be indicated.

As a general proposition it may be stated that all these soils naturally deficient in phosphorus. With the exception of the Montgomery and some of the Hagerstown and McGary soils, they are also decidedly low in nitrogen and organic matter. In some cases there is also need of more available potassium, especially in the Calhoun, Lickdale, Vigo, and the flat-phase Tilsit soils. With few exceptions, they are also more or less in need of lime.

The steep and rough phases of the types of soil included in this group are not adapted to grain crops, and should be utilized as pasture or forest lands.

Drainage.—The Elk, Cincinnati, Muskingum, much of the Frederick, and most of the Hagerstown soils have fair or good natural drainage, so that they are not in need of artificial drainage. The more nearly level areas of Frederick silt loam need to be tile drained before the best results can be obtained from other good treatments. Some of the Hagerstown soils also would be benefited by tile drainage. For the most part, the Tilsit, Gibson, and Bedford soils have good surface drainage; but their subsoils are heavy, and underdrainage is needed to lessen surface run-off and to improve their physical condition. The soil conditions should be made as favorable as possible for the absorption of rain water. Surplus water should pass down through the soil and run away in underdrains rather than over the surface. Surface drainage is wasteful of the plant-food elements. Tile underdrainage would also tend to lessen soil erosion on hillsides which causes enormous losses every year. The best of the topsoil is washed away, carrying with it the available plant-food elements that should go into the production of crops. These losses should be guarded against in every way by means of terraces and a covering of vegetation.

The rest of the soils of this group are all more or less seriously in need of tile underdrainage, since their generally flat surfaces and tight subsoils make natural drainage very slow and difficult. A mottled subsoil is a further indication of insufficient natural drainage. Without tile drainage these soils can not be satisfactorily managed, and no other beneficial soil treatment can produce its full effect. Experience on experimental fields on other soils of similar texture and surface features indicates that tile lines laid 30 inches deep and not more than 3 rods apart give good results. Where the land is very flat, great care must be exercised in tiling to obtain an even grade and uniform fall. Grades should never be established by guess or any rule-of-thumb method. Nothing less accurate than a surveyor's instrument should be used, and the lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet without interruption or slackening of the current. The rate of fall may be increased toward the outlet, but it should never be lessened. Checking the current may cause the tile to fill with silt. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with straw, weeds, or grass cut from the fields. This will prevent silt from washing into the tile at the joints while the ground is settling, thus insuring proper operation of the tile from the beginning.

Liming.—All the soils of this group, except some of the Elk, Hagerstown, Frederick, and Montgomery soils, are more or less acid and are in need of lime. Application of some form of lime should be one of the first steps in their improvement. When the needed lime is supplied, the other materials for soil improvement may be used with greater profit. In fact, a very acid soil will not respond properly to certain other treatments until it has been limed. The failure of clover to develop satisfactorily on any of these soils indicates their need of lime, although clover failures may also be due to a lack of available prosphorus. Wherever there is doubt, a soil should be tested for acidity, and some form of lime should be applied whenever the need is indicated.

On the Francisco experiment field, located on Tilsit silt loam, 3 tons of ground limestone an acre, applied in 1915, has since resulted in crop increases averaging 10.4 bushels of corn, 3 bushels of wheat, and 819 pounds of clover-and-timothy hay an acre. On manured land a similar application of ground limestone has produced crop increases averaging 3.8 bushels of corn, 4.4 bushels of wheat, and 710 pounds of hay an acre. In the 10 years since the limestone was applied, the value of the total crop increases produced by the liming has totaled from $40 to $50 an acre, based on present crop prices and a cost of $10.50 for the limestone applied. (Pl. XLIX, fig. 1.)

On the Bedford experiment field located on Bedford silt loam, 3 tons of ground limestone, applied in 1917, has since produced crop increases averaging 4.6 bushels of corn, 2 bushels of soy beans, 1.7 bushels of wheat, and 555 pounds of hay an acre. The value of these crop increases up to the end of 1925, at present crop prices, has amounted to more than $25 an acre.

Liming these acid soils is one of the most profitable investments that can be made. As a rule 2 tons of ground limestone an acre should be the initial application. After that 1 ton an acre applied every second round of the rotation will keep the land in a reasonably "sweet" condition. Where alfalfa or sweet clover is to be grown on an acid soil, heavier applications of lime may be needed.

Organic matter and nitrogen.—All the soils of this group, except the Montgomery and some of the Hagerstown and McGary soils are naturally low in organic matter and nitrogen. Constant cropping without adequate addition of organic matter has resulted in reduced yields, so that now in many cases the conditions are such that satisfactory crops can not be raised until the organic matter and nitrogen supplies are very considerably increased. There is only one practical way to do this, and that is to plow under more organic matter than is used and to utilize legumes in sufficient quantities to supply the needed nitrogen. To do this satisfactorily, the land must be put in condition to grow clover and other legumes. This means liming wherever the soil is acid, and also the application of soluble phosphates, because acid soils are deficient in available phosphorus. After liming, at least 200 or 300 pounds of acid phosphate should be applied to the acre. Wet lands must also be drained before legumes can do well.

In a practical program for building up the organic matter and nitrogen content of a soil, clover or other legumes should appear in the crop rotation every two or three years, as much manure as possible should be made from the produce that is fed, and all produce not fed, such as cornstalks, straw, and cover crops, should be plowed under. It must be remembered that legumes are the only crops that can add any appreciable quantity of nitrogen to the soils, and then only as they are turned under for green manure or as they are fed and the resulting manure is applied to the land. The beneficial effect of a legume in the rotation is strikingly shown on the Francisco experiment field located on Tilsit silt loam in Gibson County. This experiment has been running 10 years; and although only the second-growth clover has been plowed under, the average grain yields have been increased by 10.5 bushels of corn and 2.8 bushels of wheat an acre. Aside from these increases in the cereal crops, the clover has produced, as an annual average, 725 pounds more hay an acre than the timothy on the adjoining plot. (Pl. XLIX, fig. 2.) Wherever cloverseed crops are harvested, the threshed haulm should be returned to the land and plowed under. Cover crops should be grown wherever possible to supply additional material for plowing under. Planting soy beans or cowpeas between the corn rows at the time of the last cultivation and seeding rye for a cover crop early in the fall on cornland that is to be plowed the following spring, are good practices to increase both nitrogen and organic matter. It is important to have some cover crop to take up the soluble nitrates which otherwise would be lost through leaching between the cropping seasons. In this latitude the ground is not frozen much of the time during the winter, hence the frequent heavy rains cause much leaching, especially of nitrates, and also soil erosion where the ground is not well covered with vegetation. These losses may be considerably lessened by a good cover of winter rye on all lands that would otherwise be over winter.

Crop rotation.—With proper fertilization, and liming and tile drainage where needed, these soils will satisfactorily produce all the ordinary crops adapted to the locality. On account of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume for soil improvement. Corn, soy beans, wheat, and clover makes an excellent rotation on these soils. Oats are not adapted to the climatic conditions and, as a rule, should be omitted. The soy bean crop is not only worth more for itself but adds some nitrogen, and it also improves the ground for the wheat which follows. If more corn is wanted, the rotation may be lengthened to five years on the better areas by growing two corn crops in succession. Cover crops of rye should be seeded in the corn in September and plowed under the following spring. Where two corn crops are grown in succession, the second one should be more liberally fertilized. Timothy is not a good crop for these soils; but if wanted, it may be seeded with the clover and the rotation lengthened another year. Alfalfa and sweet clover may be grown on the better drained and more friable soils of this group if they are sufficiently limed and properly inoculated. Special literature on the requirements of these crops can be obtained from Purdue University Agricultural Experiment Station.

Pastures.—There is much land in Monroe County that is too hilly and subject to erosion to be satisfactorily used for grain crops. Such areas include the eroded and rough phases of the Frederick soils, Muskingum stony silt loam, the eroded phase of Tilsit silt loam, and Hagerstown stony silt loam, shallow phase. Though much of this land, especially the stony phases, should be used for the production of timber, that which is cleared should be laid down to permanent pasture. For new seedings, a mixture of 5 pounds of Kentucky bluegrass, 5 pounds of redtop, 1 pound of white clover, and 6 pounds of Lespedeza an acre is recommended. On the Hagerstown and Frederick soils, bluegrass and white clover will be most important, and on the other soils dependence will have to be placed on redtop and Lespedeza to provide the bulk of the pasturage. When preparing the seed bed, a dressing of from 200 to 400 pounds an acre of acid phosphate should be disked in. Liming the acid areas would be highly beneficial to Kentucky bluegrass and white clover, but it may not be practical to do so in many cases.

Old thin pastures can be greatly improved by sowing a few pounds an acre of Lespedeza. This plant makes excellent pasturage and will thrive on both acid and "sweet" soils, and will reseed itself and spread everywhere. The bare spots should also receive some grass seed. All the old pastures should receive a top-dressing of 300 or 400 pounds of acid phosphate every few years. Liming the acid areas will also be helpful. Such treatment of old pastures will provide good pasturage for many more head of livestock and turn to profitable production much land that is now practically waste. A few pounds of Lespedeza seed an acre will do wonders, and at least that much should be undertaken as an initial seeding.

Fertilization.—All the soils of this group are naturally low in phosphorus, and, except in the Montgomery silty clay loam, the available supplies are so low that the necessary phosphorus should be supplied by manure and commercial fertilizer. The nitrogen supplies are also too low for the production of satisfactory crops of corn, wheat, and other cereals, especially on Muskingum, Tilsit, Guthrie, Cincinnati, Robinson, Vigo, and some of the Frederick soils. The total quantity of potassium in these soils is large; but the quantity available to crops is in many places comparatively low, so that some potash fertilizer should prove profitable, especially where little manure is used.

The problem of supplying nitrogen has been discussed in connection with the provisions for supplying organic matter. Legumes and manure are the logical and only practical means of supplying the bulk of the nitrogen needed by crops and should be largely relied upon for this purpose. The livestock system of farming with plenty of legumes in the crop rotation is therefore best for these soils. However, it will pay in most cases to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Even where wheat follows soy beans or cowpeas it should receive some fertilizer nitrogen at seeding time, because the nitrogen in the residues of these legumes does not become available soon enough to benefit the wheat in the fall. The material must first decay and that does not take place to any considerable extent until the following spring.

Phosphorus is the mineral plant-food element most deficient in all these soils. The only practical way to increase the supply is through phosphatic fertilizers. It will pay well to supply the entire needs of crops in this way. In rotation of ordinary crops producing reasonably good yields it may be counted that 20 pounds of available phosphoric acid (P_2O_5) an acre a year is required. It will pay well at first to use a larger quantity, so as to create a little reserve. Enough for the entire rotation may be applied at one time, or the application may be divided. Where manure is used it may be counted that each ton supplies about 5 pounds of phosphoric acid, so that a correspondingly smaller quantity should be applied in the form of commercial fertilizer.

On the experiment field located on Bedford silt loam on Moses Fell Annex farm, belonging to Purdue University, highly profitable returns have been obtained wherever phosphate fertilizers have been used. During the 10 years since this experiment was begun applications of 225 pounds an acre of 16 per cent acid phosphate on each corn and wheat crop in a 4-year rotation of corn, soy beans, wheat, and mixed clover and timothy on limed land, have produced additional crop increases averaging 16 bushels of corn, 5.5 bushels of soy beans, 7 bushels of wheat, and 1,159 pounds of hay an acre, worth $35.60 an acre for each rotation, the phosphate costing $5.40. On land receiving 6 tons of manure for corn, a similar use of acid phosphate has increased the crop yields over manure alone by 8.2 bushels of corn, 6.1 bushels of soy beans, 8 bushels of wheat, and 1,096 pounds of hay an acre. Without liming rock phosphate has been just as profitable as acid phosphate, but on limed land acid phosphate has given much better results. These experiments demonstrate the importance of using liberal applications of phosphate on this type of soil both with and without manure. Most of the upland soils of this county will respond similarly to phosphate. High-grade complete commercial fertilizers have also produced large profits, averaging about 300 per cent.

The quantity of potash that should be supplied as fertilizer will depend on the general condition of the soil and the quantity of manure used. In building up an exhausted soil some potash fertilizer should be used until such time as considerable amounts of manure be applied and the general condition of the soil is materially improved. The gray soils on flat areas are most likely to be in need of potash fertilizer. There is plenty of potash in these soils for all time if it could be made available. Its availability can be materially increased by good farming, including proper tillage, tile drainage, the growing of deep-rooted legumes, and the incorporation of liberal quantities of organic matter. The better these practices are carried out and the more manure used the less potash will have to be purchased as fertilizer.

As a general rule, from 200 to 300 pounds an acre of a high-analysis complete fertilizer should be applied for wheat. Usually manure should be plowed under for corn. Two tons of manure an acre may be profitably applied on wheat as a top-dressing during the winter. This practice is also helpful in obtaining a stand of clover. Corn should also receive enough acid phosphate or some other available phosphate—applied with the drill when preparing the seed bed—

Report of Bureau of Soils, U.

FIG. 1. EFFECT OF LI

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FIG. 2. EFFECT OF

From left to right: Firs

FIG. 1. EFFECT OF LIME AND PHOSPHATE ON CORN YIELDS ON TILSIT SILT LOAM

From left to right: First, yield after legume only; second, yield after legume and lime; third, yield after legume, lime, and phosphate

FIG. 2. EFFECT OF LEGUMES ON CORN YIELDS ON TILSIT SILT LOAM

From left to right: First, yield after lime and timothy; second, yield after lime and legumes so that the phosphorus applied in the form of fertilizer for wheat and that in manure would be sufficient for all crops in the rotation. A portion of the phosphate or a phosphate-potash mixture for corn, say 100 pounds an acre, may be drilled into the row at planting time. Where legumes and manure are used it will seldom pay to use fertilizer nitrogen for corn.

SANDY UPLAND AND TERRACE SOILS

Sandy upland and terrace soils include Elk fine sandy loam and Princeton fine sandy loam. These soils are naturally very deficient in organic matter and all three of the major nutrient elements—nitrogen, phosphorus, and potassium. Lime is not generally needed, except on a few small areas for such crops as alfalfa and sweet clover. In some cases clover may also need some lime. Wherever clover fails to do well the soil should be tested and then limed if the test shows it to be acid.

Drainage on these sandy lands varies from good to excessive, so that crops often suffer from drought. The only remedy is to increase the organic matter of the soil so as to impart to the soil greater power for holding water.

Organic matter and nitrogen.—Chemical analyses of these sandy soils show them to be low in both organic matter and nitrogen. Some special provision, therefore, must be made for increasing both these constituents before their productiveness can be materially increased. As much manure as possible, as well as all unused crop materials, should be plowed under. Special green-manure crops and cover crops should be planted wherever possible for plowing under, including such crops as soy beans, cowpeas, rye, and winter vetch. What has been said concerning this problem in the improvement of upland silt loams applies equally well here, and the practices recommended for those soils should be followed also on these sandy soils. In fact, very sandy soils need larger supplies of both organic matter and nitrogen than heavier soils, because they use up these constituents at a faster rate.

Crop rotation.—Among the extensively grown farm crops these sandy soils are best adapted to the small grains and legumes, especially alfalfa. Corn as a rule does well only on the lower lying areas and where the sandy surface layer is shallow and is underlain by heavier material, as in the case of most Elk fine sandy loam.

The higher and drier sandy soils, including the Princeton soils, are better adapted to such crops as melons, sweet potatoes, early potatoes, and early tomatoes. They are also good for cowpeas, alfalfa, and sweet clover, although liming is needed for the latter two crops wherever there is any considerable degree of acidity. Clover will not stand so much drought as alfalfa and sweet clover and should perhaps be replaced by the latter crops. Alfalfa can be as satisfactorily used in short rotations as clover after the land is once inoculated for this crop, and it will not suffer so much from drought.

Fertilization.—The sandy soils are naturally deficient in all the principal plant-food constituents. Chemical analyses show that the total supplies of phosphorus are so low that they should not further drawn upon. Stable manure should be applied as liberally as possible both for its fertilizer constituents and for the organic matter it supplies. Manure, however, is seldom available in sufficient quantities, so that commercial fertilizers high in phosphorus must be used. Early potatoes and tomatoes on these soils respond profitably to heavy applications of high-analysis complete fertilizers. Five hundred or more pounds an acre of a 2–12–6 mixture should be applied for these and other truck crops. For wheat, 300 pounds an acre of such a fertilizer is advisable. Where manure is not used, the fertilizer for truck crops should contain more potash, especially on the more sandy soils.

Where alfalfa or sweet clover are to be grown, 500 pounds per acre of an 0–12–6 or an 0–12–12 fertilizer, or the equivalent in some other fertilizer, should be applied at seeding time. A continuous stand of alfalfa should receive a top-dressing of several hundred pounds per acre of such a fertilizer every two years.

LIGHT-COLORED BOTTOM LANDS

Light-colored bottom lands include Holly silt loam, Waverly silt loam, and Waverly silty clay loam. The Waverly soils are naturally wet, heavy, and generally acid. The Holly soil is more friable and drains more readily where the water table is not too high, but it is also generally acid and in need of lime. Chemical analyses show the Holly soil to be especially low in available plant-food constituents. Waverly silt loam in this county seems to be naturally more fertile than the average of this soil in other parts of the State.

Drainage.—All these soils should be tile drained wherever suitable outlets can be provided, so as to enable the surplus water in the soil to drain away more readily during the time when the land is not covered with flood waters. Lines of tile should be laid about 30 inches deep and from 2½ to 3 rods apart. The precautions suggested in the discussion of the drainage of heavy upland soils should be carefully observed in tiling this land in order to get satisfactory results.

Liming.—These bottom soils are generally acid and are in need of lime. Therefore, one of the first steps in their improvement should be the application of 2 or 3 tons an acre of ground limestone or its equivalent in some other form of lime. After that 1 or 2 tons an acre every five or six years will keep the land in good condition.

Organic matter and nitrogen.—What has been said about supplying organic matter and nitrogen to light-colored upland and terrace soils applies equally well to light-colored bottom soils, especially to Holly silt loam and Waverly silt loam. On the lighter colored and poorer phases of these soils considerable quantities of organic matter should be plowed under, either as green manure or manure, and legumes should be grown frequently in the rotation and largely returned to the land in one form or another in order to increase the nitrogen content.

Wherever the land is periodically flooded, clover and other deep-rooted legumes, especially biennials and perennials, can not be depended upon, but certain shallow-rooted legumes such as soy beans, cowpeas, and sometimes alsike clover and Lespedeza can be satisfactorily grown. These latter plants should be used largely for gathering nitrogen from the air, which they will do in a large degree when the soil is properly inoculated. Here again it must be remembered that only the top growth plowed under, either directly or in the form of manure, will really increase the nitrogen content of the soil. Cover crops, such as cowpeas, soy beans, and rye in cornfields, should be used to the fullest possible extent. Cornstalks should not be burned, but should be completely plowed under wherever this is practicable.

Crop rotation.—Where overflowing can not be prevented, the crop rotation must consist largely of annual spring-seeded crops and such grass-and-clover mixtures as will not be seriously injured by ordinary floods. For the most part, corn, soy beans, or cowpeas, and in some cases oats or wheat with a mixture of timothy and alsike clover following for a year or two, are the only crops that can be saisfactorily grown. With proper fertilization two crops of corn may follow the soy beans or cowpeas. Timothy and alsike, mixed, will do well on this land after the soil is limed, and the seeding may be allowed to stand for two or three years. Where the land is too acid for alsike clover, Lespedeza may be used. For late seeding in emergencies, early varieties of soy beans and Sudan grass for either hay or seed may be found useful.

Fertilization.—After the land is limed most of the nitrogen required can be provided through the growth of legumes. Cowpeas and soy beans will do fairly well on acid soils, but lime will aid the development of the nitrogen-gathering bacteria. The frequent growth of legumes on this land is very important, because it is naturally very poor in nitrogen. Fertilizer nitrogen can not be profitably used to any considerable extent on corn and the other cereal crops, it being too expensive for these low-value crops. Legumes should therefore be grown frequently enough to supply the nitrogen required by the other crops. Manure, of course, should be used whenever it is available.

There is also a greater or less deficiency in available phosphorus and to some extent also in available potassium, Holly silt loam being poorest in both elements.

As a general rule, if wheat or oats are grown, these crops should receive 200 pounds an acre of a 2–12–4 or 2–12–6 fertilizer. Corn should receive from 200 to 300 pounds an acre of 16 per cent acid phosphate, or its equivalent, broadcast and harrowed in before planting, and 100 pounds of an 0–12–6 or 2–12–6 fertilizer, drilled into the row at planting time. Where manure is used the fertilizer for corn may be correspondingly reduced. Soy beans and cowpeas may also need some phosphate and potash fertilizer. Timothy meadows may be materially improved, particularly on lighter-colored soils, by broadcasting 100 pounds of nitrate of soda an acre, or its equivalent in the form of some other good carrier of nitrogen, after growth is well under way in April.

DARKER-COLORED BOTTOM LANDS

Darker-colored bottom lands include soils of the Genesee and Huntington series and the dark-colored Waverly soil. The greatest difficulty in the management of these soils is to provide adequate drainage and to prevent damage from flooding. The heavier soils should be tile drained wherever suitable outlets can be provided. For the most part these soils are well enough supplied with lime for all ordinary crops.

All this land is well adapted to corn; but wherever the drainage is satisfactory and flooding does not interfere some wheat and clover should be included in the rotation. Soy beans or cowpeas and Sudan grass may often be used to advantage, particularly in providing some variation from constant cropping with corn, when small grains can not be satisfactorily grown.

Most of these soils are fairly well supplied with organic matter; and with reasonable care in their management the nitrogen supplies may be satisfactorily maintained, except perhaps in the case of Genesee fine sandy loam, on which legumes should be grown regularly in the rotation. Cover crops for plowing under should be seeded in the corn and all crop residues should be plowed under.

Much of this land receives rich sediments from the periodic overflows, and for this reason little fertilizer is needed. The poorer areas, however, will respond to applications of soluble phosphates, and in some cases potash will also prove profitable.

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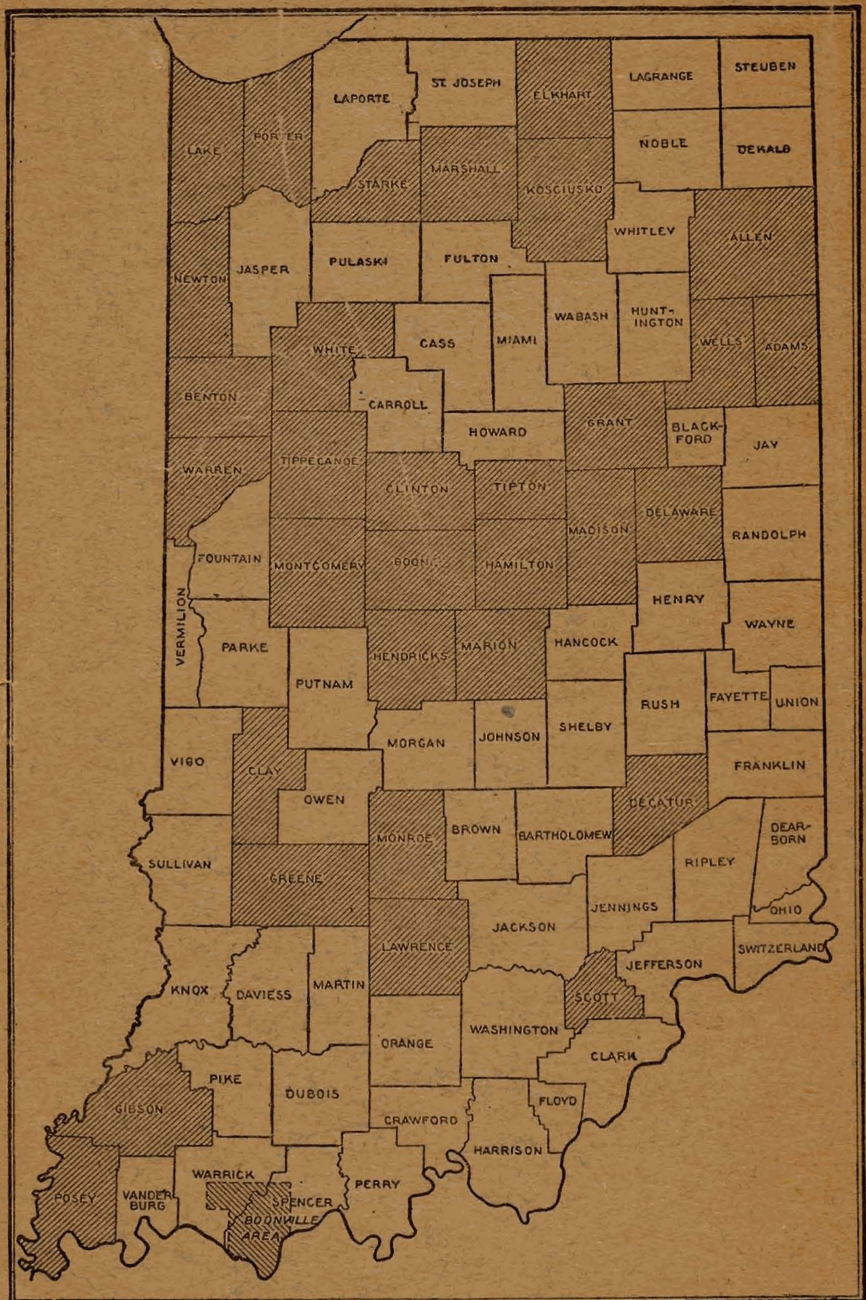

Areas surveyed in Indiana shown by shading