Series 1937, No. 17 Issued August, 1946

Soil Survey

Fulton County Indiana

By

O. C. ROGERS
United States Department of Agriculture, in Charge

and

A. P. BELL, T. E. BARNES, and SUTTON MYERS
Purdue University Agricultural Experiment Station

with a section on
Management of the Soils of Fulton County
by

A. T. WIANCKO
Purdue University Agricultural Experiment Station

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. The report on each survey and the map that accompanies the report 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 private or public forests, recreation, and wildlife management. The following sections are intended for such users; (1) General Nature of the County, in which physiography, relief, drainage, climate, water supply, vegetation, history, population, industries, transportation, markets, and cultural developments are discussed; (2) Agriculture, in which a brief history of the agriculture is given and the present agriculture described; (3) Productivity Ratings and Land Use, in which the productivity of the soils is given and the present use of the soils is described, their management requirements are discussed, and suggestions made for improvement in management.

Readers interested chiefly in specific areas—such 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. The reader's first step is to locate on the map the tract with which he is concerned. The second is to identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them. The third step is to 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. He will also find useful specific information relating to the soils in the section on Productivity Ratings and Land Use.

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, Productivity Ratings and Land Use, and the first part of the section on Soils of particular value in determining the relations between their special subjects and the soils in the area.

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

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

Robert M. Salter, *Chief*

Division of Soil Survey

Charles E. Kellogg, *Head Soil Scientist, in Charge*

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

H. J. Reed, *Director*

A. T. Wiancko, *Chief, Department of Agronomy*

T. M. Bushnell, *Associate in Soil Survey*

Series 1937, No. 17 Issued August, 1946

SOIL SURVEY OF FULTON COUNTY, INDIANA

By O. C. ROGERS, Division of Soil Survey,[1] Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, in Charge, and A. P. BELL, T. E. BARNES, and SUTTON MYERS, Purdue University Agricultural Experiment Station, with a section on Management of the Soils of Fulton County by A. T. WIANCKO, Purdue University Agricultural Experiment Station

Area Inspected by MARK BALDWIN, Senior Soil Scientist, Division of Soil Survey

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

CONTENTS

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

542135—46——1

FULTON COUNTY is characterized by smooth to rolling uplands, low morainic hills, broad nearly level glaciofluvial outwash plains and terraces, muck areas, swamps, and numerous small lakes. Agriculture, consisting mainly of corn, wheat, oats, soybeans, alfalfa, clover, pasture plants, and vegetables and the raising of livestock, had its beginning in the county about 1830. A few farms specialize in truck crops, poultry raising, or dairying, but a system of general farming is practiced in most places. The county, in general, has the good homes, good buildings, and modern farm equipment essential to the maintenance of agriculture, its chief industry. Its numerous lakes afford opportunities for fishing, swimming, and other recreational activities. 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 results of which may be summarized as follows.

SUMMARY

Fulton County is in the north-central part of Indiana. The surface features of its 367 square miles are characterized by smooth to rolling uplands, low morainic hills, broad nearly level glaciofluvial outwash plains and terraces, muck areas, swamps, and numerous small lakes. It is drained by Tippecanoe River and its tributaries, but no definite drainage pattern has been established. More than 600 miles of open drainage ditches are maintained. The maximum elevation above sea level is 900 feet and the minimum is 715 feet. The average is about 760 feet.

A heavy forest growth of deciduous trees originally covered practically all the county. An oak-hickory-maple association occupied the heavier well-drained soils, but oaks predominated on the sandier soils. An ash-elm-maple association predominated on the poorly drained areas. Swamp oak, willow, tuliptree (poplar), and tamarack grew on the organic soils.

Fulton County was organized January 23, 1836, with Rochester as the county seat. Excellent transportation facilities, including five railroads, five Federal and State hard-surfaced highways, and well-graveled county roads, serve the county. A modern consolidated school system is maintained, and churches are numerous. A large part of the county is served with electricity and gas.

The climate is continental, humid, and temperate. The average annual precipitation, including snowfall, is 36.72 inches. The average frost-free season is 155 days. The mean temperature is about 50° F.

Agriculture had its beginning in 1830. At present it consists mainly of the growing of corn, wheat, oats, soybeans, alfalfa, clover, pasture

plants, and vegetables and the raising of livestock. A few farms specialize in truck crops, poultry raising, or dairying, but a system of general farming is practiced in most places.

The farm population, as reported by the 1940 census, is 8,228. Farms vary greatly in size, averaging 93.2 acres for each of the 1,967 reported.

For discussion, the soils are placed in three major groups, as follows: (1) Soils of the glacial moraines and till plains; (2) soils of the glaciofluvial outwash plains and terraces; and (3) soils of the stream bottoms and bogs. These major groups are, in turn, divided into subgroups on the basis of drainage. There is also mapped a group of miscellaneous land types. Both mineral and organic soils are mapped, but the mineral soils cover more than 85 percent of the area of the county.

The very rapidly drained soils of the glacial moraines and till plains are in the Coloma and Metea series, which are sandy, droughty, light-colored, and subject to erosion by wind and water when improperly managed. The well-drained soils of this group, comprising types and phases of the Miami, St. Clair, Hillsdale, and Bellefontaine series, are light-colored but are responsive to good management and produce all the common farm crops. A large part of the area of the imperfectly drained soils, which consist of members of the Crosby, Nappanee, and Aubbeenaubbee series, has been sufficiently drained for the production of crops. The poorly drained soils of this group, the Brookston, Clyde, and Washtenaw series, having a large content of organic matter and a high fertility, are potentially the most productive in the county and most areas have been drained sufficiently for cultivation.

The soils of the glaciofluvial outwash plains and terraces occupy smooth plains, terraces, or dunelike areas and overlie substrata of sand and gravel. The Plainfield, Fox, Oshtemo, and Mill Creek soils are very rapidly and rapidly drained, low in organic matter, light in color, and low in moisture-holding capacity, but the Fox and Mill Creek soils are fairly productive when properly managed. The imperfectly drained soils of this group, which are light-colored, generally low in organic matter, and have mottled subsoils, are members of the Berrien, Morocco, and Bronson series. The poorly drained Westland, Abington, Nyona, Lear, Brady, Gilford, Granby, Maumee, and Newton soils have dark surface soils with a high content of organic matter; with the exception of the Newton soils, which are very acid in reaction, all are suited to the production of corn when properly drained.

The soils of the stream bottoms and bogs occupy a small total area along the Tippecanoe River and the smaller streams and in depressions. Because of the danger of overflow, most of the alluvial land is in forest or permanent pasture. The well-drained alluvial soils are members of the Genesee and Ross series; the poorly drained alluvial soils are members of the Sloan and Griffin series; and drained areas of organic soils—Carlisle and Edwards mucks and Wallkill loam—produce good yields of crops.

Fulton County, in general, is characterized by good homes, good buildings, and modern farm equipment essential to the maintenance of agriculture as a successful industry. Its numerous lakes afford ample opportunities for fishing, swimming, and other recreational activities and attract a large number of visitors each year.

GENERAL NATURE OF THE COUNTY

Fulton County is in the north-central part of Indiana (fig. 1.). Its county seat, Rochester, is 90 miles north of Indianapolis, the State capital, 55 miles west of Fort Wayne, and about 100 miles southeast of Chicago. The area of the county is 367 square miles, or 234,880 acres.

The county is drained by the Tippecanoe River and its tributaries. This river enters the county along the northeastern boundary, follows a somewhat winding course, and leaves near the northwestern corner. It flows in a southwesterly direction until it reaches a point within 2

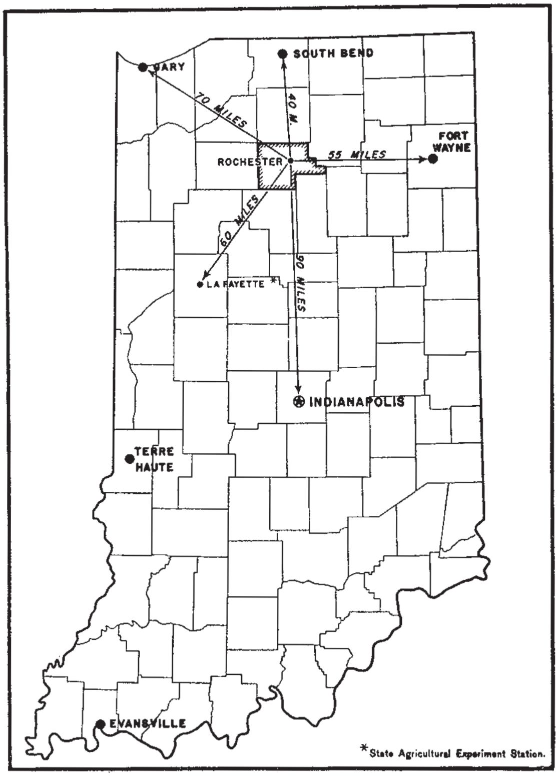

FIGURE 1.—Location of Fulton County in Indiana.

miles of Rochester and about 5 miles south of the northern boundary of the county, and then its course changes to a northwesterly direction. Along this river is a belt, or plain, of glaciofluvial material, consisting of sand, gravel, and silt, which was deposited by the waters flowing from melting glaciers. Much of this land is practically level, although a small area of rolling land borders the drainageways. The plain lies largely on the south side of the river and ranges in width from ½ to 5 miles, its greatest width being near the center of the county.

Abundant geological evidence indicates that Fulton County, along with most of the rest of Indiana, was covered more than once by great sheets of glacial ice comparable to those that now cover Greenland and

Antarctica. Tens of thousands of years ago the ice sheets are thought to have formed from the accumulated snows and to have spread in all directions from several centers in what is now Canada. The last ice sheet extended at least as far south as Richmond and Logansport, Ind. Apparently the southern limit of the extension of the ice at any one time was determined by the rate of melting at its outer edge in relation to the rate of its forward movement. During unusually warm seasons the ice front would retreat, and during colder seasons it would advance faster than it melted.

As the ice moved slowly over the surface of the land it destroyed all higher forms of life in its path and ground and pulverized the rocks beneath it. Some rocks were carried hundreds of miles on or in the ice, to be deposited far from their source when the ice melted. Many of the boulders in this county are completely unlike the bedrock beneath them; instead they resemble the bedrock several hundred miles to the north.

The pulverizing action of the ice ground many of the rocks into fine fragments that could be easily converted into soil by weathering processes and by the activities of plants and animals. In places where the rate of melting about equaled the rate of the forward movement of the ice, the glacial debris piled up to form more or less hilly moraines largely of unassorted materials. At times when the melting of the ice was much more rapid than its forward movement the load of ground-up rocks and minerals was dumped to form a thoroughly mixed mass of stone flour, clay, and pebbles. Where the original surface of the land was level or nearly so, the new surface was made undulating or billowy. A deposit of this sort is a kind of ground moraine or till plain. The unassorted material in the hilly moraines and ground moraines is known technically as glacial till.

During periods of warm weather the rapidly melting glaciers made great floods, which spread out over the lowlands, to form lakes and rivers. Many of the rivers were several miles wide near the front of the ice in summer seasons, but during the winters they diminished greatly or disappeared. The waters from the glaciers carried a large quantity of sediments ranging in size from the finest silt and clay to large cobblestones. The cobblestones and pebbles were deposited in swift water, the sands in more slowly moving water, and the silt and clays in the relatively quiet waters of lakes. Commonly associated with hilly moraines are kames, or hillocky deposits of imperfectly assorted water-laid gravel and sand. The stratified and assorted deposits laid down by more or less rapidly flowing glacial waters are known collectively as glaciofluvial deposits, and those laid down in lakes are known as lacustrine deposits.

All deposits made by both ice and water during glacial times are sometimes spoken of collectively as glacial drift—a term that includes glacial till and glaciofluvial, kame, and lacustrine deposits. Much of the glacial drift in Fulton County includes such a wide variety of minerals that the reserves of mineral plant nutrients are fairly high, but some of the deposits are so sandy that soils developed from them are droughty. A small part of the glacial till contains such a high proportion of heavy-textured clay that the soils developed from it are difficult to work and decidedly limited in their suitability for crops.

North of the Tippecanoe River, except in the extreme northwestern corner, and back half a mile or more from the river, is an area of rolling morainic hills with which are associated many kames, and much of the land is badly dissected and eroded. Farther north lies an area of smooth to gently rolling round moraine. The extreme northwestern part of the county is composed of glaciofluvial deposits that were partly reworked by the action of wind, probably very soon after deposition.

The southern part of the county consists of a smooth to gently undulating till plain. It includes a few moraines having a gently rolling relief and several small lakes and ponds.

Lake Manitou, covering about 1,000 acres, lies east of Rochester. It is fed and drained by East Mill Creek. A narrow belt of outwash materials and muck extends along this stream southeasterly to the southern county line. Glaciofluvial gravel, sand, and silt extend in a narrow belt east from Lake Manitou to Akron and the eastern county line. A narrow belt of glaciofluvial gravel, sand, and silt, similar in composition to the other areas of outwash, borders Mill Creek Ditch in the southwestern part of the county, Collins Ditch in the west-central part, and Yellow and Chippewanuck Creeks in the northeastern part.

An area of black Prairie-like soils occurs in the south-central part of the county between the outwash plains on the north and the till plain on the south. Here the underlying materials are gravel and coarse sand.

In the southeastern part of the county, in an area of rolling till plain and moraines, the soils have a somewhat heavier textured subsoil than elsewhere. Small lakes occupy many of the depressions between areas of the more rolling uplands.

There is an intimate association between the well-drained lighter colored soils and the poorly drained dark-colored soils.

Small bodies of alluvial soils occur along the Tippecanoe River and the larger streams of the county. Muck occurs throughout the county, and a large part of it is drained and cultivated.

Few of the streams have dissected the area noticeably, and large areas are artificially drained. About 600 miles of open artificial drainage ditches are maintained,[2] and most of them have their origin in bodies of muck.

Abundant water is everywhere available at a depth of 12 to 75 feet, and wells are the source of practically all water for home use. The presence of the numerous lakes and undrained muck areas indicates that the water table generally lies close to the surface.

There are about 20 lakes, all of which are well stocked with fish, and at the larger lakes numerous cottages and fishing facilities for summer visitors are maintained.

The highest elevation in the county is 900 feet above sea level, and the lowest is 715 feet, giving a maximum relief of 185 feet. The greatest difference in local relief is about 80 feet. The average altitude of the county is 760 feet, which is also the average for the State. The elevation at Rochester is 779 feet.

The first permanent white settlement in Fulton County was established near the shores of Manitou Lake in 1830. Other settlements were soon made around this lake and near the Tippecanoe River.

---

[2] Estimates given by county surveyor.

Most of the settlers came from Ohio, Pennsylvania, and other Eastern and Southeastern States.

At the time of settlement the county was inhabited by the Potawatomi Indians, and practically all of it was heavily forested except for some areas of muck and poorly drained soils. At present little if any virgin forest remains. The well-drained areas supported a growth of white, red, and black oaks, hickory, ash, black walnut, butternut, hackberry, sugar maple (hard maple), red and silver maple (soft maple), and elm. On some of the sandier types of soil an almost pure stand of oak was present. The poorly drained mineral soils supported growths of elm, tuliptree (poplar), swamp oak, maple, beech, basswood, and sycamore.

The vegetation on very wet areas differed widely, depending on the height of the water table, the extent of decomposition of organic matter, and on the content of mineral matter in the soil. The wetter areas, where the water table was at the surface or above it practically all of the year, had a growth of sedges, reeds, wildrice (*Zizania aquatica* L.), and waterlily (*Nymphaea tuberosa* (Paine) Greene). On the better drained muck areas tuliptree, chokeberry, tamarack, willow, sedges, and reeds were the principal vegetation, and aspen, elm, swamp oak, and ash grew around the edges. The scarcity of wood deposits in the muck areas indicates that the trees were somewhat scattered and that reeds, sedges, and other small shrubs provided the principal cover. At present the forested areas contain second-growth reproductions of the original tree species and an understory of papaw, wild rose, orchard grass, and Kentucky bluegrass (*Poa pratensis* L.). At present a large part of the better drained, uncultivated areas of muck support a growth of Kentucky bluegrass with varying stands of American and Canadian thistle.

Fulton County was organized on January 23, 1836, and Rochester was selected as the county seat. Settlement progressed rather rapidly in the well-drained areas, and by 1900 the population was 17,453, well distributed, with slight concentrations near the larger towns. Since then the population has declined slightly, and the 1940 census reported it as 15,577.

Rochester, with a population of 3,835 in 1940, is the largest town and an important center for agricultural products, containing a canning factory, a butter-manufacturing plant, and a grain elevator. Peas, sweet corn, cucumbers, tomatoes, and other vegetables are grown throughout the county on contract for the canning factory; dairy products are sold to the butter-processing plant, and corn, wheat, oats and other grains are sold to the elevator for cash.

Akron, which had 990 inhabitants in 1940, also has a canning factory and an elevator, which serve the eastern part of the county. Other trading points are Kewanna (population of 701), Fulton (373), Leiters Ford, Athens, Delong, Talma, Tiosa, Grasscreek, Disko, Lake Bruce, Pershing, and Bluegrass.

Transportation facilities are excellent. Five railroads, including the Erie, the Chesapeake & Ohio, the Pennsylvania, the New York, Chicago, & St. Louis (Nickel Plate), and the Winona (electric), serve practically all the towns and communities, furnishing an outlet for produce to the surrounding markets. A network of hard-surfaced highways—United States Highway No. 31 and 5 State highways—traverse the county. Practically all county roads are graveled and are passable at all times of the year. According to the 1940 census, 409 farms are on hard-surfaced roads; 1,469 are on roads improved by gravel, shale, shell, etc.; 19 are on improved dirt roads; and 7 are on unimproved dirt roads. A total of 2,000 automobiles are owned on 1,760 farms, and 224 motortrucks on 252 farms.

An excellent consolidated school system is maintained. Numerous churches serve the needs of various communities. Free mail-delivery service is available to all districts, rural telephones are common, and a large part of the county is served by electric power and gas. The 1940 census reports that 1,047 farms are served by telephone, and that of 1,492 farms within a quarter of a mile of electric distribution lines, 1,000 have dwellings lighted by electricity. An additional 65 farm homes are lighted by home plants.

The close proximity of Rochester to Lake Manitou provides the town with a large summer trade from visitors, and produce growers find a ready market for their products. Rochester is also the winter home of a large circus. A Federal fish hatchery just east of the town stocks the lakes and streams of the surrounding country. A tool factory at Akron furnishes employment to many people.

CLIMATE

The climate of Fulton County is continental, humid, and temperate. In winter cold waves sweep down from the west and northwest, and occasionally in summer there are hot periods, but these extremes of temperature are usually of short duration. Temperatures or climatic conditions do not vary greatly within the county, although the low, wet areas are more susceptible to frost than the well-drained uplands.

Rainfall is well distributed throughout the growing season and is usually sufficient for the growth and ripening of practically all crops common to the region. Long periods of drought are not common, and when they occur the effect is most noticeable on the sandier areas. Excessive rainfall in spring sometimes retards the planting of corn and oats and may affect the yields. The snowfall in winter varies widely in different years. In years of light snowfall, accompanied by alternate freezing and thawing, alfalfa, clover, and fall-sown grains may be seriously injured by heaving. Rainfall is usually gentle, and hailstorms are rare.

The average frost-free season is 155 days, from May 5 to October 7. The latest killing frost in spring occurred on May 26, and the earliest killing frost in fall was on September 16. The frost-free period usually allows ample time for the maturing of corn and other crops. Crops grown on the rolling, well-drained uplands, where air drainage is good, have the advantage of a somewhat longer growing season than those in the lower lying areas. Humidity is somewhat high and evaporation low.

A high wind velocity is seldom reached, and tornadoes are rare. Prevailing winds are southwesterly.

The normal monthly, seasonal, and annual temperature and precipitation as recorded at the United States Weather Bureau station near Rochester are given in table 1.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Rochester, Fulton County, Ind.*

[Elevation, 779 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1925)	Total for the wettest year (1905)	Average snowfall
	°*F.*	°*F.*	°*F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	28.9	61	−30	2.46	.068	2.44	7.6
January	25.6	68	−20	2.47	.65	1.84	7.4
February	27.0	70	−21	1.92	1.47	3.56	6.4
Winter	27.2	70	−30	6.85	2.80	7.84	21.4
March	37.6	79	−4	2.96	3.91	1.99	4.7
April	50.4	93	14	3.26	2.13	5.04	.9
May	60.8	96	24	3.90	.78	8.80	(1)
Spring	49.6	96	−4	10.12	6.82	15.83	5.6
June	69.8	103	37	3.88	3.23	4.65	0
July	74.4	104	41	3.30	1.93	4.57	0
August	71.6	102	39	3.44	2.05	5.01	0
Summer	71.9	104	37	10.62	7.21	14.23	0
September	65.4	102	29	3.68	4.44	4.24	0
October	53.7	90	14	2.68	2.34	3.99	.8
November	40.7	79	−3	2.77	3.68	4.11	2.3
Fall	53.3	102	−3	9.13	10.46	12.34	3.1
Year	50.5	[2] 104	[3] −30	36.72	27.29	50.24	30.1

[1] Trace. [2] July 1916. [3] December 1924.

AGRICULTURE

Agriculture in Fulton County had its beginning about 1830. The early pioneers cleared the land of trees and planted corn, wheat, and vegetables for home use. Settlements were made on the well-drained plains and uplands, parts of which had formerly been cultivated by the Potawatomi Indians. An abundance of wild game in the forests and of fish in the lakes and streams supplemented the home-grown products. Lumber and flour mills sprang up along East Mill Creek and the Tippecanoe River, adding to the income of the settlers as well as furnishing an outlet for their products.

The influx of settlers was steady until 1900. Most of the muck and low areas were undrained, and travel over them was difficult and often dangerous. As settlement increased, more of these areas were artificially drained and at present most of the land is available for cropping.

Gradually a more extensive system of agricultural crops developed, including corn, wheat, oats, rye, clover, and various vegetables. No great change in agricultural methods has taken place in the last 50 years, but to meet the need for soil-improving crops that has become more apparent in the last 5 years, the growing of soybeans, alfalfa, and sweetclover has been introduced. Power machinery has replaced horses on many of the farms, and 588 tractors were in use in 1940.

The acreage sown to wheat has decreased somewhat in recent years, and that of other principal crops has fluctuated from year to year with no decided trends. Table 2 gives the acreage and yield of the principal crops in Fulton County from 1879 to 1939.

TABLE 2.—*Acreage of principal crops and number of apple trees and grapevines in Fulton County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn, total	----------	----------	----------	----------	----------	52,694	48,040
Harvested for grain	28,977	30,881	49,493	48,406	46,382	47,778	46,576
Cut for silage	----------	----------	----------	21,953	----------	1,493	703
Cut for forage, hogged, or used for other purposes	----------	----------	----------	----------	18,694	3,423	761
Wheat, total	27,554	30,687	18,857	20,674	33,484	7,868	8,778
Oats threshed	4,697	10,577	7,707	21,953	18,441	22,423	9,343
Rye threshed	143	249	335	1,042	9,327	5,406	5,198
Hay, all	13,318	24,991	23,991	16,850	19,615	22,055	25,521
Alfalfa	----------	----------	47	20	436	3,318	9,301
Clover or timothy (alone or mixed)	----------	----------	[1] 11,045	15,824	18,229	16,095	8,186
Annual legumes	----------	----------	----------	----------	52	2,010	7,284
Small grains	----------	----------	1,176	104	559	109	546
Other tame hay	----------	----------	11,231	457	160	452	204
Wild hay	----------	----------	492	445	179	71	----------
Potatoes	----------	1,348	1,314	925	777	999	752
Market vegetables (except potatoes)	----------	----------	----------	----------	504	1,480	2,516
Soybeans grown alone	----------	----------	----------	----------	----------	1,710	12,078
Clover seed	----------	----------	----------	----------	----------	10,165	2,171
Alfalfa seed	----------	----------	----------	----------	----------	32	134
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Apples, trees	----------	[2] 53,772	[3] 71,694	65,078	37,404	[4] 22,821	[5] 12,994
Grapes, vines	----------	----------	[3] 31,923	5,324	5,828	[4] 3,437	[5] 7,251

[1] Clover alone.
[2] Trees are for the year 1890.
[3] Trees and vines are for the year 1900.
[4] Trees and vines are for the year 1930.
[5] Trees and vines are for the year 1940.

Cornland is plowed either in fall or early in spring, depending on weather conditions and type of soil. Fall plowing encourages erosion, especially on the more rolling land, and the greater part of cornland is left for spring plowing. The ground is thoroughly disked and smoothed with either a harrow or a cultipacker before planting. Most of the farmers use mechanical equipment for plowing and preparing the seedbed. Many of them have their own variety of corn, selected over a period of years, but since 1935 they have used a large quantity of hybrid seed. Methods of harvesting vary with the individual farm requirements. The corn may be cut and shocked in the field, cut for silage, husked in the field, or hogged off. A large part of the corn grown is fed on the farm, but some is marketed for cash at local elevators. In 1939, 2,230,887 bushels of corn was harvested from 46,576 acres, 7,158 tons of silage was cut from 703 acres, and 761 acres of cornland was hogged off, grazed, or cut for fodder.

Oats usually follow corn, wheat, or beans. The land is thoroughly disked or plowed in the spring, and seeding takes place in April or early in May. An unusually wet spring retards planting somewhat, and reduced yields may result. Some oats are cut for hay, but the greater part is harvested for grain. Part of the threshed grain is fed on the farm, the remainder being sold to elevators nearby. In 1939, 213,308 bushels of oats were threshed from 9,343 acres, and oats on 153 acres were cut and fed unthreshed.

Wheat may follow either corn, beans, oats, or vegetables. It is planted in September, usually after the "fly-free" date (the date on which the hessian fly ceases to be a danger) as given by the Purdue University Agricultural Experiment Station. When wheat follows corn it may be sown between the rows or after cutting for silage. A seedbed may be prepared by plowing and disking. If wheat follows oats, beans, or vegetables, the land is plowed and disked and allowed to settle somewhat. Practically all the wheat sown is harvested for grain, and winter wheat is one of the more important cash crops. Very little spring wheat is grown. In 1939, 8,613 acres of winter wheat yielded 166,166 bushels of grain and 165 acres of spring wheat yielded 3,555 bushels of grain.

Soybeans are increasing in popularity both as a hay crop and for seed. They are sown in May or June in a thoroughly prepared seedbed, and for seeding land on which wheat or clover is winterkilled. The acreage varies from year to year, depending on individual needs for the hay and current market price of the beans. Of the 12,078 acres of soybeans grown alone in 1939, 4,454 acres harvested for beans yielded 55,979 bushels.

Clover and timothy are generally seeded with oats in spring in fields of wheat or rye, but some are seeded alone or with wheat or rye early in fall. The seedbed is carefully prepared. Most farmers, especially those on the more acid soils, realize the importance of liming for the successful growth of clover and alfalfa, and few attempt to grow them without first applying some form of lime. Most of the clover is grown on the heavier textured soils. The kinds most commonly grown are the true clovers—common red clover, mammoth clover, and alsike clover—and sweetclover. Sweetclover is usually grown for soil improvement, whereas the true clovers are used for pasture and hay as well as for soil improvement. Timothy and clover, alone or mixed, yielded 7,806 tons of hay from 8,186 acres and sweetclover 88 tons from 64 acres in 1939.

Clover seed is also an important crop, though not so important now as formerly. In 1939, 2,136 bushels was harvested from 2,171 acres. In addition 88 bushels of alfalfa seed was produced on 134 acres, 233 bushels of sweetclover seed on 214 acres, and 131 bushels of grass seed on 101 acres.

A large acreage is planted to alfalfa. This crop is grown for hay and pasture throughout the county, on the sandier soils to the exclusion of clover. Liming is essential for the successful growing of alfalfa on most of the soils. Good stands are allowed to remain for several years, or until the alfalfa is winterkilled or the land taken over by Kentucky bluegrass. The yield varies with the type of soil and with weather conditions.

The production of vegetables for sale, especially sweet corn, has increased rapidly in recent years, owing in part to the increasing number of visitors to the various lake resorts. Growers are also finding it profitable to plant a larger acreage to sweet corn, cucumbers, peas, and tomatoes for the canning factories at Rochester and Akron, and at Peru, Monterey, and other points outside the county. In 1919, 503 acres were planted to vegetables; in 1929, 1,480 acres; and in 1939, 2,516 acres. The total value in 1939 was $68,972. Of the total value, 2,008 acres of sweet corn represented $32,031, 46 acres of dry onions $10,469, 57 acres of celery $11,250, 169 acres of cucumbers $5,115, 58 acres of tomatoes $3,046, 109 acres of peas $3,035, and 69 acres of other vegetables $4,026.

Rye, barley, and millet are produced on a few farms, but they are not important crops.

The raising of livestock in Fulton County has increased in recent years and at present is an important source of farm income. Table 3 gives the number and value of livestock on farms on April 1, 1940.

TABLE 3.—*Number and value of livestock on farms in Fulton County, Ind., on Apr. 1, 1940*

Livestock	Number	Value	Livestock	Number	Value
Horses	[1] 4,593	$328,833	Goats	[2] 82	$369
Mules	[1] 256	19,456	Chickens	[2] 169,800	106,974
Cattle	[1] 21,937	924,196	Other poultry [4]	1,627	1,741
Swine	[2] 28,733	244,388	Bees (hives)	209	710
Sheep	[3] 7,976	48,097			

[1] Over 3 months of age.
[2] Over 4 months of age.
[3] Over 6 months of age.
[4] Includes turkeys, ducks, geese, and guinea fowl.

The number of cattle over 3 months of age on farms on April 1, 1940, was 21,937, an increase of about one-third over the number reported in 1930. The present trend toward soil conservation practices is increasing the acreage in permanent and semipermanent pasture, thus encouraging the feeding of a greater number of cattle. Hereford and Shorthorn are the most common breeds. Some are raised on the farm, but most of them are purchased when young from Chicago, Indianapolis, and other markets. Some are allowed to graze during summer and fall and are marketed, but most are finished with corn, commercial feeds, or other grains and hay. The latter command the higher price and are marketed at Indianapolis, Chicago, or other nearby markets. In 1939, 4,484 cattle and 1,007 calves were purchased. During the same year 6,246 cattle and 4,211 calves were sold alive and 299 cattle and 138 calves were butchered.

Dairy products are largely sold as fluid sweet milk or cream. Motortrucks call at the farms daily for these products, marketing them at Rochester, Peru, Chicago, and other markets. Practically all the milk consumed in the county is produced by specialized dairies. Most of the farms have one or more cows, and several have small dairies of 10 to 20 head. Good grade Jersey, Holstein-Friesian, Guernsey, and a mixture of these are popular. The number of cows milked has risen from 8,586, producing 4,550,314 gallons, in 1929, to 10,158, producing 5,570,261 gallons, in 1939. About half the milk produced in 1939—2,611,714 gallons—was sold as fluid milk; in addition 746,371 pounds of butterfat was sold.

The production of poultry and poultry products, especially chickens and eggs, showed a decided increase from 1919 to 1929, followed by a slight decrease in 1939. Because of the activities of a strong cooperative association at Mentone, in Kosciusko County, poultry and egg production has become important. Eggs are shipped to the eastern markets in carload lots by the association at an increase of 2 to 4 cents a dozen over local prices. There were 169,800 chickens over 4 months old in the county on April 1, 1940. In 1939, 1,307,673 dozen eggs were produced and 325,382 chickens raised. Only 928 turkeys were on hand on January 1, 1935.

The number of swine has increased considerably in recent years. On April 1, 1940, there were 28,733 head over 4 months of age, as compared with 19,693 more than 3 months old on April 1, 1930. A few hogs are raised on almost every farm, but larger numbers on the farms that are better adapted to the production of corn. Poland China, Duroc-Jersey, and Hampshire are the most common breeds. In years of high yields of corn, hogs are allowed to reach a large size before marketing. Practically all are shipped by motortruck to Indianapolis, Chicago, or other markets. In 1939, 7,499 hogs and pigs were bought by farmers, 3,802 were butchered, and 49,787 were sold alive.

A number of farms keep a few sheep each, but large flocks are uncommon. Shropshire is the most popular breed. On April 1, 1940, sheep over 6 months of age numbered 7,976.

The relative importance of the several sources of farm income can be gaged from table 4, which gives the value of products sold, traded. or used by farm households in 1929 and in 1939.

TABLE 4.—*Value of farm products sold, traded, or used by farm households in Fulton County, Ind., in 1929 and 1939*

Product	1929	1939
Crops sold or traded	$783,117	$593,901
Field crops sold or traded	(1)	502,291
Vegetables harvested for sale	(1)	67,475
Fruits and nuts sold or traded	(1)	16,001
Horticultural specialties sold	(1)	8,134
Forest products sold	30,174	2,938
Livestock sold or traded	1,259,844	1,036,292
Livestock products sold or traded	1,148,777	818,564
Dairy products	(1)	528,986
Poultry and poultry products	(1)	275,393
Other livestock products	(1)	14,185
Farm products used by farm households	449,426	395,806
Total products sold, traded, or used by farm households	3,671,338	2,847,501

1 Not reported.

As reported by the census, farmers spent $69,484 on 1,026 farms for commercial fertilizer in 1939, and $8,705 on 265 farms for liming materials. The total of these amounts is greater than the total for 1929, which was $74,112. The use of limestone and marl has increased greatly in recent years.

The amount paid for farm labor in 1939 was $137,821, an average of $252.42 for each of the 546 farms reporting. This almost equaled the expenditure reported for 1929, which was $141,960. For farm implements and machinery in 1939, a total of $208,510 was paid on 571 farms; and for gasoline, distillate, kerosene, and oil $106,715 on 1,121 farms.

Feed is another important farm expense, costing the farmer $261,438, or an average of $183.72 for each of the 1,423 farms reporting purchases in 1939.

The degree of farm improvement is reflected to some extent in the amount spent for building materials, which was $117,990 in 1939, or an average of $152.64 for each of the 773 farms reporting.

No general system of crop rotation is practiced in Fulton County, but in general, corn, soybeans, wheat or oats, and clover follow one another. The type of soil generally determines the crops grown. Muck may be planted to corn for several years in succession, but on the sandier soils corn may be grown only once in 4 or 5 years.

There were 8,228 persons living on farms in 1940, as compared with 8,085 in 1930, an increase of 1.8 percent. Of the former number 5 were Negroes. The proportion of tenancy is not large—29.9 percent in 1940.

The 1940 census reports 1,967 farms, a decrease in number since 1930, when 2,010 were reported. During this period the average size also decreased, from 110 acres to 93.2 acres. The size of farms varies greatly. In 1940 the largest number, 1,338, or about 67 percent, were between 30 and 179 acres, 16 percent less than 30 acres, and 17 percent more than 180 acres. Nine farms contained between 500 and 699 acres, five between 700 and 999 acres, and one more than 1,000 acres.

The total area of land in farms decreased from 221,063 acres in 1930 to 218,919 in 1940, or from 94.1 to 93.2 percent of the total area of the county. In 1939, crops were harvested from 106,670 acres, on 2,269 acres they were a failure and 11,276 acres were idle, a total of 120,215 acres of cropland. This, together with 55,768 acres of plowable pasture, represents 175,983 acres of improved land, or 80.3 percent of the land in farms. Other land in farms includes 14,738 acres of woodland and 28.198 acres unclassified.

The average value of land and buildings, according to the 1940 census, was $6,066 a farm and $54.50 an acre. This represents a decrease from the values of $7,263 a farm and $66.04 an acre reported in 1930 and a decided decrease from the $12,375 and $124.49, respectively, in 1920. Land values vary greatly within the county, depending on quality of soil, improvements, and location.

The problems and difficulties of farm management in Fulton County are similar to those in the adjacent counties having similar soil types. Because of the great diversity of the soils within the county, the methods of management and practices of crop rotation necessarily vary greatly.

Lime has been leached to a depth of more than 4 feet in practically all the sandy soils and to a depth of 2 feet or more in the heavier textured soils. Owing to the lack of a well-planned soil conservation program in the past, much organic matter and plant nutrients have been lost and on the more rolling land erosion has become severe.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their 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 exposures, such as those in road and railroad cuts, are studied. Each excavation exposes a series of layers, or horizons, called collectively the soil profile. Each horizon of the soil, 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 [3] and its content of lime are de-

[3] 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 indicate alkalinity, and lower values acidity. Indicator solutions are used to determine the reaction of the soil. The presence of lime is detected by the use of a dilute solution of hydrochloric acid.

termined by simple tests. The drainage, both internal and external, and the relief, or lay of the land, and other external features, are taken into consideration, and the interrelation of soils 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 growing of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the three principal of which are (1) series, (2) type, and (3) phase. Areas of land, as marshes or excavations, that have no true soil are called (4) miscellaneous land types.

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 conditions, 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. Miami, Fox, Oshtemo, and Brookston are names of important soil series in Fulton county.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. The class name of this texture, as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Miami loam and Miami fine sandy loam are soil types within the Miami 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 soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from the type in some minor feature, that may be of special practical significance. Differences in relief, stoniness, and degree of accelerated erosion may be shown as phases. For example, within the normal range of relief for a type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Even though there may be no important differences 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 an instance the more sloping parts of the soil type may be segregated on the map as a sloping or hilly 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.

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

Aerial photographs are used as a base for mapping soils in Indiana. The pictures are taken from an airplane flying at a height of about 13,500 feet, and each picture covers about 4½ square miles. 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 the 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 colored map was produced.

SOILS

The soils of Fulton County include a wide range of color, texture, consistence, slope, moisture conditions, fertility, and degree of erosion. These characteristics have important effects on productivity, and in many places one or more of them are limiting factors in agricultural use. Soil types, embodying different combinations of the above-mentioned factors, are closely associated, and one field unit may include a wide range of soil conditions. This fact makes it almost impossible to apply individual systems of crop rotation, fertilization, and improvement to the individual soils; therefore more general methods of management are used.

The soils range in texture from silty clay loam to loose sand. Natural drainage ranges from excessive to very poor. Colors range from light gray in the imperfectly drained soils of the uplands to nearly black in the organic soils. In consistence the range is from tenacious, or sticky clayey, soils to loose incoherent sands. The well-drained soils vary in degree of slope, the more important differences being shown as phases on the soil map.

In general, the tilth is good. The sandy soils are more easily handled and in general are somewhat earlier in spring than the heavier textured, more clayey soils having similar drainage conditions; but the sands are subject to drought and as a whole are less productive.

Water erosion is more or less severe on the rolling areas, especially where clean cultivation has been practiced. Eroded and gullied phases are indicated on the map for areas in which sheet and gully erosion have been severe. Wind erosion is severe on the lighter textured, well-drained soils, especially in areas that have been clean cultivated for several years in succession.

The soils have developed for the most part under a forest vegetation, and the content of organic matter is low except in poorly drained depressions. Swampy and marshy soils and small areas that had an original cover of grassy vegetation have a moderately high content of organic matter.

The system of agriculture practiced in Fulton County is typical of that prevailing throughout the region. In general, crops adapted to particular soils have been grown, and a large part of the more productive soils has been used for the soil-depleting crops. A few farms specialize in vegetables, but for the most part a mixed system of farming is practiced that includes the production of crops for the support of livestock.

Artificial drainage has been developed in most areas of the county and has lowered the ground-water table. A network of open drainage ditches connecting numerous tile-drain branches is in operation.

Most of the soils occur in small irregular areas and in close association, especially those on the uplands developed from glacial till. The accompanying soil map shows the distribution of the 63 soil types, 32 phases of soil types, and 2 miscellaneous land types. The acreage and proportionate extent of the various soils of the county are given in table 5.

TABLE 5.—*Acreage and proportionate extent of soils mapped in Fulton County, Ind.*

Type of soil	Acres	Percent
Coloma loamy fine sand	9,152	3.8
Eroded slope phase	128	.1
Slope phase	704	.3
Metea loamy fine sand	7,424	3.2
Eroded slope phase	896	.4
Gullied slope phase	192	.1
Slope phase	64	(1)
Metea fine sandy loam	2,944	1.5
Miami loam	24,768	10.2
Eroded slope phase	5,056	2.3
Gullied slope phase	640	.3
Slope phase	1,280	.5
Miami fine sandy loam	16,320	6.9
Eroded slope phase	2,560	1.1
Gullied slope phase	576	.2
Slope phase	448	.2
St. Clair loam	2,112	.9
Eroded slope phase	1,280	.5
Gullied slope phase	192	.1
Slope phase	128	.1
Hillsdale loam	640	.3
Depression phase	64	(1)
Hillsdale fine sandy loam	128	.1
Hillsdale loamy fine sand	256	.1
Bellefontaine loam	704	.3
Eroded hilly phase	576	.2
Gullied hilly phase	64	(1)
Bellefontaine fine sandy loam	1,600	.7
Eroded hilly phase	832	.4
Gullied hilly phase	192	.1
Hilly phase	128	.1
Crosby loam	14,784	6.2
Crosby fine sandy loam	8,896	3.8
Nappanee loam	192	.1
Aubbeenaubbee fine sandy loam	1,024	.4
Aubbeenaubbee loamy fine sand	704	.3
Brookston silt loam	16,512	7.0
Brookston loam	14,272	6.1
Clyde silt loam	1,024	.4
Clyde loam	640	.3
Clyde silty clay loam	192	.1
Washtenaw silt loam	1,664	.7
Washtenaw loam	384	.2
Plainfield loamy fine sand	7,808	3.3
Eroded slope phase	64	(1)
Slope phase	1,600	.7
Fox fine sandy loam	8,512	3.6
Eroded slope phase	960	.4
Slope phase	192	.1
Fox loam	3,200	1.4
Oshtemo fine sandy loam	3,840	1.6
Eroded slope phase	256	.1
Slope phase	320	.1
Oshtemo loamy fine sand	3,520	1.5
Mill Creek fine sandy loam	640	.3
Eroded slope phase	64	(1)
Slope phase	64	(1)
Berrien loamy fine sand	4,160	1.8
Allendale loamy fine sand	960	.4
Bronson fine sandy loam	2,240	1.0
Bronson loam	512	.2
Westland silt loam	2,432	1.0
Westland loam	1,600	.7
Abington silt loam	576	.2
Abington loam	256	.1
Nyona silt loam	1,472	.6
Lear silt loam	640	.3
Lear loam	128	.1
Brady fine sandy loam	832	.4
Brady loam	1,408	.6
Gilford fine sandy loam	192	.1
Gilford loam	128	.1
Granby fine sandy loam	2,880	1.2
Granby loam	960	.4
Granby loamy fine sand	3,904	1.7
Maumee fine sandy loam	1,536	.7
Ferruginous phase	128	.1
Maumee loam	1,408	.6
Maumee loamy fine sand	3,136	1.3
Newton loamy fine sand	320	.1
Newton fine sandy loam	192	.1
Genesee loam	576	.2
Genesee fine sandy loam	128	.1
Ross loam	128	.1
Ross loamy fine sand	256	.1
Sloan loam	768	.3
Griffin fine sandy loam	768	.3
Griffin loamy fine sand	64	(1)
Carlisle muck, drained phase	15,360	6.5
Carlisle muck	6,656	2.8
Shallow phase over sand	2,752	1.2
Edwards muck, drained phase	512	.2
Edwards muck	256	.1
Wallkill loam	960	.4
Marsh	192	.1
Pits	128	.1
Total	234,880	100.0

1 Less than 0.1 percent.

For convenience in discussion, the soils are described under the following main heads: (1) Soils of the glacial moraines and till plains; (2) soils of the glaciofluvial outwash plains and terraces; (3) soils of the stream bottoms and bogs; and (4) miscellaneous land types.

SOILS OF THE GLACIAL MORAINES AND TILL PLAINS

The soils of the glacial moraines and till plains are subdivided on the basis of natural drainage into very rapidly drained soils, well-drained soils, imperfectly drained soils, and poorly drained soils.

VERY RAPIDLY DRAINED SOILS

Included in the subgroup of very rapidly drained soils are the various members of the Coloma and Metea series. These are relatively light colored, have a low content of organic matter, and for the most part occupy a relief that makes them subject to water and wind erosion. The predominant texture is loamy fine sand, a small total area consisting of fine sandy loam. These soils require careful management and constant replenishment of plant nutrients and organic matter to maintain a satisfactory level of productivity. Owing to the porosity of the material, plant nutrients are quickly leached away, and continued cropping to clean-cultivated crops favors erosion.

Because of the requirements of rotation and because of economic factors, practically all the general farm crops are grown on the soils of this group.

Coloma loamy fine sand.—This soil consists of sandy material to a depth of 4 feet or more. The relief is generally rolling and in some places is distinctly dunelike. Internal movement of air and water is free, and internal drainage is excessive.

The surface soil is light yellowish-brown loamy fine sand containing a small quantity of silt and clay, which give the material a very slight degree of coherence when moist. The reaction is medium acid. Only enough organic matter is present to stain the material to a depth of 2 to 4 inches. In cultivated areas the organic matter is mixed with the lighter colored material below, making the plow soil slightly dark to a depth of about 8 inches. Below this the subsoil is brownish-yellow fine sand containing streaks of deep-yellow loamy sand. Some stones occur both on and below the surface but nowhere extensively enough to interfere seriously with cultivation. Roots penetrate with ease to a greater depth in this soil than in the heavier, clayey soils.

This soil is associated with Metea, Miami, and other soils of the uplands and for the most part is on a higher level than the surrounding areas. A few dunelike areas adjoin the lakes and muck areas within the glacial till plain.

The accumulation of the sands probably was brought about partly by glacial action and partly by wind.

Because of its occurrence in irregular-sized and irregular-shaped areas, in association with heavier soils, Coloma loamy fine sand in many places is used for corn, wheat, and other crops that are economically unprofitable on it. When the soil is properly limed, alfalfa produces fair yields and tends to prevent damage from erosion, but there are a few blow-outs here and there, where the roots of plants are exposed. Under present economic conditions Coloma loamy fine sand is best suited for alfalfa, pasture, and forest.

Coloma loamy fine sand, slope phase.—This phase includes areas of this soil type where the gradient is more than 15 percent; but erosion is not serious. Most of the land is used for forest or pasture.

When the soil of this phase is cultivated, accelerated erosion begins immediately. Agriculturally this phase is unimportant, and crop yields are very low.

Coloma loamy fine sand, eroded slope phase.—On sloping areas of Coloma loamy fine sand, where the soil has been cultivated for a number of years, a large part or all of the surface soil has been removed and blow-outs are common. First cultivation removed the organic material, which helped to hold the sand particles together; and then wind and water erosion removed the surface soil and in some areas a part of the subsoil. About 70 percent of the area is planted to general farm crops, but yields are much lower than on the normal phase. The rest of the land is used for pasture or is covered by brush.

Metea loamy fine sand.—Areas of this soil are closely associated with areas of the Coloma and Miami soils throughout the glacial till uplands except in the eastern part of the county, and boundaries between these soils are not accurately drawn everywhere. The relief is gently to strongly rolling, and drainage is good to excessive.

The surface soil is light yellowish-brown loamy fine sand with enough organic matter to make the mass very slightly coherent. The surface soil is so like that of Coloma loamy fine sand that the two cannot be distinguished by surface appearance alone. The reaction is medium acid. Below the surface soil to a depth of 22 to 30 inches, the material consists of grayish-yellow loose incoherent fine sand containing a few pockets or bands of brownish-yellow loamy fine sand. This overlies yellow and gray sandy clay loam or sandy loam that is only slightly acid in reaction. Calcareous glacial till occurs at a depth of about 50 inches.

This soil is more productive than Coloma loamy fine sand, because of the presence of the heavier textured material in the subsoil and substratum. In years of normal rainfall corn yields 15 to 35 bushels an acre, but when droughts occur the yields are materially reduced. Yields of small grains are comparatively low. Clover does not grow well because of the loose sandy nature of surface soil and upper subsoil, but fair stands of alfalfa are obtained after applications of lime. The soil is low in plant nutrients but responds well to fertilizers. Liberal applications of stable manure and the plowing under of green-manure crops help to maintain fertility. The growing of soil-depleting crops should be discouraged, and the growing of alfalfa, pasture plants, and forests should be encouraged.

Metea loamy fine sand, slope phase.—This phase includes areas of this soil type having a slope of 15 percent or more. The profile is similar in the two except that the several layers are somewhat thinner in this phase. Very little of it is under cultivation, and it is relatively unimportant agriculturally, as most of it is used for forest and pasture.

Metea loamy fine sand, eroded slope phase.—Where intensively cultivated or where a cover crop has not been maintained on the sloping areas of Metea loamy fine sand, a large part or all of the surface soil has been lost through accelerated erosion. Thus, much of the natural supply of plant nutrients has been lost and the productivity lowered. Some of the soil included in this phase occurs where the gradient is less than 15 percent. At present about 60 percent of this phase is under cultivation, but the crop yields are relatively low.

Metea loamy fine sand, gullied slope phase.—This phase includes areas of this soil type occupying slopes of more than 15-percent gradient where relatively deep gullies have developed in areas. In many cases the gullies extend downward into the heavier textured glacial till. These areas are practically useless agriculturally and should be in permanent pasture or in forest. At present the larger part of the land is second-grade pasture or is idle.

Metea fine sandy loam.—The surface is light yellowish-brown fine sandy loam, 8 to 10 inches deep. The subsoil and substratum are practically identical with the corresponding layers of Metea loamy fine sand.

This soil is mapped in association with Coloma and Miami soils in the southern part of Aubbeenaubbee Township and in scattered areas in Wayne, Liberty, and Union Townships. Because of its close association with other well-drained soils of the uplands, its treatment is very similar to that given to Miami fine sandy loam and other associated soils. A larger part is cropped than on Metea loamy fine sand, and yields are higher.

WELL-DRAINED SOILS

The naturally well-drained soils of glacial moraines and till plains are dominantly loam and fine sandy loam in texture. These soils are comparatively light colored, are low in organic matter, and have a relief that subjects them to erosion when clean cultivated. Runoff and percolation are medium to rapid.

Good soil-conserving practices are required to maintain satisfactory productivity and to check loss of valuable plant nutrients by erosion. The soils respond well to fertilizers and manures, and under good management they may be expected to produce fair to good crop yields except on the slope and eroded phases. The lighter textured soils are subject to drought and do not produce as high yields of most crops as do the heavier textured types. All the common farm crops are grown, and because these soils occur in irregular-sized, irregular-shaped, closely associated areas, agricultural practices are similar on various members of the group. As mapped, many areas of one soil include small areas of other or closely associated similar soils.

Members of the Miami, St. Clair, Hillsdale, and Bellefontaine series are developed on the well-drained glacial moraines and till plains.

Miami loam.—Bodies of this soil are generally small and irregular in shape and are mapped in all areas of glacial till except those in the eastern part of the county. The relief is undulating to rolling, and the drainage is good.

In cultivated areas the surface soil is light yellowish-brown friable loam, much darker when wet. The content of organic matter is low, but it is probably a little higher than in the other well-drained soils. Tilth is excellent, and aeration and internal drainage are good. The reaction is slightly acid. Below a depth of 8 inches the subsoil is composed of a mixture of sand, silt, and clay, the proportion of sand varying greatly and the texture ranging from sandy clay loam to clay loam. The material is yellowish brown when moist and is somewhat lighter when dry. When moist it breaks into small nut-shaped aggregates, which become hard on drying. Below a depth of 30 to 50 inches is the calcareous glacial till.

Practically all general farm crops are grown on this soil, and under careful management the yields are good. Constant additions of organic material and plant nutrients are necessary to maintain fertility. The presence of a moderately heavy but permeable subsoil prevents serious injury from drought. When the soil has received good treatment corn may be expected to produce 30 to 50 bushels an acre. It is excellent for growing wheat and rye. Because of good drainage conditions, injury from heaving is not severe, and the yields of 15 to 25 bushels of these crops may be expected in normal years under good management. Soybeans are included in the rotation system and yield 10 to 20 bushels. Less than 30 percent of this crop is grown for seed, the rest is used as hay.

Clover grows better on Miami loam than on the sandier very rapidly drained soils. A large part of the crop is from this soil, and if lime is applied, no great difficulty is experienced in obtaining good stands. Alfalfa also produces well when the soil is properly limed.

Miami loam, slope phase.—Areas of this soil type having a gradient of 15 percent or more are separated as a slope phase. The profile is similar to that of Miami loam, except that each of the several layers is thinner. This phase occurs principally along drainageways and is largely in forest and pasture. Under cultivation, loss of the original surface soil is rapid and crop yields are low.

Miami loam, eroded slope phase.—Cultivated areas of Miami loam, slope phase, that in many places have lost much or all of the original surface soil by erosion are mapped as an eroded slope phase. The loss of so much of the surface soil has resulted in the loss of plant nutrients, which greatly decreases productivity. Careful management, including liberal use of soil-amendment crops, will help to arrest this erosion. Probably 50 percent of the land is cultivated, and the rest is largely in permanent pasture.

Miami loam, gullied slope phase.—This phase includes areas of Miami loam that have a gradient of 15 percent or more. They have been cultivated extensively over so long a period that numerous gullies have formed. Practically all the gullies are too large to be crossed by heavy farm machinery, and the soil in its present condition is practically worthless agriculturally. Most of it is used for pasture or forest.

Miami fine sandy loam.—In cultivated fields this soil is light yellowish-brown loose fine sandy loam having a somewhat lower organic matter content than Miami loam. The reaction is slightly acid. The subsoil is similar in color to that of Miami loam but is lighter in texture. Calcareous glacial till lies at an average depth of 42 inches.

This soil occurs in all but the eastern part of the glacial till plain and is closely associated with Miami loam and the Metea soils. The transition between these soils and Miami fine sandy loam is very gradual and areas mapped as Miami fine sandy loam may include small areas of Miami loam and Metea fine sandy loam.

Rotation systems similar to those followed on Miami loam are practiced on this soil, but yields are somewhat lower. The sandy texture of the surface soil subjects crops to injury from drought. The soil responds well to fertilizers and manure and to maintain a good level of productivity requires a rotation system that includes a large proportion of soil-amendment crops.

Miami fine sandy loam, slope phase.—Areas of this soil type having a gradient of over 15 percent are separated as a slope phase. The profile is similar to that of the normal phase, except that the several layers are somewhat thinner. Practically all the areas are in permanent pasture or in forest. When cultivated for a few years, much of the surface soil may be lost through accelerated erosion.

Miami fine sandy loam, eroded slope phase.—Cultivated sloping areas of Miami fine sandy loam on which erosion is active but has not reached the gully stage are mapped as an eroded slope phase. Erosion has removed a large part or all of the surface soil, resulting in the loss of plant nutrients and greatly decreasing crop yields. As on the eroded slope phase of Miami loam, the growing of soil-conserving crops is necessary to arrest erosion.

Miami fine sandy loam, gullied slope phase.—This phase is mapped where numerous gullies have formed on sloping areas of the soil type. Many of the gullies extend into the subsoil, and the intergully areas have undergone severe sheet erosion, making this soil practically useless for the production of cultivated crops. At present, it is largely used for pasture or left idle, having a cover of weeds and a thin stand of bluegrass.

St. Clair loam.—In cultivated fields, the surface soil to a depth of 8 inches is light yellowish-brown friable loam having a slightly acid to medium acid reaction and an organic-matter content similar to that of Miami loam. The subsoil of brownish-yellow heavy clay loam breaks into large irregular-shaped aggregates. When wet, it is sticky; when dry, it becomes hard. Gray and yellow calcareous heavy clay glacial till lies below a depth of 24 to 30 inches. The chief difference between this soil and Miami loam is the extremely heavy texture of the subsoil and the occurrence of lime at a shallow depth. The heavy-textured subsoil tends to prevent rapid absorption of water, increasing the rate of surface runoff over that of Miami loam and induces somewhat greater erosion.

This soil is mapped in the southeastern part of the county, in Henry Township, where the underlying glacial till is of heavier texture than elsewhere. The relief is rolling, and surface drainage is good to excessive.

About the same crops are grown on this soil as on Miami loam, and about the same yields are obtained but a somewhat larger proportion of the more rolling areas is in pasture.

St. Clair loam, slope phase.—This phase includes areas of this soil type having a gradient of over 15 percent. The profile is similar to that of St. Clair loam except that the several layers are somewhat thinner. Very little of the land is under cultivation, and, when it is cropped the yields are low. Most of it is in pasture or forests. It is very susceptible to erosion, and if it is not carefully handled, gullies soon develop.

St. Clair loam, eroded slope phase.—Sloping areas of this soil type that have been under cultivation for a number of years and have lost a large part of the surface soil are separated as an eroded slope phase Yields of crops are relatively low. Careful management, including the growing of clover, alfalfa, and bluegrass pasture, is required to prevent further loss. Clean-cultivated crops should not be grown.

St. Clair loam, gullied slope phase.—This phase is mapped where sloping areas of this soil type have been so cultivated, without attention to control of erosion, that gullies have developed. Many of these extend into the subsoil, making the areas practically worthless for agriculture. This land is largely in poor-grade pasture or remains idle.

Hillsdale loam.—One square mile of this soil is mapped along the northern county line in north-central Richland Township and northeast of Kewanna. The relief is gently undulating to gently rolling. The surface soil is light yellowish-brown friable loam, about 10 inches deep. Small pebbles are scattered on the surface, but not enough to interfere with cultivation. The content of organic matter is similar to that in Miami loam. The reaction is slightly acid. The subsoil is yellowish-brown friable loam or sandy loam, containing pockets of sand. In places the deeper material is pale-brown or mottled yellow, gray, and brown sandy loam to light silty clay loam. Brown, gray, and yellow mottled calcareous sandy clay lies at an average depth of about 80 inches.

Hillsdale loam differs from Miami loam in having a gentler relief, in being twice as deep to lime, and in having phases of Hillsdale instead of Brookston or Clyde soils in the associated depressions.

Agriculturally this soil is about equal to Miami loam, and similar crops are grown on the two. Tilth is excellent, and drainage good. Erosion is not severe, as the soil is porous and the relief gentle. In periods of dry weather, crops grown on the more sandy parts may suffer somewhat from drought.

Hillsdale loam, depression phase.—This soil has a darker colored and slightly heavier surface soil than the normal phase, and the organic-matter content is higher and moisture conditions are better. The subsoils of the two are similar. A small total area of this phase is mapped in depressions associated with Hillsdale loam. Yields of crops are slightly higher than on the normal phase.

As mapped, this soil includes a variation that consists of dark brownish-gray friable silt loam about 10 inches deep. The subsoil is similar to Hillsdale loam. The total area is small. Corn and soybeans yield slightly higher than on the normal phase, but other crops yield about the same.

Hillsdale fine sandy loam.—Areas of this soil lie east of Kewanna and in the northern part of Newcastle Township. The relief is undulating to rolling, and the drainage good. The more rolling areas are subject to injury from erosion. The surface soil is brownish-gray friable fine sandy loam having a relatively low content of organic matter comparable with that of Miami fine sandy loam. The reaction is medium to slightly acid. The subsoil is similar to that of Hillsdale loam, and lime occurs at about the same depth in both.

The common farm crops are grown on this soil, and yields are comparable with those obtained on Miami fine sandy loam. The soil responds well to manures and fertilizers, and their use, together with increased use of soil-amendment crops, is necessary to maintain productivity.

Hillsdale loamy fine sand.—A small total area of this soil is mapped east of Kewanna. The relief is rolling and the drainage good to excessive. The surface soil is light yellowish-brown loose loamy fine sand, the content of organic matter is low, and the reaction is medium to slightly acid. Below a depth of 10 inches the subsoil is brownish-yellow sandy loam, becoming lighter with depth, and at about 36 inches it is gray and yellow. The substratum is sandy clayey material, in which the sand content is extremely variable.

General farm crops are grown on this soil, producing yields considerably lower than those obtained on Hillsdale loam. It responds well to fertilizers and manures; but, because of its loose sandy nature, plant nutrients are leached away rather easily.

Bellefontaine loam.—A small acreage of this soil is mapped, mainly in Newcastle Township. The relief is rolling, and drainage is good to excessive. It is generally associated with the Miami soils and other soils of the uplands, occupying glacial moraines and eskers. The surface soil is light yellowish-brown friable loam about 7 inches thick. The organic content is relatively low, probably about the same as in Miami loam. The reaction is medium to slightly acid. The subsoil, to a depth of about 20 inches, is yellowish-brown heavy compact gravelly sandy clay loam. At depths ranging from 30 to 40 inches is loose calcareous gravel and sand.

General farm crops are grown on this soil in a rotation system similar to that practiced on Miami loam. The heavy-textured subsoil layer prevents rapid downward movement of moisture in normal years, but in seasons of drought crops suffer somewhat because of the loose gravelly substratum. Corn may be expected to yield 20 to 40 bushels an acre under good management. Small grains yield fairly well in normal years. Wheat produces 10 to 20 bushels. Good stands of clover and alfalfa are obtained when sufficient lime is applied, but the clover does not survive droughty conditions so well as alfalfa. A rotation that includes a large proportion of clover and other soil-amendment crops, together with liberal applications of fertilizers and barnyard manure, is essential to maintenance of satisfactory productivity.

Bellefontaine loam, eroded hilly phase.—Cultivated areas of Bellefontaine loam having a gradient exceeding 18 percent erode easily, and in most places the surface soil has been largely or completely removed, exposing the subsoil. These areas are separated on the map as an eroded hilly phase. About half the land is cultivated and planted to general farm crops; the rest is in permanent pasture. Close-growing crops are essential to prevent further damage, and clean cultivation should be discontinued.

Bellefontaine loam, gullied hilly phase.—This phase includes the more severely eroded and gullied areas of Bellefontaine loam having a slope steeper than 18 percent. Gullies are numerous, and many are several feet deep. This condition has resulted from attempts to cultivate the steeper slopes and from lack of proper methods of controlling erosion in its earlier stages. Areas of this soil are now either used for pasture or remain idle.

Bellefontaine fine sandy loam.—This soil is mapped here and there throughout the areas of glacial till and moraines. The larger areas are on the moraines and eskers in the eastern part of Richland Township, and in Henry Township. The relief is rolling, and drainage is good to excessive.

In cultivated areas the surface soil is light yellowish-brown granular fine sandy loam, containing little organic matter. To a depth of 15 to 25 inches the subsoil is light yellowish-brown sandy loam. Below this the material is similar to Bellefontaine loam. Pits in areas of this and other Bellefontaine soils furnish gravel for use on roads and in building construction.

The general farm crops are grown, but at present the trend is to avoid soil-depleting crops in favor of permanent pasture and soil-amendment crops. Yields are lower than on Bellefontaine loam, and injury from drought is more severe. Areas having a comparatively thick heavy-textured subsoil layer retain moisture better than those having a thin layer in the subsoil.

As mapped, this soil includes a few small areas in which the surface soil is light yellowish-brown loamy fine sand with little organic matter. In uncultivated areas the organic content is generally sufficient to hold the fine sand grains together, but when cropped this material disappears and the surface soil becomes more susceptible to wind and water erosion.

Bellefontaine fine sandy loam, hilly phase.—Areas of Bellefontaine fine sandy loam having a slope of more than 18 percent and not seriously eroded are mapped as a hilly phase. This phase includes some of the steepest land in the county, practically all is in forest or pasture. The profile is similar to that of the normal phase, but the several layers, especially the surface layer, are somewhat thinner. This soil is unimportant agriculturally and, as mapped, includes a few small areas of Bellefontaine loam, hilly phase.

Bellefontaine fine sandy loam, eroded hilly phase.—When plowed and cultivated, hilly areas of Bellefontaine fine sandy loam are subject to sheet erosion. The surface soil is largely or completely eroded, exposing the yellowish-brown subsoil. Treatment similar to that needed for Bellefontaine loam is required to prevent further erosion. It is estimated that about 30 percent of this land is under cultivation to general farm crops, although the yields are extremely low.

Included with this soil on the map are a few areas of Bellefontaine loamy fine sand, eroded hilly phase, all of which are either used for pasture or allowed to remain idle.

Bellefontaine fine sandy loam, gullied hilly phase.—Where erosion on hilly areas of this soil type is not controlled, gullies develop. In many areas these are more than 10 feet deep and have worked back into the uplands to such an extent as to make the land useless for agricultural crops. The intergully areas have undergone severe sheet erosion and at present are largely in pasture or left idle. An inclusion

542135—46——4

made in mapping this soil comprises a few small gullied areas in which the original surface soil was of loamy fine sand, which now are either abandoned to weeds or support a poor stand of bluegrass; in any event they are practically useless agriculturally. A second inclusion not shown separately on the soil map comprises small areas of Bellefontaine loamy fine sand, hilly phase, the profile of which is similar to that of the normal soil, except that the layers, especially the surface soil, are somewhat thinner and sandier. Practically all the land is in timber and pasture and is unimportant agriculturally.

IMPERFECTLY DRAINED SOILS

The third subgroup of soils of the glacial moraines and till plains includes those having imperfect natural drainage, occupying a topographic position intermediate between the well-drained and the poorly drained soils. The content of organic matter is higher than in the well-drained soils but lower than in those poorly drained. They include the Crosby, Nappanee, and Aubbeenaubbee soils and are closely associated with the Miami, Metea, Brookston, and Clyde soils.

Because of their occurrence in irregular-shaped and generally small areas, no special agronomic treatments can be given these soils. The crops are similar to those of the associated soils. A large part of the land has been sufficiently drained to allow successful cultivation, but some areas need more adequate artificial drainage.

Crosby loam.—This soil occurs throughout the areas of glacial till. It occupies a position intermediate between the Miami and Brookston soils and is closely associated with them. Natural drainage originally was poor but most areas have been artificially drained sufficiently to allow cultivation. The 7- to 9-inch surface soil is light brownish-gray friable granular loam. The organic content is relatively low, and the reaction is slight to medium acid. Formerly, numerous rocks and boulders were present on the surface, but now most of these have been removed. The subsoil is mottled gray, yellow, and brown heavy silt loam that is somewhat plastic when wet and becomes hard when dry. In places it is somewhat compact, but it breaks into irregular nut-shaped aggregates ranging from three-eighths to three-fourths of an inch in diameter. Being somewhat impervious, the subsoil retards the downward movement of surface water. At a depth of 30 to 40 inches is gray and yellow plastic calcareous glacial till containing numerous angular rock fragments.

As mapped, Crosby loam includes numerous areas of Conover loam and a few areas of Conover silt loam. The surface soil of the included Conover loam is dark brownish-gray friable granular loam, while the surface soil of Conover silt loam is dark brownish-gray friable silt loam. The organic content of the surface soil of both Conover loam and silt loam is somewhat higher than in the surface soil of Crosby loam. The subsoil and underlying calcareous material is similar to Crosby loam, except that the subsoil is somewhat less compact and more pervious. Bodies of Conover silt loam are in the vicinity of Reiter School in Rochester Township and in other areas of glacial till. Areas of Conover loam are closely associated with Crosby and Brookston soils throughout the glacial till region.

The crop rotation system in practice includes corn, wheat or oats, and legumes, with some areas used for rye and soybeans. The soil warms rather slowly in spring, and seeding may be delayed to such an extent as to cause injury to crops by early fall frosts. This disadvantage, however, is partly offset by the rapid crop growth. Corn yields about 35 bushels an acre, but under good management practices yields may be increased to 45 bushels or more. Wheat yields average about 15 bushels an acre, and may be increased to 20 bushels or more under good management practices. Yields of 12 to 25 bushels of soybeans are obtained. Clovers and alfalfa can be grown successfully after 1 or 2 tons of ground limestone and sufficient phosphate and potash fertilizer are applied to the soil. Small grains may be injured by heaving and are not so well adapted to this soil as to those better drained. Clover and alfalfa grow well but are injured occasionally by heaving.

Crosby fine sandy loam.—This fine sandy loam is mapped throughout the areas of glacial till, generally in association with the other Crosby soils and the Brookston soils.

In cultivated fields, the 7- to 9-inch surface soil is brownish-gray fine sandy loam. The organic content is relatively low, and the reaction is slight to medium acid. The subsoil is gray, yellow, and brown mottled loam to silt loam breaking into subangular nut-shaped aggregates three-eighths to three-fourths of an inch in diameter. Calcareous glacial till lies at a depth of 32 to 40 inches below the surface.

Included on the soil map with Crosby fine sandy loam are numerous areas of Conover fine sandy loam. These included areas have a dark brownish-gray surface soil that is somewhat higher in organic-matter content than the surface soil of Crosby fine sandy loam. It occurs in the glacial till uplands in close association with Crosby loam, Brookston loam, Miami fine sandy loam, and other soils of the uplands.

Similar crops are grown on Crosby fine sandy loam as on Crosby loam, but yields are lower.

Nappanee loam.—Areas of this soil are in the southeastern part of the county, associated with areas of St. Clair loam. The relief is undulating to gently rolling. The soil is formed over calcareous glacial till containing a larger percentage of clay than the parent material of Crosby loam.

Under cultivation the 8-inch surface soil is gray to light brownish-gray friable loam having about the same content of organic matter and reaction as the corresponding layer of Crosby loam. The subsoil is mottled gray, yellow, and brown heavy silty clay loam to clay loam that falls apart into irregular-sized sharply angular pieces. The subsoil is heavier textured and more impervious to the downward movement of moisture than in Crosby loam. At a depth of 28 to 32 inches is gray and yellow heavy clayey calcareous glacial till.

The general farm crops are grown on this soil, and yields are only slightly less than on Crosby loam. Because of the heavy-textured subsoil, heaving of clover, alfalfa, and fall-sown small grains is occasionally severe. The seeding of oats and corn may be delayed in spring because of failure of this soil to drain properly.

Aubbeenaubbee fine sandy loam.—This soil occurs in the areas of glacial till, especially in the western and southern parts of the county.

Its boundaries are in some instances arbitrarily drawn, as there is a gradual transition in drainage conditions to Metea fine sandy loam and in depth of sand to Crosby fine sandy loam.

In cultivated areas the surface soil is light brownish-gray fine sandy loam. The content of organic matter is about the same as that in the lighter colored variations of Crosby fine sandy loam—in fact, these soils are difficult to distinguish by observation of the surface alone. To a depth of 22 to 30 inches the subsoil is mottled yellow and gray fine sandy loam or fine sand. Heavier textured material below this is practically identical with that in the subsoil of Crosby fine sandy loam.

Aubbeenaubbee fine sandy loam is somewhat droughty, owing to the sandy surface soil and upper subsoil layers. It responds well to applications of manure and commercial fertilizers, but plant nutrients are more quickly exhausted than in the heavier textured soils. The rotation system is similar to that practiced on the associated soils, and yields are lower than on Crosby fine sandy loam. Alfalfa does better than clover on this soil, but it requires applications of lime to assure good stands.

Aubbeenaubbee loamy fine sand.—This soil occurs in the western and southern parts of the county, generally associated with the lighter textured well-drained soils. In cultivated areas the surface soil is light brownish-gray loose loamy fine sand. Below this layer, the soil is similar to Aubbeenaubbee fine sandy loam, and the average depth to the heavier textured material is about the same. The organic-matter content is comparatively low. Not enough silt and clay are present in the surface soil to hold the sand grains together well, and in periods of strong winds this soil is subject to wind erosion, especially in fields that do not have a cover crop.

Good management is required to maintain productivity. This soil is responsive to fertilization, but plant nutrients are leached rather easily. The general farm crops are grown, although yields are lower than on Aubbeenaubbee fine sandy loam.

POORLY DRAINED SOILS

The fourth subgroup of soils of the glacial moraines and till plains have poor natural drainage and are dark-colored except Washtenaw. They consist of the Brookston, Clyde, and Washtenaw series and are characterized by a high content of organic matter, high fertility, and high content of moisture, and are potentially the most productive soils in the county. Most areas have been sufficiently drained artificially to allow cultivation. The reaction of the surface soil is very slightly acid to neutral, and little, if any, lime is required for the successful growth of clover and alfalfa. These soils are well adapted to corn, beans, clovers, and vegetables. The high content of organic material enables soil-depleting crops to be grown to a greater extent than on the light-colored mineral soils. Erosion is not only negligible, but most areas of these soils receive quantities of more or less fertile soil material washed from adjacent higher areas. These soils occupy depressions throughout the glacial till, generally small and irregular-shaped and closely associated with areas of the well-drained and imperfectly drained soils of the uplands. This makes special handling and cropping impracticable, except in a few areas.

Brookston silt loam.—This soil occurs in connected and unconnected small depressions of the glacial till uplands in close association with the Crosby, Miami, Nappanee, Metea, and Aubbeenaubbee soils.

The surface soil to a depth of 8 inches consists of dark-gray to very dark brownish-gray friable silt loam high in content of organic matter, which is thoroughly incorporated in the soil, improving it and allowing it to remain in good tilth even when tillage methods are used that would be harmful to many other soils. Plowed when wet, it becomes very cloddy, but the clods break into loose, friable material after a few alternating rainy and dry periods. The organic material is durable under intensive cultivation to corn and other soil-depleting crops. The subsoil is mottled gray and yellow heavy silty clay loam or clay loam containing a few small stones and angular pebbles. The material breaks into irregular-sized angular lumps that may be broken into smaller angular aggregates. Gray and pale-yellow calcareous glacial till of heavy clay loam texture lies at a depth of 40 to 50 inches.

This is not only one of the most productive soils in the county but also in the State. Very little organic matter is applied, other than that plowed under as stubble or green manure. Yields of corn range from 40 to 80 bushels an acre and average about 55. Soybeans yield 12 to 25 bushels of seed and 2 to 4 tons of hay. Yields of oats, wheat, and other small grains are usually good, but these crops often grow somewhat rank and may lodge during windy rainstorms. Wheat and other fall-sown grains are occasionally injured by heaving in winter and early in spring. Clover and alfalfa do well, and good stands are obtained without the use of lime, but they are subject to injury from heaving. This is an excellent soil for growing vegetables, especially tomatoes.

Brookston loam.—Every township in the county contains depressions occupied by this soil. It is associated with the lighter textured soils of the glacial till uplands.

Under cultivation the 8-inch surface soil is dark-gray to very dark brownish-gray friable loam having about the same organic-matter content as the corresponding layer of Brookston silt loam. The subsoil is mottled gray and yellow heavy silty clay loam that breaks into irregular-sized angular aggregates. Calcareous till is reached at a depth of 42 to 50 inches.

In drainage conditions, management practices, and crops grown this soil is comparable with Brookston silt loam. Yields of corn, soybeans, and clovers are slightly lower, but yields of small grains are probably equal or slightly higher.

Clyde silt loam.—This soil occupies the lower depressions associated with the Brookston soils. In cultivated areas the surface soil is very dark-gray to nearly black silt loam, about 8 inches deep. The content of organic matter is high, and in many undisturbed areas the first 1- to 2-inches of the surface is granular muck. The upper part of the subsoil is dark-gray plastic clay loam containing a few dull-yellow streaks. At a depth of about 16 inches the material has a dark bluish-gray cast and is tough and plastic. The deeper subsoil is gray and yellow mottled silty clay loam. Calcareous clayey till occurs at a depth of 38 to 50 inches.

Natural drainage conditions are poorer than in the Brookston soils, but a large part of this soil has been sufficiently drained artificially to allow cultivation in years of normal rainfall. In years of unusually high summer rainfall, as in 1937, many areas are too wet to produce crops.

When properly drained this is an excellent soil for corn, beans, clover, and alfalfa. Yields equal or exceed those obtained on Brookston silt loam in years of low rainfall, but over a period of years the average is considerably lower, owing to low yields in years of extremely high rainfall. This soil is not well suited to small grains, because of high moisture content, danger of injury from heaving, and damage caused by lodging just before harvesttime.

Clyde loam.—This soil occupies the lower depressions in areas of glacial till, generally associated with Brookston loam. The crops supported are similar to those on Clyde silt loam, and the yields are about the same. The surface soil consists of very dark-gray to nearly black friable loam having an organic-matter content about equal to that of Clyde silt loam. It is underlain by a subsoil of heavy silty clay loam similar in color to that of Clyde silt loam.

Clyde silty clay loam.—Only a small total area of this soil is mapped, largely in Henry and Wayne Townships. The surface soil is very dark-gray to nearly black silty clay loam, having a high organic-matter content. The subsoil is very similar to that of Clyde silt loam. Present drainage conditions are somewhat poorer than in the lighter textured Clyde soils. When the soil is sufficiently drained, however, the crop yields about equal those obtained on Clyde silt loam.

Washtenaw silt loam.—This soil occurs in depressions of the more rolling uplands, principally in Richland, Newcastle, and Henry Townships. The characteristic feature is an accumulated surface layer of recently deposited silty material over dark heavy material. It has an 8-inch surface soil of dark brownish-gray to light brownish-gray friable silt loam. The content of organic matter is variable, but lower than in the Brookston soils. The reaction is slightly acid. In undisturbed areas the material has a laminated structure. Below this surface layer and continuing to a depth of 10 to 20 inches the material is medium to dark brownish-gray heavy silt loam having a laminated structure and varying in organic-matter content. These two layers represent accumulations of lighter colored silty material that has been washed down from the surrounding uplands and deposited over the darker colored soils of the Brookston and Clyde series. The light-colored subsoil and substratum, therefore, are similar to the corresponding layers of those soils.

It is estimated that less than 30 percent of this soil is cultivated. The rest is used largely for bluegrass pasture and forest. When the soil is sufficiently drained, good yields of corn, beans, hay, and vegetables are obtained, but many areas cannot be drained economically. It is not well suited to small grains.

A few areas included on the map have an 8-inch surface layer of medium to dark brownish-gray friable silty clay loam. The rest is similar to the normal phase, and the thicknesses of the accumulated material is extremely variable. The few small areas of this variation occupy depressions associated with areas of the heavier textured soils of the uplands, mainly in Henry Township. Corn and beans yield well on this variation, but it is not well adapted to small grains.

Washtenaw loam.—This soil has a surface layer of dark brownish-gray or light brownish-gray friable loam, about 8 inches deep, with a variable content of organic matter. Below the surface layer dark brownish-gray heavy loam extends to a depth of 10 to 20 inches. It is variable in texture and composition and has a laminated structure. These two layers represent accumulated material washed from the surrounding uplands. In the next layer the material is similar to that of Washtenaw silt loam. Washtenaw loam is comparable to Washtenaw silt loam in drainage conditions, occurrence, management, and use, but it is generally associated with the lighter textured soils of the uplands.

As mapped, this soil includes a few areas in which the 8-inch surface layer is dull-brown fine sandy loam, instead of loam, with a variable but generally lower content of organic matter. Underlying this is brownish-gray fine sandy loam to heavy loam, which extends to a variable depth, averaging about 15 inches. The subsoil below this is similar to that in typical Washtenaw loam. This fine sandy loam variation occurs in small depressions, partly surrounded by eroded slopes of the lighter textured soils of the uplands. It is of minor agricultural importance—most of it is devoted to permanent pasture and only a few areas are under cultivation.

SOILS OF THE GLACIOFLUVIAL OUTWASH PLAINS AND TERRACES

The soils developed from glaciofluvial outwash material and deposits reworked by the wind occupy smooth plains, terraces, and dune-like areas and make up the second major group of soils of the county. Their main feature is that all are underlain with gravel or sand. For the purposes of discussion they have been subdivided into: (1) Very rapidly and rapidly drained soils; (2) imperfectly drained soils; and (3) poorly drained soils.

VERY RAPIDLY AND RAPIDLY DRAINED SOILS

Very rapidly and rapidly drained soils of the glaciofluvial outwash plains and terraces are members of the Plainfield, Fox, Oshtemo, and Mill Creek series. All are low in organic matter, light in color, and low or moderately low in moisture-holding capacity. They represent different levels of deposition, and the more sandy soils are subject to severe wind erosion.

Plainfield loamy fine sand.—This soil is mapped in the northwestern part of the county, in the southern part of Richland Township, and in other scattered areas in the outwash plains.

In cultivated fields the surface soil is light yellowish-brown incoherent loamy fine sand, about 9 inches deep. The content of organic matter is very low. The reaction is medium acid. The subsoil is light grayish-yellow loose fine sand containing a few streaks and pockets of yellowish-brown fine sand. In some areas, particularly in the vicinity of Delong, the subsoil contains some coarse sand and fine gravel. The substratum is yellow and gray loose stratified fine sand and sand. A mechanical analysis of this soil is given in table 6.

TABLE 6.—*Mechanical analysis of Plainfield loamy fine sand.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Plainfield loamy fine sand:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
285501	0–2	0.8	8.2	32.9	36.1	3.4	13.4	5.2
285502	2–7	1.3	11.2	35.8	38.3	2.8	7.9	2.7
285503	7+	1.3	8.9	34.0	34.6	3.4	7.1	1.7

Drainage is very rapid. The soil responds well to manure and commercial fertilizers, but owing to the porosity of the entire soil mass, its plant nutrients are leached out quickly. The content of silt and of organic matter is not sufficient to hold the sand grains together, so that the surface soil in many places is shifted by the wind. The land is level to undulating. The material was originally deposited by waters from the retreating ice sheets, and it has been partly reworked by the action of the wind.

Crop yields are relatively low, because of the droughty nature of this soil and its deficiency in plant nutrients. Rye appears to produce higher yields than wheat and oats, but yields of corn are low. Fair stands of alfalfa are obtained after heavy applications of lime, but the stands are frequently damaged by blow-outs. The soil is too droughty for the successful growing of clover and timothy.

Plainfield loamy fine sand, slope phase.—Areas of the normal phase having a gradient of 10 percent or more are mapped as the slope phase. The profiles of the two are similar. This soil occurs adjacent to drainageways and in narrow dunelike areas. The land is unimportant agriculturally, and practically all is in forest, orchard, or pasture.

Plainfield loamy fine sand, eroded slope phase.—Many sloping areas of the normal soil have been eroded by the action of both wind and water. A large part of the surface soil in this phase has been removed, and blow-outs are common. Most of these areas have no cover crop, which probably accounts for a large part of this erosion. On the few areas cropped the yields are very low.

Fox fine sandy loam.—This soil occurs on the outwash plains, chiefly in the northeastern part of Rochester Township and in the central part of Henry Township.

In cultivated areas the 7-inch surface soil is light yellowish-brown structureless fine sandy loam. The content of organic matter is rather low but is sufficient to darken the color of the surface somewhat. The reaction is slightly acid. To a depth of about 18 inches the subsoil is yellowish-brown medium to strongly acid sandy loam or loam, breaking into nut-shaped aggregates. Below this is dark-brown heavy sticky gravelly clay loam that is neutral in reaction. This layer varies in thickness from 6 to 24 inches, with an average of 15 inches and is underlain by stratified calcareous gravel.

The relief is nearly level to gently undulating. Drainage through the gravelly substrata is rapid. The heavy subsoil layer checks the rapid downward movement of moisture, but in years of light rainfall this soil is somewhat droughty.

Practically all the general farm crops are grown on this soil, including a variety of vegetables. Corn yields 15 to 40 bushels an acre, averaging about 25 bushels under good management. The production of soybeans, both for seed and for hay, has increased. Wheat yields 10 to 20 bushels and does not appear to be injured by heaving. This soil is not so well suited to clover as to alfalfa, but excellent stands of alfalfa were observed. A few farmers are devoting a large part of the land to alfalfa to the exclusion of corn and report incomes equal to those obtained from a rotation that includes corn, wheat, and oats. Cucumbers, peas, sweet corn, watermelons, and other vegetables are grown commercially, and good yields are obtained when the soil is fertilized. Because of the sandy and well-drained character of this soil, vegetables and other crops may be seeded earlier than on those more poorly drained, and crops usually mature early enough to escape early frosts.

Fox fine sandy loam, slope phase.—Areas of this type having a slope of more than 10 percent are mapped as the slope phase. The profile is similar to that of the normal phase, but the surface layer is thinner. A large part of the land is in forest or pasture, and it is not important agriculturally. Whenever cultivation has been attempted erosion has resulted. As mapped, this phase includes a few small areas in which the surface texture is loam. Most areas occur adjacent to drainageways.

Fox fine sandy loam, eroded slope phase.—Areas of Fox fine sandy loam, Fox loam, and Fox gravelly loam having a gradient steeper than 10 percent that have been managed improperly have lost a large part or all of the surface soil. Such areas are designated as Fox fine sandy loam, eroded slope phase, and include slightly rolling areas, especially in the eastern part of Rochester and Henry Townships, and a few gullied areas. Crop yields are low, and some areas have been taken out of cultivation and used for pasture.

Fox loam.—Areas of this soil are scattered over the outwash plains, especially in the eastern part of Rochester Township and in Henry Township. In cultivated areas, the surface soil is light yellowish-brown friable loam with comparatively little organic matter. Areas that have been recently put into cultivation have a somewhat darker surface soil. The reaction is slightly acid. The subsoil to a depth of 18 inches is yellowish-brown heavy loam to silt loam, and breaks into medium-sized nut-shaped aggregates. It is medium to strongly acid. Below this is dark-brown to reddish-brown heavy sticky gravelly clay loam, which is compact in place and breaks into blocky aggregates. At a depth of 36 to 44 inches is loose stratified calcareous gravel.

This soil is comparable with Fox fine sandy loam in relief, drainage conditions, management practices, and crops produced, but the yields are somewhat higher. The heavier texture of the surface soil and subsoil prevents serious injury to crops in years of low rainfall. Manures and soil-amendment crops are necessary to maintain productivity.

A few areas of Fox gravelly loam are included on the map with Fox loam. In cultivated areas this inclusion has a surface soil of light yellowish-brown loam or sandy loam containing a large quantity of gravel and small stones. Below plow depth the subsoil becomes

542135—46——5

lighter colored and slightly heavier textured. At a depth of about 18 inches the subsoil changes rather abruptly to yellowish-brown compact gravelly clay loam containing a larger proportion of gravel and stones than the surface layer. Although the quantity of gravel and stones varies, it is generally sufficient to make penetration with a soil auger or spade difficult and interferes seriously with cultivation. A few areas of this variation occur in Henry Township. Yields of crops are low.

Depressions within the larger areas of Fox loam are included on the map with Fox loam. The surface soil is slightly heavier textured, is darker in color, and contains more organic matter than that of the typical soils. This soil occurs in a few small areas in Rochester Township. As it is closely associated with Fox loam, it is used for the same crops and produces slightly higher yields.

Oshtemo fine sandy loam.—This soil occurs on the outwash plains, especially in eastern Aubbeenaubbee, northern Rochester, and western Newcastle Townships. It is closely associated with the Fox and Plainfield soils, and a few areas mapped may include small areas of these soils, especially south of the Tippecanoe River in Rochester Township.

Under cultivation the 8-inch surface soil is light yellowish-brown fine sandy loam, low in organic matter, and slightly acid to medium acid in reaction. The subsoil is light yellowish-brown to brownish-yellow fine sandy loam or loamy fine sand, generally containing numerous small pebbles and having a medium acid to strongly acid reaction. At a depth of 26 to 48 inches the material is weak-brown waxy gravelly clay loam, resting on stratified gravel and coarse sand. The depth to and thickness of the heavy layer are extremely variable, but the thickness does not exceed 7 inches.

Although Oshtemo fine sandy loam is used for general farm crops, its adaptability is somewhat limited, owing to low organic-matter content and susceptibility to drought. It is better suited to watermelons, cucumbers, and other special crops than to general farm crops. It responds well to fertilizers but its plant nutrients leach out rather quickly. Alfalfa growing has increased in recent years, and fair to good stands have been obtained.

Areas of this soil mapped in the vicinity of Talma are somewhat more productive, because of greater thickness of a heavy-textured subsoil layer. The slight depressions occurring within the larger areas of Oshtemo fine sandy loam are included on the map with that soil. The surface soil of the depressions contains more organic matter and is slightly heavier in texture, but the rest of the profile is practically the same as that of the typical soil. Only a few small areas are mapped, and they are associated with the normal phase. Crop yields are slightly higher than those obtained on that soil.

Oshtemo fine sandy loam, slope phase.—Areas of Oshtemo fine sandy loam and Oshtemo loamy fine sand having a gradient exceeding 10 percent are mapped as Oshtemo fine sandy loam, slope phase. This soil occurs adjacent to drainageways and is used largely for forest and pasture. It is too droughty to be suitable for cultivation.

Oshtemo fine sandy loam, eroded slope phase.—Sloping areas of Oshtemo fine sandy loam and Oshtemo loamy fine sand that have lost a large part or all of the surface soil are mapped as Oshtemo fine sandy loam, eroded slope phase. All these areas have been in cultivation, and erosion has resulted from improper treatment and too frequent clean cultivation. About 50 percent of the land is cropped, though yields are comparatively low, and the rest is used for pasture or left idle. Mapped with this phase are a few areas that are so badly gullied as to be unfit for cultivation and are either used for pasture or allowed to remain idle.

Oshtemo loamy fine sand.—This soil occurs on the outwash plains, chiefly in the eastern part of the Aubbeenaubbee Township and the northern part of Rochester Township. It is closely associated with the Plainfield and Fox soils in the northwestern part of Rochester Township, and in places in this area the boundaries between it and Plainfield loamy fine sand are arbitrarily drawn. In cultivated areas, the 8-inch surface soil consists of light yellowish-brown loose loamy fine sand with a low content of organic matter and a slightly acid reaction. The subsoil is light yellowish-brown medium to strongly acid loamy fine sand or fine sand. At a depth of 25 to 48 inches there is a layer, only a few inches thick, of weak-brown compact gravelly or sandy clay loam, underlain by stratified gravel and coarse sand.

The common farm crops are grown on this soil, but the area devoted to corn, oats, and clover is rather limited because of low organic-matter content and droughty character. The yields are influenced by the thickness and depth of the heavy subsoil layer, but they are usually lower than on Oshtemo fine sandy loam and higher than on Plainfield loamy fine sand.

Mill Creek fine sandy loam.—This soil is mapped in the southwestern parts of Henry and Rochester Townships, the north part of Liberty Township, and south of Grasscreek adjacent to Gault Ditch. The land is nearly level, and drainage is good.

The 8-inch surface layer is light yellowish-brown slightly acid fine sandy loam. The content of organic matter is rather low and is probably about equal to that in Fox fine sandy loam. The subsoil is light yellowish-brown to yellowish-brown slightly compact medium to strongly acid sandy loam to a depth of 15 to 20 inches. Below this the material is brown sandy and gravelly clay loam. In places this layer, which varies widely in texture, consists chiefly of sand and gravel, but the heavier textured material is generally dominant. The subsoil becomes waxy and more compact with depth and contains a few large stones. At about 48 inches is calcareous material, chiefly gravel and sand, somewhat stratified but it is not so well assorted as the substrata in Fox soils. In areas along Mill Creek the subsoil is of heavier texture than elsewhere.

Most of this soil is in cultivation, and most of the general farm crops are grown. It responds well to manure and fertilizers. Crop yields probably average slightly higher than on Fox fine sandy loam because the soil is somewhat less droughty.

Mill Creek fine sandy loam, slope phase.—Areas of this soil type having a gradient of more than 10 percent are mapped as the slope phase. The surface layer is thinner, but those below are similar to the corresponding layers of the normal phase. This soil occupies a small total area along the drainageways, chiefly in the southwestern part of Rochester Township and the northwestern part of Liberty Township. About 50 percent is used for crops.

Mill Creek fine sandy loam, eroded slope phase.—Sloping areas of this soil type that have been cultivated and have lost a large part or all of the surface soil by erosion are separated as the eroded slope phase. Much of the plant nutrient has been lost, and crop yields are low. This soil is best suited to pasture or forest.

A few gullied areas in the southwestern part of Henry Township are mapped with the eroded slope phase. The gullies vary in size, but are large enough to make the land unfit for agricultural use. It is used largely for pasture or allowed to remain idle.

IMPERFECTLY DRAINED SOILS

The soils of the glaciofluvial outwash plains and terraces that occupy positions slightly higher than the dark-colored poorly drained soils have a relatively high water table and slow internal drainage. They include the Berrien, Morocco, and Bronson series. All are light-colored and low in organic matter, and all have mottled subsoils.

Berrien loamy fine sand.—The plowed surface soil is brownish-gray to light yellowish-brown loamy fine sand, low in organic matter, and medium acid in reaction. The subsoil is grayish-yellow loose fine sand, grading into mottled gray and yellow sand at a depth of 14 to 30 inches. The substratum is mottled gray and dusky-yellow loose sand. This soil occurs on outwash plains in close association with the Plainfield, Granby, and Maumee series, so that similar crops are grown on all these soils. Because of the porosity of the surface soil and subsoil, plant nutrients are quickly leached away. Rye yields better than other small grains, but corn gives low returns. When rather heavy applications of lime are used, fair stands of alfalfa are obtained. This soil is probably best suited to special crops, as berries, watermelons, and cucumbers.

Morocco loamy fine sand.—This soil is imperfectly drained and is closely associated with Berrien, Newton, Granby, and Maumee soils. It often occurs in an intermediate position between areas of Berrien soils and the poorly drained sandy soils.

The 6- to 8-inch surface soil is brownish-gray to light brownish-gray loamy fine sand, with enough heavier material present to hold the sand grains together very feebly. The organic-matter content is low but is usually somewhat higher than in the surface soil of Berrien and Plainfield soils. The reaction is medium to strongly acid. The subsoil is gray and yellow mottled loose loamy fine sand that grades into loose fine sand. Yields of crops are higher than those obtained on Berrien loamy fine sand because more moisture is available for the plants during the greater part of each growing season.

Included with Morocco loamy fine sand on the map are 40 acres of soil having the following characteristics: The surface soil to a depth of 8 inches is brownish-gray loose loamy fine sand, low in organic matter, and medium acid in reaction. The subsoil is mottled gray and yellow fine sand containing a few iron concretions. At an average depth of about 18 inches there is a 4- to 7-inch layer of mottled gray and yellow compact sandy clay, underlain by mottled gray and pale-yellow sand and gravel. This included soil occurs in the outwash plains associated with Brady, Granby, and Oshtemo soils. Although the content of organic matter is higher than in Berrien loamy fine sand, it is somewhat lower than in Morocco loamy fine sand. The heavy layer aids in preventing the downward movement of plant nutrients and moisture, and crops do not suffer in years of diminished rainfall so much as on well-drained light-textured soils.

Bronson fine sandy loam.—A few small areas of this soil occur in the northern part of Liberty Township, the southwestern part of Rochester Township, and elsewhere on the outwash plains, generally in association with the Fox, Westland, and Brady series. The land is nearly level. To a depth of 8 inches the surface soil is light yellowish-brown to brownish-gray fine sandy loam. The content of organic matter is low, but is usually somewhat higher than in the Fox soils. The reaction is slightly acid. Immediately below this layer the color is pale yellowish gray and the reaction is medium to strongly acid. At a depth of about 18 inches the subsoil is mottled yellow and gray sandy gravelly clay loam, sticky when wet and hard when dry. This layer is similar in mineral composition to the heavy layer in the Fox soils, but the mottled color is evidence of slow internal drainage. The substratum is stratified gravel and coarse sand. About the same crops are grown on this soil, with about the same yields, as on the associated Fox soils. In extremely wet periods they may suffer somewhat from too much water; but, in periods of drought, injury is not so great as on the associated rapidly drained soils.

Bronson loam.—In cultivated fields the surface layer of this soil is light yellowish-brown to brownish-gray friable loam. The subsoil and substrata are essentially the same as the corresponding layers of Bronson fine sandy loam. It is associated with the Fox and Nyona series. The same general farm crops are grown on this soil as on Bronson fine sandy loam, and slightly higher yields are reported.

POORLY DRAINED SOILS

The poorly drained soils of the glaciofluvial outwash plains and terraces are characterized by dark surface layers and a high content of organic matter. They are underlain by gravel or sand, and the natural water table is comparatively high. With the exception of the Newton soils, when properly drained they are rather well suited to the production of corn and other clean-cultivated crops. Included in this group are soils of the Westland, Abington, Nyona, Lear, Brady, Gilford, Granby, Maumee, and Newton series.

Westland silt loam.—This soil occupies shallow depressions in the outwash plains in association with Fox and Abington soils, chiefly in the northern part of Rochester Township and the western parts of Newcastle and Henry Townships. The surface soil is similar to that of Brookston silt loam. To a depth of about 8 inches it is dark-gray to very dark brownish-gray friable silt loam having a slightly acid or neutral reaction. The abundant organic matter is well mixed with the mineral material, giving the soil mass an excellent tilth and maintaining good tilth even under methods of tillage that would be injurious to many other soils. The subsoil is dark-gray and yellow mottled light silt loam or silty clay loam. At a depth of about 20 inches it is underlain by mottled yellow and gray plastic gravelly clay loam containing some small stones. Stratified calcareous gravel lies from 38 to 48 inches below the surface.

Although natural drainage is very slow, most areas of this soil have been sufficiently drained artificially to allow cultivation. The rotation system includes most of the general farm crops grown in the county. It is an excellent soil for growing corn, soybeans, and alfalfa, and the yields are only slightly lower than on Brookston silt loam. Small grains make fair returns, but they are not so well adapted to this as to soils better drained. Little, if any, manure is applied, and where practicable, corn is grown for 2 or more consecutive years.

Westland loam.—This soil is associated with the Abington, Fox, and Mill Creek soils in Rochester, Newcastle, and Henry Townships. The surface soil is dark-gray to very dark brownish-gray friable loam, comparatively high in organic matter and slightly acid to neutral in reaction. The subsoil of mottled dark-gray and pale-yellow loam or light silt loam is underlain at a depth of 20 inches by mottled gray and yellow heavy gravelly clay loam. Substrata of stratified calcareous gravel lie at a depth of 3 to 4 feet.

The methods of management and the crops grown are similar to those on Westland silt loam, and the yields are about the same, but the soil is somewhat more easily cultivated.

Where this soil is associated with the Mill Creek soils, the substrata are not so definitely stratified and include more sand and clay than elsewhere. In these areas lime is reached at a depth of about 60 inches and crop yields are somewhat lower than on the typical soil.

Abington silt loam.—This soil occurs in the lowest and wettest depressions of the outwash plain in association with Fox and Westland soils. Natural drainage is slower than in the Westland soils. The surface layer consists of very dark brownish-gray to nearly black silt loam, with a large quantity of organic matter. Undisturbed areas generally have 1 to 2 inches of black muck on the surface. The reaction is neutral. To a depth of 18 inches the subsoil is dark-gray sandy silt loam that breaks into irregular-sized angular aggregates. Below this the material is gray heavy gravelly clay loam containing numerous small stones. When wet, the material is sticky. Stratified calcareous gravel makes up the substrata.

Because of the close association of this soil with the Westland soils, the rotation system practiced is very similar. When the soil is sufficiently drained, good yields of corn, soybeans, and alfalfa may be expected. Small grains, however, are likely to lodge before they can be harvested. In the abnormally wet season of 1937, many areas planted to corn, soybeans, and wheat were drowned out.

Abington loam.—The surface soil of this type is very dark brownish-gray to nearly black friable loam with a high content of organic matter. The subsoil is similar to Abington silt loam but it is generally associated with the lighter textured Westland and Fox soils. Crop rotations, practices of management, and crop yields are about the same as on Abington silt loam, but this soil is more easily cultivated.

Nyona silt loam.—This soil occurs in an area locally called a prairie, lying on outwash plains in the southwestern part of Rochester Township in which the dark Nyona and Lear soils predominate. The surface soil and the upper part of the subsoil closely resemble the corresponding layers of Brookston silt loam. At one time natural drainage was poor, but at present practically all the areas have been drained artificially and are under cultivation. In cultivated fields the surface soil is dusky-brown or very dark brownish-gray friable silt loam to a depth of about 8 inches. The organic content is comparable with that of the Brookston and Westland soils, and the reaction is neutral. The subsoil is mottled dark-gray and yellow silt loam or silty clay loam. The upper part of this layer falls apart into coarse nut-shaped pieces, and the lower part into roughly cubical pieces. The substratum of mottled gray and yellow loose gravel and coarse sand is reached at a depth of 24 to 30 inches. This material is calcareous at a depth of about 36 inches.

General farm crops are grown on this soil, but corn, sweet corn, and soybeans predominate. Fairly large areas are associated with areas of the Lear soils and are often planted to corn for two or more consecutive years. In years of normal rainfall the crop yields are about equal to those obtained on Brookston silt loam; but in years of lower rainfall, they are considerably reduced, chiefly because of the loose porous substratum.

In a few small areas of Nyona loam included with this soil on the map the surface soil is very dark brownish-gray friable loam. The subsoil and substratum are very similar to the corresponding layers in the silt loam. The included soil is closely associated with the Lear soils in the southwestern part of Rochester Township. In drainage conditions, organic-matter content, management, crop rotation, and yields of crops, it is comparable to the normal phase.

Lear silt loam.—Cultivated areas of this soil have an 8-inch surface layer of very dark-gray friable silt loam containing a large quantity of organic matter. The reaction is neutral. The subsoil is dark-gray sandy silt loam or clay loam, breaking into irregular-sized angular aggregates 3/8 to 3/4 inch in diameter. At a depth of 26 to 34 inches is gray calcareous gravel and coarse sand. This soil occupies wet depressions on the so-called prairie, closely associated with the Nyona soils. The crops and methods of management are essentially the same on the two soils because of their close association. In years of normal moisture conditions, the crop yields almost equal those obtained on Nyona silt loam, but in seasons of abnormally high rainfall crops are materially injured. It is estimated that more than 20 percent of the crops on this soil were drowned out in 1937.

Lear loam.—This soil has a very dark-gray friable loam surface soil to a depth of about 8 inches. The subsoil and substratum are essentially the same as in Lear silt loam. It is associated with Lear silt loam and the Nyona soils and is comparable with Lear silt loam in management practices used, crops grown, and yields obtained, but it is somewhat more easily cultivated.

Brady fine sandy loam.—This soil occurs on the sandy and gravelly outwash plains in association with the Gilford and Berrien soils. The larger areas are in the western part of Rochester Township. In cultivated areas the surface soil is dark-gray fine sandy loam to a depth of 9 inches. The content of organic matter is high, but it is somewhat less than in the Gilford and Maumee soils. The reaction is slightly acid to neutral. The subsoil is mottled dark-gray and yellow sandy loam. At a depth of about 15 inches the material is mottled brownish-yellow and gray compact sandy silt loam. It ranges in thickness from 5 to 11 inches, averaging about 8 inches. The material appears to be compact in place but breaks down without much pressure into coarse granular material. It is underlain by loose gray neutral sand and fine gravel, becoming calcareous at a depth of about 60 inches.

The common farm crops are grown on this soil, corn and soybeans predominating. Corn and soybeans produce fair to good yields. Several good stands of mixed clovers and timothy were observed on this soil in the course of mapping. When adjacent areas of muck and areas of the Gilford soils are drained sufficiently to allow cultivation, the water table in this soil may be so lowered as to make it droughty.

Brady loam.—This soil has a surface of dark-gray granular loam. Compared with Brady fine sandy loam the content of organic matter appears to be slightly higher and the subsoil slightly heavier textured, but the substratum is essentially the same. Brady loam occurs in association with the heavier textured soils on the sandy and gravelly outwash plains, and practically the same crops are grown on all. The yields from this soil are higher than on Brady fine sandy loam.

Gilford fine sandy loam.—This soil occupies the more poorly drained areas associated with the Brady, Oshtemo, and other soils in the sandy and gravelly areas on the outwash plains. The surface soil to plow depth is very dark-gray to nearly black loose fine sandy loam. In undisturbed areas the first 1 or 2 inches is granular mucky material. At a depth of 15 to 20 inches the subsoil is dark-gray loamy sand containing enough silt and clay to make it feebly cohesive when moist. Beneath this material is a layer of gray compact sandy clay loam about 8 inches thick, resting on gray loose gravelly sand. Practically all the land is cultivated under a rotation that includes most of the common farm crops. In seasons of high rainfall the yields may equal or exceed those obtained on the Abington soils, but in normal years they are somewhat lower.

Gilford loam.—The surface soil is very dark-gray to nearly black granular loam, and in most undisturbed areas the first 1 or 2 inches is loamy muck. The subsoil and substratum are similar to those of Gilford fine sandy loam. Crop yields are higher on this soil than on the associated lighter textured soils, but somewhat lower than on Abington loam.

Granby fine sandy loam.—This soil occupies a position topographically similar to that of the Brady soils, but it is associated with the Maumee and Berrien soils and with muck on the sandy outwash plains and in small local sandy plains within areas of glacial till. The organic and mineral constituents of the surface soil are well mixed, and the tilth is good.

To a depth of about 9 inches, the surface soil is dark-gray loose fine sandy loam, comparable in content of organic matter and in appearance with the corresponding layer of Brady fine sandy loam. The reaction is slightly acid to neutral. The subsoil is brownish-gray to grayish-yellow fine sandy loam, which changes gradually to mottled gray and yellow loose sand. The substratum consists of gray loose sand.

In seasons of normal rainfall the crop yields are only slightly lower than on Brady fine sandy loam, but in years of drought they are greatly reduced. The sandy surface soil and subsoil allow free downward movement of water. A high content of organic matter favors the growing of corn, soybeans, and other soil-depleting crops. Few farmers use fertilizer on this soil, and little if any manure. Fair to good stands of alfalfa are obtained with light applications of lime. Good stands of timothy and a mixture of timothy and alfalfa were observed in 1937. The larger areas of this soil are in the western part of Rochester Township and in Aubbeenaubbee and Wayne Townships. The areas mapped in Wayne Township adjacent to Gault Ditch are slightly better drained than the others.

Granby loam.—The surface soil consists of dark-gray friable loam having a somewhat higher content of organic matter than Granby fine sandy loam. The subsoil is grayish-yellow sandy loam. Below a depth of about 15 inches the material is mottled gray and yellow loose sand. In drainage conditions, management practices, and crops grown, this soil is comparable with Granby fine sandy loam, but the yields are somewhat higher.

Granby loamy fine sand.—The surface soil is dark-gray incoherent loamy fine sand. The subsoil and substratum are practically the same as the corresponding layers of Granby fine sandy loam. The lighter texture of the surface soil makes it subject to wind erosion, and in periods of strong winds there is some shifting of this material. Crop yields are lower than on Granby fine sandy loam.

Maumee fine sandy loam.—This soil is associated with the Granby and Berrien series and with muck on the sandy outwash plains. In cultivated areas, the surface soil is very dark-gray to nearly black fluffy granular fine sandy loam. In most undisturbed areas the first 2 or 3 inches is black loamy muck. The reaction is slightly acid to neutral. Below the surface the subsoil is dark-gray loose loamy fine sand or fine sandy loam containing a few pockets or thin layers of silty material. This grades into gray loose sand.

Natural drainage conditions are poorer than in the Granby soils, as the water table is at or near the surface most of the time. A large part of the soil has been artifically drained, but somewhat too poorly for small grains. When it is properly drained, good yields of corn, beans, and vegetables may be expected. The better drained uncultivated areas have good to excellent stands of bluegrass pasture.

Maumee fine sandy loam, ferruginous phase.—This ferruginous phase is associated with the normal phase and receives the same management. It is characterized by the presence of iron stains and small segregations or concretions of bog-iron ore in the surface soil and subsoil. Although variable, the quantity of iron is sufficient to give

542135—46——6

the soil mass a decided yellowish-brown color. Only a few small areas are mapped in sec. 9, T. 30 N., R. 2 E., and on one area about 4 miles west of Rochester the surface soil is loam instead of fine sandy loam.

Maumee loam.—This soil occurs on the sandy outwash plains, generally in association with the Granby soils and Carlisle muck, shallow phase over sand, the gradation to the latter being in many instances very gradual, and boundaries between the two soils are occasionally arbitrarily drawn. The surface soil contains a larger proportion of organic matter and extends to a greater depth than in Maumee fine sandy loam. In most undisturbed areas the 3- to 4-inch surface layer is granular muck. The subsoil is dark-gray heavy loam that changes gradually to gray fine sand.

This soil is often planted to corn or sweet corn for several consecutive years, as it has a very high content of organic matter. Some areas receive treatment similar to areas of muck. Most of the soil is deficient in potash and phosphorus. Cornland usually receives liberal applications of a 0–20–20 or 0–8–24 fertilizer.[4] There are excellent stands of bluegrass on uncultivated areas, and the carrying capacity for grazing stock is relatively high.

Maumee loamy fine sand.—The 8- to 10-inch surface soil of this type is very dark-gray loose loamy fine sand. The subsoil is dark-gray loamy fine sand or fine sandy loam grading into loose gray sand. It is associated with other light-textured soils occupying the sandy outwash plains. The light texture of the surface soil encourages wind erosion. Corn is the principal crop grown, but wheat, oats, and alfalfa are included in the rotation systems. Yields are lower than on Maumee fine sandy loam.

Newton loamy fine sand.—Important characteristics of this soil are its slow natural drainage and strongly acid reaction. It is not so dark in the surface soil or so gray in the subsoil as the Maumee soils. It occurs on the sandy outwash plains, principally in sec. 6, T. 30 N., R. 2 E. To a depth of 8 to 10 inches the surface soil is dark-gray to very dark brownish-gray loose loamy fine sand. The reaction is strongly acid. When the material is dry, the light-gray quartz sand grains stand out in contrast with the dark organic material. The subsoil of mottled gray and yellow loamy fine sand grades into loose gray sand in the deeper layers.

A large part of this soil has been drained sufficiently to allow cultivation in years of normal rainfall. Corn, wheat, and oats are the principal crops, but owing to the strong acidity, the yields are low. Several fields composed largely or entirely of this soil and Newton fine sandy loam have been seeded to bluegrass, timothy, and a mixture of grasses for permanent pasture, but a comparatively large percentage of the land was idle when surveyed. Proper artificial drainage and heavy applications of lime and commercial fertilizer are required to make this soil economically productive.

Newton fine sandy loam.—The 8- to 10-inch surface layer of this soil is dark-gray loose fine sandy loam. The subsoil and substratum

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

are practically identical with those of Newton loamy fine sand. In position, drainage, reaction, content of organic matter, and management practices, this soil is comparable with Newton loamy fine sand, but the yields are slightly higher.

SOILS OF THE STREAM BOTTOMS AND BOGS

The soils of the stream bottoms are relatively unimportant agriculturally. They occupy a small total area, over 90 percent of which lies along the Tippecanoe River and the rest borders Mud, Yellow, and Chippewanuck Creeks or other small streams. A large part of the soils of the first bottoms is subject to overflow every year, and practically all the land is flooded in periods of extremely high water. The hazard of overflow probably accounts for the use of a large part—probably more than 85 percent—of the bottom land in and large depressions throughout the county.

The soils of the stream bottoms represent an accumulation of material left by overflow waters, and stratification planes representing the various stages of deposition are generally observed. The soils vary in color, natural drainage, content of organic matter, and texture. The color generally depends on the drainage conditions and quantity of organic material present. Natural drainage ranges from good to poor. Textures range from silt loam to loamy fine sand, but the lighter textures predominate. The organic soils occur in many small and large depressions throughout the county.

For purposes of discussion and comparison the soils of the stream bottoms and bogs are placed in the following subgroups: (1) Well-drained alluvial soils; (2) poorly drained alluvial soils; and (3) organic soils.

WELL-DRAINED ALLUVIAL SOILS

The well-drained alluvial soils are in the Genesee and Ross series. Most areas are directly adjacent to streams and are on a somewhat higher elevation than the poorly drained alluvial soils.

Genesee loam.—The surface soil is light yellowish-brown to brown friable loam. The subsoil is light brown to brown loam or fine sandy loam. Below a depth of about 36 inches are layers of sands, silt, and fine gravel. The soil is approximately neutral in reaction throughout. The cultivated land is planted to corn, wheat, alfalfa, and clover, from which the returns are fairly high. About 50 percent of the land is in forest.

Included on the map with Genesee loam are a few small areas of slightly more productive Genesee silt loam.

Genesee fine sandy loam.—The 10-inch surface layer of this soil is light yellowish-brown to brown fine sandy loam, below which is light-brown to pale-brown loose loamy fine sand or sand. The color and texture of this material are extremely variable, and layers of different textures, representing successive deposits, may be easily distinguished. The reaction is neutral throughout. Like the other alluvial soils, it is subject to overflow, and the composition and texture of the surface soil may, in a few years, be somewhat altered. More than 50 percent of the areas are in forest, and the part in cultivation is used largely for corn, wheat, or special crops.

Ross loam.—The 8- to 12-inch surface soil of this type contains sufficient organic matter to make it dark brown or dusky brown. The subsoil is similar to that of Genesee loam, except that in a few areas it contains a larger quantitiy of organic material. The reaction is almost neutral throughout. It receives treatment similar to Genesee loam, but potentially it is more productive.

As mapped, Ross loam includes a few areas of Ross silt loam, which is more fertile but not separately mapped because of the small total area. A few areas of less productive Ross fine sandy loam also are included because the total area is very small.

Ross loamy fine sand.—This soil occurs along the Tippecanoe River. To a depth of 6 inches the surface soil is dark-brown or dusky-brown incoherent loamy fine sand, in which the content of organic matter varies but is everywhere sufficient to darken the soil. Below this is pale-brown to grayish-yellow fine sand and gravel in which color and composition vary and layers representing successive deposits may be distinguished. Practically all the land is used for forest or pasture.

POORLY DRAINED ALLUVIAL SOILS

The poorly drained alluvial soils of bottoms and bogs are in the Sloan and Griffin series. They occur along the smaller streams and drainageways or farther back from the larger stream channels than the Genesee soils and also occupy old abandoned stream channels and temporary channels formed in periods of extremely high water.

Sloan loam.—The surface soil is dark brownish-gray friable loam, having a variable but comparatively high content of organic matter. The reaction is neutral. Below the surface soil the material is mottled dark-gray, yellow, and brown loam interstratified with fine sandy loam. Occasionally the yellow color is concentrated in pockets. This material grades into stratified fine sand, silt, and gravel that is mottled gray and yellow. These layers represent different periods or stages of accumulation. Most areas are in woodland pasture, but a few that are planted to corn, wheat, and hay produce good yields. Potentially this is the most productive poorly drained soil of the stream bottoms.

Griffin fine sandy loam.—This soil occurs along Tippecanoe River and Yellow Creek and is in forest. Variable, but generally poor drainage conditions and the presence of numerous old drainage channels account for the fact that it is not cultivated. The surface layer is dark brownish-gray to weak-brown fine sandy loam underlain by very fine sand and sand. The material and color are variable, and conspicuous rust-brown spots and blotches occur below a depth of 3 to 4 inches. The reaction is slightly acid to neutral in the upper part and neutral or alkaline below. A few areas having a loam surface are included with this soil on the map.

As mapped, this soil includes a few small patches that would be separated as Kerston muck if the total area justified. These patches border the stream and river bottoms and comprise alternate layers of muck and mineral material, the thickness and occurrence of which vary greatly from place to place. The organic material has accumulated both in place and by transportation and deposition by streams. The surface soil is composed either of muck or sand, but in cultivated areas it is a mixture of both and is very dark gray. All but a few areas are too poorly drained or too susceptible to flooding to allow cultivation and are in forest or pasture. A few areas from which timber has been removed now support an excellent stand of bluegrass.

Griffin loamy fine sand.—The surface soil of this type is dark brownish-gray to weak-brown loamy fine sand. It overlies material similar to that in the corresponding layer of Griffin fine sandy loam. Only a few small areas are mapped. Drainage conditions vary somewhat but are generally poor.

ORGANIC SOILS

Organic soils occur in areas of various sizes and shapes in bogs or swamps, in depressions, and in old drainageways in all parts of the county. They range from very small to almost 500 acres. Most of the larger bodies were formerly occupied by shallow lakes, but now they either have been made available for crops by artificial drainage or are only swamps or poorly drained areas. A few small bodies occur on slight slopes that have been kept moist by seepage.

These soils vary in drainage conditions, degree of decomposition, and character of underlying material. Included are Carlisle and Edwards mucks, phases of these mucks, and Wallkill loam. All range from slightly acid to mildly alkaline in reaction.

Carlisle muck, drained phase.—The drained areas of Carlisle muck are agriculturally the most important organic soils in the county. The larger areas have been burned over, lowering the level of the surface soil somewhat and increasing their mineral content.

In cultivated areas the surface soil to a depth of 8 to 10 inches is very dark brownish-gray to black granular loamy muck. Immediately below this is coarse granular and somewhat fibrous muck, which breaks into large chunks that are easily broken down into coarse granular fragments. To a depth of about 18 inches the material is well decomposed and black. Below this, and continuing in places to a depth of 15 feet or more, is brown or dark-brown peat containing large quantities of identifiable plant remains. Variations include differences in the depth to the brown peat and in its total depth. In the northeastern and eastern parts of the county the depth to peat is much less than elsewhere.

Areas of drained Carlisle muck are either under cultivation or support a good growth of bluegrass pasture. The principal crops are field corn, sweet corn, and potatoes, onions, cabbage, and other vegetables. The soil is high in organic matter and nitrogen and relatively low in phosphorus and potash. Crops require liberal applications of the two latter plant nutrients for successful growth. The fertilizer mixtures most commonly used are 0–8–24, 0–20–20, or 50-percent superphosphate. Small grains make too rank a growth to be successful. This soil should not be plowed too deep, and packing the surface by rolling is usually beneficial. Crop damage and wind erosion may be induced by overdrainage.

Carlisle muck.—Included in this separation are areas that have not been sufficiently drained for agricultural use. The larger areas are mapped southeast of Lake Manitou along Mill Creek, in the northeastern part of the county, and adjacent to other lakes. All stages of poor drainage are included, ranging from areas in which the water table is a few inches below the surface, and which support a good stand of bluegrass; to marshes and swamps in which the water table is above the surface, and which support a growth of reeds, sedges, and water-loving trees. Some areas included on the map will be available for crops when ditches are redredged.

Carlisle muck, shallow phase over sand.—Included in this separation are areas of muck that are underlain by sand at a depth of less than 36 inches. To a depth of 15 to 36 inches the material is practically the same as in Carlisle muck. Underlying this is loose gray sand containing pockets or spots of mottled yellow and brown sand.

Only a small total area is mapped. The larger areas occur in the sandy outwash-plain region and most of them border areas of Carlisle muck. Management practices and crops grown are very similar to those on the drained areas of Carlisle muck. The draining of the adjacent areas of Carlisle muck has in a few instances so lowered the water table as to make the soil somewhat droughty.

Edwards muck, drained phase.—Drained areas of Edwards muck have a very dark brownish-gray to black fine granular loamy muck surface soil of neutral to alkaline reaction. Immediately below this is black coarse granular muck. At a depth of 12 to 30 inches this material rests on gray calcareous marl containing numerous small shells and partly decomposed plant remains.

This soil is mapped north of Delong, southwest of Akron, and in other scattered parts of the county. It produces about the same crops as are grown on Carlisle muck, drained phase. In areas where the marl lies deepest, the yields of crops are good, but where it is close to the surface the soil may be too strongly alkaline for best results.

Edwards muck.—This separation includes areas of Edwards muck that are too poorly drained to allow cultivation. The water table is at or near the surface practically all the time. Only a few areas are mapped and they are largely in forest or pasture.

Wallkill loam.—This type is characterized by a mineral surface soil and an organic subsoil. It occurs in small depressions where the original muck soil has been covered by deposits of mineral soil material washed from surrounding slopes. The moisture conditions and depth to organic matter are extremely variable and are the limiting factors in the value of areas of this soil for agricultural production.

Under cultivation the 6- or 7-inch surface soil is dark brownish-gray to brownish-gray granular loam, although in a few areas it is silt loam. The reaction is generally neutral, but in a few areas slightly acid. In undisturbed areas the material has platy or laminated structure. Below the surface soil and continuing to a depth of 10 to 26 inches the material is dark-gray coarse granular loam or silt loam, containing pockets of weak-brown fine silty material. The lower part of this layer contains large quantities of organic matter. Immediately below this is black compact muck containing a small quantity of partly decomposed plant remains. There is a gradual change with depth to less compact black or dark-brown muck and peat material.

When Wallkill loam is properly drained, good crops can be produced. It is associated with Brookston, Clyde, and in some places with light-colored soils, and it is managed in a manner similar to the soils with which associated.

As mapped, Wallkill loam includes one small area of Wallkill fine sandy loam. This included soil has a dark brownish-gray loose fine sandy loam surface soil that is underlain at a depth of about 12 inches by muck similar to that in Wallkill loam.

MISCELLANEOUS LAND TYPES

Classed as miscellaneous land types in Fulton County are marsh and pits. These areas are unsuited to crops but may have commercial or recreational uses.

Marsh.—The marsh, or fresh-water swamp, areas at the southeastern part of Lake Manitou were formed by the damming of the outlets of the lake. This raised the general water table of the area, causing water to stand on areas of muck and sand. The more or less stationary level maintained in Lake Manitou causes permanent flooding, although the depth of the water is never more than a few feet.

Areas of marsh land adjacent to Mill Creek were formed by the damming of Mill Creek between section 36 of Rochester Township and section 31 of Henry Township.

Pits.—Areas shown as pits represent land from which 3 or 4 feet of surface material has been removed, and the underlying gravel has been or is being used for road building, concrete work, and various other purposes. The pits occur in areas of Bellefontaine, Fox, and Oshtemo soils, which have rather clean gravel and coarse sand underlying the surface and upper subsoil material. One area indicated on the map by a pit symbol, about 1 mile southeast of Akron, occurs in Nappanee loam. It represents an old clay pit, from which material was taken for firebrick and tile.

PRODUCTIVITY RATINGS AND LAND USE

Table 7 lists the soils of Fulton County by groups under the prevailing practices of soil management with the more productive groups first. The grouping of the soils conforms in general with the color groups shown on the soil map.

TABLE 7.—*Productivity ratings of soils in Fulton County, Ind.*

Soil	Crop productivity index [1] for—																				General productivity grade [3]		Type of farming, principal crops, or use [4]
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Rye (100=25 bu.)		Soybeans (100=25 bu.)		Mixed timothy and clover (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Vegetables [2]		Bluegrass pasture [2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Dark-colored and relatively fine-textured soils underlain by calcareous materials.																							
Brookston silt loam	100	120	60	90	70	90	60	90	80	100	80	100	80	100	80	100	70	80	90	100	1	1+	General grain and livestock farming. Principal rotation is corn, oats or wheat, soybeans, and clovers.
Westland silt loam	90	110	60	85	60	80	60	80	80	100	85	100	85	100	85	100	70	80	90	100	1	1+	Do.
Nyona silt loam	90	110	60	85	70	90	60	65	80	100	80	100	80	100	80	100	70	80	90	100	2	1	Chiefly used for grain farming. Corn, oats or wheat, soybeans, and clover are the principal crops.
Brookston loam	95	110	70	100	70	90	70	100	80	100	80	100	80	100	85	95	80	90	90	100	2	1	Chiefly used for general grain and livestock farming. Corn, oats, wheat, and soybeans are the principal crops.
Westland loam	85	105	60	80	60	80	60	80	80	100	80	100	80	100	85	95	80	90	90	100	2	1+	Do.
Clyde loam	75	100	60	75	50	70	60	75	80	100	75	90	75	90	80	90	70	90	90	100	2	1	Chiefly used for general grain and livestock farming; especially adapted to corn and soybeans. Small grains occasionally injured by heaving.
Abington loam	75	100	60	80	50	70	60	75	80	100	75	90	75	90	60	70	70	90	80	100	2	1	Do.
Lear loam	80	100	60	75	50	70	60	75	80	100	55	90	55	80	55	80	65	80	90	100	2	1	Used principally for corn, oats, and wheat, with some soybeans and clovers. Small grains occasionally injured by heaving.
Clyde silt loam	75	100	60	75	45	70	60	75	80	100	75	90	75	90	80	90	70	90	90	100	2	1	General grain and livestock farming; especially adapted to corn and soybeans. Small grains occasionally injured by heaving.
Abington silt loam	75	100	55	70	50	70	55	70	80	100	75	90	75	90	85	90	70	90	90	100	2	1	Do.
Lear silt loam	85	105	60	75	50	70	60	75	85	100	25	90	25	80	25	80	60	85	90	100	2	1	Used principally for corn, oats, and wheat, with some soybeans and clovers. Small grains occasionally injured by heaving.

Clyde silty clay loam	70	90	50	65	45	60	50	65	75	90	75	90	75	90	70	80	----	----	90	100	3	1	General grain and livestock farming; especially adapted to corn and soybeans. Small grains occasionally injured by heaving.
Washtenaw silt loam	50	75	40	60	40	60	40	60	60	80	60	80	60	80	55	75	60	80	60	80	5	3	General grain and livestock farming. Crops subject to injury from drowning out, especially in small pocketlike areas.
Washtenaw loam	45	70	40	60	40	60	40	60	55	75	55	75	55	75	50	70	55	75	55	75	6	3	Do.
Dark-colored and relatively coarse-textured soils underlain by calcareous or neutral materials.																							
Granby loam	65	85	45	60	40	55	45	60	70	85	70	85	70	85	60	70	75	85	80	90	3	2	General grain and livestock farming. Principal crops are corn, oats, wheat, and soybeans; especially adapted to corn and soybeans.
Brady loam	70	90	50	65	45	60	50	65	75	90	75	90	75	90	65	75	80	90	85	95	3	1	Do.
Maumee loam	70	90	50	65	45	60	50	65	75	90	75	90	75	90	65	75	80	90	85	95	3	1	Do.
Gilford loam	70	90	50	65	45	60	50	65	75	90	75	90	75	90	65	75	80	90	85	95	3	1	Do.
Brady fine sandy loam	60	75	50	65	40	55	45	60	60	80	60	75	60	75	55	70	75	85	80	90	4	3	General grain and livestock farming. Principal crops are corn, oats, wheat, and soybeans. Crops may be injured by wind erosion and drought.
Granby fine sandy loam	60	75	50	65	40	55	45	60	60	80	60	75	60	75	55	70	75	85	80	90	4	3	Do.
Gilford fine sandy loam	60	80	50	65	40	55	45	60	60	80	60	75	50	75	55	70	75	85	80	90	4	3	Do.
Maumee fine sandy loam	60	80	50	65	40	55	45	60	60	80	60	75	60	75	55	70	75	85	80	90	4	3	Do.
Maumee fine sandy loam, ferruginous phase.	60	80	50	65	40	55	45	60	60	80	60	75	60	75	55	70	75	85	80	90	4	3	Do.
Granby loamy fine sand	50	70	40	55	30	45	35	50	50	70	50	65	50	65	45	60	65	75	70	80	5	4	Do.
Maumee loamy fine sand	50	70	40	55	30	45	35	50	50	70	50	65	50	65	45	60	65	70	70	80	5	4	Do.
Organic soils:																							
Carlisle muck, drained phase	70	120	50	75	50	70	----	----	60	90	----	----	----	----	----	----	30	120	90	100	3	1+	Used principally for corn, special crops, and bluegrass. Excellent soil for special crops as potatoes, mint, and onions.
Edwards muck, drained phase	60	90	45	65	45	65	----	----	50	80	----	----	----	----	----	----	30	100	90	100	4	2	Used principally for corn, special crops, and bluegrass. Excellent soil for special crops as potatoes, mint, and onions. Some injury to potatoes if marl is close to surface.
Carlisle muck, shallow phase over sand (drained).	70	90	50	65	45	60	50	65	60	90	----	----	----	----	----	----	30	95	85	95	3	1	Used principally for corn, special crops, and bluegrass. Excellent soil for special crops, as potatoes, mint, and onions.
Wallkill loam	75	95	50	70	50	70	50	70	80	100	70	80	70	80	70	80	80	90	90	100	3	1	General grain and livestock farming. Crops subject to injury from drowning out when soil occurs in small pockets.

See footnotes at end of table.

TABLE 7.—*Productivity ratings of soils in Fulton County, Ind.*—Continued

Soil	Crop productivity index [1] for—																				General productivity grade [3]		Type of farming, principal crops, or use [4]
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Rye (100=25 bu.)		Soybeans (100=25 bu.)		Mixed timothy and clover (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Vegetables [2]		Bluegrass pasture [2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Organic soils—Continued																							
Carlisle muck	30	----	----	----	----	----	----	----	30	----	----	----	----	----	----	----	20	----	60	----	9	----	Not generally cropped because of inadequate drainage. Some areas used for bluegrass pasture.
Edwards muck	20	----	----	----	----	----	----	----	20	----	----	----	----	----	----	----	20	----	60	----	9	----	Do.
Marsh	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	Too wet for agricultural use.
Alluvial soils:																							
Ross loam	75	105	65	75	55	75	60	75	80	105	80	95	85	100	80	90	70	90	90	100	3	1	Used principally for corn, bluegrass pasture, and timber. Crops subject to injury from flooding.
Genesee loam	75	100	60	80	60	70	60	75	80	100	75	90	75	90	55	70	70	90	90	100	3	1	Do.
Sloan loam	60	75	50	65	50	65	55	65	60	80	70	80	70	80	----	----	50	70	80	95	4	2	Do.
Genesee fine sandy loam	55	70	45	65	45	50	55	65	55	70	55	65	55	65	55	65	50	70	70	80	5	3	Do.
Ross loamy fine sand	50	60	35	40	25	30	35	40	50	60	----	----	----	----	55	65	60	75	70	80	5	4	Do.
Griffin fine sandy loam	50	65	----	----	----	----	----	----	45	60	----	----	----	----	----	----	----	----	60	70	5	4	Used principally for corn, bluegrass pasture, and timber, with small quantities of hay and small grains. Crops subject to injury from flooding.
Griffin loamy fine sand	40	50	----	----	----	----	----	----	40	55	----	----	----	----	----	----	----	----	60	70	6	5	Used chiefly for corn. Subject to overflow. Too droughty for small grains and clovers.
Imperfectly drained soils of the smoother uplands on glacial till:																							
Crosby loam	70	90	60	80	65	80	60	80	70	90	60	80	60	80	50	75	50	60	70	90	4	2	General grain and livestock farming. Well adapted to the growing of alfalfa when drained and limed.
Nappanee loam	60	80	50	75	60	75	60	80	65	80	50	75	50	75	50	75	40	50	60	80	4	2	General grain and livestock farming. Relatively large acreage in bluegrass pasture.
Crosby fine sandy loam	55	70	45	65	45	65	45	65	60	70	45	65	55	70	40	70	40	50	65	75	5	4	General grain and livestock farming. Well adapted to growing alfalfa when drained and limed.
Aubbeenaubbee fine sandy loam	45	60	50	70	40	60	50	60	50	60	45	55	45	55	40	55	20	40	50	55	6	4	Do.
Aubbeenaubbee loamy fine sand	35	50	35	50	30	40	30	45	40	50	40	50	30	50	30	45	----	----	40	45	7	5	Do.

Imperfectly drained to moderately well drained soils of the outwash plains:																							
Bronson loam	55	65	45	60	35	60	50	60	55	75	40	65	50	65	50	70	60	70	65	75	5	3	Do.
Bronson fine sandy loam	40	60	40	55	40	45	50	55	50	65	40	60	30	60	40	65	60	70	60	70	5	4	Do.
Imperfectly drained soils of the sandy lake plain:																							
Morocco loamy fine sand	35	50	30	45	35	50	30	45	35	50	35	50	----	----	----	----	----	----	20	30	7	5	General grain and livestock farming. Not well adapted to clovers or bluegrass.
Berrien loamy fine sand	30	50	25	50	20	40	25	50	20	45	20	50	----	----	----	----	----	----	15	25	8	6	Do.
Well-drained soils of the smoother uplands on glacial till:																							
Miami loam	60	80	60	85	60	85	60	85	60	80	50	75	50	80	50	85	50	65	70	80	4	2	General grain and livestock farming.
St. Clair loam	60	80	60	85	60	80	60	80	60	80	60	80	60	80	60	80	50	70	80	95	4	2	General grain and livestock farming. Relatively large acreage in bluegrass pasture and alfalfa.
Hillsdale loam, depression phase	60	80	60	85	60	80	60	80	65	85	40	75	25	80	45	75	50	60	70	80	4	3	General grain and livestock farming.
Hillsdale loam	50	75	60	85	60	85	60	85	60	80	30	75	20	75	40	70	----	----	70	80	5	3	Do.
Miami fine sandy loam	45	65	50	80	55	75	50	75	45	70	45	65	30	65	30	70	40	55	60	70	5	3	Do.
Hillsdale fine sandy loam	40	65	50	70	50	65	50	70	45	60	20	60	15	50	20	60	35	50	60	70	5	4	Do.
Hillsdale loamy fine sand	30	50	40	60	40	50	45	55	35	50	15	40	10	50	20	50	40	50	50	60	7	5	General grain and livestock farming. Crops subject to injury from drought.
Well to excessively drained soils of the smoother gravelly moraines and outwash plains:																							
Bellefontaine loam	45	75	45	75	40	65	45	65	50	65	45	65	35	65	40	70	35	50	70	80	6	4	General grain and livestock farming. Adapted to corn, wheat, soybeans, and alfalfa.
Fox loam	55	75	45	80	45	55	50	80	65	80	50	65	50	65	50	80	65	80	70	80	5	3	Adapted to corn, wheat, soybeans, and alfalfa.
Mill Creek fine sandy loam	45	70	45	70	35	50	40	70	55	75	45	60	45	60	45	70	50	70	65	75	5	4	Do.
Fox fine sandy loam	45	65	40	70	35	45	45	70	50	65	45	60	45	60	45	70	55	70	55	75	6	4	Adapted to corn, wheat, soybeans, and alfalfa. Oats and clovers (except alfalfa) subject to injury from drought.
Bellefontaine fine sandy loam	40	55	35	55	25	45	35	55	40	55	35	55	35	50	35	65	50	65	45	55	6	5	Do.
Oshtemo fine sandy loam	40	55	35	50	30	45	35	50	30	45	30	45	30	45	35	65	35	65	45	60	7	5	Do.
Oshtemo loamy fine sand	35	55	30	45	25	35	30	45	25	35	30	55	15	30	25	55	30	45	35	45	7	6	Do.
Excessively drained soils of the smoother sandy uplands and outwash plans:																							
Metea fine sandy loam	40	60	35	65	50	65	50	65	40	55	35	55	30	60	20	60	30	45	50	60	6	4	General grain and livestock farming.
Metea loamy fine sand	30	50	30	55	30	50	30	50	20	40	15	40	15	40	20	50	25	35	40	50	7	5	General grain and livestock farming. Crops subject to injury from drought.
Coloma loamy fine sand	30	40	30	45	20	30	25	45	25	45	20	35	15	35	20	65	50	70	45	55	7	5	Used for general farm crops. Not adapted to oats and clovers (except alfalfa). Crops subject to injury from drought and wind erosion.
Plainfield loamy fine sand	35	55	25	45	25	35	25	45	25	35	25	45	15	35	15	55	30	45	30	40	8	6	Do.

See footnotes at end of table.

TABLE 7.—*Productivity ratings of soils in Fulton County, Ind.*—Continued

Soil	Crop productivity index[1] for—																				General productivity grade[3]		Type of farming, principal crops, or use[4]
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Rye (100=25 bu.)		Soybeans (100=25 bu.)		Mixed timothy and clover (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Vegetables[2]		Bluegrass pasture[2]				
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
Poorly drained soils of the depressions (dark-colored and underlain by acid sands):																							
Newton fine sandy loam	30	75	30	55	30	75	30	55	45	65	35	55	15	45	15	45	30	75	25	45	7	6	Used for general farm crops. Not adapted to clovers because of high acidity.
Newton loamy fine sand	25	55	25	45	25	55	25	45	35	50	30	45	15	45	15	45	25	65	25	40	8	6	Do.
Well to excessively drained soils of the uneroded slopes of the till uplands:																							
Miami loam, slope phase	40	55	40	55	35	50	35	55	35	60	40	60	35	60	35	60	----	----	60	70	6	5	General grain and livestock farming. Crop yields subject to erosion control.
St. Clair loam, slope phase	40	55	40	55	35	50	35	55	35	60	40	60	35	55	40	60	----	----	70	80	6	5	General grain and livestock farming. Crop yields subject to erosion control. Large acreage in alfalfa and bluegrass pasture.
Miami fine sandy loam, slope phase.	30	40	25	35	25	35	25	35	25	35	25	40	10	30	30	50	----	----	40	50	7	5	General grain and livestock farming. Crop yields subject to erosion control.
Well to excessively drained soils of the eroded slopes of the till uplands:																							
Miami loam, eroded slope phase	20	25	15	30	15	30	15	30	20	30	20	30	10	35	25	45	----	----	40	50	8	7	General grain and livestock farming. Crop yields lowered because of erosion.
St. Clair loam, eroded slope phase	20	25	15	30	15	30	15	30	20	30	20	30	10	35	25	45	----	----	50	60	8	7	General grain and livestock farming. Crop yields lowered because of erosion. Large acreage in alfalfa and bluegrass pasture.
Miami fine sandy loam, eroded slope phase.	15	25	15	25	15	20	15	20	15	25	15	25	10	25	25	40	----	----	25	40	8	7	General grain and livestock farming. Crop yields lowered because of erosion.

Well to excessively drained soils of the uneroded slopes of the gravelly moraines and outwash plains:																							
Mill Creek fine sandy loam, slope phase.	20	35	20	30	----	----	15	30	15	35	15	20	15	20	20	40	----	----	40	50	8	6	General grain and livestock farming. Crop yields subject to erosion control. Better adapted to alfalfa and bluegrass because of droughtiness.
Fox fine sandy loam, slope phase.	20	35	20	30	----	----	15	30	15	35	15	20	5	20	20	40	----	----	40	50	8	7	Do.
Bellefontaine fine sandy loam, hilly phase.	20	30	15	20	----	----	15	25	15	25	20	25	10	25	25	45	----	----	40	50	8	7	Do.
Oshtemo fine sandy loam, slope phase.	20	30	15	20	10	15	15	20	10	15	10	20	10	20	15	30	----	----	25	35	9	8	Do.
Excessively drained soils of the uneroded slopes of the sandy uplands and outwash plains:																							
Metea loamy fine sand, slope phase.	25	35	25	35	20	25	25	35	25	35	15	25	15	30	20	45	----	----	25	35	8	7	General grain and livestock farming. Crop yields subject to erosion control.
Coloma loamy fine sand, slope phase.	15	35	15	25	5	15	15	25	----	----	10	20	5	20	10	30	30	50	25	35	9	7	Used for general farm crops. Not adapted to oats and clovers (except alfalfa). Crops subject to injury from drought and wind erosion.
Plainfield loamy fine sand, slope phase.	15	30	10	25	20	30	15	25	5	30	10	20	5	20	5	30	20	35	20	30	9	8	Do.
Well to excessively drained soils of the eroded slopes of the gravelly moraines and outwash plains:																							
Mill Creek fine sandy loam, eroded slope phase.	10	20	10	20	----	----	10	20	----	----	----	----	----	----	15	30	----	----	10	20	9	8	Used for general farm crops. Crop yields lowered because of erosion. Better adapted to alfalfa, bluegrass, or timber.
Fox fine sandy loam, eroded slope phase.	10	20	10	20	----	----	10	20	10	20	----	----	----	----	15	30	----	----	10	20	9	8	Do.
Bellefontaine loam, eroded hilly phase.	10	20	10	20	----	----	10	20	10	20	----	----	----	----	15	30	----	----	10	20	9	8	Do.
Bellefontaine fine sandy loam, eroded hilly phase.	10	20	10	20	----	----	10	20	10	20	----	----	----	----	15	30	----	----	10	20	9	8	Do.
Excessively drained soils of the eroded slopes of the sandy uplands and outwash plains:																							
Metea loamy fine sand, eroded slope phase.	15	25	15	25	10	15	15	25	15	25	10	20	10	20	10	40	----	----	20	25	9	8	General grain and livestock farming. Crop yields lowered because of erosion.
Coloma loamy fine sand, eroded slope phase.	10	20	10	15	----	----	10	15	----	----	----	----	----	----	----	----	20	30	15	30	9	8	Used for general farm crops. Crop yields lowered because of erosion. Better adapted to alfalfa or timber.
Plainfield loamy fine sand, eroded slope phase.	5	10	5	10	----	----	5	10	----	----	----	----	----	----	5	20	----	----	----	----	9	8	Do.
Oshtemo fine sandy loam, eroded slope phase.	5	15	----	----	----	----	----	----	10	20	----	----	----	----	15	25	----	----	20	30	9	8	Best suited to timber.

See footnotes at end of table.

TABLE 7—*Productivity ratings of soils in Fulton County, Ind.*—Continued

Soil	Crop productivity index [1] for—																				General productivity grade [3]		Type of farming, principal crops, or use [4]
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Rye (100=25 bu.)		Soybeans (100=25 bu.)		Mixed timothy and clover (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Vegetables [2]		Bluegrass pasture [2]				
	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 the gullied slopes of the uplands:																							
Bellefontaine fine sandy loam gullied hilly phase.	5	10	5	10	----	----	5	10	5	10	----	----	----	----	10	20	----	----	10	20	10	9	Best suited to timber.
Miami loam, gullied slope phase.	5	15	5	15	----	----	5	15	5	15	5	15	5	15	10	25	----	----	10	20	10	9	Not suited for crop production.
St. Clair loam, gullied slope phase.	5	15	5	15	----	----	5	15	5	15	5	15	5	15	10	25	----	----	10	20	10	9	Do.
Miami fine sandy loam, gullied slope phase.	5	15	5	15	----	----	5	15	5	15	5	15	5	15	10	25	----	----	10	20	10	9	Do.
Metea loamy fine sand, gullied slope phase.	5	10	5	15	----	----	5	15	5	10	5	15	5	10	5	25	----	----	10	20	10	9	Do.
Bellefontaine loam, gullied hilly phase.	5	10	5	15	----	----	5	15	5	10	5	15	5	10	5	25	----	----	10	20	10	9	Do.

[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, as yield data are too fragmental to be adequate. Indexes in column A refer to average yields obtained under prevailing practices, whereas indexes in column B refer to average yields obtained under improved methods of farm management that include crop rotations, erosion control practices, the use of legumes, commercial fertilizers, lime, and barnyard and green manures. 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.

[4] Crop uses for each soil type and phase are given in table 8.

The rating compares the productivity of each of the soils for each crop to a standard of 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 is given at the head of each respective column. Soils given amendments, as lime and commercial fertilizers, or special practices, as artificial drainage, and unusually productive soils, may have productivity indexes of more than 100 for some crops.

The ratings in table 7 are based primarily on interviews with farmers and the county agent and observations in the field by members of the soil survey party and others who have had experience in the agriculture of Fulton County. They are presented only as estimates of the average production over a period of years according to two broadly defined types of management. These ratings may not apply directly to specific tracts of land for any particular year, as the soils shown on the map vary somewhat, 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 productivity ratings for vegetables and pasture are relative because of limited information as to the yields of the individual kinds of vegetables, or the carrying capacity of soils in terms of cow-acre-days or pounds of beef produced an acre each year.

The indexes in column A under each crop indicate yields obtained under the prevailing practices, which, on most of the soils, include the use of small to moderate quantities of commercial fertilizers, but which 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. The indexes in column B indicate yields under more careful and intensive practices. These practices consist of a regular crop rotation including the growing of legumes, the use of barnyard and green manures, the application of lime and liberal quantities of suitable commercial fertilizers, the use of improved varieties and high-quality seed, and where needed, the use of mechanical measures, such as contour tillage, strip cropping, and terracing or the construction of diversion ditches for the control of erosion.

The arrangement of the soils by groups is a departure from other ratings published previously in Indiana, in which the soils have been arranged in the order of their general productivity. The present arrangement allows direct comparisons to be made between rather similar soils, and it is hoped thereby increases the convenience and use of the table.

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 Fulton 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 principal factors affecting the productivity of land are climate, soil (this includes the many physical, chemical, and biological characteristics), slope, drainage, and management, including the use of amendments. No one of these factors operates separately from the others, although some one may dominate. The factors listed may be grouped simply as the soil factor and the management factor, as slope, drainage, and most of the aspects of climate may be considered characteristics of a given soil type, since the soil type, as such, occupies specific geographical areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available summation of the associated factors and, therefore, are used where available. As stated earlier, in Fulton County many of the indexes are based on estimated yields rather than on actually reported yields, although the benefit of the experiences of farmers and members of the Purdue University Agricultural Experiment Station was had.

Productivity tables do not present the relative roles that soil types, because of their extent and the pattern of their 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 a soil for agricultural use. In turn, steepness of slope, presence or absence of stone, the resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristics that influence the relative ease with which soils can be tilled. Inherent fertility and susceptibility to erosion are also 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 of these and other factors, such 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 sutability of land for agricultural use generally give some separate recognition to them.

The percentage of the soils of Fulton County according to their present uses are given in table 8.

TABLE 8.—*Present uses of the soils of Fulton County, Ind.*[1]

Soil	Corn	Oats	Wheat	Rye	Soybeans	Truck crops	Clover hay	Mixed hay	Timothy	Alfalfa	First-grade pasture [2]	Second-grade pasture [2]	Third-grade pasture [2]	Wooded pasture	Special pasture [3]	Idle land [4]	Oak-hickory timber	Other uses [5]
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Average for the county, all soils combined [6]	28.7	6.1	8.5	2.4	2.0	0.4	0.4	2.9	0.9	3.9	2.7	14.6	3.6	2.4	1.0	4.4	4.6	10.5
Abington loam	25.6	7.9	7.3	.5	(7)	-----	-----	1.1	1.6	3.7	2.1	18.8	-----	2.6	3.7	9.4	7.8	7.9
Abington silt loam	23.5	4.4	5.9	3.2	2.9	-----	-----	4.1	-----	.3	1.2	21.2	2.9	3.8	-----	11.5	3.2	11.9
Aubbeenaubbee fine sandy loam	29.3	9.9	7.6	8.5	2.9	-----	-----	4.2	1.2	3.4	2.7	6.9	2.9	1.3	4.2	2.9	3.1	9.0
Aubbeenaubbee loamy fine sand	28.0	3.5	12.9	2.0	5.0	-----	-----	3.7	-----	.2	5.0	25.0	2.2	.2	.2	4.0	3.2	4.9
Bellefontaine fine sandy loam	22.9	1.6	5.4	1.0	-----	-----	-----	2.6	-----	5.5	1.0	17.9	5.0	2.6	2.3	10.6	7.7	13.9
Eroded hilly phase	11.1	1.7	8.9	7.6	.4	.4	-----	.4	-----	.4	-----	-----	5.1	.9	3.9	31.9	6.4	20.9
Gullied hilly phase	48.4	-----	-----	-----	-----	-----	-----	-----	-----	12.3	-----	36.9	.8	-----	.8	-----	-----	.8
Hilly phase	-----	-----	-----	-----	3.0	-----	-----	-----	-----	-----	1.5	31.3	-----	-----	-----	10.4	35.8	18.0
Bellefontaine loam	22.8	3.0	6.1	3.4	.4	.6	1.3	2.7	1.3	6.7	1.9	15.0	2.1	3.0	-----	9.1	6.3	14.3
Eroded hilly phase	20.0	1.5	12.6	5.1	1.0	.5	.8	3.3	-----	2.0	.8	22.8	8.7	.8	-----	11.0	3.1	6.0
Gullied hilly phase	10.0	-----	-----	-----	-----	-----	10.0	20.0	-----	10.0	40.0	10.0	-----	-----	-----	-----	-----	-----
Berrien loamy fine sand	29.4	6.5	3.8	2.3	4.9	.7	.3	2.1	.4	5.4	3.1	9.1	2.9	1.4	.9	9.1	7.4	10.3
Brady fine sandy loam	22.4	9.2	13.2	.9	1.1	-----	.9	3.7	.5	1.5	2.4	17.1	2.4	-----	.7	7.9	6.8	9.3
Brady loam	22.1	9.4	9.2	2.9	3.2	.1	.6	8.0	.5	4.5	1.0	16.1	2.1	4.1	1.3	5.6	4.2	5.1
Bronson fine sandy loam	37.1	10.8	6.5	1.9	4.4	.9	1.3	5.1	.5	1.9	3.0	8.9	2.0	1.7	.1	1.8	3.7	8.4
Bronson loam	26.3	9.1	11.0	.6	2.8	.3	2.5	2.8	2.2	4.4	1.9	16.3	1.6	1.9	.3	2.2	1.9	11.9
Brookston loam	28.6	6.6	11.7	2.8	2.0	.2	.6	4.0	1.1	2.2	3.4	15.1	3.0	2.1	1.5	3.3	4.1	7.7
Brookston silt loam	29.0	9.6	12.8	2.5	2.2	-----	.5	4.1	.8	2.4	2.6	14.4	2.0	2.9	.9	3.6	5.4	4.3
Carlisle muck	6.8	.8	1.2	.4	.2	.2	-----	.3	-----	.8	1.6	20.0	16.4	3.3	.5	9.1	6.3	32.1
Drained phase	38.9	3.5	2.5	1.1	1.0	2.0	.2	2.1	.4	1.0	2.7	21.5	8.0	1.5	.3	5.6	1.9	5.8
Shallow phase over sand	26.8	4.8	2.6	1.5	1.1	-----	1.0	3.9	.1	.3	4.4	29.4	6.7	4.0	.1	2.6	2.3	8.4
Clyde loam	20.3	5.4	2.3	1.4	1.4	-----	-----	1.7	6.3	.9	2.8	21.7	5.7	1.4	.6	11.4	6.0	10.7
Clyde silt loam	19.3	12.2	9.9	2.3	2.6	-----	.1	2.8	.4	1.5	5.1	18.8	1.7	3.2	2.6	2.9	10.6	4.0
Clyde silty clay loam	31.0	5.2	11.0	2.2	2.2	-----	-----	.7	-----	3.6	2.2	8.1	9.6	8.8	1.5	6.6	7.3	.0
Coloma loamy fine sand	30.8	5.7	6.8	4.3	2.6	.3	.3	2.4	.4	5.5	.9	10.6	2.9	2.2	1.7	5.5	5.3	11.8
Eroded slope phase	35.7	8.7	25.5	-----	-----	-----	-----	-----	-----	1.8	-----	6.9	-----	-----	5.2	6.9	3.5	5.3
Slope phase	13.9	17.7	3.3	.6	.8	-----	.4	13.9	.8	2.5	.6	11.0	3.3	1.3	-----	6.2	12.7	11.0
Crosby fine sandy loam	29.1	9.0	9.4	3.8	2.3	-----	.3	3.4	1.1	3.2	2.4	10.2	2.7	2.1	2.5	3.6	7.5	7.4
Crosby loam	32.2	6.4	12.8	2.5	2.1	-----	.6	3.1	1.2	3.0	3.7	12.1	1.6	2.9	.7	2.2	4.3	8.6
Edwards muck	7.7	-----	.5	-----	.5	2.9	-----	3.4	-----	.5	1.4	40.6	8.2	3.9	-----	4.8	15.0	10.6
Drained phase	43.3	4.3	4.8	-----	1.7	-----	-----	2.6	-----	-----	.4	26.8	9.5	2.6	-----	.4	1.7	1.9
Fox fine sandy loam	25.0	2.4	10.5	2.9	1.7	.3	.5	2.4	.7	7.1	1.1	10.8	2.8	2.2	.6	5.3	3.1	20.6
Eroded slope phase	21.1	3.3	17.3	.9	1.3	-----	-----	.9	.2	3.7	2.7	16.7	6.8	3.3	.2	7.1	2.7	11.8
Slope phase	29.4	10.2	2.9	4.4	-----	-----	-----	-----	-----	4.4	1.5	16.1	1.5	5.9	-----	-----	7.4	16.3

See footnotes at end of table.

TABLE 8.—*Present uses of the soils of Fulton County, Ind.*[1]—Continued

Soil	Corn	Oats	Wheat	Rye	Soybeans	Truck crops	Clover hay	Mixed hay	Timothy	Alfalfa	First-grade pasture [2]	Second-grade pasture [2]	Third-grade pasture [2]	Wooded pasture	Special pasture [3]	Idle land [4]	Oak-hickory timber	Other uses [5]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Fox loam	24.3	3.9	16.6	1.4	1.4	0.4	0.4	1.9	.1	7.1	1.2	13.6	2.6	2.7	0.4	4.5	4.8	12.7
Genesee fine sandy loam	10.9	----	1.6	----	----	----	----	----	----	----	----	8.5	----	11.6	----	----	58.9	8.5
Genesee loam	10.1	2.0	.6	.6	----	.3	----	----	----	4.6	6.0	21.8	----	40.2	1.4	3.4	4.9	4.1
Gilford fine sandy loam	24.3	7.6	2.5	----	----	----	9.2	6.7	1.7	.8	----	30.3	7.6	----	----	2.5	----	6.8
Gilford loam	20.0	12.2	10.0	4.5	4.5	----	----	----	----	5.6	----	15.6	3.3	1.1	----	5.6	13.3	4.3
Granby fine sandy loam	40.3	11.3	6.8	1.3	2.6	----	.5	3.4	----	1.5	.9	12.5	2.0	3.5	1.0	3.6	3.9	4.9
Granby loam	33.9	15.6	5.8	1.8	3.3	----	----	2.1	.6	3.7	6.6	6.6	.8	1.8	.6	7.6	2.9	6.3
Granby loamy fine sand	33.2	6.9	9.1	2.6	3.2	.7	----	4.0	.7	2.2	2.7	13.3	3.7	.9	1.6	10.5	4.0	5.4
Griffin fine sandy loam	9.5	1.6	2.2	.4	2.5	----	----	1.1	.2	3.3	----	21.7	9.3	3.3	.4	12.4	21.2	10.9
Griffin loamy fine sand	31.3	----	----	----	----	----	----	----	----	----	----	----	----	----	----	62.6	----	6.1
Hillsdale fine sandy loam	38.1	----	15.9	11.1	9.5	----	----	4.8	6.4	----	----	4.8	----	----	----	7.9	----	1.5
Hillsdale loam	36.3	3.2	9.5	1.2	1.3	.2	----	3.8	1.0	13.0	.7	7.5	1.0	1.5	----	5.3	1.0	13.5
Depression phase	18.3	6.4	6.4	7.5	3.2	----	----	5.4	----	.2	----	----	----	----	----	12.9	35.5	1.2
Hillsdale loamy fine sand	16.9	6.8	12.8	14.9	8.1	----	----	----	.7	4.1	----	4.7	----	1.3	2.7	18.9	----	8.1
Lear loam	47.0	17.0	28.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	8.0
Lear silt loam	46.1	24.5	2.2	1.5	.4	----	----	6.6	1.5	----	----	1.8	----	2.6	----	----	----	12.8
Maumee fine sandy loam	40.3	9.9	4.6	.4	1.9	.2	.1	4.6	----	.3	2.3	14.8	4.7	----	.2	5.9	2.5	7.3
Ferruginous phase	28.7	37.5	----	3.7	1.3	----	----	1.3	6.3	----	----	15.0	----	----	----	2.5	----	3.7
Maumee loam	43.4	9.9	4.2	.9	2.9	----	----	8.7	----	3.3	.6	11.8	1.7	1.3	1.2	6.2	1.2	2.8
Maumee loamy fine sand	24.9	10.3	4.6	4.2	2.7	.1	----	4.2	.4	1.3	1.2	13.6	3.9	.7	.4	13.0	7.8	6.7
Metea fine sandy loam	33.0	5.9	9.9	2.8	2.9	.1	.1	3.9	.8	6.5	2.3	10.0	1.8	4.0	1.2	4.4	3.0	7.4
Metea loamy fine sand	29.6	6.9	7.4	4.7	3.4	.1	.4	2.7	.5	5.6	2.8	9.7	2.5	1.4	1.4	5.2	6.6	9.1
Eroded slope phase	30.7	13.2	7.9	2.5	4.6	.2	.4	----	----	2.5	6.2	10.6	3.5	1.3	----	6.5	4.6	5.3
Gullied slope phase	17.2	1.1	5.4	4.3	----	----	4.3	1.1	2.1	6.5	9.7	22.6	7.5	----	----	7.5	6.5	4.2
Miami fine sandy loam	31.4	6.1	8.4	3.3	2.3	.2	.9	3.2	.9	4.3	2.2	11.9	2.3	2.7	1.5	4.0	5.7	8.7
Eroded slope phase	30.5	6.7	6.2	2.1	1.6	.1	.9	3.3	.9	6.1	.8	18.1	3.3	.9	1.3	6.4	3.4	7.4
Gullied slope phase	20.0	6.8	4.1	5.3	----	----	.7	3.1	1.7	2.9	2.2	26.2	7.7	.5	1.0	3.1	1.9	12.8
Slope phase	9.2	2.1	11.3	2.9	.3	----	----	8.6	----	2.1	1.5	15.7	3.0	12.5	2.1	3.9	16.3	8.5
Miami loam	28.1	4.9	11.7	1.5	1.2	.2	.4	3.1	1.5	5.0	3.6	16.1	1.9	2.1	.5	2.8	3.9	11.5
Eroded slope phase	26.7	4.4	10.7	2.2	.8	.1	.6	2.0	1.0	3.3	4.5	22.1	4.1	1.3	.2	5.6	2.6	7.8
Gullied slope phase	21.4	2.8	9.9	3.1	1.0	----	1.0	1.0	1.3	7.1	2.1	29.3	5.8	1.0	----	6.1	2.0	5.1
Slope phase	18.2	3.5	7.0	2.1	.7	.1	.7	2.8	1.0	4.9	5.1	21.3	3.5	2.7	.8	2.5	9.8	13.3

Mill Creek fine sandyl oam	28.5	3.6	10.0	3.2	.2	.5	.9	1.6		7.5	1.1	8.0	1.1	2.5	1.8	4.5	12.1	12.9
Eroded slope phase	25.0	1.9					1.9	5.8		3.8		44.2	7.6	3.8		5.8		.2
Slope phase	23.4	26.7								3.3	6.7	33.3						6.6
Morocco loamy fine sand	44.5	12.1	5.1	1.1	4.3	.4		1.3	.8	.6	3.3	4.8	1.4	.2	.2	2.9	4.3	12.7
Nappanee loam	25.0	22.8	3.3	1.1		1.1		3.9		2.8	.6	30.0	.5			1.1	2.8	5.0
Newton fine sandy loam	36.4	13.2	2.8	1.2	1.2			4.0		7.6		10.4	2.8			5.6	11.6	3.2
Newton loamy fine sand	20.4	4.4	3.8	1.7	2.9			1.5		3.8		16.9	6.1	2.9	.6	7.8	9.0	18.2
Nyona silt loam	46.0	13.8	7.4		4.2		.3	2.3	.8	.8	4.6	10.3	.1	.8	2.5	1.8	1.0	3.3
Oshtemo fine sandy loam	28.8	3.5	7.1	2.2	3.2	.5	.1	2.0	1.4	6.3	.5	8.9	2.1	1.9	.2	5.9	7.4	18.0
Eroded slope phase	26.7	6.9	6.4	4.4	1.5	.5		.5	1.5	6.9	1.5	12.9	4.0	1.0	5.9	10.4		9.0
Slope phase	12.4	3.2			1.1	1.1		1.1		5.0		21.1	6.2	7.2	3.2	17.7	10.4	10.3
Oshtemo loamy fine sand	31.1	5.6	5.3	3.6	3.3	.6	.4	1.3	1.7	6.6	.7	8.1	2.4	1.3	1.4	7.6	6.4	12.6
Plainfield loamy fine sand	28.7	4.0	4.3	2.4	3.0	.3	.1	1.5	.5	9.6	1.5	10.0	4.3	1.5	1.3	8.7	5.3	13.0
Eroded slope phase	33.3		4.2	4.2								16.7		29.2		8.3		4.1
Slope phase	17.5	1.6	2.2	1.1	2.6	.3		.3	.2	5.6	1.6	14.8	7.0	4.1	.7	5.7	18.4	16.3
Ross loam	22.4	1.7						6.9				34.5	10.1	22.4				2.0
Ross loamy fine sand	3.3		4.9									9.8	13.1	47.5			11.5	9.9
St. Clair loam	17.2	4.1	6.4	.3	.4			.4	2.5	8.1	6.8	27.2	3.3	4.1	.2	1.2	4.6	13.2
Eroded slope phase	20.3	4.7	9.8	.9	.2	.5		.4	1.8	3.7	2.8	31.7	6.5	1.9	.1	2.4	3.7	8.6
Gullied slope phase	8.7	2.5	1.2			1.2	2.5			4.9	23.4	28.4	8.6			1.2	2.5	14.9
Slope phase	5.1		2.6		2.5					10.2		23.1				2.5	28.1	25.9
Sloan loam	15.7	.6	1.2	1.2	1.6			1.4	.2	.8	1.6	28.2	3.9	16.5		3.1	15.1	8.9
Wallkill loam	23.4	7.0	3.3	.3	1.5	.7		2.8	2.2	2.7	4.3	24.3	5.8	1.2	.3	8.3	1.8	10.1
Washtenaw loam	16.7	10.2	13.8	1.8	.4		.4	6.5	2.2	3.6	5.4	10.9	6.9	5.8		2.9	4.0	8.5
Washtenaw silt loam	24.5	4.5	9.1	4.5	1.3	.1	.2	3.2	1.4	5.1	3.4	21.0	3.9	.9	.6	3.5	4.9	7.9
Westland loam	26.9	7.1	9.8	1.2	.7	.1	2.7	1.9	1.3	6.8	2.2	11.7	3.4	1.7	.2	3.2	7.2	11.9
Westland silt loam	24.1	5.9	17.2	2.9	2.1	.1	1.8	3.9	.7	1.2	1.6	12.8	3.6	3.9	1.2	6.0	3.9	7.1

[1] Use data collected by survey party during the field mapping of soils (1937).

[2] First-grade pasture includes areas having 90 percent or more of bluegrass and white clover; second-grade, 50 to 90 percent bluegrass; third-grade, less than 50 percent bluegrass.

[3] Special pasture includes spring planted millet and rape.

[4] Idle land includes arable land not under cultivation.

[5] Includes all other crops and uses.

[6] A comparison of the uses of individual soils with the average use of all soils gives some suggestion of the relative adaptability of different soils for desirable uses. Large proportions of a soil in an undesirable use may not be due to adaptation to such use so much as to a lack of adaptation to desirable uses.

[7] Blank spaces indicate less than 0.1 percent of the total area in a given use.

These data, obtained at the time of the survey (1937), were compiled by the Purdue University Agricultural Equipment Station. The cereals and hays were mapped regardless of the quality of the crop. Pasture was divided into three groups, depending upon the quality and estimated percentage of bluegrass present. First-grade pasture includes areas where 90 percent or more of the cover is bluegrass or a mixture of bluegrass and white clover; second-grade, 50 to 90 percent bluegrass; and third-grade less than 50 percent bluegrass. Wooded pasture includes areas with a somewhat sparse tall growth where trees are far enough apart to permit a fair to good growth of bluegrass, and where natural reproduction is not developing. Idle land includes areas or fields that are arable but not in cultivation. Under the heading "Other uses" are included minor crops and special forested conditions that are of small extent and relatively unimportant.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the soil materials deposited or accumulated by geologic agencies. Its characteristics 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 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 soil development have acted on the soil material. External climate is less important in its effects on soil development than internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and the relief. The relief, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The soils of Fulton County have developed from drift material of the Late Wisconsin glaciation. They occur in the region of Gray-Brown Podzolic soils, which occupy the east-central parts of the United States, and have developed under a heavy forest cover of deciduous trees. 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. There is a comparatively large glaciofluvial outwash plain, however, that represents the deposits made by the waters from the receding glacier. It is composed largely of sand and gravel, contains a small proportion of silt and clay, and is stratified. A small part of the sandier material has been reworked by the wind into dunes that have been held in place a long time by vegetation. Both mineral and organic soils are represented in the county, the former making up about 85 percent of the area.

The soils are grouped into three main divisions, on the basis of parent material and method of occurrence, as follows: (1) Soils of the glacial moraines and till plains; (2) soils of the glaciofluvial outwash plains and terraces; (3) soils of stream bottoms and bogs. Miscellaneous land types also are mapped.

The soils of the first division are subdivided into four groups on the basis of natural drainage conditions as follows: Very rapidly drained, well-drained, imperfectly drained, and poorly drained soils.

The Coloma and Metea soils are very rapidly drained because of the very sandy texture of their parent materials.

The A and upper B horizons of the Metea soils are sandy and porous to an average depth of about 26 inches. The lower B and C horizons are very similar to those of the Miami soils, and calcareous till is the underlying material. The sandy surface material represents the material accumulated by wind and deposited by glaciers.

The Coloma soils represent much thicker accumulations of sand than the Metea, although the surface layers probably were formed in a similar manner. They occur on more rolling areas than the Miami soils and are commonly in positions adjacent to large areas of muck. The presence here and there of large stones on and in the soil discredits the assumption that the Coloma soils are entirely the result of the action of wind.

The well-drained soils are representative of the Gray-Brown Podzolic soils of this region. They have been leached of soluble bases and calcium and magnesium carbonates to a depth of 24 inches or more, and sesquioxides have been removed from the surface soils and deposited, in part, in the B horizon. The depth to which the soluble bases have been leached depends in general on the texture of the material. The depth of leaching increases with coarseness of texture. This group comprises members of the Miami, St. Clair, Hillsdale, and Bellefontaine series, which occupy the glacial till plains and moraines of the uplands.

A profile description of Miami loam, taken in an oak-hickory-maple forest, in the NW¼ sec. 20, T. 30 N., R. 1 E., is as follows:

A_0. A thin accumulated layer of leaves, forest mold, and moss, about ½ inch thick.

A_1. 0 to 2 inches, dark-gray mealy loam containing much organic matter, largely decomposed and mixed with the mineral material. Numerous roots are present. The reaction is neutral.

A_{11}. 2 to 5 inches, dusky-brown mealy loam containing less organic matter and fewer roots than the material above. Worms are active in this horizon. There is a slight development of thin-platy structure. The reaction is very slightly acid.

A_2. 5 to 13 inches, pale-brown friable loam containing a very small quantity of organic matter. There is much activity of worms, and only a few roots are present. When moist, the material breaks into coarse-granular or small nut-shaped aggregates. The reaction is medium acid.

B_1. 13 to 17 inches, pale-brown to light yellowish-brown heavy loam. The material pulverizes rather easily into small subangular nut-shaped aggregates ⅜ to ½ inch in diameter. There is a thin gray coating on some of the cleavage faces, and small spots of gray silty material from the A horizon give the material a mottled appearance. This gray silt cannot be seen when the material is pulverized. The reaction is strongly acid.

B_2. 17 to 31 inches, heavy compact light-brown to yellowish-brown silty clay loam, representing an abrupt change from the layer above. The material breaks into medium-sized subangular nut-shaped aggregates ⅜ to ¾ inch in diameter that have a thin brown silty coating. The material is sticky when wet and hard when dry. The reaction is medium acid.

B_3. 31 to 34 inches, pale-brown heavy silt loam having a structure similar to the layer above but not so compact. Some sticky brown colloids cover parts of the cleavage faces. This is the neutral horizon of the Miami series and consists of leached and partly weathered parent material, with some accumulated colloids. The reaction is neutral.

C. 34 inches +, drab-gray to yellow sandy clay loam calcareous till containing numerous angular stone fragments.

As mapped, the Miami soils vary from the foregoing description in texture and in thickness of the various horizons. Within a given type the chief variability is the presence here and there in all but the A horizon of more sandy material, which occurs as pockets of various sizes. If two borings are made only a few rods apart, one may reveal a profile similar to the one described, whereas the other may be decidedly sandier in all horizons but the first three.

St. Clair loam has an A horizon much like that of Miami loam, but the subsoil and parent material are much heavier in texture.

The Hillsdale soils differ from Miami soils in having free lime carbonates at about twice the depth and an internal drainage that is more rapid, owing to a somewhat less compact B horizon. The associated depressions consist of the depression phase of Hillsdale loam rather than of soils of the Brookston and Clyde series.

Bellefontaine soils are characterized by heavy waxy clayey B_2 and B_3 horizons and unconsolidated gravel and sand substrata. A profile description of Bellefontaine fine sandy loam, on rolling land, in the NW¼NW¼ sec. 3, T. 31 N., R. 2 E., is as follows:

A_1. 0 to 2 inches, brownish-gray incoherent loamy fine sand containing many grass roots and a rather small quantity of organic matter. The reaction is neutral or slightly acid.

A_2. 2 to 8 inches, pale-brown fine sandy loam. Grass roots are numerous, and the content of organic matter is very small. Numerous worm casts are evidence of the great activity of earthworms. The reaction is slightly acid.

A_{22}. 8 to 15 inches, light yellowish-brown fine sandy loam containing some gravel and larger stones. The reaction is slightly to medium acid.

B_2. 15 to 24 inches, light-brown to brown compact gravelly clay loam. The material breaks into irregular-sized chunks that may be broken into angular aggregates. It is sticky when wet and becomes hard and compact when dry. The reaction is strongly acid.

B_3. 24 to 27 inches, dark-brown heavy gravelly clay loam, very sticky when wet. This layer is darker than the material above and tongues of it project downward into the C horizon. The reaction is neutral.

C. 27 inches +, unconsolidated calcareous gravel and coarse sand. Cross bedding is prominent.

The Bellefontaine soils vary in the thickness of the various horizons and occupy rolling to strongly rolling areas, many of which are kames and eskers in morainic areas. They are generally associated with Miami soils.

The glacial till soils that have been subjected to imperfect drainage conditions during their development comprise the third subgroup, consisting of the Crosby, Nappanee, and Aubbeenaubbee soils. Natural drainage conditions are intermediate between those of the well-drained soils, as represented by the Miami series, and those of the poorly drained soils, as represented by Brookston series.

A representative profile of Crosby fine sandy loam, in an oak-hickory wooded area, SW¼, sec. 10, T. 30 N., R. 1 E., is as follows:

A_0. About ½ inch of partly decayed forest litter and moss.

A_1. 0 to 5 inches, dark-gray mellow fine sandy loam containing sufficient organic matter to give the material a dark color. Numerous grass and tree roots are present, and there is evidence of some worm activity. The reaction is slightly acid.

A_2. 5 to 10 inches, pale yellowish-gray loam, having a coarse-crumb structure. A few small pebbles are present, and there is evidence of considerable worm activity. The reaction is slightly acid.

B_2. 10 to 23 inches, mottled yellow, gray, and light-brown sandy clay loam. The material is compact in place, but may be broken down with some difficulty into small nut-shaped aggregates, ⅜ to ½ inch in diameter. The reaction is medium acid.

B_3. 23 to 35 inches, mottled gray and yellow heavy sandy clay loam containing a small proportion of pebbles and small stones. The material breaks into irregular-sized angular lumps ¼ to 3 inches in diameter. The reaction is approximately neutral.

C. 35 inches +, gray streaked with pale-yellow calcareous sandy clay. It breaks into irregular-sized angular chunks as much as 5 inches in diameter.

Nappanee loam has a surface soil much like that of Crosby loam, but the subsoil and the substratum are much heavier.

Aubbeenaubbee soils resemble Metea soils in having sandy A and upper B horizons and heavier textured lower B and C horizons. In natural drainage and relief, however, they are similar to the Crosby soils. The content of organic matter in the Aubbeenaubbee series is lower than in any of the other imperfectly drained soils.

The poorly drained soils of this division are characterized by a dark color and a high content of organic matter. They occupy depressions where natural drainage conditions indicate that the water table was near or at the surface during most of their development. These soils of the Brookston, Clyde, and Washtenaw series, are higher in nitrogen, phosphorus, potash, and calcium than those of the first and second subgroups.

In a wooded area that had a good stand of maple and elm with an undergrowth of pawpaw in the SE¼ sec. 35, T. 29 N., R. 1 E., Brookston loam has the following profile:

1. About 1 inch of accumulated forest litter.
2. 0 to 7 inches, very dark brownish-gray friable loam of granular structure and high organic-matter content. The reaction is neutral.
3. 7 to 14 inches, dark-gray silt loam, breaking out into irregular-sized subangular particles. The reaction is neutral.
4. 14 to 23 inches, mottled, gray and yellow heavy clay loam of medium-nut structure with subangular particles ⅜ to ½ inch in diameter. The texture is noticeably heavier than in the horizon above. The reaction is neutral.
5. 23 to 44 inches, mottled gray and yellow clay loam. The color is somewhat lighter than the layer above, and the material breaks into irregular-sized angular blocks. When wet it is sticky, and when dry it is hard and compact. The reaction is neutral.
6. 44 inches +, gray calcareous clay loam, with streaks of pale yellow. Numerous small angular pebbles are present. It breaks into irregular-sized angular blocks.

The Brookston soils vary from the description above in thickness and texture of horizons and in depth to free lime.

The Clyde soils occupy lower depressions where natural drainage conditions are poorer than those existing in the Brookston series. The surface soil has a higher content of organic matter than the Brookston soils, and the subsoil is predominantly gray and slightly mottled with yellow.

The surface soil of the Washtenaw soils to a depth of 10 to 20 inches is an accumulation of light-colored material washed from the surrounding soils of the uplands and deposited on areas of Brookston and Clyde soils. A laminated structure is noticeable in the accumulated layer. Drainage conditions are similar to those existing in the Brookston and Clyde soils, but, where the recent deposits are thick, the soils are somewhat better drained.

All the soils of the glaciofluvial outwash plains and terraces are underlain by stratified sand and gravel; and, with the exception of slope and eroded phases, all occupy level to very gently undulating relief. They represent the deposits made by waters from the receding glacier, and some of the sandy materials were shifted somewhat by the wind soon after they were deposited. They are classified as very rapidly and rapidly drained soils, imperfectly drained, and poorly drained soils.

All the rapidly or very rapidly drained soils, which comprise the first subgroup, are light-colored and all are low in content of organic matter. The predominant texture of the surface soil is fine sandy loam, but the texture of the B horizons varies widely. In this group are the Plainfield, Fox, Oshtemo, and Mill Creek soils.

Plainfield loamy fine sand consists of loose sand throughout and represents an accumulation of material by the action of wind and water. Where the movement of material has resulted in the formation of dune ridges the slope phase is mapped. The Plainfield soils are very rapidly drained and, hence, droughty.

The profile of the Fox soils is very similar to that of the Bellefontaine soils. The thickness of the horizons is variable, and the heavy B_3 horizon occurs at an average depth of about 30 inches. The underlying gravelly deposits are stratified.

Oshtemo soils differ from Fox soils in having a thinner heavy B_2 horizon, which generally occurs at a lower depth than the heavy layer in the Fox soils. This layer is 3 to 7 inches thick. The stratified substratum generally contains a larger proportion of fine gravel and coarse sand than the corresponding layer of the Fox soils.

Mill Creek fine sandy loam is similar to Fox fine sandy loam in the A and upper B horizons, but the lower B horizon is much thicker and the C horizon contains a large quantity of clay and silt, indicating that the assortment of materials has not been so complete as in the Fox soils. The textural profile is extremely variable in all but the upper part of the A horizon.

Natural drainage conditions in the Berrien, Morocco, and Bronson soils, which comprise the second subgroup of this division, are intermediate between the well-drained and the poorly drained soils. The content of organic matter of the surface soils is somewhat higher than in the well-drained soils. Mottling is present in the subsoil of all three.

Berrien loamy fine sand differs from Plainfield loamy fine sand in being mottled below a depth of 14 to 30 inches. Morocco loamy fine sand has a surface soil somewhat darker than Berrien loamy fine sand and a highly mottled subsoil. The Bronson soils differ from the Fox soils in having mottled lower B horizons and a slightly higher content of organic matter in the surface soil.

Members of the subgroup of poorly drained soils are dark and occupy depressions in the outwash plains and terraces where natural drainage conditions are poor. The water table was very near or at the surface most of the time until the soils were artificially drained. The Westland, Abington, Nyona, Lear, Brady, Gilford, Granby, Maumee, and Newton soils comprise this group.

Westland loam, in a thinly wooded area about 1 mile northeast of Rochester, has the following profile:

1. A thin accumulated layer of partly decayed forest litter.
2. 0 to 6 inches, very dark brownish-gray friable granular loam containing many roots and much organic matter. The reaction is slightly acid.
3. 6 to 12 inches, dark brownish-gray heavy loam, having a small nutlike structure. The aggregates range from 3/8 to 1/2 inch in diameter. Roots are fewer but worms are more active than in the horizon above. The reaction is neutral.

4. 12 to 20 inches, dark-gray sandy loam, breaking into small subangular aggregates. The reaction is very slightly acid.
5. 20 to 31 inches, mottled gray and yellow heavy plastic gravelly silty clay loam, very sticky when wet and hard when dry. The reaction is neutral.
6. 31 to 37 inches, mottled gray and yellow gravelly silt loam that is less compact than the horizon above and breaks out into irregular-sized blocks. The reaction is neutral.
7. 37 to 70 inches, gray loose stratified gravel and coarse sand of neutral reaction.
8. 70 inches +, gray loose stratified calcareous gravel.

Variations in the Westland soils from this profile are in the thickness and texture of the various horizons.

The Abington soils are somewhat more poorly drained than the Westland soils and contain more organic matter in the surface layers. The subsoil horizons are solid gray or faintly mottled with yellow.

The Nyona soils are similar to the Brookston soils in the upper part, but have a substratum of stratified gravel and coarse sand at a depth of about 24 inches. They occur on the Prairielike part of the outwash plain associated with the Lear soils.

The Lear soils resemble those of the Clyde series in the upper part, but are underlain by stratified gravel and sand at about the same depth as in the Nyona series. The subsoil is gray.

In a wooded area, about 2 miles west and north of Rochester, the following profile of Brady fine sandy loam was observed:

1. 0 to 2 inches, very dark-gray fine sandy loam containing a mass of roots and much organic matter. The reaction is slightly acid.
2. 2 to 9 inches, dark-gray mealy fine sandy loam containing numerous roots and much evidence of the activity of worms. The reaction is medium acid.
3. 9 to 14 inches, mottled gray and yellow sandy loam that is feebly cohesive. Lenses and streaks of darker colored material extend through this layer and occasionally into the layer below. The reaction is slightly acid.
4. 14 to 23 inches, mottled gray and yellow sandy silt loam, the yellow more intense than in the layer above and becoming yellowish gray when pulverized. The material is compact in place, but it breaks into small subangular fragments. The reaction is neutral.
5. 23 to 58 inches, loose stratified gray sand, neutral in reaction.
6. 58 inches +, gray loose stratified calcareous sand containing some fine gravel.

The Brady soils are variable in content of organic matter, in texture of surface soil, and in the thickness of the sandy silt loam horizon.

The Gilford soils differ from the Brady soils in having poorer natural drainage, a higher content of organic matter in the surface soil, and very little, if any, yellow mottling.

The Granby soils differ from the Maumee soils in being slightly less poorly drained, in having a lower content of organic matter in the surface soil, and in being mottled yellow and gray in the subsoil.

In an undisturbed area of Maumee loam, in the SW¼ sec. 31, T. 30 N., R. 1 E., the following profile was observed:

1. 0 to 2 inches, very dark-gray to nearly black granular mucky loam containing a mass of grass roots. The reaction is slightly acid.
2. 2 to 7 inches, very dark-gray friable granular loam containing many roots. On drying, the light-gray rounded quartz sand grains contrast sharply with the nearly black organic matter. The reaction is neutral.

3. 7 to 17 inches, very dark-gray sandy loam, breaking into irregular-sized lumps that are easily pulverized into granular aggregates. The reaction is neutral.
4. 17 to 42 inches, gray fine sand containing pockets of pale-yellow material and streaks of dark-gray material, largely organic matter. The reaction is neutral.
5. 42 inches +, gray loose sand of neutral reaction.

Members of the Maumee series vary in the thickness of the mucky loam surface soil, the lighter textured members having a somewhat thinner layer. Under natural drainage conditions the water table was at the surface practically all the time. The ferruginous phase of Maumee fine sandy loam contains concretions and segregations of bog iron in the profile.

The Newton soils are characterized by a highly acid reaction. The content of organic matter is somewhat high in the surface soil, and the subsoil is highly mottled.

The soils of the stream bottoms and bogs occupy a small part of the area of the county. They are divided into well-drained and poorly drained alluvial soils and organic soils.

The well-drained alluvial soils are represented by the Genesee and Ross series. The surface soil in the Genesee series is light brown, and little or no mottling has developed at a depth of about 32 inches. The Ross soils are much darker than the Genesee, but are otherwise similar.

The poorly drained alluvial soils are in the Sloan and Griffin series and occur along the smaller streams and drainageways and along the Tippecanoe River but farther back than the Genesee soils. The Griffin soils are characterized by rust-brown or yellow spots and streaks that are present below a depth of 3 to 10 inches. The Sloan soils are dark-colored and poorly drained.

The organic soils of the county vary in thickness, in composition of underlying material, and in height of water table. They consist of Carlisle and Edwards mucks, phases of these soils, and Wallkill loam.

Carlisle muck is the most extensive organic soil in the county; a drained phase is recognized on the basis of present artificial drainage conditions. A typical virgin profile of Carlisle muck, having a thin secondary growth of elm, swamp oak, and ash and an excellent stand of bluegrass, in the SE¼ sec. 16, T. 30 N., R. 4 E., is as follows:

1. 0 to 4 inches, black granular loamy muck containing numerous roots.
2. 4 to 10 inches, black coarse granular muck that is somewhat soft when wet and contains few roots and some partly decomposed remains of reeds, sedges, and other plants.
3. 10 inches +, dark-brown fibrous muck containing numerous partly decomposed sedges and remains of woody plants. With increasing depth the material becomes brown fibrous mucky peat.

Carlisle muck, shallow phase over sand, consists of black muck to a depth of 15 to 36 inches, below which is loose gray sand.

Edwards muck has a surface layer of black granular muck similar to that of Carlisle muck. At a depth of 10 to 30 inches this overlies gray calcareous marl containing numerous shells and fragments of partly decomposed sedges and reeds.

Wallkill soils are characterized by mineral surface soils and organic subsoils, the former representing an accumulation of material washed in over muck soils.

Miscellaneous land types in Fulton County consist of areas of marsh and pits unsuited to crops. Marsh was formed by the damming of the Lake Manitou outlet and of Mill Creek. Pits are formed by the removal of surface soil to procure gravel for road building, concrete work, and other purposes. These pits occur in areas of Bellefontaine, Fox, and Oshtemo soils.

MANAGEMENT OF THE SOILS OF FULTON 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 the productivity of a soil 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 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 treatment 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 and of the weak-acid soluble phosphorus and potassium in certain soils in Fulton County, expressed in pounds of elements in the 6- to 7-inch layer of plowed surface soils of an acre, estimated at 2,000,000 pounds, is shown in table 9.

The total plant-nutrient content is more significant of the origin and age of a soil than of its fertility. This is particularly true of potassium. The quantity of total potassium in a soil is seldom indicative of its need for potash. Some Indiana soils that have more than 30,000 pounds of total potassium to the acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization, because so little of the potassium is available.

The total content of nitrogen is generally indicative of the need for nitrogen, but some soils with a low content may have a supply of available nitrogen sufficient to grow a few large crops without the addition of that element. Soils having a low total nitrogen content soon wear out, as far as that element is concerned, unless the supply is replenished by growing and turning under legumes or by the use of nitrogenous fertilizer. The dark-colored soils are generally higher in organic matter. Organic-matter supply and nitrogen content are closely correlated in the soils of Indiana; hence it is a fairly safe rule that the darker the soil, the richer it is in nitrogen.

TABLE 9.—*Approximate quantities of nitrogen, phosphorus, and potassium in certain cultivated soils of Fulton County, Ind.*

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

Soil type	Total nitrogen [1]	Total phosphorus [2]	Total potassium [1]	Weak-acid soluble phosphorus [3]	Weak-acid soluble potassium [3]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Abington loam	8,000	1,200	24,000	110	120
Abington silt loam	8,000	1,400	26,000	160	120
Aubbeenaubbee fine sandy loam	2,000	440	20,000	25	30
Aubbeenaubbee loamy fine sand	1,800	400	19,000	25	25
Bellefontaine fine sandy loam	1,400	490	24,000	45	60
Bellefontaine loam	2,400	520	31,000	25	150
Berrien loamy fine sand	1,200	650	21,000	190	40
Brady fine sandy loam	8,000	960	21,000	65	200
Brady loam	10,200	1,030	22,000	150	160
Bronson fine sandy loam	2,400	610	19,000	40	160
Bronson loam	2,600	800	23,000	50	140
Brookston loam	9,600	960	31,000	140	130
Brookston silt loam	8,000	1,000	38,000	130	140
Carlisle muck	24,800	800	3,600	35	120
Drained phase	26,800	920	2,800	80	100
Shallow phase over sand	18,800	900	3,500	30	180
Clyde loam	18,400	1,400	31,000	230	150
Clyde silt loam	12,000	1,140	32,000	130	120
Clyde silty clay loam	15,000	1,630	39,000	250	200
Coloma loamy fine sand	800	520	20,000	50	50
Crosby fine sandy loam	1,800	350	18,000	20	80
Crosby loam	2,000	520	29,000	25	80
Edwards muck	30,400	610	1,800	60	100
Fox fine sandy loam	1,800	440	23,000	30	100
Fox loam	2,000	610	34,000	50	130
Genesee fine sandy loam	5,000	1,220	20,000	110	100
Genesee loam	5,400	1,340	23,000	130	170
Gilford fine sandy loam	8,000	960	19,000	170	150
Gilford loam	10,000	1,050	23,000	180	160
Granby fine sandy loam	10,400	800	20,000	90	120
Granby loam	8,000	800	23,000	100	140
Granby loamy fine sand	7,200	870	18,200	160	70
Griffin fine sandy loam	5,600	870	23,000	35	50
Griffin loamy fine sand	5,000	1,200	24,000	30	40
Hillsdale fine sandy loam	1,400	520	29,000	70	75
Hillsdale loam	1,600	610	28,100	55	100
Depression phase	2,800	960	31,000	75	120
Hillsdale loamy fine sand	1,000	520	23,000	130	110
Lear loam	10,400	870	23,000	180	130
Lear silt loam	15,200	1,140	28,000	140	120
Maumee fine sandy loam	10,400	900	22,000	60	90
Ferruginous phase	7,200	700	19,000	20	70
Maumee loam	13,600	1,050	26,000	110	120
Maumee loamy fine sand	11,200	1,010	19,000	190	150
Metea fine sandy loam	1,600	400	25,000	35	60
Metea loamy fine sand	1,000	610	22,000	60	100
Miami fine sandy loam	1,400	310	21,000	25	70
Miami loam	1,800	520	33,000	30	150
Mill Creek fine sandy loam	1,600	520	20,000	80	120
Morocco loamy fine sand	2,000	700	20,000	120	40
Nappanee loam	2,800	610	32,000	25	160
Newton fine sandy loam	4,400	650	18,000	60	70
Newton loamy fine sand	5,600	760	19,000	60	80
Nyona silt loam	9,600	700	21,000	90	110
Oshtemo fine sandy loam	1,400	610	25,000	120	100
Oshtemo loamy fine sand	1,600	680	26,000	130	100
Plainfield loamy fine sand	1,000	610	23,000	190	30
Ross loam	11,200	1,750	20,000	30	140
Ross loamy fine sand	6,200	1,000	18,000	30	100
St. Clair loam	2,400	700	34,000	40	200
Sloan loam	15,200	2,180	25,000	50	200
Wallkill loam	14,400	1,700	30,000	80	260
Washtenaw loam	6,000	1,000	28,000	40	150
Washtenaw silt loam	5,200	1,240	42,000	70	320
Westland loam	10,400	1,400	21,000	90	120
Westland silt loam	10,000	1,480	30,000	100	150

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

The quantity of total 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. In Indiana the supply of this element may indicate whether or not a soil needs phosphatic fertilizers.

The quantity of phosphorus soluble in weak acid is considered by many authorities to be a still better indication of the phosphorus needs of a soil. The depth of a soil may modify its needs for phosphates. Everything else being equal, the more weak-acid soluble phosphorus a soil contains, the less it is likely to need phosphate fertilizers. Where the weak-acid soluble phosphorus runs less than 100 pounds to the acre, phosphates are usually needed for high crop yields.

The quantity of potassium soluble in strong or weak acid is to some extent significant. This determination, however, is not so reliable an indicator as is the determination for phosphorus, particularly with soils of high lime content. Sandy soils and muck soils are more often in need of potash than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need potash more than well-aerated deep soils.

The use of strong or weak acid in the analysis of a soil has been criticized by some, yet such analyses can more often be correlated with crop production than can analyses of the total elements of the soil. For this reason acid solutions have been employed in these analyses.

No one method of soil analysis will definitely indicate the deficiencies of a soil. 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 horizons, and the previous treatment and management of the soil are all factors of the greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in subsurface layers and in subsoils than they are in surface soils. On the other hand, potassium in the subsoil seems to have relatively high availability. Crop growth depends largely on the quantity of available plant nutrients in contact with the roots. If the crop roots deeply, it may be able to make good growth on soils of relatively low analysis. If the crop roots shallowly, it may suffer for lack of nutrients, particularly potash, even on a soil of high analysis. The better types of soils and those containing large quantities of plant nutrients 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 more important factors in soil fertility is the degree of acidity. Many soils that are very strongly acid will not produce well, even though plant nutrients are not lacking. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect where lime is deficient. The percentage of nitrogen, acidity, and lime requirements of certain soils in Fulton County are given in table 10.

TABLE 10.—*Nitrogen, acidity, and lime requirements of certain soils in Fulton County, Ind.*

Soil type	Depth	Nitrogen	pH value	Average depth to neutral soil[1]	Indicated ground limestone requirements per acre
	Inches	*Percent*		*Inches*	*Tons*
Abington loam	0- 6	0.40	7.0	0	0
	6-18	.18	6.9		
	18-36	.07	7.5		
Abington silt loam	0- 6	.40	7.2	0	0
	6-18	.20	7.2		
	18-36	.08	7.1		
Aubbeenaubbee fine sandy loam	0- 6	.10	6.2	45	1-2
	6-18	.05	5.5		
	18-36	.04	6.0		
Aubbeenaubbee loamy fine sand	0- 6	.09	6.3	45	1-2
	6-18	.05	5.6		
	18-36	.04	6.1		
Bellefontaine fine sandy loam	0- 6	.07	6.2	30	1-2
	6-18	.04	5.8		
	18-27	.04	7.0		
Bellefontaine loam	0- 6	.12	6.1	35	1-2
	6-18	.06	6.0		
	18-35	.04	6.0		
Berrien loamy fine sand	0- 6	.06	6.8	90	2-3
	6-18	.04	5.0		
	18-36	.04	4.9		
Brady fine sandy loam	0- 6	.40	5.5	15	0-1
	6-18	.20	6.4		
	18-36	.07	6.8		
Brady loam	0- 6	.76	6.0	15	0-1
	6-18	.24	6.4		
	18-36	.10	6.8		
Bronson fine sandy loam	0- 6	.16	5.9	40	1-2
	6-18	.06	5.4		
	18-36	.03	5.2		
Bronson loam	0- 6	.17	6.0	35	1-2
	6-18	.08	5.4		
	18-35	.04	5.5		
Brookston loam	0- 6	.48	6.8	0	0
	6-18	.24	7.5		
	18-36	.03	7.6		
Brookston silt loam	0- 6	.40	6.9	0	0
	6-18	.21	7.0		
	18-36	.04	7.2		
Carlisle muck	0- 6	2.48	6.1	40+	0
	6-18	2.70	6.0		
	18-36	2.30	6.4		
Drained phase	0- 6	2.68	6.2	40+	0
	6-18	3.04	6.0		
	18-36	2.35	6.5		
Shallow phase over sand	0- 6	1.88	5.6	40+	0
	6-18	.96	5.0		
	18-36	.05	6.2		
Clyde loam	0- 6	.92	7.5	0	0
	6-18	.30	7.6		
	18-36	.05	7.8		
Clyde silt loam	0- 6	.60	7.6	0	0
	6-18	.20	7.6		
	18-36	.06	7.8		
Clyde silty clay loam	0- 6	.75	7.4	0	0
	6-18	.30	7.6		
	18-36	.06	7.8		
Coloma loamy fine sand	0- 6	.04	5.9	70	2-3
	6-18	.02	5.4		
	18-36	.02	5.5		
Crosby fine sandy loam	0- 6	.09	6.2	35	1-2
	6-18	.05	5.6		
	18-35	.04	6.2		
Crosby loam	0- 6	.10	6.2	30	1-2
	6-18	.05	5.8		
	18-30	.04	6.8		
Edwards muck	0- 6	3.04	6.2	0	0
	6-18	.30	7.4		
	18-36	.05	[2]		
Fox fine sandy loam	0- 6	.09	6.0	36	1-2
	6-18	.09	5.9		
	18-36	.07	6.7		
Fox loam	0- 6	.10	5.9	38	1-2
	6-18	.07	5.9		
	18-36	.06	6.2		

See footnotes at end of table.

TABLE 10.—*Nitrogen, acidity, and lime requirements of certain soils in Fulton County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH value	Average depth to neutral soil [1]	Indicated ground limestone requirements per acre
	Inches	*Percent*		*Inches*	*Tons*
Genesee fine sandy loam	0-6	.25	7.3	0	0
	6-18	.09	7.6		
	18-36	.05	7.6		
Genesee loam	0-6	.27	7.5	0	0
	6-18	.15	7.6		
	18-36	.10	7.6		
Gilford fine sandy loam	0-6	.40	6.4	15	0-1
	6-18	.24	6.3		
	18-36	.08	6.6		
Gilford loam	0-6	.50	6.6	15	0-1
	6-18	.28	6.3		
	18-36	.08	6.5		
Granby fine sandy loam	0-6	.52	5.3	15	0-1
	6-18	.24	6.0		
	18-36	.05	6.5		
Granby loam	0-6	.40	5.6	15	0-1
	6-18	.19	6.2		
	18-36	.05	6.7		
Granby loamy fine sand	0-6	.36	5.1	15	0-1
	6-18	.18	6.2		
	18-36	.04	6.5		
Griffin fine sandy loam	0-6	.28	7.4	0	0
	6-18	.21	7.2		
	18-36	.05	7.1		
Griffin loamy fine sand	0-6	.25	7.2	0	0
	6-18	.20	7.2		
	18-36	.05	7.1		
Hillsdale fine sandy loam	0-6	.07	5.9	60	1-2
	6-18	.04	5.4		
	18-36	.03	5.3		
Hillsdale loam	0-6	.08	6.9	85	1-2
	6-18	.04	6.8		
	18-36	.03	6.2		
Depression phase	0-6	.14	5.3	85	1-2
	6-18	.06	5.1		
	18-36	.03	5.3		
Hillsdale loamy fine sand	0-6	.05	6.1	69	1-2
	6-18	.04	6.0		
	18-36	.03	5.2		
Lear loam	0-6	.52	6.2	10	0-1
	6-18	.20	7.0		
	18-30	.04	7.2		
Lear silt loam	0-6	.76	6.0	0	0-1
	6-18	.20	7.2		
	18-28	.06	7.3		
Maumee fine sandy loam	0-6	.52	5.8	15	0-1
	6-18	.21	6.1		
	18-36	.03	6.4		
Ferruginous phase	0-6	.36	6.0	15	0-1
	6-18	.32	5.8		
	18-36	.13	6.9		
Maumee loam	0-6	.68	6.6	10	0-1
	6-18	.30	6.8		
	18-36	.10	6.9		
Maumee loamy fine sand	0-6	.56	6.0	10	0-1
	6-18	.24	6.2		
	18-36	.05	6.6		
Metea fine sandy loam	0-6	.08	6.2	50	1-2
	6-18	.04	6.0		
	18-36	.03	6.2		
Metea loamy fine sand	0-6	.05	6.0	50	1-2
	6-18	.04	5.8		
	18-36	.03	6.2		
Miami fine sandy loam	0-6	.07	6.0	40	1-2
	6-18	.05	6.0		
	18-36	.03	5.6		
Miami loam	0-6	.09	6.3	34	1-2
	6-18	.06	5.4		
	18-34	.04	6.0		
Mill Creek fine sandy loam	0-6	.08	6.2	48	1-2
	6-18	.06	6.1		
	18-36	.03	5.9		
Morocco loamy fine sand	0-6	.10	6.4	90+	2-3
	6-18	.06	5.4		
	18-36	.04	5.3		

See footnotes at end of table.

TABLE 10.—*Nitrogen, acidity, and lime requirements of certain soils in Fulton County, Ind.*—Continued

Soil type	Depth	Nitrogen	pH value	Average depth to neutral soil [1]	Indicated ground limestone requirements per acre
	Inches	*Percent*		*Inches*	*Tons*
Nappanee loam	0– 6	.14	6.2	24	1-2
	6–18	.06	5.4		
	18–24	.05	6.4		
Newton fine sandy loam	0– 6	.22	5.0	100	3-4
	6–18	.06	4.3		
	18–36	.03	4.5		
Newton loamy fine sand	0– 6	.28	5.0	70	3-4
	6–18	.05	4.3		
	18–36	.03	4.5		
Nyona silt loam	0– 6	.48	6.7	0	4
	6–18	.16	7.2		
	18–36	.03	7.4		
Oshtemo fine sandy loam	0– 6	.07	6.8	0	1-2
	6–18	.06	6.7		
	18–36	.04	6.5		
Oshtemo loamy fine sand	0– 6	.08	6.0	40	1-2
	6–18	.07	5.8		
	18–36	.05	5.8		
Plainfield loamy fine sand	0– 6	.05	5.9	100+	2-3
	6–18	.04	5.3		
	18–36	.04	5.3		
Ross loam	0– 6	.56	7.4	0	0
	6–18	.20	(2)		
	18–36	.05	(2)		
Ross loamy fine sand	0– 6	.31	7.6	0	0
	6–18	.18	(2)		
	18–36	.04	(2)		
St. Clair loam	0– 6	.12	6.8	20	1-2
	6–18	.07	6.0		
	18–26	.05	6.8		
Sloan loam	0– 6	.76	7.1	0	0
	6–18	.24	7.5		
	18–36	.04	7.5		
Wallkill loam	0– 6	.72	5.9	40+	0
	6–18	.83	5.9		
	18–36	2.72	6.5		
Washtenaw loam	0– 6	.30	7.2	0	0
	6–18	.20	7.0		
	18–36	.15	6.8		
Washtenaw silt loam	0– 6	.26	7.5	0	0
	6–18	.24	7.0		
	18–36	.17	6.0		
Westland loam	0– 6	.52	6.0	0	0
	6–18	.12	6.3		
	18–36	.05	6.8		
Westland silt loam	0– 6	.50	6.5	0	0
	6–18	.13	6.7		
	18–36	.05	6.8		

[1] For practical application, soils that have pH from 6.6 to 7.3 are considered neutral.
[2] Calcareous.

The acidity is expressed by the pH value, or intensity of acidity. A soil of pH 7 is neutral and contains just enough lime to neutralize the acidity. If the pH is over 7, it indicates that there is some lime in excess. Soils with a pH value ranging from 6 to 7 are slightly acid, and those ranging from a pH value of 5 to 6 are of medium acidity. If the pH value runs below 5.6 the soil is strongly acid. As a rule, the stronger the acidity, the more a 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 of the lower layers as well. Given two soils of the same acidity in the surface layer, 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. Those 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 soil-improvement legumes in the rotation, it is in many places desirable to apply lime so that sweetclover or alfalfa will grow.

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

SOIL MANAGEMENT

For convenience in discussing the management of the several soils of this county, they are arranged in groups according to certain important characteristics, which indicate that in many respects similar treatment is required. For example, the light-colored soils 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 each were discussed separately. Where different treatments are required they are specifically pointed out. The reader should study the group including the soils in which he is particularly interested.

LIGHT-COLORED SOILS OF THE UPLANDS AND TERRACES

The light-colored soils of the uplands and terraces include the loams of the Miami, Crosby, St. Clair, Nappanee, Fox, Bellefontaine, Bronson, and Hillsdale series; the fine sandy loams of the Metea, Miami, Crosby, Fox, Bellefontaine, Oshtemo, Hillsdale, Aubbeenaubbee, Bronson, and Mill Creek series; and the loamy fine sands of the Coloma, Metea, Aubbeenaubbee, Hillsdale, Oshtemo, Plainfield, Berrien, and Morocco series. Together, these soils occupy more than 54 percent of the total area of the county, with Miami loam and fine sandy loam predominating. Viewing the group as a whole, these soils are mostly deficient in organic matter and nitrogen, all are deficient in phosphorus, and most of them are deficient in available potash as well. Most of these soils are acid and more or less in need of liming. They vary widely, however, in natural productivity, owing to different degrees of sandiness and droughtiness and in present productivity according to the systems of cropping and management to which they have been subjected since they were brought under cultivation.

DRAINAGE

The Coloma, Metea, Fox, Oshtemo, Mill Creek, and Plainfield fine sandy loams and loamy fine sands have very open-textured subsoils as well as sandy surface soils and therefore are rapidly drained and decidedly droughty under dry-weather conditions. They need to have their water-holding capacity increased by constant attention to the incorporation of as much organic matter as possible, including manure, crop residues, cover crops, and especially grown green-manure crops. The Bellefontaine, Fox, Miami, St. Clair, and Hillsdale loams are naturally well drained but because of their heavier subsoils are not overdrained and crops are not so liable to suffer from drought, except in prolonged periods of dry weather.

The Berrien, Morocco, and Bronson soils are imperfectly drained, owing to their intermediate position between well-drained and poorly drained soils but are open-textured enough not to need artificial drainage under conditions of normal rainfall.

The Crosby and Nappanee soils, even though fairly open-textured in their surface layers, are generally in need of tile underdrainage before they can be made most productive because they have heavy subsoils that impede drainage. This has been recognized by farmers and on many areas some tile drainage has been provided. Where tiling is still needed, the lines should be laid 30 to 36 inches deep and spaced from 3 to 4 rods apart, depending upon the heaviness of the soil. Wherever there is a gray or grayish-mottled subsoil insufficient natural drainage is indicated. Without tile under-drainage such soils cannot be satisfactorily managed and no other beneficial soil treatment can produce its full effect. Tile drainage facilities soil aeration that helps to render the plant nutrients available and encourages deeper rooting of crops, which enables them to withstand drought better as well as to obtain more nutrients from the subsoil.

LIMING

All the soils in this light-colored group, except limited areas of St. Clair loam and Oshtemo fine sandy loam, are at least acid in the surface layer and upper subsoil, and as a result are more or less in need of liming. The relative acidity of the soils in Fulton County as shown in table 10 indicates the required rate of application in terms of ground limestone. It is advisable, however, to determine the lime requirement of each field by making soil acidity tests. If the farmer cannot make the test himself, he can have it made without charge by the county agricultural agent or by the Purdue University Agricultural Experiment Station at La Fayette. A very acid soil will not respond properly to other needed treatments until it has been limed. Failure of clover to develop satisfactorily indicates a need of lime, although lack of thriftiness in clover may also be due to lack of available plant nutrients or other unfavorable conditions. Ground limestone generally is the most economical form of lime to use, except where marl deposits are near. As a rule, the first application should be at least 2 tons to the acre, or its equivalent in other liming material. After that 1 ton to the acre every second or third round of the crop rotation will keep the soil reasonably sweet. Where alfalfa or sweetclover is to be grown on an acid soil, a heavier application of limestone may be needed.

ORGANIC MATTER AND NITROGEN

All light-colored soils are deficient in organic matter and nitrogen. The light-colored sandy soils are particularly in need of organic matter to increase their water-holding capacity and thus protect crops from droughts. These two deficiencies go hand in hand, and both should receive the first attention of farmers located on these soils.

On the very poor sandy areas, the cheapest and most effective first aid, if little money is available, is to grow a crop of soybeans. Soybeans will stand a considerable amount of soil acidity. They will, however, also respond to liming and the land should be limed as soon as possible, and certainly before clovers or other lime-loving crops are attempted. Where grown for the first time, soybeans must be artificially inoculated with special nitrogen-fixing bacteria. As these soils are poor in available mineral plant-nutrient 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 not more than 100 pounds an acre should be drilled with the seed. Evidence is accumulating that fertilizer may be profitably plowed under for soybeans as well as for corn. It would seem advisable, therefore, to plow under two or three times as much of the same fertilizer as is to be applied at seeding time. The seed may be drilled at the rate of 2 bushels to the acre or in rows for cultivation at 2 to 4 pecks to the acre. 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 soybeans.

If the droughty light-colored sandy soils are limed and well fertilized with phosphate and potash, they will produce good yields of alfalfa and sweetclover which are able to go deep for moisture, and these crops can be profitably used to build up the organic matter and nitrogen supplies. There is no better crop than sweetclover for green manuring.

A very important thing that should be remembered in the management of sandy soils is that they lose organic matter very rapidly. Their loose, open, excessively aerated condition favors rapid decomposition and oxidation, or the burning out of the soil organic matter. For this reason more than ordinary quantities of organic materials, such as manure, crop residues, specially grown green-manure crops, and cover crops should be constantly added. The land should never be left without something growing on it to reduce leaching and erosion losses.

CROP ROTATION

For the most satisfactory progress in the improvement of these soils, the land should be limed and put in condition to grow clover, alfalfa, or sweetclover. Usually 2 tons of ground limestone to the acre will take care of the harmful acidity. If possible the liming should be done a year before seeding. Alfalfa is most valuable for the well-drained and droughty soils as its deep root system enables it to withstand drought much better than clover. The alfalfa must also be inoculated with a special kind of bacteria. Full instructions concerning alfalfa culture, also for sweetclover and soybean culture, may be procured from Purdue University Agricultural Experiment Station at La Fayette.

Corn, soybeans, wheat or rye, and alfalfa 1 or more years make an excellent rotation for these sandy soils, after liming. Wheat is a better cash crop than rye if the nitrogen supply is adequate. A light winter dressing of manure on the wheat will greatly increase the yield and help to obtain a stand of alfalfa. On Plainfield loamy fine sand at the Sand Experiment Field near Monterey, 2 tons of manure to the acre on wheat has increased the yields about 5 bushels on the average for the last 18 years. A top dressing in April of a soluble nitrogen carrier supplying 15 to 20 pounds of nitrogen to the acre may be expected to increase wheat yields from 4 to 6 bushels where the crop is adequately supplied with phosphate and potash.

An extra field to remain in alfalfa for several years is a wise provision against failure to obtain stands in some years on the rotated land. On the Sand Experiment Field mentioned above, the most successful stands of alfalfa have been obtained from late July or early August seedings on disked small grain stubbleland (pl. 1).

The sandy loams produced high-quality potatoes. When grown on old, well-manured, and well-fertilized alfalfa sod, potatoes are a profitable cash crop for supplying home markets and may well be fitted into the rotation in place of some of the corn. On the more sandy areas, cantaloups for home markets are a good cash crop.

On the high-ground fine sandy loams and loamy fine sands that are suitable for farming at all, increasing consideration is being given to other than grain and hay systems of cropping. These soils are adapted to apples, peaches, grapes, and blackberries and other bush fruits, and with proper management commercial fruit growing can be made a profitable enterprise.

FERTILIZATION

As these sandy soils are deficient in nitrogen it is important that legumes be grown on them. Manure should be used extensively and all unutilized crop residues should go back to the land. When these sources of nitrogen are inadequate for satisfactory yields of crops, commercial nitrogen can be profitably used if other production factors are favorable.

Phosphates are needed in considerable quantities, because all these soils are low in phosphorus. They are also low in available potassium and require potash fertilizers, the amount depending on the quantity of manure used. Manure supplies about 10 pounds of potash to the ton.

The scheme of fertilization on these soils should be such as to supply all the phosphorus required by the crops. As a rule, most of the manure should be applied on the small grain or on the young clover or alfalfa after the grain harvest, or on sod several months before plowing, especially on the more sandy soils. On areas with heavier subsoils, the common practice of applying manure through the winter before plowing for corn is advisable. Small grains should receive from 200 to 300 pounds to the acre of 2–12–6 fertilizer, or 3–12–12 if manure is scarce, especially where a legume seeding is to be made. For corn, where manure is plentiful, a row or hill application of fertilizer may be sufficient. Otherwise, it will pay to use much larger quantities of fertilizer for corn by plowing under the major part of it as planter applications should be limited to 100 to 150 pounds to the

Effect of lime on a stand of alfalfa on Plainfield loamy fine sand at the Sand Experiment Field near Monterey, Ind.: Left, fertilizer only; right, fertilizer and lime.

acre on these sandy soils. On the Miami, Crosby, Nappanee, and St. Clair soils, which have heavier subsoils and where moisture is not so much of a limiting factor, the fertilizer needs for large crops can be provided in this way, preferably by use of a fertilizer attachment on the plow. When properly inoculated, soybeans will procure much of their nitrogen from the air but their phosphate and potash must come from the soil or from fertilizer. Soybeans do not respond well to surface applications of fertilizer and there is danger of seedling injury when more than a small amount is placed with the seed. Therefore, where the phosphate and potash needs of the soybean crop have not been provided for by extra applications to preceding crops, they should be provided largely by the plow-under method. Potatoes, truck, and fruit crops should be specially fertilized.

DARK-COLORED SANDY SOILS OF THE OUTWASH PLAINS AND TERRACES

The dark-colored sandy soils of the outwash plains and terraces include the fine sandy loams of the Brady, Gilford, Granby, Maumee, and Newton series and the loamy fine sands of the Granby, Maumee, and Newton series. Altogether these soils occupy 13,120 acres, including ferruginous phase of Maumee fine sandy loam or 5.7 percent of the total area of the county, with the Granby soils predominating.

DRAINAGE

The Brady and Granby fine sandy loams and the Granby loamy fine sand generally have sufficient drainage except where they border on Maumee or Gilford soils, and in periods when the water table is high. In dry seasons crops may even suffer from drought owing to their very open subsoils.

The Gilford, Maumee, and Newton soils are naturally poorly drained and are characterized by a relatively low situation and flat relief, which, especially during the spring months, give a high water table. Most areas of these soils have been provided with drainage facilities where outlets are available, and additional drainage, if needed in these areas, can be provided by ditches or large tile at wide intervals as water moves freely in the sandy subsoil.

LIMING

The Maumee soils generally need little liming. For the most part the Brady and Gilford soils are only slightly acid and not much in need of liming. The Granby soils are moderately acid in the surface soil and upper subsoil and generally require 1 to 2 tons of ground limestone or its equivalent at least for clover and other lime-loving legumes. The Newton soils are naturally so very strongly acid that liming should be one of the first steps in any improvement program. At the Pinney-Purdue Experiment Field near Wanatah, on Newton fine sandy loam, an application of 4 tons of ground limestone an acre in 1920 produced crop increases valued at $97.94 up to the end of 1939. The crop rotation consisted of corn, oats, and mixed clover and timothy hay, and the returns were computed on the basis of corn valued at 50 cents a bushel, oats at 30 cents, and hay at $8 a ton. Equivalents of the ground limestone in marl and other forms of lime produced practically the same results.

ORGANIC MATTER AND NITROGEN

The Brady, Gilford, Granby, and Maumee soils have fair to adequate supplies of organic matter and nitrogen, and, with reasonable care in the return of manures and crop residues, these constituents may be satisfactorily maintained. The Newton soils are not so high in these constituents, and more attention should be given to their maintenance.

CROP ROTATION

With proper attention to drainage of the lower lying areas and liberal phosphate and potash fertilization, these soils will produce good crops of corn, soybeans, small grains, and mixed hay. The Newton soils, however, must be heavily limed before much can be expected from them. Alfalfa can be grown on drained areas of Brady and Granby soils, and vegetables can be grown on Brady, Granby, Maumee, and Gilford. These soils are also suited to potatoes, melons, and various small fruits when adequate drainage is provided.

FERTILIZATION

Most of these dark-colored sandy soils are more deficient in available potash than in nitrogen or phosphorus. They are naturally fairly well to very well supplied with nitrogen, the darker soils being best in this respect. The available supplies of phosphorus are low in the Brady and Maumee fine sandy loams and very low in the Newton soils.

In fertilizing crops on these soils, the supplying of potash should be given the major emphasis except on the Newton soils, where phosphate seems equally important. In places where farmers also have lighter colored soils, most of the manure should be used on them and commercial fertilizer high in the mineral elements used on the dark-colored soils, which are not so much in need of the organic matter and nitrogen supplied by manure.

In the general plan for fertilizing these dark-colored soils, corn should receive from 75 to 100 pounds an acre of 0–12–12, 0–20–20, or 0–10–20 placed on both sides of the hill or twice as much drilled continuously in the row. Where additional quantities of fertilizer are needed, they should be plowed under as suggested for the light-colored soils. Wheat and rye should receive from 200 to 300 pounds to the acre of 3–12–12 or 2–8–16 drilled with the seed. Oats are not as responsive to fertilizer as other small grains and might be given about the same fertilization as corn, especially if followed by a clover seeding. For most truck crops, 500 pounds of 0–10–20 or 0–9–27 is recommended.

DARK-COLORED LOAMS AND HEAVIER SOILS OF THE UPLANDS AND TERRACES

The dark-colored loams and heavier soils of the uplands and terraces include all of the Brookston, Clyde, Washtenaw, Westland, Abington, Nyona, and Lear soils, and the Brady, Granby, and Maumee loams. This group includes the more productive soils of the county. Altogether, these soils occupy 45,568 acres or 19.4 percent of the county. The Washtenaw silt loam, which carries light-colored overwash, is included in this group because of the dark-colored subsoil. The Brookston silt loam and loam are by far the most extensive types, with 16,512 and 14,272 acres, respectively.

DRAINAGE

The soils of this group are naturally wet because of the low or depressional positions, but most areas have been provided with drainage facilities. In plans for additional tile drainage, provision must be made to insure sufficient fall and a uniform or increasing current so that there will be no opportunity for silt to settle and choke the tile.

LIMING

The soils of this group are, in general, neutral to only slightly acid in reaction and are not in need of liming. Some areas of Brady, Gilford, Granby, and Maumee soils are slightly to moderately acid and would be benefited by about a ton of ground limestone to the acre. Whenever there is doubt, the soil should be tested for acidity.

ORGANIC MATTER AND NITROGEN

These soils are well supplied with organic matter and nitrogen, and with reasonable care in their management no special provisions for supplying these constituents will be necessary for a long time. Some areas of the Washtenaw soils, which have light-colored surface soils will be benefited by the incorporation of additional organic matter. Even on the dark-colored soils, the burning of crop residues is a wasteful practice that should be avoided.

CROP ROTATION

These soils are among the best in the county and, with proper attention to liming and drainage where needed, will produce all the ordinary crops adapted to the region. They are especially well suited to corn, which should generally be the major crop. Among the rotations that may be satisfactorily employed are the following: Corn, wheat or oats, and clover; corn, corn, wheat or oats, and clover; corn, soybeans, wheat or oats, and clover; or corn, corn, soybeans, wheat or oats, and clover. To guard against the hazards of winterkilling of clover, it is generally advisable to seed some timothy with clover. Whenever clover fails, soybeans make a satisfactory substitute legume-hay crop. On sufficiently drained areas of the neutral and slightly acid soils, alfalfa and sweetclover may be grown successfully, and their use should be encouraged wherever they can be economically utilized.

FERTILIZATION

These soils are naturally well supplied with nitrogen, and with legumes in the crop rotation the fertilizer need not contain nitrogen for the ordinary field crops, except wheat. The total and available supplies of phosphorus are higher than in the light-colored soils. These supplies, however, should not be drawn on to any considerable extent, and as a rule most of the phosphorus required by the crops should be supplied to the land. On farms having both light-colored and dark-colored soils, the manure should generally be applied to the light-colored soil where the organic matter and nitrogen of the manure are most needed. Corn should generally receive from 100 to 150 pounds of a phosphate and potash mixture in the hill or row to the acre. This may range from 0–12–12 or 0–20–10 on the heavier soils to 0–9–27 on the loams of the Westland, Abington, Lear, Brady, Gilford, Granby, and Maumee series. Wheat should receive from 200 to 300 pounds to the acre of a complete fertilizer as 2–12–6 or 3–12–12. Such fertilization will also help the clover crop. Oats will seldom respond to nitrogen in fertilizer, and where this is the small-grain crop a phosphate and potash mixture will generally be sufficient.

ORGANIC SOILS

The organic soils include Carlisle and Edwards mucks and Wallkill loam. Altogether these soils occupy 26,496 acres of which 24,768 are Carlisle muck. The profitable management of these soils involves the following points: Careful drainage where drainage is at all possible, the growing of suitable crops, and the application of large quantities of potash and some phosphate. The potash fertilizer needs are especially urgent on the mucks, which are naturally very low in both total and available potassium. Wallkill loam is much better supplied with potassium and may not require much fertilizer for some time.

The question is sometimes asked if muck soils can be improved by burning. Mucks cannot be permanently improved by burning, and they may be seriously injured. Burning adds nothing; on the other hand it destroys much valuable organic matter and nitrogen. The mineral plant food elements concentrated in the ash cannot be considered as gain. The elements in this ash are soon used up, and the land is left in a poorer condition than before burning because of the destruction of organic matter and the consequent lowering of the land level to such an extent as to make drainage more difficult in many places.

DRAINAGE

In improving muck soils, the first requisite is proper drainage. As a general rule the water table should be lowered to a depth of 2 to 3 feet below the surface. For meadows, 2 feet to the water table may be enough. Muck soils will drain freely if the water has a chance to get away. It is not necessary for ditches and tile lines to be as close together as in the fine-textured soils. Ordinarily, the distance between tile drains or lateral ditches should be about 100 feet. Whether tile or open ditches should be used depends on local conditions. If the subsurface material is sufficiently firm to hold tile in place, tiling is to be preferred, as open ditches are always a nuisance. In extensive areas, large open outlet ditches may be necessary. These, however, should not be deeper than is necessary to keep the water table at a proper level to meet the needs of crops. Most muck areas receive considerable surface and seepage waters from the higher lands adjoining, and the plan of drainage should provide for the removal of such waters as well as the excess water that falls on the muck areas. The first thing to be done is to cut a ditch or lay a line of tile along the edge of the marsh next to the higher land adjoining. This will catch the seepage from the higher land and make the drainage of the rest of the muck area comparatively easy, provided, of course, that a suitable outlet can be procured.

It has been stated that muck soils should not be too deeply drained, because the crops on them are apt to suffer from lack of moisture at critical times. Where tile drainage is used, however, the lines of tile must be placed deep enough so that subsequent settling of the soil will not leave them too near the surface, as, after drainage, muck settles considerably within the first few years, and allowance for this should be made. The aim should be, ultimately, to have the water table from 2 to 3 feet below the surface. Great care should be exercised in establishing an even grade for each line of tile, so that the flow of water will be uniform. Fine materials which wash in at the tile joints settle easily and will soon clog the tile if the grade line is uneven. As a rule, nothing smaller than 5-inch tile should be used for muck soils. It is a good plan to cover the tile with a few inches of straw or grass before filling the ditches. This will keep much fine material out of the tile while the ground is settling.

In some places it may be desirable to raise the water table when the dry season of the year approaches, especially for shallow-rooted crops. This can be done by temporarily damming up the outlets of the ditches or by blocking the tile outlets, thus holding the water table up until sufficient rains come again.

As a rule these soils do not need liming for the crops commonly grown.

CROPS

Organic soils, when properly drained and fertilized, may be satisfactorily used for all the field and garden crops adapted to the climatic conditions of the section, except wheat, oats, and barley, and also for many crops not adapted to the common upland soils. Most of the truck and vegetable garden crops will do better on mucks when properly managed than on mineral soils. It may be said, therefore, that the farmer who has muck soil has a much greater range in the choice of crops that he may grow.

For the general farmer corn is the best crop, as these soils can endure cropping with corn longer than any of the other soils except those on the rich overflow bottom lands. With the addition of much potash and some phosphate, corn may be grown on muck fields almost continuously. It is necessary, however, to use early varieties of corn in order to escape early frosts. For a change in the cropping system, such crops as soybeans, rye, and mixed timothy and alsike for meadow or pasture are suggested. Potatoes also may be fitted into the rotation.

The small grains are the least suitable crops for muck soils, as they are apt to lodge because they produce a rank growth of weak straw. Liberal applications of potash will aid materially in producing stiffer straw. Other crops adapted to muck soils are mint, hemp, Sudan grass, millet, sorghum, buckwheat, sugar beets, turnips, and mangels. Of the truck crops, onions, cabbage, cauliflower, kale, rutabagas, celery, lettuce, parsnips, beets, carrots, and sweet corn do well on this kind of land, where proper drainage can be arranged and the crops are properly fertilized. Details concerning production practices for any particular crop can be obtained from the county agricultural agent at Rochester or the Purdue University Agricultural Experiment Station at La Fayette.

COMPACTING OF MUCK SOILS FERTILIZATION

One of the difficulties in managing muck soils is that they are apt to be too loose on the surface. In preparing the seedbed, therefore, it is important to pack the ground thoroughly by the use of a heavy roller, going over the field several times if necessary. Thorough compacting of the muck is not only better for crop growth, but it also aids materially in lessening the danger of early frosts.

In the fertilization of muck soils, potash is of first importance. Nitrogen is present in great abundance; hence, the addition of nitrogen fertilizers is not required except for early truck crops that need quickly available nitrogen. This is especially important in late seasons when nitrification, the bacterial action which makes nitrogen available, does not begin early enough to supply these crops. For the grain and hay crops, the natural soil supplies of nitrogen become available fast enough to meet all needs.

For the common field crops, about 100 pounds of muriate of potash to the acre should be applied each year or 200 pounds every other year. For row fertilization, 0–9–27 and 0–10–20 should be used. For truck crops the rates of application of fertilizers should be much greater than for grain crops. For celery, some growers use as much as 2,000 pounds of fertilizer to the acre. For early planted crops, as onions, lettuce, and cabbage, large quantities of 3–9–18 or 2–8–16 are used by many growers.

Farm manure may be used to supply potassium and phosphorus to these soils; however, on farms including both organic and light-colored mineral soils, the manure preferably should be applied to the mineral soils, because the organic soils do not need the nitrogen and organic matter it supplies; whereas the mineral soils especially need these constituents. In some places the application of manure on raw muck soils will be helpful in supplying beneficial bacteria which may be lacking, especially if the material is very raw or the land has always been very wet.

BOTTOM LANDS

The bottom lands of Fulton County, bordering the streams in narrow strips, consist of Genesee loam and fine sandy loam, Ross loam, and loamy fine sand, Sloan loam, and Griffin fine sandy loam and loamy fine sand. These soils occupy 2,688 acres or about 1 percent of the total area of the county.

The greatest difficulty in the management of these soils is to provide adequate drainage and to prevent damage by flooding.

Most of this land is not adapted to rotational cropping, and much of it has been left in timber. Some of it is in bluegrass pasture, which does very well as these soils are all neutral to slightly alkaline in reaction. Where the flooding hazard is not too great, corn and other crops will do very well with a little phosphate and potash.

NONARABLE LANDS

The eroded and gullied phases of the Coloma, Metea, Miami, St. Clair, Bellefontaine, Plainfield, Fox, Oshtemo, and Mill Creek soils and portions of the Washtenaw and other excessively wet areas that cannot be successfully drained, are classed as nonarable land and are undesirable for ordinary farming. They are of value mainly for forestry or pasture. In some places slope phases of these soils are being successfully tilled, but in most cases tillage of such areas has been highly destructive and should be discouraged. Terracing and contour cropping might be practical in many places and many areas should be forested with adapted trees and given protection from livestock. Some areas that are unfit for tillage may be successfully utilized as pasture land.

U. S. GOVERNMENT PRINTING OFFICE: 1946

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.
Price 50 cents

Areas surveyed in Indiana shown by shading.

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.