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Soil Survey

Martin County Indiana

By
H. P. ULRICH, in Charge, T. E. BARNES, and SUTTON MYERS
Purdue University Agricultural Experiment Station
and
RALPH G. LEIGHTY
United States Department of Agriculture
with a section on Management of the Soils of Martin County
by
A. T. WIANCKO
Purdue University Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
Purdue University Agricultural Experiment Station

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HOW TO USE THE SOIL SURVEY REPORT

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

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) County Surveyed, in which location and extent, physiography, relief, and drainage, vegetation, history and population, rural culture, transportation and markets, and industry and business are discussed; (2) Agricultural History and Statistics, in which a brief history and the present status of the agriculture are described; (3) Productivity Ratings, in which the productivity of the soils is given, and (4) Management of the Soils of Martin County, in which management requirements of the soils are discussed and suggestions made for improvement.

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

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

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

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

ROBERT M. SALTER, *Chief*

DIVISION OF SOIL SURVEY

CHARLES E. KELLOGG, *Head Soil Scientist, in Charge*

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

H. J. REED, *Director*

DEPARTMENT OF AGRONOMY

A. T. WIANCKO, *Chief*

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

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SOIL SURVEY OF MARTIN COUNTY, INDIANA

By H. P. ULRICH, in Charge, T. E. BARNES, and SUTTON MYERS, Purdue University Agricultural Experiment Station, and RALPH G LEIGHTY, Division of Soil Survey,[1] Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture

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

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

CONTENTS

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

MARTIN COUNTY is in the hilly part of the southwestern part of Indiana and in the Interior Low Plateaus province of the United States. Most of the early settlers came from Ohio, Kentucky, Tennessee, and the Carolinas, and the county was organized in 1820. Agriculture developed slowly, as the area was entirely forested with a mixed stand of hardwoods. The principal crops are corn, oats, wheat, and hay, most of which are either fed to livestock or consumed locally. Wheat, livestock, dairy, and poultry products are the most important sources of income. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1936 by the United States Department of Agriculture and the Purdue University Agricultural Experiment Station. The report here presented may be briefly summarized as follows.

SUMMARY

Martin County is in the southwestern part of Indiana, 85 miles southwest of Indianapolis and 65 miles northeast of Evansville. It has an area of 337 square miles. The county lies almost entirely within the Crawford upland, the most rugged and highly dissected part of the State. Deep drainage lines with steep, often rocky walls have cut into every part of the upland, leaving divides with an average elevation of about 660 feet. The upland varies greatly in form and relief owing to the advanced cycle of erosion and the many different geological formations that are exposed. Along the eastern border of the county the Mitchell limestone outcrops in a few small areas. Throughout the central part are exposures of the massive Mansfield sandstone, which acts as a cap rock on hills and also produces numerous rocky bluffs. This sandstone produces some interesting and unusual rock formations, such as Pinnacle Rock, Jug Rock, and House Rock. In the western part of the county, where the soft shales of the "Coal Measures" cover the Mansfield sandstone, the ridges are broad, the slopes are less precipitous, and the valleys are wide and either level or U-shaped.

The streams of the area flow southwesterly in narrow, deeply entrenched meandering channels. The East Fork of the White River drains nearly the entire county. The dendritic drainage system has reached into every part of the county except several low-lying lacustrine plains along the western border. Less than 15 percent of the area is in need of artificial drainage. The elevation of the county ranges from a maximum of 860 feet in the eastern part to a minimum of 425 feet in the White River Valley in the western part. The climate is characterized by warm and humid summers and moderately cold winters. Rainfall is fairly well distributed throughout the year, but there is usually an excess during the spring and an inadequate supply during midsummer. The average length of the frost-free period is 177 days.

Agriculture developed very slowly, as the county was completely covered by a heavy stand of hardwood forest. In the period of agricultural expansion, ending about 1900, nearly half the land was cleared of timber and put into crops. Corn, oats, wheat, and hay are the principal crops. Since 1900 there has been a very marked decline in

the acreage of crops, in the number of livestock, and in agriculture in general.

Soils of the uplands, developed over sandstone, siltstone, and shale, include the well-drained Zanesville and Wellston silt loams, the Wellston-Muskingum complex, and the somewhat imperfectly drained Tilsit silt loam. Muskingum silt loam, colluvial phase, occurs on foot slopes, where drainage is slightly retarded, and Johnsburg silt loam occurs on the level uplands, where internal and external drainage are very slow. Various slope and erosion phases of Wellston and Zanesville soils are mapped, and Muskingum stony silt loam and rough stony land (Muskingum soil material) occur on steep slopes. Soils with suitable slopes that are not too severely eroded are used for general farming to some extent, but agriculture is declining rapidly in this part of the county, owing to soil erosion and depletion of soil fertility. Farms that include areas of bottom land are better situated, and agriculture is more stable in these places.

Upland soils developed over limestone include Frederick silt loam and Corydon silty clay loam and slope and eroded phases of Frederick silt loam. Frederick silt loam is a valuable agricultural soil for general farming, but Corydon silty clay loam, because of its shallow and stony profile, is best suited to pasture and forestry.

Soils developed from aeolian sands of the uplands include Princeton fine sandy loam, its slope phase, and Ragsdale loam. Corn, wheat, and hay as well as special crops are produced on these soils, and corn grows especially well on Ragsdale loam.

Soils of the uplands developed over calcareous glacial till include Cincinnati silt loam and its shallow phase, Parke silt loam, Gibson silt loam, and Vigo silt loam. In addition, steep, eroded, and gullied phases of Cincinnati silt loam are recognized. These soils are used for general farming and especially for small grain. Cincinnati and Parke soils, where not too steep or eroded, are better suited to corn than Vigo silt loam. Gibson silt loam is one of the best of the soils in this group, because it is not too imperfectly drained for good corn production and is not so subject to erosion as Cincinnati and Parke soils. Vigo silt loam lies in level areas with very slow internal and external drainage. All the soils of this group are low in plant nutrients and need to be fertilized heavily and in many instances need to be limed in order to produce good yields. Otwell, Haubstadt, Dubois, and Robinson silt loams and slope and eroded phases of Otwell silt loam occur on old glacial-lake beds of the uplands. Otwell silt loam is much like Cincinnati silt loam in general profile characteristics and in use suitability; Haubstadt silt loam corresponds likewise to Gibson silt loam; and Robinson silt loam corresponds more or less to Vigo silt loam. Agricultural conditions are much the same as on the Cincinnati and associated soils.

Soils of the older stream terraces are strongly acid in reaction and are developed from mixed alluvial deposits. They include Elkinsville silt loam, Martinsville loam, and Pekin silt loam, all of which are well drained or only slightly imperfectly drained, and Bartle silt loam, in which internal drainage is slow. These soils are well suited to general farming but are low in plant nutrients and need to be fertilized. They are used chiefly for hay and corn and for general farming. Bartle silt loam is suitable for raising hay without drainage but will not produce corn well unless drainage is provided.

Another group of terrace soils includes Markland silt loam, McGary silt loam, and Montgomery silty clay loam. The first is well drained and occurs on the edges of the terraces; McGary silt loam has fair external drainage but slow internal drainage; and Montgomery silty clay loam has areas that were swampy when the land was first settled. Calcareous stratified clay occurs within 20 to 40 inches of the surface, and the soils, especially Montgomery silty clay loam, are fairly high in plant nutrients. Montgomery silty clay loam is especially well suited to corn and does not need as much fertilization as the other two soils.

Soils of the stream bottoms are devoted very largely to corn, of which they produce fair to very high yields. The Genesee soils, including six types and phases, are neutral in reaction and high in plant nutrients and are well drained. The Eel and Shoals soils, including four types, are not so well drained as the Genesee, and the Shoals soils will produce better corn yields if artificial drainage is provided. Yields on all these soils are usually fairly high.

The acid alluvial soils, totaling nine types, include members of the Pope, Philo, Stendal, and Atkins series. The Pope and Philo soils produce medium to high yields of corn, and the Stendal soils will produce fairly high yields if artificially drained. Atkins soils are poorly drained, and many areas lie so low that artificial drainage is impracticable. These soils are used chiefly for pasture and hay crops.

COUNTY SURVEYED

Martin County is in the southwestern part of Indiana (fig. 1). It has an area of 337 square miles, or 215,680 acres. Shoals, the county seat, is 85 miles southwest of Indianapolis, 65 miles northeast of Evansville, and 65 miles northwest of Louisville, Ky.

Martin County is in the hilly part of the State and in the Interior Low Plateaus province of the United States. It lies almost entirely within the Crawford upland, the most rugged and highly dissected part of Indiana.[2] Although few hills exceed an elevation of 800 feet and none occurs at a uniform elevation, the Crawford upland is a remnant of a former level peneplain, which existed at an elevation of 800 to 1,000 feet above sea level. The average elevation on the narrow, deeply notched divides is about 660 feet. The Crawford upland varies greatly in form and relief, owing to the postmature cycle of erosion and many different geological formations that are exposed. The upland consists of high and low hills; great ridges, some sharp and others rounded, but none of an even altitude for any great distance; trenchlike valleys and flat-bottomed valleys with wall-like bluffs. Benches, caused by rock strata that are resistant to erosion, occur in many places between the ridge tops and the valley floor. Along the eastern border the underlying Mitchell limestone approaches the surface or outcrops in a few areas, forming low basin-like areas that have a sinkhole relief. Stream dissection throughout the area is complete and thorough. The ridges are narrow and many-lobed, with frequent hills and sharp knife-edge saddles and

[2] LOGAN, W. N., CUMINGS, E. R., MALOTT, C. A., and others. HAND BOOK OF INDIANA GEOLOGY. Ind. Dept. Conserv. Pub. 21, 1120 pp., illus. 1922.

peaks, particularly in the eastern part. They drop steeply 100 feet or more to the valley floor. Bluffs and crags are common in the eastern part.

The higher elevations are in the eastern part; elevations decline toward the west, owing to the dip in the rock strata of 30 to 35 feet per mile and the exposure of less resistant rock formation. In the western part, where the soft shales of the "Coal Measures" formation cover the Mansfield sandstone, the ridges are broad, the slopes are less precipitous, and the valleys are wide and either level or U-shaped. Monadnocks are found in these aggraded, or filled-in, valleys, a

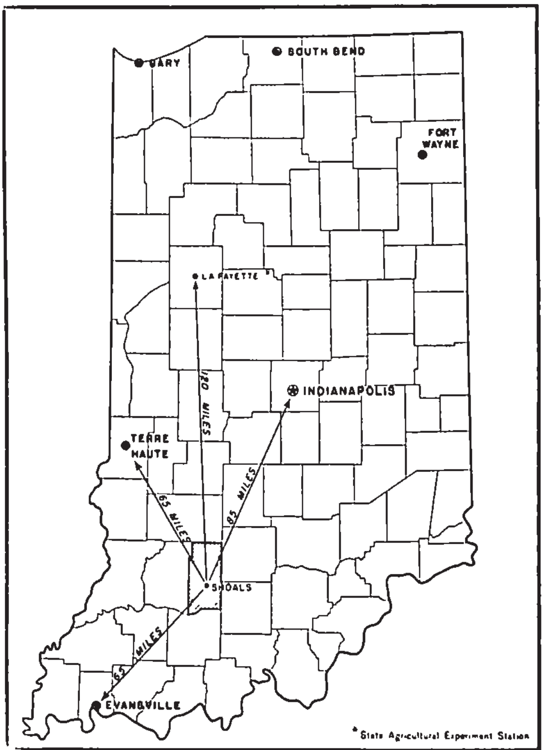

FIGURE 1.—Location of Martin County in Indiana

feature that is characteristic of the Wabash lowland. This formation, developed at an elevation of about 500 feet, extends westward from the western edge of the county.

Of the several geologic formations exposed in the county, the lowest is the Mitchell limestone. Caves form in this limestone and produce the sinkhole land characteristic of parts of western Lawrence and Orange Counties and bordering eastern Martin County. The Chester formations consist of four thin layers of limestone separated by shales and sandstones, which usually outcrop on the steep hillsides. They are capped by the massive Mansfield sandstone of the Pennsylvanian formation. The Mansfield, Hardinsburg, and Cypress sandstones are hard and resistant to erosion and form bluffs, crags, and hilltops. The Mansfield sandstone, capping the Chester series, outcrops in many places to form great unscalable bluffs, such as occur in the vicinity of Shoals. This sandstone produces some very unusual rock formations, such as Pinnacle Rock, Jug Rock, and House Rock, which are north of Shoals. Along the western border the Mansfield formation is capped by soft shales of the Pottsville series. Unconsolidated drift of the Illinoian period occurs in local areas along the western border, the most extensive area being developed in the vicinity of Loogootee.

The streams of the area flow southwesterly in narrow, deeply entrenched, meandering channels. The East Fork of the White River drains practically all the area. It flows about 250 feet below the general level of the tops of the hills. A small area in the northwestern part is drained by Furse Creek, a tributary of the West Fork of the White River. The streams have a dendritic drainaege pattern. They have dissected every part of the county except several low-lying lacustrine (flats) areas in the vicinity of Loogootee. As the land slopes toward the western part the flood plains broaden and become aggraded or filled in with alluvial sediments.

The maximum elevation in Martin County is 860 feet, and the minimum is 425 feet. The elevation at Shoals is 481 feet, at Pinnacle Rock 630 feet, at Martin County Farm 683 feet, at Brooks Bridge 464 feet, and on the hill a quarter of a mile northwest of Armstrong School 790 feet.

Originally the county was entirely forested with a mixed stand of hardwoods, consisting principally of black, white, and red oaks and a variety of hickories. In the stream bottoms more rapidly growing trees, such as walnut, sycamore, ash, elm, and soft maple, flourished. Several decades after the county was settled, all the land in any degree suitable for crops had been cleared of forest. Most of the timbered land is now on the steep hillsides and on very poorly drained bottom land. Very little merchantable timber remains, and most of the second-growth timber is cut when it reaches tie size. Although much of the woodland is pastured, reproduction is retarded only in the vicinity of farmsteads, where the cattle graze more heavily.

Martin County was organized January 17, 1820, and named in honor of Col. John P. Martin. The original county seat was Hindostan. Altogether this county has had six county seats. Shoals has been the county seat since 1869.

Most of the early settlers came from Ohio, Kentucky, Tennessee, and the Carolinas. The present population consists of native whites. The total population in 1940 was 10,300, all classed as rural. The population reached the peak of 14,711 in 1900, and since that time there has been a steady decline in total population and a more rapid decline in the farm population. Shoals, with a population of 1,031, and Loogootee, with 2,325, are the principal towns in the county. Burns City, Indian Springs, Trinity Springs, and Cale are centers of trade. The natural resources are coal and limestone, which are produced for local use. Farming is the chief occupation. A few small manufacturing establishments are in Shoals and Loogootee.

The county is served by two railroads, the Baltimore & Ohio and the Chicago, Milwaukee, St. Paul & Pacific, and a transcontinental bus line. Several State highways and a good system of graveled roads connect all the towns. There are 437 miles of dirt roads, which are likely to be impassable for automobiles during several months of the year.

A large part of the farm products are consumed locally. Wheat, some livestock, eggs, and cream are shipped, usually by truck, to Indianapolis, Washington, and Vincennes. Flour mills use much of the local wheat supply.

Four high schools, one parochial school, and many one-room schools are scattered throughout the county. According to the Federal census for 1940, 219 farms had electricity, and 226 had telephone service.

CLIMATE

The climate of Martin County is characterized by a wide range of temperature between winter and summer. The summers are warm and humid, and the winters, though generally mild, frequently have very cold periods of short duration. The winters are open, with considerable freezing and thawing. Rainfall is well distributed throughout the year, although the greatest precipitation occurs in the spring, when the ground becomes saturated. Seeding dates of some crops, such as corn, may be delayed in spring by excessive rainfall. Growing crops frequently suffer from short periods of drought during midsummer.

The average frost-free season extends from April 23 to October 17, a period of 177 days. This provides a long growing season for such crops as corn. The warm days and warm, humid nights during the summer favor the growth of corn. Frost has occurred as late as May 25 and as early as September 24.

Table 1 gives the more important climatic data, as compiled from the records of the United States Weather Bureau station at Shoals.

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

[Elevation, 523 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1914)	Total for the wettest year (1912)	Average snowfall
	°F	*°F.*	*°F*	*Inches*	*Inches*	*Inches*	*Inches*
December	33 3	68	−21	3 56	2 93	1.40	3 1
January	30 8	69	−22	3 74	1 25	3.53	4 7
February	32 5	74	−10	2 53	3 70	3 50	2 7
Winter	32 2	74	−22	9 83	7 88	8 43	10 5
March	42 9	87	2	4 46	2 57	4 83	2 2
April	53 3	90	15	3 67	2 41	6 90	1
May	63 6	103	29	3 09	.86	10 26	(1)
Spring	53 3	103	2	12 12	5 84	21 99	2 3
June	71 6	106	37	3 94	88	3 18	0
July	75 8	112	45	3 36	1 44	8 87	0
August	74 0	106	40	4 21	4 45	5 84	0
Summer	73 8	112	37	11 51	6 77	17.89	0
September	67.6	99	26	3 82	2 52	4 41	0
October	55 2	95	16	3 51	2 53	.79	.2
November	43 6	79	−2	2 74	.07	1 33	.5
Fall	55 5	99	−2	10 07	5 12	6 53	.7
Year	53 7	112	−22	43 53	25 61	54 84	13.5

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The agricultural development of Martin County was very slow during the first half of the nineteenth century. The county was covered by a heavy stand of hardwood forest, which was slowly cleared. General farm crops have always occupied the greater part of the cropland. Special crops that require much hand labor have occupied a very minor place in the farming system. Corn, oats, wheat, and hay are the principal crops. The total area used for these crops, exclusive of forage, increased gradually to a peak of 62,722 acres in 1899. With the exception of a temporary increase in 1919, when the aggregate acreage was 52,583, there has been a steady decline. In 1939 the total acreage of all cropland harvested was 32,645.

The decline in acreage has been accompanied by decreased yield of oats and by increases of corn, wheat, and potatoes. The pronounced increases of wheat and potatoes are probably due to improved agricultural practices. Alfalfa and soybeans are the only crops in which acreages have increased.

Table 2 shows the acreage of the important crops in Martin County in certain years.

TABLE 2.—*Acreages of the principal crops in Martin County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn (for grain)	25,483	22,306	24,966	26,429	23,966	15,663	13,541
Oats							
Threshed	6,425	8,707	6,970	3,232	3,082	2,168	1,607
Cut and fed unthreshed						868	422
Wheat	17,470	12,442	14,714	6,837	10,590	3,935	3,097
All hay	7,950	14,983	16,072	14,461	14,945	11,820	12,197
Alfalfa				86	180	328	810
Legumes for hay					215	1,444	2,351
Sweetclover							93
Lespedeza							3,268
Timothy and clover, alone or mixed			6,365	12,241	11,562	[1] 8,142	4,303
Small grains for hay			304	227	1,657	484	588
Other tame hay			9,401	1,878	1,109	1,218	685
Wild hay			2	32	222	174	96
Potatoes		641	369	509	396	174	109
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		67,347	51,503	76,534	54,681	14,227	6,740
Peaches		12,014	[2] 35,435	[2] 33,469	17,963	7,365	898

[1] Includes some sweetclover and lespedeza
[2] Includes nectarines

Most of the farm crops are either fed to livestock or consumed locally. Wheat, livestock, dairy, and poultry products are the most important sources of income. Only a few dairy cows are kept on each farm to supply the family with milk and butter and a small surplus for sale. According to the 1940 census, 3,057 cows were milked and produced 985,518 gallons of milk and 43,227 pounds of butter. Most farmers also keep a flock of chickens, averaging less than 100 to the farm. The 1940 census shows that 98,811 chickens were raised and 431,639 dozen eggs were produced. The excess cream and eggs above home consumption furnish the principal source of income.

The value of certain agricultural products as reported by the Federal census for the years 1919, 1929, and 1939 is shown in table 3.

TABLE 3.—*Value of certain agricultural products in Martin County, Ind., in stated years*

Products	1919	1929	1939
Crops produced			
Cereals, other grains, and seeds	$1,155,742	$400,802	$311,437
All vegetables (including potatoes)	122,793	109,743	54,605
Vegetables for sale (excluding potatoes)		17,398	4,640
Vegetables for home use (excluding potatoes)		60,158	39,134
Potatoes		[1] 32,187	[1] 10,831
Hay and forage	527,045	159,148	125,881
Fruits	25,928	16,299	5,943
All other crops	29,721	3,284	1,398
Forest products sold	(2)	42,286	9,860
Livestock products			
Dairy products sold	114,686	137,186	44,243
Poultry and eggs	332,355	322,732	117,173

[1] Includes sweetpotatoes
[2] Not reported

An increase in the number of livestock accompanied the increase in crops, which reached the highest level between 1880 and 1900. Likewise, the decrease in crop acreages has been accompanied by a decline in the number of livestock. This is particularly pronounced with reference to sheep and hogs. The 1940 census reports, as of April 1, 1940, 7,398 cattle over 3 months of age, 7,278 hogs over 4 months of age, and 2,720 sheep over 6 months of age.

Potatoes, garden vegetables, and tree fruits are grown largely for home use. Tomatoes, snap beans, and sweet corn are the principal vegetables grown. Some tomatoes are sold to canneries in adjoining counties. A few commercial orchards are planted in the vicinity of Shoals.

The value of commercial fertilizers is generally recognized. In 1939, $14,665 was spent for fertilizer on 404 farms, an average of $36.30 a farm. Owing to increased interest in the growth of legumes, the use of lime is increasing. Ground limestone is available from quarries in the eastern part of the county.

Other important farm expenses are those for feed and labor. Supplementary feed for dairy cattle and other livestock is purchased by 74.2 percent of the farmers. The total value of feed purchased on 865 farms in 1939 was $78,808, or $91.11 per farm reporting. Labor was hired on 208 farms in 1939, for which $30,921 was paid in wages, or an average of $148.66 per farm reporting. On some of the farms extra labor is employed during harvesttime. Because there is no competition with nearby industries, labor requirements are easily filled at rates ranging from $1.00 to $2.00 a day and $25 to $30 a month.

The number of farms reached a peak in 1900, but since that time there has been a steady decline. The area of improved land, which includes cropland and plowable pasture, continued to increase until 1910, when it comprised 69 percent of the farm land.

The Federal census reported 1,165 farms in the county on April 1, 1940, comprising 135,980 acres, an average of 116.7 acres to the farm. In table 4 are given selected data concerning acreage of improved land in farms and land tenure.

Farms range in size from less than 10 acres to over 1,000 acres. About one-third of the farms range from 70 to 140 acres. As nearly all of the arable land has been brought under cultivation, the average size of the farms tends to vary inversely with the number of farms.

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The average size of farms declined to the lowest point, 101 acres, in 1900, when there were 1,985 farms. After this there was a steady increase in size until 1930, when the number of farms began to increase again with the subdivision of existing farms and a resulting decrease in average size to 116.7 acres by 1940.

TABLE 4.—*Statistics on farm land in Martin County, Ind., in stated years*

Year	Farms				Land in farms			Improved land in farms		
	Total	Operated by— Owners	Operated by— Tenants	Operated by— Managers	All land	Percentage of county area	Area per farm	Total	Percentage of farm land	Area per farm
	Number	*Percent*	*Percent*	*Percent*	*Acres*	*Percent*	*Acres*	*Acres*	*Percent*	*Acres*
1880	1,704	78.5	21.5	....	206,565	95.2	121.2	120,170	58.2	70.5
1890	1,796	81.5	18.5	....	195,350	90.0	108.8	120,802	66.5	72.3
1900	1,985	78.0	21.2	0.8	201,006	92.6	101.3	139,659	69.5	70.4
1910	1,742	80.6	19.0	.4	194,877	89.8	111.9	134,436	69.0	77.2
1920	1,661	82.2	17.1	.7	196,490	90.6	118.3	119,493	60.8	71.9
1930	1,150	79.9	19.7	.4	153,155	70.6	133.2	80,144	52.3	69.7
1940	1,165	81.3	18.5	.1	135,980	61.6	116.7	71,826	52.8	61.7

The percentage of farms operated by owners has always been large. In 1940, owners operated 81.3 percent of the farms. Very few farms have been operated by managers. Both the share and the cash rental systems are used. Under the share system the tenant supplies the labor and equipment and receives half of the products grown.

SOIL SURVEY METHODS AND DEFINITIONS

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

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [3] and its content of lime and salts are determined by simple tests. Drainage, both internal and external, and other external features, such as relief or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis on features that influence the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped in classification units. The three principal ones are (1) series, (2) type, and (3) phase.

[3] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values indicate alkalinity; and lower values, acidity. Indicator solutions are used to determine the reaction of the soil. The presence of lime in the soil is detected by the use of a dilute solution of hydrochloric acid.

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

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

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

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

Aerial photographs taken vertically are used as a base for mapping soils in Indiana. The pictures are taken from an airplane flying at a height of about 13,500 feet, and each picture covers about 4½ square miles. About 200 pictures, similar to that shown in plate 1, were taken to cover the county.

The map showing roads, buildings, streams, soils, and other features was drawn on a sheet of celluloid covering the picture to separate the map and the photographic features. All features mapped were identified on the picture by ground observation, the surveyor covering the ground closely enough either by automobile or on foot to see at least two sides of every 40-acre field. Soils were studied and identified by observing road cuts and by boring in the fields with a soil auger. Soil boundaries and other features were then drawn in their correct positions and in proper relation to other features. The small field maps were later assembled into larger sheets, from which the final colored map was produced.

SOILS AND CROPS

Martin County has a variety of soils, despite the fact that three-fourths of the area consists largely of soils of two series—Zanesville and Muskingum. The soils range in texture from loose fine sandy loam to heavy silty clay loam; in organic content from very low to high; in reaction from strongly acid to neutral; and in productivity from high to very low. Almost all of the soils are light-colored, as they have been formed under a mixed deciduous forest cover, of which oaks were the predominant species. They are low in organic matter and moderately to strongly acid in reaction. Less than 0.2 percent are dark and have an abundant supply of organic matter. Less than 4 percent are approximately neutral in reaction. Although the land is predominantly rolling throughout, 15 percent of the soils have defects in drainage owing either to low position, high water table, flat relief, or an impervious claypan in the subsoil. About 5 percent of the area has soils of intermediate to high natural productivity.

About 75 percent of the soils are derived from sandstone, siltstone, and shale. In the eastern part of the county minor local outcrops of limestone occur, usually on the slopes. The rest of the area consists of soils derived from unconsolidated material deposited by wind, water, and glacial ice. Those derived from the glacial drift deposits of the Illinoian period constitute about 5 percent of the area and are strongly acid, as they have been leached of free carbonate of lime to a depth of 10 feet or more.

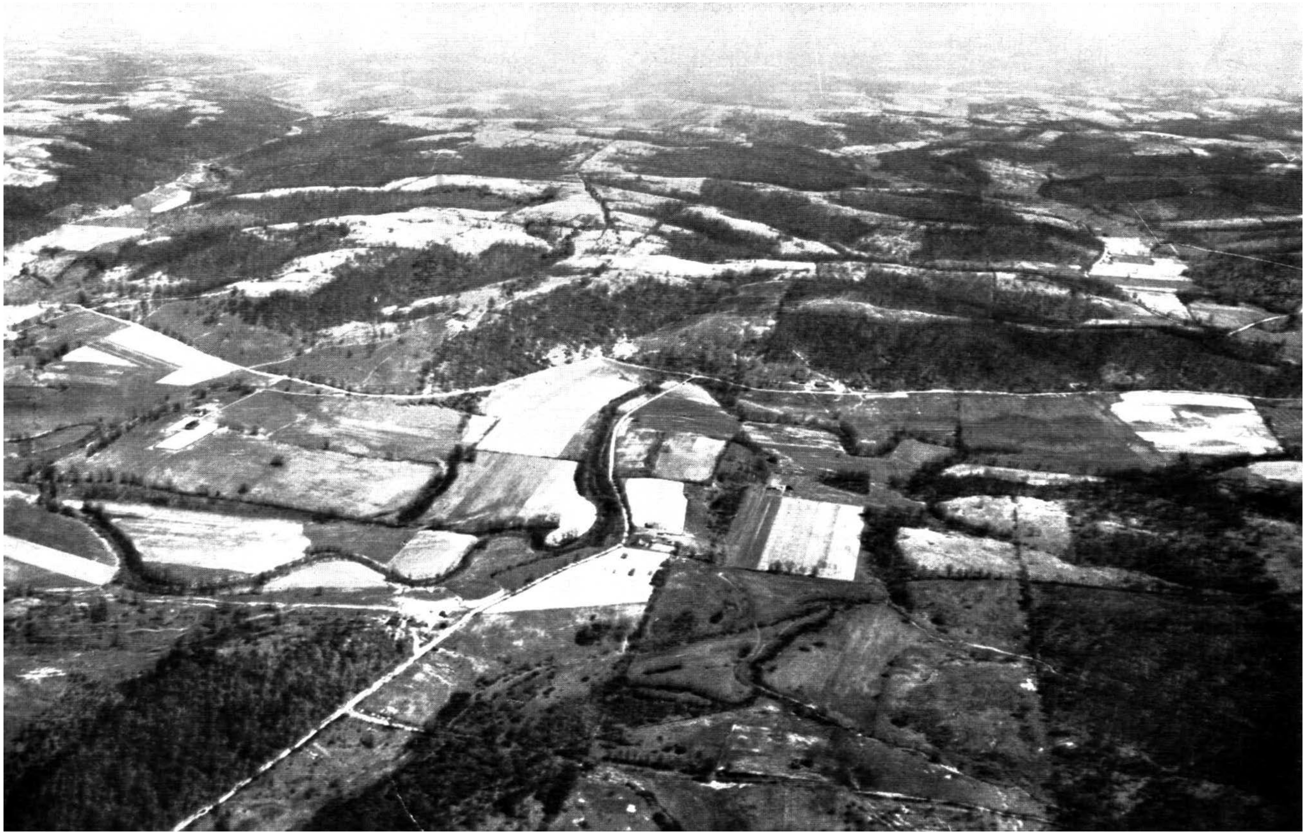
Martin County lies on the western border of the southern hill farming area.[4] General farming is carried on in this area, with specialization in dairying, poultry, fruit, and special crops where topography and markets permit. Throughout the more rolling part of the county farming is done on small irregular fields on the narrow ridge tops and in the narrow stream bottoms. The intervening steep hillsides are used almost entirely for forest. The principal soils of this area are Zanesville silt loam, which occurs on the ridge tops, and Muskingum stony silt loam, on the hillsides (pl. 2). Philo, Stendal, and Pope silt loams are the dominant soils of the small stream bottoms. Farmers usually grow most of the corn on the bottom land and as far as possible use the ridge-top fields for wheat, hay, and pasture.

Generally a self-sufficient type of agriculture is practiced in the county. With the exception of wheat, most of the farm crops are consumed on the farm or sold within the county. Eggs, poultry, and cream furnish the principal sources of income for many farms. Fruit and truck crops are produced to only a limited extent. Because the family of the farmer furnishes most of the labor, these products might

[4] YOUNG, E. C., and ELLIOTT, F. F. TYPES OF FARMING IN INDIANA Ind Agr. Expt Sta Bul 342, 72 pp, illus. 1930

EXPLANATION OF PLATE 1

Aerial view eastward, across Boggs Creek, sec 9, T 4 N, R. 4 W, Martin County, Ind. Note erosion in pastures in the foreground and general pattern of land use. The steep and the moderately sloping lands (Muskingum stony silt loam) are in timber and pasture, respectively, and the gentle slopes and hilltops (Zanesville silt loam) are cultivated.



For explanation see facing page

For explanation see facing page

be produced more extensively, but lack of markets, poor roads, and low soil productivity limit the production.

A general land use map of Martin County, based on soil characteristics and present use, is shown as figure 2.

Corn, wheat, and hay have always been the principal farm crops. They are usually grown either in a 3-year rotation in which red clover is the hay crop the third year or in a 4-year rotation with timothy the fourth year. Owing to the acid soil condition, the low crop yield, and the high degree of erosion in the fields on the sloping ridge tops, systematic crop rotations are followed only on the more productive soils or by the better farmers. Korean lespedeza is grown to some extent as a leguminous hay crop on unlimed land.

Corn comprises 45 percent of the total acreage harvested. Although it is grown on most soils, it is best adapted to the stream-bottom soils, which are high in moisture content, organic matter, nitrogen, and other plant nutrients. On the upland, corn is frequently planted in fields that have been idle or in grass for several years. Although this crop is not generally fertilized, some farmers apply 100 pounds of 2–12–6 or 2–18–6 [5] fertilizer. Corn is grown most extensively on the bottom lands of the White River and the Lost River. As the corn yield, which ranges from 35 to 40 bushels an acre, has been declining, 2- or 3-year rotations that include corn, soybeans, wheat, and clover are becoming more widely used. The better farmer generally tries to raise most of the corn on the bottom lands and wheat and hay on the ridge-top fields. This practice results in higher average corn yields and retards erosion by maintaining a more complete ground cover on the uplands.

Wheat, a cash crop, is the second most important grain crop and is grown on 12 percent of the cropland harvested. It is best adapted to the well-drained soils where winter damage is less severe and the moisture supplies are adequate during the spring and early summer when the crop needs it most. From 100 to 200 pounds of 2–12–6 fertilizer to the acre is generally used. Wheat is an important nurse crop for the grass seed.

Because of unfavorable climatic conditions, oats are probably the least profitable grain crop. They occupy about 4 percent of the cropland harvested. They are produced mainly for horse feed and are grown after corn in a 4- or 5-year rotation.

Soybeans are grown mainly as a leguminous hay crop and occupy about 9 percent of the crop acreage harvested. They are well adapted to acid soil conditions and also withstand the midsummer droughts. They are usually grown after corn in a 4- or 5-year rotation and yield 1½ to 3½ tons an acre.

The total acreage in hay aggregates 31 percent of all the cropland harvested. Because of acid soil conditions and midsummer droughts, red clover is not grown successfully. It produces best results on the

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

EXPLANATION OF PLATE 2

Aerial view of the White River Valley in the vicinity of Shoals, Ind., showing the intensively cultivated river bottom, which is the most fertile land in the county. The steep wooded slopes of the Muskingum soil and the partly used Zanesville silt loam of the ridge crests are also shown.

nonacid soils. Redtop and lespedeza, or a mixture of these with red clover, is usually seeded. The meadows contain very little clover the second year.

On the basis of topography and drainage and of soil character-

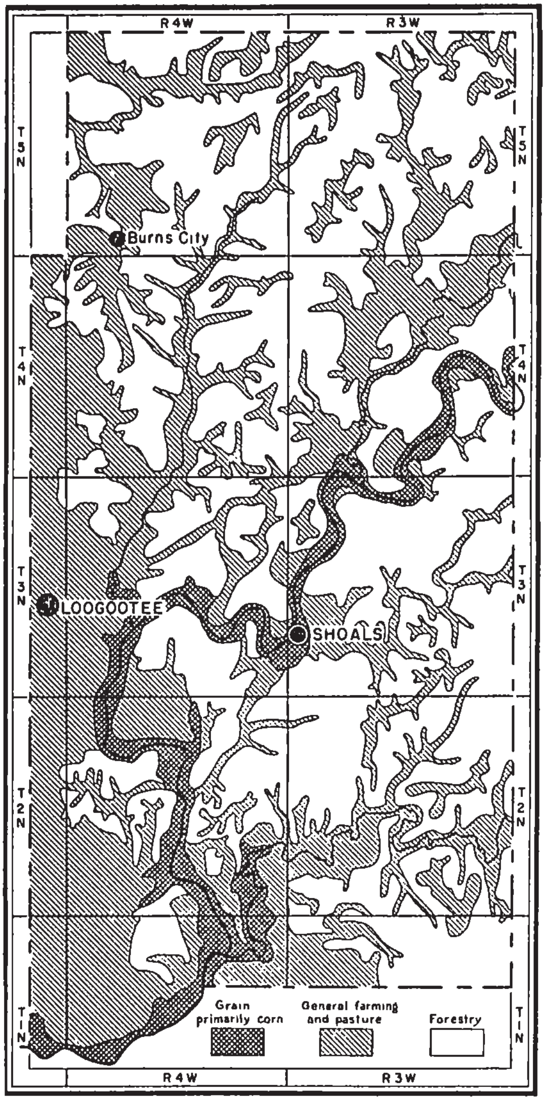


FIGURE 2.—General land use map of Martin County, Ind., based on soil characteristics and present use.

istics dependent upon these factors, the soil types are placed in three groups for convenience in this report: (1) Soils of the uplands; (2) soils of the terraces; and (3) soils of the overflowed stream bottoms. As this county is rolling and is dissected by streams, about 85 percent of the soils are well drained. On the rest the yields are affected by imperfect natural drainage of varying degree, which in many places may be corrected by artificial means.

In the following pages the soils of Martin County are described in detail and their agricultural relations are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

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

Soil type	Acres	Percent	Soil type	Acres	Percent
Zanesville silt loam	35,264	16 3	Dubois silt loam	832	0 4
Wellston silt loam	5,248	2 4	Robinson silt loam	320	.1
Wellston-Muskingum complex	448	2	Otwell silt loam, slope phase	384	.2
Tilsit silt loam	2,048	.9	Otwell silt loam, eroded phase	576	3
Muskingum silt loam, colluvial phase	2,624	1 2	Elkinsville silt loam	320	1
Johnsburg silt loam	64	(1)	Martinsville loam	192	1
Zanesville-Wellston silt loams, slope phases	16,256	7 5	Pekin silt loam	384	.2
Zanesville-Wellston silt loams, eroded phases	20,736	9 6	Bartle silt loam	1,024	5
Zanesville-Wellston silt loams, gullied phases	6,272	2 9	Markland silt loam	1,792	8
Muskingum stony silt loam	64,832	30 0	McGary silt loam	896	4
Rough stony land (Muskingum soil material)	1,984	9	Montgomery silty clay loam	256	1
Frederick silt loam	384	2	Genesee silt loam	2,752	1.3
Corydon silty clay loam	640	3	Genesee silt loam, high-bottom phase	640	.3
Frederick silt loam, slope phase	640	3	Genesee loam	1,280	6
Frederick silt loam, eroded phase	128	1	Genesee loam, high-bottom phase	384	.2
Princeton fine sandy loam	1,216	6	Genesee fine sandy loam	448	.2
Princeton fine sandy loam, slope phase	576	3	Genesee fine sandy loam, high-bottom phase	128	.1
Ragsdale loam	64	(1)	Eel silty clay loam	1,408	.7
Cincinnati silt loam	1,728	8	Eel silt loam	1,472	7
Cincinnati silt loam, shallow phase	384	2	Shoals silt loam	1,408	.7
Parke silt loam	512	2	Shoals silty clay loam	576	.3
Gibson silt loam	448	2	Pope silt loam	10,560	4.9
Vigo silt loam	128	1	Pope loam	384	.2
Cincinnati silt loam, steep phase	1,152	5	Pope gravelly loam	1,216	.6
Cincinnati silt loam, eroded phase	1,088	5	Philo silt loam	10,816	5 0
Cincinnati silt loam, gullied phase	192	1	Philo loam	64	(1)
Otwell silt loam	1,536	7	Stendal silt loam	6,656	3 1
Haubstadt silt loam	1,216	6	Stendal silty clay loam	64	(1)
			Atkins silt loam	576	3
			Atkins silty clay loam	64	(1)
			Total	215,680	100 0

[1] Less than 0 1 percent

SOILS OF THE UPLANDS

The soils of the uplands are placed in subgroups on the basis of the source of parent material as follows: (1) Soils developed over sandstone, siltstone, and shale; (2) soils developed over limestone; (3) soils developed over sandy. deposits; (4) soils developed over calcareous glacial till; and (5) soils developed over silty deposits of former lakes.

SOILS DEVELOPED OVER SANDSTONE, SILTSTONE, AND SHALE

Martin County is hilly, and most of the hills have relatively narrow tops and are separated in most localities by rather narrow valleys. As a result, many of the soils are on medium to steep slopes, and much of the land is not well suited to agriculture. The underlying sandstone, siltstone, and shale furnish the parent material for a large part of the soils, although the Illinoian glacier left deposits of glacial till and water-laid silts on a small proportion of the uplands in the western part of the county. Where the land has a medium to gentle slope the parent rocks are weathered to a considerable depth, and fairly deep well-drained soils have been formed. These soils include Zanesville silt loam, Wellston silt loam, and Wellston-Muskingum complex. On the gentle to medium slopes of the upland, where surface drainage is fair and where internal drainage has been retarded by a claypan or siltpan, Tilsit silt loam occurs. Muskingum silt loam, colluvial phase, occurs at the foot of the steep slopes where the land levels off to merge with the terraces and stream bottoms. On some of the broader ridge tops, where the land is almost level, there are a few small areas of Johnsburg silt loam in which both surface and internal drainage are slow.

On the steeper areas of Wellston and Muskingum soils the runoff is much more rapid, and where the land is cleared, erosion has been severe. Wooded areas are not severely eroded. Zanesville-Wellston silt loams, slope phases, occupies wooded land that has not been severely eroded. Eroded phases and gullied phases of Zanesville-Wellston silt loams have been mapped on these steep areas. More than 40 percent of the total area of the county is included in steep and stony soils. Of these, Muskingum stony silt loam is the most important, and rough stony land (Muskingum soil material) is of less extent.

Zanesville silt loam.—This soil type occurs on the rounded ridge tops throughout the sandstone, siltstone, and shale upland. The more extensive areas occur on the broader ridges along the western border of the county, but the greater part of the soil is on long, narrow, many-lobed ridge tops. The total area is 35,264 acres. Soils derived from sandstone, siltstone, and shale are frequently referred to as freestone soils.

The 8- to 12-inch surface soil of Zanesville silt loam is brownish-gray smooth mellow silt loam, which becomes light brown when wet. In wooded areas the first 3 inches of surface soil is slightly dark brown, containing an abundance of organic matter, which disappears quickly when the soil is cultivated.

The upper subsoil layer is slightly yellowish-brown friable silty clay loam, which crumbles readily into subangular particles less than half an inch in diameter. The particles become larger and more angular and the soil more compact as the depth increases. At a depth of 25 to 32 inches the subsoil is mottled with gray and yellow because of a moderately tough, compact, impervious claypan, which causes slow internal drainage. The lower subsoil layer becomes more friable and slightly gritty with depth and grades into the bedrock at a depth of 4 to 6 feet. Except for a few shale and siltstone fragments, the disintegrated parent material extends practically to the interbedded sandstone, siltstone, and shale.

The nearness of the Mitchell limestone to the surface along the eastern border of the county has produced slight variations in Zanesville silt loam in some places. The presence of sinkholes and a less friable

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EXPLANATION OF PLATE 3

Aerial view showing the wooded slopes of Muskingum soils and the ridge crests of Zanesville soils with irregular-shaped fields that are used partly as cropland or have been abandoned because of erosion and low fertility. Several small creek valleys are shown with their more intensively cultivated bottom lands.

For explanation see facing page

For explanation see facing page

moderately tough subsoil, and to some extent the healthy condition of bluegrass in pastures, are the results of some limestone. These variations occur in sec. 1, in the northeastern corner of the county, south of Grade-Road School, and in the vicinity of Powell Valley School. In secs. 18 and 19, T. 1 N., R. 4 W., and elsewhere at elevations of about 700 feet, pieces of dull bronzed, hard cherty gravel are found in Zanesville silt loam, principally in the subsoil. Small pieces of white quartz or quartzite gravel are also found in more or less abundance in some places, especially in sec. 8, northeast of Loogootee. This gravel was formerly embedded in the Mansfield sandstone.

The rolling relief of Zanesville silt loam causes rapid runoff. Corn, wheat, and other tilled crops were grown rather extensively when organic matter was abundant and the moisture-holding capacity good. Under cultivation the soil has been subject to very severe sheet erosion, particularly on the steeper slopes and on the crests of the hills (pls. 3 and 4). The slope of tilled land is usually from 4 to 12 percent, but in the western part of the county some fields are cultivated where the slopes are 20 percent. Crops such as corn usually suffer from lack of moisture during dry periods in the summer. This condition becomes worse as the organic content is lowered and the surface soil becomes thinner through erosion.

Farming is done on the irregular narrow fields of Zanesville silt loam and on the narrow stream bottoms. Local relief of 200 feet or more is common throughout most of the area. The steep, wooded slopes surrounding the numerous ravines result in most farms having a number of isolated small fields. Where a farm unit contains sufficient bottom land to produce the corn that is needed, the fields on the ridge tops are used primarily for wheat and hay by the better farmers. Less than 5 percent of this soil in 1935 was used for corn. Corn yields from 25 to 30 bushels an acre, although 40 bushels is possible under good management. Although commercial fertilizers are not generally used, some of the better farmers apply 100 to 125 pounds of 2–12–6 fertilizer drilled in the row.

Wheat is relatively more productive than corn because it furnishes adequate ground cover to retard erosion during a greater part of the year. The crop is generally fertilized with 100 to 200 pounds of 2–12–6 or 2–18–6. The average yield is about 12 bushels an acre, but under good management yields of 20 bushels are obtained.

Grass mixture is usually seeded in the spring on the wheat ground. Red clover forms a part of the mixture, but because of acid soil conditions an application of lime to the land is necessary to grow it most successfully. On unlimed fields the plants usually die after the first year. Common lespedeza volunteers in most pastures and frequently grows on barren eroded spots. Korean lespedeza is frequently grown by farmers where clover has failed repeatedly. It forms an excellent leguminous hay crop that is well adapted to acid soils, in a section

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EXPLANATION OF PLATE 4

Aerial view of the vicinity of Cole and Indian Springs, showing the more intensively used bottom lands of small creeks, the wooded Muskingum soils on slopes, and Zanesville silt loam on ridge crests with fields in various stages of use or abandonment.

where the meadows quickly run out and become too weedy to be cut for hay. Soybeans are widely grown in small tracts to supply leguminous hay for dairy cattle. This crop is able to withstand drought and produce a fair-sized hay crop on relatively poor soils.

Some oats and rye are grown as feed for horses and hogs, respectively. Spring oats are not generally grown because of the low yields resulting from drought. A few farmers have tried winter oats with moderate success.

About 50 percent of this soil is either idle land with no vegetative cover except weeds, or low-grade pasture of broomsedge, poverty grass, and ticklegrass. Probably 15 percent of it is now being naturally restocked with timber. Briers, persimmon, sassafras, and other trees and shrubs first make their appearance, to be followed later by hickory and oak sprouts.

Wellston silt loam.—This soil is similar to Zanesville silt loam except that it occupies the very narrow ridge tops and has a shallower soil covering the rock. A total of 5,248 acres is mapped, most of it occurring as narrow, tortuous ridge tops and benches on the hillsides. The land is rolling, with gradients ranging up to 15 percent.

Wellston silt loam has a light-brown to grayish-brown smooth surface soil 8 to 10 inches thick. It is underlain by a yellowish-brown friable silty clay loam subsoil, which in a few places is slightly mottled at the contact with parent material. This soil has no claypan layer, and internal drainage is good. Shale and sandstone fragments occur within 2 feet of the surface, and the undecomposed parent rock lies at a depth of 3 feet or less.

Probably 50 percent of these sharp ridges were cleared of their original timber cover and farmed for a short period of time. Because of the very small fields, the severity of erosion, and the rapid depletion of fertility, this soil is gradually reverting to low-grade pasture and eventually to woodland. Probably less than 10 percent of it is in crops, consisting of corn, wheat, and pasture plants. The acid soil prevents the growing of clover and other legumes that require sweet soils. Crop yields on this soil are somewhat lower than on Zanesville silt loam.

Wellston-Muskingum complex.—The long, narrow, knife-edge ridge tops that have a soil cover mostly less than 18 inches thick have been classified as Wellston-Muskingum complex. The thin layer of this soil is relatively free of large stones, but it is usually underlain by a cap rock of very hard, resistant sandstone. This complex occurs near Wellston silt loam on small saddles of the ridge tops or on the extreme points of the ridges.

The areas of shallowest soils consist of Muskingum silt loam or stony silt loam, and the areas of deeper soils consist largely of Wellston silt loam. Owing to the rolling relief, runoff is rapid. This soil is almost entirely timbered. Because of moisture deficiency, tree growth is very slow, and most of the trees have little commercial value. The vegetation consists principally of chestnut oak, black oak, brush, and briers. A total of 448 acres of this soil is mapped.

Tilsit silt loam.—This soil occurs in small areas on the broader ridge tops throughout the sandstone upland. The largest single area was mapped in the vicinity of Burns City. The aggregate area is 2,048 acres.

The 10- to 12-inch surface soil is brownish-gray smooth mellow silt loam, underlain by yellow, friable, light silty clay loam, which becomes slightly heavier and more compact with depth. At a depth of 20 inches the material is mottled gray and yellow, owing to slow drainage, resulting from the underlying claypan, and below 42 inches it becomes more friable and less mottled, grading into shale and sandstone at a depth of 4 to 7 feet. The entire profile is strongly acid. Surface drainage is slow, and internal drainage is only fairly well established.

One mile southwest of Burns City there is a small area of similar soil underlain by shale at a depth of about 5 feet, but it contains some glacial pebbles such as quartz or granite. This soil is partly developed from Illinoian glacial till.

The Tilsit silt loam is more extensively cropped than the Zanesville soil with which it is associated. Corn, wheat, and mixed hay are grown on nearly 50 percent of the area. The rest consists largely of low-grade pasture land. Crop yields are similar to those on Zanesville silt loam.

Muskingum silt loam, colluvial phase.—Small areas of this phase occur on gentle slopes, generally at the base of the Muskingum hillsides. The soil on these areas is much deeper than that on the steep hillsides. These soils are formed from clay, silt, and to some extent shaly and stony material transported by gravity and local wash from the steep slopes. The 11- to 15-inch surface soil is light brownish-gray silty clay loam to slightly gravelly loam. The subsoil is dull brown or yellowish brown, in some places blotched with orange-colored iron stains and some light-gray mottling. This soil is strongly acid throughout. The total area is 2,624 acres.

Many areas of this phase have been cleared and cultivated in the past. They are also frequently used as sites for farmsteads. Corn, wheat, and soybeans are grown to a limited extent, but yields are rather low, especially on the more shaly and the more recent deposits. Much of this soil is reverting to grassland of low value or is being naturally restocked with a timber cover consisting largely of sassafras, persimmon, and elm.

Johnsburg silt loam.—This soil occurs on the broader ridges of the sandstone, siltstone, and shale upland. Areas of it are in sec. 30, T. 5 N., R. 3 W.; sec. 14, T. 2 N., R. 3 W.; sec. 30, T. 2, N., R. 4 W.; sec. 34, T. 3 N., R. 3 W.; and sec. 28, T. 5 N., R. 4 W. It has a total area of 64 acres. The soil is similar to Dubois silt loam except that it is underlain by sandstone at a depth of 4 to 7 feet.

Zanesville-Wellston silt loams, slope phases.—This complex occurs on the moderately steep slopes of 15 to 25 percent where the soil is 3 to 4 feet deep overlying the rock. It is most extensively developed where the parent material consists largely of shale. In the western part of the county where the soft "Coal Measures" shales form the soil parent material, it occupies entire slopes in some places. In this area the soil in some places is slightly deeper than under average conditions. Eastward it occurs in narrow belts below the crest of the hills or on the slopes in conformity with the outcropping shales of the Chester formations. In such areas much of the soil is less than 3 feet deep. A total of 16,256 acres is mapped.

Under a forest cover the 3-inch surface soil is dark brownish gray, underlain to a depth of 10 inches by yellow silt loam, below which the yellowish-brown friable silty clay loam extends to the bedrock at depths of 2½ to 3 feet.

More than 60 percent of this soil is woodland. The soil is moderately productive except on the upper slopes where the supply of moisture is limited. The principal varieties of trees are oaks and hickories.

Much of this land was cleared during the period of agricultural expansion, but with the decline in yields resulting from loss of organic matter and surface soil by erosion, most of this land has now reverted to pasture or is reverting to woodland where livestock is excluded.

Zanesville-Wellston silt loams, eroded phases.—This complex is the most extensive eroded soil in the county. A total area of 20,736 acres is mapped. It occurs around the heads of most of the natural drainageways, or draws, and in fields as narrow strips along the crests of ridges. Many areas that were too small to show separately on a small-scale map have been included with the typical Zanesville and Wellston silt loams.

The present surface soil consists of brownish-gray or yellowish-gray silt loam, variable in thickness but averaging less than 7 inches thick. Sheet washing has not uniformly removed the original surface soil, but in many spots the strongly acid, yellow, heavier subsoil is exposed. Straight shallow grooves, formed by washing in the cultivator rows of cornfields, and shoestring gullies, or rills, are of common occurrence.

Corn, wheat, and hay are the principal crops, and the eroded condition is a result of the frequent growing of corn. The yields of crops depend largely on the depth and uniformity of the silty surface soil that remains. Yields of corn range from 5 to 15 bushels an acre and those of wheat from 4 to 8 bushels. Owing to the decline in yields, the land has gradually reverted to a thin grass cover and eventual abandonment, especially on the narrow ridge tops. Very little timber grows on this phase. Considerable natural restocking of timber is occurring where the land is not pastured. Although the nitrogen and organic-matter contents are low and the physical condition of the soil is rather unfavorable, reasonable success in restocking much of this land to timber may be expected, especially if the land is rehabilitated by the growth of lespedeza and black locust.

Zanesville-Wellston silt loams, gullied phases.—A total of 6,272 acres of the Zanesville-Wellston silt loams have been dissected and practically destroyed by gully erosion. Three or more gullies per hundred feet across the slopes have cut into the yellowish-brown subsoil to depths of 1 to 4 feet, and in many places down to the bedrock. Gully erosion is usually associated with sheet erosion, which has reduced the thickness of the silt loam surface soil between the gullies to less than 6 inches.

This phase usually occurs as wasteland with a thin cover of broomsedge, poverty grass, and other grass of low pasture value. Broomsedge, briers, brush, and some sassafras, persimmon, and locust sprouts constitute the principal vegetation. These plants and trees probably will prepare the soil for natural reforestation by more valuable trees.

Muskingum stony silt loam.—This is the most extensive soil in the county, comprising 30 percent of the area. A total of 64,832 acres is mapped. It occurs on slopes of 25 to 40 percent. Probably 80 percent of the area is timbered.

In wooded areas the 3-inch surface soil is dark brownish gray, highly organic, and nearly neutral in reaction. The mineral soil is usually covered by a thin mat of partly decomposed leafmold. The subsurface soil is light yellowish-gray silt loam, in most places containing a small quantity of very fine sand. The subsoil consists of pale-yellow silt loam, underlain by hard, resistant sandstone or siltstone rock or interbedded sandstone, siltstone, and shale at a depth of 15 to 20 inches. Hard, resistant brown or brownish-gray stone fragments 4 to 10 inches in diameter are commonly found on the surface and embedded in the soil. Crags and bluffs are common where the soil is derived from Mansfield sandstone and some members of the Chester series. The Mansfield formation in some places acts as a cap rock forming ledges below which the outcropping shales of the Chester series may produce a deeper soil mass relatively free of stones.

This soil originally was completely covered by timber, but most of the commercially valuable trees have been removed. Very little of the present tree growth gets larger than tie size before it is cut. Tree growth is rather slow, and nearly all the trees are less than 10 inches in diameter 4 feet from the ground. The most common species are black oak and pignut and shellbark hickory, with some sugar maple, ash, and elm on the moist lower slopes where the soil mantle is a little thicker.

On the upper slopes that have been cleared, a small acreage of crops may be grown; but most of the cleared land consists of low-grade pasture land or land that is naturally reverting to forest, as only a few head of livestock are pastured on this soil.

Rough stony land (Muskingum soil material).—The Mansfield sandstone and some members of the Chester series, notably the Cypress sandstone in conjunction with the Beech Creek limestone, give rise to massive bluffs and crags along all the major and minor streams. Outcrops, 20 feet or more thick, of the sandstone formations of the Chester series produce numerous local areas of rough stony land on the hillsides. The greater thickness of the Mansfield sandstone and its nonbedded character result in great unscalable bluffs, which are most pronounced in the vicinity of Shoals. Small areas of Muskingum stony silt loam are usually included in areas of this land type. Tree growth is very sparse on this soil, but many small gnarled trees grow out of crevices in the rock.

SOILS DEVELOPED OVER LIMESTONE

A small total area of soils in Martin County are developed over limestone of the Chester formation. Frederick silt loam is a deeply weathered soil on medium slopes, and Corydon silty clay loam is a shallow, fairly dark-colored soil generally developed on steeper areas. The slope and eroded phases of Frederick silt loam, for the most part, are on steeper slopes.

Frederick silt loam.—This soil occurs in a number of small areas near the eastern border of the county where the Mitchell limestone and the various limestone formations of the Chester rock series have been exposed. The principal areas are in the valley of Indian Creek and near Powell Valley School. A total of 384 acres is mapped.

The 10-inch surface soil consists of friable, smooth, light-brown to grayish-brown silt loam that changes abruptly to friable crumbly yellowish-brown silty clay loam, which below a depth of 18 inches gradually merges with a more compact, tough, heavy silty clay. At a depth of about 30 inches the subsoil is brownish-red, waxy, tough plastic clay containing some chert fragments. This material is underlain by bluish-gray cherty limestone. The entire soil profile is strongly acid in reaction. Sinkholes are numerous in some places, especially where the soil is derived from Mitchell limestone.

The soils derived from the various limestone formations of the Chester series are free from chert, but siliceous fossils are generally plentiful. As these stones outcrop below the freestone, most areas are more friable and crumbly in the upper 15 inches, owing to the inclusion of weathered sandstone fragments. Benchlike limestone outcrops are occasionally found on the hillsides.

This soil gives good returns on all crops grown. Corn yields 30 to 35 bushels an acre, but because of the rolling land, sheet erosion is a serious problem. For this reason the soil is better suited to small-grain, meadow, and pasture uses. Wheat yields generally are 2 to 5 bushels higher than on Zanesville silt loam. Bluegrass pastures have a much higher carrying capacity than those of the Zanesville, Wellston, and Muskingum soils.

Corydon silty clay loam.—This soil is formed from the relatively pure limestone of the Chester rock series and from the cherty Mitchell limestone, where they outcrop on the steep hillsides along the eastern border of the county, principally in the valleys of Indian Creek and the White River. Limestone crags and rocks are on the surface in some places. A total area of 640 acres is mapped.

The surface soil consists of moderately dark brown silty clay loam, 10 to 14 inches thick, generally covered by a mat of leafmold. The subsoil consists of yellowish-brown or light reddish-brown silty clay with some rock usually embedded in the soil mass. Limestone bedrock occurs at depths of 18 to 36 inches. The entire soil mass is neutral in reaction and well supplied with lime.

Few areas of this soil are suitable for farming, because of the stoniness and steep slopes. It is almost entirely in timber, to which use it is well adapted. The timber cover consists of mixed hardwoods such as sugar maple, ash, elm, walnut, oak, and hickory. Tree growth is quite rapid, and the timber is above the average in commercial value for the section. The areas of this soil that have been cleared produce excellent bluegrass pasture.

Frederick silt loam, slope phase.—The slope phase of Frederick silt loam occurs on slopes of 18 percent or more, which are too steep for general farming operations. The soil is similar to Frederick silt loam. It has a light-brown surface soil with occasionally some dark color owing to penetration of organic matter. The subsoil is dominantly brown to yellowish brown, with reddish-brown clay overlying the limestone. A total of 640 acres is mapped.

This soil is well adapted to the growth of both timber and bluegrass. Probably 50 percent has never been cleared of timber, although the present stand has been heavily cut over and contains very few trees larger than tie size. The cleared land consists largely of pasture containing much bluegrass. Cultivated crops are grown only to a limited extent, because of the severity of erosion.

Frederick silt loam, eroded phase.—Under cultivation, sloping areas of Frederick silt loam are susceptible to severe sheet erosion. The soil of this eroded phase is best used for bluegrass pasture or forestry, but wheat and mixed hay may be grown with moderate success. The grayish-brown surface soil averages less than 7 inches thick, and the tough yellowish-brown subsoil is exposed on 50 percent of the area. Crop yields are slightly higher than on Zanesville-Wellston silt loams, eroded phases, owing to the less acid soil conditions and the greater abundance of plant nutrients. Much of this soil is in pasture or crops. A total of 128 acres is mapped.

SOILS DEVELOPED OVER SANDY DEPOSITS

During the period of Wisconsin glaciation farther north in Indiana, strong westerly winds picked up sand from some of the larger stream bottoms of Martin County and deposited them on the uplands to form low dunelike areas. These sands for a long time have been fixed in place by forest vegetation and have weathered to form Princeton fine sandy loam. A slope phase of Princeton fine sandy loam is also mapped. In depressions of the sandy deposits, Ragsdale loam, a poorly drained, dark-colored soil, is shown on the map.

Princeton fine sandy loam.—This soil type has a total area of 1,216 acres. It has been formed from loose, calcareous, fine sand deposited by wind action in scattered areas along the bluffs on the eastern and southeastern sides of the White River Valley. This soil has a sand-dune relief and is irregularly rolling, with swells and depressions in the larger areas.

The surface soil to a depth of 12 inches consists of loose, light-brown fine sandy loam, which is slightly coherent when moist. The content of organic matter has always been low, even under the native forest cover, and consequently the moisture-holding capacity is rather low. From a depth of 12 to 30 inches the upper subsoil layer consists of strong-brown to light reddish-brown friable clay loam or sandy clay loam. The texture ranges from a loose loamy fine sand to a moderately compact clay loam. The lower subsoil layer is loose light reddish-brown fine sand, underlain by limy yellowish-gray sand at a depth of about 50 inches.

In a few places, such as south of Pinnacle Rock at Shoals, the soil as mapped consists of deep loose brown sand that has been washed from the higher areas and has accumulated on the lower slopes.

In the vicinity of Shoals a few small poorly drained depressed areas, totaling about 25 acres, were included with this soil. These areas have gray to light-gray surface soils, 10 inches deep, which are underlain by mottled gray and yellow heavy clay loam to silty clay loam subsoils. Drainage is retarded, owing to the low position and the impervious subsoil. If a larger area had been involved this soil would have been mapped separately as Ayrshire loam.

Princeton fine sandy loam is used primarily for general farming. Owing to its low moisture-holding capacity, corn yields generally are only about 25 bushels an acre. Higher yields are possible in years of well-distributed and adequate rainfall during the growing season.

Wheat, soybeans, and alfalfa are able to utilize the available moisture supplies to greater advantage. Wheat is probably the principal crop grown; yields range from 10 to 15 bushels an acre when fertilizer is applied. Since the soil is only slightly acid, alfalfa and sweetclover can be grown with light applications of lime to the land. Probably 90 percent of the soil is cultivated, and one-third or more of it is used for rotation pasture.

This soil is naturally adapted to a variety of special crops such as watermelons, cantaloups, sweetpotatoes, early tomatoes, and tree fruits, especially peaches. As its use for general farm crops is limited primarily by lack of moisture, the more extensive development of this soil for special crops probably would bring more profitable returns.

Princeton fine sandy loam, slope phase.—This phase is too steep for normal tillage operations, although much of it is used for field crops and pasture. Erosion is not a serious problem, because the loose fine sandy loam surface soil and the friable sandy clay loam subsoil absorb most of the rainfall. Timber growth is excellent on the timbered slopes, but regeneration of the timber stand, on areas that have been cropped, is somewhat difficult because of the low content of organic matter. A few areas included with this soil have moderately coherent loam surface soil and more compact, heavier subsoil. A total of 576 acres is mapped.

Ragsdale loam.—This soil occurs in several small depressed areas surrounded by Princeton fine sandy loam. A total of 64 acres is mapped. The soil is similar to Montgomery silty clay loam in color, but as it is developed from sandy materials, it is more friable throughout. The dark brownish-gray surface soil is underlain at a depth of 15 to 20 inches by a friable mottled yellow and gray sticky sandy clay loam subsoil extending to a depth of about 30 inches. At a depth of 5 feet or more the material becomes more sandy. This soil is somewhat less productive for certain crops than the heavier Montgomery soils, but high yields are obtained where the land is drained artificially.

A few small areas of lighter colored, poorly drained soils were included with Ragsdale loam. This included soil also occurs in depressions where artificial drainage may be difficult to establish. The 10-inch surface soil is dark- to brownish-gray loam grading into mottled gray and yellow or brown loam or clay loam. Dark-brown rounded concretions, together with rust-colored blotches and stains, are frequently present throughout the soil. This soil is only slightly less productive than the typical Ragsdale loam.

SOILS DEVELOPED OVER CALCAREOUS GLACIAL TILL

The remains of glacial deposits left by the ancient Illinoian glacier are in the western part of the county. Probably these deposits were originally calcareous, but the limestone fragments and rock flour have been leached and are now acid in reaction to a depth of 8 to 12 feet. On medium slopes where natural internal and external drainage are good, Cincinnati silt loam and its shallow phase are mapped. Parke silt loam occurs on reddish-brown lighter textured glacial drift that has been described as Illinoian in age. Internal drainage is somewhat more rapid than in Cincinnati silt loam. On the nearly level areas of glacial till, external drainage is slow and internal drainage has become exceedingly slow because of the development of a claypan or hardpan in the subsoil. Gibson silt loam occurs on the gently sloping areas, and it is not quite so slowly drained as the nearly level Vigo silt loam. Soils on steep areas developed from glacial till have been eroded severely wherever they have been cleared. Uncleared areas are mapped as Cincinnati silt loam, steep phase, and the eroded areas as Cincinnati silt loam, eroded phase, and Cincinnati silt loam, gullied phase.

Cincinnati silt loam.—This soil type occurs on rolling upland bordering streams of the Illinoian till plain, which projects into the county in several places along the western border. The most extensive areas of this soil are in the vicinity of Loogootee. A total of 1,728 acres is mapped.

In cultivated fields the 7- to 12-inch surface soil is light brown to brownish gray. After a rain the fields have a strong-brown color. The land slopes from nearly flat to 15 percent, and on the more sloping areas erosion is a serious problem, especially when clean-cultivated crops such as corn are grown. At a depth of 12 to 34 inches the subsoil consists of friable yellowish-brown silty clay loam, which becomes slightly mottled below 25 inches. In many places light-gray silty streaks occur along the cleavage planes and extend to the moderately heavy claypan at a depth of about 3 feet. Internal drainage conditions are only slightly affected by the claypan. At a lower depth the acid subsoil becomes less mottled and more friable and gritty, and it extends to the parent material at a depth of 10 feet. This material consists of a heterogeneous mixture of limy clay, silt, sand, and some small gravel consisting of rounded chert, quartzite, and granitic and feldspathic rocks deposited tens of thousands of years ago by glacial ice. The entire soil mass is strongly acid nearly to the limy substratum.

About 90 percent of this soil has been cleared of timber and cultivated. The mixed cover of forested areas consists largely of oak and hickory with some elm, ash, maple, and beech.

The crops grown and the yields are similar to those on Zanesville silt loam. Because of the deeper soil, the moisture-holding capacity is a little better and corn yields are slightly higher. Corn yields 30 to 40 bushels an acre and wheat 14 to 20 bushels. A large part of the cropland is used as meadow and pasture in order to retard the destructive erosion that occurs with clean-cultivated crops such as corn. Corn, small grains, and hay each occupy about 10 percent of the soil, and pasture land about 30 to 40 percent.

Cincinnati silt loam, shallow phase.—In several places on the borders of the Illinoian till plain the ice deposited a thin covering of glacial till on the sandstone and shale upland. This soil is similar to typical Cincinnati silt loam to a depth of 4 to 7 feet, where it overlies sandstone, siltstone, and shale. A total of 384 acres is mapped in small areas in the vicinity of Bramble and Loogootee and southward from Parsons School.

Because of the rolling relief and the slightly greater susceptibility to erosion, a large part of this soil is used for pasture and timber. The crops grown and yields obtained on cultivated areas are similar to those on Cincinnati silt loam.

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Parke silt loam.—This soil is associated with Cincinnati silt loam. A total of 512 acres is mapped. The principal areas occur near Loogootee, in the vicinity of Mount Pleasant and Strawn Schools, and in the northwestern corner of the county near Culpepper School.

The surface soil to a depth of 10 inches consists of light-brown smooth silt loam somewhat reddish when moist. At a depth of 30 inches the subsoil is friable light reddish-brown silty clay loam. Below this the material gradually becomes more friable and gritty until the characteristic reddish-brown mixed silt, sand, and gravel substratum is reached at a depth varying from 40 to 60 inches. The soil is acid, and at no place does limy parent material occur.

In a few places there is included with Parke silt loam a soil that is derived from water-assorted sands, silts, and clays. This soil is similar in most respects to true Parke silt loam, except that it has only small quantities of gravel. The fine gravel is generally found in the red sandy substrata such as may be seen in the road cut east of Boggs Creek on United States Highway No. 50. The parent material consists of noncalcareous assorted and stratified sands with some gravel and silty material. The land is nearly flat except for the rather steep narrow slopes to the adjacent bottom land. This included soil is much like Bainbridge silt loam and is found in association with Otwell silt loam.

The relief of Parke silt loam is moderately rolling to flat, and the soil is susceptible to erosion when clean-cultivated crops are grown on the rolling areas. Although the cropping system is similar to that of the associated Cincinnati silt loam, somewhat higher yields may be expected. The permeable, friable subsoil permits roots to penetrate to greater depths; consequently crops are less likely to suffer from drought. Although the soil is strongly acid, legumes, including alfalfa, are reported to yield well when sufficient lime is applied.

Gibson silt loam.—The principal areas of this soil type occur in the vicinity of Loogootee and southwest of Burns City on the county line. A total area of 448 acres is mapped. The soil is similar to Tilsit silt loam, although the claypan varies in depth from 2 to 3 feet from the surface. The lower subsoil layer differs principally in the presence of some rounded glacial gravel and in being underlain by moderately compact limy mixed clay, silt, sand, and gravel at an average depth of 10 feet. Glacial gravel is present in the entire soil mass. A detailed description appears in the section on Morphology and Genesis of Soils. West of Burns City there is a small area of similar soil which is included with Tilsit silt loam because it is underlain by shale at a depth of 5 feet.

A variety of farm crops are grown, but corn, the principal crop, is grown on about 20 percent of the soil. Corn yields about 35 to 40 bushels and wheat about 20 bushels to the acre when the land is fertilized. Liming is necessary in order to grow clover.

Vigo silt loam.—The 7-inch surface soil of Vigo silt loam consists of smooth light brownish-gray silt loam that is slightly rust-stained. This material grades through a lighter gray subsurface soil into mottled gray and yellow moderately tough compact silty clay loam extending to a depth of 15 to 18 inches. Beneath this is very tough compact impervious silty clay, which breaks into irregular angular blocks about 2 inches in diameter. Below 30 inches the soil becomes slightly more gritty and friable, but it still maintains the compact massive blocky structure. Some glacial pebbles and grit occur throughout the profile. The soil to a depth of 5 feet is strongly acid, and below this the acidity declines to the calcareous parent material at about 10 feet. The parent material consists of a compact bluish-gray heterogeneous mixture of clay, silt, sand, and some glacial gravel, which was deposited during the Illinoian glacial period.

The heavy impervious subsoil makes it rather difficult to drain this soil with tile. Corn, wheat, and timothy are the principal crops. Corn yields about 20 to 25 bushels an acre. Red clover requires lime on this soil. A total of 128 acres is mapped, principally in the vicinity of Loogootee.

A few small areas of Loy silt loam are included with Vigo silt loam as mapped. It is a light-gray soil occupying flat to slight depressions associated with typical Vigo silt loam. At a depth of 10 inches the subsoil is rust-stained light-gray compact silty clay loam that grades, at a depth of 18 inches, into a very compact impervious clay. At a depth of about 10 feet the parent material consists of limy mixed clay, silt, sand, and some glacial gravel, laid down during the Illinoian glacial period. This included soil is a little colder and wetter in the spring than the associated Vigo silt loam. Crop yields generally are slightly lower.

Cincinnati silt loam, steep phase.—This phase occurs on the steep slopes around the drainage lines on the Illinoian till plain in the vicinity of Loogootee. A total area of 1,152 acres is mapped. It is very similar to the typical Cincinnati silt loam except for the steep slope, which precludes farming operations. Although it is covered largely by a mixed stand of hardwoods, consisting mostly of oaks and hickories, some of it has been cleared and cultivated. Because the crop yields are low, it has reverted to pasture.

A small part of this phase occurs on the borders of the sandstone land, where the soil resembles Cincinnati silt loam, shallow phase, with bedrock occurring at shallow depths. Several areas of Parke silt loam, steep phase, which was not mapped separately, are included with this soil.

Cincinnati silt loam, eroded phase.—This phase is similar to the typical Cincinnati silt loam except for the loss of much of the surface soil. In most places the original surface soil has been reduced to less than 6 inches deep. Occasionally sheet wash may be actively removing part of the subsoil. A total area of 1,088 acres is mapped. Less than 10 percent of the land is used for crops, principally corn and wheat. The rest consists largely of wasteland, idle land, and low-grade pasture land. Reclamation for forestry purposes is probably the best possible use for this land, although it may also be used for pasture if lime and fertilizer are applied.

Several areas of eroded Parke silt loam have been included with this soil. In these areas the subsoils are reddish brown. On areas bordering the sandstone upland, bedrock may occur within 5 to 7 feet of the surface.

Cincinnati silt loam, gullied phase.—The gullied phase of Cincinnati silt loam has a total area of only 192 acres. It consists of areas of Cincinnati silt loam that have been destroyed as cropland by gully erosion. The surface soil has been largely removed, and the gullies range from 1 to 5 feet deep or more. Several gullied areas of Cincinnati silt loam, shallow phase, and Parke silt loam are included with this phase on the map. The best use for the land probably is to reclaim it for forestry purposes by the growth of lespedeza and black locust.

SOILS DEVELOPED OVER SILTY DEPOSITS OF FORMER LAKES

A relatively small total area of soils in the glaciated part of the county is developed over stratified silty and clayey deposits that are supposed to have been laid down in lakes that formed around the border of the Illinoian glacier when it was melting. Natural drainage in these areas is dependent largely on the degree of slope and on the proximity of valleys that will carry runoff. Otwell silt loam is on medium slopes, and both internal and external drainage are good for agricultural purposes. Haubstadt silt loam is on somewhat more gentle slopes, and although its external drainage is good, internal drainage is somewhat slow. The soil does not need artificial drainage to grow agricultural crops, but it cannot be cultivated as early in the spring as Otwell silt loam. Dubois and Robinson silt loams occur on the nearly level areas, where external drainage is medium to slow and where internal drainage is very slow. Dubois silt loam can be cultivated successfully without artificial drainage, although the kinds of crops are limited by excess moisture; but artificial drainage is necessary for practically all crops on Robinson silt loam. Wooded areas of Otwell silt loam, slope phase, and cleared areas of Otwell silt loam, eroded phase, occur where recent stream action has dissected the land and slopes are steep. All the soils developed over silty deposits of former lakes are strongly acid in reaction.

Otwell silt loam.—This soil is generally developed from noncalcareous fine-textured sediments consisting largely of silts and clays laid down in ponded or slack-water areas along the border of the Illinoian till plain and in old abandoned ox bows of the White River. Areas of this soil occur as terraces along Furse Creek and Sugar Creek in the vicinity of Loogootee and in the several abandoned ox bows of the White River between Pea Ridge School and Houghton School. A total area of 1,536 acres is mapped.

The relief ranges from undulating to gently rolling. In general the relief is less than 20 feet; this results in less rapid runoff and considerable less loss from erosion as compared with the Cincinnati and Zanesville soils. This soil is almost entirely under cultivation. The crops grown and the yields produced are similar to those on Cincinnati silt loam.

This soil is relatively free of gravel and sand throughout. Valley slopes along the stream south of Loogootee contain small quantities of rounded gravel. The entire soil profile is strongly acid to a depth of 7 feet. In a few places around Loogootee the slack-water plain is known to contain abundant supplies of free lime at depths of 6 to 8 feet.

Haubstadt silt loam.—This soil is most extensive on the high terraces around Loogootee and in the northwestern corner of the county. Smaller areas are found in old abandoned ox bows and high-terrace remnants scattered along the White River Valley from Pea Ridge School to the Dubois County line. A total area of 1,216 acres is mapped.

This soil is derived from moderately acid stratified deposits of clays and silts originally laid down in slack water. In the vicinity of Loogootee a few areas of the deposits are known to be moderately calcareous. This soil has characteristics similar to those of the Gibson and Tilsit soils. Although a little rounded cherty gravel is present in many places, the soil is generally free of coarser materials. The system of farming and the crop adaptations and yields in general are similar to those of Gibson silt loam and associated well-drained soils.

Dubois silt loam.—This soil is developed over water-laid assorted silts and clays of the Illinoian glacial age and occurs in small areas in the vicinity of Loogootee and in the northwestern corner of the county. Other areas are in the abandoned ox bows of the White River.

The 10- to 12-inch surface soil is smooth brownish-gray silt loam in which a few round brown iron and manganese concretions, or turkey-shot gravel, are usually found. As the soil tends to bake and form a crust when it dries, it is sometimes difficult to obtain a good stand of soybeans, because they cannot break through the crust. To a depth of 17 inches the subsoil is mottled gray and yellow heavy silt loam or silty clay loam, which becomes heavier with depth. A heavy impervious claypan generally occurs at a depth of 30 to 36 inches, but in a few places it is developed at shallower depths. The underlying subsoil becomes yellower, more friable, and slightly gritty and rests on stratified assorted silts, clay, and sand at depths of 6 to 8 feet. The soil is strongly acid throughout.

Nearly all of this land was originally cleared of its timber cover and brought under cultivation. Corn, wheat, and mixed hay are the principal crops. Corn may yield as high as 50 bushels an acre when the land is tiled, limed, and fertilized, but the general average is 35 to 40 bushels. Red clover is productive where the soil has been limed. On unlimed areas timothy and redtop are usually grown. Lespedeza and soybeans are grown to some extent as leguminous hay crops. Wheat is grown most successfully on the drained areas, as considerable difficulty is experienced in some years with winterkilling.

Robinson silt loam.—This soil type occurs on flat land where drainage is very slow and the soil is subject to saturation for long periods. Artificial drainage is more necessary than on Haubstadt silt loam, and the crop response to drainage is greater. A total area of 320 acres is mapped. It occurs in several areas near Loogootee, in the northwestern corner of the county, and in the old river bed south of Pea Ridge School.

The surface soil is brownish gray when moist but is light gray when dry. The subsoil is rust-stained light-gray slightly heavier silt loam with some iron concretions. A claypan occurs at a depth of 30 to 36 inches and retards internal drainage. Below this the subsoil is more friable mottled gray and yellow heavy silt loam and is underlain by assorted silt and clay layers at a dept of 6 to 8 feet.

Corn, wheat, and mixed hay or timothy are the principal crops. Red clover cannot be grown successfully without the use of lime, because of the acid condition of the soil. Lime is usually applied to the land at the rate of 2 tons an acre.

Otwell silt loam, slope phase.—The slope phase of Otwell silt loam occupies a total area of 384 acres, associated with Otwell silt loam on slopes of 12 to 25 percent. It has a grayish-brown surface soil and a yellowish-brown subsoil. The narrow, steep slopes with slight relief are frequently cultivated where they form part of a field. Crop yields are usually low because of the limited supply of moisture and the loss of surface soil through erosion. These slopes are better adapted to pasture or timber than to cultivation.

Otwell silt loam, eroded phase.—Most of the surface soil of the eroded phase of Otwell silt loam has been removed by erosion, because of the slopes being planted to clean-cultivated crops or failure to maintain a vegetative cover on them. The slopes are narrow and steep, ranging from 15 to 20 percent, although the relief generally is less than 15 feet. Probably 30 percent or more of this phase is used for crops, although the yields are relatively low. The rest is largely in pasture land, to which it is probably best adapted. A total area of 576 acres is mapped.

SOILS OF THE TERRACES

The soils of the terraces are placed in the following subgroups on the basis of the source of parent material: (1) Soils developed over mixed alluvial deposits, and (2) soils developed from calcareous slack-water clay.

SOILS DEVELOPED OVER MIXED ALLUVIAL DEPOSITS

A number of terraces that lie generally above stream overflow occur along the White River and its tributaries in Martin County. These natural terraces consist of mixed alluvial deposits laid down by the streams a long time ago. Since the materials were laid down the streams have cut into them to sufficient depth to leave most of them above present high-water levels. A part of the materials in these terraces were laid down by flowing water, and the materials are composed of acid sands, silts, and clays in varying proportions. The well-drained soils developed from these acid materials belong to the Elkinsville series; the imperfectly drained soils belong to the Pekin series; and the very slowly drained light-colored soils with moderately developed claypans belong to the Bartle series. Along the White River are terrace deposits of sand, silts and clays that are neutral in reaction and in places are actually calcareous. Martinsville loam is developed from this kind of material.

Elkinsville silt loam.—This soil occurs on low terraces that generally have a slope of less than 5 feet in the valleys of the White River and Indian Creek, where it may be subject to overflow during unusually high water. A total area of 320 acres is mapped. The surface soil is light brown to grayish brown, and the subsoil is yellowish-brown silty clay loam with a reddish tint that is free of mottles to a depth of 25 inches or more. The substratum consists of stratified deposits of sand, silt, and clay, which are usually somewhat acid in reaction. Corn and wheat are the principal crops grown on this soil.

At the edges of the terraces, adjacent to the bottom land, there is an inclusion on narrow, short, steep slopes of 12 to 20 percent. This included soil occurs mainly along the breaks to streams. Under a timber cover the surface soil is grayish brown and ranges from 8 to 11 inches in thickness. Many of the narrow slopes in fields are cultivated with the associated typical Elkinsville silt loam, and much of the surface soil is lost through erosion. Crop yields are low. The total area of this inclusion is small.

Martinsville loam.—This soil type occurs in several small areas in the White River Valley between Shoals and Indian Creek. A total area of 192 acres is mapped.

The 8- to 12-inch surface soil consists of light-brown loam or fine sandy loam. The subsoil consists of light-brown friable clay loam or sandy clay loam, underlain by stratified sand and silt at a depth of 3 to 4 feet. The soil is moderately acid to a depth of 3 feet. Because of the sand content, the soil dries and warms quickly in the spring and tillage operations are easily performed. Corn, wheat, and clover are the principal crops, although soybeans and alfalfa are also grown to some extent. Liming is necessary for the successful growth of alfalfa.

Pekin silt loam.—This soil occurs as low alluvial terraces in the valleys of Indian and Boggs Creeks and along small tributaries near the White River. In some places it is subject to overflow during high floods. In most respects the soil is similar to Haubstadt silt loam, but the underlying material contains a higher content of sand. Yields of crops, especially corn, may be slightly higher, as the supply of moisture and organic matter is more abundant.

Bartle silt loam.—This soil is developed from the more recently deposited noncalcareous water-laid silts and clays on low terraces along Indian Creek and Boggs Creek, where it is occasionally subject to overflow. The surface soil is brownish-gray silt loam, but in the bends of streams some sand may be present. The subsoil is mottled gray and yellow light silty clay loam. Slow drainage is due mainly to the low, flat position, although in places a moderately heavy claypan is present, which retards moisture movement to some extent.

A few small areas that have poorer natural drainage have been included with this soil. These areas occur in Indian Creek Valley, the principal one being near the Lawrence County line. The surface soil is light gray, and it usually has numerous iron concretions scattered over it. The subsoil is a rust-stained light-gray to bluish-gray silt loam that becomes slightly heavier with depth and is underlain by a compact impervious claypan at a depth of 3 feet.

The farming system and crop adaptations are similar to those on Dubois silt loam, although the yields are lower on the more poorly drained areas. A total area of 1,024 acres is mapped.

SOILS DEVELOPED FROM CALCAREOUS SLACK-WATER CLAY

The soil material developed from calcareous slack-water clay was laid down when the valleys were flooded for a long period of time and temporary lakes were formed in the valleys. Water was quiet in these lakes, and only the fine-textured materials remained in suspension except near the place where water entered. These fine materials gradually settled out to form deposits of calcareous clay. Since the draining of these temporary lakes the deposits have been dissected somewhat, and they now remain above all but the highest flood levels. Markland silt loam is developed near the edges of these terraces where surface drainage is fairly rapid and internal drainage is good. McGary silt loam occurs a little farther back on the terraces where the land is nearly level and drainage is fair to slow. McGary silt loam can be cultivated successfully without artificial drainage, but the crops adapted to it are limited. Montgomery silty clay loam occurs in the depressions of the low terraces. The soil is dark-colored and very poorly drained except where ditches and tile drains have been installed. It is highly productive of corn and other crops when it has been artificially drained.

Markland silt loam.—This soil is derived from calcareous heavy clay deposited in protected coves of the White River Valley at an elevation of 460 to 470 feet above sea level and near the outlets of all the larger tributary streams to the White River. It was probably laid down by the ponding of the melt waters of the late Wisconsin glacier. This soil occurs on the breaks or sloping borders of low terraces. The drop to the nearby bottom is rarely more than 12 feet. A total area of 1,792 acres is mapped. The larger areas are at the mouths of the Lost River and Indian Creek.

The soil to plow depth consists of grayish-brown smooth rather heavy silt loam that becomes cloddy if cultivated when wet. The material is usually 7 to 10 inches thick, and there is little loss through erosion. It changes abruptly to a moderately friable yellowish-brown silty clay loam, which becomes very compact and tough at a depth of 15 inches. The subsoil is plastic and sticky when wet. Calcareous grayish-brown silty clay occurs at depths of 24 to 30 inches. Areas of this soil that occur farther from the White River are likely to have more friable, deeper subsoils, and the calcareous parent material lies at depths of about 45 inches.

This soil is only slightly acid and is above the average productivity for the area. A rotation of corn, wheat, and clover is usually followed, although the soil is probably best adapted to small grains and grasses. Alfalfa and sweetclover grow well, although an application of lime is generally needed. Red clover can be grown successfully without the use of lime. Corn yields about 30 bushels an acre, wheat 20 bushels, and clover hay 1½ tons. It is the common practice to apply commercial fertilizer to wheat.

McGary silt loam.—This soil is derived from assorted clays, containing a high content of lime, deposited on low benches near the mouths of all the larger tributaries to the White River. A total area of 896 acres is mapped.

The 10-inch surface soil consists of brownish-gray to gray rather heavy silt loam, which puddles and bakes under improper management. It is underlain by mottled gray and yellow silty clay loam, which grades into a very heavy tough waxy brown or yellowish-brown silty clay at a depth of 17 inches. Grayish-brown limy clay occurs at an average depth of 30 inches. Areas of this soil that occur farthest upstream are often derived from more silty deposits with less lime at a depth of about 45 inches. The subsoil is also a little more friable.

Corn, wheat, and clover are usually grown in rotation on this soil. Corn yields about 30 bushels an acre, and wheat 20 bushels. As the soil is only moderately acid, red clover can be readily grown. Owing to the heavy subsoil at a shallow depth, tile drains must be laid close to obtain best results. Alfalfa may be grown on well-drained land.

Montgomery silty clay loam.—This soil occurs on terraces near the mouths of the larger tributaries to the White River, associated with the Markland and McGary soils. It is underlain by calcareous clay. A total area of 256 acres is mapped.

The 15- to 18-inch surface soil consists of dark-gray silty clay loam, underlain by mottled gray and yellow tough waxy silty clay. Limy clay is present at depths of 5 feet or more. The soil is neutral in reaction.

Although the soil is plastic and sticky when wet, a granular seedbed may be prepared easily if the soil is worked under proper moisture conditions. Under cultivation a loose granular soil mulch develops. Corn yields about 50 bushels an acre, but in favorable years the yield is much higher. Wheat is susceptible to some winterkilling, especially when water stands on the soil, and it is likely to lodge before harvest. When fertilizer is applied to the land, wheat yields about 22 to 25 bushels an acre. Red clover can be grown successfully.

Included with Montgomery silty clay loam is an inextensive soil much like Lyles silty clay loam that would have been mapped separately if the area were larger. It is best suited to corn, the yield of which averages about 50 bushels an acre. As this inclusion covers only a few small areas, the agriculture is determined by the surrounding soils.

SOILS OF THE OVERFLOWED STREAM BOTTOMS

Most of the stream bottoms of Martin County are level, but the land adjacent to the stream courses in many places is somewhat undulating and natural drainage is better than on those areas some distance from the stream courses. The soils of the overflowed stream bottoms are placed in the following subgroups on the basis of the source of parent material: (1) Soils consisting of nonacid alluvium, and (2) soils consisting of acid alluvium.

SOILS CONSISTING OF NONACID ALLUVIUM

The alluvium of streams coming from the glaciated areas is either neutral or only slightly acid in reaction. The well-drained soils of this alluvium include Genesee silt loam; Genesee silt loam, high-bottom phase; Genesee loam; Genesee loam, high-bottom phase; Genesee fine sandy loam; and Genesee fine sandy loam, high-bottom phase. The high-bottom phases of the various soils are on slightly higher levels and are less frequently flooded than the normal soils. They are also somewhat more acid in reaction, although not sufficiently so to require lime for producing alfalfa and red clover. Although the Genesee soils are among the most productive of the entire county, they are somewhat less productive than Genesee soils farther north where the proportion of sandstone and shale fragments is less. Their usefulness is limited somewhat by the fact that they are subject to frequent floods in the spring. They are well suited to corn and produce fairly high yields without fertilization. Eel silty clay loam and Eel silt loam are level and imperfectly drained, but artificial drainage is not necessary for the production of corn and most other crops. Shoals silt loam and Shoals silty clay loam are more slowly drained than the Eel soils and are improved

498445—40——5

by artificial drainage. These soils generally occur throughout the White River Valley on broad, elongated flats at a slight elevation above the Genesee soils.

The system of farming on the sweet bottom soils consists dominantly of growing corn, which is usually grown continuously for a number of years on the same land. Corn is the principal crop because the hazard from overflow is lower than with fall-seeded crops and there is a good supply of moisture, organic matter, and nitrogen in the soil. Floods usually occur during the early spring months before the corn is planted. Corn yields from 30 to 60 bushels an acre, and wheat about 15 bushels. Alfalfa, sweetclover, and red clover give high yields if the crop escapes overflow. Tame-grass hay, such as timothy, also makes excellent yields, especially on the less well drained soils. These soils are locally referred to as sycamore land. Many farmers on these soils are now rotating crops to diversify the farming system and increase the corn yields. Rotations that have been followed are (1) corn, corn, oats, wheat, sweetclover; (2) corn, wheat, soybeans; and (3) corn, wheat, and red clover.

These soils were originally covered with a good stand of sycamore, elm, ash, soft maple, cottonwood, tuliptree, and beech. Less than 5 percent of the land is now timbered.

Genesee silt loam.—This is the most extensive soil of the sweet alluvial group. A total area of 2,752 acres is mapped. It occurs along the valley of the East Fork of the White River. The 10- to 15-inch surface soil is light-brown mellow silt loam, which is easily kept in a granular condition under tillage because of the organic content and the moderate quantity of very fine sand. A few small areas having a slightly heavier surface soil have been included. Underneath this is a slightly lighter brown to yellowish-brown friable subsoil ranging from silt loam to light silty clay loam. Seams or strata of fine sand, which were deposited during former periods of overflow, may occur throughout the subsoil. Corn, the principal crop, yields about 40 bushels to the acre. It is usually grown without the use of commercial fertilizer. Other farm crops suitable to this section may be grown on this soil. Special cash crops such as tomatoes, cabbage, and sweet corn may be grown successfully.

Genesee silt loam, high-bottom phase.—This phase has a total area of only 640 acres. It occurs at an elevation of 2 to 5 feet above the typical Genesee silt loam and consequently is not flooded so frequently. This soil is similar to Genesee silt loam, although a few areas have developed slight acidity and have slightly heavier subsoils. It is occasionally used as building sites for farmsteads.

Genesee loam.—This soil type has a more mellow surface soil than Genesee silt loam, owing to a larger proportion of sand, although sufficient silt and clay is present to make the soil mass quite coherent. The surface soil is brown and grades into a lighter yellowish brown friable clay loam or silty clay loam subsoil at a depth of 10 to 15 inches. As it occurs in natural levee positions along the river throughout the valley, it is less frequently flooded, and there is greater diversification of crops. Corn occupies a smaller part of the land, and alfalfa is more extensively grown. The yields of most crops are comparable to those on Genesee silt loam. A total area of 1,280 acres is mapped.

Genesee loam, high-bottom phase.—Several small areas of the high-bottom phase of Genesee loam are mapped in the White River Valley. This soil occurs on slightly higher positions than the typical Genesee loam, consequently it is subject to less frequent overflow. Slight acidity has developed in some areas, and the subsoil may be a little heavier, but in most respects it is similar to Genesee loam in soil character and crop adaptation.

Genesee fine sandy loam.—This soil type occurs on natural levees on the higher ground bordering the river, principally near the mouth of Boggs Creek. The 10- to 15-inch surface soil is loose light-brown fine sandy loam that coheres slightly when wet. It is underlain by loose lighter brown or yellowish-brown loamy fine sand to loam, which in some places is slightly calcareous and grayish within a depth of 3 feet. A total area of 448 acres is mapped.

Corn is the principal crop grown, but the yields may be expected to be slightly lower than on Genesee loam because of the more limited supply of moisture. Although alfalfa is grown in very few places, this soil is probably better suited to alfalfa than to any other crop. A few areas are in pasture and wheat.

Genesee fine sandy loam, high-bottom phase.—This phase occurs above the mouth of Boggs Creek in the White River Valley. A total area of 128 acres is mapped. This soil is similar to the typical soil in crop adaptation, use, and soil character. As it occurs at slightly higher levels, it is not often flooded.

Eel silty clay loam.—This soil has a brownish-gray, smooth, friable surface soil when the soil is wet. Owing to its heavy texture, clods form readily if the land is tilled when wet. At a depth of 10 to 18 inches the surface soil grades into brownish-gray heavy tough silty clay loam that is mottled gray and yellow below a depth of 20 inches. Because the soil occupies low areas, it is subject to frequent overflow, and water also stands for longer periods of time, causing considerable crop damage. The soil occurs in narrow swales in association with the Genesee soils. Corn that is planted early may be drowned out and have to be replanted. Yields of corn are from 45 to 50 bushels an acre. Owing to danger of winterkilling and overflow, this soil is not well suited to wheat. Soybeans may be expected to yield 20 to 25 bushels of beans or 3 tons of hay to the acre.

A total area of 1,408 acres is mapped. A small part of the area occurs at slightly higher levels than the rest of the soil.

Eel silt loam.—This soil type differs from Eel silty clay loam principally in the smaller amount of clay in the surface soil and in the subsoil; consequently it may be more easily kept in good physical condition. This is especially true of a few areas having a moderate content of sand that have been included with this soil. The crop adaptations and yields are similar to those of Eel silty clay loam.

Shoals silt loam.—The 10-inch surface soil of Shoals silt loam is brownish-gray smooth silt loam that dries to a gray or light gray. The subsoil is slightly mottled brown and gray silt loam to a depth of 18 inches, where it becomes rust stained. When dry, this layer consists of loose, powdery silt, but in many places it is slightly heavier. Corn, the principal crop grown, yields about 30 bushels an acre.

The most extensive area of this soil lies near the mouth of the Lost River, although the type also occurs throughout the White River Valley below the Devils Elbow. The soil is level and lies at approximately the level of or slightly higher than the Genesee soils. It is nearly neutral in reaction. A total area of 1,408 acres is mapped.

Shoals silty clay loam.—This soil occurs in low, broad swales that are frequently flooded. A few areas occur on slightly elevated flats. The surface soil is brownish gray to bluish gray when moist and is medium gray when dry. When wet, it is moderately plastic and heavy. If cultivated when wet, it forms very hard clods. At a depth of 10 inches the subsoil is mottled gray and yellow tough silty clay or silty clay loam. Corn, the principal crop grown, averages from 30 to 35 bushels an acre. A total area of 576 acres is mapped.

SOILS CONSISTING OF ACID ALLUVIUM

The agriculture of the rolling freestone upland is very closely connected with and intimately dependent upon the associated soils of the bottoms. The best cropland on many farms is found on the soils of the bottom lands. Although many of the small narrow bottoms in their upper stream courses have been allowed to remain in timber, 85 to 90 percent of the wider bottoms have been brought under cultivation. A variety of crops are grown, but corn is the principal one and occupies about 20 percent of the area of these bottoms. Wheat is grown on 10 percent or more of the area. Crops are harvested on approximately 50 percent of the acid bottom soils, and the rest of the untimbered land consists of low-grade pasture and idle land. The vegetative cover on these old pastures consists largely of broomsedge. Because of the small number of livestock, many of these pastures are reverting to timber by natural restocking through the growth of sprouts. This is particularly true of the Pope soils, which occupy the narrow bottoms of the upper stream courses.

As a group these soils are strongly acid. They are largely derived from sediments washed from the strongly acid soils of the sandstone, siltstone, shale, and Illinoian till areas. The content of nitrogen and organic matter is relatively low. Lime is used to only a limited extent, chiefly to grow alfalfa and sweetclover. Some of the better farmers are attempting to improve yields by following a rotation of corn, wheat, and clover. Lime is also needed for the most successful growth of red clover.

In the valleys of Indian Creek and the Lost River the soils are usually less acid because the sediments are derived in part from the limestone soils to the east in Lawrence and Orange Counties. They are browner in color and contain a slightly higher proportion of nitrogen and organic matter. These soils have a higher average productivity than those derived entirely from freestone.

Drainage conditions are best in the narrow upper stream courses and become progressively poorer as the valleys widen and the gradient declines. The well-drained slightly undulating soils are Pope silt loam, Pope loam, and Pope gravelly loam. Most of the Pope soils occur in the narrower valleys near stream heads and along the courses of the streams where the land is slightly higher than it is farther back. Philo silt loam and Philo loam are fairly well drained. Stendal silt loam and Stendal silty clay loam are slowly drained. In the lowest parts of the alluvial lands drainage is very slow and soils are wet for the greater part of the year except where they are artificially drained. Atkins silt loam and Atkins silty clay loam occur in these areas.

Pope silt loam.—This is the most extensive well-drained acid bottom soil. It is the principal soil of all the small drainageways. The larger areas are in the upper courses of Boggs, Turkey, and Sulphur Creeks. A total area of 10,560 acres is mapped.

The surface soil is light-brown to grayish-brown friable silt loam, which in some places contains considerable fine sand. At a depth of 10 to 15 inches this material grades into a lighter brown slightly gritty silt loam that in some places contains considerable gravel at a depth of 30 inches or more. Nearly everywhere the soil is strongly acid, although a few areas in the valleys of Indian Creek and the Lost River are only slightly acid. In such places the entire soil mass is browner and has a slightly higher content of organic matter. In these valleys the soil texture is a little heavier, some areas approaching a silty clay loam.

Pope silt loam is a moderately productive soil. About 30 percent or more of it is under cultivation, and corn and wheat are the principal crops. Corn yields about 30 bushels and wheat 12 bushels to the acre. Alfalfa is grown to some extent where lime has been applied to the land. A large part of the soil either is timbered or is in low-grade pasture land. The narrow bottoms and the rather limited moisture supply limit the more extensive use of this soil. The part of this soil that occurs in a limestone valley is more intensively used, owing to its higher level of productivity, but this small area is not typical Pope silt loam. Here the average yield of corn is about 45 to 50 bushels and wheat 15 to 18 bushels.

Pope loam.—The larger areas of Pope loam occur in natural levees along the Lost River and Indian Creek. There is also sufficient sand in many areas of Pope silt loam to produce a loam texture, but the areas are too small to map separately. A total area of 384 acres is mapped.

The 10- to 15-inch surface soil consists of light-brown mellow loam or very fine sandy loam containing enough sand to maintain a friable consistence under cultivation. The subsoil consists of light-brown or yellowish-brown loam or silt loam. This soil is moderately acid. Where it lies in larger bottoms there is less crop loss through overflow. Owing to its occurrence in narrow belts, its use is frequently determined by the associated less well-drained soils. Corn, wheat, and hay are the principal crops. Corn yields about 35 bushels an acre. Some areas in the valleys of the Lost River and Indian Creek are somewhat browner, less acid, and more productive.

Pope gravelly loam.—This soil occurs in the narrow bottoms at the headwaters of the sharp V-shaped valleys of the sandstone and shale upland. The 10-inch surface soil is brown and ranges from a gravelly loam to a silt loam. The content of gravel or flat brown sandstone fragments constitutes 10 to 60 percent of the soil mass, the largest proportion being in the subsoil below a depth of 15 to 20 inches. The subsoil is light brown; the moisture-holding capacity is very low; and crops usually suffer from drought during the dry hot summer months. Drainage is excessive, and the contents of organic matter and plant nutrients are very low; therefore only a small part of this soil is cropped. Corn and wheat are grown on 10 percent of the soil, 40 percent of it consists of low-grade pasture land, and the rest is timbered. A total area of 1,216 acres is mapped.

Philo silt loam.—This is the most extensive alluvial soil in the county. It is an imperfectly drained soil intermediate between the well-drained Pope silt loam and the more slowly drained Stendal silt loam. A total area of 10,816 acres is mapped.

The surface soil is smooth, mellow, and grayish brown to a depth of 10 to 15 inches, where it grades into a slightly lighter brown or brownish-yellow subsoil containing less organic matter. At a depth of about 18 inches the silty subsoil is mottled gray and yellow. The subsoil is generally slightly heavier than the surface soil. The soil is strongly acid, but in the valleys of Indian Creek and the Lost River, because of the influence of limestone, the acidity of the soil varies from place to place, and in some areas it is nearly neutral in reaction. There is some tendency in these valleys and in a few small areas elsewhere for this soil to be slightly heavier than a silt loam.

Crops do not generally suffer from the imperfect drainage, and in most years the moisture supply is adequate for large yields of crops. Corn, the principal crop, is grown on nearly one-fourth of the soil and yields about 35 bushels an acre. Where a systematic crop rotation is followed, including the use of lime and the growth of legumes, yields frequently average nearly 50 bushels an acre. Commercial fertilizer is used only to a limited extent on corn. Wheat, the second crop in importance, is grown on about 15 percent of the soil. Commercial fertilizer is generally used. The average yield is about 15 bushels an acre. Because of the acid conditions and the low level of crop yields on the bottom lands, the more progressive farmers are beginning to recognize the value of crop rotation, including the growth of legumes, in building up soil fertility. On unlimed land timothy and soybeans are the principal hay crops. This is one of the more productive soils of the county, as well as the one most responsive to good management.

Philo loam.—This soil occurs in scattered areas in the Lost River Valley and elsewhere in the small bottom lands. A total area of 64 acres is mapped. It differs principally from Philo silt loam in having sufficient sand in the surface soil to prevent the soil from becoming sticky and forming hard clods. Crop adaptations and yields are similar to those of Philo silt loam in the small bottom lands.

Stendal silt loam.—The larger areas of Stendal silt loam occur in the valleys of the Lost River and Boggs and Sulphur Creeks. This type also occurs as the slowly drained soil in the wider bottoms of streams throughout the county. A total area of 6,656 acres is mapped.

The surface soil is brownish-gray to grayish-brown smooth silt loam that becomes quite gray when dry. Under improper handling it puddles and bakes, forming hard clods when dry. A few areas, principally in the Lost River Valley, contain sufficient sand to produce a mellow surface soil. The subsoil is mottled gray and yellow or brown silty clay loam. Brown iron and manganese concretions are numerous on the surface, and blotches and stains are usually found in the subsoil.

This soil is used to about the same extent as Philo silt loam, although the crop yields are somewhat lower. A larger part of timber and low-grade pasture land occurs on the more extensive areas of the type, reflecting the poorer drainage conditions. Yields of crops depend largely on the season and the quantity of rainfall. In dry years the yields are good. Artificial drainage is difficult because of the low position, but drainage is frequently improved by plowing in narrow lands with dead furrows acting as surface drains. Corn and wheat are the principal crops, although the yields are usually low. The lowest, wettest areas are generally timbered. The forests consist largely of pin oak, swamp white oak, ash, elm, red maple, beech, and gum.

Stendal silty clay loam.—A few small areas of this soil having a total area of 64 acres are mapped. The largest area is near the Orange County line in an abandoned ox bow of the Lost River. The soil has a heavy slightly brownish gray silty clay loam surface soil and a mottled gray and yellow tough waxy silty clay subsoil. General farm crops are occasionally grown, but most areas are probably best suited to timber.

Atkins silt loam.—This soil occurs in the lowest, most poorly drained parts of the bottom lands and is generally surrounded by areas of Stendal silt loam. Areas of this soil occur in the valleys of Sulphur Creek, Boggs Creek, Haw Creek, Barn Run, and Sugar Creek. A total area of 576 acres is mapped.

The surface soil is light gray and usually has brown turkey-shot gravel scattered over and throughout it. It usually puddles and bakes when it dries. The underlying subsoil at a depth of 10 inches is bluish-gray silt loam to silty clay loam with numerous rusty-brown blotches and stains.

About 30 percent of this soil has been kept in timber—a use to which it is best suited because of the poor drainage. The smaller areas are planted principally to corn, wheat, and hay as weather conditions permit. Corn yields about 20 bushels an acre.

Atkins silty clay loam.—This soil occurs in a large area of 64 acres near the Orange County line in an old abandoned channel of the Lost River. The soil is similar in character to Atkins silt loam except that it is tough and heavy. It is entirely timbered.

PRODUCTIVITY RATINGS

In table 6 the soils of Martin County are listed alphabetically and crop productivity indexes or ratings are assigned for each of the important crops according to two distinct levels of farm management.

TABLE 6.—*Productivity ratings of soils in Martin County, Ind.*

Soil	Crop productivity index [1] for—																					General productivity grade [4]		Type of farming, principal crops, or land uses
	Corn (100=50 bu.)		Wheat (100=25 bu.)		Oats (100=50 bu.)		Soybeans (100=25 bu.)		Mixed timothy and red clover (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu.)		Vegetables [2]		Apples [2]		Pasture [3] (100=100 cow-acre-days)			
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	B	
Atkins silt loam (drained)	40	60	30	40	20	30	40	50	60	80								20				6	5	General farming
Atkins silt loam (undrained)	20						30		40												30	8		Pasture and timber.
Atkins silty clay loam (drained)	20	30	20	30			40	50	40	70											40	7	6	General farming
Atkins silty clay loam (undrained)	10		10				20		20												20	9		Timber
Bartle silt loam (drained)	60	90	50	80	50	60	50	70	60	70	20	50		15	25	50	20	40			40	5	3	General farming
Bartle silt loam (undrained)	40		30		30		40		40												30	7		More hay and pasture, less grain
Cincinnati silt loam	40	70	50	80	50	70	50	70	30	60	10	60		30	25	50	30	50	50	60	30	6	3	General farming
Cincinnati silt loam, eroded phase	10	20	20	30	10	20	20	30	20	30		10		10							20	9	8	General farming and pasture, better suited for pasture or forestry
Cincinnati silt loam, gullied phase																					20	10		Poorly suited for crops, grasses, or trees, but the areas should be reclaimed for forestry purposes
Cincinnati silt loam, shallow phase	40	80	40	70	50	70	50	70	30	60	10	60		30	20	40	30	50	40	50	30	6	4	General farming
Cincinnati silt loam, steep phase									20	30										30	20	8	8	Primarily suited to forestry
Corydon silty clay loam									20	30			10	15							40	9	8	Well suited to pasture or forestry
Dubois silt loam (drained)	40	80	40	80	50	60	60	70	60	70	10	50		15	25	50	20	40			40	5	3	General farming
Dubois silt loam (undrained)	40		30		30		40		40												30	7		More hay and pasture, less grain
Eel silt loam (protected by levee and drained)	80	100	60	70	50	60	70	90	80	100	30	60										3	1	Corn is the principal crop, followed by soybeans
Eel silt loam (unprotected by levee and undrained)	70		30		10		60		70		10										90	5		Do
Eel silty clay loam (protected by levee and drained)	90	100	60	80	50	70	70	90	90	100	30	60										3	1	Do
Eel silty clay loam (unprotected by levee and undrained)	80						60		80												90	4		Do

498445—45——6

Elkinsville silt loam	50	80	50	85	50	60	60	70	40	70	10	60		40	30	60	30	50	40	50	30	5	3	General farming
Frederick silt loam	40	80	40	85	40	60	40	60	40	70	40	60		30	25	50	30	50	30	50	60	6	4	General farming, well suited to wheat and pasture
Frederick silt loam, eroded phase	10		15						20	30											20	9	8	General farming and pasture; well suited to Kentucky bluegrass
Frederick silt loam, slope phase									20	30											40	9	8	General farming, pasture, and timber, well suited to Kentucky bluegrass and forestry
Genesee fine sandy loam (protected by levee)	60	80	50	60	40	50	70	80	40	60	30	40	50	55	40	60	40	50				5	3	Principal crop is corn, higher lying areas comparatively well suited to alfalfa
Genesee fine sandy loam (unprotected by levee)	60		40		30		60		30		20		40		35		40				70	6		Principal crop is corn
Genesee fine sandy loam, high-bottom phase	60	80	50	70	40	50	60	80	30	40	20	40	50	55	40	60	40	50			70	5	3	Principal crop is corn, comparatively well suited to alfalfa
Genesee loam (protected by levee)	80	90	50	70	50	70	80	100	90	100	50	60	75	80	40	60	60	70			100	3	1	Principal crop is corn, higher lying areas comparatively well suited to alfalfa
Genesee loam (unprotected by levee)	70		40		40		70		80		40		30		35		50				90	4		Principal crop is corn
Genesee loam, high-bottom phase	70	100	60	80	50	70	70	100	50	90	50	70	50	55	40	60	60	70			100	4	1	Principal crop is corn, higher lying areas comparatively well suited to alfalfa
Genesee silt loam (protected by levee)	90	100	50	70	50	70	80	100	90	100	50	60	75	80	40	60	60	80			100	3	1	Do
Genesee silt loam (unprotected by levee)	80		40		40		70		90		40		25		35						90	3	1	Principal crop is corn
Genesee silt loam, high-bottom phase	80	100	60	80	50	70	70	100	90	100	60	80	30	40	40	60	60	80			100	3	1	Do
Gibson silt loam	50	80	50	80	50	70	50	70	30	60	10	60		30	25	50	30	50	40	50	30	6	3	General farming
Haubstadt silt loam	50	80	50	80	40	60	50	80	50	60	10	60		30	25	60	30	50	30	40	30	5	3	Do
Johnsburg silt loam (drained)	50	70	40	70	40	50	50	60	40	70	10	50		15	25	60	20	40				6	4	Do
Johnsburg silt loam (undrained)	30		30		20		40		20												20	7		More hay and pasture, less grain
Markland silt loam	50	80	60	90	30	50	50	80	50	75	40	70	30	55	25	50	20	30		20	50	5	2	General farming, 3-year rotation of corn, wheat, and clover
Martinsville loam	60	80	60	70	40	50	60	70	40	60	30	60	10	55	30	60	50	70	40	50	60	5	3	Principal crops are corn and wheat
McGary silt loam (drained)	50	70	50	80	30	40	50	60	40	50	40	60		30	25	40	20	30			40	6	4	General farming
McGary silt loam (undrained)	40		40		10		40		30		20										30	7		More hay and pasture, less grain
Montgomery silty clay loam (drained)	80	100	80	100	60	70	90	100	80	100	60	90		50	40	70	60	80			100	2	1+	General farming, 3 year rotation of corn, wheat, and mixed hay
Montgomery silty clay loam (undrained)	50		60		20		50		70		40				25		40				70	5		More hay and pasture, less grain
Muskingum siltl oam, colluvial phase	30	50	40	60	40	60	30	40	40	60	10	50		15	20	40	30	50		10	20	7		General farming, pasture
Muskingum stony silt loam																					20	10		Primarily suited to forestry.

See footnotes at end of table.

TABLE 6.—*Productivity ratings of soils in Martin County, Ind.*—Continued

Soil	Crop productivity index [1] for—																					General productivity grade [4]		Type of farming principal crops, or land uses
	Corn (100=50 bu)		Wheat (100=25 bu)		Oats (100=50 bu)		Soybeans (100=25 bu)		Mixed timothy and red clover (100=2 tons)		Red clover (100=2 tons)		Alfalfa (100=4 tons)		Potatoes (100=200 bu)		Vegetables [2]		Apples [2]		Pasture [3] (100=100 cow-acre-days)			
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	B	
Otwell silt loam	50	80	50	80	50	60	60	80	40	70	10	60	----	40	25	60	30	50	40	50	30	5	3	General farming
Otwell silt loam, eroded phase	20	40	----	20	----	20	----	20	20	30	----	----	----	----	----	----	----	----	20	30	10	8	7	General farming, pasture, and timber
Otwell silt loam, slope phase	----	20	----	20	--	20	----	20	20	30	----	20	----	----	----	----	----	----	---	30	20	9	8	Do
Parke silt loam	50	70	50	80	50	70	50	80	30	70	10	70	----	55	25	50	40	50	60	70	30	6	3	General farming
Pekin silt loam	50	80	50	80	40	60	50	70	50	60	10	60	----	30	25	60	30	50	30	40	30	5	3	Do
Philo loam (drained)	70	90	50	60	40	60	60	70	70	80	20	60	----	25	20	40	40	60	----	----	50	4	3	Principal crops are corn, soybeans, and hay
Philo loam (undrained)	60	----	30	----	20	----	40	----	50	----	----	----	----	----	----	----	30	----	----	----	40	6	----	Do.
Philo silt loam (drained)	70	90	50	60	40	60	60	70	70	80	20	60	----	25	20	40	40	60	----	----	50	4	3	Do
Philo silt loam (undrained)	60	----	30	----	20	----	40	----	50	----	----	----	----	----	----	----	30	----	----	----	40	6	----	Do
Pope gravelly loam	40	60	30	50	40	50	40	50	40	50	----	30	----	30	20	50	30	50	---	----	30	7	5	Principal use is for pasture and timber
Pope loam	50	80	40	60	40	60	50	60	50	70	----	40	----	30	20	50	30	50	----	----	30	6	4	Principal crops are corn, soybeans, and hay.
Pope silt loam	60	80	50	60	40	60	50	60	50	70	----	50	---	30	25	50	40	60	----	----	40	6	4	Do
Princeton fine sandy loam	40	60	40	[5]50	30	40	40	50	20	40	----	30	40	55	25	60	50	[6] 100	50	[7] 70	20	6	4	General farming with alfalfa; well suited to melons, tomatoes, sweetpotatoes, and peaches
Princeton fine sandy loam, slope phase.	10	20	----	20	----	----	30	40	----	----	----	----	30	50	----	----	----	----	40	[7] 60	20	8	6	Moderately steep slopes may be used for special crops and alfalfa Commonly used for general farming and timber
Ragsdale loam (drained)	90	100	70	90	70	80	80	100	90	100	70	80	25	50	35	60	70	90	----	----	90	2	1	General farming, 3-year rotation of corn, wheat, and mixed hay
Ragsdale loam (undrained)	50	----	30	----	40	----	50	----	60	----	40	---	----	----	30	----	30	----	----	----	70	6	----	More hay and pasture; less grain
Robinson silt loam (drained)	50	90	40	80	50	60	60	70	60	70	10	50	----	15	20	40	20	30	----	---	40	5	3	General farming
Robinson silt loam (undrained)	30	----	20	----	20	---	40	----	40	----	----	----	----	----	----	----	----	----	----	----	30	7	----	More hay and pasture, less grain
Rough stony land (Muskingum soil material)	----	----	----	----	----	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----------	10	----	Primarily suited to forestry

Shoals silt loam (protected by levee and drained)	70	90	40	60	50	60	70	90	90	100	40	60										3	2	Principal crop is corn, some wheat, soybeans, and hay
Shoals silt loam (unprotected by levee and undrained).	60		20		20		60		80		20										90	4		More hay and pasture, less corn.
Shoals silty clay loam (protected by levee and drained).	70	90	40	60	50	60	70	90	90	100	40	60										3	2	Principal crop is corn, some wheat, soybeans, and hay
Shoals silty clay loam (unprotected by levee and undrained)	60		20		20		60		80		20										90	4		More hay and pasture, less corn
Stendal silt loam (drained)	50	70	40	50	30	40	50	60	60	70						40	20	40			60	5	4	Principal crops are corn, hay, and soybeans.
Stendal silt loam (undrained)	30		20		10		40		50												50	7		Better suited to timber and pasture than to crops
Stendal silty clay loam (drained).	40	50	20	30	20	30	40	50	50	60											40	6	5	Principal uses are for corn, hay, and pasture
Stendal silty clay loam (undrained)	30						30		40												30	7		Principal uses are for corn, hay, and pasture, better suited for forestry
Tilsit silt loam	40	80	40	80	40	60	40	60	50	70	10	60		25	25	50	30	50	30	40	30	6	3	General farming
Vigo silt loam (drained)	40	70	40	70	40	60	50	70	40	70	10	50		15	20	40	20	40				6	3	Do.
Vigo silt loam (undrained)	40		30		30		40		20												30	7		Do
Wellston silt loam	30	50	30	50	30	50	40	50	30	50	10	50		25	20	40	20	30	10	20	30	7	5	General farming, pasture, and timber.
Wellston-Muskingum complex									20	30											20	9	8	Do
Zanesville silt loam	40	80	40	80	40	60	40	50	40	60	10	70		25	25	50	30	50	30	40	30	6	4	General farming, pasture, and timber
Zanesville-Wellston silt loams, eroded phases	10		15					10	20	30											20	9	8	General farming and pasture, best suited to pasture or timber
Zanesville-Wellston silt loams, gullied phases.																					20	10		Poorly suited for crops, grasses, or trees, but the areas should be reclaimed for forestry purposes
Zanesville-Wellston silt loams, slope phases				20					20	30		20								10	20	9	8	Primarily suited to forestry

[1] The soils are given indexes that indicate the approximate average production of each crop in percentage of the standard of reference The standard represents the approximate yield obtained without the use of amendments on the more extensive and better soil types of those regions of the United States in which the crop is most widely grown The indexes are based on estimates of yields, as specific yield data are very limited. Blank space indicates that the crop is not commonly grown on the particular soil type The indexes in the column headed A under each crop refer to yields that may be expected at a comparatively low level of management that includes only infrequent use of legumes and manure; the indexes in column B refer to yields that may be expected with improved practices of soil management that include the commercial fertilizer, or lime; use of manure, commercial fertilizers, lime, legumes in the rotation, and green manures Actual practices and yields in Martin County vary from one column to the other

[2] These indexes are only locally comparative, as they do not refer to specific yield standards, although those of apples probably approximate indexes based on 100=300 bushels For vegetables they are very general, as no specific vegetables are designated

[3] Cow-acre-days represents the product of the number of animal units carried per acre and the number of days the animals are grazed without injury to the pasture. For example, the soil capable of supporting 1 animal unit per acre for 360 days of the year rates 360, whereas another soil capable of supporting 1 animal unit on 2 acres for 180 days rates 90.

[4] The general productivity grade indicates the comparative general productivity of the soils for the common crops Refer to the text for further explanation

[5] Rye is also commonly grown on Princeton fine sandy loam and yields slightly more than wheat

[6] Melons, sweetpotatoes, and tomatoes are the principal truck crops on Princeton fine sandy loam.

[7] Peaches are more common than apples on Princeton fine sandy loam and the slope phase

The rating compares the productivity of each of the soils for each crop with a standard of 100. This standard index represents the approximate average yield obtained under modal management on the more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive for the specified crop as is the soil with the standard index. The standard yield for each crop shown in table 6 is given at the head of each respective column. Soils given extra amendments, such as lime and commercial fertilizers, or special practices, such as irrigation, and unusually productive soils of small extent, may have productivity indexes of more than 100 for some crops.

The crop indexes in table 6 are estimates of yields that are based primarily on observations in the field and on interviews with farmers, members of the staffs of the State experiment station and the College of Agriculture, and others who have had experience in the agriculture of the county and State. As such, they are presented only as estimates of the average production over a period of years. It is realized that these estimates may not apply directly to specific tracts of land for any particular year, inasmuch as the soils as shown on the map vary somewhat, management practices differ slightly from farm to farm, and climatic conditions fluctuate from year to year.

The indexes in column A under each crop heading are estimates of the yields to be expected with only the infrequent use of manure, commercial fertilizer, lime, or legumes in the rotation. The indexes in column B are estimates of yields to be expected under the more intensive types of management, including the use of commercial fertilizers, lime, manure, legumes in the rotation, and green manures. Wheat commonly receives from 100 to 200 pounds of 2–12–6 or similar fertilizers. Two to four tons of lime is commonly applied, depending on the specific requirements of the soils in question, for the establishment of legumes in the rotation.

Two sets of indexes are given to the soils with poor or imperfect natural drainage, one for the artificially drained condition and one for the natural condition. Likewise, two sets of indexes are shown for the bottom lands that are subject to periodic overflow, one for the protected condition and one for the unprotected condition.

The principal factors affecting the productivity of land are climate, soil (including the many physical, chemical, and biological characteristics), slope, drainage, and management (including the use of amendments). No one of these factors operates separately from the others, although some one may dominate. In fact the factors listed may be grouped simply as the soil factor and the management factor, since slope, drainage, and most of the aspects of climate may be considered as characteristics of a given soil type and because the soil type occupies specific geographical areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available summation of the associated factors, and therefore they are used where available.

General productivity grade numbers are assigned in the column headed "General productivity grade." As prepared for most productivity rating tables, this grade is based on a weighted average of the indexes for the various crops, the weighting depending upon the relative acreage and value of the crops. If the weighted average is between 90 and 100, the soil type is given a grade of 1; if it is between 80 and 90, a grade of 2 is given, and so on.[6] In Martin County no precise mathematical procedures were followed in establishing the general productivity grade. The grade numbers were assigned arbitrarily by visual inspection of the indexes, particularly those for corn, wheat, soybeans, and mixed hay. On the soils with definite crop adaptions, such as the Genesee soils for corn, more consideration was given to the particular crop index. Since it is difficult to measure mathematically or otherwise either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops, too much significance should not be given to the exact general productivity grade number.

Information on the prevailing types of farming, principal crops, or land uses is given in the right-hand column of the table.

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

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

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the soil materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent soil material; (2) the climate under which the soil material has accum-

[6] The grade number 1+ is used for soils with a weighted average above 100

TABLE 7.—*Key to the principal soils of Martin County, Ind.*

SOIL CHARACTERISTICS IN RELATION TO GREAT SOIL GROUPS

Item	Lithosols (shallow soils)	Gray-Brown Podzolic soils		Planosols			Half-Bog (glei) soils, HMU horizon designation [1]
	VI	V	IV	III [2]	II	I	VIII
Color of surface soil	Brownish gray and dark brown	Light brown	Grayish brown	Brownish gray	Light brownish gray	Light gray	Dark gray.
Color of subsoil	Yellow to yellowish brown	Light reddish brown.	Yellowish brown	Pale yellow, mottled below 18 inches	Mottled below 10 inches	Rust-stained gray.	Gray and yellow mottled below 15 inches
Relief (upland soils)	Steep	Rolling to level	Rolling to undulating.	Gently sloping or undulating	Undulating to level	Level	Depressed and level
Surface drainage	Very rapid	Rapid	Rapid	Medium	Slow	Very slow	Waterlogged
Internal drainage	Medium	do	Medium	Slow	Very slow	do	Do

SOILS OF THE UPLANDS AND TERRACES [3]

Item	VI	V	IV	III	II	I	VIII
Soils of the uplands Parent material from—							
Sandstone, siltstone, and shale	Wellston-Muskingum complex, Muskingum stony silt loam (AC)		Zanesville silt loam (AB(X)YC)	Tilsit silt loam (ABXYC).	Johnsburg silt loam (A(B)XYC)		
Pennsylvanian and Chester (sandstone and shale) formations	Rough stony land (Muskingum soil material) (AC)		Wellston silt loam (ABC), Muskingum silt loam, colluvial phase (A(B)C)				
Mitchell and Chester (limestone formations)	Corydon silty clay loam (A(B)C).		Frederick silt loam (ABXYC)				
Illinoian till (calcareous)		Parke silt loam (ABYC).	Cincinnati silt loam (AB(X)YC)	Gibson silt loam (ABXYC)	Vigo silt loam (A(B)XYC)		
Illinoian till (shallow and leached)			Cincinnati silt loam, shallow phase (on sandstone)(AB(X)YC)				
Sandy wind-blown materials.			Princeton fine sandy loam (ABYC)				Ragsdale loam (HMU)

See footnotes at end of table

Soils of the terraces Parent material from—							
Acid slack-water deposits of former lakes	....	....	Otwell silt loam (ABYC)	Haubstadt silt loam (ABXYC)	Dubois silt loam (A(B)XYC).	Robinson silt loam (AXYC)	
Acid alluvial deposits.	....	....	Elkinsville silt loam (ABYC);	Pekin silt loam (AB(X)YC)	Bartle silt loam (ABXYC).	....	
Calcareous slack-water clay, shallow to lime	....	....	Markland silt loam (ABC)	....	McGary silt loam (ABC)	....	Montgomery silty clay loam (HMU)
Calcareous, stratified silt and sand with some clay and gravel of Wisconsin glacial age.	....	....	Martinsville loam (ABC)	....	....	....	

ALLUVIAL SOILS[4]

Soils of the overflowed stream bottoms Parent material washed from—							
Wisconsin drift (sweet)	....	....	Genesee silt loam (DD); Genesee loam (DD), Genesee fine sandy loam (DD)	Eel silty clay loam (DD), Eel silt loam	Shoals silty clay loam (DD), Shoals silt loam (DD)	....	
Sandstone, shale, and Illinoian till (acid).	....	....	Pope silt loam (DD), Pope loam (DD), Pope gravelly loam (DD)	Philo silt loam (DD), Philo loam (DD)	Stendal silt loam (DD), Stendal silty clay loam (DD)	Atkins silt loam (DD), Atkins silty clay loam (DD)	

[1] H denotes much humus, M, modified parent material, U, underlying material

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

[3] Formulas for profiles indicate horizons represented in each soil Parentheses around individual letters denote that the horizon indicated is neither strongly nor consistently developed

[4] The alluvial soils resemble those in the columns above them only in color and drainage characteristics. They do not have B, X, and Y horizons DD represents layers of deposited material Such layers are not genetic soil horizons.

ulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material. External climate is less important in its effects on soil development than internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and the relief. The relief, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The soils of Martin County have been developed under environmental conditions characteristic of the Gray-Brown Podzolic soil region of the United States, in which the county is located.

The soils were formed under a mixed hardwood deciduous timber cover in a region of temperate climate and moderate rainfall. The mean annual rainfall is 43.53 inches, and the mean temperatures range from 32.2° in winter to 73.8° F. in summer. Most of the soils are light colored. The soil-forming process is characterized by leaching of the soluble bases, particularly the carbonates of calcium and magnesium, and the sesquioxides of iron and aluminum, the retention of silica, and the movement in suspension, and probably in solution, of the finer material by percolating water. The result is the formation of a lighter textured surface horizon (A) and a moderately compact and heavy lower horizon (B). Some of the older, more highly leached soils have one or two other horizons present, namely, X,[7] a very compact, impervious horizon with columnar structure developed below the B, and Y,[7] a more friable gritty horizon in which structure is not well developed and which is less acid and less thoroughly leached, lying between the X horizon and the unleached or only partly leached parent material or C horizon.

Climate, vegetation, parent material, time, drainage, and relief are the more important factors that have influenced soil development. The soils of nearly the entire county have been developed in place from local materials consisting of sandstone, siltstone, shale, and limestone formed during the Pennsylvanian and Mississippian geological periods. Minor areas of soil along the western border of the county have been developed from drift of the Illinoian glacial period, whereas other areas of soils in and along the East Fork of the White River outside the county are derived from materials of Wisconsin age.

Local relief and drainage conditions have also markedly influenced soil development. More than three-fourths of the total area of the soils has been developed under conditions of adequate drainage; whereas on the rest, periodic saturation prevailed. Drainage as mentioned refers to the original or natural drainage. Many wet areas were artificially drained during the occupation and development of the farm lands.

Table 7, a key to the soils of Martin County, shows the more important soil relations, such as color of surface soil and subsoil, physiography, topography, parent material, and natural drainage.

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[7] The use of X and Y to designate these horizons has been developed at the Purdue University Agricultural Experiment Station and is a special modification of the more general use of B and C.

The soils of the uplands and terraces have been placed in seven groups based on the relative moisture conditions that prevailed during the period of soil development. These groups correspond to the columns in table 7 headed by Roman numerals. The Roman numerals and the arrangement of the soils beneath them were taken from Bushnell's recent key to the soils of Indiana.[8] Certain characteristics of the soils are shown in the various columns as follows: VI, Brownish-gray and dark-brown soils on steep land with very rapid surface drainage; V, light-brown soils with rapid drainage; IV, grayish-brown soils with medium to rapid drainage; III, brownish-gray soils with slow to medium drainage, in which drainage imperfection is confined to the deeper subsoil; II, light brownish-gray slowly drained soils periodically saturated; I, light-gray very slowly drained soils, periodically saturated; and VIII, dark-gray soils almost permanently saturated.

BROWNISH-GRAY AND DARK-BROWN SOILS ON STEEP LAND WITH VERY RAPID SURFACE DRAINAGE

In the group of brownish-gray and dark-brown soils on steep land with very rapid surface drainage (column VI), several soils occur on steep slopes of 30 percent or more. The resulting soils have thin profiles in which normal A horizons have been developed, but little eluviation has occurred; consequently there is a thickened A horizon, the B is incipient or absent, and parent material occurs at shallow depths. Soils included in this group are members of the Corydon and Muskingum series.

Corydon silty clay loam is a dark-colored soil that occurs on steep slopes and is developed from limestones similar to those under Frederick soils. The solum is shallow with rock fragments in the soil mass and bedrock within 30 inches of the surface. The A horizon, 6 to 10 inches thick, consists of dark-brown silty clay loam underlain by light to pale reddish-brown silt clay. The entire profile varies from slightly acid to slightly alkaline.

Muskingum stony silt loam, the dominant member of the series, is developed from sandstone, siltstone, and shale of which a large part is hard sandstone. It occurs on slopes of 25 to 40 percent where very rapid runoff combined with the resistant parent material inhabits the formation of an illuviated B horizon, although an incipient textural B may be developed in a few places. Sandstone rock fragments are present from the surface to the bedrock, which generally occurs at a depth of 18 inches or less. In some places precipitous bluffs occur on which little or no soil has been formed. Such areas have been classified as rough stony land (Muskingum soil material).

Wellston-Muskingum silt loams is a complex of shallow Wellston silt loam and typical Muskingum silt loam, which occurs on narrow gently sloping ridge tops where the runoff is high and erosion is rapid. Depth to bedrock varies somewhat, but in most places it is approximately 18 inches.

LIGHT-BROWN SOILS WITH RAPID DRAINAGE

The group of light-brown soils with rapid drainage (column V) is represented by Parke silt loam. It is highly leached, with a well-

[8] BUSHNELL, T. M. MAP OF SOIL REGIONS AND KEY TO SOIL SERIES OF INDIANA. Ind. Agr. Expt. Sta. [2] pp. La Fayette, Ind. 1943.

developed profile, the parent material of which is of Illinoian glacial age. The relief is flat to rolling. The following profile description of Parke silt loam taken in a grassy road cut is representative of the series:

A_1. 0 to ½ inch, moderately dark brownish-gray silt loam
A_2. ½ to 10 inches, grayish-brown to brown mellow silt loam having a phylliform structure. The very thin leaflike plates shatter into small flakes.
A_3. 10 to 13 inches, pale yellowish-brown fine granular silt loam.
B_1. 13 to 18 inches, friable granular yellowish-brown silty clay loam, slightly plastic and sticky when wet.
B_2. 18 to 29 inches, friable yellowish-brown silty clay loam having a nutlike structure.
Y_1. 29 to 45 inches, more friable yellowish-brown light silty clay loam. The proportion of red gradually increases with depth, and some fine sand is present.
Y_2. 45 to 65 inches, reddish-brown clay loam.
Y_3. 65 inches +, reddish-brown loam or clay loam containing increasing quantities of gravel downward.

Some gravel may be present throughout the profile. The underlying material consists of glacial outwash and gravelly till of Illinoian age, which ranges from stratified sands and gravels to mixed sand and silt with considerable quantities of gravel. The soil material is generally acid to a depth of 10 feet or more, but the deep layers are generally calcareous. As mapped, Parke silt loam includes a few areas of soil that is more like Bainbridge silt loam.

GRAYISH-BROWN SOILS WITH MEDIUM TO RAPID DRAINAGE

The grayish-brown soils with medium to rapid drainage (column IV) have been formed on rolling land where both internal and external drainage conditions are well established. They have a fairly high proportion of clay in the solum and also in the parent material of those soils that are of glacial or water-laid origin. The soil series represented are Zanesville, Wellston, Frederick, Cincinnati, Princeton, Otwell, Elkinsville, Martinsville, and Markland.

As Zanesville silt loam is the most extensive soil, it will be described as a representative of this group. It has been developed on rolling land from fine-grained sandstone, siltstone, and shale of the Pennsylvanian and Chester formations. The following profile description was taken in a cut-over oak-hickory woods:

A_0. ½ to 0 inch, dark brownish-gray partly decomposed leafmold. Neutral.
A_1. 0 to 6½ inches, loose mellow phylliform brownish-gray silt loam with slight organic penetration in upper 2 inches Medium acid.
A_2. 6½ to 10 inches, grayish-brown silt loam, which when crushed is yellowish gray. The structure is slightly platy or phylliform. Strongly acid.
B_1. 10 to 15 inches, yellowish-brown granular light silty clay loam with a slight reddish cast due to a colloidal coating on the cleavage faces. Very strongly acid.
B_2. 15 to 30 inches, friable yellowish-brown slightly heavier silty clay loam having a nutlike structure. The lower 6 inches is more compact and slightly mottled with gray, yellow, and rusty brown. Very strongly acid.
(X). 30 to 40 inches, compact, mottled gray, yellow, and brown silty clay loam Light-gray silt caps the prismatic structural aggregates and penetrates along the cleavage planes. Extremely acid
Y_1. 40 to 52 inches, more friable mottled pale yellowish-brown silt loam with some penetration of light-gray silt along cleavage planes Very strongly acid.

Y_3. 52 to 60 inches, yellow slightly gritty silt loam containing a few shale and flat sandstone fragments overlying sandstone and shale rock. Strongly acid.

The principal variation within the profile is in the depth to rock, which ranges from 3 to 6 feet or more. In the shallow variety the claypan (X) may be more friable and pervious to moisture movement, so that there is less mottling in the deep subsoil.

Wellston silt loam, which is developed from parent material similar to that of Zanesville silt loam, differs stratigraphically in the number of horizons developed and in the thickness of the solum. The X and Y horizons are absent, and mottling is rarely found except on the deep transitions to the Zanesville soils. Parent rock occurs at a depth of 3 feet or less, and partly weathered sandstone and shale fragments are more abundant above the C horizon.

Frederick silt loam is formed principally from the impure cherty Mitchell limestone, but smaller areas have been developed from the Glen Dean, Golconda, Beech Creek, and Elwren limestone formations of the Chester series in which shale and sandstone impurities influence the soil. Both the surface soil and the upper subsoil layer are slightly browner in color and heavier in texture than the Zanesville soils. At a depth of 30 inches or more the subsoil consists of red waxy clay that extends to the limestone at 5 feet or more. Some chert is present in the lower part of the subsoil.

The Cincinnati soils are highly leached and strongly acid. They have been formed on rolling land over calcareous Illinoian glacial till. The horizons are similar to those of Zanesville series. The parent-material carbonate of lime has been leached to an average depth of 10 feet, resulting in a thickness of the friable brownish-yellow Y horizon greater than that of Zanesville silt loam. In some places where the glacial till is thin the carbonate of lime has been entirely removed to the sandstone bedrock at a depth of 4 to 8 feet. In such places the soil was classified as Cincinnati silt loam, shallow phase.

Princeton fine sandy loam is developed from calcareous aeolian sands deposited on and along the southeastern bluffs of the White River during the late Wisconsin glacial period. The strong-brown to somewhat reddish-brown B horizon varies locally from a moderately heavy clay loam to a loamy fine sand, because of shifting of sand resulting in the thickening of the A horizon and the quantity of clay-forming mineral present in the parent material. A strong-brown or reddish-brown loose fine sand horizon (Y) overlies the yellowish-gray calcareous parent material to an average depth of 5 feet. The profile ranges from nearly neutral to medium acid in reaction.

The Otwell soils have been developed from noncalcareous stratified silts and clays laid down in ponded areas on the glacial border during the Illinoian glacial period. The profile characteristics are similar to those of Zanesville silt loam. The B horizon is usually brownish yellow to yellowish brown, and the X and Y horizons are somewhat more compact and heavier. The soil is usually strongly acid to a depth of 10 or more feet, but in local areas the substratum contains some carbonate of lime at a depth of 7 or more feet.

The Elkinsville soils are derived from alluvial terrace deposits of noncalcareous fine sand, silt, and clay, presumably washed from areas of Illinoian till and sandstone, siltstone, and shale. They occupy the breaks of low terraces generally less than 10 feet above the flood plains. Although profile characteristics are similar to those of the Otwell soils, they are less strongly expressed. Elkinsville silt loam has been developed from acid highly leached sediments of more recent deposition than the parent materials of the Otwell soils.

Martinsville loam developed in the White River Valley has been formed from somewhat less leached sandy and silty sediments than Elkinsville silt loam.

Markland silt loam is developed on strongly undulating land from highly calcareous clay deposited in slack-water position in the White River Valley and near the mouths of the tributaries. It has a tough yellowish-brown silty clay B horizon. The soil is only medium to slightly acid, and leaching of carbonate of lime has occurred to an average depth of 3 feet.

BROWNISH-GRAY SOILS WITH SLOW TO MEDIUM DRAINAGE

The Tilsit, Gibson, Haubstadt, and Pekin soils (column III) occur on the gently sloping to nearly level land near stream courses and on the broader upland ridges. Because of the slight slope, surface drainage is only fair, and internal drainage is impaired by a claypan or X horizon at a depth of about 3 feet. The following description of Gibson silt loam represents the group. It was taken from a cultivated area, and the A_1 horizon is really a mixture of the original A_1 and part of the A_2.

A_1. 0 to 8 inches, brownish-gray smooth silt loam, which crushes into grayish yellow with a thin platy structure. Very strongly acid

A_2. 8 to 11 inches, pale yellowish-gray mellow silt loam, platy in structure. Strongly acid

B_1. 11 to 16 inches, friable yellow light silty clay loam with a fine crumb structure Very strongly acid

B_2 16 to 21 inches, slightly heavier, with larger structure particles Very strongly acid

B_{3} 21 to 28 inches, moderately compact mottled gray and yellow silty clay loam with subangular nutlike aggregates ¼ to 1½ inches in diameter. Very strongly acid.

X_1. 28 to 32 inches, mottled gray and yellow compact hard silty clay loam that has light-gray silt coating on the rounded columnar structure particles. Very strongly acid

X_2 32 to 38 inches, very compact, tough, impervious, dull-brown heavy silty clay loam. The columns in many places have a coating of light-gray silt, especially along vertical cleavage planes Very strongly acid

Y_1 38 to 46 inches, mottled gray and yellow friable slightly gritty silty clay loam. Structure blocky or massive. Very strongly acid.

Y_2 46 to 82 inches, slightly heavier, more compact yellowish-brown silty clay loam with a dull brown colloidal coating on the massive blocks in the lower part. Medium acid

Y_3 82 to 100 inches, more friable, softer, gritty silty clay loam Variegated in color and containing some exotic siliceous glacial pebbles Neutral in reaction.

C_1 100 to 112 inches +, a calcareous moderately compact grayish-yellow heterogeneous mixture of sand, silt, clay, and siliceous exotic glacial pebbles deposited during the Illinoian glacial period

Tilsit silt loam is similar in profile characteristics to Gibson silt loam in the A, B, and X horizons. It is developed from fine-grained sandstone, siltstone, and shale of the Pennsylvanian and Chester formations, which occur at depths of 5 feet or more. The mottled gray and brown Y horizons are friable, because of the influence of very fine sand and the dominance of silt. Fragments of shale usually occur 6 inches or more above the parent rock.

Haubstadt silt loam is developed from acid silts and clays laid down in Illinoian glacial-border lakes and at lower elevations in abandoned channels or ox bows of the White River. The soil is strongly leached, and horizons are well developed. Occasionally calcareous parent material is found at a depth of 8 to 10 feet or more below the surface, but the solum is strongly acid.

The Pekin soils are developed from silts and clays washed from areas of Illinoian drift and sandstone, siltstone, and shale. The materials were deposited more recently than those of Haubstadt silt loam, and in many places the terraces are less than 3 feet above the present flood plains. The characteristics of the horizons are less well developed than in the Haubstadt soil.

LIGHT BROWNISH-GRAY SLOWLY DRAINED SOILS PERIODICALLY SATURATED

The poorly drained soils developed under periodic excess moisture conditions (column II) comprise a comparatively small part of the county. Surface drainage is poor because of the slight relief, and internal drainage is poor because of an impervious claypan or X horizon. Soil series included in this group are Dubois, Johnsburg, Bartle, Vigo, and McGary. The following profile description of Dubois silt loam was taken 1 mile east of Houghton Bridge:

A_1. 0 to 6 inches, plow layer smooth brownish-gray silt loam having phylliform structure Strongly acid

A_2 6 to 9 inches, light-gray smooth silt loam Strongly acid

A_3. 9 to 22 inches, mottled gray and yellow heavy silt loam having a soft crumb structure. Friable in the moist condition Strongly acid

B_1 22 to 38 inches, similar to the above, with a considerable quantity of rust staining and an increasing quantity of light-gray silt in the lower part. Very strongly acid

X. 38 to 45 inches, rust-stained and mottled gray and yellow compact silty clay loam having columnar structure. The columns are 8 to 12 inches long and 4 to 7 inches wide. Very strongly acid.

Y_1 45 to 60 inches, mottled gray and yellow mellow silt loam Strongly acid

Y_2. 60 to 110 inches, mottled gray and yellow silty clay loam Strongly acid

Y_3. 110 to 118 inches +, mottled gray and yellow loam. Strongly acid grading downward to medium acid

The parent material consists of noncalcareous stratified silts and clays deposited in glacial-border lakes during the Illinoian period. It is also developed in high alluvial terrace positions from acid alluvial deposits.

In this group of soils the degrees of heaviness and structural development of the B horizons are variable and are dependent on the drainage conditions. The grayest, most poorly drained soils usually have the least B-horizon development, and in some the fourth horizon might better be considered as a part of the A_3.

Johnsburg silt loam occurs on small flats on the broad upland divides. Profile characteristics are similar to those of Dubois silt loam except that the parent rock is sandstone, siltstone, and shale and occurs at a depth of 5 feet or more.

Bartle silt loam is developed from acid alluvial deposits of clay, silt, and fine sand of mixed origin consisting of Illinoian glacial drift and sandstone and shale, and along the eastern border of the county limestone may have contributed a small part of the material. Profile development is similar to the Dubois series but more variable. The claypan (X) horizon is not consistently present. The terraces in many places are scarcely above flood-plain level.

Vigo silt loam is developed from Illinoian glacial till that has been leached of carbonate of lime to an average depth of 10 feet. The till contains a large proportion of "Coal Measures" shales of the Pennsylvanian geologic period. The soil has a very compact, impervious claypan extending to a depth of 18 to 35 inches. The underlying material becomes slightly more friable with depth, but the entire profile consists of very compact material. Some glacial pebbles occur throughout the profile, but they are most numerous in the parent material.

McGary silt loam is developed in protected coves and tributaries to the White River from very heavy calcareous yellowish-gray clay deposited during the Wisconsin glacial period. The high proportion of clay in the parent material has resulted in the development of a mottled gray and yellow tough waxy B horizon, which grades into the calcareous parent material at depths varying from 3 to 4 feet. In some places the parent material is more silty and is lower in lime, with the result that there is a slightly more friable B horizon and greater depth to the lime-bearing horizon. This tendency was most pronounced in the upstream areas farthest from the White River.

LIGHT-GRAY VERY SLOWLY DRAINED SOILS PERIODICALLY SATURATED

Robinson silt loam is the only light-gray soil developed under very slow surface and internal drainage (column I) that was mapped. The flat land surface and a claypan contribute to the sluggish drainage conditions. A few small areas of Loy silt loam have a similar profile, but they were included on the map with Vigo silt loam because of the small total area.

Robinson silt loam has been developed from noncalcareous stratified silt and clay of Illinoian age occurring as glacial-border lakes or as high terraces in abandoned channels of the White River. The soil is dominantly gray in color, with numerous rusty-iron concretions, blotches, and stains occurring throughout the profile. The soil is silty from the surface downward, although it becomes slightly heavier with depth. At an average depth of 3 feet there is a compact, impervious claypan horizon that has a columnar structure. The soil is acid to a depth of 10 feet or more.

DARK-GRAY SOILS ALMOST PERMANENTLY SATURATED

The dark-colored soils (column VIII) occupy low, depressed positions, where they were developed under conditions of almost continuous excess moisture. Water-loving grasses, sedges, and trees composed the vegetative cover during the formation of the soil. The soil profiles are characterized by a dark-colored surface soil, relatively high in nitrogen, grading at a depth of 15 to 20 inches into a mottled gray and yellow glei horizon in which some of the iron compounds probably are reduced. These soils are neutral in reaction and are only slightly or moderately leached. They are developed in part from clay and leached materials washed from the adjacent high ground and from organic accumulation. The series represented in this group are Montgomery and Ragsdale. The H horizons are those with much humus, the M are modified parent material, and U represent the underlying material.

Montgomery silty clay loam has a moderately dark brownish-gray silty clay loam H_1 horizon that is friable and granular. At a depth of 10 inches this material grades into a compact plastic dark bluish-gray silty clay that becomes lighter in color with depth. Under some conditions this material breaks into small angular blocks. At an average depth of 20 inches is a mottled gray and yellow or rust-gray plastic silty clay. Some penetration of organic matter occurs along cleavage planes throughout this horizon, and the soil breaks into small angular blocks. Below a depth of 3 feet the subsoil becomes somewhat less plastic and generally is better oxidized. At 5 feet or more it is underlain by slack-water deposits of calcareous clay, which is supposed to have been laid down in the valley of the East Fork of the White River and its tributaries during the Wisconsin glacial period. The soil is neutral to slightly alkaline.

Montgomery silty clay loam, shown on the map in association with the Elkinsville soils, is similar to Lyles silty clay loam in that the textures of the U horizons are more variable.

The Ragsdale soils have been mapped in association with the sandy Princeton soils. The sequence of horizons is the same as in the Montgomery soils, but the solum and the parent material are more sandy.

ALLUVIAL SOILS

The alluvial soils comprise 19.2 percent of the area of the county. They may be divided into two broad groups—the acid soils and the nonacid or neutral soils. The acid soils are the more extensive and occupy 14.1 percent of the county. They are derived from mixed alluvium washed from the sandstone, siltstone, and shale and the Illinoian drift sections. In the eastern part of the county there is some mixture of alluvium from limestone areas. This is particularly true in the bottoms of the Lost River and Indian Creek, which, through a part of their courses, flow through limestone formations. The acid soils comprise the Pope, Philo, Stendal, and Atkins series. The nonacid soils are derived largely from sediments of the Wisconsin glacial drift section of the State and are found in the White River bottom, to which they have been brought from outside the county. The Genesee, Eel, and Shoals series represent the nonacid soils. These are all youthful soils having little profile development. Such textural variation as occurs in the profile is caused largely by stratification. The principal characteristics that have been considered in making soil separations are (1) acidity, (2) origin of the material, (3) organic content, (4) drainage conditions, and (5) texture. In addition to being classified in regard to acidity the soils have been subdivided on the basis of drainage as follows: (1) Well-drained brown soils that are unmottled throughout the 3-foot section, such as Genesee of the nonacid group and Pope of the acid group; (2) fairly well drained soils with grayish-brown or brownish-gray surface soils to a depth of 10 inches or more, where they become mottled gray and yellow in color (the Eel soils represent the nonacid group and Philo the acid group); (3) slowly drained soils having brownish-gray or gray surface soils and coarsely mottled gray and yellow subsoils below a depth of 10 inches (the Shoals soils represent the neutral soils and Stendal the acid group); and (4) very slowly drained light-gray soils having gray subsoils, in which more of the iron is in the form of rust-colored concretions, blotches, and stains (the Atkins soils represent the acid group).

MANAGEMENT OF THE SOILS OF MARTIN COUNTY

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

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

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county and to outline in a general way the treatments most needed and most likely to yield satisfactory results. No system of soil management can be satisfactory unless in the long run it produces profitable returns. Some soil treatments and methods of management may be profitable for a time but ruinous in the end. One-sided or unbalanced soil treatments have been altogether too common in the history of farming in the United States. A proper system of treatment is necessary in making a soil profitably productive.

PLANT NUTRIENTS

Table 8 shows the approximate total content of nitrogen, phosphorus, and potassium and the weak-acid-soluble or available phosphorus and potassium in the different soils in Martin County, expressed in pounds of elements in the 6- to 7-inch plowed surface soil of an acre, estimated at 2,000,000 pounds.

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

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

The amount of total phosphorus in ordinary soils is usually about the same as that shown by a determination with a strong acid. For this reason a separate determination of total phosphorus has been omitted. In Indiana the supply of total phosphorus usually indicates whether or not a soil needs phosphatic fertilizers.

TABLE 8.—*Approximate quantities of nitrogen, phosphorus, and potassium in certain soils of Martin County, Ind.*

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

Soil type	Total nitrogen	Total phosphorus [1]	Total potassium	Weak-acid-soluble phosphorus [2]	Weak-acid-soluble potassium [2]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Zanesville silt loam	2,400	610	30,400	20	185
Tilsit silt loam	2,200	700	28,600	10	145
Wellston silt loam	2,000	650	30,300	25	185
Muskingum silt loam, colluvial phase	1,800	520	22,200	10	175
Cincinnati silt loam	1,400	440	29,100	10	170
Cincinnati silt loam, shallow phase	1,600	440	31,600	10	200
Parke silt loam	2,000	610	30,000	10	180
Gibson silt loam	1,600	520	28,200	10	120
Markland silt loam	2,000	610	33,100	10	170
Frederick silt loam	2,000	520	28,000	10	220
Princeton fine sandy loam	2,000	440	20,800	70	235
Martinsville loam	2,200	900	27,000	70	135
Otwell silt loam	2,000	520	27,700	10	170
Haubstadt silt loam	2,600	520	28,200	10	140
Pekin silt loam	2,000	700	29,000	20	150
Vigo silt loam	1,800	700	24,800	10	125
Johnsburg silt loam	2,200	610	25,200	10	200
Dubois silt loam	2,000	610	21,200	10	150
Robinson silt loam	2,000	520	27,000	25	150
Bartle silt loam	1,600	600	27,000	10	135
McGary silt loam	2,200	700	28,000	10	170
Montgomery silty clay loam	3,800	1,130	34,000	65	305
Genesee silt loam	3,200	870	30,000	25	200
Genesee silt loam, high-bottom phase	2,000	700	29,300	20	235
Genesee loam	1,600	610	28,600	60	160
Genesee loam, high-bottom phase	1,800	520	23,900	25	215
Genesee fine sandy loam	1,600	610	21,500	105	170
Genesee fine sandy loam, high-bottom phase	1,600	600	21,000	20	200
Eel silty clay loam	3,200	1,220	32,200	60	200
Eel silt loam	2,200	870	28,200	20	170
Shoals silty clay loam	2,400	870	34,000	70	220
Shoals silt loam	2,400	790	31,000	20	140
Pope gravelly loam	2,600	670	34,800	10	230
Pope loam	1,600	440	26,700	20	185
Pope silt loam	2,400	790	31,000	20	140
Philo silt loam	1,800	520	25,700	10	150
Philo loam	1,200	590	30,900	35	210
Stendal silty clay loam	2,200	900	30,200	40	180
Stendal silt loam	2,000	700	26,400	20	140
Atkins silty clay loam	2,000	610	28,200	25	140
Atkins silt loam	1,600	500	27,000	20	130

[1] Soluble in strong hydrochloric acid (specific gravity 1 115)
[2] Soluble in weak nitric acid (fifth normal).

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

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

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

It must be admitted, however, that no one method of soil analysis will definitely indicate the deficiencies of a soil. For this reason these chemical data are not intended to be the sole guide in determining the needs of the soil. The depth of the soil, the physical character of the horizons of the soil profile, and the previous treatment and management of the soil are all factors of the greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than they are in surface soils. On the other hand, potassium in the subsoil seems to be of relatively high availability. Crop growth depends largely on the amount of available plant nutrients with which the roots may come in contact. If the crop can root deeply, it may be able to make good growth on soils of relatively low analysis. If the roots are shallow, the crop may suffer from lack of nutrients, particularly potash, even on a soil of higher analysis. The better types of soils and those containing large amounts of plant-nutrient elements will endure exhaustive cropping much longer than the soils of low plant-nutrient content.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the degree of acidity. Many soils that are very strongly acid will not produce well, even though there is no apparent lack of plant-nutrient elements. Although nitrogen, phosphorus, and potassium are of some value when added to acid soils, they will not produce their full effect where calcium is deficient. Table 9 shows the percentage of nitrogen and the acidity of the important soils in Martin County.

The acidity is expressed as pH, or intensity of acidity. For example, pH 7 is neutral, and a soil with a pH value of 7 contains just enough lime to neutralize the acidity. If the pH value is more than 7, there is some lime in excess. A pH value of from 6 to 7 indicates slight acidity, and one of from 5.6 to 6 shows medium acidity. If the pH value runs below 5.6 the soil is strongly acid. As a rule, the stronger the acidity the more a soil needs lime. Samples were taken from the surface soil (0 to 6 inches), from the subsurface soil, and from the subsoil. It is important to know the reaction not only of the surface soil but of the lower layers of the soil as well. Given two soils of the same acidity, the one with the greater acidity in the subsurface layer is in greater need of lime than the other. The slighter the depth of acid soil, the less likely it is to need lime. Those soils having the greater clay content will need a greater amount of lime to neutralize them, given the same degree of acidity. The less phosphorus, calcium, and magnesium the soil contains, the more likely it is to need lime. It is well to remember that sweetclover, alfalfa, and red clover need lime more than other crops. As it is advisable to grow these better soil-improvement legumes in the rotation, it is in many places desirable to lime the land in order that sweetclover or alfalfa may grow.

TABLE 9.—*Nitrogen and acidity requirement in certain soils of Martin County, Ind.*

Soil type or phase	Depth	Nitrogen	pH[1]	Average depth to neutral material	Indicated limestone requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
Zanesville silt loam	0-6	0.12	5.6	(2)	2-4
	6-18	.05	5.2		
	18-36	.04	5.1		
Tilsit silt loam	0-6	.11	5.1	(2)	2-4
	6-18	.06	4.9		
	18-36	.04	4.9		
Wellston silt loam	0-6	.10	5.5	(2)	2-4
	6-18	.07	5.0		
	18-36	.05	5.0		
Muskingum silt loam, colluvial phase	0-6	.09	5.5	(2)	2-4
	6-18	.06	5.2		
	18-36	.04	5.0		
Cincinnati silt loam	0-6	.07	5.4	100	2-4
	6-18	.06	5.1		
	18-36	.03	5.1		
Cincinnati silt loam, shallow phase	0-6	.08	5.3	(2)	2-4
	6-18	.05	5.1		
	18-36	.04	5.0		
Parke silt loam	0-6	.10	5.4	150	2-4
	6-18	.05	5.1		
	18-36	.03	5.0		
Gibson silt loam	0-6	.08	5.0	100	2-4
	6-18	.06	4.9		
	18-36	.04	4.9		
Markland silt loam	0-6	.10	5.5	22	0-2
	6-18	.07	6.5		
	18-36	.06	(3)		
Frederick silt loam	0-6	.10	5.3	70	2-4
	6-18	.07	5.1		
	18-36	.03	5.0		
Princeton fine sandy loam	0-6	.10	6.7	40	0-1
	6-18	.04	6.8		
	18-36	.02	6.8		
Martinsville loam	0-6	.11	5.4	34	1-2
	6-18	.07	5.8		
	18-36	.05	7.1		
Otwell silt loam	0-6	.10	5.5	80	2-4
	6-18	.07	5.2		
	18-36	.05	5.1		
Haubstadt silt loam	0-6	.13	5.7	80	2-4
	6-18	.05	5.3		
	18-36	.03	5.1		
Pekin silt loam	0-6	.10	5.3	80	2-4
	6-18	.06	5.0		
	18-36	.04	5.0		
Vigo silt loam	0-6	.09	5.4	110	2-4
	6-18	.05	5.1		
	18-36	.03	5.1		
Johnsburg silt loam	0-6	.11	5.5	(2)	2-4
	6-18	.05	5.1		
	18-36	.03	5.1		
Dubois silt loam	0-6	.10	5.3	80	2-4
	6-18	.04	5.2		
	18-36	.03	5.1		
Robinson silt loam	0-6	.10	5.5	80	2-4
	6-18	.07	5.5		
	18-36	.06	5.4		
Bartle silt loam	0-6	.08	5.5	75	2-4
	6-18	.05	5.1		
	18-36	.04	5.4		
McGary silt loam	0-6	.11	6.0	35	1-2
	6-18	.07	5.7		
	18-36	.05	6.8		
Montgomery silty clay loam	0-6	.19	7.0	0	0
	6-18	.17	7.0		
	18-36	.08	7.2		
Genesee silt loam	0-6	.16	7.0	0	0
	6-18	.11	6.9		
	18-36	.06	7.0		

1 pH determined by Morgan colorimetric method
2 Acid to bedrock.
3 Calcareous

TABLE 9.—*Nitrogen and acidity requirement in certain soils in Martin County, Ind.*—Continued

Soil type or phase	Depth	Nitrogen	pH[1]	Average depth to neutral material	Indicated limestone requirement per acre
	Inches	*Percent*		*Inches*	*Tons*
Genesee silt loam, high-bottom phase	0-6	0.10	6.5	40	0
	6-18	.08	6.5		
	18-36	.06	6.3		
Genesee loam	0-6	.08	6.9	0	0
	6-18	.07	6.9		
	18-36	.06	7.0		
Genesee loam, high-bottom phase	0-6	.09	7.0	40	0
	6-18	.07	6.6		
	18-36	.06	6.8		
Genesee fine sandy loam	0-6	.08	6.9	0	0
	6-18	.06	7.1		
	18-36	.03	7.1		
Genesee fine sandy loam, high-bottom phase	0-6	.08	6.8	30	0
	6-18	.06	6.5		
	18-36	.03	6.3		
Eel silty clay loam	0-6	.16	7.0	0	0
	6-18	.13	7.0		
	18-36	.08	6.7		
Eel silt loam	0-6	.11	6.7	30	0
	6-18	.10	6.8		
	18-36	.09	6.7		
Shoals silty clay loam	0-6	.12	6.5	40	0
	6-18	.10	6.9		
	18-36	.07	6.9		
Shoals silt loam	0-6	.12	6.9	45	0
	6-18	.09	6.6		
	18-36	.06	6.5		
Pope gravelly loam	0-6	.13	5.3	(4)	0
	6-18	.08	5.5		
	18-36	.04	5.6		
Pope loam	0-6	.08	5.4	(4)	2-4
	6-18	.05	5.4		
	18-36	.04	5.3		
Pope silt loam	0-6	.10	5.5	(4)	2-4
	6-18	.06	5.4		
	18-36	.05	5.2		
Philo silt loam	0-6	.09	5.2	(4)	2-4
	6-18	.07	5.1		
	18-36	.06	5.4		
Philo loam	0-6	.06	5.4	(4)	2-4
	6-18	.05	5.3		
	18-36	.04	5.3		
Stendal silty clay loam	0-6	.11	5.3	(4)	2-4
	6-18	.07	5.0		
	18-36	.06	5.1		
Stendal silt loam	0-6	.10	5.4	(4)	2-4
	6-18	.06	5.4		
	18-36	.06	5.4		
Atkins silty clay loam	0-6	.10	5.4	(4)	2-4
	6-18	.07	5.2		
	18-36	.05	5.2		
Atkins silt loam	0-6	.08	5.5	(4)	2-4
	6-18	.06	5.5		
	18-36	.06	5.1		

[4] Acid to all depths

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

TREATMENT ACCORDING TO SOIL TYPE

For convenience in discussing their management, soils of Martin County are arranged in groups according to certain important characteristics which indicate that in many respects similar treatment is required. For example, several of the silt loams of the uplands and terraces, which have practically the same requirements for improvement, may be conveniently discussed as a group, and thus the repetition that would be necessary if each were discussed separately may be avoided. Where different treatments are required they are specifically pointed out.

About 83 percent of the soils of Martin County are rolling to broken and hilly silt loam and stony silt loam uplands, of which over two-thirds are nonarable. About 1.5 percent of the total area of the county is occupied by poorly drained flat to gently undulating uplands and terraces, and about 15.3 percent consists of overflow bottom lands. The management of these groups of soils will be discussed separately. The reader should study the group including the soils in which he is particularly interested.

WELL-DRAINED SILT LOAM SOILS OF THE UPLANDS AND TERRACES

The group of well-drained silt loam soils of the uplands and terraces comprises the Zanesville, Zanesville-Wellston, Tilsit, Wellston, Muskingum, Cincinnati, Gibson, Parke, Frederick, Otwell, Haubstadt, Elkinsville, Pekin, and Markland silt loams, Corydon silty clay loam, the Muskingum stony silt loam, and the Wellston-Muskingum complex. Together, these soils occupy 169,216 acres, or 78 percent of the total area of the county. All of Muskingum stony silt loam, which occupies 64,832 acres, or 30 percent of the total area of the county; the eroded, gullied, and slope phases of the Zanesville, Wellston, Cincinnati, Parke, Frederick, and Otwell soils; and most of the Zanesville-Wellston silt loams and the Wellston-Muskingum complex are unfit for cultivation and are classed as nonarable land. A separate discussion of these will be found at the end of this section.

The arable soils of the group, although differing more or less in appearance because of origin and topography, have certain important characteristics in respect to which their management problems are similar. All are low in total content of organic matter, nitrogen, and phosphorus; most of them are low in available potash; and all are acid and in need of liming.

DRAINAGE

The almost level and gently sloping areas of Tilsit silt loam on the broader ridge tops and the more level areas of the Haubstadt and Gibson silt loams would be benefited by some tile underdrainage. The more rolling and hilly soils have fair to good internal drainage, but, owing to slow permeability and sloping topography, much of the rain water that falls on them is liable to run off over the surface instead of being absorbed for the benefit of crops and often results in serious erosion damage where the land is not protected against excessive runoff.

CONTROL OF EROSION

On most of the soils of this group the problems of controlling erosion are of major importance in practical systems of soil management. Even after taking out of cultivation all the rough and very sloping land, which should never be plowed, the rest of the tillable land needs especial care in order to prevent further destructive erosion. In many places the surface soil has already gone, and further sheet erosion and gullying are constantly making matters worse. The surface soil contains the greater part of the store of fertility and should be protected against erosion by every practical means. Gradual sheet erosion, whereby the runoff of rain water moves the surface soil down the slope a little at a time and rather evenly, is the most insidious form of erosion and may not be noticed until the subsoil begins to appear. Many one-time fertile fields have been irreparably damaged in this way, and many others have only a little of the surface soil left, and the plow reaches into the unproductive subsoil. Plowing and the other tillage operations should extend crosswise of the slopes wherever possible, in order to prevent the formation of watercourses down the slopes, which are sure to carry away much valuable surface soil and may start serious gullies. Contour plowing and contour strip cropping may be most practical on fields of irregular slopes, whereas terracing may be most practical on long even slopes. By rearranging fences or other field boundaries it may be possible to arrange the cropping system in such a way as to facilitate the performance of all tillage operations crosswise of the slopes. Intertilled crops should be interspersed with small-grain and sod-forming crops. Incipient gullies, or draws, forming natural waterways down the slopes, should be kept permanently in grass with a good sod of sufficient width to allow the water to spread and thereby prevent soil cutting.

LIMING

All the soils of this group are strongly acid, and liming should be a first step in any soil-improvement program. A very acid soil will not respond properly to other needed treatments until it has been limed.

To determine the lime requirement, the soil should be tested for acidity. The test is simple and should not be neglected. If the farmer cannot make the test, he can have it made by the county agricultural agent or the vocational agriculture teacher, or he can send representative samples of the surface soil and the subsoil to the Purdue University Agricultural Experiment Station at La Fayette.

Ground limestone is generally the most economical form of lime to use. Comparative values should be calculated on the calcium carbonate equivalent. On the more acid soils the first application should be at least 2 tons to the acre. After that a ton to the acre every second round of the crop rotation will keep the soil sufficiently sweet for most crops otherwise adapted to these soils.

ORGANIC MATTER AND NITROGEN

All the soils of this group are naturally low in organic matter and nitrogen. Constant cropping without adequate returns to the land and more or less soil erosion on sloping areas are steadily making matters worse. In many places the original supplies of organic matter have become so reduced that the soil has lost much of its natural mellowness, and it readily becomes puddled and baked. The only practical remedy for this condition is to plow under more organic matter than is used in the processes of cropping. Decomposition is constantly going on and is necessary to maintain the productivity of the soil. Decomposing organic matter must also supply the greater part of the nitrogen required by crops. For this reason, legumes should provide large amounts of the organic matter to be plowed under. On the strongly acid soils, soybeans or cowpeas may be used to start with, because they will stand considerable soil acidity; but the land should be thoroughly limed and put into condition to grow clover and alfalfa as soon as possible. On the naturally poor soils, liberal phosphate and potash fertilization will be necessary also, in order to produce satisfactory crops.

Clover or some other legume should appear in the rotation every 2 or 3 years; as much manure as possible should be made from the produce that can be utilized for livestock; and all produce not utilized, such as cornstalks, straw, and cover crops, should be plowed under. It must be remembered that legumes are the only crops that can add appreciable quantities of nitrogen to the soil, and then only in proportion to the amount of top growth that is returned to the land, either directly or in the form of manure. Wherever clover seed crops are harvested, the threshed haulm should be returned to the land and plowed under. Cornstalks, straw, and other crop residues should not be burned. Burning destroys both organic matter and nitrogen. Modern plows equipped with Purdue trash shields will turn down and completely cover cornstalks or other heavy growth. Cover crops should be grown wherever possible, to supply additional organic matter for plowing under. Planting soybeans, cowpeas, or sweetclover between the corn rows at the time of the last cultivation and seeding rye as a cover crop early in the fall on cornland that is to be plowed the following spring are good practices for increasing the supply of both nitrogen and organic matter. It is important to have a growing crop of some kind on these soils during the winter to take up the soluble nitrogen that otherwise would be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses may occur between crop seasons through drainage. In this latitude the ground is not frozen much of the time during the winter, and frequent heavy rains cause much leaching and loss of plant nutrients, especially nitrates, if they are not taken up by crops.

CROP ROTATION

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

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

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

Alfalfa and sweetclover may be grown on most of the soils of this group if properly inoculated and sufficiently limed to meet the needs of these crops. Alfalfa is preferable for hay, and sweetclover is excellent for pasture and for soil-improvement purposes. Special literature on the cultural requirements of these crops may be obtained from the Purdue University Agricultural Experiment Station at La Fayette.

FERTILIZATION

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

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

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

The quantity of potash that should be supplied as fertilizer depends on the general condition of the soil and the quantity of manure used. According to the analyses in table 8, most of the soils of this group are low in available potash. If the weak-acid-soluble potassium is below 200 pounds an acre of plow depth, the chances are that it will pay to use some potash fertilizer. In building up a run-down soil, considerable quantities of fertilizer potash should be used, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has materially improved. There is plenty of potassium in these soils for all time if it could be made available at a faster rate. As a rule it becomes available too slowly. The availability of the soil potash may be increased by good farm practices, including proper tillage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of organic matter. The better these practices are carried out and the larger the quantity of manure applied, the less potash fertilizer need be purchased.

In the practical fertilization of these soils, most of the manure should be plowed under for the corn crop. When the crop rotation includes wheat, as should generally be the case, a part of the manure, about 2 tons to the acre, may be applied profitably on the wheatland as a top dressing during the winter. Manure so used not only helps the wheat and lessens winter injury but also helps to insure a stand of clover or other crop seeded in the wheat. Unless very heavily manured, corn should receive in addition 100 to 150 pounds of 0–14–6 or 0–12–12 fertilizer to the acre in the row or on both sides of the hill at planting time. Without manure, corn should be given from 150 to 200 pounds to the acre of a phosphate and potash mixture such as 0–12–12 or 0–10–20 applied by a fertilizer attachment that places the fertilizer on both sides of the row or hill and an inch or more away from the seed. Wheat should be given from 200 to 300 pounds to the acre of a high-analysis complete fertilizer such as 2–12–6 or 3–12–12.

On the poorer soils, where large quantities of fertilizer are needed to build up productivity quickly, it may be most practical to plow under extra amounts of fertilizer. Such deep application is especially advantageous in dry seasons because it insures availability of the fertilizer to crop roots, while shallow applications might lie in dry soil and be temporarily unavailable. Such deep applications should supply a balanced ration of the nutrients required by the crop until such time as more of the nitrogen needed can be supplied through legumes.

In places where the wheat is backward in the spring because of an insufficient supply of available nitrogen, a top dressing of 100 pounds to the acre of a soluble nitrogen fertilizer should be applied soon after growth begins. Such top dressing generally will add about 5 bushels an acre to the yield. It will be most efficient if the fall application of fertilizer has supplied liberal amounts of phosphate and potash.

For special crops special fertilization will be needed. Specific fertilizer recommendations for different crops on different soils under different conditions can be procured from the Agricultural Experiment Station at La Fayette.

POORLY DRAINED SOILS OF THE UPLANDS AND TERRACES

The group of poorly drained soils of the uplands and terraces comprises the silt loams of the Vigo, Johnsburg, Dubois, Robinson, Bartle, and McGary series, Ragsdale loam, and Montgomery silty clay loam. Although not extensive in total area, these soils are nevertheless important in a county that has so little arable land, because, with proper attention to drainage, liming, and fertilizing, they are all tillable and may be made profitably productive.

The soils of this group have several important characteristics in common, in respect to which their management problems are similar. They are all in need of artificial drainage; all except Montgomery and Ragsdale are low in total content or organic matter, nitrogen, and phosphorus; most of them are low in available potassium; and all except Montgomery and Ragsdale are acid and in need of liming.

DRAINAGE

The soils of this group were all developed under conditions of poor drainage. Their generally flat topography and heavy subsoils make them naturally wet and more or less seriously in need of artificial drainage. Wherever practicable, tile underdrainage should be installed as early as possible in any permanent improvement program. Without tile drainage these soils cannot be managed to the best advantage and no other beneficial soil treatment can produce its full effect.

With reasonable provision for drainage, these soils respond well to good fertility practices and can be made profitably productive. This has been fully demonstrated on the soil-fertility experiment fields conducted by the Purdue University Agricultural Experiment Station on poorly drained soils in other parts of the State. Experiments on such fields indicate that tile lines laid 30 to 36 inches deep and not more than 3 rods apart will give satisfactory results.

Where the land is flat, great care must be exercised in tiling in order to obtain an even grade and a uniform fall. Unsatisfactory results in tiling these flat lands are traceable to errors in grades, which allow silting up in low places, and to poor grades of tile, which chip and break down easily. Only the best grade of tile should be used. Grade lines should not be established by guess or by rule-of-thumb methods. Nothing less accurate than a surveyor's instrument should be used, and the lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet with no interruption or slackening of the current. The grade, or rate of fall, should be not less than 3 inches to 100 feet. The rate of fall may be increased toward the outlet, but it should never be lessened without the introduction of a silt well or settling box, as checking the current in the line may cause the tile to become choked with silt. Silt wells may be made of brick or concrete and should be at least a foot square inside. The bottom should be a foot lower than the bottom of the tile. The well should have a removable cover, in order that it may be opened once or twice a year for the purpose of dipping out the silt that has settled in the bottom. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with a layer of straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling, thus insuring perfect operation of the drains from the beginning.

In a special tile-drainage experiment on the Clermont silt loam of the Jennings County experiment field near North Vernon, the land tiled 3 rods apart in 1920 has since averaged 15.4 bushels more corn, 1.1 bushels more soybeans, 7.3 bushels more wheat, and 518 pounds more hay to the acre than the untiled land with the same lime and fertilizer treatment. The cost of tiling was paid for by the increased yields of crops during the first 8 years of the experiment, and since then the increased returns have averaged approximately $5 an acre per year.

LIMING

All the soils of this group except Montgomery silty clay loam, Ragsdale loam, and Princeton fine sandy loam are acid and more or less in need of liming. A very acid soil will not respond properly to other needed treatments until it has been limed. The quantities of ground limestone that should be applied to these soils are shown in the last column of table 9.

ORGANIC MATTER AND NITROGEN

With the exception of Ragsdale loam and Montgomery silty clay loam, the soils of this group are similar to the well-drained soils of the uplands and terraces in their low content of organic matter and nitrogen, and what has been said concerning the improvement of those soils in this respect applies equally well here. The cropping systems and the soil-management program on all light-colored soils should provide for the use of legumes, which supply both organic matter and nitrogen. Special green-manure crops and winter-cover crops for plowing under in the spring should be utilized wherever possible, and all available manure and unused crop residue should be plowed under.

CROP ROTATION

With proper attention to drainage where practicable, liming where needed, and reasonable fertilization, the soils of this group are best adapted to the grain and hay crop used in general farming, and the rotations suggested for the well-drained soils of the uplands and terraces may be used. Because soil erosion is not a problem on these flat soils, the 5-year rotation of corn, soybeans, wheat, and mixed clovers and grass will be satisfactory. Where poor drainage is not a limiting factor, Ragsdale loam will grow some of the crops suited to Princeton fine sandy loam, with which it is associated, and it should be managed accordingly.

FERTILIZATION

The discussion of the manure and fertilizer requirements of the well-drained soils of the uplands and terraces applies also to the light-colored soils of this group, except that the ratio of potash in the fertilizers used may need to be somewhat higher because the natural processes that make the soil potash available are less active in poorly drained soils. Corn particularly will respond to liberal quantities of potash, and tests generally indicate either 0–12–12 or 0–10–20 unless unusually large quantities of manure are used. For wheat it is also generally advisable to use more potash than on well-drained soils, especially for the benefit of the hay crop following. The Montgomery and Ragsdale soils are naturally more fertile than the light-colored soils and therefore not so much in need of either manure or fertilizer.

SANDY SOILS OF THE UPLANDS AND TERRACES

In the group of sandy soils of the uplands and terraces are included Princeton fine sandy loam and Martinsville loam. Princeton fine sandy loam is deficient in water-holding capacity, and all except the very deep rooted crops, such as alfalfa and sweetclover, are liable to suffer from drought. Martinsville loam, though rather sandy on top, has a heavier subsoil and so is much less droughty.

LIMING

Princeton fine sandy loam is fairly well supplied with lime and seldom needs liming. Martinsville loam is acid and in need of liming. About 2 tons of ground limestone to the acre is the usual recommendation.

ORGANIC MATTER AND NITROGEN

These sandy soils are naturally low in organic matter and nitrogen, and some special provision must be made for building up and maintaining these two constituents in order to utilize these soils to the best advantage. As much manure as possible, as well as all unused crop materials, should be plowed under. Special green-manure crops and cover crops, such as soybeans, cowpeas, sweetclover, rye, and winter vetch, should be planted wherever possible, to produce nitrogenous organic matter for plowing under. What has been said concerning this problem in the improvement of the upland and terrace silt loam soils applies equally well here, and the practices recommended for those soils should be followed also on these sandy soils. In fact, very sandy soils need larger supplies of both organic matter and nitrogen than heavier soils, because they use up these constituents at a faster rate. Their loose, open, often excessively aerated condition favors rapid decomposition and oxidation or the "burning out" of the soil organic matter. For this reason more than ordinary quantities of organic materials, such as manure, crop residues, specially grown green-manure crops, and cover crops, should be plowed under. The land should never be left without something growing on it. When any considerable quantities of nonleguminous crop residues or green manures are to be plowed under, especially on land used for truck crops, it will be advantageous to broadcast and plow under with the organic material a few hundred pounds to the acre of a high-nitrogen fertilizer to aid the processes of decomposition and at the same time provide additional nitrogen for the crop that is to be grown.

CROP ROTATION

Among the extensively grown field crops adapted to the region, winter small grains and the deep-rooted legumes are best adapted to these sandy soils. The winter small grains make most of their growth before there is much danger of shortage of moisture, and the deep-rooted legumes can usually find enough moisture in the deeper subsoil to tide them over the ordinary dry periods. Corn and spring small grains on these soils nearly always suffer from drought. Early potatoes, early tomatoes, and melons do relatively well on these sandy soils if special provisions are made for maintaining the nitrogen content and the moisture-holding capacity by frequent incorporation of leguminous organic matter. A mixture of winter rye and winter vetch is practical for this purpose, serving both as a winter cover for the land and as a source of organic matter for plowing under in the spring. Where the vetch is grown for the first time the seed or soil should be inoculated with the proper nitrogen-gathering bacteria. A 5-year rotation of melons (rye and vetch cover crop), early potatoes (rye and vetch cover crop), tomatoes, and alfalfa for 2 years is well suited to the sandy soils on which these crops can be grown to advantage. Success with this rotation will depend largely on the success with the cover crops and the alfalfa. All crops should be fertilized. Where alfalfa responds to additions of lime it will be advisable to confine liming to drilling 300 to 400 pounds to the acre of ground limestone with the alfalfa seed each time this crop is sown, because heavier liming may be detrimental to the potatoes and tomatoes. The alfalfa seeding should be made immediately after potato harvest, and the cover crop should be seeded as soon as possible after the melons are harvested.

For general farming on most of these sandy soils, a rotation of corn, soybeans, wheat or other winter grain, and a hay or pasture mixture containing a high proportion of alfalfa for one or more years may be satisfactorily practiced. An early seeding of winter rye should be made in the cornfield to serve as a winter cover crop and to provide additional organic matter for plowing under, which is always needed on these soils.

Most of these sandy soils are well adapted to alfalfa and sweetclover. Martinsville loam, however, needs liming for these crops and should be given at least 2 tons of ground limestone to the acre. A good seeding mixture for either hay or pasture is composed of 3 to 4 pounds of early timothy and 8 pounds of alfalfa. The timothy should be seeded with the wheat in the fall.

FERTILIZATION

These sandy soils are naturally deficient in nitrogen and need special provision for building up a supply of this element. The total supply of phosphorus is so low that it should not be depleted further. As a rule the available potash also is low. Stable manure should be applied as liberally as possible, both for its plant-nutrient constituents and for the organic matter it supplies, in order to improve the water-holding capacity of the soil as well as its productiveness. Manure, however, is seldom available in sufficient quantities; therefore liberal use should be made of commercial fertilizers.

Legumes, in rotation or as special green-manure or cover crops, should be used to supply much of the needed nitrogen that is not provided in the form of manure. Early potatoes, melons, tomatoes, and other truck crops on these soils will respond to heavy applications of high-analysis complete fertilizers. Five hundred pounds or more to the acre of a 2–12–6 or 2–16–8 mixture should be used. Where little or no manure is used, a 3–12–12 analysis may be preferable.

For winter grains, fertilization with 200 to 300 pounds of 2–12–6 or 3–12–12 at seeding time, and a spring top dressing of 15 to 20 pounds to the acre of nitrogen supplied by such materials as nitrate of soda, cyanamid, or sulfate of ammonia, is to be recommended. For corn, row or hill applications of phosphate-potash combinations such as 0–14–6 and 0–12–12 at the rate of 100 pounds to the acre are most practical.

Where alfalfa or sweetclover is grown, from 300 to 500 pounds to the acre of a high-grade phosphate-potash mixture should be applied at seeding time. A continuous stand of alfalfa should receive a top dressing of phosphate and potash fertilizer every 2 years.

SOILS OF THE BOTTOM LANDS

The bottom or overflow lands in Martin County may be divided into two general classes—the sour bottoms and the sweet bottoms. The sour bottoms, consisting of Pope silt loam and gravelly loam, Philo silt loam and loam, Stendal silt loam and silty clay loam, and Atkins silt loam and silty clay loam, have been formed by deposits from the acid soils of the uplands and terraces and are strongly acid. They should receive from 2 to 4 tons of ground limestone to the acre, as tests for acidity will show. The sweet bottoms, consisting of Genesee silt loam, loam, and fine sandy loam, Eel silt loam and silty clay loam, and Shoals silt loam and silty clay loam, receive their deposits from the lime-bearing soils of the uplands and terraces. They are either neutral or only slightly acid and seldom need liming. Natural drainage is limited by the periodic overflows and in the heavier types by tight subsoils. The latter should be tile-underdrained wherever suitable outlets can be obtained, in order that the land may drain more quickly after floods or heavy rains.

ORGANIC MATTER AND NITROGEN

The silt loams and silty clay loams of the Eel, Genesee, and Shoals series and the silt loam, loam, and gravelly loam of the Pope series, have fair supplies of organic matter and nitrogen; but the other soils of this group are in need of additional supplies of these important soil constituents. What has been said about supplying organic matter and nitrogen to the light-colored soils of the uplands and terraces applies equally well to the light-colored soils of the bottom lands. On the lighter colored and poorer areas of these soils, especially, considerable quantities of organic matter should be plowed under, either directly or in the form of manure, and legumes should be included in the rotation wherever possible and largely returned to the land in one form or another, in order to increase the nitrogen content.

Where the land is periodically flooded, clover and other deep-rooted legumes, especially biennials and perennials, cannot be depended on; but certain shallow-rooted legumes, such as soybeans, cowpeas, and sometimes alsike clover and lespedeza, can be grown satisfactorily. These crops should be used largely for gathering nitrogen from the air, which they will do in large measure when the soil is properly inoculated. Here again it must be remembered that only the top growth plowed under, either directly or in the form of manure, can really increase the nitrogen content of the soil, on which grain crops must depend. Cover crops, such as soybeans, winter vetch, and rye, should be used to the fullest possible extent in the cornfields. Cornstalks should not be burned but should be completely plowed under whenever this is practicable.

CROP ROTATION

Where overflows cannot be prevented, the crop rotation must consist largely of annual spring-seeded crops and such grass and clover mixtures as will not be seriously injured by ordinary floods. For the most part, corn, soybeans, and in some places, where flooding is not too prolonged, wheat with a mixture of timothy and alsike clover following for a year or two, are satisfactory crops for this land. Corn should doubtless continue to predominate, but some sort of rotation is advisable to help maintain fertility. Doubtless soybeans will become more important as a rotation crop on these soils if proper inoculation is provided. Timothy and alsike mixed will do well on most of this land after the strongly acid areas have been limed, and this crop may be allowed to stand for more than 1 year. In places where the land is too acid for alsike, lespedeza may be used. For late seeding in emergencies, early varieties of soybeans and Sudan grass, for either hay or seed, will be found useful. On the high-bottom phases of the Genesee soils some short-season truck crops and also alfalfa may be grown successfully.

FERTILIZATION

Most of the bottom lands of this county are low in the principal plant nutrients. It should be recognized that in most instances the floodwater sediments coming to these bottom lands from the adjoining watersheds are not so rich as they were years ago. The rich surface soil has gone from much of the upland, and the present floods carry little but eroded subsoil material of low fertility.

Genesee silt loam and Eel silty clay loam contain fair supplies of nitrogen for the ordinary farm crops. The other soils of these bottom lands are all relatively low in nitrogen. They are all low in available phosphorus except Genesee fine sandy loam, which, however, is so low in total phosphorus that it should not be further drawn upon. Eel silty clay loam shows a fair supply of total phosphorus but is low in the available supply of this element. About two-thirds of these bottom-land soils are too low in available potash for large yields of crops. The soils that show less than 200 pounds to the acre of weak-acid-soluble potassium (see table 8) will generally respond profitably to potash fertilization.

Where wheat is grown it should receive 200 to 300 pounds of 2–12–6 fertilizer to the acre. For corn, 150 to 200 pounds of 0–12–12 or 0–20–20 should be drilled in the row or placed beside the hill. It has been found that it does not pay to include nitrogen in the fertilizer applied for corn in the row or hill unless the soil is otherwise well supplied with available nitrogen to meet the much larger needs of the crop later on in the growing season. For maximum yields additional quantities of fertilizer should be plowed under. In recent experiments on upland soils it has been found profitable to supply the entire fertilizer needs of the crop in that way.

NONARABLE SOILS

The more sloping, eroded, and gullied phases of the Cincinnati, Zanesville, Wellston, Frederick, Princeton, and Otwell soils, most of the Wellston-Muskingum complex, and all of the Muskingum stony silt loam and other rough stony land are not suited to ordinary farming purposes and should be regarded as nontillable and kept out of cultivation. Some of the land in this category that has been cleared may be put into permanent pasture by seeding to a mixture of bluegrass, redtop, and lespedeza, but much of it should be reforested and given protection from livestock as the most practical means of saving it from destruction by erosion. Where it seems feasible to establish pasture on acid-soil areas of nontillable land, the chances of success may be greatly improved by applications of 2 to 4 tons of ground limestone and 300 to 400 pounds of superphosphate to the acre, either on top of present stands or before fresh seedings.

Thousands of acres in this county have been severely eroded or damaged seriously by erosion, and such damage will become progressively worse unless decisive steps are taken to prevent it. Establishment of a good vegetative cover to hold the soil in place is essential. Contour furrows on hillsides and dams or other engineering devices in gullies should be employed wherever practicable, but undisturbed forest or a solid vegetative cover of some other kind should be the ultimate aim.

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