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Soil Survey

of

Putnam County, Ohio

By

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United States Department of Agriculture, in Charge

and

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Ohio Agricultural Experiment Station

Bureau of Chemistry and Soils

In cooperation with the Ohio Agricultural Experiment Station

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SOIL SURVEY OF PUTNAM COUNTY, OHIO

By ARTHUR E. TAYLOR, United States Department of Agriculture, in Charge, and J. G. STEELE and W. S. MOZIER, Ohio Agricultural Experiment Station

COUNTY SURVEYED

Putnam County is in the northwestern part of Ohio (fig. 1). Ottawa, the county seat, is about 50 miles southwest of Toledo. The land area of the county is 482 square miles, or 308,480 acres.

Putnam County lies largely in a level plain described by Leverett and Taylor [1] as part of the old glacial basin of second glacial Lake Maumee, with the exception of a comparatively small belt of knolls and short choppy ridges described by Leverett [2] as a part of the Defiance Moraine, between Gilboa and Leipsic, and a level area, covering not more than a square mile, in the extreme southeastern corner that probably forms a part of the later Wisconsin ground moraine. The plain gradually rises from an altitude of about 700 feet in the northwestern part of the county to 821 feet in the southeastern corner.

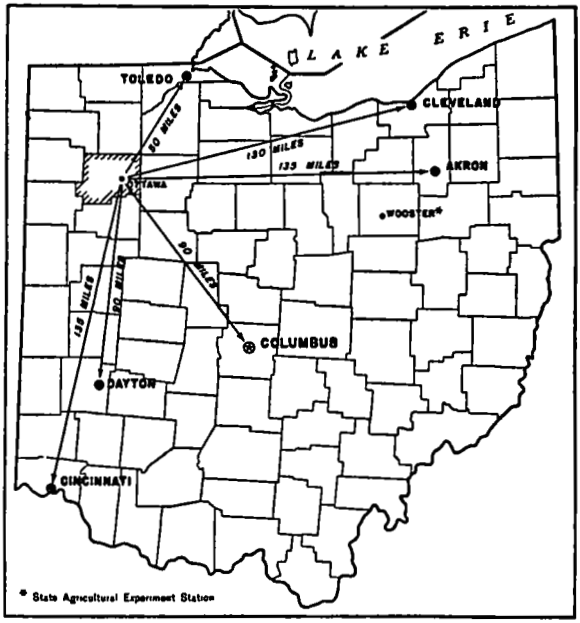

FIGURE 1.—Sketch map showing location of Putnam County, Ohio.

The belt of knolls and short choppy ridges ranging from 1 to 4 miles in width lie at an elevation ranging from 760 to 790 feet above sea level. This belt begins about 3½ miles northwest of Leipsic. Its northern boundary follows the ridge road that extends in a northwest-southeast direction through Leipsic; the western boundary extends from the cemetery 1 mile west of Gilboa, northwestward through New Cleveland to its starting point, 3½ miles northwest of Leipsic; and the southern boundary extends from the cemetery into Hancock County, passing about one-half mile north of the inter-

[1] LEVERETT, F., and TAYLOR, F. B. THE PLEISTOCENE OF INDIANA AND MICHIGAN, AND THE HISTORY OF THE GREAT LAKES. U. S. Geol. Survey Monog. 53, 529 pp., illus. 1915.

[2] LEVERETT, F. GLACIAL FORMATIONS AND DRAINAGE FEATURES OF THE ERIE AND OHIO BASINS. U. S. Geol. Survey Monog. 41, 802 pp., illus. 1902.

section of the Putnam-Hancock County line by Blanchard River. Most of the knolls and ridges are less than 3 acres in extent, lie from 5 to 20 feet above the surrounding land, have rather pronounced slopes, and are separated by poorly drained sloughs and basins.

Flanking Defiance Moraine on the north and west are sand and gravel ridges, which are beach remnants of second Lake Maumee. Other beach remnants of this old glacial lake are represented by a broken series of low sand and gravel ridges which enter Putnam County from Hancock County, 5 miles northeast of Pandora, and extend southwestward across the lake plain through Pandora, Columbus Grove, and Vaughnsville, entering Allen County south and southwest of Vaughnsville. Each of these ridges represents the shore line of a large body of water formed toward the close of the glacial period. These beach remnants range in elevation from 760 to 770 feet above sea level, from one-eighth mile to 3 miles in length, from 100 to 800 feet in width, and from 5 to 20 feet above the surrounding land.

Passing in a northwesterly and northeasterly course through Belmore and for a distance of about 7 miles across the northeastern corner of the county is a succession of sand and gravel ridges which range in elevation above sea level from 730 to 740 feet, in width from 100 to 700 feet, in length from one-fourth mile to 2 miles, and in height from 5 to 15 feet above the adjacent land. These ridges are beach remnants of the glacial lake described by Leverett as Lake Whittlesey.[3]

In addition to these old beaches the plain region is also traversed, in the vicinity of Dupont, by a belt of well-marked low broken parallel sand ridges, which range from one-fourth mile to 2 miles in width and extend in a northwestern-southeastern direction for about 8 miles, passing into Paulding County southwest of Hartzburg. These ridges appear to be old bars which range from 100 feet to one-fourth mile in length, from 50 to 500 feet in width, from 2 to 5 feet above the surrounding country, and from 720 to 725 feet above sea level. The rest of the plain, which comprises 75 percent of the county, is characterized by level surface relief slightly broken by numerous small isolated knolls, low sand ridges, and the shallow valleys of Auglaize River, Blanchard River, Ottawa River, and various creeks. These valleys range from 10 to 30 feet in depth and from one-tenth to three-fourths mile in width.

Most of the drainage waters of Putnam County find their way to Auglaize River, a tributary of Maumee River which empties into Lake Erie. In the northeastern corner, drainage is northeastward through Yellow Creek to Maumee River. However, only comparatively small sections of the county are well drained, and these are confined to the sandy and gravelly ridges and knolls and to sandy flats in the stream valleys. The greater part consists of extensive flat interstream areas, in which run-off is extremely slow and no well-developed natural drainageways exist.

Originally Putnam County was completely covered by a deciduous forest. The trees growing on the well-drained light-colored fine sandy loams and gravelly fine sandy loams of the ridges, knolls, and flat areas adjacent to stream valleys were mainly hard maple, black walnut, wild cherry, shellbark hickory, red elm, and white ash; and

[3] LEVERETT, F. See footnote 2.

those growing on the poorly drained dark-colored sandy loams and loams were principally soft maple, cottonwood, sycamore, aspen, black ash, bur oak, white elm, shellbark hickory, pignut hickory, willow, and basswood. The poorly drained light-colored clays, clay loams, silty clays, and silty clay loams, which occur along streams and on slightly elevated surfaces, supported mainly a growth of white oak, red oak, shellbark hickory, pignut hickory, beech, basswood, and white ash; white elm, bur oak, black ash, and sycamore grew largely on the dark friable clay loams and clays; white elm on the dark impervious clay; and white elm and pin oak on the light-colored impervious clay. The present tree growth consists of a second growth of the original species in small wood-lot pastures.

Putnam County was organized in 1834, but permanent settlement in this locality began in 1824, according to Howe's Historical Collections of Ohio.[4] The early settlers were largely from eastern Ohio and Pennsylvania. The 1930 census reports a total population of 25,074, all classed as rural, of which 14,319 are classed as rural farm and 10,755 as rural nonfarm. The population consists almost entirely of native-born whites. The distribution is fairly uniform, and the average density is reported as 52 persons to the square mile.

Ottawa, the county seat, has a population of 2,169. It is connected by two railroads and one interurban railway with Toledo. Columbus Grove with 1,633 people, Leipsic with 1,571, Continental, Pandora, Vaughnsville, Fort Jennings, Ottoville, Kalida, and Miller City are important railway shipping points, and a number of small towns are scattered over the county. Few people live more than a few miles distant from a store. Water-bound pikes extend into most sections, and in addition to these a number of macadam roads provide more than 95 percent of the population with well-improved roads. Practically all sections are supplied with rural delivery of mail and telephone facilities.

CLIMATE

The climate is characterized by rather short periods of extreme heat and cold, moderate precipitation, moderately high humidity, prevailing westerly winds, and an average frost-free season of 155 days.

The mean annual temperature is 50.3° F. It is somewhat higher, and the frost-free season is longer, than for adjacent counties to the west and north, but both are about the same as for sections lying to the east and south a distance of 50 miles or more.

The average annual precipitation is 35.15 inches, which is 1 inch lower than for counties to the north and 4 or 5 inches lower than for northeastern and southeastern counties of the State. The precipitation is fairly evenly distributed throughout the year, the spring and summer seasons having the greatest rainfall. The snowfall averages about 30.8 inches annually and is heaviest in January. It is from 10 to 15 inches below that of counties to the north, and only half that of northeastern Ohio, but, in most winters, it is sufficient to provide considerable protection for fall-sown grain crops.

A study of the United States Weather Bureau reports for Ottawa, which is located approximately at the geographical center of the

[4] HOWE, H. HISTORICAL COLLECTIONS OF OHIO . . . AN ENCYCLOPEDIA OF THE STATE . . . 2 v., illus. Cincinnati. 1902.

county, for a period extending from 1891 to 1934, indicates that very wet springs, when the total precipitation for April, May, and June, which averages 10.09 inches, exceeded 13.4 inches three times, or an average of once in 13 years; and that summer droughts, when the total precipitation for July and August, which averages 6.68 inches, was less than 3.2 inches, occurred twice, or an average of once in 20 years. In excessively wet springs crop failures are common on Paulding and Palmer silty clays, but after summer droughts, as well as after excessively wet springs, partial failures are common on all other upland soils of the county.

Where natural drainage is very poor and tiling or ditching inadequate, the water-soaked soils remain very cold until late in the spring. Corn, the leading crop of the county, will not germinate or grow when the temperature is below 48° F. When the soil water changes from liquid to vapor by evaporation a very great quantity of heat is drawn from the soil, thus keeping it cold. It requires about five times as much heat to raise the temperature of water as it does of soil. Thus it is apparent why the water-soaked Paulding, Palmer, Brookston, Pandora, Nappanee, and Bono silty clays become warm very slowly.

The average dates of the latest and earliest killing frosts at Ottawa are May 6 and October 7, respectively, but frost has been recorded as late as May 27 and as early as September 11.

Table 1 gives the more important climatic data, as recorded at the United States Weather Bureau station at Ottawa, which are considered representative for the county as a whole.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Ottawa, Putnam County, Ohio*

[Elevation, 720 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1925)	Total amount for the wettest year (1929)	Snow, average depth
	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Inches*
December	29.5	69	−19	2.57	0.96	4.18	7.2
January	26.3	71	−22	2.60	.59	3.32	9.7
February	26.8	65	−20	1.88	2.29	1.23	6.1
Winter	27.5	71	−22	7.05	3.84	8.73	23.0
March	38.5	85	−2	3.38	2.72	4.49	5.7
April	49.3	91	11	3.15	.77	4.00	.7
May	59.9	98	27	3.50	1.36	3.83	(1)
Spring	49.2	98	−2	10.03	4.85	12.32	6.4
June	68.7	100	36	3.44	2.25	4.92	.0
July	73.4	102	43	3.60	3.24	4.08	.0
August	71.4	106	35	3.08	2.70	3.76	.0
Summer	71.2	106	35	10.12	8.19	12.76	.0
September	65.3	98	28	3.06	4.12	1.93	0
October	53.3	90	13	2.41	2.67	4.45	.1
November	40.8	74	8	2.48	3.42	2.86	1.3
Fall	53.1	98	8	7.95	10.21	9.24	1.4
Year	50.3	106	−22	35.15	27.09	43.05	30.8

[1] Trace.

AGRICULTURE

Agriculture had its beginning in Putnam County when David Murphy erected a cabin of poles and cleared land along Auglaize River in 1824,[5] but early development was greatly retarded, owing to the lack of roads and capital, remoteness of markets, vast swamps that covered 95 percent of the county, and forests which spread over all of it. Only along the streams and on the sandy gravelly ridges could the early settlers find adequately drained land for producing crops.

During the seventies and eighties, the manufacturing of staves and the cutting of railroad ties, hoop poles, ship timber, and lumber of various kinds were important industries.

State statistics[6] show a gradual increase in both acreage and yield of corn from the decade 1860–69, when the average acreage was 17,563 acres and the average acre yield was 28.8 bushels, to the decade 1900–09, when the average acreage was 60,991 acres and the average acre yield was 40.8 bushels. There was a gradual increase in the acreage and yield of wheat from the decade 1850–59, when the average acreage was 6,724 acres and the average acre yield was 10.9 bushels, to the decade 1890–99, when the average acreage was 40,967 acres and the average acre yield was 15.7 bushels. Oats gradually increased from 3,234 acres with an average yield of 9.7 bushels an acre, in the decade 1850–59, to 6,192 acres with an average acre yield of 31.6 bushels in the decade 1890–99; but, owing to winter-killing of wheat, rose to an acreage of 22,711 acres in the decade 1900–09. According to census reports covering the period from 1880 to 1930, a gradual decrease in corn acreage has occurred since 1910, the wheat acreage increased because of the demand during the World War but has declined since 1920; and the oats acreage increased gradually from 1880 to 1890, and then quadrupled by 1910, but since that year has repeatedly gone down and up without any pronounced change.

Corn is the most important and most extensively grown crop. The 1930 census reports that, in 1929, 62,550 acres planted to corn for grain yielded 2,202,879 bushels, and in addition corn from 1,033 acres yielded 10,505 tons of silage, from 3,138 acres was cut for fodder, and from 3,519 acres was grazed off. Almost all the corn is used for feed on the farms.

Hay ranks next to corn in acreage. It was grown on 34,760 acres in 1929, and the yield was 47,772 tons. Hay, composed of timothy and/or timothy and clover mixed, was grown on 18,650 acres, clover alone on 10,805 acres, and alfalfa on 4,777 acres. All the hay is fed on the farms.

Wheat was grown on 29,277 acres in 1929 and yielded 561,842 bushels. Wheat growing is considered by many farmers commercially unprofitable, owing to the low market price, ravages of insects, plant diseases, and winter-killing, but others favor its retention as a nurse crop for clover and as a winter cover crop. Most of the wheat is shipped out of the county.

Oats were grown on 38,907 acres in 1929 and yielded 1,274,082 bushels. In addition, oats from 453 acres were cut and fed un-

[5] HOWE See footnote 4, p. 3.

[6] LLOYD, W. A., FALCONER, J. I., and THORNE, C. E. THE AGRICULTURE OF OHIO. Ohio Agr. Expt. Sta Bull. 326, 441 pp., illus. 1918.

threshed. All oats are fed on the farms. Barley was grown on 7,265 acres in 1929 and yielded 192,067 bushels. It is used as feed for livestock.

Sugar beets, the most important special crop, were produced on 1,594 acres in 1929 and yielded 13,658 tons. The beets are grown under contract with a sugar-manufacturing company. The farmer plants the crop, cultivates it, and delivers it to the shipping point; and the beet-sugar company furnishes seed and laborers who do the weeding, thinning, and topping, for which (in 1930) a charge of $25 an acre was made. Sugar beets yield best on heavy soils of the Brookston, Pandora, Clyde, and Toledo series.

Potatoes are an important crop on the lighter textured fairly or well drained soils. In 1929, 765 acres of potatoes yielded 88,967 bushels. A large part of the crop is marketed locally.

Most farms have small home orchards, but as a rule little or no attention is given to tillage, pruning, spraying, or fertilizing. Bearing apple trees numbered 33,245 in 1929, peach trees 3,686, pear trees 3,004, plum trees 2,995, and cherry trees 2,637.

In 1929, fertilizers to the value of $83,432 were used on 1,279 farms. The fertilizers in general use are superphosphate for small grain and a complete fertilizer, such as 2–12–6 [7] or 4–24–4, for corn. Fine-ground limestone, or its equivalent in other forms of lime, such as the lime residue from the beet-sugar plant at Ottawa, has been used in a small way on all the light-colored soils with good results.

Most of the farm laborers are native-born whites, and the supply is sufficient. Members of the farmer's family do a large part of the farm work, and when extra help is needed, as during threshing and silo filling, exchange of help among neighbors is common. Monthly wages for farm hands range from $30 to $45 with board and washing. Day laborers are paid from $1 to $2, or from 25 to 30 cents an hour. The census reports $194,309 paid for farm labor during the year 1929, an average of $166.36 for each of the 1,168 farms reporting.

The average size of farms increased from 89 acres in 1880 to 100.2 acres in 1930. Most of the farms range in size between 40 and 160 acres. The 1930 census reports 2,825 farms in the county. The same census reports 1,909 farms operated by owners and part owners, 905 by tenants, and 11 by managers. In renting, the landlord pays one-half of the seed, threshing, and fertilizer bills and receives one-half of the income. Where land is rented for cash, from $5 to $7 an acre is paid.

Farm buildings are generally substantially built and are kept painted and in good repair. The barns, corncribs, and other buildings provide ample room for housing livestock and storing crops and machinery. Sanitary conditions are maintained, and the water on most farms is pumped from deep drilled wells. Most farms are equipped with gasoline engines which are used for pumping water, sawing wood, shredding corn, and filling silos. The work animals are medium-sized draft horses. Tractors are used extensively, particularly in breaking heavy soils, as the period when the moisture content is suitable for pulverization is in general brief, and rapid work is imperative.

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

In 1930 there were 2,965 automobiles on the farms, 210 motor trucks, 876 tractors, 471 electric motors for farm work, and 1,032 stationary gas engines. Telephones were in 2,236 farm homes, water piped to the dwelling in 684, and 958 were lighted by electricity.

Livestock raising is almost wholly dependent on general farming, in which the growing of corn to be fed to hogs is particularly stressed. According to the estimates of farmers having the better soils for corn, such as soils of the Brookston, Clyde, and Pandora series and the heavy member of the Toledo series, 1 hog is turned off annually for each 3 acres of land. Most farmers have some hogs to sell. Duroc-Jersey and Poland China are the favorite breeds, although many farmers raise Chester Whites. The 1930 census reports that the farms of Putnam County had 1 hog to each 4.1 acres, 1 head of cattle (dairy and beef) to each 12.8 acres, 1 sheep to each 10.9 acres, 1 horse to each 34.3 acres, and 1 chicken to each 0.75 acre.

Although dairying is not greatly important, on a few farms it is combined with general farming. On such farms, Holstein-Friesian cattle are more numerous than cattle of other breeds, but there are a number of herds of Guernseys and Jerseys. Some of the dairy herds are purebred, but most of the cows are grades. Practically all the sires are purebred. The value of dairy products sold in 1929 amounted to $720,387.

A small number of farmers, well distributed over the county, feed beef cattle for market. The cattle are shipped in from western points in the fall and are marketed in the spring. Hereford and Shorthorn are the leading breeds. A small number of farmers keep a few sheep. Shropshire is the leading breed. A few horses are raised. Some farmers breed their working mares and raise enough work animals for their own use. The value of poultry raised and eggs produced in 1929 was $1,512,873. Most farmers keep from 50 to 200 chickens, and a few farmers are specializing in poultry, mainly White Leghorns, but the average farmer usually has a mixture of various breeds of chickens.

The sugar beets produced are largely handled by the beet-sugar factory at Ottawa. Other beet-sugar factories in this part of Ohio are located at Findlay, Paulding, Toledo, and Fremont.

SOILS AND CROPS

Putnam County lies in a section characterized by a humid temperate climate and a growth of deciduous forests, where soil materials have been accumulated by glacial processes, mainly from sedimentary rocks containing a predominance of limestone. In this county, 90 percent of the land, under natural conditions, was poorly or imperfectly drained, so that those soil characteristics common to mature, well-drained soils of this climatic and vegetal environment, have not been fully developed. Consequently, drainage and textural character are of chief importance in determining differences in the agricultural use of the various soils. The soils with fair or good drainage are light in color, low in organic matter, and for the most part acid in reaction. They occur on knolls and ridges in the northeastern and southeastern parts of the county and along streams.

Poorly drained soils are slightly acid or neutral, and their textures are largely determined by and are coextensive with certain surface features and certain underlying geologic materials.

Putnam County is situated in a part of the area that was once a part of second glacial Lake Maumee, with the exception of the extreme southeastern corner (later Wisconsin till plain) and the hummocky region (Defiance Moraine) between Gilboa and Leipsic. Sandy and gravelly glacial lake beaches extend in a northeast-southwest direction through and in the vicinity of Pandora in the southeastern and south-central parts of the county, and in a south-east-northwest direction through Leipsic and Belmore in the north-eastern part; and numerous small sand knolls and ridges occur in the vicinity of Dupont and in isolated spots throughout the county. Soils associated with such surface features are gravelly or sandy.

The surface formations in about 95 percent of glacial Lake Maumee basin in this county consist of heavy-textured glacial till, and the soils overlying this till are heavy textured. Only along streams, on knolls, and in better drained areas has the parent material been markedly modified by normal soil-making processes. In such situations the fine material has been carried from the surface layers 10 or 12 inches downward and deposited at a depth ranging from 14 to 30 inches, thus producing distinctly heavier subsoils which, locally, are called "hardpan." Where drainage has been very poor, the texture of the surface soil and subsoil is about the same as that of the underlying parent material, yet other marked changes, such as the addition of organic matter, have taken place. The heavy plastic impervious silty clays of the Paulding and Palmer series, which cover most of the northwestern quarter of the county, the extensive areas of Brookston clay in the northeastern corner, and the large areas of Pandora and Brookston silty clay loams in the southern half are all underlain by glacial materials which have similar textures to those of the soils immediately over them.

In texture, the surface soils range from very heavy plastic silty clays to incoherent sands. About 20 percent consists of silty clays which are especially difficult to manage because of their impervious refractory character; 30 percent of heavy silty clays and silty clay loams, which are less difficult to manage but must be worked within a very narrow range of moisture content; 40 percent of comparatively friable clays, silty clays, clay loams, and silty clay loams, all of which may be worked into very good seed beds, but must be handled when moisture conditions are right for pulverization; and 10 percent of loams, fine sandy loams, very fine sandy loams, fine sands, and very fine sands, which are free working and easily managed.

About 50 percent of the soils are well supplied with organic matter, 30 percent are fairly well supplied, and 20 percent are poorly supplied. About 80 percent of the soils are neutral or slightly acid and thus naturally adapted to the growing of legumes, and 20 percent are acid to a depth ranging from 16 to 22 inches. Furthermore, 80 percent of the soils lie on very smooth surfaces and were in a swampy condition until ditched and tiled.

General farming, consisting of the production of corn, small grains, and hay crops, is the leading type of agriculture, yet farmers

are guided, to a marked degree, by the adaptation of certain crops to the soils, giving special consideration to soil texture, color, content of organic matter, drainage, and reaction. For example, a higher percentage of the light-colored acid soils, which are low in organic matter and occur along streams and on ridges, knolls, or elevated areas, is devoted to small grains and timothy and a lower percentage to corn and clover than of the dark-colored neutral soils which are high in organic matter and cover 80 percent of the county. On the heavy-textured soils of the first group, particularly Palmer silty clay, occurring south of North Creek, and on the imperfectly drained Nappanee, St. Clair, and Fulton soils, alsike clover and timothy are grown, whereas red clover and timothy are more common on the soils of the second group. Sweetclover is commonly grown on Paulding silty clay and on the silty clays, clays, clay loams, and silty clay loams of the Brookston, Pandora, Clyde, and Toledo series, for green manure and for opening up the subsoils. It is generally recognized that Brookston, Pandora, and Toledo silty clay loams and Clyde clay, all having moderately friable surface soils and subsoils, are best for the production of corn, sugar beets, alfalfa, and sweetclover. It is equally well known that sandy and gravelly soils are best for potatoes and have been found well suited to melons, cucumbers, small fruits, and berries. Well-drained muck is used for corn, potatoes, and onions and is also known to be well adapted to cabbage, celery, carrots, beets, and head lettuce. Small grains are apt to lodge on the Clyde soils, and the quality is not so good as on the Nappanee, St. Clair, and Fulton soils.

About 85 percent of the farm land is classed as crop land and plowable pasture, 8.5 percent is in woodland and other pasture, and 6.5 percent is in wood lots and other land. Corn, the most important crop, is grown as feed for livestock—mainly hogs—oats, second in importance, are used as feed for horses. Ranking next in importance is wheat, the main cash crop. Other general farm crops produced, named in order of their importance, are hay, barley, and soybeans. Sugar beets are grown as a cash crop in some sections.

The heavy-textured soils are used largely for the production of corn, oats, wheat, hay, and barley, ranking in importance in the order named; in addition to these crops, the light-textured soils are used to some extent for potatoes; and muck is used for corn, potatoes, and onions.

In interpreting the soil map, it is well for the reader to understand that in nature soils are sharply separated in very few places, and in soil mapping it is necessary to include small areas of other soils and minor variations with a given soil. Therefore each color represents the presence of a dominant soil type and not an absolutely uniform single type. As mapped, areas of only 1 or 2 acres are usually included with larger areas, because the scale of the map is so small.

Agriculturally, the soils of Putnam County may be classed in two general groups. The first group includes the heavy-textured soils which have loam, silt loam, silty clay loam, silty clay, clay loam, or clay surface soils and clay loam, silty clay loam, silty clay, or clay subsoils; and the second group includes the sandy and gravelly

soils, or those having light friable surface soils, such as sandy loam and gravelly sandy loam, in most places grading downward into sandy or gravelly friable easily drained subsoils. In addition to these two general groups are small areas of muck and flood-plain soils. Members of the heavy-textured group occur in large areas and are well distributed throughout the county, but the light-textured soils are restricted principally to ridges, knolls, and elevated surfaces in the eastern half and the extreme western part in the vicinity of Dupont. Muck soils occur in small bodies west of Miller City, and flood-plain soils lie along stream courses throughout the county.

In the following pages the soils are divided into series on the bases of differences in structure, color, consistence, degree of leaching, and minor details of the soil profile and on the bases of the source, character, and process of accumulation of the material from which the soils have been derived. A further differentiation into types has been made on the basis of the texture of the surface soil. Minor variations in the soil, not sufficient to produce type or series differences but significant in land use, are indicated as soil phases. The distribution of the various soils is shown on the accompanying soil map, and their acreage and proportionate extent are given in table 2.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in Putnam County, Ohio*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Nappanee silty clay loam	9,920	3 2	Clyde clay	3,136	1 0
Nappanee silty clay	6,272	2 0	Paulding silty clay	36,352	11 8
Nappanee clay loam	4,544	1 5	Paulding silty clay loam	13,632	4.4
Crosby silty clay loam	20,160	6 5	Bono silty clay	1,088	3
St Clair silty clay loam	9,216	3 0	Toledo silty clay loam	1,920	.6
St Clair silty clay loam, heavy phase	3,072	1 0	Rimer very fine sandy loam	8,320	2.7
Fulton silty clay loam	2,048	.7	Fulton loam	512	.2
Fulton silt loam	896	3	Vaughnsville loam	64	.1
Palmer silty clay	5,376	1 7	Belmore loam	2,624	9
Brookston clay	36,608	11 9	Wauseon loam	2,304	7
Brookston clay loam	5,440	1.8	Toledo loam	576	.2
Brookston silty clay	5,248	1.7	Berrien fine sandy loam	5,440	1 8
Brookston silty clay, dark-colored phase	2,240	7	Belmore fine sandy loam	1,536	.5
Brookston silty clay loam	14,400	4.7	Rimer fine sandy loam	320	1
Brookston silty clay loam, heavy phase	11,712	3 8	Toledo very fine sandy loam	640	2
Pandora silty clay loam	7,808	2.5	Genesee silty clay loam	11,776	3.8
Pandora silty clay loam, heavy phase	27,840	9 0	Genesee silt loam	2,624	.9
Pandora clay loam	3,776	1 2	Eel silty clay	1,024	.3
Pandora silty clay	37,120	12.0	Wabash clay loam	576	.2
			Muck	320	.1
			Total	308,480	

HEAVY-TEXTURED SOILS

The heavy-textured soils are subdivided into four subgroups, each of which is composed of soil types having certain common soil characteristics which have much influence in determining productiveness. These subgroups are as follows: (1) Light-colored acid soils underlain by heavy subsoils; (2) dark-colored neutral soils underlain by heavy subsoils; (3) light-colored acid soils underlain by friable pervious subsoils; and (4) dark-colored neutral soils underlain by friable pervious subsoils.

LIGHT-COLORED ACID SOILS UNDERLAIN BY HEAVY SUBSOILS

The first subgroup includes the Nappanee, Crosby, St. Clair, Fulton, and Palmer soils. The Nappanee, Crosby, St. Clair, and Fulton soils are similar to one another, in that they have friable silty clay loam surface soils, plastic impervious silty clay layers in the subsoils, fair surface but poor internal drainage, and occur principally along rivers and creeks. Palmer silty clay differs little from the other soils in the heavy silty clay texture of both surface soil and subsoil, but it has very poor drainage, both surface and internal.

The dominant tree growth on the Nappanee, Crosby, St. Clair, and Fulton soils consists of beech, white oak, red oak, pin oak, and shellbark hickory. Less common trees are soft maple, hard maple, bur oak, black walnut, and basswood. The principal tree growth on Palmer silty clay is pin oak, and other trees are bur oak, white elm, black ash, sycamore, shellbark hickory, pignut hickory, and soft maple.

Nappanee silty clay loam.[8]—Nappanee silty clay loam covers a total area of 15.5 square miles. It occurs principally along the rivers and creeks as long narrow bodies gently sloping toward the streams. Surface drainage of this soil is fair, but internal drainage is very slow on account of the compactness of the subsoil layers and artificial drainage is extremely difficult to establish.

Nappanee silty clay loam, to a depth of 9 inches, consists of light-gray friable comparatively light textured silty clay loam with a very low content of organic matter. Below this and continuing to a depth of 22 inches is gray plastic silty clay with brown mottlings, which, at a depth of about 15 inches has a brown or yellowish-brown tint with gray mottlings. This layer rests on brittle much less impervious and somewhat friable silty clay which continues to a depth of about 35 inches, where the material is calcareous. Throughout the surface soil and subsoil, as well as scattered over the surface, are small crystalline pebbles and a few boulders. Small irregular fragments of limestone occur below a depth of 2 feet.

About 90 percent of this soil is cultivated, 5 percent is in permanent pasture, and 5 percent is in wood lots.

Most farmers practice the rotation common to the county, consisting of (1) corn, (2) oats or wheat, and (3) mixed timothy and clover hay. Barley may take the place of oats or wheat; and alfalfa, sweetclover, red clover, or soybeans, of mixed timothy and clover. Corn yields average about 35 bushels an acre, oats 40 bushels, wheat 20 bushels, hay 1½ tons, and barley 25 bushels. Land for corn commonly receives an acre application in the row of 150 pounds of a 2–12–6 fertilizer, and oats 125 pounds of 20 percent superphosphate. In addition to stable manure, some farmers plow under green-manure crops, in order to furnish a supply of actively decomposing organic matter. To neutralize acidity, farmers apply, before planting in the fall or spring, from 1 to 2 tons of finely pulverized limestone. This practice has greatly assisted in obtaining good stands of clover.

Nappanee silty clay.—Nappanee silty clay occurs in broad flat areas contiguous to stream courses, west of Rice, north of Vaughns-

[8] The soil type descriptions in this section are of cultivated soils under normal moisture conditions.

ville, south of Miller City, and north of Ottawa. Its total area is 9.8 square miles. In color of profile and in depth to calcareous material it resembles Nappanee silty clay loam, but it differs from that soil in that the 8-inch surface layer is heavy silty clay loam and is underlain by a 12- to 16-inch layer of very heavy impervious silty clay which rests on somewhat less plastic and less impervious heavy silty clay.

About 70 percent of this soil is cultivated, 20 percent is in permanent pasture, and 10 percent in wood lots. The crops grown and agricultural practices followed are essentially like those on Nappanee silty clay loam, but yields are somewhat lower. This results from the heavier surface soil, which makes tillage more difficult, and the more extremely impervious subsoil which restricts drainage.

Nappanee clay loam.—Nappanee clay loam is similar to Nappanee silty clay loam in color and in depth to calcareous material, but it differs in that its topsoil is pervious clay loam which is underlain, at a depth of 8 inches, by heavy clay that is somewhat lighter textured below a depth of 20 inches. It also differs in having more fine gravel and sand in both its surface soil and subsoil. Consequently, it has better drainage, is more easily handled, and is somewhat more productive.

The total area of Nappanee clay loam is 7.1 square miles. The main developments of the more typical soil, aggregating about 1 square mile, are along Yellow and Little Yellow Creeks in the northeastern part of the county. The crops grown and methods of land treatment are like those on Nappanee silty clay loam, but yields are somewhat better, owing to better drainage and workability, on account of the more favorable texture of both surface soil and subsoil.

A heavier variation of Nappanee clay loam occurs in fairly large bodies, principally west and north of Gilboa, and on small knolls and ridges in the old glacial-lake plain in the northeastern part of the county. Its aggregate area is about 2 square miles. This soil differs from typical Nappanee clay loam in having a heavy clay loam surface soil which extends to a depth of 9 inches and is underlain by a 14-inch layer of heavy plastic impervious silty clay. This material rests on heavy somewhat pervious brown clay. The depth to calcareous material and the color throughout the profiles of the typical soil and the heavier soil are very much alike, except that the heavier soil is a little more gray in the subsoil.

A lighter textured variation of Nappanee clay loam resembles typical Nappanee clay loam in the depth to calcareous material and the color of its profile, except that it is a little more brown and less gray; but it differs from the typical soil in having a much higher content of silt, fine sand, and very fine sand throughout. This lighter textured soil has a very pervious clay loam surface soil underlain, at a depth of 8 inches, by pervious clay loam which grades, at a depth of about 12 inches, into a 10-inch layer of impervious plastic clay that rests on porous sandy clay. This lighter textured soil covers an aggregate area of about 4 square miles, and occurs in the eastern part of the county in comparatively large level or undulating bodies. About 80 percent of the land is cultivated, 10 percent is in permanent pasture, and 10 percent is in wood lots. It is used for the same crops as typical Nappanee silty

clay loam but is more productive, owing to its perviousness and better workability.

Crosby silty clay loam.—Crosby silty clay loam, owing to a higher content of grit and very fine sand and a lighter texture throughout than Nappanee silty clay loam, has better aeration and drainage in both topsoil and subsoil, warms up earlier in the spring, pulverizes more readily, and is more easily cultivated. Consequently yields are somewhat higher. Along Little Auglaize River a few small strips of Crosby silt loam are included in mapping.

Crosby silty clay loam is developed in large, smooth, level, or undulating areas of low elevation in the eastern part of the county, aggregating 31.5 square miles.

St. Clair silty clay loam.—The surface soil and heavy texture of the subsoil of St. Clair silty clay loam are like those of Nappanee silty clay loam, but the color of the subsoil is brown, and the material throughout the soil is more free of fine gravel and sand.

To a depth of 8 inches, St. Clair silty clay loam is light-gray or light brownish-gray friable silty clay loam. This layer is underlain by heavy plastic brown silty clay which extends to a depth ranging from 20 to 25 inches. This material rests on decidedly less heavy somewhat friable brown silty clay which is calcareous below a depth ranging from 26 to 36 inches.

A gravel-free variation, which extends over a total area of about 1 square mile, is contiguous to the bluffs of Auglaize River west of Dupont and those of Blanchard River between Dupont and Cuba. Below the impervious plastic layer, at a depth of about 24 inches, the soil material consists of heavy rather friable well-laminated silty clay which is calcareous at a depth ranging from 34 to 40 inches.

St. Clair silty clay loam occurs in the western half of the county, the largest bodies lying along Blanchard River. Smaller areas are along Ottawa and Auglaize Rivers and South Powell Creek.

About 70 percent of the land is cultivated, 15 percent is in permanent pasture, and 15 percent is in wood lots. The types and methods of farming, crops grown, and yields are much the same as those for Nappanee silty clay loam.

St. Clair silty clay loam, heavy phase.—St. Clair silty clay loam, heavy phase, is similar in color to typical St. Clair silty clay loam, but it has a heavier surface soil and a more impervious subsoil. Consequently it is more difficult to till and underdrain, thereby causing yields to be lower. It occurs in rather large areas along Blanchard River northwest of Glandorf, along Sugar Creek north of Vaughnsville, and along North Powell Creek. Its total area is 4.8 square miles.

The percentages of land cultivated, in permanent pasture, and in wood lots, the crops grown, and agricultural practices are about the same as for the more typical soil.

Fulton silty clay loam.—More or less closely associated with St. Clair silty clay loam are areas of Fulton silty clay loam on the higher terraces along Blanchard, Auglaize, and Ottawa Rivers. The aggregate area of this soil is 3.2 square miles. It is like St. Clair silty clay loam in having a friable silty clay loam surface soil underlain by a 17-inch layer of plastic impervious silty clay which rests on

friable silty clay; but it is unlike the St. Clair soil in color. The surface soil is gray or brownish gray, the impervious layer is gray mottled with brown, and the parent material is mottled lighter yellow, light-gray, and brown material. This soil resembles Nappanee silty clay loam in color, texture, and consistence of both surface soil and subsoil, also in depth to calcareous material; but it differs from the Nappanee soil and also from St. Clair silty clay loam in containing no material coarser than sand and in being well laminated in and below the lower part of the subsoil.

About 80 percent of Fulton silty clay loam is cultivated, 10 percent is in permanent pasture, and 10 percent is in wood lots. The crops, yields, and type of farming are comparable to those for Nappanee silty clay loam.

Fulton silt loam.—Fulton silt loam is associated with Fulton silty clay loam and St. Clair silty clay loam along Blanchard River northwest of Glandorf. This soil has a total area of 1.4 square miles. It differs from Fulton silty clay loam in that it consists of gray or brownish-gray friable silt loam, to a depth of 10 inches, which grades downward into mottled gray and brown friable clay loam, and this layer, at a depth of about 14 inches, rests on a 10-inch layer of brown, mottled with gray, heavy impervious silty clay which, in turn, rests on pervious brown silty clay loam containing gray mottlings. It resembles Fulton silty clay loam in having no coarse material throughout its profile, in being calcareous at about the same depth as that soil, and in being laminated in the lower part of the subsoil.

About 90 percent of Fulton silt loam is cultivated, 5 percent is in permanent pasture, and 5 percent in wood lots. The relative acreages of the various crops and the treatment of the soil are essentially like those for Fulton silty clay loam, but yields, owing to a more friable consistence and consequently better aeration and drainage, are a little higher.

Palmer silty clay.—Palmer silty clay has a much heavier and more acid surface soil than the silty clay loams of the Nappanee, St. Clair, or Fulton series.

The principal development of the Palmer soil is a large continuous area between Nappanee silty clay loam along South Powell Creek and St. Clair silty clay loam, heavy phase, along North Powell Creek. Smaller bodies lie southeast of Miller City. The total area of this soil is 8.4 square miles. The surface relief ranges from level to gently undulating.

Under normal moisture conditions the cultivated soil of Palmer silty clay, to a depth of 8 inches, consists of acid brownish-gray rather heavy silty clay. This is underlain by mottled brown, gray, and drabbish-gray plastic impervious silty clay which is calcareous at a depth ranging from 36 to 46 inches.

A light-textured variation, embracing about one-third square mile, occurs 1½ miles southeast of Miller City. Here the texture of both surface soil and subsoil is lighter than typical, thereby favoring artificial drainage and cultivation.

About 60 percent of Palmer silty clay is tilled, 25 percent is in permanent pasture, and 15 percent is in wood lots. The relatively low proportion of this soil cultivated is owing to low productivity resulting from the heavy surface soil and plastic impervious subsoil,

which greatly retard the circulation of both water and air. These features cause the soil to warm up very slowly in the spring, to puddle when wet, and to become extremely hard and crack when dry, breaking into large lumps when plowed. To obtain fair drainage, the farmers install 4-inch tile at intervals of 2 rods and at a depth of about 24 inches, but in places where the soil material is extremely impervious it is necessary to place the laterals only 1 rod apart.

A rotation that is commonly followed on this soil is corn, oats or wheat, and a mixture of timothy and red or alsike clover. Sweetclover sometimes takes the place of red clover, as its heavy roots will penetrate and open up the impervious subsoil. Yields of corn average about 32 bushels an acre, oats 35 bushels, wheat 17 bushels, and hay 1¼ tons. Most farmers use commercial fertilizer for wheat, generally at the rate of 150 pounds an acre, and sometimes for corn. The fertilizer most commonly used for wheat is 20 percent superphosphate, and a complete fertilizer, such as a 2–12–6 or 4–24–4, is used for corn.

DARK-COLORED NEUTRAL SOILS UNDERLAIN BY HEAVY SUBSOILS

To the second subgroup of heavy-textured soils, those having dark-colored surface soils with neutral or slightly acid reaction, underlain by heavy subsoils, belong the Paulding, Bono, Brookston, Clyde, and Pandora soils, and the heavy member of the Toledo series. The surface soils of the Bono and Clyde soils are very dark gray or black and are very high in organic matter, the surface soils of the Brookston and Toledo soils are dark brownish gray or very dark brownish gray and have a high content of organic matter, and the surface soils of the Paulding and Pandora soils have a somewhat lower content of organic matter, the Paulding having a dark-gray color and the Pandora dark brownish gray. The Paulding and Bono soils are very much heavier, more plastic, and more impervious than the other soils of this subgroup. The surface relief of all these soils is level. Both natural surface drainage and internal drainage of the soils of this subgroup are very poor, owing to the nearness to the surface of the ground-water level and to the heavy textures of the surface soils and subsoils.

The tree growth on these soils is principally white elm and bur oak. Sycamore is abundant on the Pandora soils, pin oak on the Paulding soils, and black ash on the Clyde and Bono soils. Other trees are cottonwood, soft maple, shellbark hickory, basswood, white ash, white oak, red oak, beech, and quaking aspen.

Brookston clay.—Brookston clay is the second most extensively developed soil in the county, covering a total area of 57.2 square miles. It is developed in a large continuous area in the northeastern and northern parts, and smaller bodies are scattered throughout the eastern part.

The 8-inch surface layer of Brookston clay consists of dark brownish-gray friable crumbly clay. It is underlain by olive-gray pervious granular clay containing yellowish-gray, gray, and brownish-yellow mottlings. This layer, in turn, is underlain, at a depth of about 23 inches, by olive-gray heavy but somewhat porous clay

mottled with yellowish gray. Below a depth ranging from 38 to 42 inches the material is calcareous.

Owing to its heavy texture, this soil is sticky when wet and clods when dry. Consequently, it must be worked when fairly moist, but, because of its mellowness and friability, cultivation is much easier than on the stiff heavy clay soils. The friable crumbly subsoil greatly facilitates tile drainage.

About 90 percent of this soil is cultivated, 5 percent is in permanent pasture, and 5 percent in wood lots. The most important crop (corn) gives an average yield of about 45 bushels an acre, oats 39 bushels, wheat 19 bushels, mixed clover and timothy hay 1½ tons, alfalfa 2½ tons, barley 35 bushels, and sugar beets 12 tons. Almost all the corn, oats, barley, and hay is fed to livestock on the farms. Wheat and sugar beets are cash crops.

Brookston clay is naturally fertile, and under good farming methods the fertility is easily maintained. Most farmers practice a rotation consisting of corn for 1 or possibly 2 years, followed by oats or wheat seeded to mixed red clover and timothy or red clover alone. The clover sod is plowed early in the spring, sometimes in the fall, in preparation for corn, or is left the second year for pasture. All farmers use commercial fertilizer for wheat, generally 20 percent superphosphate at the rate of 150 pounds an acre. On many farms a similar application is used for oats, and 125 pounds of a 2–12–6 or 4–24–4 fertilizer is applied to corn.

Brookston clay loam.—Occurring between gravelly or sandy ridges and Brookston clay in the northern part of the county and closely associated with the Rimer soils throughout the eastern and southern parts, are areas of Brookston clay loam. This soil covers a total area of 8.5 square miles.

In color of soil material and in depth to calcareous material this soil corresponds closely to Brookston clay, but it differs from that soil in having a mellow friable clay loam surface soil extending to a depth of 8 inches, underlain by an upper subsoil layer of pervious clay loam which, at a depth of about 14 inches, grades into a lower subsoil layer of pervious clay. The higher content of fine sand, very fine sand, and fine gravel throughout, gives this soil better natural drainage and workability than Brookston clay.

Brookston silty clay.—Closely associated with Clyde silty clay is Brookston silty clay which comprises an aggregate area of 8.2 square miles. Most of this soil occurs in a few large bodies in the western part of the county. Small areas lie between Vaughnsville and Columbus Grove.

Brookston silty clay resembles Brookston clay in that it has a high content of organic matter, in its color throughout the profile, and in the depth to calcareous material; but it differs from that soil in having an 8-inch somewhat friable silty clay surface soil underlain by plastic silty clay which grades, at a depth of about 12 inches, into heavy plastic silty clay that continues downward.

This soil is high in organic matter, is friable, and can be worked into a good seed bed. About 90 percent of the land is cultivated, and the rest is in wood lots and permanent pasture. The crops grown, yields, and methods of treatment are practically the same as for Brookston clay.

Brookston silty clay, dark-colored phase.—Associated with the main areas of Brookston silty clay in the vicinity of Muntanna, is a dark-colored phase of this soil, which extends over a total area of 3.5 square miles. This dark soil differs from typical Brookston silty clay in that it has a larger content of organic matter, the surface soil is darker, and the texture throughout is heavier and more plastic. Owing to its heavier texture, tillage and drainage are more difficult.

About 80 percent of Brookston silty clay, dark-colored phase, is farmed, and the rest is in wood lots and permanent pasture. About the same crops are grown as on typical Brookston silty clay.

Brookston silty clay loam.—Lying in the southern part of Putnam County are many areas of Brookston silty clay loam, the most extensive developments being in the southeastern and southwestern corners. The total extent of these areas is 22.5 square miles. The high content of organic matter in the surface soil and the relatively high degree of friability throughout makes this one of the most fertile and most easily tilled soils of the county.

Brookston silty clay loam is similar to the clay, silty clay, and clay loam members of the Brookston series in having crystalline gravel scattered over the surface and throughout the soil mass, in the color of the soil material throughout, in the high content of organic matter and neutral reaction in the surface soil, and in the depth to calcareous material; but it differs from the other Brookston soils in that the surface soil, to a depth of 8 inches, is pervious mellow silty clay loam which is underlain by a friable silty clay subsoil.

About 90 percent of Brookston silty clay loam is tilled. The crops grown and yields obtained are essentially the same as on Brookston clay, but, because of greater porosity, the silty clay loam is easier to handle and more easily drained.

Brookston silty clay loam, heavy phase.—The heavy phase of Brookston silty clay loam differs from the typical soil in being decidedly less friable, in having a much lower content of sand, and in having a heavier texture throughout.

The largest developments, covering about 15 square miles, lie between Brookston silty clay areas on the north and Brookston silty clay loam areas on the south in the southwestern corner of the county. Smaller bodies occur in association with Pandora silty clay loam, heavy phase, in the southeastern and southern parts of the county. The total area of this soil is 18.3 square miles.

About 90 percent of this heavy soil is cultivated, and the rest is used as permanent pasture and wood lots. About the same agricultural practices are pursued and about the same crops are planted as on typical Brookston silty clay loam, but, owing largely to poorer drainage, the heavy soil is more difficult to handle and average yields are a little lower.

Pandora silty clay loam.—In most of their characteristics Brookston silty clay loam and Pandora silty clay loam are very much alike, their chief difference being in the greater content of organic matter in the surface soil of the Brookston soil. Pandora silty clay loam is closely associated with Brookston silty clay loam and Crosby silty clay loam. It occurs in comparatively large bodies in the eastern part of the county and in smaller bodies along Blanchard River west of Glandorf. It covers a total area of 12.2 square miles.

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Pandora silty clay loam has an 8-inch layer of dark brownish-gray friable mellow light-textured silty clay loam which is neutral or slightly acid in reaction and has a decidedly higher content of organic matter than the light-colored soils of the county. Below this layer is mellow brownish-gray light-textured silty clay loam which contains slight mottlings of brown and gray and which, with increasing depth, becomes lighter in color and heavier in texture until, at a depth of 10 or 11 inches, it is olive-gray friable silty clay loam containing distinct mottlings of yellow and brown. This material continues to a depth of about 39 inches, and below this the underlying glacial-till material is gray friable calcareous silty clay loam or light-textured friable silty clay with brown mottlings. Crystalline gravel occurs throughout the soil mass, irregular pieces of shale below a depth of 2 feet, and fragments of partly decayed limestone below a depth of 3 feet.

This soil has a fair content of organic matter, is retentive of moisture, and is comparatively easy to till. Although natural surface drainage and internal drainage are slow, owing to the level surface relief, artificial drainage is comparatively effective because of the pervious subsoil.

About 90 percent of this soil is tilled, 5 percent is in permanent pasture, and 5 percent is in wood lots. Crops, yields, and agricultural practices are about the same as for Brookston silty clay loam, but yields of small grains are slightly higher, as the stalks grow less rank and are less likely to lodge on the Pandora soil.

Pandora silty clay loam, heavy phase.—Pandora silty clay loam, heavy phase, is one of the most extensively developed soils in the county. It occurs throughout the southern half. Large areas, some of which embrace several square miles, are west of Riley Creek, and between Ottawa and Auglaize Rivers. The total area of this soil is 43.5 square miles.

The surface soil resembles that of typical Pandora silty clay loam in its fairly high content of organic matter and in color, but this soil differs from the typical soil in the much heavier texture and more plastic character of the soil material throughout. Owing to these qualities, it is more difficult to handle than typical Pandora silty clay loam and must be worked within a narrow range of moisture conditions.

About 90 percent of this heavy soil is under cultivation, and the rest is in permanent pasture and wood lots. Agricultural practices, crops produced, and yields are comparable to those on Brookston clay, except that small grains do a little better on this soil because of lighter stalk growth and less danger of lodging.

Pandora clay loam.—The main areas of Pandora clay loam are closely associated with Crosby silty clay loam and Brookston silty clay loam east of Riley Creek and south of Blanchard River, and small bodies occur along streams and ridges in most sections of the southeastern quarter of the county. This soil has an aggregate extent of about 6 square miles.

In content of organic matter, neutral reaction in the topsoil, color of the soil material, quantity of crystalline gravel throughout, and depth to calcareous material, this soil resembles Pandora silty clay loam, but it differs from that soil in having an 8-inch surface layer

of pervious clay loam which becomes heavier with increasing depth and grades, at a depth of about 13 inches, into light-textured pervious sandy clay continuing to some depth.

About 90 percent of Pandora clay loam is cultivated, 5 percent is in permanent pasture, and 5 percent is in wood lots. About the same crops are grown as on Brookston clay, equal yields are obtained except that small grains yield a little better, because the straw is not so rank and consequently lodges less, and the same type of farming is carried on.

Pandora silty clay.—Pandora silty clay is developed in large areas lying between bodies of Brookston clay and Paulding silty clay in the northern part of the county, between Pandora silty clay loam and Paulding silty clay in the central and southern parts, and between Brookston silty clay and Brookston silty clay loam in the western part. Its total area is 58 square miles.

Pandora silty clay is like Pandora silty clay loam in content of organic matter, neutral reaction in the topsoil, depth to calcareous material, and color, except that the gray tinge is a little more prominent and the brown less prominent; but it differs from that soil in being somewhat pervious silty clay to a depth of 8 inches, where it is underlain by plastic silty clay that extends downward for several feet, and in having decidedly less crystalline gravel throughout. In texture and consistence of topsoil and subsoil material it resembles Brookston silty clay. Owing to greater difficulty in handling and draining, on account of the heavy plastic surface soil and subsoil, it does not produce so well as Pandora silty clay loam.

About 75 percent of Pandora silty clay is tilled, 15 percent is in permanent pasture, and 10 percent is in wood lots. The crops grown and type of farming followed are comparable to those on Brookston clay, but yields of small grains are slightly higher, because of a less rank straw growth and consequently less lodging. Corn returns an average yield of about 40 bushels an acre, oats 40 bushels, wheat 20 bushels, and hay 1½ tons.

A variation of Pandora silty clay differs from the typical soil in its higher content of organic matter and darker color in the surface soil. It covers an area of about one-half square mile 3 miles northeast of Vaughnsville.

Clyde clay.—Lying in shallow basins within and adjacent to extensive Brookston clay areas in the northeastern part of the county, are large areas of Clyde clay, which cover a total area of about 5 square miles.

Clyde clay is similar to Brookston clay in its depth to calcareous material, its neutral reaction in the topsoil, in quantity of crystalline pebbles throughout the soil mass, and in quantity of irregular fragments of limestone and small pieces of shale in the parent material; but it differs from the Brookston soil in that it has an 8-inch layer of very dark mellow clay loam or light-textured clay, which is higher in organic-matter content than the topsoil of Brookston clay, and has a light-gray more porous clay subsoil which rests, at a depth of about 24 inches, on heavy light-gray glacial till.

With adequate drainage, this has proved to be the best soil in the county for corn. Drainage is naturally poor, but the pervious clay subsoil renders tile drainage effective.

About 90 percent of the land is under cultivation, 3 percent is in permanent pasture, and 7 percent is in wood lots. It receives about the same treatment as Brookston clay, but yields of corn are slightly higher, and, owing to lodging, yields of small grain are lower. Corn yields average about 47 bushels an acre, oats 35 bushels, wheat 18 bushels, and timothy-and-clover-mixed hay 1½ tons.

A variation of Clyde clay occurs in areas 4 miles northeast of Miller City and east of Vaughnsville, which together cover about 1 square mile. This soil is similar to typical Clyde clay but is lighter in texture in both surface soil and subsoil. Because of this light texture, the land drains more readily and is easier to work.

Paulding silty clay.—Lying in broad flat areas between drainage courses in the northwestern quarter of the county are extensive developments of Paulding silty clay. Its aggregate extent is 56.8 square miles.

This soil, because of its greater imperviousness and plasticity, is much more difficult to drain and handle than Brookston silty clay, Clyde clay, or Pandora silty clay. Owing to its predominantly level surface relief, surface run-off of rainfall is very slow, and the compact plastic impervious soil layers very greatly impede the movement of ground water, making drainage difficult to establish. A conspicuous characteristic of the surface soil is that, when thoroughly wet, it retains water for a long time, but when it becomes dry it is so dense that water enters it slowly and absorption is hardly noticeable except during long-continued rains. When old tree roots or large sweetclover roots are decomposing in the subsoil, fair drainage is much more easily obtained than where root courses have become closed by the running together of the subsoil materials.

The 8-inch surface soil of Paulding silty clay is gray or dark-gray heavy plastic impervious silty clay containing brown mottlings and having a neutral reaction. Beneath this is gray, mottled with brown, extremely heavy and extremely impervious silty clay which, at a depth of 21 inches, grades into light yellowish-gray extremely impervious and extremely heavy silty clay mottled with brown. At a depth ranging from 40 to 50 inches, this material, in turn, grades into calcareous light yellowish-gray impervious heavy plastic glacial-till material which contains brown mottlings and has a silty clay texture. Lime concretions, ranging in diameter from one-twentieth inch to 3 inches, are common in this layer. Both surface soil and subsoil are comparatively free of sand and gravel, although a few crystalline pebbles are present.

About 60 percent of the land is cultivated, 25 percent is in permanent pasture, and 15 percent is in wood lots. Agricultural practices and crops grown are much the same as on Brookston clay, but average yields are much lower, because of the slowness of air and water circulation, causing the surface soil to warm up very slowly in the spring, puddle when wet, and, if plowed when dry, to break into large lumps. However, when moisture conditions are ideal for plowing, seeding, and cultivating, crop yields are fully equal to those obtained on Brookston clay. The most important crop (corn) returns an average yield of about 35 bushels an acre, oats 37 bushels, wheat 18 bushels, mixed-clover-and-timothy hay 1½ tons, and sugar beets 9 tons.

Paulding silty clay loam.—Paulding silty clay loam differs from Paulding silty clay in that it has less plasticity and imperviousness in its surface soil, subsoil, and underlying glacial till; but it is distinctly more heavy and impervious than Brookston silty clay, Clyde clay, Pandora silty clay, and Toledo silty clay loam. The areas west and north of Continental, in the vicinity of Myers Corners, southwest of Glandorf, and east and southeast of Miller City, like Paulding silty clay, contain few gravel and very little sand in any part of the soil mass; but the areas northeast and north of Miller City, like Brookston silty clay, contain considerable fine sand and much crystalline gravel throughout the surface soil, subsoil, and underlying glacial till.

Areas of Paulding silty clay loam border the extensive Paulding silty clay areas and lie between bodies of the Palmer and St. Clair soils in the vicinity of Rice. The total area of this soil is 21.3 square miles.

About 75 percent of the land is cultivated, 15 percent is in permanent pasture, and 10 percent is in wood lots. Farm practices and crops grown are like those on Brookston clay, but, owing mainly to the more impervious and more plastic character of the surface soil and subsoil and consequent greater difficulty in establishing drainage and in working, yields of corn and sugar beets are lower. Yields of small grains are about the same. On the other hand, the lower degree of imperviousness and plasticity in Paulding silty clay loam favors workability and artificial drainage, causing the land to be more productive than Paulding silty clay or Palmer silty clay. For a similar reason the variation of this soil northeast and north of Miller City, that has a considerable content of sand and gravel throughout the soil mass, is more productive.

Bono silty clay.—Bono silty clay occurs in shallow basins within areas of Paulding silty clay southwest of Miller City. It covers a total area of 1.7 square miles.

This soil resembles Paulding silty clay in the neutral reaction of its topsoil, in the depth to calcareous material, in an almost entire lack of sand or crystalline gravel in the soil mass, in color, and in having an extremely plastic and extremely impervious subsoil between depths of 9 and 40 inches, which rests on impervious clay; but it differs from that soil in that it has a very dark gray heavy but mellow silty clay surface soil with a very high content of organic matter, which causes it to rank among the better corn soils of the county. As on Clyde clay, small grains tend to lodge, owing to a rank growth of straw.

About 95 percent of Bono silty clay is cultivated. It is used principally for the production of corn, small grains, and hay. Corn yields average about 45 bushels an acre, oats 35 bushels, and hay 1 ton. Owing to the great difficulty in securing effective artificial drainage, on account of the extremely impervious subsoil, average yields are somewhat lower than on the Brookston or Pandora soils, but because of a very high organic content in the surface soil, they are better than on the Paulding or Palmer soils.

A lighter textured phase of Bono silty clay occurs 2 miles southwest of Pandora along the northwestern base of the old glacial-lake beach, in a long narrow belt covering about one-half square

mile. This soil differs from typical Bono silty clay in having a friable loamy silty clay loam surface soil and a pervious silty clay subsoil. Owing to its more favorable texture, it is much easier to work and to drain than typical Bono silty clay, and consequently it produces somewhat better yields.

Toledo silty clay loam.—Toledo silty clay loam is like Brookston silty clay loam, in that it has a dark brownish-gray friable silty clay loam surface soil with a neutral reaction and, below a depth of 8 inches, a gray, mottled with brown, pervious silty clay subsoil underlain, at a depth ranging from 34 to 40 inches, by calcareous friable silty clay; but it differs from the Brookston soil in being composed of homogeneous material which is free of gravel.

This soil occurs principally along Auglaize River near Cloverdale and Dupont, and very small areas lie along old beach lines and streams in many parts of the county. The total area is 3 square miles.

About 93 percent of the land is cultivated and is used largely for the production of corn, small grains, and mixed-clover-and-timothy hay. Crop yields and fertilization practices are comparable to those on Brookston clay.

LIGHT-COLORED ACID SOILS UNDERLAIN BY FRIABLE PERVIOUS SUBSOILS

In the third subgroup, which is represented by light-colored acid soils underlain by friable pervious subsoils, are Rimer very fine sandy loam, Fulton loam, Vaughnsville loam, and Belmore loam.

Belmore loam differs from the other members of this group in being well drained throughout, and Vaughnsville loam differs in having a light brownish-red surface soil and a light reddish-brown upper subsoil layer. Rimer very fine sandy loam differs from Fulton loam in that the soil materials, below a depth ranging from 26 to 40 inches, are heavier textured, whereas in Fulton loam the texture changes little if at all. The three poorly drained members of this subgroup, because of their perviousness, respond readily to artificial drainage. On them, white elm, soft maple, and black ash constitute the principal tree growth, and pin oak, swamp white oak, white oak, red oak, pignut hickory, shellbark hickory, red elm, poplar, cottonwood, beech, and white ash are less abundant.

The dominant tree growth on the well-drained soil, Belmore loam, includes hard maple, white oak, white ash, black walnut, wild cherry, and shellbark hickory, and less abundant trees are beech, basswood, cottonwood, pignut hickory, pin oak, red oak, yellow oak, and butternut.

Rimer very fine sandy loam.—Rimer very fine sandy loam is well distributed over the county in small areas aggregating 13 square miles. It is closely associated with Wauseon loam and Toledo silty clay loam on terraces along the larger streams, with Belmore loam and Belmore fine sandy loam on slightly elevated areas of the old glacial beaches in the southeastern and northeastern parts of the county, and with Crosby silty clay loam in the hummocky region (Defiance Moraine) between Gilboa and Leipsic.

Where adequately drained this soil is warm, early, and easily handled. It is somewhat low in organic matter.

Rimer very fine sandy loam is similar to Crosby silty clay loam in its acid reaction, color of the surface soil, and depth to calcareous

material; but it differs from that soil in its friable very fine sandy loam or loam topsoil underlain, at a depth of 8 inches, by mottled brown and light yellowish-gray pervious loam which, at a depth of about 12 inches, grades into pervious clay loam that rests on mottled gray and brown pervious clay at a depth of about 24 inches.

About 90 percent of the Rimer soil is cultivated, and the rest is largely in permanent pasture and wood lots. Corn, oats, wheat, mixed-clover-and-timothy hay, and potatoes are grown. Corn yields average about 38 bushels an acre, oats 40 bushels, wheat 20 bushels, hay 1¼ tons, and potatoes 150 bushels. The fertilizer treatment practiced is essentially the same as on Brookston clay, except that potatoes receive an acre application of about 800 pounds of complete fertilizer, such as 4–10–6.

Fulton loam.—Fulton loam is not extensive. It occurs 3½ miles northwest of Columbus Grove and northwest of Dupont, where it occupies slightly elevated bodies within larger areas of Pandora silty clay loam and Pandora silty clay. This soil, when properly drained, is warm, early, and easily handled. It is somewhat low in organic matter.

Fulton loam resembles Fulton silt loam and Rimer very fine sandy loam in content of organic matter, acid reaction of its surface soil, color throughout, and depth to calcareous material. It differs from those soils in that the texture of the subsoil and substratum is pervious silt loam or loam.

About 90 percent of the land is cultivated, and the rest is used for permanent pasture and wood lots. This soil is cropped and farmed in about the same way as Rimer very fine sandy loam.

Vaughnsville loam.—Vaughnsville loam is of very small extent. It occurs along the bases of old glacial-lake beaches southwest of Vaughnsville, northeast of Pandora, and southeast of Leipsic, bordering areas of Belmore loam and Belmore fine sandy loam. Because of its friable and pervious character, it warms up early in the spring and is easy to manage.

Vaughnsville loam resembles Belmore loam and Belmore fine sandy loam in the consistence of its topsoil and the depth to calcareous material, but it differs from those soils, in that the topsoil is light brownish-red material which, at a depth of 8 inches, grades into reddish-brown comparatively pervious clay loam becoming yellowish brown, with brownish-yellow and gray mottlings, below a depth of 20 inches.

Practically all of Vaughnsville loam is cultivated. The crops produced, yields, and methods of handling are very much the same as for Rimer very fine sandy loam.

Belmore loam.—Closely associated with Rimer very fine sandy loam in the southern and northeastern parts of the county are areas of Belmore loam, most of which occur on old glacial-lake beaches and bars. The total area is 4.1 square miles.

This soil, in its content of organic matter, acid reaction, and perviousness of the surface soil, is similar to Rimer very fine sandy loam; but it differs from that soil, in that it is well drained in both the surface soil and subsoil, is grayish brown to a depth of 10 inches, and below this is hard compact brittle very porous grayish-brown clay loam which grades into a 6-inch layer of moderately incoherent reddish-brown fine sand or sand. This sandy layer grades below into

dark reddish-brown fine sandy loam underlain, at a depth of about 40 inches, by brown clay loam which has a calcareous reaction below a depth of 48 inches.

Probably 95 percent of the land is cultivated. The crops grown and agricultural practices are comparable to those on Rimer very fine sandy loam, but yields average a little higher because of better drainage.

Included with Belmore loam, because of its small extent, is a body of Lucas loam including about three-fourths square mile. This soil differs from Belmore loam in having an 8-inch light brownish-gray silt loam surface soil underlain by yellowish-brown sandy clay loam which grades, at a depth of about 30 inches, into light yellowish-brown sticky fine sandy loam. At a depth of about 43 inches, this material grades into grayish-yellow laminated silty clay loam with brown and gray mottlings; but it resembles the Belmore soil in being pervious throughout. In a few places the texture of the surface soil is fine sandy loam.

All of this included soil, except where it occurs in the village of Glandorf, is cultivated. On account of its level surface relief and less leaching, owing to its more compact parent material, this soil is more productive than Belmore loam.

DARK-COLORED NEUTRAL SOILS UNDERLAIN BY FRIABLE PERVIOUS SUBSOILS

The fourth subgroup includes soils having heavy dark-colored surface soils and friable pervious subsoils. It is represented by Wauseon loam and Toledo loam. These soils are similar in having a high content of organic matter and a neutral or slightly acid reaction in the surface soils. Their surfaces are level, and natural drainage is very poor, but the open subsoils allow excellent artificial drainage. The natural forest growth is mainly white elm, black ash, cottonwood, bur oak, and soft maple, together with some basswood, sycamore, quaking aspen, white ash, pin oak, swamp white oak, red oak, shellbark hickory, pignut hickory, and willow.

Wauseon loam.—Wauseon loam, developed in small bodies with an aggregate area of 3.6 square miles, is closely associated with Rimer very fine sandy loam on terraces along Ottawa River near Rimer; on glacial beach ridges extending through Pandora, Columbus Grove, and Vaughnsville; and in the hummocky region (Defiance Moraine) between Gilboa and Leipsic. It occupies shallow basins or slightly lower elevations than Rimer very fine sandy loam, where drainage has been more restricted, so that a greater accumulation of organic matter has taken place under wet conditions.

Wauseon loam in its texture and consistence throughout, in the color of its subsoil and substratum, and in depth to calcareous material is similar to Rimer very fine sandy loam; but it differs from that soil in that it is dark brownish gray and has a slightly acid reaction in the topsoil.

About 90 percent of Wauseon loam is cultivated, 7 percent is in permanent pasture, and 3 percent is in wood lots. Agricultural practices and the crops grown are similar to those on Rimer very fine sandy loam, but corn and hay yields are somewhat higher, owing to the larger supply of organic matter and the neutral reaction.

Toledo loam.—Toledo loam occurs southeast and southwest of Pandora along the base of an old glacial-lake beach bordering areas of Belmore loam, on a terrace of Ottawa River at Kalida, and in a slightly depressed area within an area of Paulding silty clay north of Dupont. Its total area is about 1 square mile.

This soil, in texture, consistence, slightly acid reaction, comparatively high content of organic matter in the surface soil, depth to calcareous material, and color throughout the profile, is much like Wauseon loam; but it differs from that soil below a depth of 8 inches in having an 8-inch layer of pervious loam grading into a 10-inch layer of fine sandy loam which rests on stratified beds of fine sandy loam, very fine sandy loam, and loam.

About 90 percent of this soil is cultivated, 5 percent is in permanent pasture, and 5 percent is in wood lots. The treatment of this soil, crops produced, and yields are comparable to those on Wauseon loam.

SANDY AND GRAVELLY SOILS

The sandy and gravelly soils may be separated into (1) well-drained soils, (2) light-colored imperfectly drained soils, and (3) dark-colored poorly drained soils.

WELL-DRAINED SOILS

To the first of these subgroups belong Berrien fine sandy loam and Belmore fine sandy loam. These soils are light in color, are acid to a depth of about 2 feet, have good surface and internal drainage, and have a low content of organic matter. They warm up early in the spring, are fairly retentive of moisture, and are comparatively easy to till. They occur on low ridges (glacial-lake beaches and bars), knolls, and hummocks (Defiance Moraine).

On these soils the principal tree growth is hard maple, white ash, black walnut, wild cherry, and shellbark hickory; and less common trees are basswood, red elm, red oak, scarlet oak, pignut hickory, black oak, and white oak.

General farming, consisting of the production of corn, oats, wheat, barley, and hay, is the principal type of agriculture practiced; and potatoes are grown by a few farmers as a cash crop.

Berrien fine sandy loam.—The most extensively developed of the sandy and gravelly soils is Berrien fine sandy loam. It occurs in small areas in the eastern and southern parts of the county and in the vicinity of Dupont. Its total area is 8.5 square miles.

To a depth of 8 inches, this soil consists of grayish-brown or light grayish-brown mellow fine sandy loam having an acid reaction. Below this layer is yellowish-brown or dark yellowish-brown fine sandy loam which grades, at a depth of about 14 inches, into a layer of loosely coherent dark yellowish-brown fine sandy loam. This material continues to a depth of about 30 inches where it rests on yellowish-brown fine sandy loam which, in turn, at a depth ranging from 50 to 60 inches, is underlain by mottled gray and yellow calcareous silty clay.

A very common variation occurs, in which, at a depth ranging from 20 to 30 inches, the material is compact friable grayish-yellow fine

sandy loam with gray mottlings. In some areas between Gilboa and Leipsic, the texture of both the surface soil and subsoil is very fine sandy loam, and in a few places it is very fine sand or fine sand.

About 95 percent of Berrien fine sandy loam is cultivated, and the rest of the land is used largely for permanent pasture and farm buildings. Corn, wheat, oats, and hay are the principal crops, and potatoes are the most important minor crop. Yields of corn average about 35 bushels an acre, hay 1 ton, oats 35 bushels, wheat 17 bushels, and potatoes 150 bushels.

Belmore fine sandy loam.—Intermixed with areas of Belmore loam and having similar surface relief and drainage, Belmore fine sandy loam occurs on old glacial-beach ridges and bars in the southern, southeastern, and eastern parts of the county. Its total area is 2.4 square miles. It closely resembles Berrien fine sandy loam, in that it is grayish-brown fine sandy loam underlain at a depth of 8 inches by grayish-brown or grayish-yellow loamy or gravelly loamy fine sand, which grades into brown or reddish-brown fine sandy loam or gravelly fine sandy loam; but it differs from the Berrien soil, in that, at a depth of 35 or 36 inches, it rests on beds of dark grayish-brown fine gravel instead of clay. The texture of the surface soil, together with the open subsoil, makes this one of the warmest and best adapted soils in the county to early vegetables.

A gravelly phase of Belmore fine sandy loam extends over an aggregate area of 1 square mile, and it is more or less intermingled with the typical fine sandy loam. It is similar to the typical soil, except that it has much more gravel scattered over the surface and embedded in the surface soil and subsoil.

About 95 percent of Belmore fine sandy loam is cultivated, and the rest is used for permanent pasture, woodland, and buildings. Crops and yields are similar to those on Berrien fine sandy loam.

LIGHT-COLORED IMPERFECTLY DRAINED SOILS

The imperfectly drained light-colored sandy and gravelly soils are represented by Rimer fine sandy loam. This soil has an acid surface soil which is low in organic matter and an open subsoil in which artificial drainage would be comparatively easy to install. The more common trees growing on this soil are white oak, red oak, soft maple, beech, cottonwood, and shellbark hickory, and less common ones are swamp white oak, pignut hickory, basswood, sycamore, pin oak, white ash, ironwood, quaking aspen, and hard maple.

Rimer fine sandy loam.—Rimer fine sandy loam covers only one-half square mile. It occupies slightly elevated positions within areas of Brookston clay in the northeastern corner of the county, in similar positions within areas of Pandora silty clay northwest of Columbus Grove, on terraces along Auglaize River, and in association with Rimer very fine sandy loam in the hummocky region between Gilboa and Leipsic.

To a depth of 8 inches the soil material consists of gray fine sandy loam. This is underlain by light-gray friable loam with yellowish-brown mottlings, which ranges in thickness from 6 to 18 inches. Below this is mottled light-gray and yellowish-brown silty clay which, at a depth ranging from 37 to 44 inches, becomes calcareous light-gray silty clay with yellowish-brown mottlings.

About 90 percent of the land is cultivated, and the rest is used for permanent pasture, wood lots, and buildings. Corn, oats, wheat, and mixed-clover-and-timothy hay are the chief crops. Corn yields average about 35 bushels an acre, oats 40 bushels, wheat 18 bushels, hay 1 ton, and potatoes 150 bushels.

DARK-COLORED POORLY DRAINED SOILS

Toledo very fine sandy loam is the sole representative of the dark-colored poorly drained soils. When drained this is a warm, early soil containing a good supply of organic matter and having a neutral reaction. The tree growth consists of white elm, quaking aspen, sycamore, cottonwood, soft maple, bur oak, black ash, and willow.

Toledo very fine sandy loam.—Toledo very fine sandy loam occurs in the vicinity of Dupont as flat areas extending in a northwest-southeast direction. This soil is well supplied with organic matter, is easy to handle, and with proper drainage is early and productive. The subsoil is open, allowing free movement of air and water.

The surface soil is dark grayish-brown very fine sandy loam which grades into grayish-brown very fine sandy loam mottled with gray, yellow, and brown. This material, at a depth of about 17 inches, is underlain by brownish-gray very fine loam with yellow, yellowish-brown, and brown mottlings; and this, in turn, at a depth ranging from 40 to 50 inches, is underlain by light grayish-yellow calcareous silty clay mottled with yellowish brown and brownish yellow.

Closely associated with this soil are a number of small areas of Toledo fine sandy loam, which have a total extent of about one-half square mile. They differ from the very fine sandy loam only in having a fine sandy loam texture in the surface soil and upper subsoil layer. Because of their small area they are not shown separately on the map.

About 80 percent of Toledo very fine sandy loam is under cultivation, and the rest is largely in permanent pasture and wood lots. A rotation including corn, oats or wheat, and mixed-clover-and-timothy hay is generally followed. Corn yields average 40 bushels an acre, oats 38 bushels, wheat 18 bushels, and hay 1 ton.

SOILS OF THE FLOOD PLAINS

Soils occurring on the flood plains along streams are included in the Genesee, Eel, and Wabash series, and in the miscellaneous classification, muck. All these soils have neutral surface soils. The surface relief is smooth and the slope toward the streams is gentle, but in places the level surface is cut by sloughs. The Genesee and Eel soils have a low content of organic matter and are light in color, but the Wabash soil is well supplied with organic matter and is dark.

Genesee silty clay loam.—Genesee silty clay loam is the most important and most extensive of the soils of the flood plains. Its total area is 18.4 square miles. The largest developments are in the western half of the county along Auglaize, Little Auglaize, Ottawa, and Blanchard Rivers, and small areas lie along many of the creeks and small streams in all parts, particularly in the southwestern quarter. Northeast of and across Auglaize River from

Ostendorf School a small body of this soil lies above the normal flood plain and is subject to overflow about once in 20 years. Drainage of most areas of this soil is naturally poor because of late spring rains and the usual overflow, which keep the soil too wet to work until late spring. The friable subsoil is well suited for artificial drainage.

To a depth of about 14 inches, this soil consists of brown friable mellow silty clay loam which grades into yellowish-brown friable silty clay loam; and this material, at a depth ranging from 35 to 48 inches, grades into calcareous yellowish-brown silty clay loam containing gray, brown, and yellowish-brown mottlings. Some crystalline gravel is scattered over the surface and embedded in the surface soil, subsoil, and underlying formation.

Probably 50 percent of this soil is cultivated, 40 percent is in permanent pasture, and 10 percent is in wood lots. Corn is the principal crop, in normal years averaging about 45 bushels an acre, but in some years, owing to floods, the crop is a total loss. Oats and hay are successfully grown. This soil is easily cultivated and works into an excellent seed bed.

Genesee silt loam.—Among the soils of the flood plains, Genesee silt loam ranks next to Genesee silty clay loam in extent and importance. It lies mainly in the eastern half of the county, principally along Blanchard River, and smaller areas are along creeks and smaller streams.

This soil differs from Genesee silty clay loam, in that both the surface soil and subsoil are friable silt loam. The surface soil, under normal moisture conditions, is brown friable mellow silt loam, and it is underlain by a yellowish-brown friable silt loam subsoil.

About 60 percent of the land is cultivated, 35 percent is in permanent pasture, and 5 percent is in wood lots. The same crops are grown as on Genesee silty clay loam, but yields are somewhat higher, owing to the more favorable texture of the surface soil and owing to better drainage on account of the more pervious subsoil.

A lighter textured phase of Genesee silt loam differs from the typical soil, in that it is friable loam to a depth of 16 inches, where it grades into fine sandy loam which is calcareous below a depth ranging from 40 to 50 inches. Its perviousness renders this included soil especially favorable to cultivation and artificial drainage. Soil of this phase occurs in comparatively small areas on the flood plains of Little Auglaize River southwest of Ottoville and along Blanchard River southeast of Ottawa. It covers a total area of about one-half square mile.

Eel silty clay.—Eel silty clay occurs in very poorly drained situations on the flood plains of Bear Creek, Deer Creek, and North Powell Creek.

Because of its very heavy texture, extreme imperviousness of both surface soil and subsoil, and consequent difficulty in the establishment of drainage, Eel silty clay is not farmed. It is decidedly inferior to the heavier members of the Genesee and Wabash series, which are pervious and friable throughout.

Eel silty clay consists of dark-gray silty clay to a depth of about 2 inches. This material grades into gray impervious heavy silty clay mottled with yellowish brown, continuing to a depth of about 6 inches, below which is light-gray impervious plastic silty clay con-

taining yellowish-brown mottlings. This material, at a depth ranging from 30 to 40 inches, rests on calcareous impervious plastic silty clay with yellowish-brown mottlings.

None of this land is cultivated, but most of it has been cleared and is used for permanent pasture. The trees growing on it are mainly pin oak, bur oak, black ash, soft maple, sycamore, willow, and quaking aspen.

Wabash clay loam.—Wabash clay loam occurs in very small areas, largely in the flood plains of small streams, and it is fairly well distributed over the southern half of the county. Its total area is 0.9 square mile.

To a depth of 10 inches, this soil consists of dark grayish-brown or nearly black friable clay loam. This is underlain by grayish-brown clay loam mottled with yellow, and this, in turn, by brown, mottled with gray, yellowish brown, and brownish yellow, friable laminated clay loam. At a depth ranging from 38 to 48 inches, the underlying material is calcareous friable laminated clay loam. In places the lower layers consist of stratified beds of fine sandy loam and very fine sandy loam.

Along Little Auglaize River 3½ miles north of Ottoville, are several small areas, aggregating about 80 acres, of Wabash silty clay, which, because of their small extent, have been included with Wabash clay loam on the map. The surface soil and subsoil of the soil in these areas are silty clay, and the land is decidedly more difficult to work and to drain than Wabash clay loam.

About three-fourths mile east and 3 miles northeast of Fort Jennings are small areas of Wabash silty clay loam, which have a total extent of about 90 acres. The soil in these areas represents an intermediate condition, in that it is lighter in texture, more workable, and more easily drained than Wabash silty clay; but it is heavier, less workable, and more difficult to drain than Wabash clay loam.

About 25 percent of Wabash clay loam is cultivated, 70 percent is cleared and is used for permanent pasture, and 5 percent is in wood lots. Corn, the principal crop, yields a little better than on Genesee silty clay loam, owing to a higher content of organic matter, but small grains are inclined to grow rank and lodge, and yields are lower than on the Genesee soil.

Muck.—Muck is of very small extent in Putnam County. A few small areas, which together total about one-half square mile, occur southwest and northwest of Miller City.

Muck, as mapped in this county, consists of organic matter, containing a noticeable admixture of mineral matter, which is in such a state of decomposition that the fiber is largely gone, and the original vegetation from which the material is derived cannot be determined. This material, at a depth ranging from 10 inches to 4 feet, is underlain by very impervious plastic silty clay. Muck is acid throughout its entire depth. Being almost entirely organic in composition, it is deficient in both phosphorus and potash, and, in the production of crops, these plant nutrients are supplied by the use of commercial fertilizers.

About 80 percent of the muck land is cultivated and is used mainly for corn, but potatoes and onions are important cash crops. Corn produces an average yield of about 40 bushels an acre, potatoes 150 bushels, and onions 250 bushels.

SOILS AND THEIR INTERPRETATION

Putnam County is located in the north-central part of the region of Gray-Brown Podzolic soils in the United States. The soils are typical of those developed in a timbered region under the influence of a humid temperate climate, where the amount of rainfall has been sufficient to compensate the loss of moisture by evaporation and surface run-off and, in addition, to afford an almost constant supply of water for downward movement through the soil. Where the drainage is fair or good the soils are light in color, as they were formed under a dense forest cover which was unfavorable for a heavy development of grass roots and for the accumulation of much organic matter in the soil. Soil development under these conditions has so modified the chemical and physical properties of the soil materials that the original geologic characteristics have, in part, given place to the subsequently developed true soil characteristics. The soils have been leached and are free of carbonates to a depth ranging from 20 to 50 inches.

About 90 percent of the soil material is glacial till, largely derived from shale and limestone materials, but a comparatively small quantity of chert, quartzite, quartz, granite gneiss, and other crystalline rock material is present. About 10 percent of the soil material is water-laid, of which 6 percent consists of lacustrine materials, 1 percent of terrace materials along streams, and 3 percent of stream flood-plains materials.

On the basis of their most striking and widely developed characteristics, the soils may be classed as (1) soils having well-developed B horizons, and (2) soils having indistinct B horizons. Soils of the first group lie in belts along streams, on sandy ridges, and on knolls, and those of the second group occur in the extensive, flat, very poorly drained interstream areas that cover 90 percent of the county, and in a very few places on sandy ridges, knolls, and in flood plains along streams, where sufficient time has not yet elapsed for soil development.

Of the first group, probably the most typical representative in the county is Nappanee clay loam, although this soil does not fully exhibit the characteristics of the well-developed soils of the region. The extremely heavy character of the soil material has inhibited the free movement of water through the soil and has resulted in imperfect drainage and a mottled coloration of the subsoil. From the surface downward, the profile of this soil, in the air-dried condition, may be described, according to layers, as follows:

A_0. 0 to ¼ inch, a thin surface covering of very dark brown organic matter composed of leaf mold, litter, and humus. The pH value is 6.0[9].

A_1. ¼ to 1½ inches, a layer of mixed mineral and organic matter—dark-gray friable pervious clay loam which, in many places, shows an irregular laminated structure. The pH value is 6 1

A_{11}. 1½ to 4 inches, a layer of mixed mineral and organic material—dark-gray friable clay loam which shows no lamination. The pH value is 5.7.

A_{12}. 4 to 6 inches, a layer of mixed mineral and organic material—gray friable clay loam which has a pH value of 5 6.

A_2. 6 to 9 inches, a layer of light-gray vesicular friable clay loam. The pH value is 5.

[9] All pH determinations given in the text of this section of the report were made by J. G Steele, using the quinhydrone-electrode method.

A_3. 9 to 12 inches, a transitional layer between A_3 and B_1, consisting of pervious friable cream-colored silt loam which shows mottlings of yellow and brown, is practically structureless in its upper part, but breaks into irregularly shaped blocks averaging about one-third inch in diameter, in the lower part. The pH value is 4.8.

B_1. 13 to 15 inches, a layer of mottled cream-colored and yellowish-brown impervious hard tough clay or silty clay, which breaks into definite irregularly shaped structure blocks. These blocks average about one-third inch in diameter and have slickened yellowish-brown surfaces and mottled cream-colored and yellowish-brown interiors The powdered material is light brownish yellow. The pH value is 4 9.

B_2. 16 to 21 inches, a layer of mottled light-yellow and yellowish-brown impervious tough clay which is impregnated with iron segregations and breaks readily into structure particles (irregularly shaped blocks) averaging about one-half inch in diameter The surfaces of these particles are slickened with colloidal iron material. The average pH value for the material in this layer is 7.2. Apparently the ground waters have carried down iron in solution and in the colloidal state from the overlying acid layers, and the iron, on reaching this alkaline layer, flocculated and was precipitated.

C_1. 21 to 24 inches, a layer of tough impervious mottled light-yellow and yellowish-brown clay which has decidedly less iron and a less defined structural development than exists in the immediately overlying layer. The pH value is 8.3.

C_2. 24 to 27 inches, a layer of heavy mottled yellowish-gray and yellowish-brown clay, somewhat more friable than the material in the layers above, which carries irregular fragments of decomposed limestone, many crystalline gravel, and pieces of chert. The material breaks into irregularly shaped lumps which have yellowish-brown surfaces and mottled yellowish-brown, gray, and brown interiors.

C_3. 28 to 42 inches, a layer of mottled light-yellow and light-gray glacial-till clay of late Wisconsin age, which, above a depth of 40 inches, contains calcium carbonate as segregations along breakage planes but below this depth is calcareous throughout the mass. Small stones and pebbles scattered through the mass consist of limestone, shale, quartzite, quartz, granite gneiss, and other metamorphic and igneous rocks.

A comparison shows the pH value to be higher in A_1 than in A_2 or B_1. It gradually decreases from A_0 downward. This points to the probability that calcium is transferred through the trees from the underlying glacial-till material to the leaves.

The A_3 layer and all layers above it are comparatively light textured, with apparent loss of lime, iron, and aluminum and a relative increase in silica. The A_3 layer shows less work by worms than the layers above, but dark irregular downward indentations from the layer above and irregularly shaped channels suggest the filling in of old worm and root channels. The A_1, A_2, and A_3 layers are filled with plant roots, and, when shaken out, small soft somewhat rounded particles, ranging from one-twentieth to one-quarter inch in diameter, cling to them. Worm casts and wormholes are very common.

The St. Clair soils have profiles resembling the Nappanee soils, but they differ from those soils in having light yellowish-brown or light grayish-brown B horizons. This difference in color is probably due to somewhat better drainage in the St. Clair soils, so that the ground water level rarely enters the B horizon.

The profiles of the Fulton soils differ from those of the Nappanee in that their materials throughout are fairly homogeneous, are free of gravel, boulders, and rock fragments, and are well laminated or stratified below a depth of 2 feet.

The profiles of the Rimer soils differ from those of the Nappanee soils, in that they are very sandy and open to a depth ranging from 18 to 30 inches, below which they grade into heavy clay or silty clay.

The well-drained soils of the sandy ridges and knolls are well represented by Belmore loam. A typical profile of this soil, from the surface downward, is as follows:

A_0. 0 to ¼ inch, a surface layer of litter and a very little leaf mold.
A_1. ¼ to 4 inches, a layer of mixed organic and mineral material—dark-gray loam.
A_2. 4 to 7 inches, a layer of grayish-brown loam which breaks down into single grains and shows a slight tendency toward lamination.
A_3. 7 to 10 inches, a layer of grayish-brown highly vesicular brittle loam which breaks into irregularly shaped lumps.
B. 10 to 18 inches, a layer of grayish-brown or reddish-brown comparatively hard somewhat vesicular clayey material consisting largely of gravel and sand held together by clay.
C. 18 to 54 inches, unconsolidated beds of sand and gravel, which are calcareous below a depth of 50 inches.

The profile of the Berrien soils resembles that of the Belmore soils, except that it does not extend downward into beds of gravel, in most places shows slight mottling below a depth of 30 inches because of somewhat restricted drainage, and is underlain by calcareous clay.

To the subgroup of soils which show no illuvial horizons belong the Paulding, Palmer, and Bono soils, which are extremely heavy, plastic, and impervious throughout their profiles; the Brookston, Pandora, Clyde, and Toledo soils, which carry much more sand and grit and are consequently more open and friable; and members of the Wauseon, Rimer, Vaughnsville, Berrien, and Belmore series, all of which are very friable and gritty.

The essential features of the first class are expressed by the profile of Brookston clay, as follows:

0 to ¼ inch, a covering of leaf mold and litter. The pH value is 6 5.
¼ to 5 inches, a layer of mixed organic and mineral matter—very dark brownish-gray friable clay. The pH value is 6.1.
5 to 10 inches, a layer of mixed organic and mineral material—dark brownish-gray friable clay. The pH value is 6.6.
11 to 26 inches, a layer of olive-gray rather friable clay having yellowish-brown and brown mottlings. The powdered material is light grayish yellow. This clay breaks into irregularly shaped lumps with olive-gray surfaces and dark grayish-brown interiors. The pH value is 7.
27 to 32 inches, a layer of light-gray somewhat friable clay with brown mottlings. This material breaks into irregularly shaped blocks which have gray surfaces and yellowish-brown interiors. The pH value is 7.5.
32 to 42 inches, a layer of calcareous somewhat friable light-gray glacial-till clay containing worm casts. The material breaks into irregularly shaped lumps, and plant roots occur on the surfaces of the lumps. Around decayed roots is gray podzolized clay which partly coats the surfaces of the lumps. Numerous crystalline gravel, some boulders, irregular fragments of decayed limestone, and some small shale fragments occur in this layer.

The layers above the sixth layer contain many more living roots, roots in various stages of decomposition, and old root channels on the surfaces of particles than in their interiors. Thus it might be assumed that the reduction of iron, resulting from the decomposition

of organic matter, might account for more of the gray color on the surfaces of particles in these layers.

The materials throughout the profile are heterogeneous, including much crystalline gravel, some boulders, and, in addition, below a depth ranging from 24 to 34 inches, small pieces of shale and irregular fragments of limestone.

The Pandora soils differ from Brookston clay in having a somewhat lighter colored A horizon, a lower content of organic matter, and a thinner organic layer.

The Clyde soils are similar to Brookston clay, except that the A horizon is darker, has a thicker organic layer, and has a higher content of organic matter. It differs also, in that the gray color is more dominant throughout the subsoil.

Heavy members of the Toledo series resemble Brookston clay, except that the soil material is homogeneous, consisting of beds of lacustrine and fluvial materials.

The profiles of the Wauseon soils correspond to those of the Brookston in color, content of organic matter, and thickness of organic layers; they differ from those soils, in that they carry a higher content of sand and are therefore more pervious and friable to a depth ranging from 18 to 30 inches, where they are underlain by heavy silty clay or clay materials which are either of glacial or water-laid origin.

The essential features of the typical soil profile of extremely poorly drained very impervious very heavy and very plastic soils are shown by the following description of a profile of Paulding silty clay:

0 to ½ inch, a layer of blackish-brown leaf mold, forest litter, and partly decayed leaves.

½ to 3 inches, a layer of mixed organic and mineral materials—dark-gray plastic silty clay.

3 to 7 inches, a layer of gray plastic very impervious silty clay somewhat mottled with yellowish brown and brownish yellow.

7 to 33 inches, a layer of most extremely impervious plastic heavy gray silty clay with yellowish-brown and brownish-yellow mottlings, which breaks readily into irregularly shaped lumps.

33 to 47 inches, a layer having the same color and consisting essentially of the same material as the immediately overlying layer, but which differs in containing many iron segregations.

47 inches+, gray extremely impervious calcareous silty clay containing numerous concretions and segregations of calcareous carbonate in bedding planes.

The materials composing this soil are rather homogeneous, but there are only a very few crystalline gravel.

The Palmer soils differ from the Paulding in having a lighter colored A horizon, less organic matter, and lower pH values to a depth ranging from 16 to 22 inches.

Bono silty clay differs from Paulding silty clay in having a very dark gray or black A horizon with a very much higher content of organic matter and very much thicker organic layer, this layer ranging in thickness from 8 to 11 inches.

The profiles of the lighter members of the Berrien, Rimer, and Wauseon series differ from the loams, heavier fine sandy loams, and very fine sandy loams of these series in that no heavy soil layers have developed.

The Vaughnsville soils consist largely of heterogeneous colluvial ferruginous materials collected along bases of lacustrine beaches. They show scarcely any soil development and differ from other soils of this subgroup, in that they are light reddish brown to a depth ranging from 17 to 23 inches.

In the deposits constituting the stream flood plains, definite soil characteristics have not yet developed. Of these the light-colored soils belong to the Genesee and Eel series and the dark-colored soil to the Wabash series.

Table 3 gives the results of mechanical analyses of five soils as determined from samples taken at various depths.

TABLE 3.—*Mechanical analyses of five soils from Putnam County, Ohio*

Soil type and sample no	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Crosby silty clay loam	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
273483	¼–1½	1 4	3 0	3.6	9.1	8 1	44.2	30 5
273484	1½–4							
273485	5 – 6							
273486	7 – 8	1.2	2.9	4 0	9 0	9 8	43 9	29.2
273487	9 –12	1 0	2.7	3 3	7 7	8.4	40 6	36.3
273488	12 –15							
273489	16 –21	.6	2.0	2.9	6.8	7.4	30 2	50.2
273490	22 –24							
273491	25 –27	1.2	2.6	2.9	6 5	7 6	32.3	47 0
273492	28 –34	1.5	3.6	3.2	6 8	7 8	35.8	41 3
273493	35 –42	2.5	4 9	4 0	8.1	9 0	37 8	33 6
273494	43 –48	2.3	4.5	4.0	8.1	9 6	37 4	34.0
Palmer silty clay:								
273455	0 – ½	1.2	3.7	1.9	3.0	2.6	37 8	49 8
273456	½–2½	.2	1.3	1 0	1.8	1 9	23 5	70 3
273457	2½–6	.2	.6	.6	1 2	1 7	20 5	75.3
273458	6 –14	.1	.8	.8	1.2	1.7	19 8	75 5
273459	14 –28	.1	.5	.5	1.2	1 7	19.0	77.1
273460	28 –38	.1	.4	.4	.8	1 4	18 4	78.6
273461	38 –42	.1	.2	.3	.8	1 9	22 0	74 8
273462	43 –46	.4	.8	.6	1 7	2.0	25.8	68.6
Brookston silty clay loam:								
273448	0 – ½	.6	2.6	1 8	5.1	8 5	43 9	37.4
273449	½– 4	.4	2.5	2.3	4 4	12.6	39 4	38 3
273450	4 – 7	.7	2.5	2.6	4 7	13.1	34 0	42.4
273451	7 –12	.6	2.3	2.6	4.5	13.5	34.3	42.2
273452	13 –18	4	2.0	2.1	4.7	8.1	33.2	49 6
273453	19 –24	.3	2.1	2.2	4 3	7 4	33 0	50 6
273454	25 –36	.6	2.2	2.0	4.0	7.1	34 5	49 6
Pandora silty clay loam, heavy phase								
273409	0 – ¼	.8	3 0	4.3	9 3	7 3	34 0	41.3
273410	¼– 5	.5	2.0	2.9	7.3	6 1	30 7	50 4
273411	5 –10	3	2 0	2.9	6.0	5 8	31 6	51 4
273412	10 –17	.8	1 8	2.4	5.5	4 9	29 7	54 9
273413	17 –27	.7	2 0	2.7	5.5	5 3	29 6	54 2
273414	26 –33	.7	1 9	2.7	5.5	4.9	29 9	54.5
273415	33 –43	.8	2.2	2.8	6 0	5 5	29 3	53.4
273416	43 –50	1 6	2.8	2 7	5.8	5.5	30 1	51.5
273417	50 –56	.6	1 8	1 9	4.5	5.7	29 9	55.7
Paulding silty clay.								
273495	1 – 3	.3	6	.6	1.5	1.7	27.6	67 6
273496	3 – 7	.1	3	.6	1 5	1.2	23 5	72.8
273497	8 –12	.0	3	.6	1 9	6.2	25 5	65 4
273498	13 –17	.1	4	.6	1.8	5.7	24 9	66.4
273499	24 –28	.2	.6	.9	2.6	6 9	25 3	63.5
2734100	29 –33	.1	.2	.6	1 9	5 9	24.7	66 6
2734101	44 –48	.1	.4	.6	2.3	8 7	30 2	57 6
2734102	52 –58	.2	.7	.6	1.2	1 8	15 9	79 6

Table 4 gives the results of pH determinations of four soils. These values were determined by the hydrogen-electrode method, by E. H. Bailey, in the laboratories of the Bureau of Chemistry and Soils.

TABLE 4.—*pH determinations of four soils from Putnam County, Ohio*

Soil type and sample no.	Depth	pH	Soil type and sample no	Depth	pH
Pandora silty clay loam, heavy phase	*Inches*		Palmer silty clay.	*Inches*	
273409	0- ¼	6 1	273455	0- ½	4. 7
273410	¼- 5	5 8	273456	½- 2½	5 1
273411	5-10	6 5	273457	2½- 6	4 8
273412	10-17	6 9	273458	6-14	4. 8
273413	17-27	7. 1	273459	14-28	5 8
273414	26-33	7. 2	273460	28-38	6. 8
273415	33-43	7 7	273461	38-42	7. 1
273416	43-50	7. 7	273462	43-46	7. 8
273417	50-56	7 9	Paulding silty clay		
Brookston silty clay loam			273495	1- 3	5 5
273448	0- ½	6 4	273496	3- 7	5. 6
273449	½- 4	6 5	273497	8-12	6 5
273450	4- 7	6. 6	273498	13-17	6. 2
273451	7-12	6. 5	273499	24-28	6. 9
273452	13-18	7 2	2734100	29-33	7 0
273453	19-24	7 2	2734101	44-48	6 9
273454	25-36	7 2	2734102	52-58	7. 7

SUMMARY

Putnam County is in the northwestern part of Ohio. It occupies a level plain broken in the eastern, southern, and extreme western parts by low ridges and knolls. The total area is 482 square miles.

The climate is characterized by a mean annual temperature of 50.3° F., an average precipitation of 35.15 inches, an average annual snowfall of 30.8 inches, prevailing westerly winds, and an average frost-free season of 155 days.

Farming began in the county about 1824. The present agriculture consists of general farming, including the growing of corn, small grains, and hay; and, on a small percentage of farms, sugar beets are produced as a cash crop.

Agricultural adaptations are mainly dependent on drainage and textural differences of the soils. The naturally poorly drained soils cover 90 percent of the county, are fairly well supplied with organic matter, and have gray or dark-gray surface soils with a neutral reaction; the sandy soils range from fairly well drained to well drained, are deficient in organic matter, and are acid in reaction to a depth ranging from 16 to 22 inches.

Agriculturally, the soils may be classed as heavy textured and light textured. The heavy-textured soils include loams, silt loams, silty clay loams, clay loams, clays, and silty clays; and the light-textured soils include fine sandy loams and very fine sandy loams. The heavy-textured soils are considered best for general-farm crops and sugar beets and the light-textured soils for truck crops.

On the basis of their most striking and widely developed characteristics the soils may be divided into two classes: (1) Soils having well-developed B horizons and (2) soils having indistinct B horizons.

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There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than 250 copies shall be for the use of each Senator from the State and not more than 1,000 copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.

Areas surveyed in Ohio, shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching; crosshatching indicates areas covered in both ways.

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