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Soil Survey

Morgan County Indiana

By
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with a section on
Management of the Soils of Morgan County
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This number is the last Soil Survey Report for the year 1937

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and
Agricultural Engineering
In cooperation with the
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and recreation. The following sections are intended for such users: (1) General Nature of the County, in which physiography, relief, drainage, climate, water supply, vegetation, organization and population, industries, transportation and markets, and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; and (3) Estimated Yields and Productivity Ratings, in which the productivity, present uses, and management requirements of the soils are discussed, and suggestions made for their improvement.

Readers interested chiefly in a specific area—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the section on Estimated Yields and Productivity Ratings.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils, in which is presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on General Nature of the County, Agriculture, Estimated Yields and Productivity Ratings, and the first part of the section on Soils of particular value in determining the relations between their special subjects and the soils of the area.

This publication on the soil survey of Morgan County, Ind., is a cooperative contribution from the—

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SOIL SURVEY OF MORGAN COUNTY, INDIANA

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United States Department of Agriculture in cooperation with the Purdue University Agricultural Experiment Station[1]

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[1] Soil map for part of county based on survey of the Stotts Creek-Indian Creek Watershed, made by J. A. Elwell, S. A. Lytle, and T. J. Longwell, Soil Conservation Service, Food Production Administration, U. S. Department of Agriculture.

MORGAN COUNTY, in the central part of Indiana, was covered one or more times by glacial ice, and much of the soil is derived from glacial drift. Corn, wheat, and hay are the principal crops. Soybeans are grown on many farms as a leguminous hay crop or for grain. Tomatoes, peas, sweet corn, and pumpkins are grown and sold to canneries in the county or in adjoining counties. The production of livestock, particularly dairy and beef cattle, hogs, and poultry, is important. Dairy products, poultry, and eggs find a ready market in Indianapolis and other industrial centers. The largest nonagricultural industry is a goldfish hatchery at Martinsville having about 1,000 acres in ponds. Furniture, brick, cooperage, and flour are manufactured. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1937 by the United States Department of Agriculture and the Purdue University Agricultural Experiment Station. The essential features may be summarized as follows.

SUMMARY

Morgan County occupies 406 square miles in the central part of Indiana and includes parts of three physiographic regions: (1) Tipton Till Plain, (2) Norman Upland, and (3) Mitchell Plain. The Tipton Till Plain, of the central and northern parts, includes nearly half the total area and is covered by deposits of Early and Late Wisconsin glacial drift. The Norman Upland, of the south-central and eastern parts, includes areas of Illinoian glacial drift and residual areas of Borden sandstone and shale. The Mitchell Plain, along the western part, includes the residual areas of Harrodsburg limestone.

The county is drained by the West Fork White River and its tributaries, which cross it from northeast to southwest and bisect each physiographic division and glaciation. The maximum and minimum elevations are 915 and 560 feet, and the average, 730 feet.

The soils developed on Late Wisconsin glacial drift include the Miami, Bellefontaine, Crosby, Bethel, Brookston, and Washtenaw. Miami silt loam is well drained and is underlain by calcareous glacial till at an average depth of about 36 inches; Bellefontaine loam is developed on kame or morainic topography, is somewhat droughty, and is underlain by calcareous gravel at a depth of about 40 inches; Crosby silt loam is normally imperfectly drained and occurs on nearly level or gently undulating topography; Bethel silt loam is poorly drained and occupies nearly level topography; Brookston silty clay loam has very poor natural drainage conditions and occupies depressional areas where organic matter has accumulated; and Washtenaw silt loam consists of an accumulation of material from the surrounding upland over areas of Brookston soils.

The soils developed on Early Wisconsin glacial drift include representatives of the Bellefontaine, Russell, Fincastle, Delmar, and Brookston series. Russell soils are well drained and underlain by calcareous glacial till at an average depth of about 48 inches; Fincastle soils are imperfectly drained; and Delmar silt loam is poorly drained.

The soils developed on Illinoian glacial drift include the Cincinnati, Grayford, Parke, Banta, Gibson, Vigo, Avonburg, and Loy. All have light-colored surface soils and strongly acid surface soils and subsoils, and all have been weathered to a depth of 120 inches or more. The Cincinnati, Grayford, Parke, and Banta are well drained; Gibson silt loam has somewhat restricted drainage in the suboil; the silt loams of Vigo and Avonburg are imperfectly drained; and Loy silt loam is poorly drained.

The soils developed on sandstone, siltstone, and shale of the Borden formation include Muskingum, Zanesville, Wellston, and Tilsit. Muskingum soils occur on moderate to steep slopes and are largely nonagricultural; Zanesville and Wellston soils are well drained, with bedrock occurring at a depth of about 60 inches and 30 inches, respectively; and Tilsit soils have restricted drainage conditions in the lower subsoil, with bedrock at an average depth of 60 inches.

The soils developed on residual cherty limestone include the Frederick and Bedford. Frederick silt loam is well drained, and Bedford silt loam has restricted drainage in the lower subsoil.

The soils developed on wind-deposited material include the Princeton, Ayrshire, and Ragsdale. Princeton soils are well to excessively drained; Ayrshire loam soils are imperfectly drained; and Ragsdale loam has very poor natural drainage and a dark-gray surface soil relatively high in organic content.

The soils developed on calcareous glaciofluvial outwash plains and terraces include the Martinsville, Fox, Whitaker, Mahalasville, and Abington. Martinsville soils are well drained, and are developed on calcareous silts and fine sands with some clay and gravel; Fox soils are well to excessively drained and are underlain by loose calcareous gravel and sand at a depth of 36 to 50 inches; Whitaker soils are imperfectly drained and are associated with Martinsville soils;

Mahalasville soils are poorly drained, have dark-colored surface layers, and occupy the depressional areas associated with Martinsville and Whitaker soils; and Abington silty clay loam is dark-colored and occupies depressional areas associated with Fox soils.

Soils developed on calcareous lacustrine silt and clay deposits include the Gregg, Monrovia, and Plano. Gregg soils are imperfectly drained and are underlain by calcareous silt and clay at a depth of about 60 inches; Monrovia soils occupy the shallow depressions; and Plano silty clay loam occupies the deeper depressions associated with Gregg soils. The Monrovia and Plano series have dark-colored surface soils.

The soils developed on acid silty terraces occurring in the regions of Illinoian glacial drift and sandstone, siltstone, and shale include the Elkinsville, Pekin, Bartle, and Peoga. They are underlain by stratified acid silts and clays.

The soils developed on noncalcareous outwash sand, silt, and gravel of Illinoian age include the Morgantown and Taggart. They are leached to a depth of over 15 feet.

The soils developed on slack-water silt and clay deposits include the Markland, McGary, and Montgomery. They are leached to a depth of 36 inches or more.

The soils of the overflow bottoms on neutral to slightly alkaline alluvium include Genesee, Ross, Eel, and Shoals; those occurring on the slightly to medium acid alluvial material include Haymond, Wilbur, and Wakeland; and the strongly acid alluvial soils include Pope, Philo, Stendal, and Atkins.

GENERAL NATURE OF THE COUNTY

LOCATION AND EXTENT

Morgan County lies in the central part of Indiana (fig. 1), the county seat, Martinsville, being 30 miles southwest of Indianapolis, 115 miles northeast of Evansville, and 55 miles east of Terre Haute. The total area is 406 square miles, or 259,840 acres.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Morgan County, with the rest of Indiana and the surrounding States, was at one time a part of an inland sea. Sandstone, siltstone, shale, and limestone were formed from sediments deposited on the floor of this sea and later raised to their present position. Various weathering processes acting on these rocks have formed the hills and valleys of the present landscape. Several kinds of these rocks are exposed on many steep hillsides, and the oldest rocks are along the eastern side. All the county except the high ridges along the southern and western borders and possibly some isolated land masses, as Nebo Ridge, was later covered one or more times by thick sheets of glacial ice. These glaciers moved slowly over the land, leveling some of the hills but filling many valleys with ground-up fragments of many kinds of rocks. The three glacial periods are known as the Illinoian, Early Wisconsin, and Late Wisconsin. The last ice sheet, the Late Wisconsin, melted many thousand years ago, leaving a layer of unassorted silt, sand, clay, gravel, and rock fragments many feet thick over the sandstone, siltstone, shale, and limestone bedrock.

Large streams and sheets of water poured from these glaciers as they melted. Beds of gravel and sand were deposited where the current was swift, silt where the current was slow, and clay in the quiet waters of lakes that filled depressions. The assorted or stratified materials deposited by streams issuing from glaciers are called glaciofluvial outwash, or simply outwash. Materials laid down in lakes are called lacustrine deposits, which in this country are largely silt

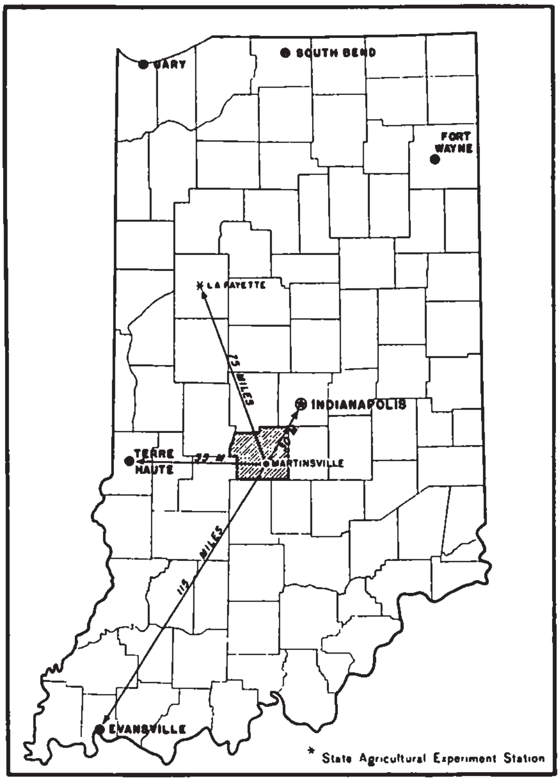

FIGURE 1.—Location of Morgan County in Indiana.

and clay. Many water-laid deposits remain today as level or nearly level plains. Some of the more sandy sediments were blown into dunes by the strong winds that usually accompany melting glaciers, and many of these dunes were later held in place by forests. Unassorted material laid down by the ice is known as glacial till, and large undulating deposits of till are known as moraines.

Morgan County occupies parts of two physiographic provinces that are subdivided into sections on the basis of local characteristics. The northern part of the county lies within the Till Plains section (also called Tipton Till Plain) of the Central Lowland province, and the southern part occupies parts of the Norman Upland and Mitchell

Plain of the Interior Low Plateaus province[2] (fig. 2). These are further subdivided and their boundaries located in detail with reference to the geologic materials and soil characteristics.

In general the topography of the area is of great variety and complexity. Each of the physiographic divisions has a characteristic land form that is related to geologic formations, land forms prior to glaciation, changes resulting from glaciation, and subsequent stream

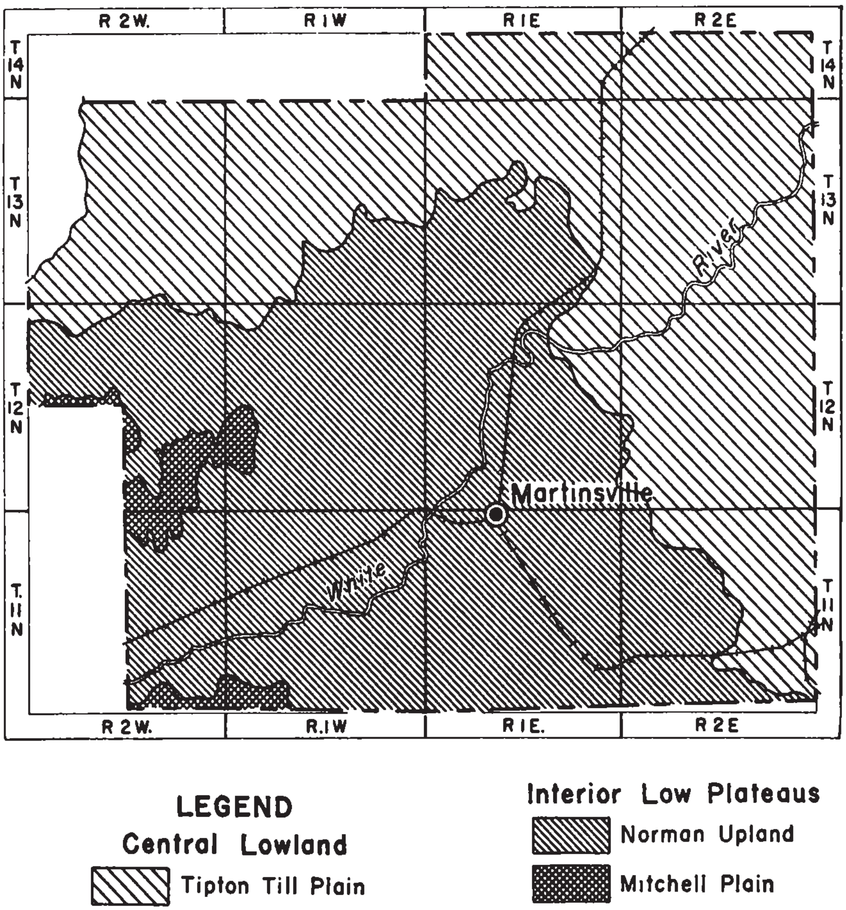

FIGURE 2.—Physiographic divisions of Morgan County, Ind.

dissection. Considerable variation from the typical land forms occurs in each division.

The Norman Upland section is the most extensive physiographic division. Typically, it is a stream-dissected area with great local relief and a drainage network everywhere deeply incised into the Borden geologic formation, which consists mainly of medium-grained sandstone, siltstone, and shale. Elevations generally range from 800

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[2] LOGAN, W. N., CUMINGS, E. R., MALOTT, C A , and others HANDBOOK OF INDIANA GEOLOGY. Ind. Dept. Conserv. Pub 21, pp. 66–104, illus. 1922.

to 900 feet, and local relief from 100 to 200 feet or more. The valley of Indian Creek lies about 200 feet below the Borden ridge to the south. The ridge tops generally are long, tortuous, and narrow. Examples of this are Nebo Ridge, Maxwell Hill, and the ridge bisected at Blue Bluffs by the West Fork White River, where it extends southward to Martinsville and northward from Centerton towards Mooresville. The valleys are V-shaped and descend sharply to near the base level of the West Fork White River, where they become flat-bottomed and flanked by steep but not precipitous slopes. As seen from the east, the Norman Upland has a wall-like appearance. This is best developed south of Morgan County, but is well illustrated at Blue Bluffs and along Indian Creek south of Martinsville.

The northern and larger part of the Norman Upland, extending to the limit of Wisconsin glaciation, was generally modified in land form by the Illinoian glacier. Most of the higher knobs were leveled, and glacial till 25 to 100 feet thick was deposited over the bedrock and around the base of the higher hills. The Illinoian till deposits are generally silty in texture and do not have the gravel and large boulders characteristic of Wisconsin glacial deposits. The ridge crests are almost level, and the elevation is generally about 800 feet. Moraines, like those in Wisconsin glacial deposits, are absent, and prominent elevations are caused by unglaciated or weakly glaciated sandstone ridges and knolls. In most places the till is less than 30 feet thick over the Borden bedrock but is thicker in till-filled preglacial valleys. Bedrock is exposed on nearly every hillside, which indicates that the preglacial topography was little changed except that the higher knolls and ridges were leveled. This area has been thoroughly stream-dissected, and the land form is similar to that of the typical Norman Upland.

West of Wakeland there is a level area of Illinoian till plain, known as "the flats," which is only moderately stream dissected. Local relief is generally less than 20 feet. The valley walls slope gently to broad aggraded bottoms. This flat is about 20 feet lower than the Mitchell Plain to the south.

West of Nebo Ridge is a thoroughly dissected outwash plain developed from weathered gravel or sand that is probably of Illinoian age. The plainlike topography is most conspicuous on the divides southwest of Sand Creek Church. The leached gravel and sand overlie highly calcareous stratified clay at a depth of about 50 feet.

The Mitchell Plain is represented by a few small areas where Harrodsburg limestone caps the ridge crests in the western and southwestern parts of the county. Typically, it is an area with a well-developed karst topography that dips to the southwest at about 20 feet to the mile. The undulating ridges are broken by numerous shallow sinkholes, 6 to 10 feet deep, that form the outlet for surface drainage water through the underlying limestone. This topography is most typically developed in the area north of the West Fork White River. Fewer sinkholes are south of the West Fork White River, and the smooth ridges are gently undulating. The limestone ranges in thickness from a few feet to about 70 feet. Near the valley of the West Fork White River, where local relief is great, streams have dissected most of this plain and cut through the limestone into the underlying sandstone, siltstone, and shale. Limestone outcrops south of

Mahalasville probably represent an extension of the fault in the rock strata, which is conspicuous around Heltonville, Lawrence County. The Illinoian glacier overrode the Mitchell Plain along the western border of the county and left thin deposits of drift over the rock.

As previously stated, the county was entirely covered by three different advances of glacial ice sheets—the Illinoian glaciation and two stages of Wisconsin glaciation. The Illinoian glacial drift was described with the Norman Upland. The two substages of the Wisconsin glaciation comprise the Till Plains section. This is a constructional plain formed by glacial deposits and is only slightly modified by stream dissection. In most places the Early Wisconsin till plain lies 25 to 50 feet lower than the Illinoian till plain, but in the northwestern part the two are nearly on the same level.

The thickest deposits of till, some as much as 100 feet, are in the northwestern part of the county, and the thinnest are on the high ridge east of Monrovia, where in many places bedrock is within a few feet of the surface. Wisconsin till is generally less than 50 feet thick in the eastern part.

The Early Wisconsin glacial drift covers the greater part of the Till Plains. In the northwestern part the topography is similar to that of the Till Plains throughout central Indiana; former marsh areas are extensive, stream dissection is slight, and local relief rarely exceeds 30 feet. Much of this area is part of a former lake bordering the Late Wisconsin drift area and is locally known as "The Lakes." In the north-central and eastern parts, stream dissection is rather complete and thorough, but the divides are broad and flat, with few marshland remnants. Streams start as troughlike areas in former marshes and cut rapidly through steep-sided valleys to the base level of the West Fork White River. In the upper courses bottoms are narrow, but when the base level is reached they are broad and the valleys are U-shaped. Sandstone, siltstone, and shale are exposed on many of the hillsides. Relief ranges from 50 to 100 feet.

The Late Wisconsin glaciation, or second stage of the Wisconsin, consists of two wedge-shaped areas—one in the northwestern part extending to the vicinity of Hall, the other in the northwestern part extending nearly to Exchange, and then east and south to the east county line. The terminus of each is roughly marked by kames or gravel knolls that rise 40 to 80 feet above the surrounding till plain. In an area extending northeast from the vicinity of Hall to Harrison and Madison Townships, there are numerous boulders. Like the Early Wisconsin glacial region it is only slightly dissected in the western lobe and extensively dissected in the eastern. Relief in the eastern lobe ranges from 20 to 70 feet and is greatest and the slopes steepest along the valley of the West Fork White River. Shale of Devonian age is exposed on a few hillsides in the northeastern part.

The West Fork White River traverses the county from northeast to southwest and is its most prominent stream. It drains about 85 percent of the area through a large number of minor tributaries. The remaining 15 percent, in the northwestern part, drains into Mill Creek. Much of the water reaching Mill Creek is carried by ditches and short streams that are just beginning to cut into the lake and till plains. This drainage eventually reaches the West Fork White River. No natural lakes exist in the county, but there are several artificial ponds and lakes.

The elevation as stated by Logan et al.[3] ranges from a maximum altitude of 915 feet, north of Martinsville, to a minimum of 560 feet where the West Fork White River leaves the county. The average elevation is 730 feet; the maximum relief between the highest and lowest elevation is 355 feet, although local variations of 200 feet are common in many parts, and the greatest local relief is 275 feet. The altitudes[4] of other places are: Whitaker, 573 feet; Martinsville Court House, 607 feet; Maxwell Hill southwest of Martinsville, 800 feet; and Pollard Hill, 730 feet.

CLIMATE

The climate is humid, temperate, and continental, marked by warm humid summers and moderately cold winters with wide ranges of temperature. The average temperature of winter is 31.4° F., and of summer, 74.2°. The lowest temperature recorded during winter was −20°, and the highest, 71°. The lowest recorded summer temperature, 36°, occurred in June, and the highest, 109°, in July. Frequently thawing temperatures in winter cause considerable damage to some crops, particularly wheat, clover, and alfalfa. About 40 percent of the alfalfa acreage and 25 percent of the spring seeding of clover were winterkilled during the winter of 1932 and 1933, according to the agricultural agent. Alternate freezing and thawing, especially if accompanied by rains, promote erosion on bare lands. Winter plowing can frequently be done when the ground is not frozen.

The average length of the frost-free season is 184 days. At Bloomington, in adjoining Monroe County, the average date of the last killing frost is April 20, and of the first, October 21. Killing frosts, however, have occurred as late as May 25 and as early as September 14. Early fall frosts occasionally kill late-planted field corn and sweet corn, and late spring frosts occasionally damage truck and fruit crops, particularly sweet corn and tomatoes. The average pasture season is approximately as long as the frost-free season—from May 1 to November 1. Bluegrass pastures generally fail during July and August because temperatures are too high and rainfall too low for the grass to maintain growth.

Apple culture is important in the central and southwestern parts where local relief provides air drainage and lessens frost hazards.

The mean annual rainfall is 41.22 inches at Martinsville and 45.87 inches at Bloomington (Monroe County). As most of the summer showers come from the southwest, higher rainfall may be expected in the southern part of the county. This is substantiated by the fact that the average annual rainfall in Bloomington is about 46 inches. Rainfall is well distributed throughout the year; the average monthly precipitation is slightly higher in spring and is lowest in February. Snow falls from October to May, but most of it melts quickly and furnishes little protection to crops. Average snowfalls of 23.6 and 16.5 inches were recorded at Bloomington and Martinsville, respectively. Most winter rains are gentle, but summer rains are generally torrential thun-

[3] See footnote 2, p. 6.

[4] United States Engineers Office. survey of west fork of white river. 73d Cong., 1st sess., H. Doc. 100, 172 pp. 1934.

derstorms and are sometimes accompanied by hail. A few summer rains last several hours and it is not uncommon for 2 inches of rain to fall within 24 hours. A rainfall of as much as 5 inches in one day has been recorded. Winter rains are usually gentle and do not cause so much soil erosion as the flash storms, which cause serious rill and sheet erosion, particularly in spring when the ground is being prepared for seeding. Abnormally high rainfall during spring frequently delays planting of some crops, particularly oats, corn, and potatoes.

The prevailing winds in summer are from the southwest and in winter from the northwest. The average velocity is about 8 miles an hour[5] but occasionally exceeds 40 miles. Tornadoes are not entirely unknown but rarely reach this area.

The average daily sunshine is about 70 percent in summer and 40 percent in winter. This degree of cloudiness favors high humidity. The relative humidity during the daytime is about 70 percent and at night reaches saturation, causing heavy dews.

Climatic data recorded by United States Weather Bureau stations at Bloomington and Martinsville are given in table 1. The data obtained at Martinsville represent an average for Morgan County, but

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Bloomington (elevation, 800 feet), Monroe County, and precipitation at Martinsville (elevation, 599 feet), Morgan County, Ind.*

Month	Temperature at Bloomington			Precipitation							
				At Bloomington				At Martinsville			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F	°F.	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
December	32 4	71	−11	3.81	3.49	3 69	4 7	3 20	1 52	1.73	4.2
January	30.4	70	−20	4.22	2 35	14 83	7.8	3.25	1 90	2 50	6 0
February	31.4	70	−20	2 94	3.50	2 41	6.4	2.25	3 62	3 51	2.8
Winter	31 4	71	−20	10 97	9 34	20 93	18 9	8.70	7 04	7 74	13 0
March	42.8	86	0	4.81	2.68	1 40	3 5	4 15	1 23	3.02	2 4
April	52.7	91	17	3.99	4 66	5 50	5	3 56	6 39	5 04	.2
May	63.3	97	29	4 36	.96	4 60	(1)	4.11	3 23	1 93	(1)
Spring	52.9	97	0	13 16	8 30	11.50	4 0	11 82	10 85	9 99	2 6
June	71 8	103	36	3 75	.44	2 87	0	3 69	3 23	2.57	0
July	76.2	110	46	3 50	3 29	4 09	0	3 49	1.44	2 90	0
August	74 6	104	41	4 02	5.38	6 03	0	3 61	2 26	8.69	0
Summer	74.2	110	36	11.27	9 11	12 99	0	10 79	6 93	14.16	0
September	68 3	103	28	3.81	3.27	4 61	0	3.70	1 17	10 89	0
October	56 5	95	17	3 51	1 43	6.57	.1	3 28	1 44	3 80	.2
November	43 9	79	−1	3 15	1 50	1 19	6	2 93	3 35	1.97	7
Fall	56 2	103	−1	10 47	6 20	12.37	.7	9 91	5 96	16 66	.9
Year	53 7	[2] 110	[3] −20	45 87	[4] 32 95	[5] 57.79	23.6	41 22	[6] 30 78	[7] 48.55	16 5

[1] Trace.
[2] July 1936.
[3] January 1918 and February 1899.
[4] In 1914.
[5] In 1937.
[6] In 1940.
[7] In 1926.

[5] VISHER, S. S. ECONOMIC GEOGRAPHY OF INDIANA. 225 pp, illus. 1923.

that reported from Bloomington applies more specifically to the southern part of the county. Temperatures at Bloomington are probably about the same as at Martinsville.

WATER SUPPLY

The water supply for local use is obtained from surface water, springs, and wells. The surface-water supply is intermittent in most localities but furnishes much of that needed by livestock, although it is unsuitable for public use unless purified. Springs fed from the strata of sand and gravel and shallow wells dug or driven into these strata also furnish permanent supplies of pure water for general use. The water supply for the goldfish industry, centered east of Martinsville, comes from spring-fed streams that rise in a gravelly and sandy outwash plain that rests on a strata of heavy clay. Wells drilled into the glacial till uplands usually reach water-bearing sand or gravel strata at depths of 25 to 100 feet. The Borden sandstone, siltstone, and shale and Devonian shale, which underlie the extreme northeastern part of the county, are not sources of permanent water supply, but occasional seep springs are developed. In some of the western and southwestern areas adequate local water supplies are obtained from the Harrodsburg limestone.

VEGETATION

The native vegetation of Morgan County was an excellent stand of mixed hardwoods consisting of three main types—oak-hickory, beech-maple, and river birch-sycamore,[6] with a few marshy areas and some open grassy forests. The better agricultural lands of the eastern and northern parts were cleared early and the land brought under cultivation. The arable ridge tops of the rolling and marshland areas were cleared later. The more valuable commercial species, as yellow-poplar, sugar maple, and walnut, were heavily culled and were an important source of income in pioneer days. Present stands of timber have little commercial value. Most of the level and gently sloping land is cleared, and the principal timberland is on steeper slopes.

The most extensive timbered areas are in the rolling Borden region south of Martinsville and in the Nebo Ridge vicinity. Probably 80 percent of these areas are covered with an oak-hickory type. The principal species are white, black, and red oaks, and pignut and shellbark hickories. In addition to these, white ash, sugar maple, American elm, and blackgum grow on the moist lower slopes, and smaller growing oak and hickory species on the droughty ridges and upper slopes. In the Borden region only the broader ridge tops and the gently sloping foot slopes are cleared.

A large acreage of timberland is also on the steep slopes in the Illinoian glacial drift region, where the species are the same as in the Borden area. Although most of the flatter land is cleared and farmed, occasional wood lots are found on nearly level land. This is particularly true on the flats of Ashland and Ray Townships, where the dominant species include beech, red maple, pin oak, and sweetgum.

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[6] SOCIETY OF AMERICAN FORESTERS. FOREST COVER TYPES OF THE EASTERN UNITED STATES. Report of Committee on Forest Types. Ed. 3, rev., 39 pp. Washington, D. C. 1940.

There is relatively little timber in the Wisconsin till region and most of this is on steep slopes, but there are scattered wood lots on the less sloping divides. The dominant species are beech and sugar maple, with some red maple, yellow-poplar, American elm, and an occasional white oak and shellbark hickory. The overflow bottom lands were originally covered with sycamore, river birch, birch, willows, and other water-loving species.

Kentucky bluegrass is the dominant wild grass in the less acid Wisconsin glacial regions, but on the highly acid sandstone, siltstone, and shale and Illinoian drift regions, Canada bluegrass, broomsedge, poverty oatgrass, and tickle grass occur frequently.

ORGANIZATION AND POPULATION

Prior to settlement by white men, most of this territory was occupied by the Miami Indians.[7] Morgan county was part of a large tract in central Indiana ceded by the Indians under the New Purchase Treaty of 1818. The county was opened up to settlement following the land surveys of 1819. Cyrus Whetzel, the first settler, located along the West Fork White River in sec. 13, T. 13 N., R. 2 E. He is reputed to have opened the first trail from the Whitewater River in the eastern part of the State to the bluffs on the West Fork White River, which was known as the Whetzel Trace. It later became the first highway in this part of the State.

The first permanent settlements were made, in 1819, in Harrison and Washington Townships by people from Ohio, Kentucky, Virginia, and North Carolina. The better lands near the West Fork White River were occupied first, and it was not until about 1830 that the marshy northwestern part of the county was occupied.

Morgan County, named in honor of General Daniel Morgan, of Revolutionary War fame, was organized December 31, 1821. Martinsville was selected as the county seat in 1822, but it was not incorporated until 1863. The important early industries were packing pork and shipping grain to New Orleans by flatboat. Later this town became a well-known health resort, because of the presence of mineral springs.

The total population of the county, according to the 1940 census, was 19,801, with a density of 48.8 to the square mile. The rural population was 14,792, averaging 36.4. Since 1910 there has been a decline of 6.5 percent and 11 percent, respectively, in the total urban and rural population. Almost all inhabitants are native-born whites, comprising 99.6 percent of the population in 1940. Martinsville, the county seat with 5,009 residents in 1940, is the largest town. Mooresville, the second largest town, has a population of 1,979. A number of smaller towns are important as local trading centers and concentration points for agricultural products. Of these, Morgantown has a population of 724, Brooklyn 485, and Paragon 454. The unincorporated towns of Monrovia, Centerton, and Waverly are also important trading centers.

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[7] GOODSPEED, W. A. HISTORY OF MORGAN COUNTY. [1884.]

INDUSTRIES

Agriculture and industries connected with agriculture provide employment for most of the inhabitants of the county. Several canning factories in the county and in nearby Johnson County provide a market for tomatoes, peas, pumpkins, sweet corn, and cabbage.

The largest nonagricultural industry is a goldfish hatchery, at Martinsville. This concern is reputed to be the largest in the world and has about 1,000 acres of land used for ponds having storage capacity for 50,000,000 fish. Many farmers obtain much of their income by raising fish and marketing them either through this concern or independently. The spring-fed streams adjacent to and east of Martinsville provide an ideal water supply for this industry. Manufactured products consist of hickory chairs, furniture, brick, cooperage products, wooden ware, and flour.

TRANSPORTATION AND MARKETS

Graveled roads well maintained throughout the year reach all parts of the county and many of the local roads are hard-surfaced. Several paved State highways cross the county and connect many of the towns and villages with large cities and important markets. Branches of the Pennsylvania and the New York Central railroads also connect Martinsville with national markets, but passenger traffic is principally by motorbus.

CULTURAL DEVELOPMENT AND IMPROVEMENT

Schools, churches, and local markets are easily accessible to all communities. Most townships have consolidated schools. Telephone lines reach most parts of the county, and electric service is available to many farms, especially those near the larger towns. Home conveniences, general farm improvements, and the quality of the buildings are directly related to the quality of the land. Building investments in the rough, rolling, highly dissected parts are being depleted, and many of the farms there may possibly be abandoned in the near future.

AGRICULTURE

Before the advent of the white man, Indians cultivated small tracts of corn in the river bottoms. The rivers, particularly the West Fork White River, were the main arteries of travel and transportation; consequently the first settlers chose the productive land near them, but later settlements were made on the better lands in the eastern and northern parts of the county. The marshland in the northwestern part could not be cultivated until artificially drained. Corn, wheat, and hay have always been the principal crops.

During the early decades, lumbering was almost as important as agriculture. Land suitable for farming was cleared, and most of the less desirable timber was burned; but the walnut, maple, and yellow-poplar were marketed. Large quantities of pork and grain were carried to New Orleans on flatboats. The arrival of railroads in central Indiana about 1850 gave new impetus to agriculture, as they enlarged the market for farm products.

CROPS

The peak of agricultural development was probably reached by 1899, when a total of about 112,000 acres was reported in farm crops. The acreage remained fairly constant until the end of World War I but declined to about 88,000 acres in 1929, and increased slightly in 1939. Census data concerning acreage of the more important crops since 1880 are given in table 2.

TABLE 2.—*Acreage of the principal crops and the number of principal fruit trees and grapevines of bearing age in Morgan County, Ind., in stated years* [1]

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn for grain	51,954	41,970	49,506	55,473	49,516	37,715	40,727
Wheat	26,940	25,963	35,628	24,252	34,301	16,578	12,818
Oats threshed	4,678	8,593	2,906	6,339	6,820	6,359	3,860
Rye	363	192	42	262	999	1,188	1,226
Soybeans [2]	-	-	-	-	-	1,534	[3] 8,607
Hay, total	11,793	21,616	22,684	21,405	20,255	18,836	18,378
Clover or timothy, alone or mixed	-	-	-	15,435	13,153	10,240	6,423
Clover alone	-	-	9,416	4,849	4,522	5,309	514
Alfalfa	-	-	12	171	702	1,506	3,476
Annual legumes for hay	-	-	-	-	266	1,231	5,522
Small grain hay	-	-	900	362	1,517	470	2,293
Other hay	-	-	12,356	588	95	80	150
Forage	-	-	1,190	1,400	[4] 3,892	[5] 2,726	[5] 223
Silage	-	-	-	-	2,524	[5] 1,294	[5] 619
Potatoes	-	585	383	403	306	162	157
Market vegetables	-	-	-	-	944	1,459	1,746
Strawberries	-	-	25	7	28	23	21
Raspberries and blackberries	-	-	80	18	83	37	21
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Apples ... trees	-	57,443	92,088	81,929	57,991	37,941	33,752
Peaches ... do	-	15,015	53,180	44,409	48,426	33,963	2,012
Grapes ... vines	-	-	20,806	5,722	4,284	7,123	4,188

[1] Fruit trees and grapevines as of years of census, 1890 to 1940.
[2] Acreage partly duplicated in annual legumes for hay.
[3] 2,957 acres harvested for beans only.
[4] 3,817 acres consisted of corn.
[5] Corn.

Corn has always been the most extensive crop grown, although farming has never been centered on the production of any one special crop. It is the most important crop partly because it is adapted to the climate and many of the soils and also because it is a basic feed for livestock. Small acreages are found in the rolling highly dissected light-colored uplands of the central and southern parts of the county. Warm days and nights and high humidity favor its growth. It is a gross feeder and requires abundant supplies of nitrogen and other plant foods and moisture. These conditions prevail over much of the county, particularly in the bottom lands along the rivers and in the dark-colored former marshlands. The yields vary widely from place to place and in most instances are directly related to the quality or capability of the soil. The average yield of corn harvested for grain, as reported by the census, was about 35 bushels an acre up to 1929, but the 1940 census shows an increase to about 50 bushels. The corn acreage reached high levels in 1879 and 1909, but since then there has been a steady decline.

Wheat ranks second and is principally a cash grain crop, but it is also used as a nurse crop for hay seedings. It is adapted to the well-drained light-colored soils that occupy much of the county. The acreage has fluctuated—the highest acreages were planted in 1899 and 1919. Following World War I the acreage dropped to 16,578 acres, and in 1939 the census showed a further decrease to 12,818 acres. The average yield has been about 15 bushels an acre.

Oats are not adapted to the climate and are susceptible to drought, consequently yields have been low. They are grown mainly for feed. The acreage for the last 30 years has been slightly more than 6,000 acres, but only 3,860 acres were reported in 1939.

The total hay acreage increased until 1899, but has gradually declined to a low level of 18,378 in 1939. In early years clover was grown extensively but has declined from a peak of 9,416 acres in 1899 to 514 acres in 1939. It is now usually grown in a mixture with timothy. Redtop, alsike, lespedeza, alfalfa, and some sweetclover also are planted for hay mixtures. Timothy, redtop, and lespedeza are grown extensively on strongly acid soils. Red clover is dominant in the mixture the first year on the less acid more fertile soils. Hay production has been increased in recent decades by the introduction of two new crops, alfalfa and soybeans. Alfalfa, first reported in 1899, has greatly increased in acreage each succeeding decade. The acreage reached a peak of 3,476 in 1939. Alfalfa and red clover are most productive on neutral or only slightly acid soils, so are grown most extensively in the Wisconsin glacial drift area of the eastern and northern parts. Alfalfa is well suited to the moderately sandy and gravelly terraces of the West Fork White River that may be somewhat droughty for shallow-rooted crops, as corn and wheat. Sweetclover is grown on some farms, but it produces a low-quality hay, as the stems are tough and stiff. It is useful as a pasture or soil-improvement crop. Like alfalfa it requires slightly acid to neutral soil conditions, consequently its production is limited to the less acid soils of the Wisconsin glacial drift region. In 1939, only 388 acres were grown.

Soybeans are grown for both hay and grain. Soybean hay constitutes a large part of the item "Annual legumes for hay" in table 2. The use of soybeans as grain other than seed began in 1922, when an oil-extraction plant was built at Decatur, Ill. A wide variety of new uses has provided a rapidly expanding market for the grain. In 1939, of the 8,607 acres grown for all purposes, 2,957 were harvested for beans. On the acid soils of the Norman Upland they are grown mainly as a hay crop. Most of the grain is produced in the valley of the West Fork White River and along the northern and eastern parts of the county. Soybeans are popular because they are a leguminous crop suitable for both hay and grain that can be grown on soils that are acid or have a low moisture-holding capacity. Their growth is best on nearly level land because they tend to develop a mellow soil that is subject to severe sheet erosion.

The decline in the acreage of general farm crops has been associated to some extent with the raising of other crops that require more intensive cultivation. In the last three decades vegetables have been grown extensively. Canneries at Martinsville and Morgantown and in several towns in Johnson County furnish markets for these crops.

Tomatoes, peas, sweet corn, and pumpkins are raised for canning. Watermelons, snap beans, and cabbage are minor perishable crops.

Tomatoes are grown most extensively on the dark-colored soils; on the light-colored soils they are reported to be of higher quality but of lower yield. Yields range from 3 to 19 tons an acre, but the average is probably 5 or 6 tons, whereas yields on dark-colored soils average about 10 tons.

Canning peas are grown principally on sandy soils where they can be sown early, as quality and yield are higher when peas mature early. Yields are 1 to 3 tons of shelled peas an acre, with an average of about 2 tons.

Sweet corn is most widely and successfully grown on the fertile bottom lands. After the sweet corn is harvested, the fodder is frequently cut for silage. Acre yields average about 2½ tons of ears.

Pumpkins, planted in field corn as a supplemental crop, are grown for canning and for livestock feed. Melons grow well on the loose sandy soils, but cantaloups are grown only to a limited extent because of bacterial wilt. This disease can be controlled by dusting with a mixture of copper compounds. Fusarium wilt of watermelons is a fungus infection carried in the soil. It lives for many years after the last infected crop is grown, and infection may be spread by the wind.

Apples, peaches, and grapes were grown extensively in the earlier decades, but because of diseases these fruits have declined steadily. Most farms have small orchards for home use, and apples are grown commercially on the high ridge that extends north from Martinsville to the Hendricks County line. The most successful orchards are on well-drained light-colored soils. Fertility is maintained and moisture-holding capacity improved by the addition of straw and by other methods of increasing the supply of organic matter. Nitrogen is frequently applied as ammonium sulfate, at the rate of 5 pounds to the tree.

AGRICULTURAL PRACTICES AND FERTILIZERS

Agricultural practices vary considerably but are related to the kind of soil and the intensity of cultivation.

Corn, the principal crop, is most extensively grown on the bottom lands and on dark-colored upland soils. On the bottom lands it may be planted for 2 consecutive years or more, but on the uplands it usually follows hay in the rotation. Most corn is drilled, but check-row planting is increasing, particularly in the bottom lands, as it permits more efficient control of weeds. It is planted in May and is commonly cultivated with a spike-tooth harrow or rotary hoe when small, and later, with a row cultivator. Tillage is generally smooth, as the old practice of ridging at the final cultivation encouraged erosion in many fields. The use of fertilizer is increasing. The most common application is about 100 pounds of 2–12–6 [8] or comparable analysis. Many farmers are using modern corn-harvesting machinery, particularly on the river bottoms or other large fields. Some corn is cut and put in shocks before wheat is seeded, and the fodder is fed to livestock.

[8] Percentages of nitrogen, phosphoric acid, and potash, respectively.

Oats are grown to a limited extent for livestock feed. They are seeded early, generally late in March or early in April, on corn stubble previously disked two or three times. Fertilizer is not generally used, but a few farmers report using 75 pounds of 2–12–6. Oats produce on the average less than 30 bushels an acre, as short periods of drought during the growing season materially reduce the yield.

Wheat follows corn, oats, or soybeans, but probably 50 percent of it is seeded in the standing corn. Where the wheat is seeded in oat stubble the ground is plowed soon after harvest, and where it follows soybeans or special crops the ground is disked before seeding. It is generally seeded about October 1, which for this part of the State is the average fly-free date (date when the hessian fly ceases to be a danger). Most fields are fertilized with 125 to 200 pounds of 2–12–6. The crop is usually harvested early in July. The use of combines is increasing, especially on larger farms.

A mixture of grasses and legumes is commonly used for hay seedings. Timothy and redtop are sown with the wheat, and medium red clover and alsike are broadcast on this seeding in the spring. Mixed seeding is generally practiced to avoid the short crops arising from clover failures that frequently result from drought or acid soil conditions. Heaving causes severe damage during some winters.

Alfalfa is widely grown in the eastern and northern parts of the county and on sandy bottom lands. It is generally seeded in spring with wheat or oats as a nurse crop. Some farmers plant it early in September in ground that had been plowed early in summer and disked several times to kill the weeds.

Soybeans are grown on many farms as a leguminous hay crop, but in the eastern and northern parts of the county and on bottom lands large acreages are grown for grain. Seeding is generally in corn stubble late in May or early in June. The beans were formerly sown with a grain drill, but now many farmers plant in rows by closing two-thirds of the shoes on the drill, thus saving seed and permitting cultivation for the control of weeds. In many instances this method of planting increases the yield of both grain and hay and shortens the growing period. On some farms the beans are cultivated with a spike-tooth harrow or rotary hoe for weed control, and where widely spaced, they are tilled with a row cultivator. Soybeans are also planted to a limited extent in corn that is to be used for silage or to be hogged down in the field.

The special crops—canning peas, sweet corn, and tomatoes—are generally followed by wheat. Peas are sown early in spring and are followed by sweet corn and then by wheat. Because the land is in excellent physical condition following special crops, wheat can be seeded with little additional soil preparation.

Several systems of crop rotations are followed but a 3-year rotation of corn, wheat, and mixed hay is most common. Corn, soybeans, wheat, and mixed hay (for 1 or 2 years) is another common rotation. On a few dairy farms, the rotation is corn, wheat, and 3 years of alfalfa. Corn is grown almost continuously on some bottom lands, and hay crops including sweetclover, are grown principally for weed control and soil improvement. A rotation of corn and soybeans is also followed on some bottom lands to maintain fertility. System-

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atic crop rotation is frequently interrupted by crop failure, changes in livestock feed requirements, and economic conditions. Crop rotations are not generally practiced on the highly stream-dissected portions of the Norman Upland soils developed from sandstone, siltstone, and shale and Illinoian drift. Corn is the principal crop, with occasional crops of wheat and soybeans followed by hay and pasture.

Lime and fertilizers are used extensively in the county. Agricultural lime (ground limestone) is available at small quarries in the western and southern parts of the county and in adjoining Monroe and Owen Counties.

The quantity of fertilizer used increased gradually from 1880 to 1920. According to the Federal census, 51.3 percent of the farms reported the use of fertilizer in 1919 at a total cost of $95,089, or an average of $74.40 a farm. In 1939, 40.4 percent of the farms spent $48,079 ($57.51 a farm) for commercial fertilizer, and 5 percent spent $4,156 ($34.91 each) for liming materials. Most of the fertilizer used is factory mixed. The most common analysis is 2–12–6. Other popular analyses are 0–12–12, 0–14–6, and 0–10–10. The trend is toward the use of higher analysis fertilizers. Most of the fertilizer is purchased through local retail agents, but large quantities are purchased cooperatively through the farm bureau.

Little attention is given to pasture improvements, but the need for such measures is great, particularly in the southern half of the county. In the roughest part, particularly in areas of sandstone, siltstone, and shale, there has been a tendency for cropland to revert to pasture. As relatively little livestock is kept, much of this low-grade pasture may be considered abandoned land. Dairying and livestock raising are important in the Wisconsin drift region, so pastures are intensively used. There is some tendency on such land for rotation pastures to replace plowable ones. Most of them can be improved by applications of lime and fertilizer, and for many poor pastures disking and reseeding are recommended, to introduce more desirable species. A mixture of grasses and legumes is superior to a single species because legumes improve the palatability of the forage and increase its nutritive value. Many permanent pastures are grazed too early in the season and some are overgrazed.

PERMANENT PASTURES

Permanent pastures have always been an important source of food for livestock. In 1939, 31,858 acres of plowable pasture were in the county. The better quality permanent pastures are found in the eastern and northern parts. These pastures consist largely of Kentucky bluegrass, as the soils are medium acid to neutral and relatively fertile. Most of the woodland pastures consist of bluegrass with scattered trees. The trees hinder most measures of pasture improvement, and the carrying capacity is governed largely by the density of the timber. Some woodland pastures are almost equal to plowable pastures, but where trees are closely spaced the carrying capacity is low. In other parts bluegrass is less important. Some of the more important grasses are Canada bluegrass, redtop, broomsedge, poverty grass, and tickle grass. These pastures, especially woodland pastures, have a low carrying capacity.

LIVESTOCK AND LIVESTOCK PRODUCTS

A large part of the farm business is concerned with livestock and livestock products. The greatest investment is in cattle, which was valued at $618,114 on April 1, 1940. Dairying is more important than beef production for, of the 12,614 cattle reported in 1940, 7,819 were listed as cows and heifers 2 years old and over on January 1, and of this number 6,624 were kept for milk and 1,195 for beef. There have been only slight changes in these numbers in the last 30 years. Dairy products sold had a value of $260,499 in 1939, of which $222,758 was whole milk. This milk is collected daily by truck and delivered to Indianapolis. Most of the rest of the dairy output is sold as cream, which is collected several times a week at local stations. Herds are small, ranging from 4 to 10 cows to the farm. There are a few purebred herds, and some farmers have one to two purebred animals, but in general grade Holstein-Friesians produce most of the market milk and grade Guernseys and Jerseys are used for the production of cream.

The beef cattle industry, although not so specialized as dairying, is encouraged on many farms by the abundance of feed grains, roughage, and pasture available in the northern and eastern parts and in the extensive bottom lands. Some purebred breeding herds are kept, but most farmers purchase feeder animals to utilize surplus corn, roughage, and pasture. Though the southern half of the county contains large areas of low-grade pasture lands, relatively little acreage is utilized. A few low-grade dual-purpose cattle are kept to supply milk and meat on some farms. A pasture-improvement program would greatly increase the number of beef cattle.

Sheep raising is relatively unimportant—only 5,499 over 6 months old were reported on April 1, 1940, or about one-third of the number reported in 1880. Small flocks are kept on some farms in the northern and eastern parts to utilize surplus pasture and roughage. A few farmers buy feeder sheep for fattening on pasture and grain.

Hogs furnish an important part of the farm income, as this county lies on the western border of the most important swine-producing section of the State. The largest number are raised in the northern and eastern parts, where there is an abundance of corn and high-grade legumes for pasture. There were 23,706 hogs over 4 months old on April 1, 1940. This is about 40 percent less than the numbers reported in peak years from 1900 to 1920.

The value of poultry products in 1929 was $565,306, an increase of about 48 percent over the value in 1910, but in 1939 the value decreased to $244,959. Nearly all farms raise some poultry. The peak reported was 202,024 in 1920, but the number decreased to 114,743 in 1940.

The number of work animals (3,730) on farms in 1940 was about 40 percent of that reported in 1880 and about 35 percent of that for 1910. Tractors and trucks have been largely responsible for this decrease. About one-eighth of the work animals are mules. Most of the replacements consist of western animals, as only about 6 percent of the farmers raise colts. The present work animals are gradually declining in value, because of age and the slight demand for horses on farms.

Many farmers purchase supplementary feeds, especially for dairy cows, poultry, and hogs. In 1939 on 71.3 percent of the farms the total expenditure for feed was $233,532, or $158.33 each.

Values of agricultural products by classes as reported by the Federal census are given in table 3.

TABLE 3.—*Value of agricultural products by classes, in Morgan County, Ind., in stated years*

Crop	1909	1919	1929	1939	Livestock products	1909	1919	1929	1939
Cereals	$1,445,424	$3,603,123	$1,139,939	$1,208,555	Dairy products sold	$145,440	$308,136	$390,503	$260,499
Corn harvested for grain	(1)	(1)	819,723	1,038,991	Whole milk	(1)	(1)	257,551	222,758
Wheat threshed	(1)	(1)	258,046	139,264	Cream [3]	(1)	(1)	126,629	36,665
Other cereals	(1)	(1)	62,170	30,300	Butter	(1)	(1)	6,323	1,076
Other grains and seeds	12,370	33,401	46,697	53,515	Poultry and eggs produced	295,027	[4] 490,912	565,306	244,959
Hay and forage	235,592	738,044	282,890	256,916	Livestock sold or slaughtered	1,078,275	(1)	(1)	1,033,471
Vegetables	110,390	165,125	163,788	130,325	Cattle and calves	(1)	(1)	(1)	326,942
For sale [2]	(1)	(1)	85,086	60,576	Hogs and pigs	(1)	(1)	(1)	678,212
For home use [2]	(1)	(1)	58,412	55,048	Sheep and lambs	(1)	(1)	(1)	28,317
Potatoes and sweetpotatoes	(1)	(1)	20,290	14,701	Wool shorn	[5] 7,044	16,832	10,349	8,513
Fruits and nuts	45,903	74,819	115,184	87,649	Honey produced	[6] 1,404	[6] 670	2,900	239
All other crops	99,935	13,235	4,487	3,917					
Forest products sold	(1)	(1)	47,470	17,162					

1 Not available.
2 Excluding potatoes and sweetpotatoes.
3 Includes both sweet and sour cream (butterfat).
4 Value of poultry other than chickens not included.
5 Includes value of mohair.
6 Includes value of wax.

Cereal grains showed a marked decline in 1929, falling below the value in 1909, largely because of low prices for agricultural products. Wheat and soybeans are the principal crops sold as grain; other crops are fed to livestock; and poultry, dairy, and livestock products are sold. Of the special crops, the increase in value of fruit is due largely to the development of commercial apple orchards. The value of dairy products sold and of poultry and eggs produced advanced steadily to 1929 but declined sharply in 1939. Indianapolis and other industrial centers provide a ready market for these products.

TYPES OF FARMS

The farms may be classified in two categories, based (1) on principal source of income and (2) on size. The number of farms reporting farm products sold, traded, or used by farm households in 1939 are classified by major source of income as follows: Livestock, 599; dairy products, 175; poultry and poultry products, 48; field crops, 483; vegetables harvested for sale, 46; fruits and nuts, 19; horticultural specialties, 2; forest products, 10; and farm products used by farm households, 652.

Farms range in size from 3 to more than 1,000 acres, and more than 30 percent are between 100 and 260. The number of farms of less than 100 acres was lower in 1940 than in 1920 but 10 percent higher than in 1930. Farms of less than 50 acres comprised about 37 percent of the total in 1940, and only two farms reported 1,000 acres or more. Small farms are more frequent near industrial areas, where part-time farming is practiced. The largest are in the valley of the West Fork White River, where power machinery can be most efficiently used, and some farms in the northern and eastern parts of the county have been consolidated.

The several types of farming are correlated rather closely with soil types. In the Wisconsin drift region, farms are operated intensively because the soils are fertile and the percentage of cropland is high. Wheat is grown as a cash crop. Corn, as a cash grain crop, is grown principally in the river bottoms and on the dark-colored soils in the northwestern part of the county. Legumes and bluegrass are well suited to the less acid soils of the Wisconsin drift region. Dairying, production of beef cattle, and raising swine are important enterprises in this region because corn and leguminous pasture are available on most farms. A few fruit-specialty farms are developed on rolling well-drained areas where good air drainage reduces the frost hazard. Vegetables are grown extensively on the dark-colored soils and on the bottoms and terraces in the Wisconsin drift region.

General farming is practiced in the southern and central parts of the county where the soils are developed from Illinoian drift, limestone, or sandstone, siltstone, and shale. In the rougher more rolling parts, the cropland consists of irregular-shaped fields on narrow ridge tops and stream bottoms. The proportion of cropland to the farm is low, generally between 10 and 30 percent. Corn is the principal crop, and wheat and hay are secondary. The principal farm enterprises are dairying, poultry raising, and some limited specialization in orchard or truck crops.

In the western part of the Illinoian drift region the land is smoother and the proportion of cropland higher. Here the acreage of corn and wheat is greater, but a large part of the farmland consists of low-grade pastures.

LAND USE

The percentage of the area in farms has fluctuated somewhat but in general has declined more or less steadily from a peak of 95.6 percent in 1880 to 80.0 percent in 1940. The average number of acres (122) to the farm was highest in 1880. The largest number of farms (2,754) was reported in 1910, when the average size (87.2 acres) was lowest. The census of 1940 reported 2,069 farms having an average size of 100.4 acres. The improved land, including all cropland and plowable pasture, declined from a peak of 71.6 percent in 1910 to 62.4 percent in 1940. The decline in percentage of area in farms has been associated with the abandonment of land less suitable for farming and the reforestation of the rougher parts.

The farm land according to use in 1929 and 1939 is shown in table 4.

TABLE 4.—*Farm land according to use in 1929 and 1939 in Morgan County, Ind.*

Kind of land	1929	1939	Kind of land	1929	1939
Land available for crops:	*Acres*	*Acres*	Woodland	*Acres*	*Acres*
Cropland harvested	92,151	85,394	Pastured	35,633	[2] 30,863
Crop failure [1]	6,321	2,120	Not pastured	14,040	....
Cropland idle or fallow	17,231	10,268	Other pasture	16,095	....
Plowable pasture	19,591	31,858	All other land in farms	12,004	[3] 38,261

[1] Total acreage of crops that failed not represented, but only that not successfully replanted to a crop that was harvested.
[2] Includes all woodland, pastured or not, having some value as timber.
[3] Includes other pasture.

The decrease in cropland harvested in 1939 is largely accounted for by the increase in plowable pasture.

FARM TENURE

The 1940 census reported 72.2 percent of the farms operated by owners and part owners, 27.2 percent by tenants, and 0.6 percent by managers. The percentage of farms operated by owners declined steadily from 78.5 percent in 1890 to 69.5 percent in 1910, after which there was an increase. There has been a corresponding steady increase in the percentage of tenants. The 50–50 share rental system is the most commonly used. About 90 percent of these farms were operated on the share rental system, the owner furnishing the farm, the tenant the labor and equipment, and the expenses and proceeds being divided equally. The cash rental depends on the productivity of the soil, farm improvements, and location.

Extra labor is used on a small percentage of the farms. In 1929, 35.9 percent of the farms reported a total of $203,981, or an average of $288.11 spent for labor, and 23.6 percent of the farms in 1939 spent $136,669, or $280.06 per farm. This labor is used mainly during harvesting season, especially for canning crops. During this season labor requirements are great and many workers come in from neighboring States, particularly Kentucky. The local labor supply is generally adequate for harvesting other crops. On the larger farms labor is hired on a monthly or annual basis; the laborers being paid a monthly or daily wage plus the use of a house and various other incidental subsistence items.

FARM INVESTMENTS AND EXPENDITURES

The average investment per farm of all property was $6,518 in 1940. Of this value, 83.6 percent was in land and buildings (24.1 percent representing value of buildings), 7.1 percent in implements and machinery, and 9.3 percent in domestic animals, poultry, and bees. The average value of land and buildings was $54.27 an acre and $5,449 a farm. The 1940 census reported farm implements and machinery valued at $963,141, which was about 90 percent of the value in 1920 but about 28 percent greater than in 1930. The use of farm machinery has expanded greatly in the last decade.

Labor-saving farm machinery is used widely, most of it on farms that have a large crop acreage. Power machinery is most extensively used on river bottoms, where fields are large and level, and on the smoother lands of the eastern, northern, and western parts of the county. The 1940 census reported that 34.4 percent of the farms had 762 tractors and 12.7 percent had 277 trucks. These numbers have increased greatly since 1930, when there were 451 tractors on 21.9 percent of the farms and 251 trucks on 11.8 percent. Small farm combines are used increasingly for harvesting wheat, oats, and soybeans. Corn harvesters are used extensively, especially in the river bottoms. Two- or three-bottom plows are used with most tractors. Hill farms with irregular-shaped fields and most farms with a small total crop acreage use horse-drawn machinery.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of the characteristics, particularly in regard to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings are made, and road or railroad cuts and other exposures are studied. Each excavation exposes a series of distinct layers, or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil and its content of lime and salts are determined by simple tests.[9] The drainage, both internal and external, and other

[9] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value A pH value of 7 indicates precise neutrality, higher values alkalinity, and lower values acidity. Terms that refer to reaction and are commonly used in this report are as follows:

	pH value
Extremely acid	Below 4.5
Very strongly acid	4.5–5.0
Strongly acid	5.1–5.5
Medium acid	5.6–6.0
Slightly acid	6.1–6.5
Neutral	6.6–7.3
Mildly alkaline	7.4–8.0
Strongly alkaline	8.1–9.0
Very strongly alkaline	9.1 and higher

external features, as the relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land for the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase. In some places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a small-scale map but must be mapped as (4) a complex. Some areas that have no true soil, as Riverwash, are termed (5) a miscellaneous land type.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Cincinnati, Fox, Genesee, Zanesville, Markland, and Miami are names of important soil series in Morgan County.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture, as sand, loamy fine sand, fine sandy loam, silt loam, or silty clay loam, is added to the series name to give the complete name of the soil type. For example, Genesee silt loam is a soil type within the Genesee series. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from it in some minor feature, generally external, that may be of special practical significance. For example, within the normal range of relief of a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Differences in relief, stoniness, and degree of accelerated erosion may be shown as phases. Even though no important differences may be apparent in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instance the more sloping parts of the soil type may be segregated on the map as a sloping or steep phase. Similarly, some soils having differences in stoniness may be mapped as phases even though these differences are not reflected in the character of the soil or in the growth of native plants. Examples in the Cincinnati series are the eroded sloping phase, shallow phase, and steep phase of Cincinnati silt loam.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, complexes, and miscellaneous land types in relation to roads, houses, streams, lakes, section and township lines, and other cultural and natural features of the landscape.

Aerial photographs are used as a base for mapping soils in Indiana. Pictures are taken from an airplane flying at a height of about 13,500 feet, and each covers about 4½ square miles. More than 225 pictures were taken to cover the county. A map showing roads, buildings, streams, soils, and other features was drawn on a sheet of celluloid covering the picture, to separate the map and photographic features. All features mapped were identified and located on the picture by going over the ground closely enough either by automobile or on foot to see at least two sides of every 40-acre field. Soils were studied and identified by observing road cuts and by boring with a soil auger. Soil boundaries and other features were then drawn in their correct positions and in their proper relations to all other features. The field maps were later assembled into larger sheets, from which the final color map was produced.

SOILS

The soils of Morgan County have been separated into 109 mapping units, but they have many characteristics in common. The parent materials are largely glacial in origin, as glaciers entered the area several times. The soils have developed largely under a dense forest cover and are, for the most part, light-colored and low in organic-matter content and in nitrogen, available phosphorus, and potash. The reaction ranges from strongly acid to neutral, and the upland soils are leached of basic elements, especially lime carbonate, to a depth of several feet.

The parent materials of nearly 90 percent of the soils consist of calcareous glacial drift. Most of the county was once nearly level to undulating glaciated plains, but some of these have been dissected by streams and most of the soils have good natural drainage.

Although climate, vegetation, and some other soil-forming factors have given these soils many common characteristics, they have operated in different degree and manner. The resulting soils differ widely within short distances in characteristics that are directly related to their fertility and to the agriculture of the area. These differences depend primarily on the character of the parent material, the relief, and the length of time the soil has been developing. These affect the acidity, organic-matter content, the supply of plant nutrients, and other characteristics. The soils are developed largely on glacial drift deposits that have been in place for varying periods. Those developed on the older Illinoian drift are acid to a depth of 10 feet or more; those on Early Wisconsin drift are acid to a depth of about 4 feet; and those from the Late Wisconsin drift, to a depth of about 3 feet. All soils developed in place from sandstone and limestone rocks are strongly acid. The depth of soil over rock is generally sufficient to assure adequate moisture, but some soils on the ridges and steep slopes with bedrock at a depth of 2 to 4 feet, and others on gravel in terrace positions have relatively low moisture-holding capacity.

Natural drainage conditions differ widely. The more rolling lands have adequate to excessive surface drainage and, if improperly managed, are susceptible to accelerated erosion, but the nearly level light- and dark-colored soils of depressions have poor natural drainage conditions. Light-colored poorly drained soils usually have a plastic subsoil that retards moisture movement, but the well-drained soils have a somewhat more friable subsoil. Drainage conditions also affect the color of both surface soil and subsoil. The subsoil under light-gray to moderately dark-gray poorly drained soils is mottled gray, yellow, and brown, and under those well-drained it is brownish yellow to yellowish brown. Tilth conditions are generally more favorable on well-drained soils, owing to the crumb or granular structure of the surface soil and the subangular aggregates of most of the subsoil. Poorly drained light-colored soils tend to puddle and bake because of the low organic-matter content of the surface soil.

The soils are composed largely of mineral matter. About 85 percent of them has a low organic-matter content; 8 percent, moderate quantities; and 7 percent, relatively high quantities. The surface soil is predominantly fine-textured; about 73 percent is classed silt loam, 10 percent silty clay loam, 8 percent loam, 6 percent stony silt loam, and 3 percent relatively sandy. It ranges from strongly acid to neutral; about 35 percent is strongly acid, 42 percent medium acid, and approximately 23 percent is neutral. The relief ranges from level to steep; about 45 percent is level or slightly sloping, 29 percent moderately sloping, 6 percent strongly sloping, and 20 percent steep. Steep and strongly sloping land is best suited to forest, and the rest, to crops. Accelerated erosion is most severe on the sloping cropland, and sheet and gully erosion is severe on about 2 percent and moderate on about 25 percent of the soils. Internal drainage is closely related to porosity of the parent material and depth to the water table; about 72 percent is naturally well drained, 21 percent poorly drained, and 7 percent very poorly drained. The well-drained soils occur on rolling relief or have permeable substrata, whereas the poorly and very poorly drained ones occur on flats or in depressions, and in some places the subsoil is relatively impervious and the water table is near the surface during much of each year.

Except for that part of the valley of the West Fork White River included with the Norman Upland, the agricultural development is closely related to the physiographic divisions of the county (see fig. 2, p. 6). The soils developed from Wisconsin drift deposits are generally better supplied with plant nutrients and more productive than those of the rest of the county. This region has a mixed-grain, with emphasis on corn, and livestock system of farming. The farms are larger, have a higher proportion of cropland, and in general have a much higher income than the rest of the county. They are generally well equipped with power machinery and have large investments in good grade or purebred livestock.

In the rest of the county, roughly falling within the more highly dissected Norman Upland physiographic division, a system of general farming is followed in which corn is the principal crop. Farms are small and 30 to 40 percent of each is in crops. Most fields are small and irregular-shaped and are unfavorable for the use of power machinery. Because of the high proportion of rolling to steep land, woodland occupies a large percentage of each farm. Livestock is of the general-purpose type.

The relations and differences among the soils of the county can be best understood when they are grouped according to the kind of parent material and the degree of development. These factors, together with drainage, largely determine the fertility and other characteristics of these soils. Most of them have developed from material deposited by three different glaciers which were separated by long periods of time, but in some places the parent material was weathered in place from the underlying rocks. The glacial material, especially the till, is similar in all three, but the soils differ in character and fertility because of differences in time that the soil materials have been in place. The oldest soil-forming materials are sandstone, shale, and limestone formations, followed successively by the Illinoian and Wisconsin glacial drifts. Two stages are recognized in the Wisconsin deposits, one in which the carbonate of lime has been leached out to depths of 4 to 6 feet, and one in which the leaching extends to depths of 2 or 3 feet. The former is called the Early Wisconsin drift, and the latter, the Late Wisconsin drift. The boundaries between Early and Late Wisconsin drift, as recognized by soil scientists, are based on characteristics of the soil and do not necessarily coincide in detail with the general boundaries established by geologists.

The soils of Morgan County may be grouped in catenas. The term was first used by Milne.[10] The catena is composed of soil series developed on similar parent material under similar climatic conditions but having differences in profile characteristics corresponding to differences in natural drainage conditions. For example, members of the Miami, Crosby, Bethel, and Brookston series comprise a catena of soils developed on calcareous till of the Late Wisconsin glaciation. Differences in the profile characteristics of these soils are due largely to differences in drainage conditions and relief and their attendant effects. The concept of the catena is very useful and convenient for field identification and mapping of soils and for considering their geographic and geologic relations.

A grouping of the soils is made in table 5, first according to origin of parent material and position as regards uplands, plains, and bottoms, and then in catenas governed by drainage and relief and by color of surface, subsurface, and subsoil. The more extensive upland catenas consist of soils developed from unassorted ice-laid materials, sandstone, siltstone, shale, and limestone residuum, and from wind-assorted sand and silt. The soils of the terraces and bottoms have been formed from water-assorted materials deposited in present or former stream valleys or former lake beds. Soils having excessive natural drainage and occurring on more rolling land appear in column VI.

The well-drained soils named in columns VI, V, and IV comprise about 65 percent of the county. They are characterized by light yellowish-brown surface soils and yellowish-brown to reddish-brown unmottled subsoils. All types of the series listed in column VI are developed on steep slopes and are shallow to bedrock. Soils in column V are generally browner than other soils of the county, owing to rapid internal drainage through the sand or gravel substrata. These soils frequently have rather low moisture-holding capacity; on terraces they occupy level or nearly level land, but on the uplands they have rolling relief. The soils named in column IV are the dominant well-drained soils with adequate moisture-holding capacity for production of the common crops.

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[10] MILNE, G. PROVISIONAL SOIL MAP OF EAST AFRICA. 34 pp., illus. 1936. London.

TABLE 5.—*Key [1] to the soils of Morgan County, Ind.*

Topography, color, and parent material	Lithosols (shallow soils)	Gray-Brown Podzolic soils		Planosols and semi-Planosols			Wiesenboden (glei) soils	
	VI	V	IV	III [2]	II	I	VIII	IX
Drainage	Rapid surface runoff	Good to excessive internal	Good internal. Good to excessive surface runoff	Good to fair internal. Good to slow surface runoff.	Imperfect internal. Slow surface runoff.	Poor internal. Very slow surface runoff	Very poor internal. Ponding	Very poor internal. Ponding.
Relief	Steep slopes	Rolling to level	Rolling to gently undulating	Level to gently rolling	Nearly level to undulating	Nearly level	Level to shallow depressions	Deeper depressions.
Color of surface soil	Light yellowish brown.	Light yellowish brown.	Light yellowish brown.	Light yellowish brown to brownish gray	Light brownish gray.	Light gray	Very dark brownish gray to nearly black.	Very dark gray to black.
Color of subsurface soil	do	do	Brownish yellow to yellowish brown.	do	Yellowish gray	do	Mottled gray, yellow, and rust brown	Very dark gray.
Color of subsoil	Yellowish brown to reddish brown	Yellowish brown to reddish brown	Yellowish brown to reddish brown.	Light brownish yellow to mottled gray and yellow.	Mottled gray and yellow.	Mottled gray and rust brown	do	Gray, and mottled gray, yellow, and rust brown.
SOILS OF THE UPLANDS								
Parent material								
Calcareous Late Wisconsin glacial drift.		Bellefontaine	Miami		Crosby	Bethel	Brookston Washtenaw [3]	
Calcareous Early Wisconsin glacial drift.		Bellefontaine	Russell		Fincastle	Delmar	Brookston	
Calcareous Illinoian glacial drift.		Parke Banta	Cincinnati	Gibson	Vigo Avonburg	Loy		
Shallow deposit of Illinoian glacial till on limestone.			Grayford					
Cherty limestone of Harrodsburg formation.			Frederick	Bedford				
Medium-grained sandstone, siltstone, and shale of Borden formation.	Muskingum		Zanesville Wellston	Tilsit				
Calcareous wind-deposited sand and silt of Wisconsin glacial age.		Princeton			Ayrshire		Ragsdale	

SOILS OF THE TERRACES AND GLACIAL OUTWASH PLAINS

Parent material:								
Noncalcareous clay, silt, and sand.			Elkinsville	Pekin	Bartle	Peoga		
Noncalcareous outwash sand, silt, and gravel of Illinoian age.		Morgantown			Taggart			
Highly calcareous slack-water silt and clay of Wisconsin age.			Markland		McGary		Montgomery	
Calcareous, stratified silt and sand with some clay and gravel of Wisconsin glacial age.			Martinsville		Whitaker		Mahalasville	
Calcareous gravel of Wisconsin glacial age.		Fox						Abington.
Calcerous lacustrine silt and clay of Wisconsin glacial age.					Gregg		Monrovia	Plano.

SOILS OF THE OVERFLOW BOTTOMS (ALLUVIAL SOILS) [4]

Parent material:								
Neutral to slightly alkaline alluvium from Wisconsin glacial drift region.			Genesee Ross [5]	Eel	Shoals			
Slightly to medium acid alluvium from limestone, sandstone, siltstone, and shale, and Illinoian drift regions.			Haymond	Wilbur	Wakeland			
Strongly acid alluvium from sandstone, siltstone, and shale and Illinoian glacial drift regions.			Pope	Philo	Stendal	Atkins		

[1] Based on The Story of Indiana Soils, Spec. Cir No. 1, by T M. Bushnell, with some modifications.

[2] Soils in column III have much in common with both Gray-Brown Podzolic soils and Planosols, the Pekin especially might be called a Gray-Brown Podzolic soil, but its internal drainage condition puts it in column III.

[3] Washtenaw soils consist of an overwash of local alluvium on Brookston and other Wiesenboden soils.

[4] The Alluvial soils resemble those in the columns above them in color and drainage characteristics but do not have well-defined horizons

[5] Ross soils have dark brownish-gray surface soils.

Columns III, II, and I include soils in which natural drainage is successively poorer in the order given. Soils in column III occur on level to gently rolling land. The surface soil is light yellowish brown to brownish gray, the upper subsoil is light brownish yellow, and the deeper subsoil is mottled gray and yellow. The natural drainage conditions are impaired only in the deeper subsoil, consequently crops do not suffer a great deal from poor drainage. The soils in column II are imperfectly drained. Slow internal drainage is indicated by the light brownish-gray surface soil and the mottled gray and yellow subsoil. It may be due to different factors, as flat relief, high water table, low position, or the presence of a siltpan within the soil. Soils in column I represent the most poorly drained of the light-colored soils. They have light-gray surface soils and mottled gray and rust-brown subsoils.

Soils in columns VIII and IX were developed in depressions under nearly permanent saturation. This favors luxuriant plant growth, and the presence of lime in the ground water promotes the accumulation of organic matter. As a result the surface soils are very dark brownish gray to nearly black. Natural drainage is not so poor or the content of organic matter so high in the soils listed in column VIII as in those in column IX.

Locations of most of the different kinds of parent material in table 5 are shown in figure 3.

Most of the soils have developed from material deposited by glaciers. Stones and fine material were ground and mixed in the ice as it advanced over the land. The glacial till, left when the glacier melted, consists of unassorted material varying in size from clay particles to large boulders. It resembles the composition of the rocks over which the glaciers passed, principally fragments of local rocks but containing also many rocks that have been carried hundreds of miles. For instance, granite and gneiss boulders are in the till in this county, but there are no outcrops of these rocks in Indiana. The local rocks are largely limestone, and as a result the content of lime carbonate in the till is relatively high, but there is some sandstone and shale in the southern part. Although several different glaciers entered Morgan County, the till of the glacial deposits is similar in color and lime-carbonate content and varies slightly in texture. The soils of each group differ in depth of leaching and in related characteristics.

The Late Wisconsin drift is the most recent glacial deposit. Soils developed on this material are moderately acid and have been leached of lime carbonate to a depth of about 3 feet. The Early Wisconsin drift deposits are somewhat older, and soils developed on them are slightly more acid and have been leached of lime carbonates to depths of 4 to 6 feet. The soils developed on the Illinoian drift deposits cover slightly more than 20 percent of the county and are more silty and have relatively few boulders or pebbles. They are strongly to very strongly acid and are leached of lime carbonate to a depth of 10 feet or more. Two groups, or catenas, of soils developed on the Illinoian drift are separated roughly by the valley of the West Fork White River. In well-drained situations the same soil is developed on both sides of the river. The imperfectly drained soils developed north of the West Fork White River, however, have heavy siltpans at a depth of 10 to 20 inches, but south of the river the average depth is 30 inches. This difference has not been fully explained but may possibly be due to a higher proportion of shale and less sandstone in the drift north of the river.

In the western part of the county a thin deposit of Illinoian till was laid down on cherty limestone of the Harrodsburg formation. Soils

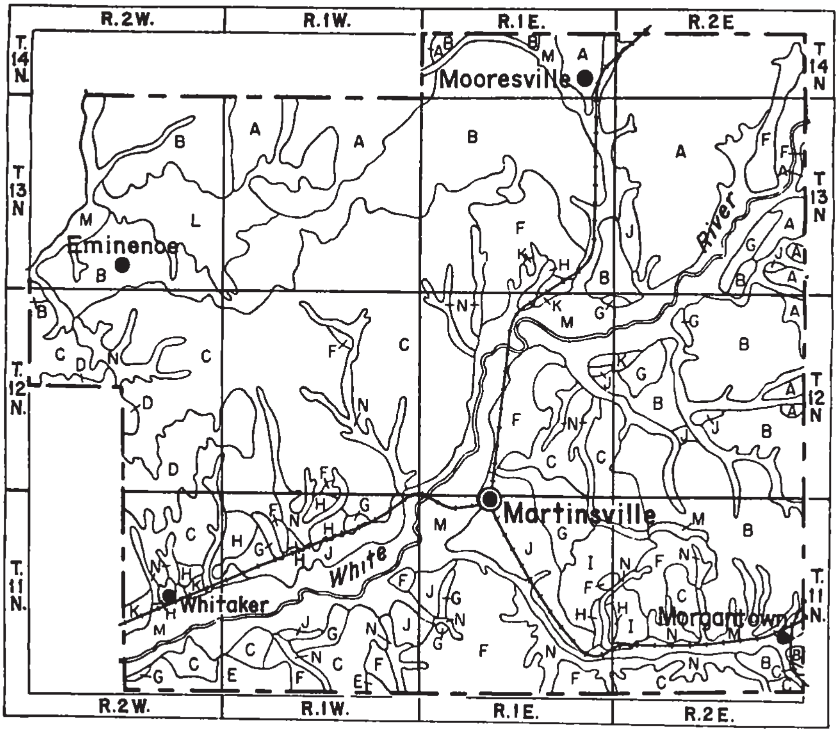

FIGURE 3.—Parent materials of soils in Morgan County, Ind.: Soils of the uplands—*A*, Calcareous Late Wisconsin glacial drift; *B*, calcareous Early Wisconsin glacial drift; *C*, calcareous Illinoian glacial drift; *D*, shallow deposit of Illinoian glacial till on limestone; *E*, cherty limestone of Harrodsburg formation; *F*, medium-grained sandstone, siltstone, and shale of Borden formation; *G*, moderately calcareous wind-deposited sands of Wisconsin glacial age. Soils of the terraces and glaciofluvial outwash plains— *H*, Noncalcareous clay, silt, and sand; *I*, noncalcareous outwash sand, gravel, and silt of Illinoian glacial age; *J*, calcareous stratified silt and sand with some gravel and clay of Wisconsin glacial age; *K*, calcareous gravel of Wisconsin glacial age; *L*, calcareous lacustrine clay and silt of Wisconsin glacial age. Soils of the overflow bottoms—*M*, Neutral to slightly alkaline alluvium from Wisconsin glacial drift region; *N*, strongly acid alluvium from Borden sandstone, siltstone, and shale, and Illinoian glacial drift regions.

developed on this material comprise about 2 percent of the area and are developed partly from leached till and partly from limestone that has been leached of lime carbonates to an average depth of 6 to 8 feet.

In the southwestern corner a group of soils comprising less than 1 percent of the county are developed almost entirely from residuum of Harrodsburg limestone. This material is impure, cherty, highly fossiliferous, and coarsely crystalline.

The soils developed on rocks of the Borden formation comprise about 12 percent of the county and are strongly acid and relatively low in fertility. Rocks in this formation include interbedded yellowish-gray to light yellowish-brown acid sandstone, siltstone, and shale. Much of the sandstone is hard and resistant to weathering.

Soils formed from sands deposited by winds along the eastern side of the valley of the West Fork White River during the Wisconsin glacial period represent about 2 percent of the area. They are moderately acid and have been leached of lime carbonates to a depth of 4 to 6 feet.

The soils of the terraces are developed from stratified water-assorted coarse-gravel to heavy clay materials that were deposited either in stream beds or in temporary lakes. The most recent deposits consist of materials laid down by the waters of the Late Wisconsin glacier. Soils developed from calcareous gravel and sand deposited in the valley of the West Fork White River represent a very small proportion of the total area of the county. Other soils on terraces are developing on mixed sand, silt, and clay deposits of approximately the same age as the gravel but contain slightly less lime carbonate and are leached to slightly greater depths.

Two lakes formerly existed near the contact between the Early and Late Wisconsin glacial till plains. The soils in these former lake beds have developed from stratified and assorted calcareous silt and clay. The light-colored soils have somewhat heavy siltpans, are medium acid, and are leached of lime carbonates to an average depth of 4 feet. The larger of these former lakes was in the northwestern part of the county and was largely marshland until artificially drained. The other, lying 1 mile east of Brooklyn, consists largely of silty material.

Two groups are developed from old acid highly leached water-deposited material. In the southeastern part of the county is a high outwash terrace, probably of Illinoian age. Here the soils are developed from a great variety of rock, gravel, and sand that is highly weathered and leached of lime carbonates to a depth of 15 feet or more. Most of the soils are well drained and have moderately heavy subsoils to a depth of 5 feet, but, below this depth they are loamy and, at a depth of 15 feet or more, are gravelly. This plain is highly dissected, and gravel is exposed on the sides of many V-shaped valleys. Soils of the other group are developed from old acid alluvial deposits of silt and occupy low terrace remnants in a few valleys in the Illinoian till region and along the edge of the valley of the West Fork White River. These soils are strongly acid.

Heavy calcareous clay beds occupy benches near the floors of many of the valleys, 30 to 50 feet or more below the level of the outwash plain. On these beds the soils are variable in character because gravel and sand have been deposited in a few places. Soils developed entirely from calcareous clay are moderately acid in the upper layers and leached of lime carbonates to a depth of 3 to 4 feet.

Three groups of soils have been developed from alluvial deposits. The most extensive are on the flood plains of the West Fork White River and tributary streams flowing from the Wisconsin glacial drift region. They are neutral to slightly alkaline and fertile and comprise about 17 percent of the county. The bottom-land soils developed on alluvium of mixed origin, as limestone, sandstone, siltstone, and shale and Illinoian till, are slightly to medium acid; and those on sediments washed from sandstone, siltstone, shale, and Illinoian till are strongly acid.

The distribution and association of the more extensive soils, as well as their relative importance within geographic units, are shown in figure 4. In each association the soil types are listed in the order of their extent.

In the following pages the soil groups and the individual soil types are described in detail and their crop adaptations discussed. Their

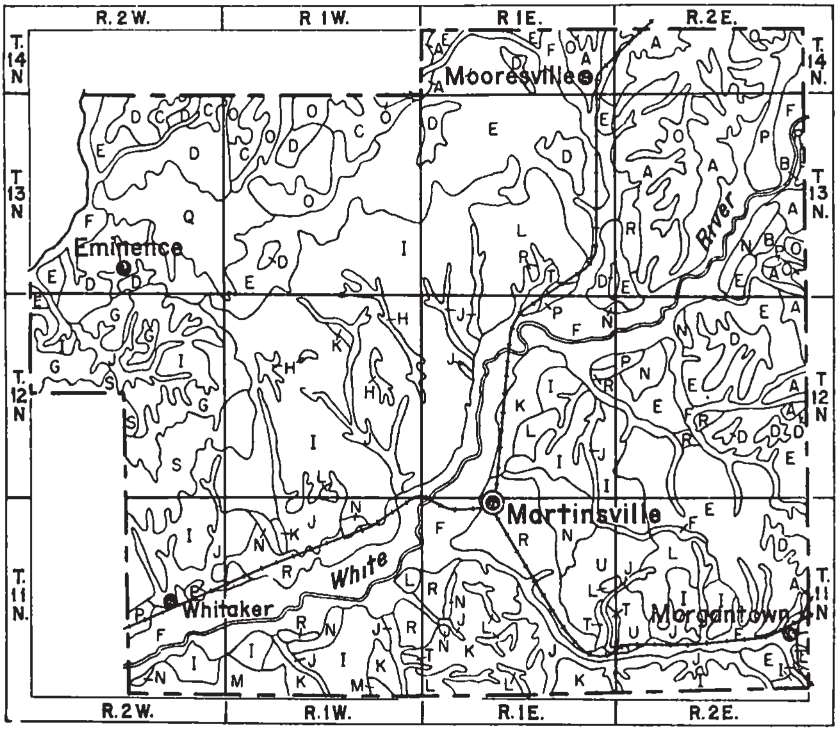

FIGURE 4.—Soil association map of Morgan County, Ind.: *A*, Miami and Crosby silt loams; *B*, Bellefontaine loam; *C*, Brookston silty clay loam, Crosby and Fincastle silt loams; *D*, Fincastle silt loam, Brookston silty clay loam, Russell silt loam; *E*, Russell and Fincastle silt loams, Brookston silty clay loam; *F*, Genesee silt loam, Genesee loam, Genesee fine sandy loam, Genesee silty clay loam, Eel silt loam, Eel silty clay loam, Eel loam, Ross silty clay loam; *G*, Vigo, Loy, and Gibson silt loams; *H*, Gibson, Vigo, and Cincinnati silt loams; *I*, Cincinnati, Gibson, and Muskingum silt loams; *J*, Philo and Stendal silt loams, Pope loam, Haymond, Wilbur, and Wakeland silt loams; *K*, Muskingum silt loam, Muskingum stony silt loam, Zanesville and Wellston silt loams; *L*, Zanesville, Wellston, and Muskingum silt loams, Muskingum stony silt loam; *M*, Frederick and Bedford silt loams; *N*, Princeton fine sandy loam, Princeton loamy fine sand, Princeton, Ayrshire, and Ragsdale loams; *O*, Crosby silt loam, Brookston silty clay loam, Miami and Bethel silt loams; *P*, Fox loam, Fox silt loam, Fox fine sandy loam, Martinsville and Whitaker loams, Mahalasville silty clay loam; *Q*, Monrovia silty clay loam, Gregg silt loam, Gregg loam, Plano silty clay loam; *R*, Martinsville loam, Martinsville silt loam, Martinsville fine sandy loam, Whitaker silt loam, Whitaker loam, Whitaker fine sandy loam, Mahalasville silty clay loam, Mahalasville loam; *S*, Grayford and Vigo silt loams; *T*, Bartle silt loam, Bartle silty clay loam, Pekin, Elkinsville, and Peoga silt loams; *U*, Morgantown, Taggart, and Markland silt loams.

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location and distribution are shown on the accompanying soil map and their acreage and proportionate extent are given in table 6.

TABLE 6.—*Acreage and proportionate extent of the soils mapped in Morgan County, Ind.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Abington silty clay loam	128	(1)	Miami silt loam	9,536	3.7
Atkins silt loam	320	0.1	Eroded sloping phase	448	2
High-bottom phase	128	(1)	Sloping phase	1,728	.7
Avonburg silt loam	256	.1	Monrovia silty clay loam	5,760	2.2
Ayrshire loam	192	.1	Montgomery silty clay loam	128	(1)
Banta silt loam	448	.2	Morgantown loam: [2]		
Bartle silt loam	1,408	.6	Eroded phase	128	(1)
Bartle silty clay loam	64	(1)	Steep phase	832	.3
Bedford silt loam	128	(1)	Morgantown silt loam	1,088	.4
Bellefontaine loam	1,408	6	Muskingum silt loam	3,840	1.5
Bethel silt loam	64	(1)	Colluvial phase	320	.1
Brookston silty clay loam	8,320	3.2	Muskingum stony silt loam	14,976	5.8
Cincinnati silt loam	15,168	5.9	Parke silt loam	960	.4
Eroded sloping phase	1,920	7	Eroded sloping phase	128	(1)
Gullied sloping phase	1,728	7	Pekin silt loam	512	.2
Shallow phase	512	2	Peoga silt loam	192	1
Steep phase	17,728	6.8	Philo loam	320	.1
Crosby silt loam	7,552	2.9	Philo silt loam	4,992	1.9
Delmar silt loam	320	.1	High-bottom phase	320	.1
Eel loam	704	.3	Plano silty clay loam	384	.2
Eel silt loam	10,176	3.9	Pope loam	2.432	.9
Eel silty clay loam	6,016	2.3	Princeton fine sandy loam	3.648	1.4
Elkinsville silt loam	320	1	Steep phase	960	.4
Fincastle loam	640	3	Princeton loam	64	(1)
Fincastle silt loam	13,184	5.1	Princeton loamy fine sand	128	(1)
Fox fine sandy loam	256	.1	Ragsdale loam	256	.1
Fox loam	1,920	.7	Riverwash	320	.1
Sloping phase	320	.1	Ross silty clay loam	1,792	.7
Fox silt loam	512	.2	Russell loam	640	.3
Frederick silt loam	832	3	Russell silt loam	22,848	8.8
Eroded phase	128	(1)	Eroded sloping phase	3,904	1.5
Steep phase	576	.2	Gullied sloping phase	640	.3
Genesee fine sandy loam	960	4	Level phase	128	(1)
Genesee loam	4,928	1.9	Sloping phase	192	.1
High-bottom phase	384	2	Steep phase	9,344	3.6
Genesee silt loam	14,336	5.5	Shoals silt loam	384	.2
High-bottom phase	1,216	5	Shoals silty clay loam	384	.2
Genesee silty clay loam	1,344	.5	Stendal silt loam	2,752	1.1
Gibson silt loam	7,040	2.7	High-bottom phase	1,088	.4
Grayford silt loam	2,880	1.1	Taggart silt loam	64	(1)
Eroded sloping phase	128	(1)	Tilsit silt loam	256	.1
Level phase	448	2	Vigo silt loam	4,672	1.8
Steep phase	256	.1	Wakeland silt loam	832	3
Gregg loam	192	.1	Washtenaw silt loam	64	(1)
Gregg silt loam	1,600	.6	Wellston silt loam	320	.1
Haymond silt loam	64	(1)	Steep phase	960	.4
Loy silt loam	448	.2	Whitaker fine sandy loam	64	(1)
Mahalasville loam	768	.3	Whitaker loam	1,216	.5
Mahalasville silty clay loam	1,216	5	Whitaker silt loam	1,920	.7
Markland silt loam	256	1	Wilbur silt loam	3,904	1.5
Eroded steep phase	64	(1)	Zanesville silt loam	3,968	1.5
Steep phase	448	2	Zanesville-Wellston silt loams.		
Martinsville fine sandy loam	1,536	6	Eroded hill phases	320	.1
Martinsville loam	3,008	1.2	Gullied hill phases	448	.2
Martinsville silt loam	2,048	.8	Steep phases	3,264	1.3
McGary silt loam	128	(1)	Total	259,840	100.0

1 Less than 0.1 percent.

2 Typical soil not mapped.

SOILS DEVELOPED ON CALCAREOUS LATE WISCONSIN GLACIAL DRIFT

Late Wisconsin drift is the most recent glacial deposit in the county. The areas extend into the county in two lobes, one in the northwestern part to the vicinity of Hall, and the other past Mooresville nearly to Exchange and then southward along the eastern boundary. The land form following glaciation was a slightly undulating plain with numerous low knolls, shallow depressions, and higher terminal moraines and gravelly kames marking halting places of the glacier. Since then drainageways have dissected this plain, particularly in the northeastern and eastern parts of the county. Small streams head in troughlike areas in former marshy depressions and gradually cut down to the base level of the larger streams. These valleys are generally less than 30 feet deep except near the West Fork White River, where the relief between the till plain and the valley floor is approximately 100 feet. The plain has not been highly dissected in most places, and the divides are relatively broad and flat, with frequent dark-colored areas intermingled with the light-colored soils.

In the northwestern part little stream dissection has occurred, and the plain is undulating to level with extensive dark-colored areas. Ninety-five percent of the area has been cleared of forest and is used as farm land. A rotation of corn, wheat, and clover is commonly followed. Corn is the principal crop and is most extensively grown on the dark-colored former marsh soils. Wheat is grown largely as a cash-grain crop and also serves as a nurse crop for meadow mixtures. Because the soils are only moderately to slightly acid, legumes, as red clover, can be successfully grown without the addition of large quantities of lime. Special crops, as tomatoes, do well on the dark-colored soils. Dairy and swine enterprises are important in the farming system of this region.

These soils include members of the Miami, Bellefontaine, Crosby, Bethel, Brookston, and Washtenaw series. Miami and Bellefontaine are well drained and the others imperfectly to poorly drained. Miami soils occur on undulating to sloping land, usually near drainageways. They have a light yellowish-brown surface soil, yellowish-brown subsoil, and grayish-yellow calcareous glacial till substrata. Bellefontaine soils developed on water-assorted calcareous gravel and sand and occur on steep-sided knolls and ridges that, where associated with moraines, may mark a place where the glacier halted. They have a light yellowish-brown surface soil, yellowish-brown to reddish-brown gravelly clay loam subsoil, and gray and light-yellow calcareous gravel and sand substrata. Crosby and Bethel are imperfectly and poorly drained light-colored soils, respectively, developed on broad divides. Crosby soils have a light brownish-gray surface soil and a mottled gray and yellow subsoil. Bethel soils, beign more slowly drained than Crosby, are lighter gray and more rust-stained throughout. Brookston soils were developed in depressions under a mixture of marsh grass and water-tolerant trees. They are neutral in reaction and have a very dark brownish-gray to nearly black surface soil high in organic-matter content and a mottled gray, yellow, and rust-brown heavy subsoil. The Washtenaw soils consist of a veneer of silty material washed from adjoining higher lying areas onto areas of Brookston or other soils occupying depressions.

Miami silt loam.—In cultivated fields the 7-inch surface layer is light yellowish-brown when dry and slightly darker brown when moist. In wooded areas there is a mat of leaves and partially decomposed dark organic material on the surface; the 3-inch surface layer is slightly dark-brown silt loam that is higher in organic matter than the surface soil in cultivated fields. In cultivated areas the surface soil is granular in structure and mellow seedbeds are easily prepared, but if this soil is worked when too wet, rather hard clods may form. In most places there is a small proportion of grit and fine gravel that makes the soil somewhat porous and easily crumbled. The reaction is slight to medium acid. To a depth of 10 inches the subsoil is slightly lighter colored and lower in content of organic matter. Below this layer, to a depth of about 30 inches, the subsoil consists of yellowish-brown friable silty clay loam. The upper part is usually more yellow and more friable, but becomes heavier and more compact with depth; however roots and moisture penetrate it readily. It separates into small angular aggregates that are about half an inch in diameter in the upper part but are ¾ to 1½ inches in the lower part. The surface of the structure aggregates is usually coated with a film of dull-brown or gray colloidal clay. The reaction is medium to strongly acid. The deeper subsoil, from a depth of 30 to 36 inches, is slightly acid to neutral, moderately plastic, brownish-yellow, sticky clay loam. Gravel is present throughout the soil but is larger and more numerous in the lower layers. A few large boulders are on the surface and in the soil. The parent material, which lies at an average depth of about 36 inches, is medium-textured compact calcareous gray and yellow glacial till deposited during the Wisconsin glacial period. It contains 20 to 30 percent of lime carbonates. This soil is retentive of moisture, and crops do not suffer from drought except during extended dry periods.

This soil occurs on moderately sloping areas throughout the Late Wisconsin till plain. The gradient is 3 to 15 percent, but in most places it is less than 8 percent, as the steeper slopes occur only near drainageways. An area of 9,536 acres is mapped.

Mixed hardwoods of sugar maple, beech, black walnut, ash, elm, hickory, and white oak originally covered this soil, but about 95 percent of the forest has been cleared and the land cultivated. Probably 65 percent is in grain or other crops; corn occupies about 30 percent, wheat 18 percent, hay 12 percent, and permanent pasture about 15 percent. The rest is occupied by minor crops, farmsteads, and roadways, as scarcely any of it is idle land. Many small acreages of arable timberland are used as pasture, and eventually, as the trees die, such areas will probably be used as cropland.

This type is used extensively as farmstead sites, especially on the morainic knolls that occur on the divides. Most farmers follow a definite system or crop rotation. The usual rotation is corn, wheat, and clover or mixed hay, but more corn than other crops. Yields of corn average 35 to 40 bushels an acre, but higher yields are obtained where heavy applications of manure and commercial fertilizer are made. This soil is not naturally adapted to the growth of corn, because the low content of nitrogen and seasonal inadequate moisture supply limit the yield. Also, clean cultivation and lack of vegetative cover during the winter may result in serious erosion on sloping fields. Wheat normally follows corn in the rotation, but it may be seeded after oats or soybeans or special crops. As wheat requires a well-drained soil for best results, it is well suited to this soil. It also furnishes ground cover from fall to spring and thus retards erosion. This crop is usually fertilized, and the yields average about 20 bushels an acre.

Red clover, seeded alone or in a mixture with timothy, redtop, alsike, and occasionally alfalfa, is the dominant hay crop. Good stands of all clovers are usually obtained, especially after an application of 1 to

2 tons an acre of ground limestone, because the surface soil is only slightly to medium acid. There is less damage from winterkilling than on the poorly drained soils, because of the good drainage conditions and less loss by heaving. Farmers generally apply more manure to this soil than to the associated dark-colored ones. The heaviest applications are made on eroded spots where the heavy subsoil is exposed. This not only improves the physical condition but also results in improved stands of clover and grass, as well as increased crop yields. Oats are grown to a limited extent. This soil warms more quickly in the spring and permits earlier seeding. Oats are usually seeded in the corn stubble, and yields average 30 to 35 bushels.

The principal variations within this soil are those of texture and thickness of the various layers. Several small scattered areas have been included where the texture of the surface soil is loam. This included soil contains a slightly higher proportion of sand in all layers, consequently it is looser and more readily penetrated by roots and moisture. In a few areas northwest of Waverly the covering of glacial till is thin and bedrock lies at a depth of less than 36 inches.

Miami silt loam, sloping phase.—The sloping phase is similar to the typical soil, except that it is situated on slopes of more than 15 percent. In most places the various layers are thinner, and the gradient is less than 20 percent. Soils on these slopes are less deeply leached and have more sand and grit in all layers than on the more level areas.

This soil occurs along small tributaries of the West Fork White River in the northwestern part of the county and totals 1,728 acres. The moderate slopes have been largely cleared of forest, and 30 to 50 percent of the land is used for crops. Corn and permanent pasture are its most important uses. In most places local relief is less than 25 percent, but along the valley of the West Fork White River the relief ranges up to 100 feet. Also in many places in this vicinity, the gradient is more than 25 percent. A few slopes northwest of Waverly have sandstone and shale within a few feet of the surface. Slopes steeper than 20 percent are seldom used for cultivated crops but are important forest and permanent pasture areas. Most of the forest areas have an undergrowth of bluegrass.

Miami silt loam, eroded sloping phase.—The eroded sloping phase is similar to the sloping phase, except that 25 percent or more of the surface soil has been removed by accelerated erosion, caused chiefly by improper land use. The brown to yellowish-brown surface soil is 2 to 5 inches thick, and the underlying yellowish-brown subsoil is exposed in places on most areas. A few shallow gullies occur on some areas, but most of these are small because they are not easily cut in the compact subsoil. In a few places gullies are too deep to be crossed by agricultural machinery.

Most of the 448 acres mapped is south of Mooresville. All of it is cleared of timber, and areas that are large enough to farm are used as hay or pasture land. Small grains are seeded only when needed as nurse crops. Mixtures of lespedeza, alfalfa, clover, and grasses are seeded for pasture, and mixed alfalfa and timothy for hay. Erosion is partly controlled where these practices are used, but it is necessary to maintain a good stand of grass and to avoid overgrazing. The agricultural value depends largely on the degree of erosion, although the exposure of subsoil is less harmful than on more acid soils of lower fertility. The physical condition is impaired by mixing subsoil and surface soil in tillage.

Bellefontaine loam.—Developed from assorted calcareous gravel, this soil generally occurs on kames in association with the Miami and Russell soils. These morainic areas usually occur where movement of the glacier halted. The parent material from which the soil was developed consists of assorted gravel and sand containing 20 to 30 percent carbonates. The size of the gravel varies considerably from place to place but the greater portion is less than 2 inches in diameter. This material was probably laid down by streams within the glacier, and many of the ridges and knolls contain small bodies of unassorted glacial till. The surface soil to a depth of about 8 inches is light yellowish-brown friable loam, low in organic content. This changes rather abruptly to yellowish-brown friable clay loam extending to a depth of about 30 inches. The content of gravel in the subsoil increases with depth. When dry this layer is compact despite the large quantity of sand and gravel. It is medium acid in the surface and subsoil layers. Those areas that occur in association with the Russell soils have a thicker subsoil, and the reaction is slightly more acid. A dark-brown sticky neutral layer, higher in organic-matter content than the other subsoil layers, marks the transition to the calcareous gray and yellow gravel and sand that underlie the soil at depths of 3 to 5 feet.

A total of 1,408 acres is on many small kames scattered throughout this region. These areas are usually conspicuous as they extend 30 to 60 feet or more above the surrounding land. The hilltops are small, and the hillsides average about 15 percent in gradient. An area of about 80 acres lies half a mile southeast of Waverly.

About half of the area is under cultivation. Corn, wheat, and hay are the principal crops. Erosion is active when clean-tilled crops are grown successively on these steep slopes. Corn yields 25 to 35 bushels an acre, but the lower figure is more common on sloping and eroded areas. On the smoother areas, somewhat higher yields are obtained. The soil is better suited to growing wheat and hay and is well adapted to alfalfa. Because of the erosion hazard and rolling relief much of the land is used as permanent bluegrass pasture. The carrying capacity for livestock is low, and pastures tend to burn out during midsummer.

Crosby silt loam.—In forests the first 3 inches of soil is dark gray and contains sufficient organic matter to give the virgin soil a good physical condition. When the soil is first cultivated the organic matter is mixed through the plow soil. In cultivated fields the silt loam surface soil to a depth of about 7 inches is brownish gray when moist and light brownish gray when dry. The content of grit is variable but is generally low, although there are small areas that have a loamy texture. The subsurface soil is light brownish-gray to brownish-gray friable coarse granular heavy silt loam to silty clay loam with an occasional light-yellow or rust-brown mottling. This material is permeable to moisture movements and to plant roots. The reaction is medium acid.

Below a depth of 10 inches the subsoil is mottled gray, yellow, and rust-brown silty clay loam, which breaks into subangular aggregates about one-half inch in diameter. Below an average depth of about 17 inches is mottled gray, yellow, and rust-brown compact silty clay loam to silty clay that is somewhat impervious to the movement of water. It contains much grit and numerous angular and partly weathered rock fragments. This material is hard when dry and plastic when wet. The reaction is medium to strongly acid. At an average depth of 36 inches the parent material is moderately compact medium-textured calcareous glacial till. This material was deposited during the Late Wisconsin glacial period and is estimated to contain about 20-percent carbonates.

This soil is imperfectly drained. The relief is nearly level to gently undulating. The total area is 7,552 acres, or approximately 3 percent of the county. This soil is the clay land part of the "black- and clay-land" complex, or soil association, that occupies a large part of central Indiana.

Originally the land was covered with deciduous hardwood trees consisting principally of beech and sugar maple, but also including elm, ash, sweetgum, sour (or black) gum, pin oak, white oak, and black oak.

About 95 percent of the land is cleared of forest, and about 85 percent is cultivated. The crop rotation usually followed consists of corn, wheat, and clover, alfalfa, or mixed hay. This soil, with a low content of organic matter, is not naturally adapted to corn, but because of the large quantity of corn needed in a livestock system of farming, nearly a third of it is planted to this crop. Yields average 35 to 40 bushels an acre. Manure is applied to cornland, and most farmers use 65 to 100 pounds an acre of commercial fertilizer in the hill or row. Wheat is seeded in standing corn or in ground prepared by disking after the corn has been removed. Most farmers fertilize wheat with 150 pounds or more of 2–12–6 or a comparable analysis. Yields average 18 to 20 bushels an acre. Hay crops include a mixture of red clover, alsike, alfalfa, and timothy. Alfalfa, sweetclover, or red clover are grown on most land that has been limed. Soybeans, grown as a supplemental hay crop on about 10 percent of the area, yield 1 to 3 tons. Other grains and pastures each occupy about 10 percent of this soil. These crops are not included in many rotation schedules but are introduced as supplemental crops when other crops fail or there is a scarcity of grain or forage.

Bethel silt loam.—When moist the surface soil to a depth of 6 to 8 inches is light brownish-gray to gray streaked with rust-brown friable medium-granular silt loam that becomes light gray when dry. Numerous rust-brown "turkey-shot" gravel, or small rounded iron concretions, are scattered over the surface and through the surface soil. The upper part of the subsoil, to a depth of about 15 inches, is mottled gray, rust-brown, and yellow compact heavy silt loam to silty clay loam. The heaviest part of the subsoil lies between 15 and 30 inches and consists of very tough, impervious mottled light-gray, light-yellow, and rust-brown silty clay loam to silty clay. The surface and subsoil layers are medium to strongly acid. The parent material, lying at a depth of about 36 inches, consists of medium-textured compact calcareous glacial till, similar to that of the Crosby, Miami, Brookston, and Clyde soils. This poorly drained, light-colored soil occurs on flat areas, usually associated with Crosby silt loam and Brookston silty clay loam. It is locally known as "beech land," because the original forest consisted largely of beech. Only 64 acres of this soil is mapped in Morgan County.

This soil is relatively unproductive and, wherever possible, it is used for pasture or forest. Most areas, however, are included in fields composed largely of other soils. Thus no specific management practices are used, but it is managed about the same as the associated soils. Crop yields are considerably below those obtained on Crosby silt loam.

Brookston silty clay loam.—This type has a dark-gray to very dark brownish-gray surface soil, 6 to 8 inches thick. Its texture ranges from a silt loam at the edges of the depressions to silty clay loam in the deeper parts. These heavier textured areas in the centers of some of the depressions are locally called gumbo. Granular structure is well developed but it is destroyed and the soil becomes cloddy if it is tilled when wet. The structure may also be partly destroyed by cattle trampling the wet soil. The reaction is neutral to slightly acid. The subsoil is dark-gray heavy silty clay loam with some yellow mottling to a depth of about 15 inches. The mottled gray, yellow, and rust-brown, tough plastic silty clay loam subsoil breaks into large clods and is hard when dry. The dark-gray upper subsoil grades into the subsoil and may extend to a depth of several feet along cracks and fissures. The subsoil is neutral in reaction. Calcareous glacial till lies at depths of 3 to 5 feet.

In the northern and eastern parts of the county this soil is extensive. Many individual areas, situated on broad divides not reached by natural drainageways, contain more than 200 acres. Most areas, however, occupy slight depressions or swales intimately mixed with Miami and Crosby silt loams or with Russell and Fincastle silt loams. In the northeastern part, where Brookston, Miami, and Crosby soils are intimately associated, this type occupies about 20 percent of the area. In the northwestern and southeastern parts, where Brookston, Russell, and Fincastle soils are associated, the swales are narrower and shorter and the soil occoupies about 10 percent of the area. A total of 8,320 acres is mapped.

This naturally poorly drained dark-colored soil developed in shallow depressions occurs in close association with Crosby and Fincastle silt loams and as the main black component of the "black- and clay-land" region of central Indiana. Under natural drainage conditions this soil was covered with water during most of each year.

Local relief to the level of adjacent soils is generally less than 3 feet. Most of this soil is now drained by tile drains that lead into natural drainageways or large open ditches.

The original vegetation consisted largely of red maple, blackgum, American elm, other water-tolerant trees, and marsh grass. When artificial drainage is provided this is one of the most productive soils in the region. Practically all this soil is cleared of timber, about 85 percent is cultivated, and the rest is used chiefly for pasture.

Variations from the typical soil are in texture, content of organic matter, and natural drainage. Very shallow depressions are more silty, less compact, lighter in color, and lower in organic content.

These areas are similar to the Cope soils. In the deeper parts of swales, where natural drainage conditions are poorest, the surface soil is darker, deeper, and somewhat heavier in texture, and the subsoil is gray or light gray similar to that of Clyde silty clay loam.

The usual crop rotation consists of corn, wheat, and clover, alfalfa, or mixed hay. Corn usually occupies about 35 percent of the type, wheat about 25 percent, and hay about 17 percent. A variety of minor crops, as oats, soybeans, and tomatoes, are grown. In most fields the soil is intimately associated with a light-colored soil and, owing to marked differences between them, the dominant soil usually determines the use of the field. As the Brookston soil has more abundant supplies of organic matter, nitrogen, other available plant nutrients, and moisture, it is best adapted to corn, and these fields may be cropped to corn for 2 or more successive years in each rotation. This is a desirable practice on farms where the acreage of soils well adapted to the growth of corn is small. Corn yields 50 bushels or more an acre with management practices that include the use of only small quantities of commercial fertilizer and no manure, and many farmers report considerably higher yields with the use of commercial fertilizer and manure. In regions where this soil constitutes a small portion of the cropland, many farmers fertilize the land for corn with 85 to 100 pounds of 2–12–6 when it is checked and as much as 150 pounds when it is drilled.

Wheat yields average 20 to 25 bushels an acre, or about the same as the associated light-colored soils. Yields are variable on the dark-colored, low-lying areas because winterkilling is occasionally serious in some years, and there is some loss from lodging of the grain. Most farmers seed wheat in standing corn and apply about 150 pounds of 2–12–6 when the grain is drilled.

This type is highly productive for hay crops and, as it is almost neutral in reaction, little difficulty is experienced in obtaining good stands of red clover and alfalfa; but damage by winterkilling is occasionally severe, therefore mixed clover, alfalfa, and timothy are grown to a considerable extent. The yield of hay is 1½ to 2 tons an acre. In the northeastern part of the county, where considerable livestock is kept, many farmers include pasture in which sweetclover, red clover, and timothy are mixed in the rotation. These fields are suitable for hay if cut early.

Special cash crops, as sweet corn and tomatoes, do well. These crops are usually fertilized, and yields are 3½ to 5 tons of sweet corn and 8 to 10 tons of tomatoes an acre. When these crops are grown they are usually followed by wheat.

Washtenaw silt loam.—This soil is an accumulation of material, washed from the surrounding upland areas, over Brookston and other dark-colored depression soils. The 6- to 8-inch dark brownish-gray to light brownish-gray friable fine granular silt loam surface soil has a variable content of organic matter that is usually lower than in the surface layer of Brookston soils. The reaction is slightly acid to neutral. This layer is underlain by brownish-gray heavy silt loam that has a laminated structure extending to depths of 12 to 38 inches. In areas where the silted-in material is thicker, it is mottled rust brown. Beneath this material is dark-gray or mottled yellow and gray silty clay loam. Calcareous till is encountered at depths of 50 to 80 inches.

A total of 64 acres is mapped in small areas west of Martinsville associated with the Parke soils, and northeast of Martinsville associated with the Banta and Russell soils.

Natural drainage conditions vary considerably, and its use depends largely on the extent of artificial drainage. Corn, soybeans, hay, and bluegrass pasture are the principal uses for this type. Fall-seeded small grains are usually drowned out on areas that have inadequate drainage.

SOILS DEVELOPED ON CALCAREOUS EARLY WISCONSIN GLACIAL DRIFT

Soils developed on Early Wisconsin glacial drift occupy about 25 percent of the total area of the county. They are developed on ice-laid materials somewhat older in age and therefore more highly leached than the soils developed on Late Wisconsin glacial drift. The soils in this group are somewhat more acid and are in general slightly lower in plant-nutrient content. This plain, originally nearly level, is more completely dissected by streams than that on which the Miami and associated soils were developed. Local relief ranges from 30 to 70 feet or more. A mixed grain-and-livestock system of farming is followed, which is similar to that of the group of soils developed on Late Wisconsin glacial drift. Because there is a lower percentage of dark-colored soils and the topography is more rolling, the proportion of acreage in corn is lower and that of hay and pasture is somewhat higher. The percentage of wheat is approximately the same, but other small grains and truck crops are more extensively grown.

The soils in this area are grouped as follows: Well-drained light-colored soils represented by the Russell series, and imperfectly and poorly drained light-colored soils represented by the Fincastle and Delmar. The poorly drained dark-colored soils of this group are represented by the associated Brookston series, which are also included in the group developed on Late Wisconsin glacial drift. Russell soils are developed from moderately compact glacial till and, like Miami silt loam, have a light yellowish-brown surface soil and a yellowish-brown to brownish-yellow subsoil. They are the most extensive soils of this group. Fincastle and Delmar soils, which resemble Crosby and Bethel, respectively, have light brownish-gray and light-gray surface soils and mottled gray and yellow subsoils. Both soils occupy nearly level topography.

Russell silt loam.—The 6- to 8-inch light yellowish-brown smooth mellow silt loam surface soil is somewhat darker colored when moist. The subsurface, to a depth of about 10 inches, is light yellowish-brown to brownish-yellow friable heavy silt loam. In forested areas the upper 3 inches is moderately dark brownish-gray mellow silt loam. When the soil is cultivated the organic matter is mixed through the surface layer and this is responsible for the lighter color in field conditions. Soft crumb to granular structure is well developed in the surface layer of the forested soil, but after an area has been cultivated for several years this is partly destroyed and the soil has a tendency to crack and bake during hot, dry weather. The subsurface soil can be separated into fragile thin plates if handled carefully, but these plates break easily into medium to coarse granular aggregates. The 18-inch friable yellowish-brown to brownish-yellow silty clay loam subsoil crumbles readily into subangular aggregates 1/4 to 1/2 inch in diameter. The upper part of the soil is very smooth and silty and, in some places may have developed on wind-blown silts. The deeper subsoil is moderatly compact brownish-yellow to yellowish-brown heavy silty clay loam with a faint gray mottling in a few plaçes. The material breaks into subangular or nuciform aggregates 1/2 to 1 1/2 inches in diameter and they are more compact than the aggregates of the upper subsoil. The surface and subsoil layers are medium to strongly acid. Moderately compact, calcareous, gray, and yellow glacial till occurs at a depth of about 45 inches. This is a mixture of clay, silt, sand, glacial pebbles, and rock fragments deposited during the Early Wisconsin glacial age. In most places the deposit is 50 feet or more thick and rests on sandstone, siltstone, or shale. Glacial pebbles occur throughout the lower subsoil and the number increases somewhat in the deeper layers.

This soil occurs on undulating to moderately sloping relief along streams and on low morainic knolls. The slope ranges from 3 to 15 percent. Drainage is well established, but on the more nearly level areas runoff is slow. It is the most extensive soil type (22,848 acres) in the county.

Some areas that lie near areas of Princeton soils may contain relatively large quantities of fine sand in the surface layer. The depth to bedrock varies from place to place; in the vicinity of Nast Chapel, the glacial till mantle is 5 to 25 feet thick. Another variation occurs south of Waverly, and southeast of Morgantown, where the depth to lime carbonate is less than 40 inches.

The native vegetation consisted principally of a mixed hardwood forest of maple, beech, and walnut, with some elm, white oak, and hickory. The timber has been cut and practically all the area is cultivated or used as pasture. Corn, wheat, and hay are the principal crops and are usually grown in a 3-year rotation. Corn is usually grown after hay. Most fields are plowed in spring because severe erosion may occur on sloping land that is plowed in fall. Corn is usually planted between May 10 and 20. Yields are 35 to 45 bushels an acre under present management. Wheat is usually seeded in the standing corn, and yields average 20 bushels an acre. Practically all farmers fertilize wheat with 125 to 150 pounds of 2–12–6 or 2–12–12. Manure is used on the wheatland, and if there is a surplus, it is used on cornland. The most common hay mixture consists of red and alsike clover, redtop, and timothy. Alfalfa and white sweetclover are grown to some extent in fields that are adequately limed. Soil erosion can be arrested on the more sloping areas by growing less clean-tilled and grain crops and keeping a good ground cover during winter. As crop yields decline a high proportion of the type is used for hay and pasture land. Some fields are mowed for several years and then used as pasture.

Russell silt loam, level phase.—The level phase differs from the typical soil in that it is situated on nearly level relief similar to that of Fincastle silt loam. The surface soil and subsoil are similar to it in color and texture.

Good internal drainage is probably due to the presence of porous layers of sandy or gravelly till at relatively shallow depths. Scattered areas totaling 128 acres occur mostly in the vicinity of Monrovia.

The soil is more easily tilled than the typical soil because of the nearly level relief. Damage by soil erosion is negligible, and areas of this level phase can be plowed in fall. Moisture relations are somewhat better than on the more rolling areas; therefore, corn yields are slightly higher. Data regarding agricultural practices and crop yields are not available because the small areas are included in fields composed principally of other soils, and the data reported are representative of these associated soils.

Russell silt loam, sloping phase.—The mantle of soil and glacial till is thin, and sandstone and shale bedrock lies at a depth of 3 to 5 feet. In many places calcareous till is absent, and the subsoil rests directly on the bedrock. These sloping areas have a low moisture-holding capacity and are susceptible to erosion.

This soil occurs on the high ridge between Monrovia and Mooresville where the slope ranges from 10 to 15 percent or more. A total of 192 acres is mapped. Practically all areas are in forest with only a few in permanent bluegrass pasture.

Russell silt loam, eroded sloping phase.—The eroded sloping phase differs from the typical soil in that from 25 to 75 percent or more of the surface soil has been removed by accelerated erosion. In most places the surface soil is light yellowish-brown silty clay loam or heavy silt loam, varying as to the quantity of the subsoil that has been mixed with it in plowing. The content of organic matter is lower than in the typical soil. An occasional gully cuts into and exposes the subsoil. The subsoil and parent material are similar to the corresponding layers of the silt loam.

In most places this soil occurs on gradients of 6 to 15 percent. These slopes have been partly or wholly denuded of their surface soil through failure to use methods that would protect the bare soil from rapid runoff. The plow soil increases in plasticity and becomes less permeable to moisture as increasing quantities of subsoil are mixed with it. These factors tend to increase the rate of erosion as they decrease the capacity of the surface soil to absorb water. Where tillage operations are performed up and down the slope, the rate of runoff is increased. Small gullies that start in the cultivated furrows are common. When small these may be plowed in but they may deepen until that method becomes difficult. When physical conditions are impaired, crop yields are lowered, and this land lies idle or is used only for meadow or pasture. This soil, totaling 3,904 acres, is widely scattered in numerous small areas on the steeper slopes of the typical soil.

Wheat, corn, and hay are the most important crops. Corn is not recommended for these sloping areas, as the yields are low and erosion is accelerated by clean cultivation. Mixed hay is more widely grown than red clover for hay.

Russell silt loam, gullied sloping phase.—This soil differs from the eroded sloping phase in the severity of erosion, particularly in the presence of gullies. On most areas the gullies are less than 100 feet apart, and the intergully areas are severely sheet eroded.

The yellowish-brown to brownish-yellow subsoil is exposed nearly everywhere, and many gullies cut into the underlying yellow and gray glacial till. In a few places gullies completely cover the area, making it devoid of vegetation and unsuitable for agricultural use. Most areas are idle or are part of pastures.

Gullied areas occur in widely scattered areas that are in various stages of destruction, but most frequently in the highly dissected area northwest of Morgantown. The total area mapped is 640 acres.

Russell silt loam, steep phase.—The phase resembles the typical soil in most respects, but the several layers are thinner and the calcareous till substratum lies at a depth of 40 inches or less. The texture ranges from a silt loam to loam. It occupies slopes of 15 to 35 percent gradient. This soil (9,344 acres) occurs in narrow strips along streams in the eastern part of the county.

About 75 percent of this phase has been cleared of timber and 30 to 40 percent of the cleared part is now cropped. About 5 to 10 percent of the area consists of idle land or low-grade pasture land located principally on eroded or overgrazed areas. Due to the steepness of the slopes they erode readily when clean-tilled crops are grown on them, and many farmers use these steep areas as pasture or woodland.

Included are several small areas where the soil is only 3 to 5 feet thick, and sandstone and shale outcrop on the hillside. These areas are shown on the map by rock-outcrop symbols.

Russell loam.—The soil consists of a thin veneer of wind-assorted sand overlying a heavy silty clay loam subsoil. The mixed character of the soil is due to the deposition of sand on glacial till. The 6- to 8-inch light yellowish-brown surface soil is slightly coherent fine sandy loam to a friable loam. The surface soil is low in organic matter and moderately acid. It is less droughty than most soils of comparable texture because the heavy subsoil has a high moisture-holding capacity. The 12- to 20-inch subsoil is yellowish-brown to brownish-yellow heavy silty clay loam and in some places is moderately heavy clay loam. It is medium to strongly acid in reaction. The lower subsoil is yellow-brownish friable silty clay loam that is slightly acid in reaction. The substratum is gray and yellow calcareous glacial till.

This rolling well-drained soil occurs in scattered areas in the northwestern part of the county between Messena and Eminence and in the vicinity of Monrovia. The total area mapped is 640 acres.

Associated with areas of the Princeton soils, this soil occupies gently undulating topography. Erosion is not a serious problem because the loamy surface soil readily absorbs rainfall.

Corn, wheat or rye, soybeans, and mixed hay are the principal crops. Small grains and hay are somewhat better suited than corn. Mixed clovers and timothy are grown for hay. Some special crops, particularly watermelons and cantaloups, are grown. Yields are slightly lower than on Russell silt loam; corn averages 35 to 45 bushels, and wheat, 16 to 20 bushels an acre.

Fincastle silt loam.—This soil has a smooth light brownish-gray medium granular surface soil 6 to 8 inches thick. The 12-inch subsurface layer is light brownish-gray silt loam, with some yellow mottling. The structure of this layer is medium granular. The organic-matter content is low, and the soil is medium to strongly acid. Under forested conditions the upper 3-inch layer is moderately dark gray and contains a moderate supply of organic matter, which is mixed through the plow soil when the land is cultivated, and with continuous cropping and exposure to the sun, the supply is depleted. Because of imperfect drainage conditions and the low organic content, the soil tends to puddle and bake. The 12- to 18-inch subsoil consists of mottled gray, yellow, and rust-brown smooth silty clay loam that is medium to strongly acid in reaction. From 18 to 45 inches is a heavy more compact silty clay that breaks into subangular aggregates ½ to 1½ inches in diameter. Moisture movement through this layer is slow. The reaction is medium to strongly acid in the upper part and slightly acid in the lower part. The parent material lies at an average depth of about 45 inches. It is gray and yellow moderately compact calcareous glacial till. Few variations from this description occur, but in a few places the surface soil is moderately gritty. In the eastern part of the county there is some variation in depth of leaching, as lime carbonates occasionally occur within a depth of 36 inches. In these places the surface soil and subsoil may be somewhat less acid.

This light-colored, imperfectly drained soil occurs on very gently undulating to nearly level areas in the eastern and northwestern parts of the county. Surface drainage is imperfect, and internal drainage is slow because of the heavy subsoil. Much of it has been tile drained. It is associated with Russell soils, which occupy sloping land, and intermingled with small areas of Brookston soils, which occupy depression areas. Most individual areas of the 13,184 acres mapped are small.

The original vegetation consisted of a great variety of broadleaved trees, the most common species being beech, sugar maple, elm, sweetgum, blackgum, and white, black, and pin oaks.

Almost all of this soil is cultivated, as only a few widely scattered areas of woodland remain. The crop rotation commonly followed consists of corn, wheat, and clover or mixed hay. Corn is grown on about 30 percent of this type and yields 35 to 40 bushels an acre. Wheat is grown on about 25 percent of the soil and is usually seeded in standing corn. Most farmers fertilize wheat with about 150 pounds of 2–12–6 fertilizer. The proportion planted to corn and wheat is slightly higher than on the well-drained associated Russell silt loam. Hay is probably grown on 15 percent of the type, most of it being mixed clover and timothy. Liming is usually a prerequisite to the successful growth of clover and alfalfa, but a few farmers report satisfactory results with clover without liming. Soybeans are grown largely as a hay crop, and yields range from 1 to 3 tons.

Fincastle loam.—This soil is similar to Fincastle silt loam except that the surface soil is loam. The lighter texture of the surface soil is probably due to deposition of sand by wind, but the glacial parent material also contains a higher proportion of sand in some places. Although the 6- to 8-inch light brownish-gray loam surface soil is low in organic content, this soil is easily kept in good physical condition and does not puddle and bake to so great an extent as the silt loam. To a depth of about 18 inches the subsoil is mottled gray and yellow friable clay loam. The clay content and compactness increase with depth, and the deeper subsoil is somewhat impervious to moisture movement. Below 3 feet the clay content decreases. The soil is medium to strongly acid. The calcareous parent material lies at a depth of 45 to 50 inches.

Most areas are in the northwestern part of the county, near the valley of Mill Creek. A total of 640 acres is mapped. This type is cropped about the same as the silt loam, corn, wheat, and mixed hay being the principal crops, but the yields are slightly lower.

Delmar silt loam.—To a depth of about 6 inches the surface soil is light brownish-gray to light-gray smooth granular silt loam that is much lighter colored when dry. To a depth of about 12 inches the subsurface soil is gray silt loam stained and mottled with rust brown. The structure is medium granular; "turkey-shot" gravel, or small rust-brown or yellow concretions, are common on the surface and through the soil mass. Between depths of 12 and 18 inches the subsoil is a rust-stained gray smooth silty clay loam. At 36 inches the lower subsoil is mottled gray and yellow plastic impervious silty clay. A zone, about 1 foot thick, of rather friable clay loam separates this and the calcareous glacial drift parent material that lies at an average depth of about 45 inches. The soil is medium to strongly acid in the upper layers. It is locally known as "beech land" and also as "hickory-brush land" because hickory sprouts usually encroach on the meadows and pastures.

This soil occurs on the nearly level areas associated with Fincastle silt loam. Most individual areas are small, and the total area is only 320 acres. The cropping system is similar to that of Fincastle silt loam, but the soil is less intensively used, as it is more poorly drained and crop yields are lower.

SOILS DEVELOPED ON CALCAREOUS ILLINOIAN GLACIAL DRIFT

Illinoian glacial drift has been in place much longer than the drift left by the glaciers of the Wisconsin glacial age. Soils developed on it are more thoroughly leached, very strongly acid, and relatively unproductive. Lime has been leached from the parent material to a depth of about 10 feet. Most of the region is thoroughly dissected, but in the west-central part there are extensive level areas. Soils developed from Illinoian drift are of the following series: Cincinnati, Grayford, Parke, Banta, Gibson, Vigo, Avonburg, and Loy. Considerable variation in crops grown and in kind and intensity of agricultural practices exists among the various soils. Most of the variation is the result of differences in natural drainage conditions. About 35 percent of the area is steeply sloping nonarable land; about 35 percent is well drained arable land; and the rest is nearly level to undulating land that is imperfectly or poorly drained.

The Cincinnati, Grayford, Parke, and Banta soils have been developed under good natural drainage conditions. They occupy rolling topography that provides good to excessive surface drainage. The subsoils are friable, except in the Grayford soils, and, even though some layers are fine-textured, they have a structure that permits percolation of water and provides good internal drainage. Cincinnati silt loam is developed on rolling topography from Illinoian till that has been leached to an average depth of 10 feet. It has a light yellowish-brown surface soil and a yellowish-brown subsoil.

Grayford silt loam is developed partly from highly leached Illinoian till deposits and partly from limestone. The surface soil is light yellowish brown with a yellowish-brown subsoil that becomes reddish brown at a depth of 40 inches or more. The subsoil is more friable and crumbles more easily than in the Bedford or Frederick series because of the presence of small quantities of glacial grit and fine gravel. Tough waxy reddish-brown clay overlies the limestone, which lies at a depth of 7 feet or more.

Parke silt loam is developed on sandy drift or stratified sand and gravel on nearly level to rolling relief and has a light yellowish-brown surface soil and a yellowish-brown subsoil grading into weak reddish brown. Banta silt loam differs from the Parke soils in that calcareous gravel lies at a depth of about 8 feet. The entire profile is better oxidized, with a reddish-brown more gravelly subsoil than that of Parke. Gibson silt loam is developed on medium-textured calcareous till on nearly level to gently sloping relief under moderate natural drainage conditions. It has an impervious siltpan horizon at a depth of 2½ to 3½ feet.

The Vigo, Avonburg, and Loy soils are developed on nearly level relief under imperfect to poor internal drainage conditions. The Vigo and Avonburg soils have light brownish-gray surface soils and mottled gray and yellow subsoils. They differ principally in the depth to the impervious siltpan—it occurs at a depth of 10 to 20 inches in the Vigo and 30 to 40 inches in the Avonburg. The Loy soils have a light-gray rust-stained surface soil and subsoil and a siltpan at a depth of about 18 inches.

A general type of farming prevails over the region as a whole, and the land is about equally divided among crops, pasture, and timber. Practically all of the land that is not steep or poorly drained is in crops.

In the central and southern parts soils developed on Illinoian glacial drifts have been highly dissected, and the land available for crops is on long narrow branching ridges. The fields are irregular shaped. In this region the land suitable for crops has been further reduced by erosion. Many rolling ridge-top fields have been abandoned or are used as hay or pasture land. Most of the steep hillsides have been kept in woodland. In this area a system of general farming is followed with a limited degree of specialization in dairying, orcharding, and special crops, as tomatoes and snap beans.

In the west-central part there is a part of the Illinoian till known locally as the flats that has not been thoroughly dissected. The valleys are shallow, and the relief is generally less than 30 feet. Poorly drained soils on nearly level land occupy about two-thirds of the area. Few slopes around drainageways are too steep to be cultivated. In this region 80 percent or more of the original forest cover has been removed, and a high proportion of the land is cropped. In general, a 3-year rotation of corn, wheat, and mixed hay is practiced, but the corn acreage is two to three times as great as either the wheat or hay. The soils in this group are strongly acid and not suited to most legumes, but red clover can be successfully grown after applying 2 to 4 tons of ground limestone an acre. Red clover forms a part of most meadow mixtures but is seldom seeded alone, as timothy, redtop, and other grasses are more tolerant of strongly acid soils.

Cincinnati silt loam.—This soil is developed on ridge tops under good natural drainage (pl. 1). Originally it was covered with an oak-hickory forest that included black, white, and red oaks and pignut and shellbark hickories. The parent material is moderately calcareous medium-textured yellow and gray till that was deposited during the Illinoian glacial period and is similar to that on which the Miami and Russell soils have developed.

In forested areas the surface soil to a depth of 1 or 2 inches is moderately dark brownish-gray silt loam containing a relatively high proportion of organic matter. The subsurface, to a depth of 10 or 12 inches, is light yellowish-brown mellow to heavy silt loam, very low in organic content. Where cultivated, the upper 6 or 7 inches of these two layers have been mixed and the resulting surface soil is light yellowish-brown silt loam. The 20- to 24-inch subsoil is yellowish-brown silty clay loam that breaks into subangular aggregates about ½ inch in diameter in the upper part and ½ to 1½ inches in the lower part. The deeper subsoil is moderately compact and has a higher clay content. Usually at a depth of about 3 feet the soil becomes slightly mottled gray and yellow and a slightly impervious siltpan is developed. Beneath this the soil is friable and gritty. Gray and yellow calcareous glacial till, representing the parent material, lies at an average depth of 10 feet. The soil, within a few inches of the parent material, is strongly acid.

Roots penetrate easily into the subsoil. The water-holding capacity is good, but, as runoff is high, corn yields may be reduced by long periods of drought. Sheet erosion is potentially severe on cultivated areas. Slip erosion also occurs on the steeper areas. Gullies, once started, cut rapidly and deeply into the subsoil.

A total of 15,168 acres is mapped. A few areas have a thin veneer of fine sand or small quantities of sand mixed through the surface soil. These occur in the vicinity of areas of Princeton soils and on the narrow fingerlike ridges that border the outwash plain between Martinsville and Mahalasville.

Three-fourths of the area was once cleared and cultivated, but only about one-fourth of it is now cropped and about one-third is in pasture. Different factors have contributed to its abandonment. Among them are the small irregular size of many areas on which cultivation with modern machinery is difficult, severity of erosion when fields are not properly managed, and comparative isolation of many areas. Corn and wheat are the principal cultivated crops. Mixed clover and timothy hay are grown extensively, as alfalfa and sweetclover are not well suited to this strongly acid soil. It is necessary to apply 3 or 4 tons of lime for the successful growing of clover. Many pastures consist of a thin stand of redtop, timothy, Canada bluegrass, broomsedge, poverty grass, and weeds, but some pastures in the western part of the county contain a little Kentucky bluegrass. Sassafras, sumac, and briers come in where pastures are poor or are not properly limed and fertilized.

Cincinnati silt loam, shallow phase.—This shallow phase occurs where the deposit of glacial till on sandstone, siltstone, and shale is less than 10 feet thick. The surface soil and subsoil are completely leached

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of carbonates, but in other features they resemble the upper layers of the typical soil. A total of 512 acres is mapped.

As this phase occurs on rolling relief, it is subject to severe sheet erosion. Many areas have been abandoned in recent years and are reverting to brush and trees.

About 20 percent of this soil is used for farm crops; about 45 percent is former cropland that now has a cover of broomsedge and poverty grass and is classified as waste, idle, abandoned, or low-grade pasture land; about 10 percent has been idle long enough for natural reforestation to be taking place; and about 25 percent was never cleared.

Cincinnati silt loam, eroded sloping phase.—Although resembling the typical soil, this phase is situated on slopes of 7 to 15 percent, and in most places the depth to the yellowish-brown silty clay loam subsoil is less than 12 inches. In plowed fields this soil has a somewhat spotted appearance. In most places several inches of the light yellowish-brown surface soil has been removed by erosion and the present surface is yellowish brown or brownish yellow mixed with small spots of light yellowish-brown surface soil that has not been removed.

Widely scattered gullies, 2 feet or more deep, are in some areas. This erosion is the result of improper management practices on the sloping soils. Areas (aggregating 1,920 acres) are scattered throughout the Illinoian till plain in association with the typical soil.

The agricultural value of the soil depends mainly on the depth of the surface soil. The subsoil is more strongly acid, has a lower content of plant nutrients, and becomes harder when dry than the surface soil, consequently yields are low. All this soil was formerly cultivated, but, at the present time, only a small proportion of it is in crops and the rest is covered by broomsedge and is classed as low-grade pasture or idle land.

Cincinnati silt loam, gullied sloping phase.—This phase is similar to the eroded sloping phase, except that erosion is somewhat more serious, as numerous gullies 3 feet or more deep occur in all areas.

The total area mapped is 1,728 acres. In areas where glacial deposits are shallow, sandstone or shale is exposed in the bottoms of some of the gullies. In most areas little attempt has been made to control erosion. They can, however, be reforested. A few small areas occur in cultivated fields, but most of them have been abandoned. Gullied areas also occur in grazed or burned-over forests, and several small areas of Parke silt loam, gullied sloping phase, have been included with this separation.

Cincinnati silt loam, steep phase.—The steep phase resembles the typical soil, but it occurs on slopes of more than 15 percent, and the various layers are thinner and calcareous glacial till may be at a depth of less than 6 feet. In a few areas the underlying till is completely leached and the soil is underlain by sandstone, siltstone, and shale outcrops on the steep lower slopes.

Most of these steep slopes are covered with mixed hardwood forest. About 25 percent of the 17,728 acres mapped has been cleared, but less than 10 percent is tilled, and the rest consists of idle land or pasture. Pastures are of low quality and are composed largely of broomsedge, tickle grass, poverty oatgrass, and redtop, with some Canada bluegrass and lespedeza.

A few areas included with this phase have loam texture. Most of these areas are on the east side of the West Fork White River and border areas of the Princeton soils. A thin veneer of sand, usually less than a foot deep, forms the surface soil on some areas. Most of it occurs on upper slopes and has been cleared and used for pasture. Also included are a few steep areas where there is no calcareous till between the soil and the sandstone, siltstone, shale, or limestone bedrock and a few areas where the substratum is assorted calcareous gravel. These last mentioned would have been mapped as a steep phase of Parke silt loam if they had been more extensive.

Grayford silt loam.—This soil occurs on undulating to rolling upland areas and includes numerous shallow limestone sinkholes caused by solution of the underlying limestone. This area was overridden by the Illinoian glacier and was covered by a thin deposit of glacial till, which originally contained a small proportion of limestone that has been removed. The underlying Harrodsburg limestone consists of a shaly impure brownish-gray limestone containing numerous fossils.

In forested areas the 2- or 3-inch surface layer consists of a dark-brown smooth mellow silt loam that is high in organic matter. This material is underlain to a depth of 10 to 12 inches by light yellowish-brown silt loam containing a relatively low quantity of organic matter. In cultivated fields the surface soil is light yellowish-brown silt loam to a depth of 6 to 8 inches. The 18-inch subsoil is yellowish-brown friable silty clay loam that breaks into subangular aggregates a fourth to half an inch in diameter. The deeper subsoil, to a depth of about 36 inches, is reddish-brown to yellowish-brown tough moderately compact silty clay loam to silty clay. The subsoil contains variable quantities of glacial material, but on many of the high knolls along the southern border of the county west of Alaska there is little glacial material. Here the soil is developed largely from limestone and has a tougher more compact subsoil that is generally reddish brown above 3 feet. At lower depths the subsoil is more friable and contains small quantities of grit and rounded siliceous glacial pebbles. At a depth of about 5 feet the subsoil is reddish-brown friable clay loam. The entire profile is strongly acid in reaction. Overlying the limestone, which lies at a depth of about 8 feet, is weak reddish-brown plastic clay 6 to 9 inches thick that contains small quantities of partly decomposed bluish gray limestone containing numerous fossils and an occasional chert fragment.

Surface drainage is moderately rapid. Slopes generally range from 3 to 8 percent, and the more sloping areas are susceptible to severe erosion. A total of 2,880 acres is mapped.

Native vegetation consisted of mixed hardwood, as red, white, and black oaks, hickory, beech, maple, ash, elm, and walnut. About 85 to 90 percent of the land had been cleared and cultivated. Crops now occupy approximately 65 percent of the area; the rest of the cleared land is largely in pasture.

A grain-and-livestock system of farming is generally followed in which the principal rotation consists of corn, wheat, and mixed hay. Corn yields average 25 to 35 bushels an acre, but higher yields are obtained on the better managed areas where soils are limed, legumes are grown, and fertilizer is used. Cornland usually receives 60 to 100 pounds of fertilizer. Applications of fertilizer for wheat range from

100 to 200 pounds of 2–12–6, and wheat yields are 12 to 20 bushels. Small acreages of oats, rye, and soybeans are grown. The hay mixture consists of red clover, alsike, timothy, redtop, and occasionally alfalfa, which is seeded in wheat. Owing to frequent crop failures, red clover is not generally grown alone unless the soil has been limed. Very little alfalfa is grown alone, but it can be successfully grown if the soil has been adequately limed and fertilized. This soil is strongly acid, and as fertility is moderately low, broomsedge is common in many pastures. The use of longer rotations with a higher proportion of winter-grown crops would materially reduce erosion and tend to maintain crop yields. Applications of lime and fertilizer would greatly increase the carrying capacity of many of the pastures.

Grayford silt loam, level phase.—This soil is similar to the typical soil, except that it is situated on nearly level slopes with gradients of 1 to 4 percent. The total area mapped is 448 acres. Water runs off slowly and erosion is not difficult to control. Crop yields are generally somewhat higher and fertility is more easily maintained than on the typical soil.

Grayford silt loam, eroded sloping phase.—The eroded sloping phase is similar to the typical soil, but it occurs on slopes of 8 to 15 percent. In most places, the combined depth of surface and subsurface layers is less than 8 inches, and in some places the reddish-brown or yellowish-brown subsoil is exposed. This soil occurs around sinkholes and drainageways. The heavy subsoil absorbs water slowly, therefore, during heavy rains serious erosion of the surface soil and subsoil may result.

The yields of the various crops depend largely on the depth of the surface soil and are lower than on the typical soil. Most areas are too small to be farmed separately but are included in fields of the typical soil. Where possible these sloping areas may be used for hay or pasture in order to control erosion. The total area shown on the soil map is 128 acres, but many areas too small to show on a map of this scale are included with Grayford silt loam.

Grayford silt loam, steep phase.—This phase occurs principally in the west-central part of the county in places where streams have dissected the till-covered limestone plain. The area mapped (256 acres) occurs on slopes of 15 to 30 percent or more. The soil is shallower to rock but otherwise is similar to the typical soil. It is too steep and too erosive for successful cropping but is suited to pasture or forest. A small part of it is used for general farm crops.

Parke silt loam.—Developed under a timber cover on rolling well-drained areas, this soil has a relief of less than 20 feet. In wooded areas the surface soil is dark brown to a depth of 1 to 3 inches. This soil is mellow and relatively high in organic matter. The 10-inch subsurface is light yellowish-brown friable granular silt loam that is low in organic matter. In cultivated fields these layers are mixed to a depth of about 7 inches to form a light yellowish-brown silt loam. The 18-inch subsoil is friable yellowish-brown to weak reddish-brown silty clay loam that becomes more compact and heavier with depth. At depths varying from 40 to 80 inches the subsoil becomes weak reddish-brown friable clay loam. The sand content of the deeper subsoil varies

Oblique aerial view (looking northwest) of Nebo Ridge. Land use pattern is adjusted to landscape. Ridge tops (Cincinnati silt loam) are cleared and slopes (Cincinnati silt loam, steep phase) are wooded. Note severe erosion in lower left where slopes are cleared.

PLATE 2

Oblique aerial view of West Fork White River about 1½ miles south of Paragon. This illustrates typical use of Genesee and Eel soils Note sand bars and ox bows of old channels somewhat, but in most places it is friable reddish-brown moderately coherent loam to a depth of 10 feet or more. This soil is strongly acid, but in most places calcareous sand and gravel lie at a depth of 10 to 15 feet.

This soil occurs in scattered areas totaling 960 acres in the Illinoian drift region. Most individual areas are small, but large ones are located west and northeast of Martinsville.

Most of the gently sloping areas are cleared. This soil is suited to farm crops, as corn, wheat, and hay, but much of the cleared land is pastured. The more rolling areas are susceptible to severe accelerated erosion when improperly managed. Occasional gullies develop and cut rapidly into the friable substrata. Soybeans and clean-tilled crops increase erosion on sloping areas. The average yield of corn is 30 to 35 bushels an acre, which is higher than that obtained on Cincinnati silt loam and other associated soils. As internal drainage and ease of root penetration are favorable, alfalfa and clover are productive if the strong acidity is corrected.

Parke silt loam, eroded sloping phase.—The phase resembles the typical soil, but it occurs on more rolling areas and 25 to 75 percent or more of the surface soil has been removed by accelerated erosion. A total of 128 acres is mapped.

The surface soil, in most places less than 7 inches thick, has been entirely removed in spots, and the yellowish-brown or weak reddish-brown subsoil is exposed. A few gullies 2 or 3 feet deep occur in this soil. Because of the permeable and incoherent character of the deep subsoil, gullies become very deep once they have cut through the compact upper subsoil. Most areas are relatively unproductive for farm crops and are used mainly as hay or pasture land or are being reforested.

Banta silt loam.—This soil has developed on rolling morainic knolls under an oak-hickory forest cover on assorted calcareous gravel deposited during the Illinoian glacial period. In forested areas, the surface soil to a depth of about 3 inches is dark-brown smooth friable silt loam. The upper subsoil to a depth of about 12 inches is yellowish-brown friable granular silt loam that is low in content of organic matter. In cultivated areas the 6- to 8-inch surface layer is light yellowish-brown friable granular silt loam, low in organic matter. The 18-inch subsoil layer is yellowish-brown friable silty clay loam. This layer grades into weak reddish-brown smooth compact silty clay loam that is relatively free of grit to a depth of 3 feet. At lower depths the subsoil gradually becomes weak reddish-brown gravelly or sandy clay loam to loam relatively incoherent and only moderately retentive of moisture. Calcareous gray gravel and sand occur at a depth of 7 to 15 feet. This soil resembles Morgantown silt loam in profile characteristics, and some of it may represent eroded remnants of an outwash plain of the Illinoian age, but it more nearly resembles the Bellefontaine soils in relief and differs from them in the greater depth of weathering because of the greater age of the Banta soils.

As the slope varies from less than 10 percent to as much as 20, this type varies in character within short distances. Slopes of less than 10 percent are as described above. Gravel and sand may be exposed on the steepest slopes, the soil layers are thinner, and calcareous gravel may occur within 4 feet of the surface. In some places the surface texture is loam. In most places the surface soil and subsoil are thick enough so that moisture-holding capacity is fair, except on sharp ridges and steep slopes. Natural drainage is good to excessive. Cultivated areas on rolling relief are subject to accelerated erosion where not managed carefully. The steepest slopes have been included with Cincinnati silt loam, steep phase.

The 448 acres mapped occur on isolated areas in a belt extending northeast from Martinsville toward Exchange and paralleling an old outwash plain of the Illinoian glacial period. These areas occur as knolls in the plain and occasionally have pot holes and kettle holes.

Native vegetation consisted principally of oak and hickory. Much of the land has been cleared and is cultivated to general farm crops, and the crop adaptation is similar to that on Parke silt loam, but the yields are somewhat lower. North of Martinsville several successful orchards are on this soil.

Gibson silt loam.—In wooded areas the 1- to 3-inch surface soil is dark-brown mellow silt loam, high in organic matter. To a depth of about 12 inches the subsurface is light yellowish-brown to brownish-gray friable granular silt loam. When cultivated, the dark surface soil is mixed with the upper part of this subsurface to form a smooth friable soil. Because of the low organic content and the fine texture this plow soil may bake or pack after a heavy rain, and in some years seedlings cannot break through the crust. To a depth of about 21 inches the subsoil is friable light brownish-yellow silty clay loam. Below this material is mottled gray, yellow, and rust-brown heavy silty clay loam that is moderately compact and hard when dry. At depths of 30 to 36 inches is a very compact, strongly acid, mottled gray and yellow silty clay loam siltpan that impedes the movement of ground water. This layer breaks into irregular columns that are capped and coated with light-gray silt. The lower subsoil gradually becomes more friable. Medium-textured calcareous glacial till lies at a depth of about 10 feet.

This soil occurs on very gently sloping to nearly level areas where the gradient is usually less than 3 percent. It is situated on the broader ridges associated with the Cincinnati, Parke, and Banta soils in the highly dissected part of this region and also occurs along the shallow drainageways associated with Vigo, Avonburg, and Loy soils on the flats in the west-central part of the county. The total area is 7,040 acres.

The slope is usually sufficient to provide good surface drainage, but the water moves slowly and causes very little erosion. The heavy nature of the subsoil layers impedes internal drainage but not to such an extent that it is a limiting factor in the growth of ordinary crops in average years. A few farmers have tilled areas of this soil.

Originally this type was covered by a mixed stand of hardwoods—beech, sugar maple, red maple, pin oak, sweetgum, sourgum, and hickory—but the original timber has been removed from probably more than 80 percent of the area.

About 40 percent of the cleared land is used for crops and for pasture and the rest for miscellaneous uses. Corn, the principal crop, is grown on about 15 percent of the area. The yield averages 25 to 35 bushels an acre under good management. Wheat, next in importance, occupies about 10 percent of the type and yields 12 to 14 bushels. Fertilizer is commonly applied to wheat but only occasionally to cornland. Some farmers grow small acreages of tomatoes and sweet corn for canneries. The soil is strongly acid in reaction, and soybeans and lespedeza are the only leguminous crops that can be successfully grown without the use of lime, although soybean yields can be increased by applications of lime. Soybeans are grown mainly as a hay crop, the yield averaging 1 to 2 tons an acre. Common lespedeza volunteers in many meadows and pastures. Korean lespedeza is seeded as part of some meadow mixtures. Red clover is seeded in most mixtures but is not successfully grown until the soil has been adequately limed. In the western part a 3-year rotation of corn, wheat, and hay is generally followed. The soil is too acid for the growth of bluegrass, consequently pastures are of poorer quality than those on the less acid soils. Most pastures are dominated by broomsedge, poverty oatgrass, and tickle grass, with small quantities of redtop and Canada bluegrass, but a few have been improved with lime and fertilizer and contain a large percentage of bluegrass. Probably the greatest need for improving this soil is the application of lime so that more legumes can be grown to build up the organic and nitrogen content of the soil. The fertility level is generally low, therefore, the use of commercial fertilizers is beneficial.

Vigo silt loam.—The 1- to 3-inch surface soil in wooded areas is dark brownish-gray, fine granular silt loam. To a depth of 9 inches the subsurface is light brownish-gray smooth friable silt loam, with some rust-brown stains. In cultivated fields the 6-inch surface soil is brownish-gray or light brownish-gray friable granular silt loam. This soil puddles and bakes after rains, as the content of organic matter is low and the soil is very silty. The 16-inch subsoil is mottled gray, yellow, and rust-brown silty clay loam that is moderately friable when moist and hard when dry. Beneath this is a mottled gray, yellow, and rust-brown, very plastic compact layer that is impervious to moisture movement and that breaks into large columnlike blocks. At an average depth of 30 inches the light brownish yellow very faintly mottled with gray subsoil becomes more friable and silty and has small quantities of sand and pebbles.

The entire soil mass to a depth of about 8 feet is strongly acid in reaction, but below this it is less acid. The parent material consists of gray and yellow moderately compact calcareous glacial till.

This soil (4,672 acres) occurs in the west-central part of the county. It is an imperfectly drained soil developed under forest cover from Illinoian glacial till.

Occurring on broad flats this soil has a heavy, tight subsoil and is imperfectly drained, therefore, both percolation and runoff are slow. The encroaching drainageways result in local improvement in surface drainage adjacent to the stream. Artificial draining by tiling is practiced by a number of farmers. Tile, to be effective, must be placed at a relatively shallow depth of about 30 inches and close together.

Originally covered with a mixture of beech, maple, pin oak, sweetgum, and hickory, 90 percent of the type has now been cleared. Sixty percent of this soil is cultivated, 10 percent is idle land, and the rest of the cleared acreage is used as pasture. The most common rotation consists of corn, wheat, and mixed hay. Corn, the principal crop, occupies nearly 30 percent of the area. On undrained land yields are low, averaging 20 to 25 bushels an acre, but on drained areas yields of 30 to 40 bushels or more are obtained. Wheat is grown on 10 percent of the land and yields 10 to 15 bushels when fertilized. Oats, rye, and soybeans are minor crops. Soybeans are grown mainly as a hay crop. Timothy and redtop are commonly seeded for hay, as they grow better than clover on this acid soil. Clover can be grown on limed fields and is included in the hay mixture on many farms. A supplementary pasture and hay crop, as millet or Sudan grass, is grown by many livestock farmers. Pastures are generally of poor quality and contain a large proportion of broomsedge and poverty grass. A soil improvement program on this type should provide for adequate drainage, liming, increasing the organic content, and the use of more commercial fertilizer.

Avonburg silt loam.—Developed on nearly level relief on Illinoian glacial drift, this imperfectly drained soil is similar to Vigo silt loam, except that the impervious clay layer lies at a depth of 30 to 40 inches instead of about 16 inches.

This soil can be more successfully drained with tile than Vigo silt loam. Sufficient drainage is obtained in some fields by plowing in narrow lands, and in others by plowing dead furrows to connect with the slightly sloping areas of the adjoining Gibson silt loam. This silt loam occurs in local flats on the broader ridge tops northeast of Sand Creek Church and north of Maple Grove Church. A total area of 256 acres is mapped.

Corn and wheat are the principal crops, and yields are about the same as on Gibson silt loam. Red clover and other legumes cannot be grown without the use of lime, because of the strong acidity. A mixture of timothy and clover is seeded for hay in fields that have been limed.

Loy silt loam.—The 2-inch surface soil in forested areas is dark-gray silt loam. The 12-inch gray silt loam subsurface has many rust-brown spots and small hard "turkey-shot" gravel, or iron concretions. In cultivated fields to a depth of about 7 inches, the soil is light-gray smooth friable silt loam. The organic content of the plow soil is very low, and the soil becomes very hard following rains. To a depth of 27 inches the subsoil is mottled gray and yellow, stained with rust-brown, silty clay loam that breaks into irregular prisms or columnlike blocks a foot or more in height. The upper part of these blocks is capped with light-gray silt and is more friable than the lower part. At lower depths the brownish-yellow mottled with gray and rust brown soil is more friable and contains some grit and sand. The entire soil mass is strongly acid to a depth of about 8 feet, but the reaction is less acid below this depth and is neutral at the contact with the parent material. The parent material, which lies at a depth of about 10 feet, consists of yellow and gray moderately compact medium-textured calcareous glacial till, similar to that found under Vigo silt loam.

This soil occurs on nearly level areas, totaling 448 acres, associated with Vigo silt loam. It is one of the most poorly drained soils developed from Illinoian glacial drift.

This type is not so intensively used as Vigo silt loam because of its poor drainage and coldness in the spring. About 80 percent of it has been cleared and cultivated but much of this has since been abandoned, about half of it is still cropped, and the rest consists of low-grade pasture land or idle land. Corn, wheat, and mixed hay are about equally important. Soybeans are more extensively grown than formerly, as they are seeded rather late in the spring when the soil has become sufficiently dry for tillage operations and warm enough so that seeds will sprout.

On the soil map about 100 acres of Clermont silt loam are included with this type. These areas occur in association with Avonburg silt loam and differ from Loy silt loam in that the upper part of the subsoil is relatively friable and the compact impervious layer lies at a depth of about 30 inches.

SOILS DEVELOPED ON SANDSTONE, SILTSTONE, AND SHALE OF THE BORDEN FORMATION

Soils developed on sandstone, siltstone, and shale of the Borden formation comprise about 11 percent of the area of the county. They occur in the southern part and have developed from mixed fine-grained sandstone, siltstone, and shale under an oak-hickory forest cover. They are low in organic matter, light in color, strongly acid, highly leached, and are better suited to forestry than to agriculture. Occupying upland areas that were not overridden by glaciers, this region has been highly stream dissected and has strong relief. More than 80 percent of this area is on steep slopes unsuited to farming. One percent occupies nearly level to undulating relief, and the rest is in sloping relief and varies widely in suitability for crops. A large part of the land that has been cleared and farmed has been abandoned and is now covered with broomsedge. These areas will eventually be reforested by natural reseeding. Most of the farming is confined to narrow irregular ridge tops and stream bottoms. A general type of farming is followed in which corn is the principal crop. Little systematic crop rotation is practiced. Crops are grown mainly for feed, but limited specialization in dairying, poultry raising, orcharding, and truck-crop gardening occurs where roads, markets, or other conditions are favorable.

The soil series included in this group are Muskingum, Zanesville, Wellston, and Tilsit. Although the relief ranges from nearly level to very steep, none of these soils is poorly drained. The Muskingum soils, occupying about 70 percent of this area, occur on steep slopes, where excessive drainage and rapid runoff have produced a shallow soil, and in most places rest on bedrock at a depth of less than 2 feet. The Zanesville are developed on undulating to sloping relief on ridge tops and upper slopes under good natural drainage. The soil mantle is 4 to 6 feet thick on bedrock. The Wellston resemble the Zanesville soils but are developed on narrow ridges and are generally less than 30 inches thick over bedrock. The Tilsit soils are developed on nearly level relief on the broader rounded ridge tops; internal drainage is fair but is impaired to some extent by a siltpan that in many places is developed at a depth of 3 feet. The surface soil is light yellowish brown, and the upper subsoil is light brownish yellow, but it is mottled below a depth of 2 feet. Bedrock lies at a depth of 4 to 6 feet.

Muskingum stony silt loam.—In forested areas the surface soil to a depth of about 3 inches is dark-brown silt loam that is almost neutral in reaction. This is covered with a thin layer of leaves in various stages of decomposition. The subsurface is light brownish-yellow silt loam that in many places contains a small quantity of very fine sand. It grades at varying depths, in most places about 12 inches, into a mixture of brownish-yellow slightly gritty silt loam and fragments of sandstone, siltstone, and shale that is underlain by hard resistant brownish-yellow or grayish-yellow interbedded sandstone, siltstone, and shale, at a depth of 15 to 30 inches. The entire soil, with the exception of the dark-colored surface soil, is strongly to slightly acid. Fragments of hard resistant sandstone, siltstone, and shale of various sizes occur on the surface and throughout the soil. Because of the variable content of sandstone, siltstone, and shale in the parent rock considerable variation occurs in the texture of the soil and in the quantity and kind of rocks present on the surface and in the soil mass. Where shale or siltstone forms a large part of the parent material the soil is more silty and shale or siltstone fragments occur on the surface and in the soil.

This soil is developed on steep slopes associated with the Zanesville and Wellston soils in the Borden region of the central and southern parts of the county. It also occurs on long steep slopes in the glacial region where the drift capping was less than 50 feet thick and on slopes associated with the Frederick and Grayford soils where sandstone, siltstone, and shale outcrop below the limestone capping the ridges. A total of 14,976 acres is mapped.

Relief ranges from 100 to 200 feet or more and slopes have gradients of 20 to 50 percent or more. Runoff is extremely rapid, although little erosion occurs in wooded areas. Sheet erosion is severe, and shallow gullies develop on areas that have been cleared and cultivated. The native vegetation includes chestnut, black, and white oaks, the first two predominating on the dry upper slopes, shellbark and pignut hickories, and beech, sugar maple, and elm are numerous on the moist lower slopes.

Small acreages of crops are grown on the less stony and less steep upper slopes. Corn is the principal crop, although small areas are occasionally used for tobacco. Cropland is usually abandoned after a few years, because accelerated erosion is rapid. These areas revert to broomsedge pasture on which persimmon and sassafras sprouts encroach as the first step in reforestation. This land is best suited to forests, but tree growth is slow, and good silvicultural practices are needed to obtain greater returns.

Muskingum silt loam.—Developed largely from shale, this soil is similar in color to Muskingum stony silt loam. Shale fragments occur on the surface and scattered throughout the soil, but rock fragments are not so numerous as on Muskingum stony silt loam. Thin standstone strata outcrop in some areas. This soil (3,840 acres) is extensive between Blue Bluffs and Martinsville, and minor areas are along the southern border of the county. Only a few small areas are cleared and are largely in low-grade pasture.

Muskingum silt loam, colluvial phase.—In most places the 6- to 15-inch light yellowish-brown surface is gritty silt loam, but it varies from fine sandy loam to channery silt loam. The sandier areas are south of Martinsville where wind-blown sands are included in the soil material. The 30-inch subsoil is a dull-brown or brownish-yellow silty clay loam that in some places is mottled with rust-brown iron stains and gray. Beneath this the material is more friable and at depths of 5 feet or more is underlain by sandstone and shale. Rock fragments occur on the surface and throughout the subsoil and in some areas are numerous enough to interfere with cultivation. The soil is strongly acid throughout. Slopes range from 3 to 15 percent, consequently, runoff is rapid and the soil is susceptible to severe accelerated erosion when poorly managed. Many of the gullies and drainage channels are caused by water that accumulates on the slopes above.

Developed on material transported from the hillsides by the action of water and gravity, the colluvial phase occurs on gently rolling foot slopes at the base of hillsides. Most areas of the 320 acres mapped are small and occur as narrow bands. Original vegetation consisted of oak and hickory mixed with beech, maple, ash, and elm.

Many areas are cleared and cultivated, especially on those farms having a small acreage of arable land. Yields are generally low and this, together with the sloping relief and small irregular-shaped fields, has resulted in abandonment of most areas for crops. Corn, wheat, and soybeans are grown to a limited extent, but most of this soil is used for pasture. In general, pastures are poor and fields will eventually revert to forests.

Zanesville silt loam.—In forested areas there is a thin layer of newly fallen and partly decayed leaves on the surface and the 2-inch mineral soil is dark-brown or brownish-gray friable silt loam. The subsurface, to a depth of 12 inches, is light yellowish-brown smooth granular silt loam. In cultivated fields the surface to a depth of 6 to 8 inches is light yellowish-brown friable granular silt loam. The subsoil is yellowish-brown to brownish-yellow friable silty clay loam that may be faintly mottled with gray and yellow below a depth of about 30 inches. In some places this material is underlain by a moderately compact somewhat impervious layer at a depth of 36 inches. Below this is less compact mottled yellow and gray silty material. Bedrock, which lies at an average depth of 60 inches, consists of interbedded grayish-brown sandstone, siltstone, and shale. Small fragments of partly weathered rock occur in the layer immediately above the bedrock.

This soil is developed on undulating to sloping ridges, many of which are very narrow, in association with the Wellston, Muskingum, and, on the broader ridge tops, Tilsit soils. An area of 3,968 acres was mapped. The slopes range from 3 to 18 percent, but only those areas having gradients of less than 12 percent are suitable for intensive cropping.

In a few areas, some of which are just north of Martinsville, the upper part of the soil is very high in silt content. It is possible that wind-blown silt may have been deposited on these areas. In these places the depth to bedrock ranges from 5 to 9 feet. In other counties, where this condition is definite, such soils are called Hosmer silt loam. On sharp narrow ridges the depth of soil to bedrock is about 4 feet. In cultivated areas the surface soil varies in depth, as it has been partly removed by erosion. Sheet erosion is severe on the steeper slopes, and gullies are common in some places. When gullies start they deepen rapidly, as the subsoil is somewhat friable. Erosion is most severe on the sharp shoulders adjoining areas of Muskingum soils.

Native vegetation was an oak-hickory forest type dominated by black, red, and chestnut oaks. Persimmon, sassafras, and hickory occur frequently in old fields. Probably 60 percent of this type has been cleared of the original timber, but less than 25 percent is now cultivated, as many fields have been abandoned and a large acreage is included in the Morgan-Monroe State Forest. Corn and wheat are the principal crops. Corn yields 25 bushels an acre, and wheat, 12 to 15 bushels. Because this soil is very strongly acid, clover can be grown only on areas that have been limed. Special crops are grown to a limited extent with variable success. North of Martinsville where air drainage is favorable several successful apple orchards are located on this soil. The deeper more silty soil in this region is somewhat better suited to orcharding than most areas of the type.

Where the ridge tops are narrow, this type constitutes a small proportion of the total land area and, with the associated Wellston and Muskingum soils, should be used for forestry. The broader ridges are more suitable for farming, as it is difficult to use labor-saving machinery on small irregular-shaped fields. The high loss of rainfall by runoff and susceptibility to erosion are other factors limiting land use and productivity.

Zanesville-Wellston silt loams, eroded hill phases.—Associated with Zanesville silt loam are 320 acres of land that have been eroded to the degree that there are less than 6 inches of the original surface soil remaining. This condition usually prevails on the steeper land at the edges of the ridges where the slope is about 15 percent. The surface soil is completely removed in many places, and the yellowish-brown subsoil is exposed. Shallow gullies are common in some areas. This soil is underlain by sandstone, siltstone, and shale at depths of 2½ to 6 feet. On the areas having rock at shallow depths the soil is Wellston silt loam and the siltpan layer is not developed.

Probably about 5 percent of this complex is now being cropped but, formerly, it was all cropland. Wheat and hay are the principal crops. Yields are low, as the physical condition is poor and the fertility low. Most of this soil has a cover of broomsedge, poverty grass, and in a few places common lespedeza. About 15 percent has little cover of any kind on the bare eroded subsoil, and about 70 percent is covered with briers, brush, and sprouts of forest trees. A grass cover is stabilizing erosion in many places. Lespedeza and black locust are desirable plants that can be grown on this land, as they retard erosion and also increase the nitrogen and organic-matter content so that more desirable species of trees can eventually be grown. The more sloping, erosive, ridge tops are better adapted to forestry than to farming.

Zanesville-Wellston silt loams, gullied hill phases.—In some places the eroded areas have been dissected by numerous gullies a foot or more deep. These areas occupy a total area of 448 acres. In some places, particularly in pastures, parts of the light yellowish-brown surface soil remain, and in many places the yellowish-brown subsoil is exposed. The depth to bedrock ranges from 2½ to 6 feet. This also represents a complex of both the Zanesville and Wellston silt loams. The land is not suitable for cropping and should be reclaimed for forest.

Zanesville-Wellston silt loams, steep phases.—This soil complex occurs on slopes of 18 to 30 percent, and the depth to bedrock is shallower than in Zanesville silt loam. It has developed under an oak-hickory forest, but much of it has, at some time, been cleared for farming. These steep areas are susceptible to severe accelerated erosion. Most of them have reverted to a broomsedge cover, and persimmon, sassafras, and hickory are returning. Most of the 3,264 acres mapped occurs as strips between the Zanesville ridge tops and the steeper Muskingum slopes. It is developed largely from shale that forms the parent material of a large part of the high ridge extending northward from Martinsville to the vicinity of Brooklyn.

Wellston silt loam.—In forested areas the surface soil to a depth of 2 inches is dark-brown friable granular silt loam, and the subsurface, to a depth of 10 to 12 inches, is light brownish-yellow silt loam. The soil of cultivated fields is light yellowish-brown friable silt loam low in organic-matter content. It is underlain by yellowish-brown friable silty clay loam extending to a depth of about 30 inches. The lower part of this layer is brownish yellow and more friable, as it contains considerable quantities of partly decomposed fragments of sandstone, siltstone, and shale. In a few places slight mottling occurs at the contact with bedrock. The parent material occurs at a depth of 24 to 36 inches and consists of relatively unweathered shale, siltstone, and sandstone.

This soil occurs on narrow ridge tops of the Borden formation in the southern part of the county. The slope ranges from 3 to 15 percent; runoff is rapid, and, in clean cultivated fields, accelerated erosion is difficult to control. The total area mapped is 320 acres.

Some areas were cleared of timber and cropped for a short time. Yields were low and the irregular-shaped fields were soon abandoned and are now reverting to forest.

Wellston silt loam, steep phase.—This phase is similar to the typical soil but is situated on slopes of 18 to 30 percent, and the depth to bedrock is less. Most of the 960 acres mapped occurs on the high Borden ridge extending from Martinsville to the vicinity of Brooklyn, and much of it lies between Zanesville silt loam on the ridge tops and Muskingum soils on the steep slopes. Many areas formerly cultivated are now being used as pasture, but owing to the poor quality of pasture they are gradually reverting to forest.

Tilsit silt loam.—The 10- to 12-inch light yellowish-brown smooth mellow silt loam surface soil is underlain by light brownish-yellow friable silty clay loam that becomes slightly heavier and more compact with depth. At about 18 inches it is mottled gray and yellow. A siltpan layer occurs at a depth of about 30 inches. This layer is mottled yellow and gray silty clay loam that breaks into vertical columns several inches in height. Below 42 inches the soil is more friable and less mottled and grades into sandstone, siltstone, and shale bedrock at a depth of 4 to 7 feet. The entire profile is strongly acid. Runoff is slow, and internal drainage is retarded by the presence of the siltpan layer.

This soil, totaling 256 acres, occupies nearly level relief on the broad divides where Zanesville silt loam occurs on the more sloping land. Most areas are on the broader ridges west of Brooklyn.

This type is extensively cropped. Rectangular fields can be laid out in many places. Drainage conditions and moisture relations are such that crops are not injured by standing water, and they usually have sufficient moisture during most growing seasons. Surface runoff is slow and erosion is easily controlled. Corn, wheat, and timothy are the principal crops, and yields are similar to those obtained on Zanesville silt loam.

SOILS DEVELOPED ON LIMESTONE

The soils developed on limestone occur on upland positions in the region of the Harrodsburg formation, which caps the ridges in the western and southwestern parts of the county. These soils are inextensive, occupying less than 1 percent of the area, and have undulating to rolling relief. They have developed under a mixed hardwood forest cover. Frederick and Bedford soils are included.

In cultivated fields the surface soil is light yellowish brown friable and silty, and the subsoil is reddish brown to yellowish brown, smooth, and relatively tough and compact. The structure is favorable to root penetration, and the soil crumbles readily into angular aggregates an inch or less in diameter. The soil profile is strongly acid and is leached of lime carbonates to a depth of 6 to 9 feet.

This group of soils is well suited to the mixed grain-and-livestock system of farming that is generally followed. The relief is favorable for farming, and probably more than 80 percent of the ridge tops has been cleared and farmed; 65 percent is used for farm crops, the rest consisting of pasture and timber. Corn and wheat are grown in a 3-year rotation with mixed hay. Minor crops are oats, rye, soybeans, and alfalfa. Orcharding is successful on areas having favorable air drainage.

Frederick silt loam.—This soil occurs on gently sloping to undulating relief in the southwestern part of the county. It is a well-drained soil developed on limestone of the Harrodsburg formation and is somewhat similar in character to the Grayford soils but does not have glacial material included in the parent material. Developed under a mixed hardwood cover, this type occurs on slopes of 4 to 10 percent. The total area mapped is 832 acres.

Under forest cover the surface soil consists of 2 or 3 inches of dark-brown smooth mellow silt loam. In cultivated areas the 6- to 8-inch surface layer is light yellowish-brown friable granular silt loam. The subsurface is light yellowish-brown silt loam to a depth of 10 to 12 inches. The light yellowish-brown to slightly reddish-brown heavy silty clay loam subsoil grades into weak reddish-brown compact silty clay that is plastic and sticky when wet. Below a depth of 3 feet it is somewhat more friable and contains geodes and fragments of chert.

At a depth of 4 feet the subsoil consists of tough, waxy, reddish-brown clay that contains chert fragments and fossils of crinoids. The parent material consists of brownish-gray interbedded limestone and shale that contains many geodes and fossils of crinoid stems.

In some places the limestone is thin or absent, and the lower subsoil lies directly on shale and sandstone of the Borden formation. In a few areas where the parent material consists of interbedded shale, sandstone, and limestone, the soil is shallow, more friable throughout, and the subsoil is yellowish brown. Occasional shallow sinkholes, 5 to 10 feet deep, occur in many areas.

The land use is similar to that of Grayford silt loam; corn, wheat, and mixed hay are the principal crops grown.

Frederick silt loam, eroded phase.—The eroded phase resembles the typical soil but occurs on slopes ranging from 8 to 20 percent where a large part of the surface soil has been removed by erosion. In some areas the yellowish-brown to reddish-brown subsoil is exposed. The thickness of the light yellowish-brown surface soil usually averages less than 7 inches. In parts of some areas the surface soil may have normal depth and in other places it is almost entirely lost. Under clean-tilled crops, erosion is more severe. A large part of this soil is used for hay or pasture. The total area is 128 acres. Included with Frederick silt loam, eroded phase, on the soil map are about 50 acres that have been destroyed for crops by the formation of numerous gullies. These areas occur as narrow strips along the sharp crests of hills or as small areas at the heads of draws such as those occurring in the vicinity of New Salem School. Most gullies are shallow, as they do not normally cut through the heavy clay subsoil, but in some places they extend 4 to 10 feet into the clay subsoil and even to bedrock. Most of these areas are now in pasture, but they should be reforested.

Frederick silt loam, steep phase.—This phase is developed from limestone on slopes that are too steep for farming operations, the slopes ranging from 20 to 30 percent or more. The soil is similar to Frederick silt loam, except that the various layers are thinner and bedrock lies at a depth of about 4 feet. Much of the 576 acres has been cleared for pasture, but most of it is in forest or woodland pasture. The limestone strata overlying the Borden formation shale are shallow, and areas of this soil occur as narrow belts around ridges where the normal type is developed. It also occurs on some steep slopes associated with the Grayford soils and in these places it may include some glacial stones and boulders.

Included with this soil on the map are several small areas south of Mahalasville and north of Whitaker where the surface soil to a depth of about 10 inches is dark brown and the yellow or olive subsoil is nonacid in reaction. Such soils are mapped in other counties, where they are more extensive, as the Fairmount series.

Bedford silt loam.—This soil is developed on gently sloping to nearly level areas associated with Frederick silt loam on the broader ridge tops south of Whitaker. An area of 128 acres was mapped. It has moderate surface and slow internal drainage. In forested areas the 3-inch surface soil is dark brownish-gray silt loam. In cultivated areas it is a light yellowish-brown mellow silt loam to a depth of about 7 inches. The subsurface soil, to a depth of 10 inches, is somewhat lighter colored. The subsoil to a depth of about 20 inches is light brownish-yellow silty clay loam that is friable in the upper part and moderately compact in the lower part. From 20 to about 36 inches it is mottled gray and yellow clay loam. The lower part of this layer is a compact impervious siltpan that breaks into prismatic structural columns 10 inches or more in height and coated with light-gray silt. Below 3 feet the soil is less mottled and more friable. It contains geodes, chert fragments, and fossils. A layer of weak reddish-brown waxy clay about a foot thick overlies the limestone, which normally occurs at a depth of about 7 feet. The bedrock consists of gray impure limestone interbedded with thin strata of calcareous shales.

Most of this type has been cleared of timber and is cultivated. Corn, wheat, and hay are the principal crops. Cropping practices and yields are similar to those on Frederick silt loam. The soil is also used to a limited extent for apple orchards.

SOILS DEVELOPED ON DEPOSITS OF WIND-BLOWN SAND AND SILT OF WISCONSIN GLACIAL AGE

Soils developed on deposits of wind-blown calcareous sand and silt occur in scattered areas on the bluffs and lower slopes in the valley of the West Fork White River. The material consists of assorted fine sand and silt. The deepest and coarsest deposits are near the river; the finer material, on the hills. This material originally contained from 10 to 20 percent of carbonate of lime and magnesia, but free lime has been leached to a depth of 5 feet or more, and the soils are slightly acid. The soils are well to excessively drained as they have loose sandy substrata. Though used for general farm crops, they are best suited to alfalfa and to melons, sweetpotatoes, early tomatoes, and other special crops, the possibilities for the development of which have not been exhausted.

Princeton, Ayrshire, and Ragsdale series are included in this group. Princeton soils are the most extensive and comprise more than 90 percent of the acreage of this group. They occupy rolling to dunelike relief with slopes of 4 to 20 percent or more, but only a very small part is too steep to be unsuited to cropping. The surface soils are light yellowish brown and sandy, and the subsoils are yellowish-brown clay loam to sandy loam. The underlying material at depths of about 6 feet consists of calcareous sand. Ayrshire soils are developed on nearly level to undulating relief where drainage is imperfect. The surface soil is light brownish gray and the subsoil is mottled gray and yellow compact clay loam to silty clay loam. Ragsdale soils are developed in depressions that were formerly marshland. Sufficient organic matter has accumulated in the surface soil to give it a dark color. The subsoil is mottled gray and yellow clay loam or silty clay loam.

Princeton fine sandy loam.—This soil occupies an area of 3,648 acres on rolling dunelike areas on the benches and foot slopes along the east side of the West Fork White River and the long ridges that project into the valley from the north. In forested areas the 3-inch surface soil is dark-brown fine sandy loam. The subsurface soil, to a depth of about 12 inches, is light yellowish-brown loose fine sandy loam. In cultivated areas the darker surface is mixed with the lighter material and, as the organic content is depleted during cultivation, the resulting plow soil is light yellowish brown. From 12 to 36 inches the subsoil is reddish-brown to yellowish-brown friable sandy clay loam. The texture of this layer ranges, within short distances, from a loose loamy fine sand to a moderately heavy clay loam. The lower subsoil is loose yellowish-brown fine sand that is underlain by yellow and gray calcareous sand at a depth of about 55 inches. The underlying material in most places is yellow and gray calcareous sand but it varies from fine sand to silt loam. The thickness of the wind-deposited material varies widely, depending upon the position on upland or terrace and on the height of the dune.

The Princeton soils have developed under a mixed hardwood forest including hickory, oak, elm, ash, walnut, and maple. Almost all of this soil has been cleared and is used for general farm crops.

The relief is gently rolling to rolling, and slopes range from 4 to 20 percent. Drainage lines seldom occur, as the soil absorbs water rapidly, and it is only during very hard rains that any water runs off. Local depressions and pot holes are common within the rolling dunes. Because rainfall is so readily absorbed by the sandy soil, little erosion occurs, but on steeper slopes slight sheet erosion may occur during very heavy rains. On bare areas that are exposed to westerly winds, wind erosion may occur, but this is usually confined to very small areas and is of relatively little importance. This may result in some loss in fields where wheat does not make a good growth in the fall. Many slopes as steep as 15 to 20 percent are cultivated.

The moisture-holding capacity is low, and it is difficult to follow a systematic crop rotation. Corn and wheat are the principal crops and occupied 20 and 20 percent, respectively, of this soil in 1938. Corn yields 20 to 25 bushels, and wheat about 10 to 15 bushels an acre, but with abundant rainfall much higher yields are obtained. Hay occupies about 15 percent of this soil. Mixed clover and timothy are usually seeded, because red clover may be killed by drought. Hay fields tend to "run out" and become weedy within a few years. Drought-resistant crops, as soybeans, alfalfa, and sweetclover, are the crops best adapted to this soil. Five percent of this soil is used for soybeans. Most pastures are poor as this sandy soil is not well suited to bluegrass. It is well adapted to the growth of sweetpotatoes, watermelons, cantaloups, and other special crops. Early tomatoes are also grown successfully as the soil warms quickly in the spring and promotes rapid growth so that vegetables can be marketed early when prices are high.

Princeton fine sandy loam, steep phase.—The steep phase is similar to the normal soil except that it occurs on slopes that are too steep for intensive farming. These areas occupy valley walls where the slopes range from 20 to 40 percent. About 50 percent of the 960 acres mapped is in forest, and the rest is used as pasture land or for crops. Wheat, the principal crop, is grown on 20 percent of this soil. Crop yields are lower than on the typical soil. Alfalfa is suited to this phase and good stands are obtained after sufficient lime (1 to 3 tons an acre) is applied.

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Princeton loam.—This soil occurs where finer textured materials were deposited on the leeward border of Princeton areas. Most of the 64 acres mapped occurs southwest of Martinsville. The 10- to 12-inch surface soil is light yellowish-brown friable loam or very fine sandy loam. The subsoil is yellowish-brown clay loam or silty clay loam that is more retentive of moisture than the subsoil of the sandy Princeton soils. The deeper subsoil is more friable and gritty and contains a lower proportion of clay. This is underlain by stratified calcareous silt and sand at a depth of about 5 feet. This soil is moderately acid to a depth of 3 feet or more. In some places the surface material is a thin veneer of wind-deposited material less than 2 feet thick, overlying such soils as Cincinnati silt loam. In these areas the subsoil is more acid and the soil is somewhat less productive. The relief is rolling, and the soil is somewhat less permeable to moisture than the sandier soils; therefore greater care must be exercised to control erosion. This soil is suited to the general farm crops common to the region but is not well adapted to special crops except that areas having favorable air drainage are good locations for apple orchards.

Princeton loamy fine sand.—This soil occupies the higher knolls in areas of Princeton fine sandy loam in the vicinity of Exchange. An area of 128 acres is mapped. The 6- to 8-inch surface soil is loose light yellowish-brown loamy fine sand. The subsoil is light yellowish-brown fine sand to a depth of 5 to 6 feet. The substratum is gray or yellow calcareous sand. The organic-matter content is very low in cultivated fields, but in forested areas it is moderate in the upper few inches.

General farm crops are grown, but corn and alfalfa receive most emphasis. Corn is the principal crop even though the average yield is lower and the crop is more likely to fail following drought than on the Princeton fine sandy loam. The soil is well suited to special crops, especially melons.

Ayrshire loam.—This imperfectly drained light-colored soil is developed on calcareous wind-blown deposits. It occurs on nearly level relief associated with the Princeton soils and receives some wash from the adjoining areas.

The surface soil to a depth of about 8 inches is gray when dry and light brownish gray when moist. The organic content is low. The texture varies from fine sandy loam to silt loam, but in most places the soil contains sufficient sand so that it crumbles easily when cultivated. The 30-inch subsoil is mottled gray, yellow, and rust-brown clay loam to silty clay loam. It is compact when dry and moderately plastic and sticky when wet. Below a depth of 30 inches the subsoil is friable mottled loam. The entire profile is moderately acid. Calcareous sand lies at a depth of about 65 inches. During periods of excess rainfall, areas with no natural or artificial outlet may be covered with water. The total area is 192 acres.

Corn, soybeans, and hay are the principal crops grown on this soil. Wheat may be winterkilled on some areas but can be successfully grown on adequately drained areas.

Ragsdale loam.—This loam includes dark-colored, poorly drained soils associated with Princeton and Ayrshire soils. Included with this soil are a few areas of Lyles soils that lie on the river terraces associated with Martinsville and Fox soils. The total area is 256 acres.

In cultivated areas the 6- to 8-inch dark brownish-gray friable loam surface soil is moderately high in organic matter, but some variation occurs as lighter colored material washed from the adjoining high ground has been deposited on some areas. The subsoil is dark brownish-gray heavy loam with slight rust-brown mottlings. Below a depth of about 15 inches the subsoil is mottled gray and yellow loam to clay loam. Below this the subsoil is more sandy and friable, and the underlying calcareous material lies at depths of 5 to 7 feet or more.

Almost the entire area is cleared and used for crops. It is best suited to corn and soybeans, but wheat, hay, and some special crops, as tomatoes and cabbage, are also grown. Corn yields 45 to 50 bushels an acre. Hay and pasture crops are better adapted than the small grains because winterkilling may occur on inadequately drained areas. The soil is neutral in reaction, so clover and other legumes can be grown on adequately drained areas without the addition of lime. Artificial drainage can be provided by tiling if sufficient fall can be obtained, but it is not feasible to drain some low-lying areas.

SOILS DEVELOPED ON CALCAREOUS GLACIOFLUVIAL DEPOSITS OF WISCONSIN GLACIAL AGE

On the terraces, or benchland, along the West Fork White River the soils are developed on assorted and stratified gravel, sand, silt, and clay. This material was deposited by waters of the Wisconsin glacial period and includes limestone, dolomite, and sandstone pebbles of local origin and many rocks and minerals foreign to this region. The terraces are generally not more than 10 feet above the overflow bottoms. The gravelly and sandy terraces occupy the higher positions, and the silts and clays, the lower. The natural drainage of these soils varies with the porosity of the material on which they were developed and with their position in relation to the stream bottoms and uplands. For the most part they are moderately acid and have been leached of lime to a depth of 3 to 5 feet.

These soils were originally covered with a forest of mixed hardwoods, but most areas are now cultivated. A grain-and-livestock system of farming is generally followed, in which corn, wheat, and mixed hay are the principal crops. Fox soils have only moderate moisture-holding capacity, and corn and clover are susceptible to drought injury, and wheat, soybeans, alfalfa, and certain special crops are better adapted. Alfalfa is well suited to all the soils of this group after sufficient lime has been applied to correct the acidity of the light-colored soils.

Soils included in this group are of the Martinsville, Fox, Whitaker, Mahalasville, and Abington series. The Martinsville and Fox soils are developed under good to excessive natural-drainage conditions. They have light yellowish-brown surface soils and yellowish-brown or weak reddish-brown subsoils. They differ in that Fox soils are underlain by gravel and sand within 3 or 4 feet of the surface, and Martinsville soils are underlain by stratified silts and sands with occasional gravelly and clay strata. The imperfectly drained Whitaker soils are developed on nearly level relief positions where the ground-water level is generally less than 2 feet. The surface soil is light brownish gray and the subsoil is mottled gray and yellow. The Mahalasville and Abington soils are developed in depressions that were formerly marshy. Excessive moisture promoted an abundant growth of reeds, rushes, and marsh grasses. Subsequently some areas were covered with water-tolerant trees. The 15- to 18-inch surface soils are dark-colored, the subsoils are plastic sticky clay loams, and the substrata are stratified silt and sand, with occasional gravel beds in the Mahalasville soils, and with stratified gravel and sand and some silt and clay in the Abington soils.

Martinsville loam.—In cultivated fields the surface soil consists of 6 to 8 inches of light yellowish-brown friable loam that is somewhat darker when moist. In wooded areas the surface soil to a depth of 2 to 3 inches is dark brown and relatively high in organic content. The subsoil to a depth of 12 inches is yellowish-brown friable loam underlain by yellowish-brown friable loam at a depth of 18 inches. This layer grades into a somewhat more compact yellowish-brown or weak reddish-brown clay loam that is hard when dry. Below 36 inches the material is more sandy. It is moderately acid in reaction and is moderately retentive of moisture. The parent material consists of stratified sand and silt with some clay and gravel. Some pebbles and rounded glacial gravel are present in the parent material and in the lower part of the soil. The parent material was deposited by glacial waters of the Wisconsin glacier.

This is an extensive soil (3,008 acres) in the valley of the West Fork White River below Martinsville and along the small tributary streams. It is associated with the Fox soils on terraces of the same or slightly higher level and with the Whitaker and Mahalasville soils. The elevation of these terraces above first bottoms is usually less than 10 feet and probably averages about 5 feet. Usually the terraces are nearly level, although sandy knolls that are partly wind-assorted may be included. The land was originally forested with mixed hardwoods, including white and black oaks, maple, ash, elm, walnut, and hickory, but probably more than 90 percent of it is now cultivated.

A mixed grain-and-livestock system of farming is generally followed in which corn, wheat, and mixed hay grown in rotation are the principal crops. The soil is used for minor field crops, as oats, soybeans, alfalfa, and special crops as sweet corn and tomatoes. Corn is the principal crop, and yields range from 30 to 50 bushels and probably average about 35 bushels an acre. Fertilizer is used to a limited extent. Wheat, the second most important crop, follows corn in rotation, is generally fertilized, and yields 15 to 20 bushels. Oats, grown mainly as a feed crop, are generally seeded early to avoid drought and to obtain the higher yields. Hay crops include a mixture of timothy, clover, redtop, alfalfa, and alsike, or alfalfa grown alone. Clover is not so well suited to the droughty conditions.

Martinsville silt loam.—In cultivated areas the 6- to 8-inch light yellowish-brown friable granular silt loam surface soil is moderately low in organic matter, medium acid in reaction, and crumbles readily under slight pressure into medium granules. To a depth of about 36 inches the subsoil is yellowish-brown silty clay loam. The lower part is moderately compact and heavier and contains numerous small rounded pebbles. The deeper subsoil is more friable as it has less clay and more very fine sand. The soil is medium to slightly acid to within a few inches of the calcareous silt and sand substratum, which lies at a depth of 45 inches or more.

This soil occurs in scattered areas, totaling 2,048 acres, throughout the valley of the West Fork White River and its major tributaries but is most extensive south of Martinsville.

Like Martinsville loam, this soil is almost all cultivated. Corn, wheat, and mixed hay are the principal crops. Because of slightly better moisture relations, corn yields are higher, averaging 30 to 50 bushels an acre. Wheat yields 15 to 20 bushels. Clover is less likely to be injured by drought, and hay yields are higher, averaging 1½ to 2 tons. Probably about 10 percent of this soil is used for bluegrass pasture.

Martinsville fine sandy loam.—In cultivated areas the 6- to 8-inch surface soil is loose fine sandy loam. In wooded areas the surface soil to a depth of about 2 inches is dark gray and relatively high in organic matter, but the cultivated soil is relatively low in organic content. To a depth of about 18 inches is slightly to moderately coherent yellowish-brown fine sandy loam subsoil that grades into yellowish-brown to reddish-brown gritty and somewhat gravelly clay loam to a depth of 36 inches. When dry this layer is hard. The deeper subsoil consists of yellowish-brown loose fine sandy loam that is underlain by calcareous assorted sand and silt parent material at a depth of 5 feet or more. This soil is medium acid in reaction and because of the low clay content has relatively low moisture-holding capacity.

This soil, totaling 1,536 acres, occurs on the higher knolls and terraces of the valley of the West Fork White River. The larger areas occur in the vicinity of Martinsville. The topography is undulating and includes a few dunelike areas. The parent material was deposited by glacial streams of the Wisconsin period and consists of a relatively high proportion of sand with silt, clay, and some gravel. The original forest cover included a higher proportion of oak and hickory than the other Martinsville soils.

Almost all of the soil is cleared and cropped. As it is somewhat droughty, wheat and alfalfa are better adapted and relatively more productive than corn. Corn yields range from 25 to 35 bushels an acre but probably average about 30 bushels. Wheat and rye are generally fertilized and yield 10 to 15 bushels. Soybeans and alfalfa, which are drought resistant, are grown for hay. Most permanent pastures are weedy and have a low carrying capacity. Tomatoes, melons, and truck crops are grown on many areas. Improvements on this soil should include increasing the organic-matter content and more liberal use of commercial fertilizers. It is necessary to apply sufficient lime to insure good stands of alfalfa.

Fox loam.—This soil is developed on calcareous stratified gravel and sand deposited as terraces along the West Fork White River and its tributaries. It is a uniform type and occurs in broad areas broken only by occasional swales of poorly drained soil or by knolls of more sandy soils. The largest areas are between Martinsville and Exchange and north of Waverly. A total area of 1,920 acres is mapped.

The soil occupies terrace positions about 10 feet higher than the adjacent overflow bottoms, and it has developed under a mixed hardwood forest that includes ash, walnut, hackberry, sugar maple, and black, red, and white oaks.

The 6- to 8-inch surface soil is light yellowish-brown gritty friable heavy loam to light mellow loam. The organic-matter content is low, and sand particles of all sizes are mixed with the soil. The yellowish-brown sandy clay loam subsoil to a depth of about 18 inches is moderately hard when dry but breaks readily into angular particles a quarter to half an inch in diameter when moist. The deeper subsoil to a depth of about 40 inches is yellowish-brown to weak reddish-brown waxy and gravelly clay loam, containing numerous rounded glacial gravels. This medium to slightly acid layer is plastic and sticky when wet. Beneath this is a darker colored sticky layer that extends to a depth of about 45 inches. The parent material consists of gray and yellow assorted coarse sand and gravel containing 25 to 30 percent lime carbonate, and includes granite, gneiss, jasper, and other rocks.

Practically all of this soil is farmed, as it is well drained, moderately productive, and situated on nearly level relief. The small acreage of forest remaining is in woodland pasture that has a dense stand of Kentucky bluegrass and furnishes good grazing. Corn and wheat are the principal crops. Wheat, having its greatest moisture requirement in the spring, is somewhat better adapted for utilizing available moisture supplies than corn. Wheat, soybeans, alfalfa, and sweetclover, all drought-resistant crops, are well suited to this soil and are extensively grown. Most livestock or dairy farms follow a 3-year rotation of corn, wheat, and mixed hay. Mixed hay is commonly grown because of the uncertainty of clover stands. Wheat yields average about 20 bushels an acre, and corn, 30 to 35 bushels.

Fox loam, sloping phase.—This phase is similar to the typical soil except that it occupies sloping land and the texture of the surface ranges from silt loam to gravelly loam. It usually contains some gravel, and in many places the light yellowish-brown surface soil has been washed away, exposing the yellowish-brown to reddish-brown gravelly clay loam subsoil.

The sloping phase occurs on the narrow breaks between the terrace and the overflow bottoms. Relief is usually less than 10 feet, and the slopes range from 10 to 30 percent. The principal areas of the 320 acres mapped occur near Waverly and Exchange.

Probably 30 percent of the slope phase is cultivated. Nearly all areas have been cleared but many are in grass. These areas are susceptible to accelerated erosion and should be kept in grass. Crop yields are lower than on the level Fox soils.

Several areas occupying breaks between the Martinsville soils and the river bottoms have been included with this soil. These areas are relatively free of gravel and have a higher proportion of sand.

Fox silt loam.—In cultivated areas the 8-inch surface soil is light yellowish-brown smooth to gritty friable silt loam. The upper subsoil layer is yellowish-brown silty clay loam to a depth of about 18 inches, and the lower subsoil, to a depth of about 40 inches, is moderately compact, yellowish-brown to weak reddish-brown waxy and gravelly silty clay loam to clay loam containing varying quantities of gravel. The material breaks into angular irregular-sized chunks that are hard when dry. Dark-brown gravelly clay loam that is neutral in reaction lies immediately above the substratum of stratified calcareous gray gravel and sand.

Associated with Fox loam, this soil occurs on flats or in narrow shallow swalelike remnants of former drainageways. It is well drained but usually not so excessively drained as the lighter textured Fox loam. Slightly depressed areas receive some runoff from the associated higher ground. The total area is 512 acres.

Crop rotations are similar to those on Fox loam, but yields are considerably higher because of the better moisture conditions in the surface soil and subsoil. This is especially true of corn.

Fox fine sandy loam.—This soil occurs on the more sandy knolls and gravelly areas associated with Fox loam. The largest areas are southwest of Exchange and in the vicinity of Mount Gilead Church southwest of Martinsville. The total area is 256 acres. In cultivated areas the surface soil to a depth of about 8 inches is light yellowish-brown mellow fine sandy loam to sandy loam. The subsoil to a depth of about 40 inches is yellowish-brown to reddish-brown gravelly clay loam. Between depths of about 40 and 45 inches is a dark-brown, sticky, gravelly layer that is neutral in reaction. The substratum is stratified calcareous gray and yellow gravel and sand. The upper layers are medium acid.

Practically all of this soil is cultivated. It is more droughty than the other Fox soils, and drought-resistant crops, as wheat, soybeans, and alfalfa, are better adapted to it than corn. Crop yields are lower than those obtained on other Fox soils.

Whitaker silt loam.—This is an imperfectly drained light-colored soil associated with Martinsville and, in some places, Fox soils. To a depth of about 10 inches the surface soil of cultivated fields is brownish-gray friable silt loam that is somewhat darker colored when moist. The organic-matter content is low, and the reaction is medium acid. To a depth of 18 inches the subsoil is mottled gray, yellow, and rust-brown silty clay loam, containing varying amounts of fine gravel, which is underlain by mottled gray and yellow waxy and gravelly clay loam. The deeper subsoil is more friable and lighter in texture. The substratum is stratified calcareous gray or mottled gray and yellow silt and fine sand with small quantities of fine gravel and clay in some places.

This type is developed on assorted silts and sands with some clay and fine gravel and occurs in scattered areas on nearly level low-lying benchlands or terraces along the West Fork White River and its major tributary streams. It also occurs in former valleys such as those north of Cope and east of Brooklyn. In most places these low terraces lie less than 5 feet above the adjoining stream bottoms. The total area is 1,920 acres.

The original vegetation consisted of a mixed beech-maple forest that included many other water-loving species, but most of it has been cleared, artificially drained, and cultivated. A mixed grain-and-livestock system of farming is followed, and most of the land is used for corn, wheat, and hay. The most common crop rotation is corn, wheat, and mixed hay. Corn yields 30 to 40 bushels an acre. As the soil is moderately acid, liming is necessary to insure a good stand of clover and alfalfa. Yields of mixed clover and timothy hay range from 1 to 2 tons. Some winter injury to wheat, clover, and alfalfa occurs on inadequately drained areas.

Included with this type are some areas where the texture of the surface soil is loam, and an area northwest of Cope that has very poor natural drainage. The surface soil is light gray when dry and contains many buckshot gravel, or small rounded iron concretions. The subsoil is highly mottled gray, yellow, and rust-stained silty clay. In other respects this soil is similar to the typical soil. A few areas associated with the Fox soils contain a higher proportion of gravel in the parent material than is typical for the Whitaker soils. In other regions, where imperfectly drained light-colored soils are developed over a gravelly substratum, they are classified in the Homer series.

Whitaker loam.—This soil differs from Whitaker silt loam principally in having a loam surface soil. The surface soil to a depth of about 8 inches is light brownish-gray gritty loam. The mottled gray and yellow clay loam subsoil grades into mottled-gray and yellow, waxy, sandy, and gravelly clay loam at a depth of about 20 inches. Below 36 inches the material is more friable, and gray and yellow calcareous silt and sand, with some gravel, is encountered at about 50 inches. Areas associated with the Fox soils contain a higher proportion of gravel in the subsoil and substrata.

The most extensive areas occur south of Martinsville near the confluence of the West Fork White River and Indian Creek. The total area mapped is 1,216 acres. Relief is slight, as the soil occurs on flats and in minor depressions of the stream terraces. Artificial drainage is needed for successful crop growth and may be obtained either by tiling or open ditches.

Almost all of this soil is cultivated. A mixed grain-and-livestock system of farming is generally followed. Corn and wheat are the principal crops. Yields are slightly lower than on Whitaker silt loam.

Whitaker fine sandy loam.—The 8-inch gray to brownish-gray fine sandy loam surface soil grades through slightly sticky or clayey sandy material into a moderately compact mottled gray and yellow subsoil that extends to a depth of about 36 inches. At lower depths the soil is more sandy and incoherent and calcareous stratified silt and sand, with minor quantities of clay and gravel, occur at a depth of 5 feet.

This soil occurs in scattered areas, totaling 64 acres, throughout the valley of the West Fork White River but principally near the foot slopes of the sandy Princeton soils. The imperfect natural drainage is partly caused by seepage from the upland and partly because of low position. The soil is similar to Whitaker silt loam except that it is more sandy throughout.

Where it occurs in small areas associated with other types its use is determined by the associated soils. Yields are somewhat lower than on Whitaker silt loam.

Mahalasville silty clay loam.—This is a dark-colored, poorly drained soil that in many respects resembles Brookston silty clay loam.

It is developed in depressions associated with the Whitaker and Martinsville soils, and in some places with the Fox soils. These depressions were very wet and supported hydrophytic vegetation consisting largely of rushes and sedges, together with some trees. Organic matter accumulated under these conditions produced a dark-colored organic-bearing layer 12 to 15 inches thick. In cultivated areas, the 6- to 8-inch surface soil is dark-gray to very dark brownish-gray silty clay loam. To a depth of 12 to 18 inches, the subsoil is dark-gray heavy silty clay loam to silty clay. Below this is mottled gray and yellow plastic silty clay. The substratum consists of calcareous assorted silt, sand, clay, and gravel. The entire soil profile is neutral in reaction. A total of 1,216 acres is mapped.

Most of this soil has been drained by tiling or open ditches, and almost the entire area is now cultivated. Corn, soybeans, hay, and special crops, as tomatoes and sweet corn, are especially well adapted. Corn, the principal crop, is grown on about 40 percent of the area. This crop may be planted 2 years or more in succession. Where crop rotation is practiced, corn, wheat, and clover are grown. Owing to abundant supplies of plant nutrients and moisture, corn yields exceptionally well, averaging 45 to 50 bushels or more an acre. Wheat may be winterkilled to some extent, but yields average 15 to 20 bushels.

Areas associated with the Fox soils are underlain by gravel and are more nearly like Westland silty clay loam. They are combined with Mahalasville silty clay loam because of small total extent. Included also are several areas of Mahalasville silt loam, which is similar to the silty clay loam type except that the texture of the surface soil is silt loam. Most of these areas occur in the vicinity of Maxwell Hill southwest of Martinsville. The land use and yield are similar to those for Mahalasville silty clay loam.

Mahalasville loam.—In color and natural drainage conditions this soil is similar to Mahalasville silty clay loam, but it is developed over a sand substratum and has a high proportion of sand in both the surface soil and the subsoil. In cultivated areas the 6- to 8-inch surface soil is dark-gray to very dark brownish-gray friable loam. The surface soil varies somewhat in texture and organic content; some areas contain a higher proportion of clay, others are somewhat sandy, and a few of fine sandy loam are included on the soil map. Narrow depressions, subject to wash, and the more sandy areas may be lighter in color and lower in organic content. To a depth of 12 to 15 inches the subsoil is dark-gray heavy silt loam to silty clay loam. Below this is moderately plastic and compact mottled gray and yellow waxy clay loam to a depth of 3 feet. The clay content decreases at lower depths, and the soil is underlain by assorted silt, sand, and clay. Areas associated with Fox soils have considerable gravel in the parent material. Relief is slight and natural drainage is poor. Most areas have been artificially drained by tiling.

This soil occurs on the sandy terraces southeast of Martinsville associated with Whitaker loam, and a total area of 768 acres is mapped. This type, like Mahalasville silty clay loam, is almost all cultivated. Corn is the principal crop, but all other crops common to the region are successfully grown. Yields are only slightly lower than those obtained on Mahalasville silty clay loam.

Abington silty clay loam.—This soil occupies the lowest most poorly drained depressions associated with areas of the Mahalasville, Whitaker, Martinsville, and Fox soils. Of the 128 acres mapped, the largest individual body lies southeast of Martinsville.

In cultivated areas this soil has a very dark-gray silty clay loam to silty clay surface soil to a depth of 6 to 8 inches. It is high in organic matter and neutral in reaction. Because of the heavy texture and the low wet position, hard clods are formed if tillage operations are carried out when the soil is wet. The subsoil is dark-gray plastic silty clay to a depth of 15 to 20 inches. This is underlain by gray plastic silty clay that is very plastic and sticky when wet. At a depth of about 5 feet gray and yellow calcareous gravel, silt, and clay occur. Because of the tough heavy surface soil, which is difficult to plow and cultivate, this soil is locally known as gumbo. Almost all of it is cultivated, but inadequate drainage causes occasional loss of crops.

This is a highly productive soil for corn, soybeans, and hay crops. Wheat yields are good in most years, but this crop may be winterkilled on inadequately drained areas, and small grain often lodges.

SOILS DEVELOPED ON CALCAREOUS LACUSTRINE SILT AND CLAY OF WISCONSIN AGE

Soils developed on calcareous lacustrine silt and clay of Wisconsin age occupy a part of the northwestern part of the country locally referred to as the "lake" area. This is an extensive slightly depressed area, with knolls rising 2 or 3 feet above the general land level. The deepest part lies roughly between Little Point and Hall; another arm lies north of Hall. The soils in this part are developed from assorted and stratified lacustrine silt and clay of Wisconsin age. The lake area grades into marshy land that probably was permanently saturated or was covered with shallow water. It was drained about 30 years ago by Lake Ditch, a shallow groove having banks less than 10 feet deep. Because of the extensive watershed drainage into the area, rains of short duration are reported to cause the ditch to overflow. Floods occur most frequently during winter and early spring, consequently use of the land is limited largely to spring-seeded crops. A cash-grain type of farming is followed, and little livestock is raised. Farming is done almost entirely by machinery. About 60 percent of the total area is planted to corn. Wheat, the second most important crop, is grown on about 17 percent of the area; it is most successfully grown, however, on the higher more protected areas where there is the least danger from overflow. Oats, soybeans, and sweetclover are grown to a limited extent, mainly for soil improvement.

Included in this group are the Gregg, Monrovia, and Plano soils. The Gregg soils are developed on low knolls, usually less than 3 feet above the associated Monrovia and Plano. They have a light brownish-gray silt loam surface soil and mottled gray and yellow heavy-textured subsoil. The Monrovia and Plano soils occupy depressional positions and have developed under nearly permanent saturation. They are dark to a depth of 10 to 18 inches, high in organic matter, and potentially very fertile. The Monrovia type has a mottled gray and yellow subsoil, and the Plano, a gray upper subsoil and a slightly mottled gray and yellow subsoil. The parent soil material lies at a depth of 4 feet or more and consists of stratified calcareous silts and clays, with small quantities of very fine sand.

Gregg silt loam.—In cultivated areas the 6- to 8-inch surface soil is light brownish-gray smooth friable heavy silt loam that is lighter colored when dry. It is low in organic matter and tends to puddle and bake readily. To a depth of 18 inches the subsoil is mottled gray and yellow moderately compact silty clay loam, with numerous rust-brown stains and blotches. This is underlain, to a depth of about 36 inches, by mottled gray, yellow, and rust-brown compact silty clay that is impervious to moisture movement. Below a depth of 36 inches, the material is more friable and contains small quantities of very fine sand. The underlying parent material lies at a depth of 50 to 60 inches and consists of gray and yellow stratified calcareous silt and clay, with small quantities of very fine sand. A few rounded pebbles are present.

Developed under a beech-maple forest cover, this soil, totaling 1,600 acres, is imperfectly drained and occurs on low knolls associated with Monrovia and Plano soils. A few areas occurring on slightly steeper gradients and having brownish-gray to light yellowish-brown surface soils and slightly better drainage conditions are included with this type.

This soil is almost entirely under cultivation. About 80 percent of it is used for general farm crops, consisting chiefly of corn and wheat, with smaller acreages in oats, soybeans, and hay. About 7 percent is in timber, farmsteads, and miscellaneous uses, and the rest is in pasture. Because of the imperfect natural drainage and susceptibility to overflow, corn, oats, soybeans, and pasture are the best uses. Wheat and fall-seeded crops can be grown successfully only on the better drained areas that are not subject to winter flooding. Corn is grown on more than 50 percent of this soil type, partly because of its occurrence in small areas surrounded by large areas of Monrovia and Plano soils, where corn is often grown for several consecutive years. Yields average 30 to 40 bushels an acre. Fertilizer is becoming more generally used to maintain fertility, as a grain system of farming is largely followed in which little manure and crop residue is returned to the soil. Approximately 20 percent of this soil type is used for wheat. Owing to imperfect drainage conditions, considerable winterkilling occurs, especially on areas that are flooded. Wheat is generally fertilized, and yields average 12 to 15 bushels. Soybeans, clover, timothy, and alfalfa occupy less than 8 percent of the total area. Some of the land is tiled, but protection from overflow is difficult to obtain because the main ditch outlets are too small to carry all the water from heavy rains and a large part of the area is flooded. This soil also requires organic matter and growth of legumes to improve the physical condition, the organic content, and the nitrogen supply. Lime is not generally needed for clover except on a few areas.

Gregg loam.—In cultivated areas the 6- to 8-inch surface soil is light brownish-gray to gray friable loam, containing moderate quantities of very fine sand which may be wind-deposited. The subsoil is mottled gray and yellow silt loam to silty clay loam, and the rest of the profile is similar to that of Gregg silt loam. An area of 192 acres is mapped.

As tilth and physical conditions are more favorable to the growth of crops and tillage operations than on Gregg silt loam, this soil is somewhat more desirable for agricultural use. About the same crops are grown, and the yields are practically the same or slightly higher.

Monrovia silty clay loam.—In cultivated areas the 6- to 8-inch surface soil is very dark brownish-gray to dark-gray silty clay loam, which is relatively high in organic matter. This is underlain by dark brownish-gray to dark-gray compact heavy silty clay loam to silty clay. Below a depth of about 14 inches the subsoil is mottled gray and yellow plastic silty clay, with streaks and blotches of rust brown. At a depth of about 36 inches the material is more friable and contains a small quantity of very fine sand. Gray and yellow calcareous clay and silt occur at a depth of 65 to 75 inches. The entire profile is neutral in reaction.

This is the most extensive soil (5,760 acres) of the group of the calcareous lacustrine silt and clay of Wisconsin age. It is developed on level to slightly depressed parts of the lacustrine area in the northwestern part of the county.

Good tilth conditions are difficult to maintain on this type because of the tendency for large clods to form when tilled too moist. Mechanized farm machinery is used extensively because of the power required to plow this soil. Practically all of this soil is under cultivation. Corn is the principal crop, and it is probably the best use for this soil. About 60 percent of the total area was planted to corn in 1937. Yields range from 40 to 85 bushels an acre, with an average of about 45 bushels. Wheat is the second most important crop, occupying about 15 percent of the area. However, injury from winterkilling due to flooding and heaving is occasionally extensive. Oats, soybeans, and sweetclover are grown occasionally for soil improvement and rotation purposes. Oats yield 35 to 45 bushels an acre. About 6 percent of it is used for hay crops. Farmers occasionally lose crops but losses rarely exceed two crops in 7 years. Commercial fertilizers are in general use as a means of maintaining soil fertility and increasing crop yields.

Plano silty clay loam.—In cultivated areas the 6- to 8-inch surface soil is very dark-gray to nearly black heavy silty clay loam, high in organic content. The dark-gray heavy and plastic silty clay subsoil is underlain at a depth of 14 to 18 inches by light-gray or steel-gray heavy compact silty clay, containing a few streaks of rust brown. Below a depth of 36 inches the material becomes more friable and is underlain by stratified silts and clays containing a small quantity of very fine sand. It is calcareous at a depth of 65 to 75 inches.

This is an inextensive soil (384 acres) occurring in the more poorly drained parts of the "lake" area. It occupies the deeper depressions where nearly permanent saturation prevailed.

The soil is almost entirely under cultivation, although a few areas on which crops are more susceptible to drowning are occasionally idle. Corn is grown almost continuously, with occasional cropping to oats, soybeans, and sweetclover. Yields are slightly lower than on Monrovia silty clay loam.

SOILS DEVELOPED ON NONCALCAREOUS CLAY, SILT, AND SAND ON STREAM TERRACES

Soils developed on noncalcareous clay, silt, and sand on stream terraces occur on low terraces in association with those developed on Illinoian till, Borden sandstone, siltstone, shale, and limestone. They are developed on water-assorted materials of mixed origin under a forest cover and are light-colored and low in organic matter. They have been leached of free lime carbonates and are of low productivity.

A general system of farming is followed in which corn, wheat, soybeans, and hay are the principal crops. About 50 to 70 percent of these soils are under cultivation. The rest is idle land supporting a growth of broomsedge and briers and low-grade pasture land. Included in this group are soils of the Elkinsville, Pekin, Bartle, and Peoga series. The group comprises about 1 percent of the total area of the county, and Bartle silt loam is the dominant soil.

Elkinsville silt loam.—The 6- to 8-inch light yellowish-brown friable silt loam surface soil is low in organic content. The subsoil is yellowish-brown or brownish-yellow silty clay loam to a depth of about 36 inches. The material breaks into subangular or small uniform aggregates that may be crushed with ease into coarse granules. Below this the material is more friable, and at depths of 5 to 7 feet is water-assorted silt and clay. The entire profile is strongly acid. Under cultivation, the steeper slopes are susceptible to considerable sheet erosion, and these areas have a thin surface soil with frequent exposures of the yellowish-brown subsoil. A few eroded areas and slightly steeper slope areas have been included with this type.

This well-drained soil (320 acres) occurs in narrow strips near the breaks of the low acid terraces on slopes of 3 to 10 percent. It is adapted to the growth of general farm crops, as corn, wheat, and hay, which are the principal ones. The erosive steeper slopes are better suited to forest than to crops. Because of the strong acidity, bluegrass and legumes as clover are not well suited unless the soil has been limed. Under good management corn yields may be as high as 50 bushels an acre, but the average is 30 to 35 bushels. Wheat yields 12 to 15 bushels and is generally fertilized. Soybeans are grown principally for hay.

Pekin silt loam.—The 6- to 8-inch smooth light yellowish-brown to brownish-gray friable silt loam surface soil is low in organic content. The subsoil is light brownish-yellow friable silty clay loam. Below a depth of 16 to 20 inches is mottled gray and yellow silty clay loam, underlain at a depth of 30 to 36 inches by mottled gray and yellow heavy compact silty clay loam that is somewhat impervious to moisture movements. Below a depth of about 50 inches the material is more friable, and stratified silt, clay, and small quantities of fine sand occur below a depth of 60 inches. The entire profile is strongly acid to a depth of 7 feet or more.

This soil occurs on gentle slopes bordering the breaks of the higher terraces or occupies the breaks of low terraces where relief is generally less than 5 feet. Surface drainage is fair to good, and internal drainage is good in the upper part of the profile and somewhat restricted in the lower part. An area of 512 acres is mapped.

Most of this type is under cultivation. Farming operations and rotations followed are largely determined by the associated Bartle soils. Corn and wheat are the principal crops. Owing to better drainage, crops are somewhat more productive than on Bartle silt loam. Mixed hay or timothy is generally grown as the soil is too acid to grow clover and alfalfa without applications of lime. Corn yields 25 to 35 bushels an acre, although yields as high as 60 bushels are reported where good management practices are followed. Wheat yields are comparable to those obtained on Elkinsville silt loam.

Bartle silt loam.—In cultivated areas the 6- to 8-inch surface soil is light brownish-gray smooth friable silt loam, low in organic content, and containing a few small rounded iron and manganese concretions. The subsurface is light brownish-gray heavy silt loam to silty clay loam that grades into mottled gray and yellow friable silty clay loam with streaks and blotches of rust brown at a depth of 10 to 12 inches. Below a depth of about 30 inches is mottled gray, yellow, and rust-brown compact moderately impervious silty clay loam that frequently breaks into irregular columns 8 to 10 inches in length. Below a depth of about 50 inches, the material is more friable, with the yellow color predominating. Stratified silt, clay, and fine sand occur at depths of about 7 feet. The entire profile is strongly acid in reaction. The upper subsoil layer is generally silty clay loam, but a few areas have compact silty clay layers that are impervious to moisture movements. Natural drainage conditions are imperfect. Occasionally, layers of heavy clay may occur at 5 feet or more.

This is the principal soil type of this group, and the 1,408 acres mapped comprise nearly 60 percent of the soils developed on acid terraces of clay, silt, and sand material of mixed origin. It occurs on nearly all the acid-terrace areas in the Illinoian drift and Borden regions. The larger areas occur in the valley of Indian Creek and west of Centerton and less extensively in the valleys of Highland, Sycamore, Little Indian Creeks, and Monocle Branch.

Practically all of this type has been cleared of timber and cultivated. Because of strong acidity, low fertility, and imperfect natural drainage it is not intensively cultivated at present; probably 60 percent of it is now being farmed. The principal crops are corn, wheat, soybeans, and hay. Corn, the most extensive crop grown, yields about 50 bushels an acre under good management, but the average yield is 30 to 35 bushels. Wheat, the second most important crop, is generally fertilized, and yields average 12 to 15 bushels. Soybeans are grown principally as a leguminous hay crop. Liming is necessary for the growth of clover, and, as little lime has been applied to this soil, most of the meadows are of mixed timothy and clover.

Bartle silty clay loam.—This soil differs from Bartle silt loam chiefly in the heavier texture of the surface soil and subsoil. The surface soil is light brownish-gray silty clay loam that cracks on drying and puddles and bakes easily. The subsoil is mottled gray and yellow heavy silty clay loam to silty clay and is more compact than the subsoil of Bartle silt loam. The surface soil and subsoil are medium acid, but below a depth of 36 inches the reaction is only slightly acid. In this respect it differs from the strong acidity of Bartle silt loam.

The 64 acres mapped occur in several small areas north of Mahalasville. It is used for general farm crops, with the crop-rotation system and yields about equal to those obtained on Bartle silt loam.

Peoga silt loam.—In cultivated areas the 6- to 8-inch surface soil is light-gray smooth friable silt loam, with numerous small rounded iron and manganese concretions, locally called buckshot, on the surface and throughout the soil profile. The subsoil of light-gray friable heavy silt loam contains numerous rounded iron and manganese concretions. Below a depth of about 30 inches the mottled gray and yellow compact silty clay is impervious to moisture movements. At a depth of about 50 inches the material is more friable and is underlain, at a depth of about 65 inches, by stratified silt and clay.

This type occurs on nearly level relief. Drainage can be improved by tiling if adequate outlets are obtained. Some improvement in surface drainage may be made by plowing in narrow lands, the dead furrows carrying surface water to the breaks of terraces. A total of 192 acres is mapped, the larger areas occurring north of Centerton.

The original forest has been largely cleared, and much of the land is cultivated. Corn and wheat are the principal grain crops and. together with mixed meadows, comprise 30 to 40 percent of the total crop acreage. A large part is idle, with a cover of broomsedge, poverty grass, briers, and sassafras.

SOILS DEVELOPED ON NONCALCAREOUS OUTWASH SAND, SILT, AND GRAVEL OF ILLINOIAN GLACIAL AGE

Soils developed on noncalcareous outwash sand, silt, and gravel of Illinoian glacial age occur a few miles east of Martinsville. The land has been almost completely dissected, and deep drainageways reach well into the plain south of Sand Creek Church. The Morgantown and Taggart series, which comprise this group, occupy approximately 1 percent of the area of the county. When limed, clover and other legumes can be very successfully grown. A mixed grain-and-livestock system of farming is followed in which corn, wheat, and clover are the principal crops.

All but 64 of the 2,112 acres in this group are members of the well-drained Morgantown series. The light yellowish-brown surface soil is underlain by a yellowish-brown to weak reddish-brown subsoil. At a depth of 50 inches or more the subsoil is moderately sandy and fairly retentive of moisture. The parent material occurring at a depth of 12 feet or more consists of roughly assorted highly leached gravel and sand. The soils have excellent drainage and despite the underlying gravel have good moisture-holding capacity. The entire profile is strongly acid.

The Taggart soil is imperfectly drained and has a light brownish-gray surface layer and mottled gray, yellow, and rust-brown subsoil, resting on an impervious layer at a depth of about 3 feet. Imperfect natural drainage is caused by the subsoil layer and a higher proportion of clay in the parent material.

Morgantown silt loam.—In cultivated areas the 6- to 8-inch light yellowish-brown smooth mellow silt loam surface soil is low in organic-matter content. In forested areas the upper 3 inches is dark-brown silt loam, relatively high in organic matter. To a depth of about 18 inches is yellowish-brown to brownish-yellow friable silty clay loam that breaks into small subangular aggregates easily crumbled into small granules. This is underlain by somewhat more compact and heavier brownish-yellow silty clay loam. At a depth of 36 inches or more the material is more friable, and below a depth of 48 inches it contains conspicuous quantities of yellowish-brown or weak-reddish-brown sand. Sufficient clay is mixed with the sand to make the soil moderately retentive of moisture to a depth of 10 feet or more. Stratified parent material consisting of sand and silt, with occasional lenses of clay, occurs at an average depth of 12 feet, and below a depth of 15 feet is stratified gravel and sand. The entire soil profile, including the gravel, is strongly acid.

This type is very uniform in profile characteristics over the broad level plain. On the sharply rounded slopes the sandy and gravelly material approaches the surface and the soil profile layers are thinner. This soil has excellent internal drainage, together with good moisture-holding capacity for the growth of most farm crops. The divides are usually nearly level to within a few feet of the breaks. On the highly dissected rounded ridges the slopes may range up to 10 percent or more. The original vegetation consisted of a mixed hardwood forest of tuliptree, white oak, walnut, sugar maple, and hickory. An area of 1,088 acres is mapped.

This soil has been almost entirely cleared of timber and brought under cultivation. Because of the susceptibility to gully erosion on the more sloping areas, narrow timber-protected strips are beneficial along borders of valleys and on the rounded erosive ridges. Corn, wheat, and clover are usually grown in a 3-year crop rotation, and a grain-and-livestock system of farming is followed, in which most of the crops grown are fed to livestock. Corn yields average 30 to 40 bushels or more an acre. Wheat is usually fertilized and yields 15 to 20 bushels with an average of about 18. Soybeans are grown as a hay crop, and alfalfa and clover on areas that have been limed.

Morgantown loam, steep phase.—In wooded areas the 3-inch surface soil consists of a dark-brown mellow loam, relatively high in organic matter and permeable to moisture movement. This is underlain, to a depth of about 10 inches, by light yellowish-brown friable loam. Below this material is yellowish-brown to weak reddish-brown silt loam to silty clay loam that grades, at a depth of about 36 inches, into light brownish-yellow relatively incoherent sand and fine gravel containing small quantities of silt and clay. With the exception of the dark surface soil, the entire profile is strongly acid.

Considerable variations occur locally in this type. A narrow belt on the upper slopes, bordering areas of Morgantown silt loam, contains a relatively high proportion of silt and clay, the upper 36 inches resembling Morgantown silt loam. Heavy calcareous gray clay outcrops on the lower slopes in many of the deep valleys, and is included with Morgantown loam, steep phase. Slopes decrease from approximately 35 to 15 or 20 percent where this material outcrops. Generally little soil development has occurred over the gray clay, which is covered to a variable depth, usually less than 10 inches, with yellowish-brown loamy Morgantown soil materials. This clay outcrop is frequently severely eroded in areas that are not in forest.

This phase occurs on the steep slopes of the plain and has a gradient of about 35 percent. The 832 acres mapped is practically all in forest, the trees consisting of walnut, ash, elm, oak, and hickory, with beech and maple on the moist lower slopes. For preservation of this soil, it is essential that the timber cover be maintained. The steep slopes and rapid runoff result in very severe gully erosion wherever the forest cover is not maintained. The removal of undergrowth by grazing frequently results in severe erosion, particularly on lower slopes where clay outcrops.

Morgantown loam, eroded phase.—This eroded phase occurs on numerous small areas, aggregating 128 acres, on the steep hillsides in association with other Morgantown soils. Most of the surface soil and a part of the subsoil have been removed by accelerated erosion, and severe gullying has developed. Gullies widen and deepen rapidly after they have cut through the surface soil and upper subsoil. Caving then occurs in the yellowish-brown underlying sand and gravel. Such areas have no agricultural value and are suitable only for forest. The usual method for stopping gully formation is to place debris and brush in the gully; this is very ineffective, and frequently encourages the widening of the gullies. Control of gullies is best accomplished by diversion of all surface water around the gully head and planting locust and other trees in and around the gullied area.

Taggart silt loam.—In cultivated areas the 6- to 8-inch surface soil is light brownish-gray smooth friable silt loam. The subsoil is mottled gray and yellow silty clay loam, with rust-brown stains and blotches. At a depth of about 15 inches the subsoil is heavier textured and more compact and below depths of 24 to 36 inches is mottled gray and yellow heavy compact silty clay that is impervious to moisture movements. This material breaks into massive irregular-sized chunks, with a tendency toward vertical columnar structure. A thin coating of light-gray colloidal clay occurs on many of the cleavage faces. Below a depth of 48 inches the subsoil is more friable and contains considerable quantities of sand. At a depth of 12 to 15 feet stratified sand, silt, and clay occur, and small quantities of gravel may also be present. The entire soil mass is strongly acid.

This soil is developed on nearly level to slightly depressional areas under imperfect drainage conditions, where the parent material of the plain consists largely of clay and silt. The larger areas of the 64 acres mapped occur southeast of Sand Creek Church, with smaller ones occurring throughout the plain.

Included with this type are small areas that are more poorly drained, and that have light-gray silt loam surface soils and rust-stained light-gray subsoils. Numerous small rounded iron and manganese concretions occur on the surface and throughout the soil mass.

The native forest consisted chiefly of beech, maple, ash, and gum, but large areas have been cleared and brought under cultivation. Tillage operations and crop rotations on small areas are largely determined by the associated Morgantown soils, although, as the soil dries more slowly than Morgantown silt loam, tillage operations may be delayed. Corn, wheat, and hay are the principal crops. Larger areas are cultivated less intensively than Morgantown silt loam, and the crop yields are lower.

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SOILS DEVELOPED ON CALCAREOUS SLACK-WATER SILT AND CLAY

Soils developed on calcareous slack-water silt and clay occur on low terraces in small valleys between Mahalasville and Centerton and along the West Fork White River. In the southern part soils included in this group are developed on outcropping clay beds that underlie the gravel and sand forming the plain area on which Morgantown and Taggart soils are developed. These clays are leached to a depth of 3 to 5 feet and generally occur as small terrace remnants associated with other terrace soils and with alluvial soils that are medium acid in reaction and moderate in fertility. A mixed grain-and-livestock system of farming is generally followed in which corn, wheat, and hay are the principal crops. On the more rolling area a higher proportion of these soils is in meadow and pasture.

This group includes the Markland, McGary, and Montgomery series. The well-drained Markland soils are developed on sloping areas bordering the breaks of the terraces. The surface soil is light yellowish brown; the subsoil is yellowish-brown compact heavy silty clay loam; and calcerous clay occurs at a depth of 3 to 5 feet. The McGary soil occurs on level to gently undulating areas usually less than 5 feet above the adjoining alluvial plains. It has a light brownish-gray surface soil and a mottled gray and yellow subsoil. Both surface and internal drainage are imperfect. The Montgomery soil is developed in depression areas under nearly permanent saturation that supports a dense growth of sedges, marsh grass, and swamp timber. It has a very dark brownish-gray to dark-gray surface and upper subsoil, 12 to 18 inches thick, is high in organic matter, and has a plastic mottled gray and yellow lower subsoil.

Markland silt loam.—In cultivated areas the 6- to 8-inch surface soil is light yellowish-brown smooth friable silt loam. The brownish-yellow to yellowish-brown friable silty clay loam subsoil grades into brownish-yellow compact silty clay at a depth of about 15 inches. The parent soil material is somewhat yellow and gray stratified calcareous clay and silt at a depth of about 36 inches. The surface and upper subsoil layers are usually medium acid in reaction.

This soil, totaling 256 acres, occurs on terrace remnants that are 5 to 30 feet above the adjacent valley floor, and has a gradient of 5 to 10 percent. Surface drainage is good to excessive, especially on the steeper slopes, and erosion is potentially severe because of the difficulty of moisture penetration of the heavy-textured subsoil.

A few areas adjacent to steep slopes of the Morgantown soils that have loam and sandy loam surface soils, with appreciable quantities of sand and fine gravel in the subsoil, are included with Markland silt loam. These areas are strongly acid in reaction, with free lime carbonate present below depths of 36 to 60 inches.

The native forest of mixed hardwood consisted chiefly of beech, maple, walnut, ash, and elm. The trees have been largely removed, and the soil is now used mainly for pasture. Kentucky bluegrass is well suited to this soil when sufficient fertilizer and lime are applied. A large part of the pasture lands at present, however, support a growth of broomsedge, poverty grass, and redtop, with small quantities of Canada bluegrass. About one-half of the area is under cultivation to corn, wheat, soybeans, clover, and small quantities of alfalfa. When sufficient lime and fertilizer are applied, good stands of clover and alfalfa are obtained.

Markland silt loam, steep phase.—The steep phase occurs on slopes that have a gradient of 15 to 25 percent or more. The soil is similar in character to the typical soil, although many areas have a loamy texture due to the material from the Morgantown soils that has accumulated over the clay. The best utilization is pasture or forest, and practically all of it is now in forest. An area of 448 acres is mapped.

Markland silt loam, eroded steep phase.—This phase occurs on slopes that have a gradient of 15 to 25 percent or more. They have been cleared of forest cover and some have been under cultivation. A large part of the surface soil and, in places, a part of the subsoil have been removed by accelerated erosion, with numerous shallow gullies occurring in many areas. Only 64 acres is mapped.

With proper liming and fertilization good stands of bluegrass can be maintained on the less seriously eroded areas, provided it is not overgrazed. Reforestation is probably the best use for the more seriously eroded areas.

McGary silt loam.—In cultivated areas the 6- to 8-inch surface soil is light brownish-gray to gray heavy silt loam that puddles under improper tillage practices. The subsoil is mottled gray and yellow silty clay loam that is underlain, at a depth of about 17 inches, by mottled gray, yellow, and rust-brown heavy plastic silty clay. At a depth of 36 to 48 inches is gray and yellow calcareous stratified clay and silt. Areas that are developed farthest upstream are often developed on more friable, silty deposits that contain less lime; free lime carbonates occur at an average depth of about 45 inches.

This is an imperfectly drained light-colored soil developed on nearly level terraces. It occurs largely as terrace remnants near the mouths of small creeks and tributaries of the West Fork White River on elevations of less than 5 feet above the associated alluvial soils. A total of 128 acres is mapped.

The original forest consisted chiefly of beech, maple, ash, elm, and various other species suited to the moist soil conditions. The crop rotation in general use includes corn, wheat, and clover. Corn yields averages 25 to 30 bushels an acre, but when properly drained and fertilized, yields are considerably more. Wheat yields 12 to 15 bushels. Red clover can be grown without liming, but owing to the moderate acidity of the soil, lime is necessary for the successful growth of both clover and alfalfa.

Montgomery silty clay loam.—In cultivated areas the 6- to 8-inch dark-gray to very dark brownish-gray silty clay loam surface soil is high in organic-matter content. Tilth conditions are fair, but large clods form when tillage operations are attempted under too moist conditions. The subsoil is dark-gray to dark brownish-gray plastic silty clay that breaks into large chunks that are hard when dry and plastic and sticky when wet. This is underlain at depths of 15 to 18 inches by mottled gray, yellow, and rust-brown plastic silty clay to clay. Gray and yellow stratified calcareous clay and silt occur below a depth of about 50 inches. The reaction of the surface soil and subsoil is neutral. Associated with Markland and McGary soils, this soil occurs in depressions on low slack-water terraces. A total of 128 acres is mapped.

Crop rotations are similar to those practiced on the McGary soil. Corn yields average 45 to 50 bushels an acre, and under favorable conditions yields are substantially higher. Wheat is susceptible to winterkilling, especially on the less well-drained areas. When properly fertilized, the average yield of wheat is 15 to 25 bushels. Clover and alfalfa can be successfully grown when sufficient artificial drainage is installed.

Included with Montgomery silty clay loam are a few small areas that have silt loam surface texture and a few small areas that have a thin accumulation of silty material with organic content lower than normal.

NEUTRAL TO SLIGHTLY ALKALINE ALLUVIAL SOILS FROM WISCONSIN GLACIAL DRIFT REGIONS

The neutral to slightly alkaline alluvial soils are developed from material washed from Wisconsin till and glaciofluvial terraces. They occupy the bottom lands of the West Fork White River (pl. 2) and of tributaries rising in the Wisconsin glacial drift regions.

The Genesee, Ross, Eel, and Shoals soil series are included in this group. These are the most extensive alluvial soils in the county, comprising about 15 percent of the total area and about 70 percent of all alluvial soils.

The surface ranges in color from dark brown in the Ross soils to gray in the Shoals. The reaction is neutral to calcareous. These soils are subject to overflow in periods of extremely high water, and the surface texture and character of the material are occasionally changed by the floodwaters of a single overflow. Any area mapped as a given texture may be changed in the course of a few years to another texture by the action of floodwaters. Thus, through the action of a single flood, areas of Genesee silt loam may be changed to a lighter or heavier textured soil.

The bottom soils were originally covered with a dense forest growth of sycamore, elm, ash, soft and hard maples, cottonwood, tuliptree, walnut, oak, beech, and gum. Probably less than 10 percent of the bottoms are now timbered, and most of the trees are adjacent to the riverbank and in the low wet parts of the bottoms.

A systematic rotation is not in general practice on areas of these soils. Corn is the highest yielding crop and the most profitable under average conditions and is grown continuously until the yield declines. Yields average 50 bushels or more an acre. Wheat or soybeans usually follow corn at intervals of 4 to 7 years. Sweetclover is occasionally seeded in wheat as a soil-improving crop. Crops that are seeded in spring and harvested in fall are less likely to be damaged by overflow, as summer floods are uncommon. The lower lying areas may be flooded a dozen times a season, although the highest parts of the overflow bottoms are not subject to more than one or two floods a year. Crop losses, however, are small, one to two being reported by farmers in a 7-year period.

Soybeans are frequently seeded on areas of Eel and Shoals soils late in spring after it is too late to plant corn. About one-third of this crop seeded on the bottom soils is harvested for hay, and the rest, for grain. Soybeans yield 2 to 4 tons of hay an acre and 20 to 30 bushels of grain.

Wheat is more extensively grown on the broad neutral to slightly alkaline bottoms than on similar soils in other counties. This is partly because of low flood losses. Wheat yields average 17 to 22 bushels an acre.

Alfalfa is usually grown on the natural levees and higher areas adjoining streams and on the high bottoms, as there is a lesser probability of damage from floodwaters. Yields are 3 to 4 tons an acre, and good stands may be maintained for about 4 years after seeding, but after this period alfalfa is likely to be replaced by Kentucky bluegrass.

Genesee silt loam.—In cultivated areas the 6- to 7-inch surface soil is light yellowish-brown friable fine granular silt loam. In wooded and pastured areas the surface 2 inches is dark-brown silt loam. The subsoil is yellowish-brown to brownish-yellow friable silt loam that has thin layers of fine sandy material in some places. Below a depth of about 30 inches the material usually becomes more loose and sandy, and a few small pebbles and stones are present, but in some areas the texture is silty clay loam. Partly decomposed twigs, branches, leaves, and other debris may occur in various depositional layers throughout the profile. The entire profile is neutral to slightly alkaline.

This is the most extensive Genesee soil; an area of 14,336 acres is mapped. It occurs throughout the valleys of the larger streams and in some of the smaller bottoms.

Corn and wheat are the principal crops. Soybeans, alfalfa, and truck crops, as tomatoes and cabbage, are well adapted but are grown to only a limited extent. Corn is grown on about 45 percent of this soil, although wide variations in use occur. In the broad river bottoms, corn is the principal crop, occupying as much as two-thirds of the area in some places. Less corn and a greater variety of uses occur in the narrow bottoms. In small bottoms, a systematic crop rotation, as corn and soybeans, is more commonly followed. Corn yields 45 to 90 bushels an acre, with an average of 50 to 60 bushels. Owing to the danger of damage from flooding, this soil is not so well adapted to growing wheat as it is to corn and soybeans, but it is probably grown on 20 to 25 percent of this soil. The land for wheat is usually fertilized, and yields average 18 to 20 bushels. Excellent yields of alfalfa and clover are obtained, although there is more danger of being drowned out in floods than on the sandy types of Genesee soils that occupy slightly higher positions in the bottom. About 10 percent of this soil on small bottoms, unsuitable for the use of machinery, is used for pasture, although little grass is found in the large bottoms. These pastures frequently include the broken land along the bottoms.

Genesee silt loam, high-bottom phase.—This phase has essentially the same profile characteristics as the typical soil. Assorted yellowish-brown or brownish-yellow gravel is occasionally found in the subsoil below 36 inches. The total of 1,216 acres occurs in scattered areas throughout the West Fork White River bottom on a level 2 to 5 feet above the typical soil, consequently it is not flooded so frequently. The elevation is not sufficient to allow general use for farmsteads.

This soil is almost entirely cultivated, and little of it is used for either pasture or forest. A more definite system of crop rotation is followed than on the normal type, but crop yields are about the same. Wheat and corn are about equally important, being grown on about three-fourths of the area, and on about 6 percent, protected from overflow, alfalfa is more extensively grown.

Genesee loam.—In cultivated areas the 6- to 7-inch surface soil is light yellowish-brown friable granular loam. This is underlain by brown or yellowish-brown friable granular loam containing thin layers of sandy material. Below a depth of 36 inches is yellowish-brown or brownish-yellow sandy or fine gravelly material.

This soil occurs in natural levee positions along the principal streams, and from 10 to 20 percent of it has remained in timber, principally along old stream channels. The 4,928 acres mapped are principally in small areas along the larger streams.

Less intensively cropped than Genesee silt loam, a higher proportion of this type is in pasture and timber. Crop yields are similar to those obtained on the silt loam. Corn, the principal crop, occupies 40 to 50 percent of the area. Wheat is second in importance and is grown on 10 to 20 percent of the soil. Alfalfa is widely grown, as it is less likely to be drowned out during floods.

Genesee loam, high-bottom phase.—This phase has essentially the same profile characteristics as the typical soil. A few areas southeast of Centerton have moderately dark yellowish-brown surface soils to a depth of 12 to 15 inches.

Occurring on a slightly higher elevation than the typical, this phase is intermediate between the more frequently overflowed land and the terraces or benchlands of the valley of the West Fork White River. The 384 acres are mapped in small areas throughout the bottoms.

This soil is more extensively used than the typical, probably 90 percent of it being cropped. Because of the higher elevation, wheat, alfalfa, soybeans, mixed hay, and special crops, as tomatoes, are more extensively grown than on the typical loam.

Genesee fine sandy loam.—This soil occurs as natural levees in the curves or oxbows of the major streams. Where the water sweeps out of its banks during floods, the speed of the current is retarded and sand is deposited; in some areas a considerable quantity of fine gravel occurs in the surface soil. The surface soil to a depth of 7 to 8 inches is light yellowish-brown slightly coherent fine sandy loam, relatively low in organic content. Below this depth the material is variable, but usually has layers of yellowish-brown or brownish-yellow sand and gravel. An area of 960 acres is mapped.

Like Genesee loam, much of this type is kept in forest to prevent streams from cutting into the soil. Corn is grown on about 50 percent of the type, and yields average 35 bushels or more an acre. Wheat is the only other crop of any importance. This soil is naturally adapted to alfalfa, but only a small acreage is used for it. Watermelons and cantaloups are grown to a limited extent.

Genesee silty clay loam.—In cultivated areas the 6- to 7-inch surface soil is light yellowish-brown to yellowish-brown silty clay loam. If it is plowed or tilled when wet, hard clods form that are not easily broken. The subsoil is yellowish-brown silty clay loam, with an occasional layer of silty and sandy material present below 36 inches. This soil occurs most extensively in the valley of the West Fork White River southwest of Martinsville. An area of 1,344 acres is mapped.

Corn and wheat are the principal crops, the former being more extensively grown. Excellent yields are obtained. On levee-protected areas, which are not so susceptible to overflow, wheat is grown in rotation with corn.

Ross silty clay loam.—This soil occupies 1,792 acres in high-bottom positions throughout the valley of the West Fork White River. In cultivated areas the 6- to 8-inch surface soil is dark-brown or dusky-brown silty clay loam, and in the air-dry condition it has a brownish-gray appearance. It is friable when properly tilled, but when worked under wet conditions hard clods form. The subsoil is dark-brown to yellowish-brown silty clay loam. Thin layers of silt and fine sand occur below a depth of 36 inches. The entire soil profile is neutral to slightly alkaline. This soil grades into Genesee silty clay loam where the surface soil is grayish brown.

About 97 percent of the soil is under cultivation; 2 percent is in bluegrass pasture; and only 1 percent is in forest. Corn and wheat, the principal crops, occupy about 45 and 35 percent, respectively, of this type. Soybeans, alfalfa, tomatoes, and sweet corn are grown to some extent. Yields of corn are slightly lower than on Genesee silt loam, and average 45 to 50 bushels an acre. Yields are occasionally reduced by drought. Because of its slightly higher position—2 to 5 feet above the overflow bottoms—crop losses from floods are seldom sustained. This has encouraged a rotation system that includes a large proportion of clean-cultivated crops and wheat. Wheat is usually fertilized, and the yield averages 15 to 20 bushels an acre. Soybeans are grown both for hay and grain. Red clover or sweetclover is occasionally seeded for hay or soil improvement.

A few small areas included with this type occur in slight swales that have imperfect drainage and approach the characteristics of the Sloan soils. In these areas the surface soil is brownish-gray to dark brownish-gray heavy silty clay loam, and the subsoil is mottled gray and yellow heavy silty clay loam. One large area of Ross silt loam southeast of Centerton is included with this type.

Eel silt loam.—This is the dominant soil of the small stream bottoms in the Wisconsin glacial drift area. To a depth of 6 or 7 inches the surface soil is light yellowish-brown to brownish-gray friable medium granular silt loam. The organic content is variable but is somewhat higher than in the Genesee soils. The subsoil is light brownish-yellow silt loam, grading into mottled gray and yellow heavy silt loam to silty clay loam at 12 to 18 inches. Below a depth of about 24 inches the material is lighter textured, and partly decomposed twigs, leaves, and other debris may occur in various depositional layers. This soil occurs in the valley of the West Fork White River, principally in abandoned channels and in areas well back from the river, and has somewhat imperfect drainage conditions. An area of 10,176 acres is mapped.

This type is not so completely or so intensively cropped as Eel silty clay loam, as much of it occurs in narrow valleys that cannot be efficiently farmed. The yields are similar to those obtained on that type. Probably 25 percent of the soil is used for corn, 15 to 20 percent for wheat, 10 percent for red clover or mixed legumes, and smaller areas are cultivated to soybeans and truck crops. About one-fourth of this soil that occurs in small bottoms is used for pastures, and about 10 percent is in forest. The original forest cover included sycamore, beech, soft maple, sugar maple, ash, and elm. Only the small bottoms and wetter areas are now timbered, although many of the pastured areas contain considerable brush and sprouts.

Eel silty clay loam.—In cultivated areas the 6- or 7-inch surface soil is light yellowish-brown to brownish-gray moderately friable silty clay loam. Hard clods form when this soil is tilled under wet conditions. The subsoil of light yellowish-brown to brownish-gray silty clay loam to silty clay grades into mottled gray and yellow silty clay loam at a depth of 12 to 18 inches. This soil is neutral in reaction and is higher in plant nutrients than the Genesee soils. Associated with Ross silty clay loam, it has a darker colored surface soil than normal. An area of 6,016 acres is mapped.

Because of its position, this soil is subject to frequent inundation. It is colder and wetter than the surrounding Genesee and Ross soils but is usually farmed with them, consequently it differs little from Genesee silt loam in its average use. Early plantings of corn are occasionally drowned out, necessitating replanting or reseeding with soybeans. The average yields of corn are 50 to 60 bushels an acre, and about half of the type is planted to this crop. Wheat yields average about 15 bushels. Because of the greater crop hazard, the proportion of idle land is slightly greater than on the associated Genesee soils.

Eel loam.—The 6- to 8-inch surface soil is brownish-gray to light yellowish-brown friable loam. The subsoil is similar to the subsoil of Eel silt loam, except that it contains varying quantities of sand and fine gravel. This soil occurs in scattered areas on 704 acres adjacent to the West Fork White River and in small stream valleys and produces crops similar to those grown on Eel silt loam. About 30 percent of it is used for pasture.

Shoals silty clay loam.—The 6- to 8-inch surface soil is brownish-gray rather compact silty clay loam in cultivated areas. The subsoil is mottled light-gray and yellow compact silty clay loam. The soil ranges from neutral to slightly acid, and the organic content is low. It is relatively compact and impervious to moisture movement and is not easily penetrated by plant roots. This soil is subject to winter and spring overflows, and poor natural drainage is chiefly responsible for the limited acreage under cultivation. Probably 50 percent of this type is used for crops. Corn, soybeans, and timothy are the principal crops, and of these corn is the most important. Areas artificially drained by tiling and open ditches are cropped more intensively.

In the valley of Indian Creek, where the larger areas occur, the soil is partly derived from local alluvium washed from adjacent acid soils of the Illinoian glacial drift region. An area of 384 acres is mapped. An area in the valley of Mill Creek bordering Monrovia silty clay loam is slightly darker colored than the typical soil.

Shoals silt loam.—The 6- to 8-inch surface soil is brownish gray and friable. The subsoil is gray or light gray and is somewhat more permeable to moisture movement than the subsoil of Shoals silty clay loam. The principal areas of a total of 384 acres consist partly of alluvium from the adjacent acid upland soils and occur near Whitaker.

This soil is somewhat more intensively cropped than Shoals silty clay loam. Corn is the principal crop and yields about 35 bushels an acre. A large part is used as pasture.

SLIGHTLY TO MEDIUM ACID ALLUVIAL SOILS FROM THE BORDEN FORMATION, ILLINOIAN GLACIAL DRIFT, AND LIMESTONE

A minor group of soils consisting of alluvium washed from the Borden formation, Illinoian glacial drift, and limestone are included in this group. These soils, classified in the Haymond, Wilbur, and Wakeland series, are slightly to medium acid. For the most part they occur as narrow bottoms adjoining Cincinnati soils. Haymond soils are well drained; the Wilbur, moderately well drained; and the Wakeland, imperfectly drained.

Haymond silt loam.—This is the only well-drained soil of the slightly to medium acid alluvial group. The 64 acres mapped occur as small areas northeast of Paragon. In cultivated areas the 6- to 7-inch surface soil is light yellowish-brown friable silt loam. The subsoil is yellowish-brown to brownish-yellow friable silt loam. Occupying slightly elevated positions 1 to 3 feet above the more frequently flooded bottom land, almost all of it is under cultivation and is moderately fertile. Corn, the principal crop, yields 40 bushels or more an acre.

Wilbur silt loam.—This soil, totaling 3,904 acres, occurs in most of the small bottoms west of Martinsville where limestone forms part of the parent soil material of the upland soils. It is similar to Philo silt loam, except that it is less acid. The 6- to 8-inch surface soil is smooth mellow light yellowish-brown silt loam. The subsoil is light brownish-yellow silt loam containing less organic matter than the surface soil. At a depth of 16 to 24 inches the subsoil is mottled gray and yellow silt loam to light silty clay loam.

Corn is the principal crop, although wheat, soybeans, and clover also may be grown successfully. Liming is not generally needed for the growth of clover. Bluegrass is somewhat better adapted to the less acid conditions than to the more acid Philo silt loam, and small stream bottoms are extensively used for bluegrass pasture.

Wakeland silt loam.—In cultivated areas the 6- to 7-inch surface soil is brownish-gray friable silt loam. The subsoil is mottled gray and yellow heavy silt loam. Both the surface soil and subsoil are slightly to medium acid in reaction.

This soil occurs principally in the lower and imperfectly drained parts of the bottoms. It is derived from alluvial material of limestone, sandstone, shale, and Illinoian till material. Some of the more extensive areas occur along Grassy Creek northeast of Martinsville. Here the material is composed partly of wash from Wisconsin drift. Areas occurring along the small streams in the vicinity of Paragon and Whitaker occupy a position 1 to 3 feet above the general level of the flood plain. A total of 832 acres is mapped.

Corn and wheat are the principal crops, and yields are somewhat higher than those obtained on Stendal silt loam. Additions of lime are not required for legumes, but these crops are not extensively grown. Bluegrass pastures are extensive on the smaller bottom areas.

STRONGLY ACID ALLUVIAL SOILS FROM THE BORDEN FORMATION AND ILLINOIAN GLACIAL DRIFT

Members of the strongly acid alluvial soils from the Borden formation and Illinoian glacial drift comprise about 4.5 percent of the county. They are light in color, relatively low in organic matter, and of medium to low productivity. The material is derived from alluvium washed from the acid upland soils developed on sandstone, siltstone, and shale materials and Illinoian glacial drift and from the associated acid terraces. These soils occur in the valleys of small streams that have the steepest gradients in the upper courses; consequently, drainage conditions are best established in the narrow upper bottoms and become progressively poorer in the lower part of the valley. The very narrow stream bottoms are generally used for pasture and timber. Many are used intensively as cropland, as in highly dissected regions the proportion of cropland to the farm is relatively small. Corn, wheat, and soybeans are the principal crops. The well-drained soils are better adapted to corn and wheat than the imperfectly and poorly drained. In the wider more intensively used bottoms, a 3-year rotation of corn, wheat, and mixed hay is practiced. When lime is applied, clover generally forms part of the rotation. Crop yields are relatively low unless acidity is corrected, legumes are grown, and good farming practices are followed.

This group consists of well-drained to very poorly drained soils of the Pope, Philo, Stendal, and Atkins series. The Pope soil comprises 12 percent of the group and is well drained. It has a light yellowish-brown surface soil and a yellowish-brown to brownish-yellow subsoil. The Philo soils are moderately well drained and comprise 45 percent of the group. They have a light yellowish-brown surface soil, light brownish-yellow subsoil to a depth of 16 to 24 inches, and mottled gray and yellow lower subsoil. The Stendal soil, comprising about 37 percent of the group, has imperfect drainage. It has a light brownish-gray surface soil and a mottled gray and yellow subsoil. The Atkins soil, comprising about 6 percent of the group, has poor natural drainage. It has a light-gray to gray surface soil and a light-gray rust-stained subsoil.

In the vicinity of Paragon and Whitaker large areas of infrequently flooded bottoms occur where small streams enter the valley of the West Fork White River and spread out over a considerable area. These areas were formerly subject to overflow following heavy rains, but since the streams have been dredged, drainage has been improved. They are now only occasionally inundated by the backwaters of the river. Small areas also occur where streams have cut to a lower level, leaving remnants of the original bottoms 1 to 3 feet above the flood plain.

Pope loam.—In cultivated areas the 6- to 8-inch surface soil is light yellowish-brown friable silt loam. Some areas that have silt loam, fine sandy loam, or gravelly loam surface soils are included with this soil, because of the small extent. In the narrow stream bottoms the gravelly loam and sandy loam surface textures predominate. The light brownish-yellow or yellowish-brown friable silt loam subsoil is readily penetrated by roots. The soil is usually strongly acid in reaction, although a few areas influenced by limestone and neutral shale are only slightly acid. Natural drainage is good. A few areas containing considerable quantities of gravel have excessive internal drainage. The native vegetation consisted of oak, hickory, beech, maple, ash, and elm.

This is the only well-drained strongly acid bottom soil in the county. Associated with the Muskingum soils on the steep hillsides, it occurs almost entirely near the heads of drainageways in narrow V-shaped valleys. A few areas occur as natural levees along streams and in the broader valleys of Rhodes and Little Indian Creeks. A total of 2,432 acres is mapped.

This soil is moderately productive. It is used chiefly for corn, but in the larger bottoms soybeans, wheat, and hay are included in the crop rotation. In the narrow upper stream courses pasture and timber are the dominant uses. Corn averages 30 to 40 bushels an acre, but higher yields are usually obtained when the soil is limed and good agricultural practices are followed.

Philo silt loam.—The 6- to 8-inch surface soil is smooth mellow light yellowish-brown silt loam. The subsoil is light brownish-yellow heavy silt loam. At a depth of 16 to 24 inches the subsoil is mottled gray and yellow friable silt loam. In most places the soil is strongly acid, although a few small areas are only medium to slightly acid. These variations occur where the soil has been influenced by wash from limestone, or by the greenish-gray shales occurring west of Martinsville.

Occurring in the smaller valleys of the Illinoian till and Borden regions, this is the most extensive soil (4,992 acres) of the group. It also occurs in the broader bottoms where drainage conditions are not so good as where Pope loam is mapped.

This is the most productive of the acid alluvial soils and occurs on the wider bottoms that can be readily farmed. Most areas have been cleared of the original timber cover and brought under cultivation. Probably 15 percent is still timbered, while approximately 55 percent is farmed and the rest is in pasture. Corn, the principal crop, occupies about 35 percent of the type.

Crops do not suffer from poor drainage, and adequate supplies of moisture are present in most years to produce good yields of corn. In areas where the soil has been limed, a rotation of corn, wheat, and clover is followed. Because of the acid soil and the lack of reserves of plant nutrients, a rotation in which legumes are grown has been found necessary to maintain crop yields. The average yield of corn on unlimed land in which legumes are not grown is 30 to 40 bushels an acre, and on well-managed areas, 50 bushels. Wheat yields about 15 bushels. Both medium-red and Mammoth clover are grown, the latter being widely used because it produces a greater quantity of organic matter. On unlimed areas, soybeans and timothy are the principal hay crops. Small acreages of tobacco, tomatoes, cabbage, sweet corn, and other special cash crops are grown.

Philo silt loam, high-bottom phase.—The high-bottom phase has essentially the same profile characteristics as the typical soil, except that it occurs at slightly higher elevations. Crops grown and yields obtained are also similar. The 320 acres mapped occur principally in the vicinity of Paragon and Whitaker. The soil is almost entirely cleared of forest and is more intensively used than the normal type.

Philo loam.—This soil is similar to Philo silt loam except that the surface soil is light yellowish-brown friable loam, and the subsoil is light brownish-yellow friable loam becoming mottled gray and yellow loam at a depth of 16 to 24 inches. It occurs in small areas, totaling 320 acres, adjacent to Rhodes and Lambs Creeks and Lick Branch. Crops grown and yields obtained are similar to those on the silt loam.

Stendal silt loam.—In cultivated areas the 6- to 8-inch surface soil is brownish-gray smooth silt loam. The subsoil is mottled gray, yellow, and rust-brown heavy silt loam to silty clay loam. Small rust-brown rounded iron and manganese concretions are numerous on the surface, and blotches and stains are usually present in the subsoil.

This soil occurs in the lower bottom positions of the broader streams, well back from the stream channel. The sediments are derived from the acid Illinoian till and sandstone, siltstone, and shale upland soils. The total area is 2,752 acres. Imperfect natural drainage, strong acidity, and low fertility restrict the use of this type.

Three-fourths of the total area of this type has been cleared of forest and brought under cultivation. Owing to imperfect drainage conditions, the number of crops grown and the yields depend largely on weather conditions and artificial drainage. In normal seasons, good yields are obtained. Artificial drainage is rather difficult to establish. Plowing in narrow lands with numerous dead furrows is the most common method of artificial drainage, but tile and open ditches are established in some areas. About 30 percent of the soil is now in crops, chiefly corn, wheat, and hay. Corn, the principal crop, yields 25 to 30 bushels an acre. Corn and soybeans are the best adapted crops, as planting can be delayed until the soil dries. Wheat is occasionally grown on the better drained areas. The more poorly drained areas have been kept in forest that includes pin oak, swamp white oak, ash, elm, red maple, beech, and gum.

Stendal silt loam, high-bottom phase.—This phase is similar to the typical soil but occurs in slightly elevated and frequently flooded positions, mostly in the vicinity of Paragon and Whitaker. Here drainage has been improved by dredging the outlets of small streams to the valley of the West Fork White River, but the land is occasionally flooded by backwater from the river. Small areas that lie 2 to 3 feet above the adjacent flood plains occur near the outlets of small valleys to the West Fork White River. This phase is almost as productive as the typical soil, but is somewhat more intensively used. An area of 1,088 acres is mapped.

Atkins silt loam.—In cultivated areas the 6- to 7-inch surface soil is light-gray friable silt loam. The subsoil is light-gray rust-stained silt loam to light silty clay loam. The entire soil is strongly acid, and numerous small hard rust-brown iron concretions are present on the surface and throughout the profile. Artificial drainage is difficult to obtain because of the poor natural drainage and the low position, although some areas have been ditched and tiled. A large percentage of the 320 acres mapped has never been cleared of forest, and many cleared areas have reverted to pasture. Corn is the principal crop, but the yields are low. Pastures have low carrying capacity. Bluegrass is not well adapted because of overflow, high acidity, and low fertility. Forestry is probably the best use for this soil.

Several areas of Atkins silty clay loam in the valley of Indian Creek, east of Mahalasville, are included with this soil, but they differ from it in having a silty clay loam surface soil and a rather heavy compact silty clay subsoil.

Atkins silt loam, high-bottom phase.—The soil profile is similar to the typical soil but occupies slightly higher positions, infrequently flooded. This phase, totaling 128 acres, occurs in the vicinity of Paragon. Where outlets for drainage can be obtained, it is somewhat more intensively cultivated than the typical. Corn is the principal crop, but wheat, soybeans, and hay are grown to some extent.

MISCELLANEOUS LAND TYPE

Riverwash.—This mixture of gravel, rock, and sand occurs in the West Fork White River and its larger tributaries and in its abandoned channels. In most areas the material lies only a few feet above the level of the river in its normal stage. The material is not stable and may disappear with the next flood. Some areas support a scant growth of small trees and weeds, but none are suited to agricultural use.

ESTIMATED YIELDS AND PRODUCTIVITY RATINGS

In table 7 the soils of Morgan County are listed alphabetically, and for each the estimated average acre yields of the principal crops are given under both the common and better farming practices.

TABLE 7.—*Estimated average per acre yields*[1] *of the principal crops on each soil in Morgan County, Ind.*

Soil	Corn		Wheat		Oats		Soybeans		Mixed hay		Red clover		Alfalfa		Potatoes	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Abington silty clay loam	*Bu*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu*	*Bu.*
Drained	45	55	17	25	37	45	22	25	2.2	2.5	1.6	2.0	2.8	3.6	150	180
Undrained	10	----	----	----	10	----	10	----	1 0	----	1.0	----	----	----	----	----
Atkins silt loam:																
Drained	20	30	7	10	10	15	10	15	1 0	1 4	.4	6	----	----	----	----
Undrained	10	----	----	----	----	----	5	----	----	----	----	----	----	----	----	----
High-bottom phase	20	30	7	10	10	15	10	15	1 0	1 4	4	.6	----	----	----	----
Avonburg silt loam																
Drained	25	45	12	20	20	30	15	20	1 0	1.8	.6	1 0	----	----	80	120
Undrained	15	----	7	----	15	----	10	----	6	----	----	----	----	----	50	----
Ayrshire loam																
Drained	30	40	15	20	25	30	15	17	1 5	1.8	1.0	1 6	4	1.6	80	120
Undrained	15	----	10	----	15	----	10	----	1 0	----	.6	----	----	----	50	----
Banta silt loam	25	35	12	20	25	35	15	20	.8	1 5	2	1 2	----	----	80	120
Bartle silt loam																
Drained	30	40	12	18	20	30	15	20	1 0	1.8	2	1.0	----	----	80	120
Undrained	20	----	7	----	15	----	10	----	.5	----	----	----	----	----	40	----
Bartle silty clay loam.																
Drained	30	40	12	18	20	30	15	20	1 0	1.8	2	1.0	----	----	80	120
Undrained	20	----	7	----	15	----	10	----	5	----	----	----	----	----	40	----
Bedford silt loam	25	40	12	18	20	30	10	15	1.2	1.6	.2	1 2	----	1 6	60	100
Bellefontaine loam	27	37	12	20	15	20	10	15	1 2	1.5	.6	1 2	1.8	3.2	60	100
Bethel silt loam:																
Drained	25	30	10	15	20	25	10	15	1.2	1 6	.8	1.4	1.2	2.4	60	100
Undrained	15	----	5	----	10	----	7	----	4	----	.4	----	----	----	20	----
Brookston silty clay loam:																
Drained	50	60	18	25	37	47	22	25	2 2	2.5	1.8	2 0	3 0	3.8	150	180
Undrained	25	----	5	----	15	----	12	----	1 6	----	1 4	----	2 0	----	50	----
Cincinnati silt loam	25	35	12	20	25	35	12	20	.8	1.5	.2	1 2	----	----	80	120
Eroded sloping phase	5	15	3	7	----	5	3	5	5	.8	----	----	----	----	----	----
Gullied sloping phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Shallow phase	20	30	10	18	25	35	12	18	.8	1 5	.2	1.2	----	----	80	120
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Crosby silt loam:																
Drained	35	45	15	20	30	40	20	25	1.8	2.5	1 4	1.8	2.4	3.2	100	140
Undrained	20	----	10	----	20	----	12	----	1.5	----	1 0	----	1 2	----	60	----
Delmar silt loam:																
Drained	25	30	10	15	20	25	10	15	1 0	1.6	.8	1.4	.8	2 4	60	100
Undrained	15	----	5	----	10	----	7	----	.4	----	.4	----	----	----	20	----
Eel loam																
Drained	45	55	15	18	30	35	22	25	2 2	2.4	1 8	2 0	2 4	3.2	100	150
Undrained	40	----	10	----	20	----	20	----	1.4	----	1 4	----	1 6	----	60	----
Eel silty clay loam:																
Drained	50	60	15	18	30	35	22	25	2 2	2 5	1 8	2 0	2.4	3.2	100	150
Undrained	45	----	10	----	20	----	20	----	1.4	----	1.4	----	1.6	----	60	----
Eel silt loam:																
Drained	50	60	15	18	30	35	22	25	2.2	2 5	1.8	2.0	2.4	3.2	100	150
Undrained	45	----	10	----	20	----	20	----	1 4	----	1 4	----	1.6	----	60	----
Elkinsville silt loam	30	40	12	20	25	35	12	15	.8	1 4	.2	1.2	----	1 6	80	120
Fincastle loam:																
Drained	35	45	15	20	30	35	20	25	1 8	2.2	1 4	1.8	2 4	3.2	100	140
Undrained	20	----	10	----	20	----	12	----	1 5	----	1.0	----	1.2	----	60	----
Fincastle silt loam:																
Drained	35	45	15	20	30	35	20	25	1 8	2.2	1.4	1.8	2.4	3.2	100	140
Undrained	20	----	10	----	20	----	12	----	1 5	----	1.0	----	1.2	----	60	----
Fox fine sandy loam	25	35	18	22	20	25	12	18	1.2	1 8	.8	1.2	2.0	3.2	50	100
Fox loam	30	40	20	25	25	30	15	20	1.4	2.0	1 0	1.4	2.4	3 6	80	100
Sloping phase	----	----	----	----	----	----	----	----	.8	1.6	----	----	1.6	2.4	----	----
Fox silt loam	35	45	20	25	25	30	17	21	1.6	2.0	1.0	1 6	2.4	3 6	80	100
Frederick silt loam	25	40	12	17	20	30	10	15	1.2	1.6	.2	1.2	----	1.6	60	100
Eroded phase	10	15	3	7	----	5	----	3	----	----	----	----	----	----	----	----
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Genesee fine sandy loam																
Protected	35	40	12	18	30	35	20	22	1.2	1.5	.8	1.2	2.4	3.2	100	120
Unprotected	30	----	5	----	10	----	15	----	.8	----	.6	----	1.6	----	60	----
Genesee loam																
Protected	50	55	17	20	40	45	22	25	2.2	2 5	2 0	2.2	3 6	4 0	140	170
Unprotected	45	----	12	----	30	----	22	----	2.0	----	1 6	----	3 2	----	120	----
High-bottom phase	50	55	17	20	40	45	22	25	2 2	2 5	2 0	2.2	3.6	4.0	140	170
Genesee silt loam:																
Protected	55	60	20	22	40	45	22	25	2.2	2 5	2 0	2.2	3.6	4.0	140	170
Unprotected	50	----	12	----	30	----	22	----	2 0	----	1.6	----	3.2	----	120	----
High-bottom phase	50	60	20	22	40	45	22	25	2.2	2.5	2.0	2.2	3.6	4.0	140	170

See footnote at end of table.

TABLE 7.—*Estimated average per acre yields*[1] *of the principal crops on each soil in Morgan County, Ind.*—Continued

Soil	Corn		Wheat		Oats		Soybeans		Mixed hay		Red clover		Alfalfa		Potatoes	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Genesee silty clay loam:	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*
Protected	55	60	17	20	35	40	22	25	2.2	2.5	2.0	2.2	3.6	4.0	140	170
Unprotected	50	----	12	----	30	----	22	----	2.0	----	1.6	----	3.2	----	120	----
Gibson silt loam	25	35	12	20	25	35	12	20	1.0	1.5	.2	1.2	----	----	80	120
Grayford silt loam	25	45	12	20	20	30	12	17	.9	1.6	.2	1.2	----	1.6	60	100
Eroded sloping phase	----	----	----	----	----	----	----	----	.6	.9	----	----	----	----	----	----
Level phase	25	45	12	20	20	30	12	17	.9	1.6	.2	1.2	----	1.6	60	100
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Gregg loam																
Drained	30	40	12	17	25	35	12	17	.8	1.4	.8	1.6	1.8	2.6	40	60
Undrained	15	----	7	----	15	----	10	----	.6	----	.6	----	1.0	----	----	----
Gregg silt loam:																
Drained	30	40	12	17	25	35	12	17	.8	1.4	1.0	1.6	1.8	2.6	60	80
Undrained	15	----	7	----	15	----	10	----	.6	----	.6	----	1.0	----	----	----
Haymond silt loam	40	50	12	20	25	35	17	22	1.8	2.2	1.6	2.0	2.4	3.2	100	130
Loy silt loam:																
Drained	20	30	10	15	15	25	10	15	.8	1.6	.2	.8	----	----	60	100
Undrained	12	----	5	----	10	----	7	----	.4	----	----	----	----	----	20	----
Mahalasville loam:																
Drained	45	55	17	22	37	47	22	25	2.0	2.2	1.6	2.0	2.4	3.2	140	170
Undrained	25	----	5	----	15	----	12	----	1.4	----	1.2	----	1.6	----	40	----
Mahalasville silty clay loam:																
Drained	45	55	17	22	35	40	22	25	2.0	2.2	1.6	2.0	2.4	3.2	40	170
Undrained	25	----	5	----	15	----	12	----	1.4	----	1.2	----	1.6	----	40	----
Markland silt loam	25	40	12	20	20	30	12	20	1.2	1.8	.8	1.2	.4	2.8	40	60
Eroded steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Martinsville fine sandy loam	25	35	10	15	20	25	15	17	1.4	1.8	1.0	1.4	2.4	3.2	80	120
Martinsville loam	30	40	20	25	25	35	17	20	1.8	2.2	1.2	1.8	2.8	3.6	80	120
Martinsville silt loam	30	45	20	25	25	35	17	20	1.8	2.2	1.2	1.8	2.8	3.8	80	120
McGary silt loam:																
Drained	25	35	12	17	15	25	12	15	1.0	1.6	.8	1.2	----	1.6	40	60
Undrained	20	----	7	----	10	----	10	----	.6	----	.4	----	----	----	20	----
Miami silt loam	35	45	17	25	35	40	17	22	1.8	2.2	1.4	1.8	2.8	3.6	100	150
Eroded sloping phase	17	22	9	12	17	20	9	11	.9	1.1	.7	.9	1.2	2.4	----	----
Sloping phase	27	32	14	17	27	30	14	16	1.4	1.7	1.2	1.4	1.0	1.4	----	----
Monrovia silty clay loam:																
Drained	45	55	12	18	35	40	22	25	2.0	2.2	1.5	1.8	----	----	80	120
Undrained	20	----	5	----	10	----	12	----	1.2	----	1.0	----	----	----	----	----
Montgomery silty clay loam:																
Drained	45	55	17	22	30	40	22	25	1.4	1.8	1.2	1.8	1.6	2.4	80	120
Undrained	20	----	5	----	10	----	12	----	----	----	----	----	----	----	----	----
Morgantown loam:																
Eroded phase	15	22	7	12	12	20	7	11	1.0	1.3	.6	1.0	1.2	1.8	----	----
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Morgantown silt loam	30	45	15	25	25	40	15	22	1.6	2.2	1.2	2.0	2.0	3.2	80	120
Muskingum silt loam	12	20	7	15	----	----	7	10	.8	1.2	----	----	----	----	----	----
Colluvial phase	15	30	7	15	15	25	7	10	1.0	1.5	.2	1.0	----	----	60	80
Muskingum stony silt loam	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Parke silt loam	30	35	12	20	25	35	12	17	.8	1.5	.2	1.2	----	----	100	140
Eroded sloping phase	15	17	6	10	12	17	6	9	.4	.7	----	----	----	----	----	----
Pekin silt loam	25	40	12	20	25	35	12	17	.8	1.4	.2	1.2	----	1.2	100	140
Peoga silt loam:																
Drained	20	30	10	15	15	25	10	15	.8	1.6	.2	.8	----	----	60	100
Undrained	12	----	5	----	10	----	7	----	.4	----	----	----	----	----	20	----
Philo loam	40	45	15	20	20	30	17	22	1.8	2.0	.6	1.2	----	----	100	150
Philo silt loam	40	45	15	20	20	30	17	22	1.8	2.0	.6	1.2	----	----	100	150
High-bottom phase	40	50	15	20	20	30	17	22	1.8	2.0	.6	1.2	----	----	100	150
Plano silty clay loam:																
Drained	45	50	7	12	35	42	22	25	1.2	1.6	1.2	1.4	----	----	80	120
Undrained	20	----	----	----	----	----	10	----	----	----	----	----	----	----	----	----
Pope loam	40	45	15	20	20	30	20	22	1.8	2.0	.6	1.2	----	----	100	150
Princeton fine sandy loam	20	30	10	15	10	20	12	15	.5	1.0	.2	.6	2.0	3.2	100	150
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	.8	1.6	----	----
Princeton loam	30	40	12	17	15	25	15	20	.8	1.2	.6	1.0	2.4	4.0	80	120
Princeton loamy fine sand	15	20	7	12	5	10	10	12	.4	.8	----	----	1.6	2.8	80	120
Ragsdale loam:																
Drained	45	55	17	22	35	42	22	25	2.0	2.2	1.6	2.0	2.4	3.2	140	170
Undrained	25	----	5	----	15	----	11	----	1.4	----	1.2	----	1.6	----	40	----
Riverwash	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

See footnote at end of table.

TABLE 7.—*Estimated average per acre yields*[1] *of the principal crops on each soil in Morgan County, Ind.*—Continued

Soil	Corn		Wheat		Oats		Soybeans		Mixed hay		Red clover		Alfalfa		Potatoes	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu*
Ross silty clay loam	45	50	17	22	35	40	22	25	2.2	2.4	1.8	2.0	1.2	1.6	120	160
Russell loam	35	45	17	25	30	40	17	22	1.8	2.2	1.2	1.8	2.4	3.6	100	150
Russell silt loam	35	45	17	25	35	45	17	22	1.8	2.2	1.2	1.8	2.4	3.6	100	150
Eroded sloping phase	17	22	9	12	17	20	9	11	.9	1.1	.7	.9	1.2	1.8		
Gullied sloping phase																
Level phase	35	45	17	25	35	45	17	22	1.8	2.2	1.2	1.8	2.4	3.6	100	150
Sloping phase	27	32	14	17	22	27	14	16	1.4	1.7	.9	1.4	2.0	2.8		
Steep phase													.8	1.2		
Shoals silt loam:																
Drained	35	45	7	12	25	30	17	22	1.4	1.8	1.4	1.8	1.6	2.4	100	120
Undrained	30		5		10		15									
Shoals silty clay loam:																
Drained	35	45	7	12	25	30	17	22	1.4	1.8	1.4	1.8	1.6	2.4	120	160
Undrained	30		5		10		15									
Stendal silt loam																
Drained	25	35	14	15	15	20	12	17	1.4	1.7	.6	1.0			80	120
Undrained	15		5		5		7									
High-bottom phase	25	35	10	15	15	20	12	17	1.4	1.7	.6	1.0			80	120
Taggert silt loam:																
Drained	25	40	12	17	20	40	12	17	1.2	1.6	.2	1.0		1.6	40	80
Undrained	15		7		15		7		.8							
Tilsit silt loam	25	35	10	17	15	25	12	17	1.2	1.6	.2	1.2			80	120
Vigo silt loam:																
Drained	25	40	10	20	15	25	12	17	1.0	1.6	.6	1.0			40	80
Undrained	15		7		5		10		.6		.4					
Wakeland silt loam.																
Drained	35	45	10	17	20	30	17	22	1.6	2.0	1.4	1.8	2.0	2.8	80	110
Undrained	30		5		10		15		.8		.6		.8		40	
Washtenaw silt loam.																
Drained	35	45	12	20	25	20	17	22	1.8	2.2	1.8	2.2	2.8	3.6	80	120
Undrained	20															
Wellston silt loam	15	25	7	12	15	25	10	12	.8	1.2	.2	1.0			60	80
Steep phase																
Whitaker fine sandy loam:																
Drained	25	35	12	17	25	30	15	17	.0	1.4	1.0	1.4	1.6	2.8	60	100
Undrained	20		10		20		10		.6		.6		.8		40	
Whitaker loam:																
Drained	30	40	15	20	25	35	15	20	1.5	2.0	1.0	1.6	2.0	3.2	60	100
Undrained	20		10		20		10		1.2		.6		.8		40	
Whitaker silt loam:																
Drained	30	40	15	20	25	35	15	20	1.5	2.0	1.0	1.6	2.0	3.2	60	100
Undrained	20		10		20		10		1.2		.6		.8		40	
Wilbur silt loam	40	50	12	20	25	35	17	22	1.8	2.2	1.6	2.0	2.4	3.2	100	130
Zanesville silt loam	20	40	10	17	20	30	12	17	1.0	1.5	.2	1.2			100	120
Zanesville-Wellston silt loams:																
Eroded hill phases																
Gullied hill phases																
Steep phases																

[1] Yields in columns A indicate the average crop obtained under prevailing practices; those in columns B indicate the average crop obtained with improved methods of farm management that include the more intensive use of crop rotations, some erosion control practices, the use of some legumes, commercial fertilizers, lime, and barnyard and green manures. Absence of a yield figure indicates that the crop is not commonly grown.

In order to compare directly the yields obtained in Morgan County with those obtained in other parts of the country, yield figures have been converted in table 8 to indexes based on standard yields.

TABLE 8.—*Productivity ratings of soils in Morgan County, Ind.*

Soil	Crop productivity index [1] for—																						General productivity grade [3]		Remarks on use and physical suitability for use
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables [2]		Apples [2]		Pasture [2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Dark poorly drained soils of the depressions:																									Largely used for grain and livestock farming. A 3-year crop rotation of corn, wheat or oats, and legumes is common. These soils, in general, are especially well suited to corn, soybeans, and truck crops. Fall-sown small grains and legumes are occasionally damaged by winterkilling and heaving. Crops grown on undrained areas are likely to be damaged by standing water.
Brookston silty clay loam:																									
Drained	100	120	70	100	75	95	90	100	110	125	90	100	75	95	75	90	70	100	----	----	90	100	1	1+	
Undrained	50	----	20	----	30	----	50	----	80	----	70	----	50	----	25	----	30	----	----	----	80	----	5	----	
Abington silty clay loam:																									
Drained	90	110	70	80	75	90	90	100	110	125	80	100	70	90	75	90	70	100	----	----	90	100	2	1+	
Undrained	20	----	----	----	20	----	40	----	50	----	50	----	----	----	----	----	----	----	----	----	70	----	8	----	
Mahalasville silty clay loam:																									
Drained	90	110	70	90	70	80	90	100	100	110	80	100	60	80	70	85	70	90	----	----	90	100	2	1+	
Undrained	50	----	20	----	30	----	50	----	70	----	60	----	40	----	20	----	30	----	----	----	80	----	6	----	
Mahalasville loam:																									
Drained	90	110	70	90	75	95	90	100	100	110	80	100	60	80	70	85	70	90	----	----	90	100	2	1+	
Undrained	50	----	20	----	30	----	50	----	70	----	60	----	40	----	20	----	30	----	----	----	80	----	6	----	
Ragsdale loam:																									
Drained	90	110	70	90	70	85	90	100	100	110	80	100	60	80	70	85	70	90	----	----	90	100	2	1+	
Undrained	50	----	20	----	30	----	50	----	70	----	60	----	40	----	20	----	30	----	----	----	80	----	6	----	
Monrovia silty clay loam:																									
Drained	90	110	50	75	70	80	90	100	100	110	75	90	----	----	40	60	40	60	----	----	90	100	2	1+	
Undrained	40	----	20	----	20	----	50	----	60	----	50	----	----	----	----	----	----	----	----	----	80	----	6	----	
Montgomery silty clay loam:																									
Drained	90	110	70	90	60	80	90	100	70	90	60	90	40	60	40	60	50	70	----	----	90	100	2	1	
Undrained	40	----	20	----	20	----	50	----	----	----	----	----	----	----	----	----	20	----	----	----	80	----	7	----	
Plano silty clay loam:																									
Drained	90	100	30	50	70	85	90	100	60	80	60	70	----	----	40	60	40	60	----	----	90	100	2	1	
Undrained	40	----	----	----	----	----	40	----	----	----	----	----	----	----	----	----	----	----	----	----	70	80	8	----	
Washtenaw silt loam:																									
Drained	70	90	50	80	50	80	70	90	90	110	90	110	70	90	40	60	40	60	----	----	90	100	3	1	
Undrained	40	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	70	----	9	----	

See footnotes at end of table.

590857—50——7

TABLE 8.—*Productivity ratings of soils in Morgan County, Ind.* Continued

Soil	Crop productivity index[1] for—																						General productivity grade[3]		Remarks on use and physical suitability for use
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables[2]		Apples[2]		Pasture[2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Alluvial soils (neutral):																									
Genesee silt loam:																									
Protected	110	120	80	90	80	90	90	100	110	125	100	110	90	100	70	85	75	95	20	30	90	100	1	1+	
Unprotected	100	----	50	----	60	----	90	----	100	----	80	----	80	----	60	----	60	----	----	----	90	100	2	----	
High-bottom phase	100	120	80	90	80	90	90	100	110	125	100	110	90	100	70	85	75	95	20	30	90	100	1	1+	
Genesee silty clay loam:																									
Protected	110	120	70	80	70	80	90	100	110	125	100	110	90	100	70	85	75	95	20	30	90	100	1	1+	
Unprotected	100	----	50	----	60	----	90	----	100	----	80	----	80	----	60	----	60	----	----	----	90	100	2	----	
Genesee loam:																									
Protected	100	110	70	80	80	90	90	100	110	125	100	110	90	100	70	85	75	95	20	30	90	100	1	1+	
Unprotected	90	----	50	----	60	----	90	----	100	----	80	----	80	----	60	----	60	----	----	----	90	100	2	----	
High-bottom phase	100	110	70	80	80	90	90	100	110	125	100	110	90	100	70	85	75	95	20	30	90	100	1	1+	Largely used for grain farming. Corn is the principal crop, with wheat second in importance. A rotation of corn, wheat or oats, and legumes is generally followed on the Genesee and Ross soils, whereas corn is the principal crop on the Eel and Shoals soils. Crops on unprotected or undrained areas may be damaged by overflow.
Eel silt loam:																									
Drained	100	120	60	70	60	70	90	100	110	125	90	100	60	80	50	75	60	80	----	----	90	100	1	1+	
Undrained	90	----	40	----	40	----	80	----	70	----	70	----	40	----	30	----	30	----	----	----	80	----	3	----	
Eel silty clay loam:																									
Drained	100	120	60	70	60	70	90	100	110	125	90	100	60	80	50	75	60	80	----	----	90	100	1	1+	
Undrained	90	----	40	----	40	----	80	----	70	----	70	----	40	----	30	----	30	----	----	----	80	----	3	----	
Eel loam:																									
Drained	90	110	60	70	60	70	90	100	110	120	90	100	60	80	50	75	60	80	----	----	90	100	2	1+	
Undrained	80	----	40	----	40	----	80	----	70	----	70	----	40	----	30	----	30	----	----	----	80	----	3	----	
Ross silty clay loam	90	100	70	90	70	80	90	100	110	120	90	100	60	80	60	80	60	80	----	----	90	100	1	1+	
Shoals silty clay loam:																									
Drained	70	90	30	50	50	60	70	90	70	90	70	90	40	60	50	60	----	----	----	----	90	100	3	1	
Undrained	60	----	20	----	20	----	60	----	----	----	----	----	----	----	----	----	----	----	----	----	80	----	6	----	
Shoals silt loam:																									
Drained	70	90	30	50	50	60	70	90	70	90	70	90	40	60	60	80	----	----	----	----	90	100	4	2	
Undrained	60	----	20	----	20	----	60	----	----	----	----	----	----	----	----	----	----	----	----	----	80	----	6	----	
Genesee fine sandy loam:																									
Protected	70	80	50	70	60	70	80	90	60	75	40	60	60	80	50	60	40	50	----	----	80	90	4	3	
Unprotected	60	----	20	----	20	----	60	----	40	----	30	----	40	----	30	----	----	----	----	----	70	80	5	----	

Alluvial soils (slightly to medium acid):																									
Wilbur silt loam	80	100	60	80	50	70	70	90	90	110	80	100	60	80	50	65	50	60	----	----	80	90	3	1	Largely used for general farming. Corn, wheat, soybeans, red clover, and alfalfa are the principal crops. Crops on the Wakeland soils are often damaged by standing water.
Haymond silt loam	80	100	60	80	50	70	70	90	90	110	80	100	60	80	50	65	50	60	----	----	80	90	3	1	
Wakeland silt loam:																									
Drained	70	90	40	70	40	60	70	90	80	100	70	90	50	70	40	55	40	50	----	----	80	90	4	2	
Undrained	60	----	20	----	20	----	60	----	40	----	30	----	----	----	20	----	20	----	----	----	70	----	6	----	
Alluvial soils (strongly acid):																									
Philo silt loam	80	90	60	80	40	60	70	90	90	100	30	60	----	----	50	75	40	60	----	----	50	70	3	1	Largely used for general farming, with corn and wheat the principal crops. A 3-year rotation of corn, wheat, and mixed clover and timothy is common. Alfalfa is not adapted to these soils. Crops grown on the Stendal and Atkins soils are subject to damage by standing water.
High-bottom phase	80	100	60	80	40	60	70	90	90	100	30	60	----	----	50	75	40	60	----	----	50	70	3	1	
Philo loam	80	90	60	80	40	60	70	90	90	100	30	60	----	----	50	75	40	60	----	----	50	70	3	1	
Pope loam	80	90	60	80	40	60	70	90	90	100	30	60	----	----	50	75	40	60	----	----	50	70	3	1	
Stendal silt loam:																									
Drained	50	70	40	60	30	40	50	70	70	85	30	50	----	----	40	60	30	50	----	----	50	70	5	3	
Undrained	30	--	20	----	10	----	30	----	----	----	----	----	----	----	----	----	----	----	----	----	30	----	8	----	
High-bottom phase	50	70	40	60	30	40	50	70	70	85	30	50	----	----	40	60	30	50	----	----	50	70	5	3	
Atkins silt loam:																									
Drained	40	60	30	40	20	30	40	60	50	70	20	30	----	----	----	----	----	----	----	----	40	60	6	5	
Undrained	20	----	----	----	----	----	20	----	----	----	----	----	----	----	----	----	----	----	----	----	20	----	9	----	
High-bottom phase	40	60	30	40	20	30	40	60	50	70	20	30	----	----	----	----	----	----	----	----	40	60	6	5	
Imperfectly drained soils of the uplands:																									
Crosby silt loam:																									
Drained	70	90	60	80	60	80	80	100	90	110	70	90	60	80	50	70	40	60	40	50	80	90	3	1	The Crosby and Fincastle soils are largely used for grain and livestock farming. A 3-year rotation of corn, wheat or oats, and legumes is common. They are well adapted to alfalfa when properly limed. The Avonburg, Ayrshire, and Vigo soils are largely used for general farming, although there is some specialization in dairying and poultry. Corn and wheat are the principal crops. These soils are not suited to alfalfa.
Undrained	40	----	40	----	40	----	50	----	75	----	50	----	30	----	30	----	20	----	----	----	70	----	6	----	
Fincastle silt loam:																									
Drained	70	90	60	80	60	70	80	100	90	110	70	90	60	80	50	70	40	60	40	50	80	90	3	1	
Undrained	40	----	40	----	40	----	50	----	75	----	50	----	30	----	30	----	20	----	----	----	70	----	6	----	
Fincastle loam:																									
Drained	70	90	60	80	60	70	80	100	90	110	70	90	60	80	50	70	40	60	40	50	80	90	3	1	
Undrained	40	----	40	----	40	----	50	----	75	----	50	----	30	----	30	----	20	----	----	----	70	----	6	----	
Avonburg silt loam:																									
Drained	50	90	50	80	40	60	60	80	50	90	30	50	----	----	40	60	20	40	----	----	30	50	5	2	
Undrained	30	----	30	----	30	----	40	----	30	----	----	----	----	----	25	----	--	----	----	----	25	----	7	----	
Ayrshire loam:																									
Drained	60	80	60	80	50	60	60	70	75	90	50	80	10	40	40	60	40	60	----	----	50	60	4	2	
Undrained	30	----	40	----	30	----	40	----	50	----	30	----	----	----	25	----	20	----	----	----	40	----	7	----	
Vigo silt loam:																									
Drained	50	80	40	80	30	50	50	70	50	80	30	50	----	----	20	40	----	20	----	----	30	50	6	3	
Undrained	30	----	30	----	10	----	40	----	30	----	20	----	----	----	----	----	----	----	----	----	10	----	7	----	

See footnotes at end of table.

TABLE 8.—*Productivity ratings of soils in Morgan County, Ind.*—Continued

Soil	Crop productivity index[1] for—																						General productivity grade[3]		Remarks on use and physical suitability for use
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables[2]		Apples[2]		Pasture[2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Imperfectly drained soils of stream and lake terraces																									Largely used for grain and livestock farming. A 3-year rotation of corn, wheat, and mixed hay is common.
Gregg silt loam:																									
Drained	60	80	50	70	50	70	50	70	40	70	50	80	45	65	30	40	----	----	----	----	50	60	5	3	
Undrained	30	----	30	----	30	----	40	----	30	----	30	----	25	----	----	----	----	----	----	----	40	----	7	----	
Gregg loam:																									
Drained	60	80	50	70	50	70	50	70	40	70	40	80	45	65	20	30	----	----	----	----	50	60	5	3	
Undrained	30	----	30	----	30	----	40	----	30	----	30	----	25	----	----	----	----	----	----	----	40	----	7	----	
Taggart silt loam:																									
Drained	50	80	50	70	40	60	50	70	60	80	10	50	----	40	20	40	30	50	30	40	40	60	5	3	
Undrained	30	----	30	----	30	----	30	----	40	----	----	----	----	----	----	----	----	----	----	----	30	----	7	----	
Whitaker silt loam:																									
Drained	60	80	60	80	50	70	60	80	75	100	50	80	50	80	30	50	30	40	----	----	40	60	4	2	
Undrained	40	----	40	----	40	----	40	----	60	----	30	----	20	----	20	----	20	----	----	----	30	----	6	----	
Whitaker loam:																									
Drained	60	80	60	80	50	70	60	80	75	100	50	80	50	80	30	50	30	40	----	----	40	60	4	2	
Undrained	40	----	40	----	40	----	40	----	60	----	30	----	20	----	20	----	20	----	----	----	30	----	6	----	
Bartle silt loam:																									
Drained	60	80	50	70	40	60	60	80	50	90	10	50	----	----	40	60	20	40	----	----	30	50	5	3	
Undrained	40	----	30	----	30	----	40	----	25	----	----	----	----	----	20	----	----	----	----	----	20	----	7	----	
Bartle silty clay loam:																									
Drained	60	80	50	70	40	60	60	80	50	90	10	50	----	----	40	60	20	40	----	----	30	50	5	3	
Undrained	40	----	30	----	30	----	40	----	25	----	----	----	----	----	20	----	----	----	----	----	20	----	7	----	
Whitaker fine sandy loam:																									
Drained	50	70	50	70	50	60	60	70	50	70	50	70	40	70	30	50	30	50	----	----	40	60	5	3	
Undrained	40	----	40	----	40	----	40	----	30	----	30	----	20	----	20	----	20	----	----	----	30	----	7	----	
McGary silt loam:																									
Drained	50	70	50	70	30	50	50	60	50	80	40	60	----	40	20	30	20	30	20	30	40	60	5	3	
Undrained	40	----	30	----	20	----	40	----	30	----	20	----	----	----	10	----	10	----	----	----	30	----	7	----	
Moderately well-drained soils of the uplands:																									General farming and some specialization in dairying. Also some specialization in orchards on the Tilsit and Bedford soils. Principal rotation is corn, wheat, and mixed hay.
Gibson silt loam	50	70	50	80	50	70	50	80	50	75	10	60	----	----	40	60	30	50	50	60	30	50	5	3	
Bedford silt loam	50	80	50	70	40	60	40	60	60	80	10	60	----	40	30	50	30	50	50	70	40	60	5	3	
Frederick silt loam	50	80	50	70	40	60	40	60	60	80	10	60	----	40	30	50	30	50	50	70	40	60	5	3	
Tilsit silt loam	50	70	40	70	30	50	50	70	60	80	10	60	----	----	40	60	30	50	50	60	40	60	5	3	

Moderately well-drained soils of stream terraces																									
Pekin silt loam	50	80	50	80	50	70	50	70	40	75	10	60	---	30	50	70	30	50	40	60	40	60	6	3	General farming, with corn, wheat, and mixed hay the principal crops.
Well-drained soils of the uplands:																									
Miami silt loam	70	90	70	100	70	80	70	90	90	110	70	90	70	90	50	75	40	70	60	70	80	100	3	1	The Miami and Russell soils are used chiefly for grain and livestock farming. 3- to 5-year rotations including corn, wheat or oats, soybeans, and legumes are commonly followed. Alfalfa and clover are well adapted. The Banta, Cincinnati, and Parke soils are used for general farming and also to a limited extent for dairying and orchards. A rotation of corn, wheat, and mixed hay is common on them. The Grayford soils, and the Muskingum, Wellston, and Zanesville silt loams are used for general farming, with some specialization in orchards. Corn and wheat are the principal crops. In general, the Wellston and Muskingum soils are better suited to forests.
Russell silt loam	70	90	70	100	70	80	70	90	90	110	60	90	60	90	50	75	40	70	60	70	80	100	3	1	
Level phase	70	90	70	100	70	80	70	90	90	110	60	90	60	90	50	75	40	70	60	70	80	100	3	1	
Russell loam	70	90	70	100	60	80	70	90	90	110	60	90	60	90	50	75	40	70	60	70	80	100	3	1	
Parke silt loam	60	70	50	80	50	70	50	70	40	75	10	60	---	60	50	70	40	50	60	70	30	40	5	3	
Banta silt loam	50	70	50	80	50	70	60	80	40	75	10	60	---	60	40	60	40	50	60	70	30	40	5	3	
Zanesville silt loam	40	80	40	70	40	60	50	70	50	75	10	60	---	---	50	60	40	50	40	60	40	60	5	3	
Cincinnati silt loam	50	70	50	80	50	70	50	80	40	75	10	60	---	---	40	60	30	50	50	60	40	60	6	3	
Shallow phase	40	60	40	70	50	70	50	70	40	75	10	60	---	---	40	60	30	50	50	60	40	60	6	4	
Grayford silt loam	50	90	50	80	40	60	50	70	45	80	10	60	---	40	30	50	30	50	50	70	50	70	6	2	
Level phase	50	90	50	80	40	60	50	70	45	80	10	60	---	40	30	50	30	50	50	70	50	70	6	2	
Wellston silt loam	30	50	30	50	30	50	40	50	40	60	10	50	---	---	30	40	20	40	30	40	30	40	7	5	
Muskingum silt loam	25	40	30	60	---	---	30	40	40	60	---	---	---	---	---	---	---	---	30	40	30	40	7	6	
Well-drained soils of stream and lake terraces:																									
Martinsville silt loam	75	95	80	100	50	70	70	80	90	110	60	90	70	95	40	60	50	80	40	50	60	80	3	1	These soils are used chiefly for grain and livestock farming. 3- to 4-year rotations including corn, wheat, soybeans, and legumes are usually followed. The Martinsville soils are well suited to alfalfa.
Martinsville loam	60	80	80	100	50	70	70	80	90	110	60	90	70	90	40	60	50	80	40	50	60	80	3	1	
Martinsville fine sandy loam	50	70	40	60	40	50	60	70	70	90	50	70	60	80	40	60	50	80	40	50	50	70	5	3	
Markland silt loam	50	80	50	80	40	60	50	80	60	90	40	60	10	70	20	30	20	30	20	30	60	80	5	2	
Elkinsville silt loam	60	80	50	80	50	70	50	60	40	70	10	60	---	40	40	60	30	50	30	40	40	60	5	3	
Poorly drained soils of the uplands:																									
Bethel silt loam.																									
Drained	50	60	40	60	40	50	40	60	60	80	40	70	30	60	30	50	30	50	---	---	50	60	6	4	The Bethel and Delmar soils are used chiefly for grain and livestock farming. The principal crops are corn, wheat, oats, soybeans, mixed hay, and alfalfa. The Loy soil is used chiefly for general farming. The principal crops are corn, wheat, mixed hay, and timothy.
Undrained	30	---	20	---	20	---	30	---	20	---	20	---	---	---	10	---	10	---	---	---	40	---	7	---	
Delmar silt loam																									
Drained	50	60	40	60	40	50	40	60	50	80	40	70	20	60	30	50	30	50	---	---	50	60	6	4	
Undrained	30	---	20	---	20	---	30	---	20	---	20	---	---	---	10	---	10	---	---	---	40	---	7	---	
Loy silt loam:																									
Drained	40	60	40	60	30	50	40	60	40	80	10	40	---	---	30	50	20	30	---	---	30	40	6	4	
Undrained	25	---	20	---	20	---	30	---	20	---	---	---	---	---	10	---	10	---	---	---	20	---	8	---	
Poorly drained soils of stream terraces																									
Peoga silt loam																									
Drained	40	60	40	60	30	50	40	60	40	80	10	40	---	---	30	50	20	30	---	---	30	40	6	4	These soils are used chiefly for general farming, with corn, wheat, and mixed hay the principal crops.
Undrained	25	---	20	---	20	---	30	---	20	---	---	---	---	---	10	---	10	---	---	---	20	---	8	---	

See footnotes at end of table.

TABLE 8.—*Productivity ratings of soils in Morgan County, Ind.*—Continued

Soil	Crop productivity index[1] for—																						General productivity grade[3]		
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed hay (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables[2]		Apples[2]		Pasture[2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Well to excessively drained soils of level outwash plains.																									These soils are used chiefly for grain and livestock farming. Corn, wheat, and legumes are the principal crops. Especially suited to the production of wheat and alfalfa.
Fox silt loam	70	90	80	100	50	60	65	85	80	100	50	80	60	90	40	50	50	80	40	50	60	80	3	1	
Fox loam	60	80	70	100	50	60	60	80	70	100	50	70	60	90	40	50	50	80	40	50	60	80	4	2	
Morgantown silt loam	60	90	60	100	50	80	60	90	80	110	60	100	50	80	40	60	40	70	40	50	60	80	4	1	
Fox fine sandy loam	50	70	70	90	40	50	50	70	60	90	40	60	50	80	25	50	45	75	40	50	50	70	5	3	
Well to excessively drained soils of uplands or outwash plains.																									The Princeton soils are used for mixed-grain and livestock farming, with melons and orchard fruits important special crops. The sloping and eroded phases of these soils of the uplands are used primarily for pasture and timber, although certain of the soils, as the Miami, Bellefontaine, and Russell, may be used for long rotations, including a predominance of legumes in a system of grain and livestock farming. Some of the areas are also used for orchards.
Princeton loam	60	80	50	70	30	50	60	80	40	60	30	50	60	100	40	60	50	100	60	70	40	50	5	2	
Miami silt loam, sloping phase	55	65	55	70	55	60	55	65	70	85	55	70	50	70	-	-	-	-	50	60	70	80	5	3	
Russell silt loam, sloping phase	55	65	55	70	45	55	55	65	70	85	45	70	50	70	-	-	-	-	50	60	70	80	5	3	
Bellefontaine loam	55	75	50	80	30	40	60	60	60	75	30	60	60	85	30	50	40	70	40	50	50	70	5	3	
Princeton fine sandy loam	40	60	40	60	20	40	50	60	25	50	10	30	50	80	50	75	50	100	50	70	30	40	6	2	
Princeton loamy fine sand	30	40	30	50	10	20	40	50	20	40	-	-	40	70	40	60	50	100	40	70	20	30	6	3	
Miami silt loam, eroded sloping phase	35	45	35	50	35	40	35	45	45	55	35	45	30	60	-	-	-	-	35	45	50	60	7	6	
Russell silt loam, eroded sloping phase	35	45	35	50	35	40	35	45	45	55	35	45	30	60	-	-	-	-	-	-	30	40	7	6	
Muskingum silt loam, colluvial phase	30	60	30	60	30	50	30	40	50	75	10	50	-	-	30	40	30	50	-	10	10	15	7	4	
Morgantown loam, eroded phase	30	45	30	50	25	40	30	45	50	65	30	50	30	45	-	-	-	-	25	35	35	45	7	5	
Parke silt loam, eroded sloping phase	30	35	25	40	25	35	25	35	20	35	-	-	-	-	-	-	-	-	40	50	20	30	8	7	
Cincinnati silt loam, eroded sloping phase	10	30	10	30	-	10	10	20	25	40	-	-	-	-	-	-	-	-	-	-	20	30	9	7	
Frederick silt loam, eroded phase	20	30	10	30	-	10	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10	9	8	
Grayford silt loam, eroded sloping phase	-	-	-	-	-	-	-	-	30	45	-	-	-	-	-	-	-	-	-	-	25	35	10	-	
Fox loam, sloping phase	-	-	-	-	-	-	-	-	40	60	-	-	40	60	-	-	-	-	30	40	50	60	10	-	

Excessively drained soils of uplands or terraces:																									
Zanesville-Wellston silt loams, eroded hill phases	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20	30	10	15	9	9	These soils are generally unsuited to cultivation and limited almost entirely to forestry purposes.
Princeton fine sandy loam, steep phase	----	----	----	----	----	----	----	----	----	----	----	----	20	40	----	----	----	----	20	40	10	----	9	----	
Zanesville-Wellston silt loams, steep phases	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20	30	10	----	9	----	
Wellston silt loam, steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20	30	10	----	9	----	
Russell silt loam, steep phase	----	----	----	----	----	----	----	----	----	----	----	----	20	30	----	----	----	----	----	----	----	----	9	----	
Grayford silt loam, steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20	30	10	9	
Russell silt loam, gullied sloping phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	15	10	10	
Cincinnati silt loam:																									
Gullied sloping phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	10	10	
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	15	10	----	
Zanesville-Wellston silt loams, gullied hill phases	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	10	----	
Frederick silt loam, steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	10	----	
Muskingum stony silt loam	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	10	----	
Morgantown loam, steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20	----	10	----	
Markland silt loam:																									
Steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	20	----	10	----	
Eroded steep phase	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	10	----	
Miscellaneous:																									
Riverwash	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	10	----	

[1] The soils are given indexes to show the approximate average production of each crop in percent of the standard of reference. The standard represents the approximate average yield obtained without the use of amendments on the more extensive and better soil types of those regions of the United States in which the crop is most widely grown. The indexes are based largely on estimates of yields (see table 7), as yield data are too fragmental to be adequate. Indexes in columns A refer to average yields obtained under prevailing practices that include crop rotations, some erosion control practices, the use of some legumes, commercial fertilizers, lime, and barnyard and green manures Those in columns B refer to average yields obtained under improved methods of farm management that include the more intensive use of the above mentioned practices. Absence of an index indicates that the crop is not commonly grown.

[2] These indexes are only relative for the county and do not refer to the standard of reference because of a lack of data.

[3] These numbers indicate the general productivity of the soils for the common crops under the two general levels of management outlined in footnote 1. Refer to the text for further explanation regarding their determination by weighting of the individual crop indexes.

The estimates in columns A under each crop indicate yields obtained under the prevailing practices. These, on most of the soils, include the use of small to moderate quantities of commercial fertilizers but generally do not include careful and intensive practices of soil management in regard to the control of erosion, the incorporation of organic matter, and the maintenance and increase of soil fertility and soil productivity. Columns B show the yields under more careful and intensive practices. These consist of a regular crop rotation, including growing legumes where possible, the use of barnyard and green manures, the application of lime and liberal quantities of suitable commercial fertilizers, the installation of artificial drainage where necessary, the use of improved varieties and high-quality seed, and, where needed, the use of mechanical measures, as contour tillage, strip cropping, and terracing or constructing diversion ditches for erosion control.

The estimates in table 7 are based primarily on interviews with farmers, the county agent, members of the Purdue University Agricultural Experiment Station, direct observation by members of the soil survey party, and results obtained on experimental farms by the experiment station. They are presented only as estimates of the average production over a period of years, according to the two broadly defined types of management. It is realized that they may not apply directly to specific tracts of land for any particular year, as the soils shown on the map vary somewhat from place to place, management practices differ slightly from farm to farm, and climatic conditions fluctuate from year to year. On the other hand, these estimates appear to be as accurate as can be obtained without further detailed and lengthy investigations and they serve to bring out the relative productivity of the soils shown on the map.

The soils are listed in table 8 by groups that conform in general to the color groups shown on the soil map. The groups are arranged in the approximate order of their general productivity. The rating compares the productivity of each of the soils for each crop to a standard—100. This standard index represents the approximate average acre yield obtained without the use of amendments on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. The standard yield for each crop shown in table 8 (except vegetables, apples, and pasture) is given at the head of its column. Soils given amendments, such as lime and commercial fertilizers, or soils improved by special practices, such as drainage and protective levees, and unusually productive soils have productivity indexes of more than 100 for some crops.

The indexes for vegetables, apples, and pasture are comparative only for the soils within the county, and do not conform necessarily to standards set up for the country as a whole. Vegetables are not important commercially, except for melons on the Princeton soils and tomatoes on the smoother areas of the Miami and Russell soils and on the Crosby, Fincastle, and Brookston soils. Apples are not an important crop. They are grown inextensively on areas of the Zanesville, Wellston, and Frederick soils. Because of the great variety of uses of pasture, the apparent lack of a well-planned pasture program on many areas, and the extreme difficulty in estimating cow-acre-days, or pounds of beef an acre in a year, the ratings for pasture are inductive to a considerable degree and apply only within the county.

General productivity grade numbers are assigned in the column "General productivity grade." This grade is based on a weighted average of the indexes for the various crops, the weighting depending on the relative acreage and value of the crops. If the weighted average is between 90 and 100, the soil is given a grade of 1; if it is between 80 and 90, a grade of 2 is given; and so on. In those instances in which the weighted average is above 100 and less than 110, a grade of 1+ is given. In this county the grades are based largely on the indexes of the crops important on each soil. Because it is difficult to measure mathematically either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops, perhaps too much significance may be given to the general productivity grades.

The right-hand column of table 8, "Remarks on use and physical suitability for use," gives additional information regarding the soils as grouped in relation to their use for agriculture.

Productivity tables do not present the relative roles that soil types, because of their extent and pattern of distribution, play in the agriculture of the county. The tables show the relative productivity of individual soils. They cannot picture in a given county the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types used for each of the specified crops.

Economic considerations have played no part in determining the crop productivity indexes. They cannot be interpreted, therefore, into land values except in a very general way. Distance to market, relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideration that determines the relative worth of a soil for growing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained, are examples of other considerations than productivity that influence the general desirability of soil for agricultural use. In turn, steepness of slope, presence or absence of stone, tillage resistance due to soil consistence or structure, and the size and shape of areas are characteristics that influence the relative ease with which soils can be tilled. Likewise, inherent fertility and susceptibility to erosion are characteristics that influence the ease in maintaining soil productivity at a given level. Productivity, as measured by yields, is influenced to some degree by all these and other factors, as moisture-holding capacity of the soil and its permeability to roots and water, and so they are not factors to be considered entirely separate from productivity, but on the other hand, schemes of land classification to designate the relative suitability of land for agricultural use generally give them some separate recognition.

Some of the characteristics that influence the suitability of the soils of Morgan County for growing crops are given in table 9.

TABLE 9.—*Some characteristics that influence the suitability of soils for growing crops in Morgan County, Ind.*

Soil	Relief	Susceptibility to erosion under cultivation	Internal drainage	Reaction	Approximate lime requirements	General productivity groups [1]		Use limitations
						A	B	
					Tons			
Abington silty clay loam	Depressions	Very slight to none	Poor to very poor.	Neutral to slightly acid.	0	High [2] Low [3]	Very high [2]	Drainage, potash deficiency.
Atkins silt loam	Nearly level	Very slight	Very poor	Strongly to very strongly acid.	3-5	Medium to low.[2] Low [3]	Medium [2]	Drainage, strong acidity, low organic content, low general fertility.
High-bottom phase	do	do	do	do	3-5	Medium to low.	Medium	Do.
Avonburg silt loam	do	do	Poor	do	3-5	Low [2] do [3]	Medium [2]	Puddles and bakes readily, drainage, acidity, low organic content, low general fertility.
Ayrshire loam	Gently undulating to nearly level.	Very slight to none.	do	Strongly acid	2-3	Medium to low.[2] Low [3]	High [2]	Drainage, low organic content, low general fertility.
Banta silt loam	Nearly level to sloping.	Very slight to moderate.	Good to excessive.	do	2-3	Medium	High	Erosion, acidity, low general fertility.
Bartle silt loam	Nearly level	Very slight	Poor	do	2-3	Medium [2] Medium to low [3]	High [2]	Drainage, acidity, low general fertility.
Bartle silty clay loam	do	do	do	do	2-3	Medium [2] Medium to low.[3]	High [2]	Do.
Bedford silt loam	Gently undulating to undulating.	Slight	Fair	Neutral to slightly acid.	3-4	Medium	High	Low organic content.
Bellefontaine loam	Undulating to sloping.	Moderate to severe.	Excessive	Slightly to medium acid.	1-2	do	do	Erosion, drought, low organic content, low fertility.
Bethel silt loam	Nearly level	Very slight	Very poor	Medium to strongly acid.	1-2	Medium to low.[2] do [3]	Medium [2]	Puddles readily, drainage, low organic content
Brookston silty clay loam	Depressions in upland.	None to very slight	do	Neutral to slightly acid.	0	Very high [2] Medium [3]	Very high [2]	Drainage.
Cincinnati silt loam	Undulating to sloping.	Severe to very severe.	Good	Strongly acid	3-4	Medium to low.	Medium	Susceptibility to erosion, strong acidity, low organic content, low general fertility.
Eroded sloping phase	Moderate to strongly sloping.	do	do	do	3-4	Low	Medium to low.	Do.
Gullied sloping phase	Undulating to sloping.	Severe gully erosion.	do	do	3-4	Very low	Very low	Destroyed for present agricultural use.

Shallow phase	do	Severe to very severe.	do	do	3-4	Medium to low.	Medium	Susceptibility to erosion, strong acidity, low organic content, low general fertility.
Steep phase	Steep to very steep	Very severe to gully	Good to excessive	do	3-4	Very low		Nonarable; severe erosion, steep slopes, low general fertility.
Crosby silt loam	Gently undulating to nearly level.	None to slight	do	Slightly to medium acid.	1-2	High [2] Medium to low [3]	Very high [2]	Drainage, low organic content.
Delmar silt loam	Nearly level	None to very slight.	Very poor	Medium to strongly acid.	1-3	Medium to low [2] do [3]	Medium [2]	Do.
Eel loam	Level or depressed	None	Poor to fair	Neutral	0	High [2] High [3]	Very high [2]	Overflow and backwater damage.
Eel silt loam	do	do	do	do	0	Very high [2] High [3]	Very high [2]	Do.
Eel silty clay loam	do	do	do	do	0	Very high [2] High [3]	Very high [2]	Do.
Elkinsville silt loam	Undulating to gently sloping.	Slight to moderate.	Good	Medium to strongly acid.	1-3	Medium	High	Acidity, erosion, low general fertility.
Fincastle loam	Nearly level to gently undulating.	None to slight	Poor to imperfect.	do	1-3	High [2] Medium to low.	Very high [2]	Drainage, low organic content.
Fincastle silt loam	do	do	do	do	1-3	High [2] Medium to low [3]	Very high [2]	Do.
Fox fine sandy loam	do	Very slight	Excessive	Slight to medium	1-2	Medium	High	Droughtiness, low organic content.
Fox loam	do	do	do	do	1-2	do	do	Do.
Sloping phase	Sloping to steep	Moderate to severe.	do	do	1-2	Very low		Droughtiness, slope, low general fertility.
Fox silt loam	Nearly level to gently undulating.	Very slight	Good to excessive.	do	1-2	High	Very high	Somewhat droughty, low organic content.
Frederick silt loam	Sloping	Moderate to severe.	Good	Strongly acid	1-3	Medium	High	Erosion, low organic content.
Eroded phase	do	do	do	do	1-3	Low	Low	Do.
Steep phase	Steep slopes	do	do	do	1-3	Very low		Nonarable.
Genesee fine sandy loam	Nearly level	None to slight	do	Neutral to slightly alkaline.	0	Medium [4] do [5]	High [4]	Overflow.
Genesee loam	do	do	do	do	0	Very high [4] High [5]	Very high [4]	Do.
High-bottom phase	do	do	do	do	0	Very high	Very high	Do.
Genesee silt loam	do	do	do	do	0	Very high [4] High [5]	Very high [4]	Do.
High-bottom phase	do	do	do	do	0	Very high	Very high	Do.
Genesee silty clay loam	do	do	do	do	0	Very high [4] High [6]	Very high [4]	Do.

See footnotes at end of table.

TABLE 9.—*Some characteristics that influence the suitability of soils for growing crops in Morgan County, Ind.*—Continued

Soil	Relief	Susceptibility to erosion under cultivation	Internal drainage	Reaction	Approximate lime requirements	General productivity groups [1] A	General productivity groups [1] B	Use limitations
					Tons			
Gibson silt loam	Gently undulating.	Slight	Fair upper; restricted lower.	Strongly to very strongly acid.	3-4	Medium to low.	Medium	Strong acidity, low organic content, low general fertility.
Grayford silt loam	Undulating to sloping.	Moderate to severe.	Good	Strongly acid	2-3	do	do	Erosion, acidity, low organic content, low general fertility.
Eroded sloping phase	Sloping	do	do	do	2-3	Very low		Do.
Level phase	Nearly level to gently undulating.	Slight	do	do	2-3	Medium to low.	High	Acidity, low organic content, low general fertility.
Steep phase	Steep slopes	Severe to very severe.	do	do	2-3	Very low	Low	Nonarable steep slopes.
Gregg loam	Nearly level	None to slight	Poor	Slightly acid	0-1	Medium [2] Medium to low.[3]	High [2]	Drainage, low organic content.
Gregg silt loam	do	do	do	do	0-1	Medium [2] Medium to low [3]	High [2]	Puddles and bakes readily, drainage, low organic content.
Haymond silt loam	Nearly level to gently undulating.	None to slight	Good	Medium acid	1-2	High	Very high	Overflow.
Loy silt loam	Nearly level	Very slight	do	Strong to very strong.	3-5	Medium to low.[2] Low [3]	Medium [2]	Puddles and bakes readily, acidity, drainage. low organic content, low general fertility.
Mahalasville loam	Depressed	None to slight	Very poor	Neutral	0	High [2] Medium to low [3]	Very high [2]	Drainage.
Mahalasville silty clay loam	do	do	do	do	0	Very high [2] Medium to low [3]	Very high [2]	Do.
Markland silt loam	Undulating to gently sloping.	Moderate to severe.	Good	Medium to strongly acid.	2-3	Medium	High	Erosion, acidity, low organic content.
Eroded steep phase	Steep	Severe to very severe.	do	do	2-3	Very low		Nonarable steep slopes.
Steep phase	do	do	do	do	2-3	do		Do.
Martinsville fine sandy loam	Nearly level to undulating.	Slight to moderate.	Good to excessive.	Slight to medium acid.	1-2	Medium	High	Somewhat droughty, low organic content.
Martinsville loam	do	do	Good	do	1-2	High	Very high	Low organic content.
Martinsville silt loam	do	do	do	do	1-2	do	do	Do.

McGary silt loam	Nearly level to gently undulating.	None to slight	Poor	Medium to strongly acid.	2–3	Medium [2] Medium to low.[3]	High [2] —	Drainage, puddles readily.
Miami silt loam	Undulating to gently sloping.	Moderate to severe.	Good	Slight to medium	1–2	High	Very high	Erosion, low organic content.
Eroded sloping phase	Sloping	Severe to very severe.	do	do	1–2	Medium to low.	Medium to low.	Do.
Sloping phase	do	do	do	do	1–2	Medium	High	Do.
Monrovia silty clay loam	Depressed to level	None to slight	Very poor	Neutral	0	High [2] Medium to low.[3]	Very high [2] —	Drainage.
Montgomery silty clay loam	do	do	do	do	0	High [2] Medium to low.[3]	Very high [2] —	Do.
Morgantown loam:								
Eroded phase	Slopes	Severe to very severe.	Good	Strongly acid	2–3	Medium to low.	Medium	Erosion, acidity, low organic content.
Steep phase	Steep slopes	do	do	do	2–3	Very low	—	Nonarable steep slopes.
Morgantown silt loam	Nearly level to undulating.	Slight to moderate	do	do	2–3	Medium	Very high	Erosion, acidity, low organic content.
Muskingum silt loam	Moderate to steep slopes.	Severe to very severe.	do	do	2–3	Medium to low.	Medium to low.	Largely nonarable, erosion, acidity, low organic content.
Colluvial phase	Moderate slopes	Moderate to severe.	do	do	2–3	do	Medium	Erosion, acidity, stoniness.
Muskingum stony silt loam	Steep slopes	Severe	do	do	2–3	Very low	—	Nonarable steep slopes.
Parke silt loam	Gently undulating to gently sloping.	Moderate to severe.	Good to excessive.	do	3–4	Medium	High	Acidity, low fertility.
Eroded sloping phase	Slope	Severe to very severe.	do	do	3–4	Low	Medium to low.	Erosion, acidity, low fertility.
Pekin silt loam	Nearly level to gently undulating.	Slight to none	Fair	do	3–4	Medium to low.	High	Acidity, low fertility.
Peoga silt loam	Nearly level	do	Very poor	do	3–4	Medium to low.[2] Low [3]	Medium [2] —	Drainage, acidity, low fertility.
Philo loam	do	None to slight	Fair	do	2–3	Medium	High	Overflow, acidity, low fertility.
Philo silt loam	do	do	do	do	2–3	do	do	Do.
High-bottom phase	do	do	do	do	2–3	do	do	Do.
Plano silty clay loam	Depressed or nearly level.	do	Very poor	Neutral	0	High [2] Low [3]	High [2] —	Drainage.
Pope loam	Nearly level	do	Good	Strongly acid	2–3	High	Very high	Overflow, acidity, low fertility.
Princeton fine sandy loam	Undulating to sloping.	Slight to severe (wind).	Excessive	Slightly to medium acid.	1–3	Medium to low.	Medium to high.	Drought, low fertility, low organic content.
Steep phase	Steep slopes	do	do	do	1–3	Low	—	Do.
Princeton loam	Undulating to sloping.	Slight to severe	Good to excessive.	do	1–3	Medium	High	Do.

See footnotes at end of table.

TABLE 9.—*Some characteristics that influence the suitability of soils for growing crops in Morgan County, Ind.*—Continued

Soil	Relief	Susceptibility to erosion under cultivation	Internal drainage	Reaction	Approximate lime requirements	General productivity groups [1]		Use limitations
						A	B	
					Tons			
Princeton loamy fine sand	Undulating to sloping.	Slight to severe (wind).	Excessive	Slightly to medium acid.	1-3	Medium to low.	High to medium.	Drought, low fertility, low organic content.
Ragsdale loam	Depressed to nearly level.	None to slight	Very poor	Neutral to slightly acid.	0	High [2] Medium to low.[3]	Very high [2]	Drainage.
Riverwash	Nearly level	None	Very poor to excessive.	Neutral to alkaline.	0	Very low		Nonarable.
Ross silty clay loam	do	None to slight	Good	Neutral	0	Very high	Very high	Occasional danger from overflow.
Russell loam	Undulating to gently sloping.	Moderate to severe.	do	Medium to strongly acid.	1-3	High	do	Erosion, low organic content.
Russell silt loam	do	do	do	do	1-3	do	do	Do
Eroded sloping phase	Sloping	Severe to very severe.	do	do	1-3	Medium to low.	Medium to low.	Erosion, low fertility.
Gullied sloping phase	do	Very severe	do	do	1-3	Very low	Very low	Nonarable, destroyed for present agricultural use.
Level phase	Nearly level	None to slight	do	do	1-3	High	Very high	Low organic content.
Sloping phase	Sloping	Severe to very severe.	do	do	1-3	Medium	High	Erosion, low organic content.
Steep phase	Steep slopes	do	do	do	1-3	Low		Erosion, nonarable.
Shoals silt loam	Level to depressed	None	Poor to very poor.	Neutral to slightly acid.	0	Medium [2] Medium to low.[3]	High [2]	Overflow, drainage.
Shoals silty clay loam	do	do	do	do	0	High [2] Medium to low.[3]	Very high [2]	Do
Stendal silt loam	Nearly level	do	Poor	Strong to very strongly acid.	2-3	Medium [2] Low [3]	High [2]	Overflow, drainage, acidity, low fertility.
High-bottom phase	do	do	do	do	2-3	Medium	High	Do.
Taggart silt loam	do	None to slight	do	Strongly acid	2-3	Medium [2] Medium to low.[3]	High [2]	Drainage, acidity.
Tilsit silt loam	Nearly level to gently undulating.	Slight	Fair	Strong to very strongly acid.	3-4	Medium	High	Acidity, low organic content, low fertility.
Vigo silt loam	Nearly level	do	Poor	do	3-4	Medium to low.[2] do [3]	High [2]	Puddles and bakes easily, strong acidity, poor drainage, low organic content, low general fertility.

Wakeland silt loam	do	None to slight	do	Medium acid	1-2	Medium[2] Medium to low.[3]	High[2] 	Overflow.
Washtenaw silt loam	Depressions in upland.	None to very slight.	Very poor	Neutral to slightly acid.	0	High[2] Low[3]	Very high[2] 	Drainage.
Wellston silt loam	Undulating to sloping.	Moderate to severe.	Good	Strong to very strongly acid.	3-4	Medium to low.	Medium	Erosion, acidity, low fertility.
Steep phase	Steep slopes	Severe to very severe.	do	do	3-4	Low		Nonarable slopes.
Whitaker fine sandy loam	Nearly level	Slight to none	Poor	Slightly to medium acid.	0-2	Medium[2] Medium to low.[3]	High[2] 	Drainage, low organic content.
Whitaker loam	do	do	do	do	0-2	Medium[2] Medium to low.[3]	High[2] 	Do.
Whitaker silt loam	do	do	do	do	0-2	Medium[2] Medium to low.[3]	High[2] 	Do.
Wilbur silt loam	Nearly level to gently undulating.	do	Fair	Medium acid.	1-2	High	Very high	Overflow.
Zanesville silt loam	Undulating to gently sloping.	Moderate to severe.	Good	Strongly acid	3-4	Medium to low.	Medium	Erosion, acidity, low fertility.
Zanesville-Wellston silt loams								
Eroded hill phases	Moderate to steep slopes.	Severe to very severe	Good to excessive.	do	3-4	Low	Low	Nonarable.
Gullied hill phases	do	do	do	do	3-4	Very low		Do.
Steep phases	Very steep slopes	do	do	do	3-4	Low		Do.

[1] General productivity is given here in descriptive terms. The terms in column A refer to the general productivity under prevailing practices that include crop rotations, some erosion control practices, the use of some legumes, commercial fertilizers, lime, and barnyard and green manures. Those in column B refer to the general productivity under improved methods of farm management that include the more intensive use of the above-mentioned practices.

[2] Artificially drained. [3] No artificial drainage. [4] Protected from overflow by levee. [5] Unprotected from overflow by levee.

The relief on which a soil occurs very often is the principal factor determining its use and largely governs the yields that can be obtained. Although susceptibility to erosion may not necessarily control soil use, it does have a great influence on the maintenance of productivity. Again, the internal drainage condition of a soil may be the principal factor influencing its productivity. The larger part of the areas of the imperfectly drained, poorly drained, and very poorly drained soils in the county have been sufficiently drained artificially to permit growing the common farm crops. The pH of a soil is usually an indication of its lime requirement, although, in general, lighter textured soils require less lime than do heavier textured ones having the same pH.

FORESTS

The various forested areas of Morgan County are described in the section on vegetation. The beech-maple, oak-hickory, and bottom-land hardwoods are the three main forest types or associations of the county.

The beech-maple, originally the most extensive, covered most of the eastern and northern parts of the county, principally in the Early and Late Wisconsin drift regions. This slightly sloping area is suited principally to agriculture. Probably less than 10 percent of it has a forest cover, mostly on nonarable slopes. The most valuable commercial species, yellow-poplar, maple, and walnut, have been cut, leaving little timber of commercial value. Most of the farm woods on arable land and the woodland on steep slopes are being pastured, preventing the natural regeneration of forest cover. The thickness of the stand, therefore, gradually declines as the trees mature. Probably most of the timberland will eventually be converted to cropland and pasture.

The oak-hickory type is most extensive in the southwestern part of the county. Many of the narrow ridge tops, which were formerly cleared and cultivated, are now being abandoned because of low productivity and susceptibility to erosion. These areas are covered with briers, persimmon, and sassafras, and will eventually return to forest.

In the bottom lands, timber grows mainly along stream channels, old bayous, and poorly drained areas. Probably less than 2 percent of these lands has a forest cover, and on such areas little change may be expected in the status of forestry.

At present little attention is being given to silvicultural practices that would increase the returns from forest land, although an increasing number of areas of woodland are being classified under a State law providing for an assessment of $1 an acre. Areas must be fenced and not pastured and adequately stocked when classified. On many woodlands the trees are cut as soon as they reach tie-size. The timber in scattered areas, however, is usually cut when it reaches maturity. A few portable commercial sawmills are in use.

Potential forest land lies mainly in the southern half of the county in a wedge-shaped area extending from Monrovia to the southern corners. In this area, long narrow ridge tops are common and result in many small irregular-shaped fields of little use as cropland. This location, together with low productivity and increasing erosion, increases the use of the land for forestry. In other places, timber might be grown more extensively on seriously eroded areas. This use might be classed as reclamation rather than forestry. The State forest that occupies a part of the Borden area south of Martinsville and other similar areas might be used almost entirely for forestry, because of the small proportion of land suitable for cropping. Recently, interest in wildlife conservation has become more active. Of the methods that might be used to improve forest management, the exclusion of livestock, selective cutting, and planting of adapted species offer the greatest possible returns. As bluegrass is not adapted to acid soils, 6 to 10 acres of woodland are required to support one animal unit on the strongly acid nonfertile soils. Livestock does extensive damage to the young trees and prevents the growth of most seedlings.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent soil material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land, and (5) the length of time the forces of development have acted on the material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity, but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Morgan County lies in the region of Gray-Brown Podzolic soils that occupies the east-central parts of the United States. Most of the soils have developed under a heavy forest cover of deciduous trees, with sufficient rainfall to wet the soil to an indefinite depth, so that a moist condition, except in short periods, is maintained throughout the profile. The climatic and biological conditions permit only a relatively thin surface accumulation of organic litter, and a few inches of dark-colored soil in the upper part of the profile. The surface mat of organic matter is thinner than in the Podzol region to the north, but thicker than in the Red and Yellow Podzolic region to the south. All soils, except certain of the poorly drained ones, are light-colored, relatively low in organic content, and range from medium to strongly acid.

The five different geologic formations, or sources of material from which the soil parent material is derived, are (1) Late Wisconsin glacial drift, (2) Early Wisconsin glacial drift, (3) Illinoian glacial drift, (4) Borden or Knobstone (Lower Mississippian) sandstone, siltstone, and shale, and (5) Harrodsburg (Middle Mississippian) cherty limestone.

The soils developed from or on drift material of the Late Wisconsin glaciation occur in the northeastern part of the county and in small areas in the extreme central-eastern part and in the central-northern part. The parent materials of the greater part of the soils are deposits of unconsolidated silt, sand, gravel, and clay left by the retreating ice sheet. Glaciofluvial outwash terraces—representing deposits made by waters from the receding glacier—occur along the valley of the West

Fork White River and along the larger tributaries in the northern part of the county. Lime carbonates are leached to an average depth of about 36 inches.

The soils developed from drift material of the Early Wisconsin glaciation occur in the eastern and northern parts, usually between areas of Late Wisconsin and Illinoian glacial drift. The parent materials are similar to those of the Late Wisconsin glaciation. Lime carbonates are leached to an average depth of about 45 inches.

Soils developed from drift material of the Illinoian glaciation occupy the upland areas in the central and central-western parts of the county north of the West Fork White River, and relatively small areas south of the river. Lime carbonates are leached to a depth of 120 to 140 inches.

Figure 5 shows the depth of leaching of soils developed on Illinoian, Early Wisconsin, and Late Wisconsin glacial till.

The bedrock formations of Borden (or Knobstone) sandstone, siltstone, and shale belong to the Lower Mississipian geologic age. They outcrop along the slopes in the region of Illinoian glacial drift and are the surface formations in the central-southern part of the county and in small areas in the extreme northeastern and east-central parts. Bedrock formations of the Harrodsburg limestone, which outcrop in the southwestern part, belong to the Middle Mississippian geologic age.

Terraces of old alluvium are adjacent to the smaller streams in the regions of Illinoian drift and Borden sandstone, siltstone, and shale. Lake-deposited clays of Early and Late Wisconsin glaciations occur in the vicinity of Martinsville and southeastward. Calcareous alluvium lies adjacent to the West Fork White River and the tributary streams in regions of Early and Late Wisconsin drift; slightly to medium acid alluvium occupies the smaller bottoms in the region of cherty limestone and Illinoian drift; and strongly acid alluvium occurs adjacent to the smaller streams in the regions of Illinoian drift and Borden sandstone, siltstone, and shale.

The soils of Morgan County are classified and discussed on the basis of their characteristics as (1) zonal soils, (2) intrazonal soils, and (3) azonal soils.[11]

The zonal soil group includes soils having well-developed soil characteristics that reflect the active factors of soil genesis—climate and vegetation. They are represented by Gray-Brown Podzolic soils, which may be divided into three subgroups: (1) Those having normal ABC profiles; (2) those having ABYC profiles; and (3) those having ABYC profiles with suggestions of an X horizon.[12]

In the first subgroup the eluviated A horizon is light yellowish brown or brown; the illuvated B horizon is brown, yellowish brown, or brownish yellow; and the C horizon is composed of physically weathered rock materials that are partly chemically weathered. The second subgroup has A and B horizons similar to those of the first subgroup, with a thicker B horizon (designated as the Y horizon in the Indiana system of horizon designation), consisting of strongly

[11] BALDWIN, M., KELLOGG, C. E., and THORP, J. SOIL CLASSIFICATION. U. S. Dept. Agr. Yearbook 1938 (Soils and Men): 979–1001. 1938.

[12] Based on The Story of Indiana Soils, by T. M. Bushnell, associate in agronomy, Department of Agronomy, Purdue University Agricultural Experiment Station.

physically and chemically weathered parent material; and a C horizon underlying the Y similar to that in the normal ABC profiles. The third subgroup has normal A and B horizons; a suggestion of a claypan development (designated as the X horizon in the Indiana system of horizon designation); and a normal C horizon. It represents a transition from the Gray-Brown Podzolic soils to the Planosols.

DEPTH OF LEACHING OF SOILS DEVELOPED ON GLACIAL TILL

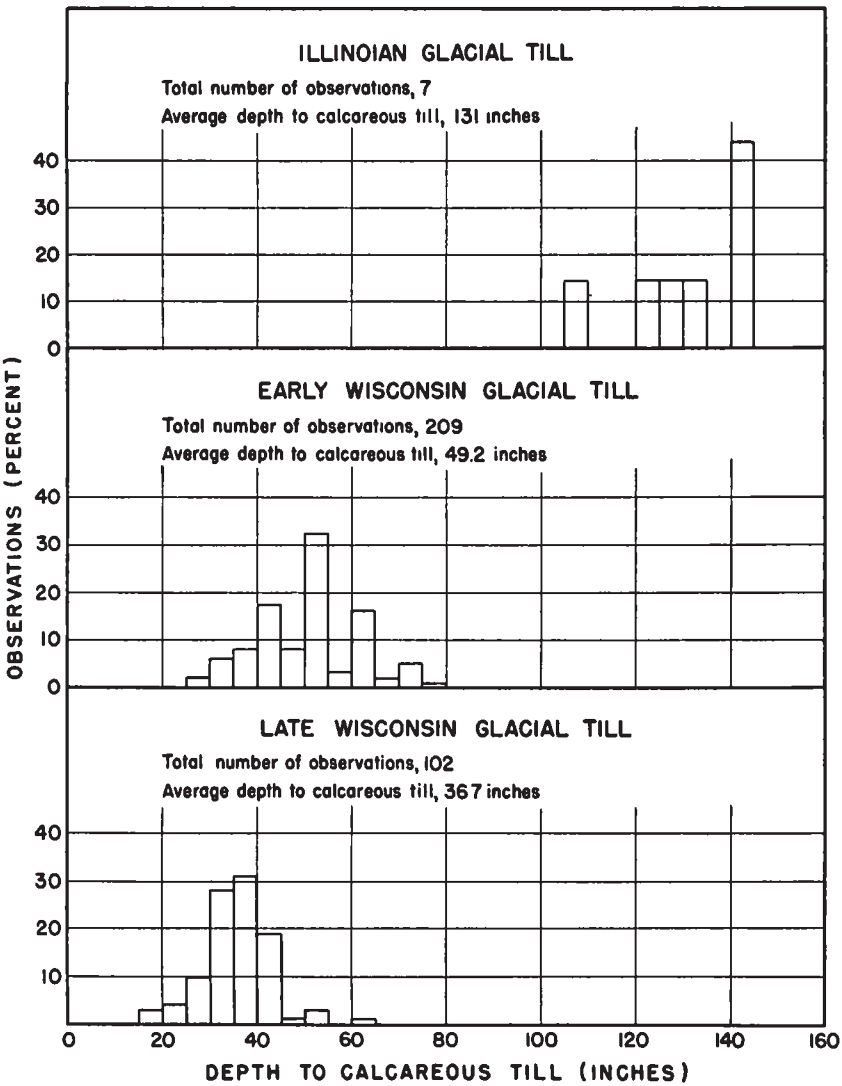

FIGURE 5.—Frequency diagram on percentage basis, showing depth of leaching of soils developed from calcareous till in Morgan County, Ind.

The intrazonal soil group includes soils having more or less well-developed soil characteristics that reflect the dominating influence of some local factor of relief, parent material, or age over the normal effect of the climate and vegetation. This group includes the Planosols, semi-Planosols, and Wiesenböden soils.

The Planosols have ABXYC profiles. They have more or less normal A and B horizons, except in the very poorly drained members. Immediately below the B horizon (if present) is a thin light-gray silty horizon varying in thickness from a fraction of an inch to a few inches. Streaks or "tongues" of this material extend downward into the immediately underlying X horizon, or claypan. This layer is always more or less mottled, has somewhat ill-defined columnar structure, and apparently develops best on flat relief after long exposure to soil-forming processes, and an oscillating ground-water table probably contributes to its formation. The Y horizon, which lies beneath the X, is similar to that layer, and is underlain by the C horizon, which consists of slightly weathered parent material. Where geologic erosion is encroaching on the old peneplain, lowering the water table and developing a mature relief, there is often a progressive transition from the ABXYC profile to the ABYC and the ABC. Here there is a tendency for the X, or claypan, horizon to be gradually lowered by soil-forming processes, to conform to the slope, and eventually to disappear.

The semi-Planosols have ABXYC, ABYC, or ABC profiles. In the ABXYC profile the X, or claypan, horizon is weakly developed, and there may be only a slight heaviness in the B horizon.

The Wiesenbodens are dark-colored soils of normally poorly drained depressions and are classified as having HMU soil profiles in the Indiana system of horizon designation. The very dark brownish-gray to nearly black H horizon is high in humus content; the underlying M is characterized by being gray to light gray in the more poorly drained members of the group, represented by the true Wiesenboden, and mottled gray, yellow, and rust brown, with gray predominating in the less poorly drained members, represented by the timbered Wiesenboden; and the U represents the relatively unmodified underlying mineral material. As drainage and relief change, a progressive transition from the HMU profile to the ABXYC is probable. Few HMU profiles occur in areas of Illinoian drift; appreciable ones are in areas of Early Wisconsin drift; and often extensive ones in areas of Late Wisconsin drift.

Azonal soils, or those that do not have well-developed soil characteristics, include the Lithosols and Aluvial soils of this county. The Lithosols are relatively thin soils developed on steep slopes where run-off is rapid and geologic erosion has been sufficiently rapid to counterbalance soil-forming processes. The soil consists largely of a mixture of rock fragments with a smaller proportion of chemically weathered materials. Eluviation is not pronounced, and there is little evidence of illuviation. This has an AC profile.

The Alluvial soils include recent deposits of materials that in most cases are subject to additional water deposits. Thus soil-forming processes have not yet had time to bring about the development of eluviated and illuviated horizons, except in the higher lying areas, where there may be a slight development.

Table 10 classifies the soil series of Morgan County by great soil groups, natural drainage conditions, drainage groups, profile horizons, and underlying material.

Table 10.—*Soil series of Morgan County, Ind., showing great soil groups, drainage, profile horizons, and underlying material*

ZONAL SOILS

Great soil group [1] and series	Natural drainage conditions [2]	Drainage group designation [3]	Profile designation [4]	Underlying material
Gray-Brown Podzolic soils:				
Cincinnati	Well drained	IV	ABYC (some X).	Illinoian till (calcareous).
Parke	Well to excessively drained.	V	ABYC	Illinoian drift (partly stratified).
Banta	do	V	ABYC	Do.
Russell	Well drained	IV	ABYC	Early Wisconsin till (calcareous).
Miami	do	IV	ABC	Late Wisconsin till (calcareous).
Bellefontaine	Well to excessively drained.	V	ABC	Loose permeable Early and Late Wisconsin drift (calcareous).
Grayford	Well drained	IV	ABYC (some X).	Shallow Illinoian till over cherty limestone.
Frederick	do	IV	ABYC (some X).	Cherty limestone of Harrodsburg formation.
Zanesville	do	IV	ABXYC	Sandstone and shale of Borden (Knobstone) formation.
Wellston	do	IV	ABC	Do.
Princeton	Well to excessively drained.	V	ABYC	Wind-deposited sands.
Elkinsville	Well drained	IV	ABYC	Clay, silt, and sand outwash material (noncalcareous).
Morgantown	Well to excessively drained.	V	ABYC	Sand and silt outwash material (noncalcareous).
Markland	Well drained	IV	ABC	Slack-water clay (highly calcareous).
Martinsville	do	IV	ABC	Stratified silt, sand, clay, and gravel (calcareous).
Fox	Well to excessively drained.	V	ABC	Gravel of Wisconsin age, leached 3 to 5 feet (calcareous).

INTRAZONAL SOILS

Great soil group [1] and series	Natural drainage conditions [2]	Drainage group designation [3]	Profile designation [4]	Underlying material
Planosols:				
Vigo	Imperfect	II	ABXYC	Illinoian till (calcareous).
Avonburg	do	II	ABXYC	Do.
Loy	Poor	I	AXYC	Do.
Bartle	Imperfect	II	ABXYC	Clay, silt, and sand outwash material (noncalcareous).
Bethel	Poor	I	ABC	Late Wisconsin till (calcareous).
Delmar	do	I	ABYC	Early Wisconsin till (calcareous).
Peoga	do	I	AXYC	Clay, silt, and sand outwash material (noncalcareous).
Semi-Planosols:				
Gibson	Good external; good to imperfect internal.	III	ABYC (some X).	Illinoian till (calcareous).
Bedford	do	III	ABXYC	Cherty limestone of Harrodsburg formation.
Tilsit	do	III	ABXYC	Sandstone and shale of Borden (Knobstone) formation.
Pekin	do	III	ABXYC	Clay, silt, and sand outwash material (noncalcareous).
Fincastle	Imperfect	II	ABYC	Early Wisconsin till (calcareous).
Crosby	do	II	ABC	Late Wisconsin till (calcareous).
Ayrshire	do	II	ABYC	Wind-deposited sands.
Taggart	do	II	ABYC	Sand and silt outwash material (noncalcareous).
McGary	do	II	ABC	Slack-water clay (highly calcareous).
Whitaker	do	II	ABC	Stratified clay, silt, sand, and gravel (highly calcareous).
Gregg	do	II	ABYC	Clay and silt lacustrine materials (calcareous).

See footnotes at end of table.

TABLE 10.—*Soil series of Morgan County, Ind., showing great soil groups, drainage, profile horizons, and underlying material*—Continued

INTRAZONAL SOILS—Continued

Great soil group [1] and series	Natural drainage conditions [2]	Drainage group designation [3]	Profile designation [4]	Underlying material
Wiesenböden (timbered)				
Brookston	Very poorly drained	VIII	HMU	Early and Late Wisconsin drift (calcareous).
Washtenaw [5]	Poor to very poorly drained.	VIII and IX.	DHMU	Do.
Ragsdale	Very poorly drained	VIII	HMU	Wind-deposited sands
Montgomery	do	VIII	HMU	Slack-water clay (highly calcareous).
Mahalasville	do	VIII	HMU	Stratified silt, sand, and clay, with some gravel (calcareous).
Monrovia	do	VIII	HMU	Clay and silt lacustrine materials (calcareous).
Wiesenboden:				
Abington	do	IX	HMU	Clay, silt, sand, and gravel of Wisconsin age (calcareous).
Plano	do	IX	HMU	Clay and silt lacustrine materials (calcareous).

AZONAL SOILS

Great soil group [1] and series	Natural drainage conditions [2]	Drainage group designation [3]	Profile designation [4]	Underlying material
Lithosols:				
Muskingum	Well to excessively drained.	VI	AC	Sandstone, siltstone, and shale of Borden (Knobstone) formation.
Alluvial soils.				
Ross	Well drained	IV	DDD	Neutral alluvium from Wisconsin drift.
Genesee	do	IV	DDD	Do.
Eel	Moderately well drained.	III	DDD	Do.
Shoals	Imperfectly drained	II	DDD	Do.
Haymond	Well drained	IV	DDD	Slightly to medium acid mixed alluvium from Illinoian drift, Harrodsburg limestone, and Borden sandstone, siltstone, and shale.
Wilbur	Moderately well drained.	III	DDD	Do.
Wakeland	Imperfectly drained	II	DDD	Do.
Pope	Well drained	IV	DDD	Strongly acid mixed alluvium from Borden sandstone, siltstone, and shale and Illinoian drift
Philo	Moderately well drained.	III	DDD	Do.
Stendal	Imperfectly drained	II	DDD	Do.
Atkins	Poorly drained	I	DDD	Do.

[1] Grouping based on soil classification defined in Soils and Men, Yearbook of U. S. Dept. of Agr., 1938.
[2] Drainage conditions existing before improvements, most areas of soils classified as having imperfect, poor, and very poor drainage conditions have been artificially drained.
[3] Based on The Story of Indiana Soils by T M. Bushnell, Department of Agronomy, Purdue University Agricultural Experiment Station. Groups VIII and IX include very poorly drained depressional soils with an accumulation of organic material in the surface horizons; group I nearly level poorly drained soils without organic accumulation and with eluviated and illuviated horizons; group II nearly level to gently undulating imperfectly drained soils, mottling occurs in the lower A horizon, group III nearly level to gently sloping moderately well-drained soils, mottling occurs in the B_1 or B_2 horizons, group IV undulating to strongly rolling well-drained soils; group V level to rolling well to excessively drained soils, characterized by loose porous substratum of gravel or sand, and group VI sloping to steep and well to excessively drained soils; geologic erosion has prevented soil development.
[4] Based on Indiana system of horizon designation. The X horizon includes the claypan, or siltpan, and is a part of the B horizon; Y horizon includes the lower B horizon that is silty in character, H horizon designates the humus or organic-bearing horizons in the VIII and IX drainage profiles; M horizon is the modified mineral subsoil below the H horizon, U horizon is the unmodified geologic deposit below the M horizon; and D horizon refers to various depositional layers in alluvium.
[5] Washtenaw soils consist of local overwash on soils in the VIII and IX drainage profile groups.

GRAY-BROWN PODZOLIC GROUP

The Gray-Brown Podzolic group includes the well-drained and well to excessively drained soils of the uplands and terraces.

WELL-DRAINED GRAY-BROWN PODZOLIC SOILS

The well-drained Gray-Brown Podzolic soils are of the Russell, Miami, Cincinnati, Frederick, Grayford, Wellston, Zanesville, Elkinsville, Markland, and Martinsville series.

Russell silt loam is a zonal soil developed on Early Wisconsin drift material. In a wooded area consisting of a good stand of maple, located in sec. 4, T. 11 N., R. 2 E. the following profile of this type was observed.

A_0. About ½-inch accumulated layer of partly decayed leaves, stems, twigs, and other forest litter. Reaction, neutral.

A_1. 0 to 2 inches, dark-brown smooth mellow silt loam. The organic-matter content is relatively high, and there is a mass of fine feeder tree roots. Reaction, medium acid.

A_2. 2 to 5 inches, yellowish-brown friable medium granular silt loam. Numerous small tree roots are present. Reaction, medium acid.

$A_{3\,1}$. 5 to 8 inches, brownish-yellow to yellowish-brown medium granular friable silt loam. The granules are firm but not hard and may be easily broken when moist into minute particles. Reaction, medium acid.

B_1. 8 to 13 inches, brownish-yellow moderately friable silty clay loam. The material breaks into subangular aggregates of ⅛ to ½ inch in diameter. Reaction, medium acid.

B_2. 13 to 23 inches, yellowish-brown silty clay loam that breaks into subangular aggregates about ½ inch in diameter. A few small pebbles, chiefly quartz, are present. Reaction, strongly acid.

$B_{2\,1}$. 23 to 36 inches, brownish-yellow moderately compact silty clay loam. A thin gray coating of colloidal clay is present on many of the cleavage faces, giving a slight mottled appearance to the material in place. This coloration disappears when the material is crushed. Reaction, medium acid.

B_3 (Y.) 36 to 45 inches, brownish-yellow compact gritty silty clay loam. The material breaks into irregular-shaped and variable-sized pieces, and many of the cleavage faces have a thin coating of grayish-brown or gray colloidal clay. The upper part of this layer is medium acid and the lower part is slightly acid.

C. 45 to 73 inches +, gray and yellow calcareous glacial till, consisting of unassorted silt clay, pebbles, and rocks. This represents the parent soil material.

Miami silt loam is developed on Late Wisconsin drift. It differs from the Russell soils in that the A and B horizons contain more grit and small pebbles, the Y horizon is absent, and the depth to the calcareous C, or parent, soil material is only about 36 inches.

Cincinnati silt loam is developed on Illinoian drift. It differs from Russell soils in color and number of horizons and in depth and degree of leaching of bases. Both the A and B horizons are strongly acid and are silty. A weakly developed siltpan, or X horizon, is present at a depth of about 36 inches in some areas. The Y horizon, representing the material between the main B and the C, is brownish-yellow to yellow silty material in the upper part and mottled yellow and gray in the lower. The calcareous C horizon, or parent soil material, lies at a depth of 120 to 150 inches.

Developed on cherty limestone of the Harrodsburg formation, Frederick silt loam occurs on rolling topography. It has an ABYC profile, which resembles Russell silt loam except that there is, in places, a thin X, or claypan, development. The A horizon is light yellowish-brown and overlies the compact yellowish-brown to reddish-brown B horizon. The Y, or lower B, horizon is usually silty clay loam that grades to silty clay at a depth of 1 to 3 feet. It contains a few rock fragments. Limestone bedrock lies at an average depth of 96 inches.

Grayford silt loam is developed on thin deposits of Illinoian till over Harrodsburg cherty limestone. The material has been leached of lime carbonates to a depth of 72 to 84 inches. The B horizon is more friable than that of Frederick silt loam and is usually developed in limestone material.

Wellston silt loam is developed on Borden sandstone and shales on narrow ridge tops. The A horizon is light yellowish-brown friable silt loam underlain by a well-oxidized yellowish-brown B horizon. Bedrock of sandstone and shale lies at a depth of about 30 inches.

Developed on Borden sandstone and shale, Zanesville silt loam occurs on the broader or rounded ridge tops. The A and upper B horizons are similar to those of Wellston silt loam, but a claypan, or X horizon, is developed at a depth of 30 to 36 inches. This layer is underlain by the silty Y, or lower B, horizon, and bedrock of sandstone and shale occurs at a depth of 5 or 6 feet.

Occurring on low terraces in the regions of Illinoian drift and Borden sandstone and shale, Elkinsville silt loam is developed on stratified silts and sands. It is similar to Cincinnati silt loam, except that the lower B, or Y, horizon is more silty, and the C horizon is stratified silt and clay.

Developed on heavy calcareous slack-water clays, Markland silt loam has smooth light yellowish-brown A horizons, a brownish-yellow compact B horizon, and a heavy smooth calcareous gray and yellow clay C horizon. The depth of leaching, or the depth to the C horizon, is about 40 inches. Areas adjacent to Morgantown soils have a thin layer of loamy material on the surface.

Martinsville soils are developed on glaciofluvial terraces consisting of stratified calcareous silt, clay, and sand of Wisconsin age. They have light yellowish-brown A horizons and yellowish-brown or brownish-yellow friable B horizons and are leached of free calcium carbonates to a depth of about 40 inches.

WELL TO EXCESSIVELY DRAINED GRAY-BROWN PODZOLIC SOILS

The well- to excessively drained Gray-Brown Podzolic soils are of the Fox, Bellefontaine, Banta, Parke, Morgantown, and Princeton series. They have well- to excessively drained surface soils and are underlain by loose sand and gravel.

Fox soils are developed on glaciofluvial outwash plains and valley terraces of Wisconsin age. The following profile description of Fox loam, taken in a cultivated field, is representative:

A. 0 to 7 inches, light yellowish-brown to brown friable mellow loam. Reaction, slightly acid.

A_3. 7 to 11 inches, light yellowish-brown friable medium granular loam. Reaction, medium acid.

B_1. 11 to 16 inches, yellowish-brown clay loam. The material breaks into subangular aggregates ¼ to ½ inch in diameter. It is moderately sticky when wet and hard when dry. Reaction, medium acid.

B_2. 16 to 32 inches, yellowish-brown or weak reddish-brown waxy and gravelly clay loam. The material breaks into irregular-sized angular pieces. It is plastic and sticky when wet and hard when dry. Reaction, medium acid.

B_{22}. 32 to 39 inches, yellowish-brown or weak reddish-brown clay loam, containing a larger proportion of gravel and sand than the layer above. Reaction, medium acid.

B_3. 39 to 42 inches, dark-brown gravelly clay loam that breaks into irregular chunks. Reaction, neutral.

C. 42 inches +, gray and yellow loose stratified calcareous gravel and sand.

Bellefontaine loam occupies rolling morainic and kame areas in the Wisconsin drift areas. The profile is similar to that of Fox soils, but there is less uniform horizon development, and the loose sand and gravel of the C layer is usually cross-bedded, rather than horizontal-bedded as in Fox soils. Bellefontaine soils associated with Early Wisconsin drift have a somewhat more acid profile than those associated with Late Wisconsin drift.

Banta silt loam is developed on kame topography from Illinoian glacial drift material. The A and B horizons are smooth silty material, and few if any pebbles are present, suggesting very thorough weathering and decomposition. The B horizon contains less gravel and is more silty than the B horizon of Fox soils. The C horizon consists of predominantly siliceous loose gravel. The entire profile is very strongly acid.

Occurring in various areas throughout the Illinoian drift, Parke silt loam differs from Banta silt loam in having developed on sandy clay material, usually gravel-free. The A horizon is light yellowish-brown friable material, and the upper B horizon is yellowish-brown friable silty material. The lower B, or Y, horizon is yellowish-brown to weak reddish-brown clay loam and extends to a depth of about 180 inches. The C horizon, or underlying material, is either partly assorted sand and silt or calcareous glacial till. The A, B, and Y horizons are strongly acid.

Developed on strongly leached glaciofluvial outwash material, Morgantown soils are probably of Illinoian age. They occur on high terraces, usually less than 25 feet below the general level of the Illinoian till plain. The A and upper B horizons are rather uniformly silty material. At a depth of 40 to 50 inches is the lower B, or Y, horizon consisting of somewhat stratified silt, clay, and sand that is underlain by stratified gravel and sand at a depth of 120 to 144 inches. The A, B, and Y horizons are medium to strongly acid in reaction.

Princeton soils are developed on wind-deposited sands and silts and occur along the bluffs throughout the valleys of the West Fork White River. Profile development has produced ABYC horizons. The clay accumulation in the B horizon is variable, and is underlain by rather loose fine sand representing the Y horizon. The C horizon of yellow and gray calcareous fine sand lies at an average depth of about 60 inches.

PLANOSOLS

The Planosols group includes the imperfectly and poorly drained soils of the Vigo, Avonburg, Loy, Bartle, Delmar, Bethel, and Peoga series.

IMPERFECTLY DRAINED PLANOSOLS

The imperfectly drained Planosols include Vigo, Avonburg, and Bartle soils.

Vigo silt loam occurs on nearly level interstream areas in the Illinoian drift region. The following profile description of this type, taken in sec. 3, T. 12 N., R. 2 W. under bluegrass vegetation, is representative:

A_1. 0 to 7 inches, light brownish-gray to yellowish-gray smooth fine granular silt loam. A few hard iron-brown concretions are present on the surface and throughout the horizon. Reaction, very strongly acid.

A_2. 7 to 9 inches, light brownish-gray smooth friable silt loam, spotted and blotched with rust brown. Reaction, strongly acid.

$B_1(X_1)$. 9 to 16 inches, mottled gray and yellow silty clay. The material breaks into blocky aggregates ¾ to 1½ inches in diameter and is plastic when wet and hard when dry. Reaction, strongly acid.

$B_2(X_2)$. 16 to 29 inches, mottled gray and yellow silty clay that breaks into blocky aggregates 1½ to 3 inches in diameter. The material has good vertical columnar structure, with the vertical axis two or three times the horizontal axis. Many of the cleavage faces have a thin coating of gray or rust-brown colloidal clay. This horizon is compact and impervious to water. Reaction, strongly acid.

$B_{21}(Y_1)$. 29 to 48 inches, mottled gray, yellow, and brown silty clay loam with pockets and blotches of light gray. The lower part of the horizon is somewhat gritty, and a few small pebbles are present. Reaction, medium acid.

$B_{22}(Y_2)$. 48 to 96 inches, mottled brown and gray gritty clay loam that breaks into irregular chunks. More pebbles are present than in the layer above. Reaction, medium acid.

$B_3(Y_3)$. 96 to 144 inches, mottled gray and yellow gritty clay loam, breaking into massive chunks. Numerous small pebbles and a few rocks are present. Reaction, slightly acid.

C. 144 inches +, gray compact calcareous till consisting of silt, clay, sand, and rock particles.

Avonburg silt loam is developed on nearly level relief in the Illinoian glacial till regions that lie south of the West Fork White River. It differs from Vigo silt loam chiefly in the occurrence of the X horizon, or claypan, at a depth of 30 to 40 inches and in the presence of a thin B horizon between the A and X horizons.

Bartle soils are developed from stratified silt and clay on low terraces of the Illinoian glaciation. The soil profile characteristics are similar to those of Avonburg silt loam, except that the X, or claypan, horizon is not so well developed.

POORLY DRAINED PLANOSOLS

The poorly drained Planosols include the Delmar, Loy, Bethel, and Peoga soils.

Developed on Early Wisconsin till, Delmar silt loam occurs on nearly level areas. The following description of this type is representative:

A_0. ¼-inch accumulated layer of partly decomposed forest litter.

A_1. 0 to 3 inches, dark brownish-gray smooth fine granular silt loam with a relatively high organic content. Reaction, neutral.

A_2. 3 to 12 inches, light-gray smooth silt loam with rust-brown stains and spots. Small hard rounded concretions are numerous. Reaction, medium acid.

B_1. 12 to 18 inches, light-gray silty clay loam with numerous rust-brown spots and blotches and small rounded concretions. The material breaks into subangular aggregates about ¼ inch in diameter. Reaction, strongly acid.

B_2. 18 to 32 inches, mottled gray, yellow, and brown silty clay loam. The material breaks into subangular aggregates ½ to 2 inches in diameter. The upper part of the horizon is smooth, but the lower part is somewhat gritty and a few small pebbles are present. Reaction, strongly acid.

$B_3(Y_1)$. 32 to 45 inches, mottled gray and yellow gritty silty clay loam containing an increasing number of small pebbles and an occasional large stone. Reaction, medium acid.

C. 45 inches +, gray and yellow somewhat friable calcareous till composed of silt, clay, sand, and rock fragments.

Loy silt loam occurs on nearly level relief or in slight depressions in the region of Illinoian glacial till. Like Vigo silt loam, with which it is closely associated, this soil has an AXYC profile. The A horizon is light gray in color, and silty in character. The X, or claypan, horizon is similar to that of Vigo silt loam, and calcareous till underlies the friable Y horizon at a depth of 140 to 170 inches. Small rounded iron concretions are present on the surface and throughout the upper horizons.

Developed on glacial till of Late Wisconsin age, Bethel silt loam differs from Delmar silt loam in having a gritty B horizon, in the absence of a Y horizon, and in the occurrence of calcareous till at a depth of 28 to 36 inches.

Developed from stratified silt and clay, Peoga silt loam is on low terraces of the Illinoian glaciation. The soil profile characteristics are similar to those of Loy silt loam, except that the X horizon or claypan occurs at a depth of about 30 inches.

SEMI-PLANOSOLS

The semi-Planosols include moderately well-drained and imperfectly drained soils of the Gibson, Bedford, Tilsit, Pekin, Fincastle, Crosby, Ayrshire, Taggart, McGary, Whitaker, and Gregg series.

MODERATELY WELL-DRAINED SEMI-PLANOSOLS

The moderately well-drained semi-Planosols include the Gibson, Bedford, Tilsit, and Pekin soils.

Gibson silt loam is developed on nearly level to undulating areas in the Illinoian glacial till regions. The following profile description is representative of this soil under a wooded cover:

A_0. About ¼-inch accumulated layer of partly decomposed leaves, twigs, and other forest litter.

A_1. 0 to ¼ inch, dark-gray friable fine granular silt loam, relatively high in organic content, and containing numerous fine feeder tree roots. Reaction, medium acid.

A_2. ¼ to 6 inches, light brownish-yellow friable medium granular silt loam. The material has a phylliform or thin platy structure. Numerous small roots are present. Reaction, strongly acid.

A_{21}. 6 to 12 inches, light brownish-yellow friable silt loam. There is some suggestion of thin platy structure, and the material breaks into firm but not hard coarse granules. Numerous dark-gray small worm casts are present. Reaction, strongly acid.

B_1. 12 to 18 inches, light brownish-yellow to pale-yellow friable silt loam that breaks into subangular aggregates about ¼ inch in diameter. A few rust-brown spots are present, and a thin coating of gray or brown colloidal clay is on some of the cleavage faces. Worm activity is low, and the number of roots present is less than in the layers above. Reaction, very strongly acid.

B_2. 18 to 30 inches, mottled gray and yellow silty clay loam that breaks into subangular aggregates ½ to 1 inch in diameter. The material is hard when dry and sticky when wet. Reaction, very strongly acid.

B_{21} (X). 30 to 38 inches, mottled gray and yellow silty clay loam with irregular rust-brown spots and blotches. The material breaks into blocky aggregates that have some suggestion of vertical columnar structure. These aggregates are 1½ to 3 inches in diameter, with the vertical axis often two or three times the length of the horizontal axis. A thin coating of light-gray colloidal clay is on many of the cleavage faces. Reaction, very strongly acid.

B_{22} (Y_1). 38 to 75 inches, mottled yellow, brown, and gray silty clay. The material has no definite breakage, and the various-sized and irregular-shaped pieces may be rather easily crushed into coarse granular material. Some grit, consisting of partly weathered small rock fragments in the lower part of this horizon, and a few soft small rounded very dark-brown concretions are present. Reaction, strongly acid.

B_3 (Y_2). 75 to 140 inches, gray, yellow, and brown gritty silty clay containing a few small well-weathered pebbles and small stones. Reaction, slightly to medium acid.

C. 140 inches +, gray and yellow friable calcareous till composed of unassorted silt, clay, sand, and rock fragments.

Variations in this type are in the texture of the lower B horizon, the depth to and thickness of the X horizon, and the depth to calcareous till. Occurring north of the West Fork White River, this soil is associated with Vigo silt loam and has an X development at a depth of 18 to 30 inches, whereas that occurring south of the river associated with Avonburg silt loam has a more friable B horizon, and the X horizon occurs at a lower depth.

Bedford silt loam, developed on cherty limestone of the Harrodsburg formation, occurs on nearly level to undulating areas and on the broader ridge tops of the Mitchell Plain. The B horizon is moderately compact and mottled at a depth of 20 to 30 inches. The X, or lower B, horizon, when present, is heavy compact silty clay. One or two feet of reddish-brown tough plastic clay overlies the cherty limestone bedrock, which lies at a depth of 90 to 120 inches. The entire profile is strongly acid to within a few inches of the bedrock.

Occurring on nearly level to undulating topography on the broader ridge tops of the Borden region, Tilsit silt loam is developed on interbedded sandstone and shale, which lie at a depth of 60 inches or more. The A horizon is similar to that of Zanesville silt loam, and the upper B layer is light brownish-yellow silt loam. The X, or lower B, horizon is not so well developed as in Gibson silt loam, and the Y horizon is silty and somewhat friable.

Developed from acid alluvium in low terrace positions in the regions of Illinoian till and sandstone and shale, the soil profile of Pekin silt loam is similar to that of Gibson silt loam, except that the X horizon is not so well developed, the material is more uniformly silty, and the C, or underlying material, consists of silt and fine sand. The entire profile is strongly acid in reaction.

IMPERFECTLY DRAINED SEMI-PLANOSOLS

The imperfectly drained semi-Planosols include the Fincastle, Crosby, McGary, Ayrshire, Taggart, Whitaker, and Gregg soils.

The Fincastle soils are developed on glacial till of the Early Wisconsin age. They have ABYC horizons, and have been leached of free-lime carbonates to a depth of about 48 inches. The A and upper B horizons are smooth and free of coarse-textured material. The B horizon is somewhat compact and impervious to moisture movement, with a slight siltpan development. The Y, or lower B, horizon is friable gritty material, and the C horizon consists of unassorted calcareous silt, clay, sand, and rock fragments.

Developed on nearly level to undulating topography from Late Wisconsin till, Crosby silt loam has an ABC profile and has been leached of free-lime carbonates to a depth of about 36 inches. The A and B horizons are not so silty or so acid as the corresponding horizons of the Fincastle soils, the Y, or lower B, horizon is absent, and calcareous till is present at an average depth of about 36 inches.

McGary silt loam occurs on stratified clays, probably lacustrine deposits, of the Wisconsin and probably Illinoian glacial periods. The brownish-gray smooth A horizon extending to a depth of 8 to 10 inches is underlain by the mottled gray and yellow compact B horizon. Calcareous smooth clay, representing the C horizon, lies at a depth of 36 to 48 inches.

Ayrshire loam is developed on nearly level relief from wind-deposited material associated with the Princeton soils. The upper B horizon is mottled gray and yellow sandy clay loam, with a somewhat impervious clay layer occurring above the calcareous sand and silt representing the C horizon that lies at a depth of 60 inches or more.

Occurring on high terraces of Illinoian outwash material, Taggart silt loam consists of stratified silt and clay overlying sand and gravel. The A and upper B horizons are similar to the corresponding horizons of Avonburg silt loam, and the X horizon, or siltpan, is not so well developed as it is in the above-mentioned soil or is absent. The Y, or lower B, horizon consists of thin stratified layers of sand and silt, and the C horizon, which lies at depths of 144 inches or more, consists of assorted sand, silt, and gravel. The entire profile is strongly acid.

Whitaker soils have developed on stratified silt, sand, clay, and, in some instances, gravel of the Wisconsin glacial period, and have been leached of free lime carbonates to a depth of 48 to 60 inches. The soil profile is similar to that of Fincastle soils, except that the C horizon consists of stratified calcareous sand, silt, clay, and gravel.

Gregg silt loam is developed on lacustrine silts and clays of the Wisconsin glacial period. The B horizon is compact silty clay or clay and is somewhat impervious to water. Calcareous silts and clays occur at a depth of 60 inches or more.

The pH values of Gregg silt loam and Monrovia silty clay loam are given in table 11.

TABLE 11.—*pH determinations of Gregg silt loam and Monrovia silty clay loam from Morgan County, Ind.*[1]

Soil type and sample No.	Depth	pH	Soil type and sample No.	Depth	pH
Gregg silt loam:	*Inches*		Monrovia silty clay loam:	*Inches*	
2856187	0–6	6.0	2856193	0–6	6.8
2856188	6–9	6.3	2856194	6–14	6.9
2856189	9–12	6.6	2856195	14–18	7.5
2856190	12–21	7.0	2856196	18–40	7.5
2856191	21–58	7.3	2856197	40–60+	7.6
2856192	58+	8.1			

[1] Determinations made by E. H. Bailey, assistant soil technologist, Division of Soil Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, by the hydrogen-electrode method.

WIESENBODEN GROUP

The Wiesenboden group includes soils now timbered and those that have a grass vegetation.

TIMBERED WIESENBODEN SOILS

The timbered Wiesenboden group, approaching the Half Bog soils, are of the Brookston, Washentaw, Ragsdale, Montgomery, Mahalasville, and Monrovia series.

Brookston soils occupy slight depressions in the regions of Early and Late Wisconsin till. The following is a typical profile of Brookston silty clay loam:

(H_1). ¼ to ½ inch, accumulated layer of leaves, twigs, and other forest litter.
(H_2). 0 to ½ inch, very dark-gray fine granular silt loam containing a high percentage of organic matter and numerous small feeder tree roots. Reaction, neutral.
(H_3). ½ to 5 inches, dark-gray coarse granular silty clay loam relatively high in organic content and containing numerous fine feeder tree roots. Reaction, very slightly acid.
(H_4). 5 to 14 inches, dark brownish-gray heavy silty clay loam that breaks into small angular aggregates ⅛ to ¾ inch in diameter. A few small pebbles are present. Reaction, neutral.
(M_1). 14 to 21 inches, mottled gray and yellow plastic silty clay breaking into angular pieces ⅜ to 2½ inches in diameter and containing much grit and numerous pebbles. It is sticky when wet and hard when dry. Reaction, neutral.
(M_2). 21 to 60 inches, intensely mottled gray and yellow heavy plastic silty clay containing numerous pebbles and an occasional large stone. The mottling often occurs in pockets or as blotches, and there is an occasional pocket of lighter textured material. There is no definite breakage; the material breaks into large irregular angular chunks varying from 1 to 6 inches in diameter. Reaction, neutral.
(U). 60 inches +, gray and yellow friable calcareous till composed of unassorted silt, clay, sand, and rock fragments.

Washtenaw silt loam represents an accumulation of material washed from the surrounding upland soils over areas of Brookston and Clyde soils. The accumulated material varies in thickness from 8 to 40 inches and is brownish gray to light yellowish brown, with some gray and yellow mottling occurring immediately above the dark-gray Brookston and Clyde material. The reaction is neutral to slightly acid.

Developed on wind-deposited material, Ragsdale loam occurs in depressional areas associated with Princeton and Ayrshire soils. The organic content of the surface soil and upper subsoil is comparable to that of the Brookston soils, but the entire profile is more friable and lighter textured. The reaction is neutral.

Associated with Markland and McGary soils, Montgomery silty clay loam occupies depressional areas on low terrace positions. It is developed on calcareous slack-water clays. The H, or humus-bearing, horizon is dark-gray to very dark brownish-gray smooth silty clay loam to a depth of 12 to 18 inches, and is underlain by mottled gray and yellow silty clay representing the M horizon. The U horizon of calcareous clay occurs at a depth of 40 to 60 inches.

Mahalasville soils are developed on stratified glaciofluvial outwash and valley terraces composed chiefly of silt and clay. The profile characteristics are similar to those of Brookston soils, except for the usual absence of pebbles and stones in the subsoil and in being underlain by stratified silt, clay, and some sand that is calcareous at a depth of 40 to 55 inches.

Monrovia silty clay loam is developed on lacustrine deposits of calcareous silts and clays of Wisconsin glacial age. The H and U horizons are similar to the corresponding layers of Montgomery silty clay loam. Calcareous clay silt and minor quantities of very fine sand occur at a depth of 60 to 96 inches.

WIESENBODEN SOILS

The true Wiesenboden group includes the Abington and Plano soils. Abington silty clay loam occupies the deeper depressional areas in the glaciofluvial outwash plain and terrace areas. The H horizon is higher in organic content and thicker than the H horizon in the Mahalasville soils. The M, or glei, horizon is gray waxy and gravelly clay loam, and the U horizon, or underlying material, consists of loose stratified calcareous gravel, coarse sand, and some silt and clay at depths of 50 to 70 inches. Plano silty clay loam is developed on lacustrine deposits of calcareous silts and clays, of Wisconsin glacial age. Natural drainage conditions are poorer than those of Monrovia silty clay loam, with which it is associated, and the organic content of the H horizon is higher and the depth greater. The M, or glei, horizon, occurring at a depth of about 18 inches, is smooth light-gray or gray silty clay, becoming mottled yellow and gray below a depth of 30 inches. The U horizon, or underlying material consisting of calcareous clays and silts, occurs at depths of 60 to 90 inches.

The results of mechanical analyses of samples of Gregg silt loam and Plano silty clay loam are given in table 12.

TABLE 12.—*Mechanical analyses of samples of Gregg silt loam and Plano silty clay loam of Morgan County, Ind.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Gregg silt loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
2856187	0- 6	0.2	0.7	3.4	15.2	6.3	52.6	21.6
2856188	6- 9	0	.7	3.7	15.9	6.2	51.1	22.4
2856189	9-12	0	.5	2.8	12.3	5.4	52.8	26.2
2856190	12-21	0	.4	2.2	10.1	4.2	53.4	29.7
2856191	21-58	.1	.6	3.5	13.4	4.3	45.7	32.4
2856192	58+	.1	.7	3.6	15.8	5.6	55.1	19.1
Plano silty clay loam:								
2856198	0- 7	.1	1.0	5.1	12.1	4.7	41.7	35.3
2856199	7-12	.1	1.1	5.3	15.6	5.8	39.6	32.5
2856200	12-15	.2	1.5	7.2	20.6	6.7	39.1	24.7
2856201	15-28	.1	1.0	5.1	15.1	6.3	44.9	27.5
2856202	28-42	.1	1.0	5.6	15.4	6.1	48.5	23.3

LITHOSOLS

The Lithosols are represented by the Muskingum soils, which occur on hilly and steep relief on sandstone and shale of the Borden formation. They have AC profiles; the A horizon is light yellowish-brown to grayish-yellow silty material that grades into the C horizon of sandstone, siltstone, and shale at depths of 12 to 20 inches with very little or no B horizon development. Muskingum stony silt loam normally has numerous rock fragments on the surface and throughout the profile. Runoff is so rapid that the soil lacks moisture for normal vegetation and normal soil formation.

ALLUVIAL SOILS

The Alluvial soils are divided into (1) neutral alluvium, (2) slightly to medium acid alluvium, and (3) strongly acid alluvium.

NEUTRAL ALLUVIUM SOILS

The neutral alluvium soils washed from areas of Early and Late Wisconsin drift include the Genesee, Ross, Eel, and Shoals series. Genesee and Ross soils are well drained, Eel moderately well drained, and Shoals imperfectly drained.

SLIGHTLY TO MEDIUM ACID ALLUVIUM SOILS

The slightly to medium acid alluvium soils washed from areas of Illinoian glacial drift, Harrodsburg cherty limestone, and Borden sandstone and shale include the Haymond, Wilbur, and Wakeland series. Haymond soils are well drained, Wilbur moderately well drained, and Wakeland imperfectly drained.

STRONGLY ACID ALLUVIUM SOILS

The strongly acid alluvium soils washed from regions of Borden sandstone and shale and Illinoian glacial drift include the Pope, Philo, Stendal, and Atkins series. Pope soils are well drained, Philo moderately well drained, Stendal imperfectly drained, and Atkins poorly drained.

MANAGEMENT OF THE SOILS OF MORGAN COUNTY

By A. T. Wiancko, *Department of Agronomy, Purdue University Agricultural Experiment Station*

The farmer should know his soil and have a sound basis for every step in its treatment. Building up its productivity to a high level, in a profitable way, and then keeping it up, is an achievement toward which the successful farmer strives. As in any other enterprise, every process must be understood and regulated in order to be uniformly successful, and a knowledge of the soil is highly important. Different soils present different problems as to treatment, and these must be studied and understood in order that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of Morgan 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 unless in the long run it produces 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 the United States. A proper system of treatment is necessary in making a soil profitably productive.

PLANT NUTRIENTS

The approximate total content of nitrogen, phosphorus, and potassium in the principal soil types in Morgan County, expressed in pounds of elements, estimated at 2,000,000 pounds an acre, in the 6- to 7-inch layer of plowed surface soil, and the relative quantities of available phosphorus and potassium are shown in table 13.

TABLE 18.—*Approximate quantities of phosphorus, potassium, and nitrogen in certain cultivated soils of Morgan County, Ind.*

[Elements in pounds per acre of surface soil, 6 to 7 inches deep]

Soil type	Total nitrogen	Total phosphorus [1]	Total potassium	Available phosphorus [2]	Available potassium [2]
	Pounds	*Pounds*	*Pounds*		
Abington silty clay loam	4,400	1,230	28,000	H	H
Atkins silt loam, high-bottom phase	2,200	660	24,000	L	L
Avonburg silt loam	2,600	730	24,000	VL	L
Ayrshire loam	2,000	510	21,000	VL	VL
Bartle silt loam	2,200	810	21,000	L	L
Bartle silty clay loam	2,400	550	30,000	VL	L
Bedford silt loam	2,800	500	25,000	VL	M
Bellefontaine loam	2,800	930	37,000	M	H
Bethel silt loam	2,100	590	30,000	L	L
Brookston silty clay loam	4,000	1,040	32,000	M	M
Cincinnati silt loam	2,400	530	31,000	VL	M
Crosby silt loam	2,200	550	28,000	L	L
Delmar silt loam	2,200	630	28,000	VL	L
Eel silt loam	2,800	840	27,000	M	M
Eel silty clay loam	3,400	1,390	32,000	H	H
Elkinsville silt loam	2,200	330	29,000	VL	L
Fincastle loam	1,800	360	25,000	VL	L
Fincastle silt loam	2,400	630	29,000	L	L
Fox fine sandy loam	1,800	670	21,000	VL	L
Fox loam	1,800	750	24,000	L	M
Fox silt loam	3,000	730	29,000	M	H
Frederick silt loam	2,600	640	25,000	VL	M
Genesee fine sandy loam	1,600	810	21,000	H	M
Genesee loam	2,400	940	28,000	M	M
High-bottom phase	2,200	560	24,000	M	M
Genesee silt loam	2,600	1,120	25,000	H	M
High-bottom phase	2,800	1,020	29,000	M	M
Genesee silty clay loam	4,000	1,540	32,000	H	H
Gibson silt loam	2,200	420	28,000	VL	M
Grayford silt loam	3,000	790	31,000	VL	M
Gregg loam	2,800	560	25,000	M	M
Gregg silt loam	2,800	520	29,000	M	M
Loy silt loam	2,200	420	24,000	VL	L
Mahalasville loam	3,200	940	27,000	H	M
Mahalasville silty clay loam	4,600	1,390	29,000	H	H
Markland silt loam	2,600	640	33,000	L	M
Martinsville fine sandy loam	2,000	670	24,000	L	M
Martinsville loam	2,000	560	27,000	VL	M
Martinsville silt loam	2,600	670	27,000	L	M
McGary silt loam	2,600	560	28,000	VL	M
Miami silt loam	2,600	530	31,000	VL	L
Monrovia silty clay loam	3,600	1,150	38,000	H	H
Montgomery silty clay loam	4,600	1,420	39,000	H	H
Morgantown silt loam	2,600	540	24,000	VL	M
Parke silt loam	2,600	670	33,000	VL	M
Pekin silt loam	2,400	670	23,000	VL	M
Peoga silt loam	3,000	1,210	21,000	L	M
Philo silt loam	2,400	670	30,000	L	M
High-bottom phase	2,600	940	28,000	L	H
Plano silty clay loam	4,800	1,550	29,000	H	H
Pope loam	2,600	690	29,000	L	M
Princeton fine sandy loam	1,400	390	24,000	L	M
Ragsdale loam	3,200	940	25,000	M	M
Ross silty clay loam	3,800	1,570	31,000	H	H
Russell loam	2,200	600	26,000	VL	M
Russell silt loam	2,600	490	31,000	VL	L
Shoals silt loam	2,000	620	25,000	VL	M
Shoals silty clay loam	2,800	900	31,000	L	H
Stendal silt loam	2,200	660	26,000	VL	L
High-bottom phase	2,600	790	25,000	VL	L
Taggart silt loam	2,600	560	26,000	L	M
Tilsit silt loam	2,800	370	28,000	VL	M
Vigo silt loam	2,200	650	25,000	VL	L
Wakeland silt loam	2,200	590	26,000	L	M
Washtenaw silt loam	3,200	740	33,000	L	H
Whitaker loam	2,000	530	25,000	VL	L
Whitaker silt loam	2,500	940	26,000	VL	L
Wilbur silt loam	2,200	660	26,000	L	M
Zanesville silt loam	2,200	650	30,000	VL	M

[1] Soluble in strong hydrochloric acid (specific gravity 1.115).
[2] Based on the Purdue "quick tests"; L=low, VL=very low, M=medium, and H=high.

The total contents of nitrogen, phosphorus, and potassium for the various soils in the county, as given in table 13, do not necessarily represent the results obtained from samples taken within the county. A number of the totals given represent an average for the soil type or phase in the State.

The total content of nitrogen is generally indicative of the soil's need for that element. It generally indicates also the need for organic matter, because nitrogen and organic matter are closely associated. In general, the darker the soil the higher its content of both organic matter and nitrogen. Soils having a low total nitrogen content soon wear out, as far as that element is concerned, unless the supply is replenished by the growing and turning under of legumes or by the use of nitrogenous fertilizer.

The total quantity of phosphorus in ordinary soils is usually about the same as that shown by a determination with strong acid. For this reason, a separate determination of total phosphorus has been omitted. The supply of total phosphorus is low in most Indiana soils and phosphatic fertilizers are generally needed.

The total quantity of potassium in the soil can seldom be taken as indicative of whether it needs potash fertilizer. Some Indiana soils that have more than 30,000 pounds of total potassium an acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization, because so little of the potassium they contain is in an available form. Sandy and muck soils are more often in need of potash fertilization than clay and loam soils. Poorly drained soils and those with impervious subsoils usually need potash fertilization more than well-aerated deep soils.

The available phosphorus and potassium determinations have been made by means of the so-called "quick tests" and are expressed in terms indicating relative quantities, as very low, low, medium, and high. In interpreting these terms it may usually be assumed that soils testing low or very low will respond to fertilization with the element concerned. If the soil tests medium, there may be doubt as to whether fertilization would pay. A soil testing high would seem to be in no immediate need of application of the plant-food element concerned. Since the quick test is easily made, it is recommended that the soil or soils of each field of the farm to be tested every few years, because the available supply of any particular element may change, owing to the cropping system, the quantities of crops removed, manure returned, and fertilizer added. Tests of plant tissue at critical periods in the development of the crop will show its nutrient status and which plant-food elements are lowest in supply and most in need of replenishing.

In view of the above, it should be recognized that there are many other factors that affect the crop-producing powers of soils. These chemical data, therefore, are not intended to be the sole guide in determining the needs of the soil. The depth of the soil, the physical character of the layers of the soil profile, and the previous treatment and management of the soil are all factors of great importance and should be taken into consideration. Tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than they are in surface soils. On the other hand, potash in subsoil seems to be of relatively high availability. Crop growth depends largely on the quantity of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth on a soil of relatively low analysis. If the roots are shallow, the crop may suffer from lack of nutrients, particularly potash, even on a soil of higher analysis. The better types of soils and those containing large quantities of plant-nutrient elements will endure exhaustive cropping much longer than the soils of low plant-nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are not the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity; soils that are very acid will not produce well, even though there is no lack of plant nutrients. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect until after such soils are limed.

The percentage of nitrogen, acidity, and estimated lime requirement of the principal soils of Morgan County are given in table 14.

TABLE 14.—*Nitrogen, acidity, and lime requirements of certain soils in Morgan County, Ind.*

Soil type	Depth	Nitrogen	pH	Average depth to neutral material	Indicated limestone requirement an acre
	In.	*Pct.*		*In.*	*Tons*
Abington silty clay loam	0-6	0.22	7.0	0	0
	6-18	.10	7.1		
	18-36	.04	7.2		
Atkins silt loam, high-bottom phase	0-6	.11	5.7	(1)	3-5
	6-18	.07	5.6		
	18-36	.05	5.7		
Avonburg silt loam	0-6	.13	5.1	120	3-5
	6-18	.08	5.0		
	18-36	.04	5.0		
Ayrshire loam	0-6	.10	5.2	60	2-3
	6-18	.05	5.4		
	18-38	.04	5.4		
Bartle silt loam	0-6	.11	5.2	(1)	2-3
	6-18	.07	5.2		
	18-36	.04	5.3		
Bartle silty clay loam	0-6	.12	5.7	(1)	2-3
	6-18	.08	6 0		
	18-36	.04	6.7		
Bedford silt loam	0-6	.14	5.9	84	3-4
	6-18	.08	5.2		
	18-36	.05	5 5		
Bellefontaine loam	0-6	.14	6 6	38	1-2
	6-18	.07	6.3		
	18-36	.05	6 2		
Bethel silt loam	0-6	.12	6 2	32	1-2
	6-18	.08	5.7		
	18-36	.05	(2)		
Brookston silty clay loam	0-6	.20	6.9	0	0
	6-18	.14	7.0		
	18-36	.06	7.1		
Cincinnati silt loam	0-6	.12	5 3	120	3-4
	6-18	.06	5 0		
	18-36	.05	5.1		
Crosby silt loam	0-6	.11	5.8	32	1-2
	6-18	.07	5.5		
	18-36	.05	(2)		
Delmar silt loam	0-6	.12	5.5	42	1-3
	6-18	.08	5.2		
	18-36	.05	5.4		
Eel silt loam	0-6	.14	7.0	0	0
	6-18	.11	7.1		
	18-36	.06	7 2		
Eel silty clay loam	0-6	0.17	7.2	0	0
	6-18	.13	7 2		
	18-36	.08	7.2		
Elkinsville silt loam	0-6	.11	5.7	(1)	1-3
	6-18	.06	5.3		
	18-36	.04	5.2		
Fincastle loam	0-6	.09	5.7	42	1-3
	6-18	.05	5.4		
	18-36	.04	5.7		
Fincastle silt loam	0-6	.12	5.6	42	1-3
	6-18	.06	5.4		
	18-36	.05	5.8		
Fox fine sandy loam	0-6	.09	6.1	40	1-2
	6-18	.04	6.0		
	18-36	.04	6.1		
Fox loam	0-6	.09	6.3	38	1-2
	6-18	.05	6.4		
	18-36	.04	6.8		
Fox silt loam	0-6	.15	6.2	38	1-2
	6-18	.09	5 5		
	18-36	.06	5.1		
Frederick silt loam	0-6	.13	6.0	84	1-3
	6-18	.08	5.4		
	18-36	.01	5.5		
Genesee fine sandy loam	0-6	.08	7.2	0	0
	6-18	.11	7.2		
	18-36	.07	7.2		
Genesee loam	0-6	.12	7.2	0	0
	6-18	.09	7.3		
	18-36	09	7.3		
High-bottom phase	0-6	.11	6.5	0	0
	6-18	.09	6.7		
	18-36	.08	7.2		
Genesee silt loam	0-6	.18	7.1	0	0
	6-18	.15	7.2		
	18-36	.18	7.2		
High-bottom phase	0-6	.14	6 8	0	0
	6-18	.16	6.9		
	18-36	.07	7 0		
Genesee silty clay loam	0-6	.20	7.2	0	
	6-18	.16	7.2		
	18-36	.15	7.2		

See footnotes at end of table.

TABLE 14.—*Nitrogen, acidity, and lime requirements of certain soils in Morgan County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH	Average depth to neutral material	Indicated limestone requirement an acre
	In.	*Pct.*		*In.*	*Tons*
Gibson silt loam	0- 6 6-18 18-36	.11 .07 .04	5.1 4.9 5.0	120	3-4
Grayford silt loam	0- 6 6-18 18-36	.15 .12 .05	5.8 5.0 5.1	90	2-3
Gregg loam	0- 6 6-18 18-36	.14 .09 .04	6.6 6.4 6.5	40	0-1
Gregg silt loam	0- 6 6-18 18-36	.14 .10 .04	6.4 6.3 6.8	40	0-1
Loy silt loam	0- 6 6-18 18-36	.11 .06 .04	5.1 5.0 5.3	120	3-5
Mahalasville loam	0- 6 6-18 18-36	.16 .08 .04	7.1 7.1 7.1	0	0
Mahalasville silty clay loam	0- 6 6-18 18-36	.23 .12 .05	6.8 6.9 7.0	0	0
Markland silt loam	0- 6 6-18 18-36	.13 .07 .04	5.7 5.3 6.5	36	2-3
Martinsville fine sandy loam	0- 6 6-18 18-36	.10 .05 .04	5.7 6.0 6.3	50	1-2
Martinsville loam	0- 6 6-18 18-36	.10 .08 .06	6.5 5.4 5.4	50	1-2
Martinsville silt loam	0- 6 6-18 18-36	.13 .09 .06	6.3 5.8 6.0	45	1-2
McGary silt loam	0- 6 6-18 18-36	.13 .08 .05	5.7 6.2 6.7	36	2-3
Miami silt loam	0- 6 6-18 18-36	.13 .07 .03	6.1 5.7 ([2])	32	1-2
Monrovia silty clay loam	0- 6 6-18 18-36	.18 .11 .06	7.0 7.2 7.2	0	0
Montgomery silty clay loam	0- 6 6-18 18-36	.23 .11 .04	6.6 7.0 7.2	0	0
Morgantown silt loam	0- 6 6-18 18-36	.13 .07 .04	5.7 5.5 5.4	180+	2-3
Parke silt loam	0- 6 6-18 18-36	.13 .08 .05	5.2 5.0 5.0	120	3-4
Pekin silt loam	0- 6 6-18 18-36	.12 .07 .04	5.8 5.2 5.1	([1])	3-4
Peoga silt loam	0- 6 6-18 18-36	.15 .06 .06	5.6 5.0 5.2	([1])	3-4
Philo silt loam	0- 6 6-18 18-36	.12 .09 .09	6.2 5.6 5.4	([1])	2-3
High-bottom phase	0- 6 6-18 18-36	.13 .08 .07	5.2 5.3 5.7	([1])	2-3
Plano silty clay loam	0- 6 6-18 18-36	0.24 .22 .05	6.9 7.0 7.2	0	0
Pope loam	0- 6 6-18 18-36	.13 .06 .05	5.8 5.6 5.8	([1])	2-3
Princeton fine sandy loam	0- 6 6-18 18-36	.07 .04 .04	6.8 6.3 6.0	60	1-3
Ragsdale loam	0- 6 6-18 18-36	.16 .12 .05	6.4 6.6 6.9	0	0
Ross silty clay loam	0- 6 6-18 18-36	.19 .16 .11	6.9 7.0 7.1	0	0
Russell loam	0- 6 6-18 18-36	.11 .07 .04	5.8 5.5 5.5	42	1-3
Russell silt loam	0- 6 6-18 18-36	.13 .09 .07	5.8 5.4 5.3	42	1-3
Shoals silt loam	0- 6 6-18 18-36	.10 .06 .05	6.9 6.5 7.0	0	0
Shoals silty clay loam	0- 6 6-18 18-36	.14 .08 .06	6.7 6.8 7.0	0	0
Stendal silt loam	0- 6 6-18 18-36	.11 .10 .10	5.8 5.5 5.7	([1])	2-3
High-bottom phase	0- 6 6-18 18-36	.13 .06 .06	5.5 5.2 5.4	([3])	2-3
Taggart silt loam	0- 6 6-18 18-36	.13 .06 .04	5.5 5.4 5.3	180+	2-3
Tilsit silt loam	0- 6 6-18 18-36	.14 .07 .05	5.4 5.0 5.1	([3])	3-4
Vigo silt loam	0- 6 6-18 18-36	.11 .06 .04	5.1 5.0 5.0	120	3-4
Wakeland silt loam	0- 6 6-18 18-36	.11 .09 .07	7.0 6.8 7.0	([4])	1-2
Washtenaw silt loam	0- 6 6-18 18-36	.16 .13 .68	5.4 5.1 5.0	([4])	0-1
Whitaker loam	0- 6 6-18 18-36	.10 .06 .04	6.6 6.2 6.4	50	0-2
Whitaker silt loam	0- 6 6-18 18-36	.13 .06 .05	6.0 5.5 5.6	50	0-2
Wilbur silt loam	0- 6 6-18 18-36	.11 .08 .05	6.8 7.0 7.1	([5])	1-2
Zanesville silt loam	0- 6 6-18 18-36	.11 .08 .05	5.5 5.1 4.9	([3])	3-4

[1] Acid to a depth of several feet.
[2] No pH determinations made but soil layer known to be calcareous.
[3] Acid to bedrock.
[4] Washtenaw soils normally neutral in both surface soil and subsoil.
[5] Varies from neutral to medium acid; 40 inches or more.

The acidity is expressed as pH, or approximate hydrogen-ion concentration. For example, pH 6.6 to 7.3 is neutral, and a soil in this range contains just enough lime to neutralize the acidity. Soils testing between pH 6.1 and 6.5 are slightly acid; between 5.6 and 6.0, medium acid; between 5.1 and 5.5, strongly acid; and below 5.0, very strongly acid. As a rule, the lower the pH value the more the soil needs lime. 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 also of the lower layers. Given two soils of the same acidity, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The slighter the depth of acid soil, the less likely it is to need lime. Soils having the greater clay content will need a greater quantity of lime to neutralize them, given the same degree of acidity. The less phosphorus, calcium, and magnesium the soil contains, the more likely it is to need lime. Sweetclover, alfalfa, and red clover need lime more than do other crops. As it is advisable to grow these better soil-improving legumes in the crop rotation, soils that are acid should be limed.

In interpreting the soil survey map and soil analyses, is should be borne in mind that a well-farmed and well-fertilized soil that is naturally low in fertility may produce larger crops than a poorly farmed soil naturally higher in fertility.

SOIL MANAGEMENT

For convenience in discussing their management, the several soils are arranged in groups according to certain important characteristics that indicate that in many respects similar treatment is required. For example, several of the light-colored silt loams of the uplands and terraces, which have practically the same requirements for their improvement, may be conveniently discussed as a group, thus avoiding the repetition that would be necessary if discussed separately. Where different treatments are required they are specifically pointed out. The reader should study the group that includes the soils in which he is particularly interested.

About 55 percent of the soils of Morgan County occur on undulating to rolling or steep relief on the uplands and terraces of which approximately two-fifths are nonarable; about 19 percent are naturally poorly drained, flat, or depressed to gently undulating upland and terrace loam, silt loam, and silty clay loam soils of which approximately one-third are dark-colored; about 23 percent are bottom land soils; and less than 3 percent fall in the sandy soils group.

IMPERFECTLY AND POORLY DRAINED LIGHT-COLORED SOILS OF THE UPLANDS AND TERRACES

The imperfectly and poorly drained light-colored soils of the uplands and terraces comprise loams of the Fincastle, Ayrshire, Gregg, and Whitaker series; silt loams of the Crosby, Bethel, Fincastle, Delmar, Vigo, Loy, Avonburg, Gregg, Bartle, Peoga, Taggart, McGary, and Whitaker series; and Bartle silty clay loam. Together, these soils

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occupy 34,112 acres, or about 13.2 percent of the total area of the county, with Fincastle silt loam greatly predominating.

The several soils of this group, although differing considerably in appearance, due to origin, topography, and natural drainage, have important characteristics in common, and consequently their management problems are similar. All are more or less in need of artificial drainage; all are low in total content of organic matter, nitrogen, and phosphorus; and most of them are low in available potassium and in need of liming.

DRAINAGE

All of the group of imperfectly and poorly drained light-colored soils of the uplands and terraces developed under poor drainage conditions. Their flat to gently undulating topography, together with a heavy subsoil, makes them naturally wet and more or less seriously in need of artificial drainage. The flatter areas, especially the Vigo, Loy, Bethel, and Delmar silt loams and much of the Avonburg, Peoga, and Taggart, may need surface furrow drainage as well as tile underdrainage.

Surface drainage by dead furrows and open ditches is more or less practical but is wasteful of fertility in surface runoff. Tile underdrainage should be installed as early as possible in any permanent improvement program. Without tile drainage, these soils cannot be managed to the best advantage and no other beneficial soil treatment can produce its full effect.

With reasonable provision for drainage, these soils respond well to lime, legumes, manure, and fertilizer and can be made profitably productive. This has been fully demonstrated on the soil fertility experiment fields conducted by the Purdue University Agricultural Experiment Station on Clermont, Avonburg, and Crosby silt loams and similar poorly drained soils in other parts of the State. The results of experiments on these fields indicate that tile lines laid 30 to 40 inches deep and not more than 3 to 4 rods apart will give satisfactory results.

Where the land is flat, care must be exercised in tiling to obtain an even grade and uniform fall. Unsatisfactory results in tiling these flat lands are traceable to errors in grades, which allow silting up in low places, and to poor grades of tile, which chip and break down easily. Only the best grade of tile should be used. Grade lines should not be established by guess or by rule-of-thumb methods. 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, with no interruption or slackening of the current. The grade, or rate of fall, should be not less than 3 inches to 100 feet. The rate of fall may be increased toward the outlet, but it should never be lessened without the introduction of a silt well, or settling box, as checking the current in the line may cause the tile to become choked with silt. Silt wells may be made of brick or concrete and should be at least a foot square inside. The bottom should be a foot lower than the bottom of the tile. The well should have a removable cover, in order that it may be opened once or twice a year for the purpose of dipping out the silt that has settled in the bottom. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with a layer of straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring perfect operation of the drains from the beginning.

In a special tile-drainage experiment on Clermont silt loam of the Jennings County Experiment Field, near North Vernon, which resembles Avonburg silt loam in Morgan County, the land tiled 3 rods apart in 1920 has since averaged 17.9 bushels more corn, 1.1 bushels more soybeans, 7.3 bushels more wheat, and 518 pounds more hay an acre than the untiled land with the same lime and fertilizer treatment in the corn, corn, soybeans, wheat, and hay rotation used in this experiment. The cost of tiling was paid for by the increased yields of crops during the first 8 years of the experiment, and since then the increased annual returns have averaged approximately $6 an acre.

LIMING

More than 80 percent of the imperfectly and poorly drained light-colored soils of the uplands and terraces will not produce a satisfactory growth of clover without liming. Furthermore, very acid soil will not respond properly to other needed treatments until it has been limed. On the Jennings County Experiment Field, located on Clermont silt loam, which resembles Avonburg soil in acidity, land that received 3 tons of ground limestone an acre in 1921 and 2 tons in 1935 has averaged 15.2 bushels more corn, 6.4 bushels more wheat, and 1,390 pounds more hay an acre than land similarly fertilized but not limed. In the 22-year period to the end of 1942, the acre value of the crop increases due to liming has amounted to more than $140.

Ground limestone generally is the most economical form of lime to use, and sources of supply are fairly convenient. The quantity that should be applied to these soils is shown in the last column of table 14. On the more acid soils, the first application should be at least 2 or 3 tons an acre. After that, 1 ton an acre every second round of the crop rotation will keep the soil sufficiently sweet for most crops otherwise adapted to the local conditions. To determine the lime requirement in any particular case, the soil should be tested for acidity. The test is simple and should not be neglected. If the farmer cannot make the test, he can have it made by the county agricultural agent or the vocational agriculture teacher or he can send representative samples of the soil and subsoil to the Purdue University Agricultural Experiment Station at La Fayette.

ORGANIC MATTER AND NITROGEN

All the imperfectly and poorly drained light-colored soils of the uplands and terraces are naturally low in organic matter and nitrogen. Soil erosion on sloping areas and constant cropping without adequate returns to the land are steadily making matters worse. In many places the original supply of organic matter has become so reduced that the soil has lost much of its natural mellowness and it readily puddles and bakes. The only practical remedy for this condition is to plow under more organic matter than is used in the processes of cropping. The decomposition constantly going on is necessary to maintain the productivity of the soil. Decomposing organic matter must usually supply the greater part of the nitrogen required by crops. For this reason, legumes should provide large quantities of the organic matter to be plowed under.

On the strongly acid soils, if money for liming and heavy fertilization is not available, soybeans may be the most practical crop to start with because the beans will stand considerable soil acidity and can obtain their nitrogen requirements from the air. As they also will respond to liming, however, the land should be limed as soon as possible; certainly before clovers or other lime-loving crops are planted.

Where grown for the first time, soybeans must be artificially inoculated with their special nitrogen-fixing bacteria. Since these soils are poor in available mineral plant-food elements as well as nitrogen, a phosphate and potash fertilizer, as 0–12–12 or 0–20–20, should be used. Soybeans, however, are sensitive to fertilizer injury during germination and early growth and, therefore, not more than 150 pounds an acre should be applied at seeding time. Two or three times as much of the same fertilizer as would otherwise be applied at seeding time may be profitably plowed under for soybeans as well as for corn. The seed may be drilled at the rate of 2 bushels an acre, or in rows for cultivation, at 2 to 4 pecks. Immediately after harvesting the soybeans, the ground should be seeded to rye or a mixture of rye and winter vetch fertilized with a high-grade complete fertilizer. If a combine harvester with a straw-spreader attachment is used, the straw may remain in the field and will not interfere with rye seeding. If other means of harvesting are used and the straw is not needed as feed, it should be spread on the rye for a winter cover and to supply organic matter to the soil. The rye should be plowed under the following spring and the land again seeded to inoculated soybeans.

As soon as the land can be put in condition for growing clover, this or some other legume should appear in the rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized for livestock; and all produce not utilized, as cornstalks, straw, and cover crops, should be plowed under. It must be remembered that legumes are the only crops that can add appreciable quantities of nitrogen to the soil, and then only in proportion to the quantity of top growth that is returned to the land either directly or in he form of manure. Wherever clover seed crops are harvested, the threshed haulm should be returned to the land and plowed under.

Cornstalks, straw, or other crop residues should not be burned. Burning destroys both organic matter and nitrogen. Modern plows equipped with Purdue trash shields will turn down and completely cover cornstalks or other heavy growth. Cover crops should be grown wherever possible to supply additional organic matter for plowing under. Planting soybeans, cowpeas, or sweetclover between the corn rows at the time of the last cultivation and seeding rye as a cover crop early in fall on cornland that is to be plowed the following spring are good practices for increasing the supply of both nitrogen and organic matter. It is important to have a growing crop of some kind on these soils during winter in order to take up the soluble nitrogen, which otherwise would be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses may occur between crop seasons through drainage. In this latitude the ground is not frozen much of the time during winter, and frequent heavy rains cause much leaching and loss of plant nutrients, especially nitrates, if they are not taken up by crops.

CROP ROTATION

With proper liming, drainage, and fertilization, the imperfectly and poorly drained light-colored soils of the uplands and terraces will produce satisfactorily 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 to be returned to the land in one form or another. Corn, wheat, and clover or mixed clover and timothy constitute the best short rotation for general use on these soils after liming, especially where the corn can be cut and the ground disked and properly prepared for wheat. On the Jennings County Experiment Field, on Clermont silt loam, with tile drainage, liming, and moderate quantities of manure and fertilizer, this rotation has averaged 79 bushels of corn, 23 bushels of wheat, and 3,411 pounds of hay an acre over the 22-year period 1921–42. The corn, wheat, and clover rotation can be lengthened to 4 or 5 years by seeding timothy, lespedeza, and alfalfa with the clover and allowing this mixture to stand for 2 or 3 years to be used for either hay or pasture.

The 4-year rotation of corn, soybeans, wheat, and clover or mixed clover, alfalfa, lespedeza, and timothy is well adapted to these soils. In this rotation, rye should be seeded in the cornfield as a winter cover crop and plowed under late in spring in preparation for the soybeans. Wheat should be seeded in the soybean stubble without plowing. The two legumes will build up the nitrogen supply of the soil. The soybean straw, or its equivalent in manure, should be spread on the wheat in winter. This not only will help the wheat and lessen winter injury, but it also will help to insure a stand of clover. Spring oats are not well adapted to the climatic conditions of this section and as a rule are not a profitable crop. Hardy varieties of winter oats and winter barley are being developed and may come into use more extensively on the better drained soils.

If more corn is wanted, as on livestock farms, the 5-year rotation of corn, corn, soybeans, wheat, and clover or mixed seeding may be used satisfactorily where the second corn crop, at least, can be given a good dressing of manure. Where enough livestock is kept to utilize all the grain and roughage in this rotation, there should be enough manure produced to make a fair application for each corn crop. A cover crop of rye for plowing under the following spring should be seeded in September on all the cornland. Even though the land has been properly limed, clover may be uncertain on some of these soils, owing to climatic conditions, and it has proved to be a good plan to sow a mixture of seeds made up of about 3 pounds of red clover, 3 pounds of alfalfa, 2 pounds of alsike clover, 2 pounds of timothy, and 4 pounds of Korean lespedeza an acre. Where the seeding fails to make a satisfactory stand, soybeans make a good substitute hay crop. Lespedeza may be used to advantage in pasture mixtures and on thin spots in old pastures that need improvement, especially where the pasture land is acid and liming is not feasible.

FERTILIZATION

The imperfectly and poorly drained light-colored soils of the uplands and terraces are naturally low in phosphorus, and in most of them the available supplies of this element are so very low that the phosphorus required by crops should be wholly supplied in applications of manure and commercial fertilizer. The nitrogen supply in these soils is also too low to meet satisfactorily the needs of corn, wheat, and other nonleguminous crops, and provisions for adding nitrogen should be an important part in the soil-improvement program. The total quantities of potassium in these soils are large but the available supplies are low, so the addition of some potash fertilizer will be profitable, especially where little manure is applied. Without substantial provision for supplying all three of these fertilizer elements, the productivity of these soils will remain relatively low.

The problem of supplying nitrogen has been discussed in connection with provisions for supplying organic matter. Legumes and manure are the logical sources of nitrogen needed by crops, and they should be employed largely for this purpose. A system of livestock farming, with plenty of legumes in the crop rotation, is best for these soils. On most farms, however, it will pay to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Even though wheat follows soybeans or other legumes, it should receive some fertilizer containing nitrogen at seeding time to start the crop properly, because the nitrogen in the residues of an immediately preceding legume does not become available quickly enough to be of much help to the wheat in the fall. The leguminous residue must first decay, and that does not take place to any great extent until the following spring.

Where a good clover sod is not available for the corn crop, it will pay well to plow under 300 to 400 pounds of ammonium sulfate or cyanamid along with liberal quantities of phosphate and potash.

Phosphorus is the mineral plant nutrient in which these soils are most deficient. In all, the natural supply is small and should not be drawn on further. On areas where much of the surface soil has been washed away, the greater part of the phosphorus has gone with it. The only practical way to increase the supply of phosphorus in the soil is through the application of purchased phosphatic fertilizers, and it will prove profitable in most instances to supply the entire phosphorus needs of crops in this way. In rotations of ordinary crops producing reasonable yields, it may be considered that 20 pounds of available phosphoric acid an acre are required each year. It will pay well to apply larger quantities at first, so as to create a little reserve. In applying phosphate, enough for the entire rotation may be applied at one time or the application may be divided, according to convenience. Where manure is applied, it may be counted that each ton supplies about 5 pounds of phosphoric acid; therefore, a correspondingly smaller quantity need be provided in the commercial fertilizer.

The quantity of potash that should be supplied as fertilizer depends on the general condition of the soil and the quantity of manure used. According to the analyses in table 13, most of the soils of this group are low in available potash. If the available potassium is below medium, it will pay to use some potash fertilizer. In building up a run-down soil, considerable quantities of fertilizer potash should be used, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has materially improved. There is plenty of potassium in these soils for all time if it could be made available at a faster rate; as a rule it becomes available too slowly. This is particularly true of the flat gray soils of the group, and the fertilizer for these should contain more potash than that for the brown or yellow soils. The availability of the soil potash may be increased by good farming practices, including drainage, proper tillage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of organic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

On the Jennings County Experiment Field, the results on which may be considered fairly applicable to all of the flat gray soils of naturally low productivity, highly profitable returns have been obtained wherever lime, legumes, manure, and fertilizer have been used with a 3-year rotation of corn, wheat, and clover. During the 22 years since the experiments were begun, 1921–42, the land without treatment other than tile drainage, which is the same for all plots, has produced average crop yields of only 26.3 bushels of corn, 3.2 bushels of wheat, and 667 pounds of weedy hay an acre. Land receiving manure alone in quantities that could be made by utilizing the entire corn crop, the wheat straw, and the hay in a livestock system has averaged 50.4 bushels of corn, 8.5 bushels of wheat, and 1,075 pounds of hay. The limed and manured land has averaged 64.9 bushels of corn, 13.5 bushels of wheat, and 2,040 pounds of hay. Land receiving lime-manure, and 100 pounds an acre of a phosphate and potash fertilizer for corn and 300 pounds of a complete fertilizer for wheat, has averaged 78.7 bushels of corn, 22.8 bushels of wheat, and 3,411 pounds of hay an acre.

In the practical fertilization of these soils, most of the manure should be plowed under for the corn crop. When the crop rotation includes wheat, as should generally be the case, a part of the manure, about 2 tons an acre, may be applied profitably on the wheatland as a top dressing during winter. Manure so used not only helps the wheat and lessens winter injury but also helps to insure a stand of clover or other crop seeded in the wheat. In addition to the manure, corn should receive 100 to 150 pounds an acre of a phosphate and potash mixture, at least as good as 0–12–12, applied in the row or beside the hill at planting time. Wheat should be given 200 to 300 pounds of a high-analysis complete fertilizer, as 2–12–6, 2–16–8, or 3–12–12, depending on the quantity of manure used in the rotation.

On run-down land or land of naturally low productivity that cannot be heavily manured, it will pay to start off with at least 500 pounds of a 10–10–10 or 8–8–8 fertilizer, or its equivalent, plowed under for corn and to accompany this with 100 pounds of 3–12–12 an acre in the row or beside the hill at planting time. Such fertilization has been found profitable in experiments on Vigo silt loam in Putnam County and on Clermont silt loam in Jennings County. In places where the wheat is backward in spring, a top dressing of about 100 pounds of a good soluble nitrogen fertilizer should be applied soon after growth begins. Such top dressing generally will add 5 to 7 bushels an acre to the yield.

For special crops, special fertilization will be needed. Specific fertilizer recommendations for different crops on different soils under different conditions may be obtained from the agricultural experiment station at La Fayette.

WELL-DRAINED LIGHT-COLORED LOAM AND SILT LOAM SOILS OF THE UPLANDS AND TERRACES

The well-drained light-colored loam and silt loam soils of the uplands and terraces comprise loams of the Bellefontaine, Russell, Princeton, Fox, Morgantown, and Martinsville series; silt loams of the Miami, Russell, Cincinnati, Gibson, Zanesville, Grayford, Parke, Pekin, Banta, Tilsit, Wellston, Muskingum, Frederick, Bedford, Elkinsville, Morgantown, Martinsville, Markland, and Fox series; and Muskingum stony silt loam. Almost all the Muskingum, Wellston, and Zanesville-Wellston soils and the very sloping, steep, eroded, and gullied phases of the Cincinnati, Parke, Russell, Frederick, Morgantown, Markland, Miami, Fox, and Grayford soils, amounting to more than two-fifths of the total area, are unfit for cultivation and are classed as nonarable lands. A separate discussion of these will be found later in the section on nonarable soils. Together these soils occupy 142,016 acres, or 54.7 percent of the total area of the county, with the Russell and Cincinnati soils predominating.

Although the arable soils of this group differ more or less in appearance, owing to origin and topography, they have certain characteristics in common, with respect to which their management problems are similar. They are all low in organic matter, nitrogen, and phosphorus; many are low in available potassium; and all are acid and more or less in need of liming.

DRAINAGE

The more level areas of Tilsit silt loam on the broader ridge tops and some areas of Markland silt loam will be benefited by tile underdrainage. Some areas of Fox loam and silt loam, Bellefontaine loam, and Martinsville soils are droughty because of shallow depth to sand or gravel. The rolling and hilly upland soils of this group have fair to good internal drainage, but, owing to sloping topography and slow permeability, much of the rain water that falls on them runs off instead of being absorbed for the benefit of crops, and in times of heavy rains much erosion damage may result.

CONTROL OF EROSION

On most of these soils, the problems of controlling erosion are of major importance in practical systems of soil management. In greater part the Fox and Martinsville soils are on nearly level relief and therefore not subject to the erosion that damages other soils of this group. Even after taking out of cultivation all the rough and very sloping land, which should never be plowed, the rest of the tillable land needs special care to prevent further destructive erosion. In many places the surface soil has already gone, and further sheet erosion and gullying are constantly making matters worse. The surface soil contains the greater part of the store of fertility and should be protected against erosion by every practicable means. Gradual sheet erosion, whereby the runoff of rain water moves the surface soil down the slope a little at a time and rather evenly, is the most insidious form of erosion and may not be noticed until the subsoil begins to appear. Many one-time fertile fields have been irreparably damaged in this way, and on many others only a little of the surface soil is left and the plow reaches into the unproductive subsoil.

Plowing and other tillage operations should extend crosswise of the slopes wherever possible, in order to prevent the formation of watercourses down the slopes, which are certain to carry away much valuable surface soil and may start serious gullies. Contour plowing and contour strip cropping may be most practical on fields of irregular slope, whereas terracing may be most practical on long even slopes. By rearranging fences or other field boundaries, it may be possible to arrange the cropping system in such a way as to facilitate the performance of all tillage operations crosswise of the slopes. Intertilled crops should be interspersed with small-grain and sod-forming crops. Incipient gullies, or draws, forming natural waterways down the slopes, should be kept permanently in grass with a good sod of sufficient width to allow the water to spread and thereby prevent soil cutting.

LIMING

Some areas of Bellefontaine, Fox, and Martinsville soils are only slightly acid and in no immediate need of liming. Martinsville silt loams and some Martinsville loam are moderately acid, and liming should be included in the improvement program, especially where alfalfa or sweetclover is to be grown. The rest of the soils are medium to strongly acid, and liming should be a first step in the soil-improvement program. What has been said about the liming of the imperfectly and poorly drained upland and terrace soils applies equally well here and should receive early consideration in plans for making these soils more profitably productive.

ORGANIC MATTER AND NITROGEN

These well-drained soils are similar to those of the imperfectly and poorly drained group in their organic matter and nitrogen content, and what has been said about ways and means and the importance of increasing the organic matter and nitrogen content of those soils applies equally well here. In fact, the rolling light-colored upland soils are especially in need of more organic matter for improving their permeability to rain water and thereby lessening surface runoff and erosion damage.

CROP ROTATION

With proper liming and fertilization, these well-drained light-colored loam and silt loam soils of the uplands and terraces will produce satisfactorily all the ordinary crops adapted to the locality. Because of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat, and clover or mixed clover and timothy constitute the best short rotation for general use after liming, especially where the corn can be cut and the ground disked and properly prepared for wheat. The corn, wheat, and clover rotation can readily be lengthened to 4 or 5 years by seeding timothy, lespedeza, and alfalfa with the clover and allowing the stand to remain and be used 2 or 3 years for either hay or pasture.

The 4-year rotation of corn, soybeans, wheat, and clover or mixed clover, alfalfa, lespedeza, and timothy is well adapted to these soils. In this rotation, rye with fertilizer should be seeded in the cornfields as a winter cover crop to lessen erosion and this should be plowed under late in spring in preparation for the soybeans. The wheat should be seeded in the soybean stubble without plowing. The two legumes will build up the nitrogen supply of the soil. The soybean straw, or its equivalent in manure, should be spread on the wheat in winter.

On livestock farms, the 5-year rotation of corn, corn, soybeans, wheat, and clover or mixed seeding may be used satisfactorily where the second corn crop, at least, can be given a good dressing of manure. Where enough livestock is kept to utilize all the grain and roughage in this rotation, enough manure should be produced to make a fair application for each corn crop. A cover crop of rye for plowing under the following spring should be seeded in September on all the cornland.

On account of the ever present erosion-control problem, cropping systems on the rolling uplands should contain a larger proportion of sod crops, and winter cover crops after corn or soybeans are especially important. Under such conditions contour strip cropping should be practiced as much as possible, with grain and sod crops alternating. On the other hand, on some of the terrace loams and silt loams included in this group, where corn usually suffers seriously from drought and wheat is the most important grain crop, soybeans may be more extensively used to good advantage because they stand periods of drought better than corn. Where sweetclover does well in such situations a short rotation of wheat and soybeans has possibilities, with sweetclover seeded in the wheat as an intercrop to be plowed down with phosphate and potash fertilizer for the soybeans.

Alfalfa and sweetclover may be grown on most of the soils of this group if properly inoculated and sufficiently limed to meet the needs of these crops. In particular, these deep-rooted legumes may be recommended for Fox, Martinsville, Bellefontaine, and Princeton soils, which have calcareous gravelly and sandy subsoils and are inclined to be more or less droughty for other crops. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and for soil-improvement purposes. Special literature on the cultural requirements of these crops may be obtained from the Purdue University Agricultural Experiment Station, at La Fayette. Alfalfa and sweetclover, however, are not adapted to Cincinnati, Gibson, Zanesville, Parke, Pekin, Banta, Tilsit, Wellston, Elkinsville, and Muskingum soils.

FERTILIZATION

The general discussion of the plant-food requirements of imperfectly and poorly drained light-colored soils holds also for the well-drained light-colored soils, except that the well-drained soils generally are not so much in need of potash fertilizer, because oxidation of the potash naturally in the soil proceeds more rapidly.

SANDY SOILS OF THE UPLANDS AND TERRACES

The sandy soils of the uplands and terraces comprise Fox, Martinsville, Princeton, and Whitaker fine sandy loams and Princeton loamy fine sand and occupy 6,592 acres, or 2.5 percent of the total land area. These soils are naturally deficient in water-holding capacity, and most crops are likely to suffer from drought, except that Whitaker fine sandy loam is often helped by seepage water from adjoining higher lands.

LIMING

With the exception of some areas of Martinsville fine sandy loam, these soils are fairly well supplied with lime to meet the needs of most crops. Martinsville fine sandy loam is acid enough to need some liming, at least for the lime-loving clovers and alfalfa.

ORGANIC MATTER AND NITROGEN

These sandy and gravelly soils are naturally low in organic matter and nitrogen, and to use them to the best advantage some special provision must be made for building up and maintaining these two constituents. What has been said concerning this problem in the improvement of the light-colored upland and terrace silt loams applies equally well here; 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. Their loose, open, often excessively aerated condition favors rapid decomposition and oxidation. For this reason more than ordinary quantities of manure, crop residues, green-manure crops, cover crops, and other organic materials should be plowed under. The land should never be left without something growing on it. When any considerable quantities of nonleguminous crop residues or green manures are to be plowed under, especially on land used for truck crops, it will be advantageous to broadcast and plow under, with the organic material, a few hundred pounds an acre of a straight nitrogen fertilizer, such as ammonium sulfate, cyanamid, nitrate of soda, or urea, to aid the processes of decomposition and at the same time provide additional nitrogen for the crop that is to be grown.

CROP ROTATION

Among the extensively grown crops adapted to the region, winter small grains and deep-rooted legumes are best suited to these sandy soils. Winter small grains make most of their growth before there is much danger of moisture shortage, and deep-rooted legumes can usually find enough moisture in the deeper subsoil to carry them over the ordinary dry periods. Corn and spring small grains nearly always suffer from drought. Early potatoes, early tomatoes, and melons do relatively well if special attention is given to their organic-matter and fertilizer requirements.

A 5-year rotation of early tomatoes (rye-and-vetch cover crop), melons (rye-and-vetch cover crop), early potatoes, and alfalfa for 2 years is well suited to the sandy soils on which these crops can be grown to advantage. Success with this rotation will depend largely on the success with the cover crops and the alfalfa. All crops should be fertilized. Where alfalfa responds to additions of lime, it will be advisable to confine liming to drilling 300 to 400 pounds an acre of ground limestone with the alfalfa seed at sowing, because heavier liming may be detrimental to the potatoes. Alfalfa seeding should be done immediately after potato harvest, and the cover crop should be seeded as soon as possible after harvesting the melons.

On general farming areas a rotation of corn, soybeans, wheat or other winter grain, and alfalfa for 2 or more years may be satisfactorily practiced. Since corn is often severely damaged by drought, it may be wise to plant a part of the corn acreage to sorghum for silage. An early seeding of winter rye or rye and vetch should be made on the corn and sorghum land to serve as a winter cover crop and to provide additional organic matter for plowing under, which is always needed on these soils.

FERTILIZATION

These sandy soils are naturally deficient in nitrogen and need special provision for building up a supply of this element. The total supply of phosphorus is so low that it should not be depleted further. As a rule, the available potash also is low. Stable manure should be applied as liberally as possible, both for its plant-nutrient constituents and for the organic matter it supplies, in order to improve the water-holding capacity of the soil as well as its productiveness. Manure, however, is seldom available in sufficient quantities; therefore, green manures and commercial fertilizers should be used liberally.

Legumes, in rotation or as special green-manure or cover crops, should be used to supply much of the needed nitrogen that is not provided in the form of manure. Early potatoes, early tomatoes, melons, and other truck crops on these soils will respond to heavy applications of high-analysis complete fertilizers; 500 to 1,000 pounds an acre of 2–12–6, 2–16–8, or 3–12–12 is commonly recommended.

For winter grains, fertilization with 200 to 300 pounds of 2–12–6 or 3–12–12 at seeding time and a spring top dressing of 15 to 20 pounds an acre of nitrogen supplied by such materials as nitrate of soda, cyanamid, or sulfate of ammonia is to be recommended. For corn on manured land, row or hill applications of phosphate-potash combinations, as 0–12–12 at 100 to 150 pounds an acre, are most practical.

Where alfalfa or sweetclover is grown, 300 to 500 pounds an acre of a high-grade phosphate-potash mixture should be applied at seeding time. A continuous stand of alfalfa should receive a top dressing of phosphate and potash fertilizer every 2 years.

DARK-COLORED SOILS

The group of dark-colored soils is composed of silty clay loams of the Brookston, Abington, Monrovia, Plano, Mahalasville, and Montgomery series; loams of the Mahalasville and Ragsdale series; and Washtenaw silt loam. Together these soils occupy 17,024 acres, or about 6.5 percent of the total area.

These dark-colored soils were all developed under more or less wet conditions, and in consequence a common natural defect is poor drainage. When drained they are the strongest and most productive soils in the county. The natural fertility level is relatively high, and additions of fertilizer are not yet urgently needed. The chemical tests show fair to good supplies of available phosphorus and potassium, and the nitrogen and organic-matter supplies are fairly ample, except in some areas of Mahalasville loam where the dark surface soil is rather shallow.

DRAINAGE

All these soils are naturally wet and more or less in need of artificial drainage. To a large extent this has been provided, and surplus water is fairly well taken care of. In many places, however, there would be good response to more tiling. Where this is needed, the same procedure should be followed as that suggested for the imperfectly and poorly drained light-colored soils of the uplands and terraces.

LIMING

With the exception of Washtenaw silt loam, these soils are neutral or only slightly acid and do not need liming for most crops, but Ragsdale loam would probably respond to some liming for such lime-loving crops as alfalfa and sweetclover, which may be grown on well-drained areas.

CROP ROTATION

These dark-colored soils are especially well suited to corn, and this may well be the major crop. Among the crop rotations that may be satisfactorily used are the following: Corn, wheat, and clover; corn, soybeans, wheat, and clover; corn, corn, soybeans, wheat, and clover. Usually some timothy is seeded in fall with the wheat, and progressive farmers on well-drained land mix some alfalfa with the clover for sowing with the wheat in spring.

FERTILIZATION

Manure and fertilizer are not so necessary on these dark-colored soils as on associated soils of lighter color. Wheat, however, generally should receive 200 to 300 pounds an acre of a complete fertilizer, as a 2–12–6, 2–16–8, or 3–12–12, both for itself and for the seeding to follow. Corn generally should receive 100 to 150 pounds an acre of a phosphate-potash mixture, as 0–12–12 or 0–20–20, beside the hill or in the row at planting time. On farms having both light- and dark-colored soils, manure should be applied to the light-colored soils, because they are more in need of the organic matter and nitrogen it supplies.

BOTTOM LANDS

The bottom, or overflow, lands may be divided into three general classes—strongly acid, slightly to medium acid, and neutral. The strongly acid bottoms, consisting of Philo and Pope loams and Atkins, Philo and Stendal silt loams and occupying 12,416 acres, or about 4.6 percent of the total area of the county, have been formed by deposits from the acid soils of the uplands and terraces. They should receive 2 to 4 tons an acre of ground limestone, as tests for acidity will show.

The slightly to medium acid bottoms, occupying 5,400 acres, or about 1.8 percent of the county, are silt loams of the Haymond, Wilbur, and Wakeland series. They usually require 1 to 2 tons of limestone an acre. The neutral bottoms, occupying 47,360 acres, or about 18.4 percent of the total area, and consisting of Genesee and Eel loams; Genesee, Eel, and Shoals silt loams; Genesee, Eel, Ross, and Shoals silty clay loams; and Genesee fine sandy loam, have been formed by deposits from the lime-bearing soils of the uplands and terraces. They are either neutral or slightly alkaline and seldom need liming.

DRAINAGE

Natural drainage is limited by the periodic overflows and, in the heavier types, by tight subsoils. The latter should be tiled wherever suitable outlets can be obtained, in order to drain the land more quickly after floods or heavy rains.

ORGANIC MATTER AND NITROGEN

The silt loams and silty clay loams of the Eel and Genesee series and Ross silty clay loam have fair supplies of organic matter and nitrogen, but the other soils of this group are in need of additional supplies of both. What has been said about supplying organic matter and nitrogen to the light-colored soils of the uplands and terraces applies equally well to the light-colored soils of the bottom lands. On the lighter colored and poorer areas especially, considerable quantities of orangic matter should be plowed under and legumes should be included in the rotation wherever possible, to be largely returned to the land in one form or another for increasing the nitrogen content.

Where the land is periodically flooded, clover and other deep-rooted legumes, especially biennials and perennials, cannot be depended on, but certain shallow-rooted legumes, as soybeans, cowpeas, and sometimes alsike clover and lespedeza, can be grown satisfactorily. These crops should be used largely for gathering nitrogen from the air, which they will do in large measures 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, can really increase the nitrogen content on which grain crops must depend. Soybeans, winter vetch, rye, and other cover crops should be used to the fullest possible extent in cornfields. Cornstalks, instead of being burned, should be completely plowed under whenever practicable.

CROP ROTATION

Where overflows cannot 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, soybeans, and in some places, where flooding is not too prolonged, wheat with a mixture of timothy and alsike clover following for 1 or 2 years, are satisfactory crops for this land. Corn should doubtless continue to predominate, but some sort of rotation is advisable to help maintain fertility. Doubtless soybeans will become more important as a rotation crop if these soils are properly inoculated.

Timothy and alsike clover mixed will do well on most of this land after the strongly acid areas have been limed, and this crop may be allowed to stand more than 1 year. Where the land is too acid for alsike clover, lespedeza may be used. For late seeding in emergencies, early varieties of soybeans and Sudan grass, for either hay or seed, will be found useful. On the high-bottom phases of the Genesee soils some short-season truck crops and alfalfa may be grown successfully.

FERTILIZATION

The neutral or slightly alkaline bottom lands, which are built up of sediments derived from the upland soils of the Wisconsin glaciations, do not need fertilizer, as they are fairly well supplied with available plant foods. Where the land has been cropped, however, for a considerable length of time it will usually pay to apply 150 to 200 pounds an acre of 0–12–12 or 0–20–20 in the row, or half that quantity beside the hill for corn. It does not pay to include nitrogen in the fertilizer applied for corn in the row or hill unless the soil is otherwise well supplied with available nitrogen to meet the much greater needs of the crop later on in the growing season. For maximum yields, additional quantities of fertilizer should be plowed under. Recent experiments on upland soils have demonstrated that it is profitable to supply the entire fertilizer needs of the crop in this way. Wheat should generally receive 200 to 300 pounds an acre of 2–12–6. Response of soybeans to fertilizer is less certain, but where fertilizer is needed this crop should receive a phosphate-potash mixture broadcast before plowing or applied through a fertilizer attachment on the plow.

On acid bottom lands, which are low in nitrogen and phosphorus and also in available potash, the need for fertilizer is much more general than on the neutral or slightly alkaline bottoms. If the bulk of the fertilizer requirements of corn can be supplied by the plow-under procedure, a complete fertilizer, as 2–12–6, 2–16–8, or 3–12–12, should be used for the row or hill application to give the corn a quick start. It should be recognized that in most instances the floodwater sediments that come to these bottom lands from the adjoining watersheds are not so rich as they were years ago. The rich surface soil has gone from much of the upland, and the present floods carry little but eroded subsoil material of low fertility.

NONARABLE SOILS

The more sloping, eroded, and gullied phases of the Cincinnati, Zanesville, Russell, Miami, Fox, Parke, Markland, and Morgantown series, and practically all the Muskingum soil are unsuited to ordinary farming purposes. They should be regarded as nontillable and kept out of cultivation. Some cleared land in this category may be put into permanent pasture by seeding to a mixture of bluegrass, redtop, and lespedeza, but much of it should be reforested and given protection from livestock as the most practical means of saving it from complete destruction by erosion. Where it seems feasible to establish pasture on nontillable acid soils, the probability of success may be greatly increased by applications of 1 to 2 tons an acre of ground limestone and

300 to 400 pounds of superphosphate, either on top of present stands or before fresh seedings.

Thousands of acres have been ruined or damaged seriously by erosion, and such damage will become progressively worse unless decisive steps are taken to prevent it. Establishment of a good vegetative cover to hold the soil in place is essential. Contour furrows on hillsides and dams or other engineering devices in gullies should be established wherever practicable, but undisturbed forest or a solid vegetative cover of some other kind should be the ultimate aim.

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