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Soil Survey
of
Rush County, Indiana

By

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and
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Bureau of Chemistry and Soils
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Purdue University Agricultural Experiment Station

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SOIL SURVEY OF RUSH COUNTY, INDIANA

By C. S. SIMMONS, United States Department of Agriculture, in Charge, and D. R. KUNKEL and H. P. ULRICH, Purdue University Agricultural Experiment Station

INTRODUCTION

Rush County lies in a region of well-distributed and high rainfall and moderate average annual temperature, with warm summers and cold winters. The climate is continental, and climatic conditions are highly favorable to a diversified agriculture based on grain growing, mainly corn, with oats and wheat as accompanying small grains, grass for hay and pasture, and fruits and vegetables.

The relief is that of a smooth plain underlain by both ice-laid and water-laid unconsolidated clay, sand, and gravel, accumulated by glacial processes. This material is sufficiently thick to cover the underlying limestones to such a depth that they contribute very little if any material from which the soils are formed. This glacial drift, as it is called, was laid down during three periods. The deposits belonging to the younger two, or Wisconsin, glacial periods occupy all the county except a very small area in the extreme southeastern corner. Within the area of these younger deposits are two comparatively narrow belts underlain by gravel. The rest of the area is underlain by glacial till consisting of an intimate mixture of sand, clay, and gravel.

The county lies within the belt of Gray-Brown Podzolic soils, which occupy the midlatitudes of the United States, extending from the Atlantic coast westward to western Indiana. Before occupation by man, this belt was covered by hardwood forest consisting principally of oak, beech, and maple.

The well-drained soils are along the streams and also occur in small slightly elevated areas scattered widely over the rest of the county. The well-drained elevated spots number many thousands, and they have no systematic distribution. As a whole the area occupied by the older, or early Wisconsin, glacial deposits is better drained than that occupied by the younger, or late Wisconsin, drift.

The better drained soils are podzolic; in other words, are leached soils. This renders them less productive than the poorly drained dark soils of the lowlands. In addition to this leached condition, which refers to their mineral content, they have a low content of organic matter and therefore of nitrogen, one of the important plant nutrients. Many of them are underlain by rather heavy subsoils which tend to reduce still further their inherent productivity. In this report the well-drained upland soils are described as members of the Miami, Fox, Russell, and Bellefontaine series. The soils of the Crosby and Fincastle series, although light colored, are imperfectly drained and have distinctly heavy subsoils which harden on drying. They are the less productive soils but under good treatment can be made productive.

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The dominant soils over large areas, which occupy shallow depressions and flats throughout the county, were poorly drained under natural conditions. Most of the poorly drained soils are dark, but a few comparatively small bodies are light colored. The dark soils are described as members of the Clyde, Brookston, Westland, and Abington series, and the light-colored poorly drained soils as members of the Bethel, Homer, and Delmar series.

In general, the soils developed from the early Wisconsin drift have been more thoroughly leached than those developed from the late Wisconsin. Only a small proportion of the area of the early Wisconsin drift is occupied by dark soils, but the total extent of dark soils in the area of the late Wisconsin drift is large, amounting to almost as much as the total extent of light-colored soils.

Agriculture is diversified, with corn as the dominant crop. The dominance of this crop is a natural response to the character of the soils, rather than a response to the geographic position of the county.

The dark soils, which were originally poorly drained but practically all of which have been artificially drained since the land has been inhabited by white men, are among the most productive soils for corn in the United States. They are productive for this crop because they have not been podzolized; in other words, they have not yet been leached to so great an extent as the light-colored soils. Not only have they not been leached, but they have accumulated a considerable, in some places a large, amount of organic matter. The organic matter furnishes material from which nitrogen may be made available, and it also assists in maintaining the physical structure of these soils. Freedom from leaching also results in the retention of a good supply of the mineral elements of fertility and in some soils the inherent, or what may be called the original content of the mineral elements of fertility, has been increased by an accumulation of these constituents washed from the adjacent higher areas of light-colored soils. Their physical characteristics and relief favor an abundant water supply. They, therefore, have both the physical and chemical characteristics necessary to a good yield of an exacting crop like corn which requires a good supply of water and an abundant supply of plant nutrients.

The light-colored soils produce better yields of small grains, especially wheat, than of corn. Wherever the distribution of soil on a farm allows, the light-colored soils are used for some crop other than corn, but because of the irregular and intricate distribution of the soils, very few, if any, farms consist entirely of either light-colored soils or dark-colored soils. The light-colored soils are naturally better producers of most vegetables and, in general, of fruit. Although they are not more productive of grass than the dark soils, it is advisable, because of their characteristics, for the farmer to devote the light-colored soils to grass and legumes for hay to a greater extent than the dark soils. This is advisable, as the light-colored soils are inherently not highly productive and require crop rotation, including the growth of grasses and legumes for supplying nitrogen, for increasing the organic-matter content, and for maintaining the structure of the soil, in order that their productiveness may be maintained. Up to the present time, the dark soils have not required such careful treatment for maintenance of their productivity.

For two reasons, the type of farming includes the raising of livestock. Livestock are needed for the consumption of the large crop of corn produced, as corn has never been a market grain crop to such an extent as has wheat but is a crop used primarily as feed on the farm. A very large part of the corn crop is fed to hogs, and an important part of the livestock production includes the raising and fattening of hogs for market. Further, the use of manure on the light-colored soils for the maintaining of their productivity is an essential part of their management. This necessitates the raising of cattle, which fits into the farm practices of growing legumes, of growing grass for pasture and hay, and of disposing of the surplus corn not required for the hogs by raising and fattening cattle. The natural conditions, determined by the characteristics of the soils and by the climate, favor, therefore, a wide range of crops and a wide diversity in the agricultural enterprises.

Fruit growing and vegetable growing are engaged in mainly to supply home needs or local markets, and neither is well developed on a commercial basis.

COUNTY SURVEYED

Rush County is in east-central Indiana (fig. 1). Rushville, the county seat, is 40 miles southeast of Indianapolis and 70 miles northwest of Cincinnati, Ohio. The area of the county is 409 square miles, or 261,760 acres.

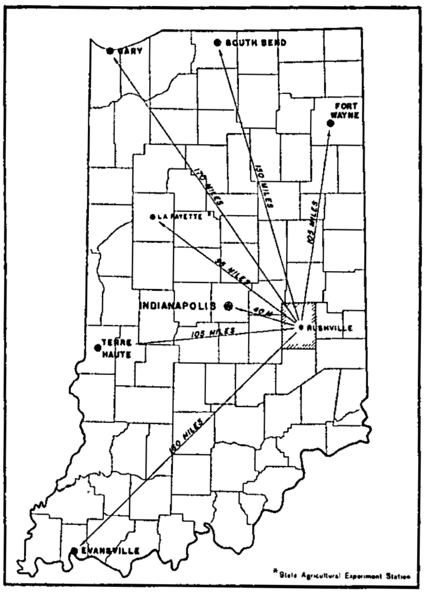

FIGURE 1.—Sketch map showing location of Rush County, Ind.

The relief in its broad aspect is that of a plain sloping gently to the southwest. In detail the relief is low but varied and lacks any striking features. The maximum elevation is 1,116 feet above sea level, the minimum 825 feet, and the average 975 feet. The maximum local relief, which occurs in the southeastern corner of the county, is 75 feet.[1] With the exception of about 60 acres of Illinoian drift in the extreme southeastern corner, the upland is underlain by ground moraine of the Wisconsin glacial period. Two substages of the Wisconsin are represented—the late Wisconsin, north and west of Flatrock Creek, and the early Wisconsin, south and east of it. This stream is not an exact boundary, as some late Wisconsin drift is south of the creek, and some early Wisconsin is west of it. The extreme northeastern part of the county also is covered with late Wisconsin drift.

[1] LOGAN, W. N., CUMINGS, E. R., MALOTT, C. A., VISHER, S. S., TUCKER, W. M., and REEVES, J. R. HANDBOOK OF INDIANA GEOLOGY. Ind. Dept. Conserv. Pub. 21, 1120 pp., illus. 1922.

Eventually all the drainage waters reach Ohio River. Drainage of the larger part of the county reaches the Ohio through East Fork White River, White River, and Wabash River. About 20 square miles in the southeastern part are in the drainage basin of Whitewater River. This basin is deeply and thoroughly dissected, as the water travels only about 100 miles to the master stream (the Ohio), whereas the drainage water entering through Wabash River travels approximately 300 miles. For this reason, in the greater part of Rush County, the erosional cycle is very young, and dissection is neither deep nor thorough. The main streams flow toward the southwest, following the general slope of the plain. Blue River was rather deeply entrenched by glacial waters, but this stream, as well as the smaller streams, has only a few short branches. Much of the land depends on artificial drainage. There are more stream branches east of Flatrock Creek, as this part of the county is somewhat older and the erosional cycle is, therefore, more nearly mature. A dendritic system of drainage is developing here.

That part of the Wisconsin glacial till plain in the drainage basin of Wabash River has, as mentioned before, no striking topographic features. The minor features of relief are extremely important, as only slight variation in relief produces marked changes in soil characteristics. The stream valleys are shallow but steep sided, and, on a cursory examination, this is the only relief apparent; but close examination of the land not dissected by drainageways shows that slight dips and swells occur, with a local difference in elevation of 1 or 2 feet. It is the intricate pattern of these dips and swells that has produced the equally intricate black-and-white-soils pattern in central Indiana. The dips, or depressions, have been receiving the local surface run-off from the swells, and they have been wet lands ever since recession of the glacier. In fact, before the land was cleared, these low areas were under water a great part of the year.

The lowest swells have had fair surface drainage, with a high water table in wet seasons and a lower water table during dry times, mostly in the late summer. Where the local relief is more than 2 feet, the water table has been sufficiently low to allow complete drainage most of the year. In narrow belts along the streams, where the local relief is several feet, the land is well drained, and it is in such locations that the greater acreage of well-drained soils occurs.

In the section where the early substage of the Wisconsin glacial till plain occurs and the dendritic drainage system is more perfectly developed, the relief is more nearly undulating, the regional drainage is better, the water table is generally lower, and the proportion of well-drained land is greater.

That part of Rush County lying in the drainage basin of Whitewater River has a rolling relief, owing to the deeply entrenched stream valleys and the good development of a dendritic drainage system. Here, the regional drainage is practically perfect, and most of the depressions have been given an outlet, so that this section includes very few poorly drained areas.

The depressions, or areas of dark soils, were forested principally with ash, elm, and sycamore; the light-colored but imperfectly drained swells with beech; and the well-drained light-colored soils with sugar maple and oak. These trees were not confined to the particular locations designated, however, as just as many beech trees grew on the poorly drained as on the well-drained soil areas, and some maple, oak, and elm grew on the light-colored but imperfectly drained swells.

When Indiana was admitted to the Union in 1816, there were no white settlers in that part now included in Rush County, but the land was ceded by the Indians in 1818, and within a few years many pioneers had established homes and small clearings. In 1822 Rush County was formed from Delaware County and the present boundaries were established. Most of the early settlers came from Kentucky and Virginia, with some Friends from the Carolinas. Both the county and the county seat were named in honor of Benjamin Rush of Philadelphia, one of the signers of the Declaration of Independence.

According to the 1930 census,[2] the population numbers 19,412, of which 5,709 are urban and 13,703 rural. The density of the rural population is 33.5 persons a square mile. Rushville, the county seat and largest town, has a population of 5,709. Smaller towns are Carthage, Milroy, Manilla, Arlington, Raleigh, Homer, New Salem, Mays, Falmouth, Richland, Sexton, Moscow, and Williamstown.

The county is very favorably situated as regards transportation facilities. Four steam railroads, the Baltimore & Ohio, the Pennsylvania, the Cleveland, Cincinnati, Chicago & St. Louis, and the New York, Chicago & St. Louis pass through Rushville. These serve practically all sections. Washington, Noble, Orange, and Richland Townships are the only townships not crossed by a railroad. In addition to the railroads, United States Highway No. 52 and several State highways serve the county. Practically all the secondary roads are graveled and kept in excellent condition throughout the year. They provide ready access to most of the farms.

The excellent roads have made possible the consolidation of all schools, and no school has less than four teachers. Churches of many denominations are well distributed in the rural districts, and nine denominations are represented in Rushville.

Many farms, especially in the northern half of the county, have private gas wells, and telephones are within reach of all. A power line crosses the southwestern corner.

This is not an industrial county, but several furniture factories and some small manufacturing concerns are at Rushville, a strawboard factory at Carthage, and tile factories at Williamstown and Homer.

CLIMATE

Rush County has a continental climate, with rather cold winters and hot summers. The winters are not consistently cold but are characterized by short cold spells. High temperatures in the summer months are not continuous but are often accompanied by high humidity which adds to the discomfort of man.

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[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given when possible.

A study of table 1 will show that the rainfall is generally well distributed throughout the 6-month growing season. The distribution differs from year to year. The year 1929, during which much of the field work on this survey was done, was very wet until the middle of June and was then dry until early fall.

In general the climate is very favorable to such crops as corn, oats, clover, and winter wheat, and the snowfall is usually sufficient to protect wheat from freezing. Potatoes are not particuarly successful, as the summers are too warm. No winter vegetables can be grown in the open. Field work can seldom be performed between December and March.

The average date of the last killing frost is May 3 and of the first is October 3, giving an average frost-free season of 153 days. Frost has occurred as late as May 28 and as early as September 11.

Table 1 gives climatic data as recorded by the United States Weather Bureau station at Mauzy.

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

[Elevation, 980 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1895)	Total amount for the wettest year (1929)	Snow, average depth
	°F.	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	30.3	65	−21	3.08	4.03	4.68	6.5
January	26.8	68	−26	3.42	4.51	6.05	8.1
February	28.9	71	−25	2.94	.61	3.60	5.8
Winter	28.7	71	−26	9.44	9.15	14.33	20.4
March	38.9	86	−4	4.10	1.56	3.23	4.5
April	50.2	87	15	3.60	1.23	5.08	.9
May	60.7	96	26	4.10	.79	6.16	.1
Spring	49.9	96	−4	11.80	3.58	14.47	5.5
June	69.7	99	35	3.94	3.78	8.45	.0
July	73.5	108	42	3.26	.35	6.04	.0
August	71.1	102	36	3.31	1.21	2.84	.0
Summer	71.4	108	35	10.51	5.34	17.33	.0
September	65.4	101	25	3.11	2.02	2.58	.0
October	53.0	90	14	2.91	.63	4.15	.1
November	40.5	79	−10	3.24	6.12	2.21	1.7
Fall	53.0	101	−10	9.26	8.77	8.94	1.8
Year	50.8	108	−26	41.01	26.84	55.07	27.7

AGRICULTURE

Rush County is a community in which general farming has always been practiced. Corn is the most important crop, and about one-third of the entire area is planted to this grain each year. The production of swine has long been the most important branch of farming, and about 60,000 head are raised annually. More hogs are raised here each year than in any other county in Indiana, and this county is among the leading hog-producing counties of the United States.

Prices for farm land are in general high, although in recent years many desirable farms have sold for less than their former value.

More fertilizer is now being used than formerly. Most of the fertilizer is bought ready mixed, the most common mixture being 2–12–6.[3]

Originally, most of the farms were operated by owners, but now nearly half are operated by tenants. About one-half of the tenants pay a cash rent, and the rest receive a share of the crops and livestock. Most of the farm labor is local, but many men come in from Kentucky and southern Indiana for the corn harvest.

The average size of farms has been about 120 acres since 1880, but several estates include more than 1,000 acres.

That this is a prosperous farming community is reflected in the prevalence of well-kept and well-equipped farms. Large houses with spacious lawns and large barns are the rule rather than the exception, and most of the farms have much modern machinery. Fences are in good repair, and the fence rows are kept clean. A very noticeable feature is that the roadsides are well sodded. They are kept mowed and not left to grow up to briers and weeds.

Tables 2, 3, and 4 give the acreage of the principal crops, the number and value of domestic animals, and selected farm statistics, as reported by the Federal census for stated years.

TABLE 2.—*Acreage of principal crops in Rush County, Ind., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn	60,872	59,098	67,225	80,287	79,645	75,283	69,872
Wheat	42,777	53,038	64,874	51,428	55,860	47,770	45,425
Oats	3,185	7,543	1,522	5,679	6,352	7,118	5,581
Rye	70	212	27	87	3,370	2,277	1,939
Potatoes		526	479	584	365	295	278
Hay	11,639	19,437	26,490	23,300	19,380	18,234	26,741
Tobacco	2	2	24	24	121	130	51
	Vines	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*	*Vines*
Grapes			20,733	3,260	2,856	1,504	
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		30,554	61,295	44,809	30,608	12,548	
Peaches		4,521	13,665	16,890	2,449	2,836	

TABLE 3.—*Number and value of domestic animals in Rush County, Ind., in 1930*

Kind of livestock	Number	Value	Kind of livestock	Number	Value
Horses	6,839	$542,005	Swine	132,455	$1,258,880
Mules	557	48,527	Sheep	15,288	118,723
Cattle	15,569	833,532	Chickens	146,872	130,716

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

TABLE 4.—*Selected farm statistics for Rush County, Ind., in stated years*

	1880	1890	1900	1910	1920	1930	1935
Farms............number..	2,152	2,066	2,267	2,143	2,044	1,875	2,139
Average size...........acres..	118.0	118.0	112.4	118.5	123.8	132.7	116.9
Improved land per farm.do....	89.4	98.1	93.4	103.5	108.9	110.2	96.6
Land value per acre..dollars..	....	....	$47.30	$95.45	$166.65	$69.50	(1)
Cost of labor...........do....	....	....	186,500.00	331,967.00	787,980.00	316,450.00	(1)
Cost of feed............do....	....	....	....	142,218.00	1,287,302.00	612,048.00	(1)
Cost of fertilizer........do....	1,535.0	1,536.00	36,370.00	57,343.00	238,438.00	191,006.00	(1)
Farm operation:							
Owners..........percent..	74.8	66.07	61.0	58.7	56.9	52.7	53.4
Tenants............do....	25.2	33.93	36.9	40.6	41.4	46.8	46.3
Managers..........do....	....	....	2.1	.7	1.7	.5	.3

[1] Not reported

Very little grain is shipped. Corn that is not used on the farm where grown is usually sold to a neighboring farmer. Wheat is the only grain that is extensively marketed, about 60 percent of this crop being shipped.[4] One of the outstanding drawbacks here is the scarcity of grain elevators.

Dairying also is important in those sections where marketing facilities are available. Milk and cream are collected daily for the Shelbyville market in the southwestern part. Charlottesville is a concentration point for milk and cream for the Indianapolis market, and these products are collected by truck. Rushville is a large local market for milk and cream. It has two ice-cream factories and a creamery, and it is also a concentration point for the cream shipped to Indianapolis.

Some cattle are fed and some sheep are raised.

Other sources of agricultural revenue are crops for canning and tobacco. A small acreage of tobacco is grown in the vicinity of Milroy, but tobacco growing is not important. Canneries, which use tomatoes, sweet corn, and pumpkins, are located in Glenwood, Arlington, and Milroy. Carthage and Charlottesville are concentration points for produce for canneries in adjacent counties. The production of crops for canning is important only in the vicinities of the towns mentioned, and even there no large acreages are planted to such crops.

SOILS AND CROPS

Agriculturally this county ranks among the richest counties in the United States. Its agricultural wealth has its basis in the fertility of its soils, but the fertility of the soils and the prosperity of the county have been maintained by an exceptionally intelligent, thrifty, and industrious group of farmers who settled here and are practicing a type of agriculture suited to the soils and climate.

Both light- and dark-colored soils occur, the light-colored soils being more extensive, covering about 60 percent of the total area. These light-colored soils are not poor soils, however, and many farmers prefer the better drained light-colored soils which they call "sugar-tree land."

As Rush County is characterized by warm moist summers so well suited to the production of corn, it is natural that corn should be

[4] Information provided by the county agricultural agent.

the principal crop, and about 80,000 acres are planted to this crop each year.

Small grains and hay, combined, are grown on about the same acreage as corn. Wheat is by far the most important small-grain crop and approximately 40,000 acres are sown annually. Oats rank next in importance, and usually less than 20,000 acres are sown each year. Rye is another small grain grown, but less than 5,000 acres are in rye each year.

It is generally recognized that corn is most successfully grown on dark soils, but the light-colored soils also return large yields of corn where fertilizer and manure are used. The small grains are best suited to the light-colored soils, as they frequently lodge, and fall-sown grains are more likely to "heave" or freeze during the winter on the dark soils.

About 20,000 acres are devoted to hay each year. Red clover, timothy, and a mixture of the two, are the most important hay crops.

In any discussion of the agriculture of Rush County, however, it is not possible to divide the light- and dark-colored soils on a regional or geographic basis. A glance at the soil map will show that these soils are so intricately mixed, except in the extreme southeastern corner, that hardly a field occurs in which all or even 90 percent of the land is in either soil group. Hence the agriculture practiced is equally concerned with soils of both groups. There are, however, two main agricultural sections in the county, roughly divided by Flatrock Creek. On the north and west of the creek is an area with a comparatively large proportion of dark-colored soils, less of the well-drained light-colored soils, or so-called sugar-tree land, and small areas of the imperfectly drained light-colored soils thickly scattered throughout the darker soils. On the south and east is an area where light-colored soils, especially the better drained ones, predominate. Here, although the dark soils cover a smaller acreage, they occur in large individual areas.

For convenience, the soils in these sections may be named for their dominant or characteristic soil types. The soils in that part of the county north and west of Flatrock Creek where the Crosby and Brookston soils are dominant are placed in the Crosby-Brookston soils group, and those in the part south and east of the creek where the Russell soils are dominant are placed in the Russell soils group. Two other geographically associated groups of soils, that occupy comparatively small acreages, are the soils of the terraces, dominated by the Fox and Westland soils which have agricultural characteristics comparable to those of the Crosby-Brookston soils group; and the overflow, or first-bottom, lands which may be termed the Genesee-Eel soils group.

In general, the areas occupied by the Crosby-Brookston soils group and the Fox-Westland soils group are suitable for the production of corn, and the areas occupied by the Russell soils group are better adapted to a somewhat more diversified type of farming, although corn continues to be the principal crop.

In the following pages, the soils are described in detail, and their agricultural relationships are discussed; their distribution and location 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 Rush County, Ind.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Miami silt loam	31,744	12.1	Genesee loam	832	0.3
Miami silt loam, terrace phase	192	.1	Eel silt loam	9,088	3.5
Crosby silt loam	32,512	12.4	Eel loam	128	.1
Bethel silt loam	1,408	.5	Russell silt loam	23,616	9.0
Brookston silty clay loam	74,688	28.5	Russell silt loam, shallow phase	20,416	7.8
Clyde silty clay loam	3,392	1.3	Fincastle silt loam	5,824	2.2
Fox silt loam	5,952	2.3	Fincastle silt loam, shallow phase	9,792	3.8
Fox silt loam, colluvial phase	192	.1	Delmar silt loam	640	.2
Fox silt loam, deep phase	5,888	2.2	Avonburg silt loam	64	.1
Fox loam	512	.2	Bellefontaine silt loam	448	.2
Milton silt loam	704	.3	Miami silt loam, slope phase	2,944	1.1
Homer silt loam	1,536	.6	Russell silt loam, slope phase	2,432	.9
Homer silt loam, dark-colored phase	1,664	.6	Fox silt loam, slope phase	320	.1
Westland silty clay loam	11,008	4.2	Edwards muck	64	.1
Abington silty clay loam	3,712	1.4			
Millsdale silty clay loam	896	.3	Total	261,760	------
Genesee silt loam	9,152	3.5			

CROSBY-BROOKSTON SOILS GROUP

The soils included in the Crosby-Brookston soils group are Miami silt loam; Miami silt loam, terrace phase; Crosby silt loam; Bethel silt loam; Brookston silty clay loam; and Clyde silty clay loam. These last two dark soils are also mapped in the section where the Russell soils are dominant.

The soils of this group cover 54.9 percent of the county, or 143,936 acres. The Crosby and Brookston soils occupy 32,512 and 74,688 acres, respectively, or more than 74 percent of the total area of the group. They are also the two soils that make up about 90 percent of the "black-and-white land" in central Indiana. The Miami and Clyde soils are mapped on 31,936 and 3,392 acres, respectively. Bethel silt loam is of very small extent, covering less than 1500 acres.

In the area covered by soils of this group, corn is the principal crop. The reason for this is twofold: (1) Corn has been a profitable crop and (2) small grains do not always make a crop on the dark soils. Corn will return a fair crop on the dark soils even if a wet spring prevents planting until June, whereas this same wet condition would greatly decrease the yield of wheat or rye and make an oat crop practically impossible. Frequently, when a wet spring makes a small-grain crop impossible, the wet spots are planted to corn, thus further increasing the acreage of this crop. The general rotation of crops here is corn, corn, wheat or oats, and a legume crop, usually red clover.

Miami silt loam.—Miami silt loam is the best drained soil of this group. It commonly occurs where the local relief exceeds 2 feet on the plain and along the drainageways. It is commonly known as sugar-tree land.

The surface soil is grayish-brown or yellowish-brown silt loam to plow depth, and below this, to a depth ranging from 8 to 12 inches, it is of similar texture but is lighter colored, in many places being grayish yellow. The subsoil, beginning at an average depth of 10 inches, is yellowish-brown or reddish-brown silty clay loam or clay loam. The material becomes darker and heavier with depth, in most places being sticky brown or reddish-brown clay loam just above the gritty limy material that occurs at an average depth of about 24 inches. The limy material extends to great depths, in most places to bedrock.

As this is the best drained soil of the Crosby-Brookston soils group, it is the first to become tillable in the spring. It is an excellent soil for small grains, and corn returns a good crop if properly fertilized and manured. On account of the well-drained subsoil and the fact that this soil in places lies higher than the surrounding country, especially in the northwestern part of the county where Blue River has dissected a deep channel, air drainage is better than on the other soils of the group. For these reasons, most orchards are planted on Miami silt loam.

Miami silt loam, terrace phase.—The terrace phase of Miami silt loam occurs only on high benchlike locations along Blue River. These benches are about 20 feet above the river bottoms and from 30 to 40 feet below the areas of typical Miami silt loam.

The surface layer of this soil has the same general color characteristics as typical Miami silt loam, and the subsurface layer is grayish-yellow silt loam, but the yellowish-brown or reddish-brown subsoil may be somewhat brighter or redder. The textural characteristics are slightly different in the two soils, as the terrace phase contains considerable grit in all layers, the surface layer in places being loam. The lower subsoil layer, or limy material, is different from that in typical Miami silt loam, as the material of the terrace phase contains more sand and stone fragments and many of the pebbles are rounded, indicating the influence of running water. The deep substratum may consist of beds of gravel.

Crosby silt loam.—Crosby silt loam, commonly known as "beech land", is the most extensive light-colored soil in this group and in many places is closely associated with Miami silt loam. It occupies the flatter positions adjacent to Miami silt loam but farther removed from the streams, also most of the slight rises in the areas of Brookston silty clay loam. This soil is imperfectly to poorly drained.

This soil has a gray or grayish-brown silt loam surface soil that is light gray when dry. Below plow depth and above the heavier subsoil is a 2- or 3-inch layer of mottled gray and yellow silt loam which in many places is decidedly gray. Beneath this, from a depth of about 9 to a depth of 20 inches, is mottled gray and brownish-yellow silty clay loam. The next layer, extending from about 20 to 30 inches, is mottled brownish-yellow and dark grayish-brown gritty clay loam, and underlying this is the gritty limy material similar to that in the Miami soil.

Bethel silt loam.—Bethel silt loam occurs on the very slight rises in the Brookston plain. It is decidedly gray from the surface downward. The surface soil is ash colored when moist and white when dry. The subsoil is heavier, similar to that of Crosby silt loam, with somewhat prominent dark rust-brown spots. The surface soil sometimes has a peculiar and disagreeable odor. Just above the limy material, which in most places begins at a depth of about 40 inches, is a dark-brown claypan layer that is very hard when dry.

This soil is very cold and soggy in the spring and in general is not very productive.

Brookston silty clay loam.—Brookston silty clay loam forms the background of the black-and-white soils in central Indiana. It occurs in low places and, unless artificially drained, is wet. It is a very fertile soil, with a high organic-matter content, is only slightly leached, and has favorable tilth and water-holding capacity. This soil is commonly known as black loam. It is the soil that is chiefly responsible for the large acreage of corn grown in Rush County. It is well distributed both in the northern and southern parts, in fact, there are few farms with none of this soil.

Brookston silty clay loam consists of dark-gray or dark grayish-brown silty clay loam to a depth of 12 or 15 inches, where it is underlain by mottled gray and grayish-yellow clay loam. The limy substratum, in most places, lies at a depth of more than 6 feet.

Clyde silty clay loam.—The other dark soil of this group, Clyde silty clay loam, in general occupies depressions within the Brookston soil areas. It is darker colored in the surface soil and grayer in the subsoil than Brookston silty clay loam. Clyde silty clay loam is called "gumbo" land by many farmers. It is widely distributed throughout this county, and most of it occurs at some distance from the streams. This soil has many characteristics similar to those of Brookston silty clay loam, but they are expressed to a greater degree. The soil is lower, wetter, deeper, and darker than the Brookston soil. If not drained artificially it may be too wet for cultivation, and for this reason many areas are in permanent wood lots or pastures.

Clyde silty clay loam has a very dark gray or black silty clay loam surface soil extending to a depth ranging from 12 to 20 inches. Beneath this is steel-gray clay or clay loam, speckled with yellow in many places. In some places, the limy substratum is more than 8 feet below the surface.

FOX-WESTLAND SOILS GROUP

The soils of this group, which includes Fox silt loam, Fox silt loam, colluvial phase, Fox silt loam, deep phase, Fox loam, Homer silt loam, Homer silt loam, dark-colored phase, Milton silt loam, Westland silty clay loam, Abington silty clay loam, and Millsdale silty clay loam, are similar agriculturally, but they are distinct soil types. The Fox, Homer, and Milton soils are light-colored soils, and the others are dark. All these soils occur on terraces, or second bottoms, and are underlain by sand or gravel, except the Milton and Millsdale soils, which are underlain by limestone.

These soils are not extensive, as they occupy, collectively, only about 32,000 acres. The light-colored soils cover about 8,000 acres and the dark soils 24,000 acres. It is this large percentage of dark soils that gives the soils of this group agricultural characteristics similar to those of the Crosby-Brookston soils group. The soils in this group differ from those in the Crosby-Brookston group in that they are underlain by gravel and are, therefore, proportionately better drained than the corresponding soils underlain by glacial till. Another difference is that many of the individual soil areas are larger, so that a field may be wholly or nearly all one type of soil.

The largest areas of these soils are in the vicinities of Carthage and Raleigh. Two soils, Milton silt loam and Millsdale silty clay loam, occur only in the southern part of the county, where limestone is near the surface. These two soils, however, are very small in extent, each covering less than 1,000 acres.

Fox silt loam.—Fox silt loam resembles Bellefontaine silt loam, but it lies on terraces where the relief is smoother than that of the Bellefontaine soil. The soil material above the gravel layer is also a little thicker. The surface soil is brown or brownish-yellow silt loam which becomes lighter yellow below plow depth. At a depth ranging from 8 to 12 inches, the material becomes reddish-brown silty clay loam which is underlain, at a depth of 30 or more inches, by dark sticky gritty clay loam. This material is underlain, at a depth of 3 feet or more, by a 3- or 4-inch layer of stratified gravel containing a high proportion of limestone pebbles. In many places the gravel is very clean and is suitable for road building. Many dry gravel pits occur in areas of this soil.

All the different types and phases of the Fox soils have about the same agricultural characteristics, and all are well suited to growing small grains.

Fox silt loam, colluvial phase.—Fox silt loam, colluvial phase, occurs on the apronlike formations between the flat terraces and the upland slopes. The surface soil is grayish-brown or brown silt loam. The subsoil in most places is reddish-brown silty clay loam, but in some places where it is imperfectly drained, it is mottled gray, rusty-brown, and brown silty clay loam. In most places gravel does not occur closer to the surface than a depth of 60 inches. The soil material was accumulated by sheet erosion carrying down the surface material from the steeper adjoining slopes. This is a very fertile soil.

Fox silt loam, deep phase.—The deep phase of Fox silt loam differs from Fox silt loam as described, in the greater thickness of the surface soil and the heavier subsoil layers, with a corresponding greater depth to the underlying gravel. The total thickness of the soil layers above the gravel is in most places 5 feet or more. This soil is as fertile as Fox silt loam and has a somewhat more favorable moisture-holding capacity in seasons of extreme drought, which at times affect crops on the silt loam.

Fox loam.—Fox loam is an inextensive soil occurring in small individual areas on the narrow terraces and not with the larger bodies of the soils of this group. Much of this soil is used as pasture. The 12-inch surface soil is grayish-yellow loam, and the upper subsoil layer is reddish-brown clayey loam or clayey sandy loam. The lower subsoil layer consists of sand and gravel, and beds of sand occur in places.

Small areas of Fox sandy loam are included with Fox loam as mapped. These sandy areas are similar in color to the loam areas, but they have more sand in the surface soil and subsoil.

Milton silt loam.—Milton silt loam occurs along Flatrock and Little Flatrock Creeks in the southern part of the county. It is similar to Fox silt loam in color and texture, but it is underlain by limestone bedrock instead of gravel. In some places a very thin (1 foot or less) bed of gravel lies above the limestone.

Homer silt loam.—Homer silt loam is one of the less extensive soils. It resembles Crosby silt loam in the upper soil layers. The surface soil is dark grayish-brown silt loam which, at plow depth, changes to yellowish-brown silt loam mottled with grayish yellow. At a depth ranging from 10 to 14 inches is the mottled yellow and brown silty clay loam subsoil which continues down to gravel that, in most places, lies at a depth ranging from 30 to 40 inches. A thin layer of dark-brown sticky sandy clay occurs in many places just above the gravel, which may be wet rather than dry.

Homer silt loam, dark-colored phase.—Homer silt loam, dark-colored phase, is the best drained dark soil in this group. It is well suited to growing both corn and small grains, as it contains sufficient organic matter for corn and has some local relief so that water seldom stands on it. It is chocolate-brown or dark brownish-gray silt loam to a depth of about 8 or 10 inches. Beneath this is yellowish-brown silty clay loam that is mottled with gray in many places. In most places the gravel beneath this soil lies at a depth of more than 40 inches, which is the average depth to ground water.

Westland silty clay loam.—Westland silty clay loam, the most extensive dark soil in the Fox-Westland soils group, resembles Brookston silty clay loam. It is dark-gray or brownish-gray silty clay loam to a depth of about 12 inches. Beneath this is dull-gray clay loam mottled with brown and brownish yellow. This layer may have a predominance of either gray or yellow. In most places gravel lies at a great depth beneath this soil, in few places occurring at a depth of less than 40 inches and in many places deeper than 50 inches. The gravel beds are wet rather than dry and do not make the land droughty. Westland silty clay loam occurs near the stream channels or in depressions on the higher terraces and is often submerged in the spring. It is, however, an excellent soil for corn.

Abington silty clay loam.—Abington silty clay loam is somewhat similar to Clyde silty clay loam. The surface soil is very dark gray or black clay loam underlain, at a depth of about 15 or 20 inches by gray clay. Water-bearing gravel occurs beneath the subsoil at a depth ranging from 4 to 5 feet. Like Clyde silty clay loam, this soil is very wet and is generally untillable unless artificially drained.

Millsdale silty clay loam.—Millsdale silty clay loam is associated with Milton silt loam. It is similar to the Brookston and Westland soils in its surface layers but is underlain by limestone at a depth of 3 feet or less. It has a dark-gray clay loam surface soil and a mottled gray and yellow clay subsoil.

GENESEE-EEL SOILS GROUP

Two other soils in the county are used primarily for corn, but they have no outstanding soil characteristics that would cause them to be included with the Crosby-Brookston soils group. These are the soils of the river bottoms mapped in the Eel and Genesee soil series. Areas of these soils occur along the streams and are overflowed practically every year. This feature makes them unsuitable for fall-sown crops or for any crop that is sown early in the spring. Therefore, when these stream bottoms are cultivated they are planted to corn. The larger proportion of the stream bottoms, about 60 percent, is in wood lots or permanent pasture.

About 19,200 acres of stream-bottom land are in the county. The widest areas are along Blue River and Flatrock Creek.

Genesee silt loam.—Genesee silt loam is the most extensive bottom-land soil in the county. It occurs in the well-drained bottoms. Both surface soil and subsoil are brown, with gray mottlings or rust-brown spots in places below a depth of 20 inches. Practically all the cultivated bottom land consists of this soil.

Genesee loam.—Genesee loam is similar to Genesee silt loam in color but has more sand in the surface soil, and the subsoil in many places is rather sandy. This soil is not extensive.

Eel silt loam.—Eel silt loam is imperfectly drained. The surface soil is dark-gray or brownish-gray silt loam speckled with rusty-brown spots or mottled with dull gray. In most places the upper subsoil layer is grayish-brown clay loam or silty clay loam. The lower subsoil layer is more gray and in most places is olive-gray clay loam or silty clay loam, mottled with rust brown. Streaks of sand occur in places in both subsoil layers. The water table is close to the surface, and in few places is the depth to free water more than 3 feet.

Eel loam.—Eel loam is similar in color to Eel silt loam, but it has a lighter texture, in many places being rather sandy, especially in the subsoil.

RUSSELL SOILS GROUP

Soils of the Russell soils group, or general-farming soils, lie south and east of Flatrock Creek and include Russell silt loam; Russell silt loam, shallow phase; Fincastle silt loam; Fincastle silt loam, shallow phase; Delmar silt loam; Avonburg silt loam; and Bellefontaine silt loam.

Natural drainage is better in this section of the county, and water seldom covers the ground for a great length of time, even in the lowest places. The areas of Brookston and Clyde soils included here are similar to those mapped in the northwestern half of the county, with the possible exception that they may have less organic matter in the surface soil and thus be a little paler or grayer. The better natural drainage also causes the subsoils to have a more yellow color.

The soils of this group cover 60,800 acres, or 23.3 percent of the county.

In this section of general farming, the small grains are dependable crops. The most common crop rotation is corn, wheat or oats, and a legume, usually red clover. Owing to their high silt content and better natural drainage, these soils usually warm up from 2 to 5 days earlier in the spring than analogous soils of the Crosby-Brookston soils group.

The most extensive soil in the group is Russell silt loam. It covers 39 percent of the area covered by the soils of the group. This is in great contrast to the Crosby-Brookston soils group, in which the best drained soil (Miami silt loam) occupies only 22 percent of the total area of the group.

Russell silt loam.—Russell silt loam also is called "sugar-tree land" and, by some farmers, "red clay land." The surface layer is very smooth silt loam which is yellowish brown when moist and grayish yellow when dry. Beneath this, ranging from a depth of 6 to a depth of about 14 inches, is grayish-yellow silt loam. The subsoil is reddish-brown or brownish-yellow grit-free silty clay loam to a depth of about 30 inches. The subsoil does not contain so much clay as the subsoil of Miami silt loam. In many places below a depth of 30 inches it becomes heavier and browner and usually contains much grit. In most places, brownish-yellow gritty limy clay loam does not occur above a depth of 50 inches.

Russell silt loam, shallow phase.—Russell silt loam, shallow phase, has layers corresponding in color and texture to typical Russell silt loam. These layers are, with the exception of the surface soil that extends down to plow depth, thinner than those of the typical soil. The grayish-yellow silt loam subsurface soil extends to a depth of about 8 or 10 inches, the reddish-brown or brownish-yellow grit-free silty clay loam layer to a depth of about 20 inches, and the heavier gritty lower subsoil layer to a depth between 30 and 40 inches, where limy material is present.

Fincastle silt loam.—Fincastle silt loam is an inextensive soil. It occupies a position analogous to that of Crosby silt loam. The surface soil is brownish-gray smooth silt loam to plow depth and beneath this is grayish-yellow silt loam, mottled with gray, to a depth of about 12 inches. The subsoil is brownish-yellow silty clay loam mottled with yellowish gray, and in many places this layer appears very yellow. It may become very gray, but in many places just above the limy material, which occurs at a depth ranging from 40 to 50 inches, it is brown gritty silty clay loam.

Fincastle silt loam, shallow phase.—Fincastle silt loam, shallow phase, is mapped where the limy material in areas of the silt loam occurs at a depth of less than 40 inches. Soil layers having the same color and texture as those of typical Fincastle silt loam are found in this shallow soil, but they are somewhat thinner.

Delmar silt loam.—Delmar silt loam occupies a very small total area and occurs mostly in very small individual bodies. It occupies very slight rises in the broader flats. It is the Bethel equivalent in this soil group. The surface soil, to a depth of about 12 or 15 inches, is ash-gray silt loam. Below this the material is mottled gray and grayish-yellow silty clay loam containing some rust-brown spots. Limy material is present at an average depth of about 50 inches, and in some places at as slight a depth as 30 inches. This is not considered a productive soil, as it is cold in the spring and becomes very dry and hard during the summer. Much of it is in wood lots and pastures.

Avonburg silt loam.—In the extreme southeastern corner of the county are about 60 acres of so-called white slash land. This soil has been mapped as Avonburg silt loam, but the area includes a number of other soils, such as Clermont silt loam and Cincinnati silt loam, which are important in some southern Indiana counties.

Avonburg silt loam has a surface soil of gray silt loam. Yellow mottlings appear at different depths, but the soil remains predominantly gray, and many rust-brown spots occur in the lower subsoil layer. Lime is not present above a depth of 10 feet. This soil is comparatively unproductive, as it is very cold and soggy in the spring and becomes very dry in dry weather. The only body in the county was not farmed in 1929.

Bellefontaine silt loam.—Several soils that occur in very small areas and have very little agricultural importance, on account of their small extent, are mapped. One of these is Bellefontaine silt loam. It occurs in all sections of the county and resembles Fox silt loam, except that it occupies knolls in the uplands. This soil occurs on drift of both early and late Wisconsin age and includes differences both in degree and depth of weathering, corresponding to the differences between the Miami and Russell soils. The surface soil is yellowish-brown silt loam, and the subsoil is reddish-yellow silty clay loam. Gravel is present in most places at a depth of about 30 inches. Much of the gravel is suitable for road construction, and there are many gravel pits in this soil.

MISCELLANEOUS LAND TYPES

Miami silt loam, slope phase; Russell silt loam, slope phase; and Fox silt loam, slope phase.—Slope phases of Miami silt loam, Russell silt loam, and Fox silt loam are mapped where the respective typical soils break to the bottom lands. Most of these areas are very steep, but in places they are cultivated in order to make the fields regular in shape. Most of the areas are long and very narrow. They are used mostly for pasture or wood lots, the uses to which they are best adapted, as, owing to their steep slope, they are difficult to till and when cultivated are subject to erosion.

Edwards muck.—Edwards muck is an inextensive soil occurring in a few very wet spots. It is similar, in color characteristics, to the Clyde soils, but the surface soil has a very high content of organic matter. The surface soil is black chaffy material, and the subsoil is gray and very limy. Except where artificially drained, the land is too wet for agricultural purposes.

SOILS AND THEIR INTERPRETATION

Rush County lies within the Gray-Brown Podzolic soils belt of the United States. This is a region that was originally forested, and leaching, or podzolization, has been one of the principal soil-forming processes. The well-drained, as well as the imperfectly drained, soils are leached of free bases and carbonates and, in the upper layers, of aluminum and iron. There is, thus, a relative concentration of silica in the surface soil, as this mineral is not readily leached.

According to their genesis, the soils of the county may be classified under two heads and rather arbitrarily designated as phytomorphic soils and hydromorphic soils. The phytomorphic soils are those which have been formed by the dominant soil-forming process of the region—podzolization; and the hydromorphic soils are those formed under the influence of a high water table.

The phytomorphic soils are all light colored and are characterized by an eluviated A horizon, an illuviated B horizon, and a C horizon of weathered or partly weathered materials. If these soils are comparatively old, they may have a dense claypan horizon with prismatic structure and a friable horizon with variable structure beneath the B horizon. The C horizon is not completely leached or podzolized but is kaolinized. Both the A and B horizons are leached of monovalent and divalent bases. Both the A and B horizons are acid in reaction. Sesquioxides of iron and aluminum and the finer

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soil particles washed from the A horizons have been concentrated in the B horizons. The A horizons are the most leached and might be expected to be the most acid in reaction, but decaying plant and animal remains restore some bases to the topmost layers of these horizons so that the B horizons are in many places the most acid. The concentration of colloids in the B horizons gives them a greater capacity to adsorb bases (or a greater base-exchange capacity) and also makes the texture heavier than in either the A or C horizons. The C horizon of about 95 percent of the soils is glacial till, and of the remainder is derived from alluvial or outwash deposits. Structurally, the A horizons are platy, the B horizons have an angular fine nut structure, and the C horizon has practically no development.

These soils are further grouped, according to the completeness of drainage, as well-drained soils, moderately well drained soils, and imperfectly drained soils. The well-drained soils occur nearest the drainage channels, or where the local relief and porous substratum are sufficient to keep the water table 30 or more inches below the surface. In this group the Russell, Miami, Fox, Milton. and Bellefontaine soils are placed.

Russell silt loam shows most completely the effects of the soil-forming processes in this county. It is a fully developed soil developed from early Wisconsin glacial drift and occurs only in the general section south and east of Flatrock Creek.

A profile of this soil, as observed 2 miles south of Orange, is typical, with the exception that in many places the carbonates lie at a greater depth than 60 inches. A description of this profile follows:

A_1. 0 to 2 inches, dark-gray silt loam, in which the silt content is very high. The material has a single-grain structure with slight indication of platiness. The reaction[5] is medium acid.

A_2. 2 to 10 inches, yellowish-gray very smooth silt loam. The structure is weakly platy, with plates about one-eighth inch thick, and the vertical structure planes are also faintly evident. Both series of structure planes are coated with a thin layer of light-gray silt. The soil material breaks across the structure planes almost as readily as along them. The reaction is strongly acid.

B_1. 10 to 13 inches, a transitional layer between the A and B horizons. The material appears mottled, owing to the presence of small spots of material from both horizons. The mass, when crushed, is grayish-yellow silt loam containing slightly more clay than the layer above. The part that resembles the A horizon extends downward from above and the browner B-horizon fraction extends upward. This is not a clear-cut saw-tooth effect, as there are small isolated areas of each horizon. The structure is fine nut, with irregular angular particles about one-eighth inch in diameter. The outsides of the particles are thinly coated with gray, but the interiors are uniformly grayish yellow or brownish yellow, generally the latter. This horizon breaks along the structure planes, but the particles are easily crushed. The reaction is strongly acid.

B_2. 13 to 26 inches, the main B horizon which consists of yellowish-brown light silty clay loam. The structure particles are small (about one-eighth inch in diameter), angular, and irregular. Some of them are coated with gray, but most of them are uniformly yellowish brown throughout. The material in this horizon breaks along the structure planes, and the particles are firm when dry. The reaction is strongly acid.

[5] Soil reactions were determined with LaMotte Teskit.

B_3. 26 to 46 inches, compact gritty yellowish-brown or brown silty clay loam containing some vertical streaks of gray and small very dark brown or black concretions. The crushed mass is brownish yellow. The structure particles are about one-fourth inch in diameter, irregular, and angular. The concretions do not appear to bear any relation to the structure planes, as they are distributed throughout the soil mass. The vertical cleavage planes are more strongly developed than the horizontal planes, giving a weak prismatic structure. This horizon is hard to penetrate with sampling tools. The reaction is strongly acid.

B_{31}. 46 to 51 inches, plastic gritty gravelly clay loam that appears brown when exposed but is yellowish brown when crushed. The material is nearly neutral in reaction, and this is the layer in which dissolved humus has been deposited. The structure planes are mainly vertical and about 1 inch apart, but some horizontal cleavage planes give the particles a very irregular shape. The faces of the planes are stained dull brown. The soil material breaks across the structure planes. The reaction is neutral.

C. 51 to 60 inches +, sticky brownish-yellow unassorted calcareous glacial till. The reaction is alkaline.

Russell silt loam, shallow phase, differs from typical Russell silt loam in that carbonates are closer to the surface, and the horizons are thinner. Carbonates are present at a depth of less than 40 inches. The difference in the texture profile from that of the deeper Russell silt loam is illustrated by comparison of the mechanical analyses of the various layers of the two profiles in table 6 (p. 23).

The other soils mentioned as having the same general characteristics as Russell silt loam differ in the character of the C horizon and in the degree to which they have developed the characteristic regional profile.

The Miami soils are younger than the Russell soils, as they are developed from late Wisconsin glacial till and are not developed so deeply. They are less silty, in some places even gritty, in the A and B horizons, as shown in table 6. The A horizons are grayer and the B horizons more plastic and browner than the corresponding horizons in Russell silt loam. In Miami silt loam carbonates are present in most places at a depth of about 36 inches.

The Fox soils have developed on river terraces and outwash plains from alluvial deposits. They are browner than the Russell soils in all horizons, and in most places calcareous gravel occurs within a depth of 3 feet.

Bellefontaine silt loam is mapped where clean, or comparatively clean, deposits of gravel occur on the moraine. The profile of this soil is similar to that of the Fox soils.

Milton silt loam occupies terraces underlain by limestone. This soil is similar to the Fox soils except that the C horizon is limestone instead of alluvial gravel. In some places, however, a very thin layer of gravel lies above the limestone. It is probable that some of the Milton soil was developed from limestone that was exposed by stream action and that other areas were developed from gravel deposited on the exposed limestone.

The moderately well drained soils occur where the normal water table may lie at a depth of 30 or more inches, but their moderately tight subsoils retard percolation of water. The soils in this group are the Fincastle, Crosby, and Homer soils.

Fincastle silt loam is associated with Russell silt loam. It is, therefore, the oldest and most thoroughly leached soil in this soil group.

The following description of a profile of Fincastle silt loam, as observed 1 mile southeast of Rushville in a cut-over wood lot, is typical, except that in most places carbonates are not present at a depth of less than 50 inches.

A_1. 0 to 3 inches, dark-gray smooth platy silt loam, with the plates about one-sixteenth inch thick. The material contains many fine root channels that are coated with rusty brown. The faces of the laminations are slightly grayer, especially at the bottom of the horizon, and this gives the material the appearance of being mottled with gray.

A_2. 3 to 11 inches, yellowish-gray or brownish-gray smooth platy silt loam, with plates about one-eighth inch thick. The faces of the plates are slightly grayer, giving the material a mottled appearance. A granular structure is slightly evident, especially at the lower limit of the horizon.

B_1. 11 to 15 inches, brownish-gray silt loam which is slightly heavier than the material in the horizon above. A fine nut structure is developed, but the particles are weak, as the mass breaks readily across the cleavage planes. The particles are angular, irregular, and about one-fourth inch in diameter. The faces of the particles are light grayish brown, but the interiors are darker. The interiors of the particles are vesicular.

B_2. 15 to 28 inches, brownish-yellow silty clay loam mottled with yellowish gray. The mottling occurs on the faces of the structure particles. The structure is fine nut, and the particles are irregular, angular, and range from one-eighth to one-fourth inch in diameter.

B_3. 28 to 36 inches, yellowish-brown gritty silty clay loam streaked with gray and dull brownish gray. The streaking occurs on the structure planes, the gray color appearing in streaks about one-eighth inch thick on the vertical planes and the brownish gray as very thin films on the horizontal planes. The structure is weakly prismatic. The material was moist when sampled, but in other observations the prisms were firm. When dry, the material in this layer is very difficult to penetrate with a soil auger. The prisms separate into an irregular angular nut structure with aggregates ranging from one-half to 1 inch in diameter.

B_{31}. 36 to 43 inches, brown gritty silty clay loam mottled with rusty brown, gray, and brownish gray and containing some soft dark concretionary masses. The material of this horizon is generally massive in structure but has horizontal breakage planes from one-fourth to one-half inch apart. The material is everywhere soft and plastic, and this feature is one of the unvarying characteristics of this soil.

C_1. 43 to 50 inches+, grayish-yellow plastic clayey calcareous glacial till.

Fincastle silt loam, shallow phase, is essentially the same as the typical soil except that the horizons are thinner, with calcareous material occurring at a depth ranging from 30 to 40 inches.

Crosby silt loam, the most extensive light-colored soil in Rush County, occurs on the less well drained areas, in association with Miami silt loam. In most places free lime is present within a depth of 36 inches. This soil is grayer than Fincastle silt loam and in places has a very heavy subsoil. The differences in the texture profiles of Fincastle silt loam and Crosby silt loam, which seem to indicate differences in age and degrees of development may be observed by comparing their analyses in table 6.

The Homer soils have the same parent material as the Fox soils, but they occur where the relief is very slight, the gravel lies at a great depth, or the water table is nearer the surface. They are not so gray as the Fincastle soils, having more yellow in the subsoils.

The surface soil in many places is rather dark gray, indicating the presence of organic matter.

Imperfectly drained phytomorphic soils cover a very small total area. The Delmar, Avonburg, and Bethel soils are distinctive soils of this group. They have ash-gray surface soils with predominantly gray subsoils. They occur on very flat areas that are often very wet.

Delmar silt loam is associated with Russell silt loam and Fincastle silt loam. The following description of a profile observed 1½ miles southwest of Moscow, in a pasture that contained a few scattered beech trees, illustrates the characteristics of the soils of this group:

A_1. 0 to 2 inches, dark-gray silt loam containing many dark worm casts. The material is platy in structure, with plates about one-sixteenth inch thick. They are partly obscured by worm casts.

A_2. 2 to 12 inches, gray silt loam with platy structure, with the plates about one-sixteenth inch thick and well developed. The mass breaks readily in any direction, but structure planes are easily distinguishable. The material contains a few rusty-brown spots and dark worm casts.

A_3. 12 to 15 inches, mottled gray and grayish-yellow silt loam, slightly heavier in texture than the material in the horizon above. The gray color predominates. The structure is platy. There are also some vertical cleavage planes. The surfaces of the cleavage planes are predominantly gray but are spotted with yellow. The interiors of the particles are yellow and brownish yellow, some containing small rusty-brown concretions.

B_1. 15 to 21 inches, mottled gray and brownish-yellow silty clay loam. The structure is angular nut with vertical cleavage planes better developed. The soil particles are angular and about one-half inch in diameter. The faces are dull gray, and the centers are darker, many being rusty brown and some containing soft dark concretions.

B_2. 21 to 29 inches, mottled brownish-yellow, rusty-brown, and gray clay loam. Vertical structure planes are well developed, and horizontal planes also are present. The vertical planes are coated with gray silt which is stained darker in places, showing that some organic matter is present. The material in this horizon is hard and impenetrable when dry and plastic when wet.

B_3. 29 to 42 inches, mottled dull-gray and brownish-yellow clay loam showing some prismatic structure. The vertical cleavage planes are coated with gray silt.

B_{31}. 42 to 60 inches, mottled grayish-yellow, yellowish-gray, and brownish-yellow clay loam which is plastic when moist.

C. 60 to 80 inches+, mottled gray and brownish-yellow gritty clayey glacial drift. The grit and fine gravel are more abundant at the lower depths.

In many places the depth to carbonates is not so great, and the average depth is about 50 inches.

Bethel silt loam is associated with Miami silt loam and Crosby silt loam. It is similar to the Delmar soil except that lime is present at a slight depth, usually about 3 feet.

Avonburg silt loam covers a very small area in this county, but it is an extensive soil in several counties farther south in Indiana. It may be regarded as older than the Fincastle or Delmar soils, as it is developed from glacial till deposited during the Illinoian period. Carbonates do not occur above a depth of 10 feet.

Hydromorphic soils are formed under the influence of a high water table. They are soils in which much of the organic matter has been preserved, hence they are dark. The soils of this group are characterized by a dark humous soil layer, a light-colored mineral soil layer, and the unmodified material. The soils in this group are the Brookston, Clyde, Abington, Westland, Millsdale, and Edwards soils.

Brookston silty clay loam is a true Half-Bog soil and the most extensive hydromorphic soil in the county. It is the low-lying dark soil associated with both Russell silt loam and Miami silt loam. Owing to its topographic situation, it has received some wash from the adjacent light-colored soils since the glacier receded, and it is reasonable to assume that some of the soil material of Brookston silty clay loam has been accumulated by surface wash from the higher areas filling the depressions in the moraine. This may be an explanation of the fact that, in a soil where the water table has always, until lowered by artificial drainage, been at, or near the surface, no carbonates occur above a depth of 60 inches.

The following description of a profile of Brookston silty clay loam, as observed in a wood lot used for pasture 1 mile north of Arlington, is representative of this soil and shows the characteristics of hydromorphic soils:

A_1. 0 to 11 inches, dark-gray silty clay loam which is grayish brown when crushed. Toward the lower part of the horizon the material breaks into small irregular fragments that are dark gray on the surfaces and dull dark brownish gray in the interiors. Fracture at the surface is destroyed by worm casts. The reaction is neutral.

G_1. 11 to 22 inches. Gray clay loam which breaks into irregular angular fragments about one-half inch in diameter. The faces of the fragments are gray, the interiors are speckled with rusty brown, and the mass is brownish gray when crushed. The material becomes lighter colored toward the lower limit of the horizon. The reaction is neutral.

G_2. 22 to 41 inches, mottled gray and yellowish-brown clay loam which breaks into irregular angular fragments ranging from three-eighths to one-half inch in diameter. The fragments are dull gray on the faces and speckled with yellowish brown inside, which gives a mottled appearance on a broken surface. The reaction is neutral or slightly alkaline.

G_3. 41 to 81 inches, mottled light-gray and brownish-yellow clay loam which breaks into irregular angular fragments ranging from one-half to five-eighths inch in diameter and which are gray or light gray on the faces. The interiors are mottled with brownish yellow and light gray, the colors grading into each other. The reaction is alkaline.

C. 81 inches +, mottled gray and yellow plastic calcareous clay.

Clyde silty clay loam differs from Brookston silty clay loam in that it is darker colored in the surface soil and steel gray in the subsoil which, in places, is speckled with yellow. Areas of this soil occur in the depressions within Brookston soil areas.

Westland silty clay loam is associated with the Fox soils, or occurs in old channels of glacial streams where the water table has remained near the surface of the ground. It is similar to Brookston silty clay loam, except that it is underlain by gravel or other stratified material.

Abington silty clay loam occupies situations similiar to those occupied by Westland silty clay loam but has profile characteristics similar to Clyde silty clay loam. It differs from the Clyde soil in that it has a stratified substratum.

Millsdale silty clay loam is the dark-colored soil associated with Milton silt loam. It is underlain by limestone at a depth of approximately 3 feet.

Edwards muck is formed where sufficient organic matter has accumulated to produce a Bog soil. The subsoil (glei horizon) is gray, as in the Clyde soils.

Table 6 gives the results of mechanical analyses of several soils.

TABLE 6.—*Mechanical analyses*[1] *of several soils in Rush County, Ind.*

Soil type and sample no.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Russell silt loam:								
284209	0- 2	0.5	1.5	2.2	4.6	3.1	64.6	23.6
284210	2- 10	.5	1.0	1.4	2.7	2.1	65.6	26.7
284211	10- 13	.2	.8	1.4	2.6	2.0	62.5	30.5
284212	13- 26	.3	.8	1.3	3.0	2.5	55.9	36.2
284213	26- 46	2.1	4.2	5.3	11.7	6.3	33.9	36.4
284214	46- 51	1.4	4.4	5.2	12.0	8.0	28.5	40.6
284215	51+	3.5	5.1	5.2	11.1	9.1	34.7	31.2
Russell silt loam, shallow phase:								
284289	0- 2	.3	1.3	1.9	4.1	3.1	66.3	23.0
284290	2- 10	.3	1.3	1.7	3.4	2.5	66.6	24.1
284291	10- 13	1.5	1.2	1.6	3.5	2.9	60.5	28.7
284292	13- 20	.8	1.8	2.2	4.6	3.5	49.2	38.0
284293	20- 26	.8	1.9	2.4	4.8	3.7	48.9	37.5
284294	26- 33	1.6	4.3	5.3	12.2	8.4	30.5	37.7
284295	33- 40+	3.3	6.6	6.4	13.6	10.8	35.9	23.3
Miami silt loam:								
284202	0- 2	2.1	5.0	6.3	13.3	7.5	39.5	26.4
284203	2- 10	1.3	3.6	4.8	10.8	7.3	44.3	27.8
284204	10- 18	1.2	2.7	3.7	8.7	7.0	35.9	40.8
284205	18- 27	.7	2.0	3.0	7.4	5.6	48.8	32.6
284206	27- 30	.9	1.8	2.3	4.6	3.9	43.2	43.3
284207	30- 50	4.8	7.5	7.7	13.9	9.1	36.0	21.1
284208	50-150+	3.9	6.5	6.7	13.8	9.4	33.8	26.1
Fincastle silt loam:								
284296	0- 3	.3	1.0	1.4	3.0	2.6	66.7	25.0
284297	3- 11	.1	.7	1.1	2.4	2.1	66.4	27.3
284298	11- 15	.2	.5	1.0	2.0	1.9	64.6	29.7
284299	15- 28	.3	1.2	2.1	4.5	3.0	55.7	33.3
2842100	28- 36	1.0	4.1	6.8	15.4	7.7	38.8	26.2
2842101	36- 43	1.2	4.1	6.7	17.0	11.8	22.3	37.0
2842102	43- 50+	2.7	5.7	6.2	14.0	11.9	35.9	23.6
Crosby silt loam:								
284254	0- 2	1.8	4.0	4.9	9.4	5.1	53.4	21.5
284255	2- 9	1.0	3.5	4.7	9.3	5.0	52.8	23.7
284256	9- 13	1.3	3.2	4.6	8.9	4.9	47.4	29.8
284257	13- 20	1.6	3.9	5.6	11.1	6.3	37.5	34.0
284258	20- 28	2.3	4.5	11.8	12.3	8.4	18.0	42.6
284259	28- 36+	5.4	6.6	6.8	13.2	12.0	36.5	19.6
Brookston silty clay loam:								
2842103	0- 8	.3	2.4	3.0	5.4	3.0	52.1	33.9
2842104	8- 17	.5	2.1	2.7	5.0	3.1	53.0	33.5
2842105	17- 24	.2	1.1	1.5	2.8	2.2	55.0	37.3
2842106	24- 38	.3	.6	1.0	2.1	1.6	58.7	35.8
2842107	38- 60	.1	.8	1.4	3.0	2.6	62.7	29.4
2842108	60- 80	3.8	8.9	10.4	19.2	10.3	30.0	17.4

[1] After treatment with hydrogen peroxide.

MANAGEMENT OF THE SOILS OF RUSH COUNTY[6]

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 every farmer should strive. 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 capabilities and 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 maintains productivity. 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.

CHEMICAL COMPOSITION OF THE SOILS

Table 7 gives the results of chemical analyses of the different types of soil, expressed in pounds of elements in the plowed surface soil of an acre.

[6] This section of the report was written by A. T. Wiancko and S. D. Conner, department of agronomy, Purdue University Agricultural Experiment Station.

TABLE 7.—*Chemical composition of the soils in Rush County, Ind.*

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

Soil no.	Soil type	Phosphorus [1]	Potassium [1]	Calcium [1]	Magnesium [1]	Manganese [1]	Iron [1]	Aluminum [1]	Sulphur [1]	Phosphorus [2]	Potassium [2]	Nitrogen [3]	Potassium [3]
1	Avonburg silt loam	874	2,859	2,286	3,260	3,313	37,700	37,200	802	9	100	2,000	29,426
54	Delmar silt loam	699	3,531	5,429	3,260	432	23,500	41,400	160	35	168	3,400	27,744
13	Fincastle silt loam	961	5,381	5,143	2,290	1,585	30,600	46,100	321	35	185	3,000	30,939
13.1	Fincastle silt loam, shallow phase	874	4,708	4,000	4,100	2,161	29,200	49,000	240	26	168	2,800	32,629
57	Bethel silt loam	874	3,867	5,143	3,860	1,152	35,600	40,000	160	35	168	2,600	30,098
15	Crosby silt loam	874	4,372	5,000	2,290	864	27,800	45,100	321	35	286	2,600	30,603
24	Homer silt loam	874	3,531	5,429	2,410	432	23,000	37,600	321	44	185	2,600	28,750
6	Milton silt loam	961	4,708	3,429	1,930	2,449	34,200	58,300	401	18	252	2,600	33,400
31	Russell silt loam	1,136	6,053	6,143	2,895	1,873	32,000	50,500	321	79	185	3,000	33,400
25	Russell silt loam, shallow phase	961	5,213	3,857	2,895	1,729	34,900	51,500	401	26	269	2,800	30,939
2	Miami silt loam	961	6,390	3,714	2,170	1,440	34,400	51,000	1,122	35	303	2,800	32,284
44	Bellefontaine silt loam	1,094	4,036	4,857	4,340	2,017	37,700	48,000	401	26	168	3,000	31,612
8	Fox silt loam	1,136	5,045	3,714	2,290	2,017	38,000	52,000	321	52	235	2,600	35,984
17	Fox silt loam, deep phase	1,136	5,213	5,000	4,100	2,017	35,800	54,400	321	18	135	3,000	30,435
43	Fox loam	1,223	3,195	4,286	3,740	1,873	36,900	42,500	240	26	168	2,400	27,912
21	Brookston silty clay loam	2,010	9,921	11,715	3,498	1,152	42,850	76,500	561	192	471	5,000	35,311
51	Homer silt loam, dark-colored phase	1,223	3,195	9,000	3,620	1,585	32,800	46,000	561	44	168	3,600	29,558
58	Millsdale silty clay loam	1,790	6,978	16,285	6,880	2,665	56,750	82,700	360	50	168	5,700	27,820
11	Westland silty clay loam	1,922	6,558	11,140	2,530	1,008	49,160	66,800	641	157	185	5,600	31,107
35	Clyde silty clay loam	1,922	7,903	14,860	3,980	576	44,000	76,700	962	280	319	5,800	31,780
56	Abington silty clay loam	1,835	6,894	14,570	5,550	720	37,800	62,000	561	210	521	6,000	29,258
10	Eel silt loam	1,311	5,381	14,290	6,997	1,152	37,700	54,600	240	105	286	4,600	31,948
18	Eel loam	961	6,053	75,570	14,355	864	27,500	60,000	401	44	319	2,600	30,267
14	Genesee silt loam	1,136	5,044	15,000	1,930	2,017	43,400	59,500	401	61	185	3,400	32,248
47	Genesee loam	1,311	4,540	31,860	9,410	1,008	32,400	52,500	561	114	219	2,600	27,072
60	Edwards muck	5,955	6,558	28,570	2,051	432	120,000	98,400	6,432	77	286	28,400	17,151

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

Three groups of analyses are given as follows: Total plant-nutrient elements, elements soluble in strong (specific gravity 1.115) hydrochloric acid, and elements soluble in weak (fifth-normal) nitric acid.

The total plant-nutrient content is more indicative of the genesis 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 which have more than 30,000 pounds of total potassium to the acre in the 6-inch surface layer fail to grow corn 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 total may have a supply of available nitrogen sufficient to produce a few large crops without the addition of that element. Soils having a low total content of nitrogen soon wear out, so far as that element is concerned, unless the supply is replenished by growing and turning under legumes or by the use of nitrogenous fertilizer. The darker soils are in general higher in organic matter. Organic matter and nitrogen are closely associated in soils, hence it is a rule that the darker a 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 strong acid. For this reason a separate determination of total phosphorus has been omitted. The supply of total phosphorus usually indicates the general need of a soil for phosphatic fertilizers.

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

The quantity of potassium soluble in strong or weak acid is to some extent significant. This determination, however, is not so reliable an indicator as is the determination of phosphorus, particularly with soils of high lime content. Sandy soils and muck soils are more often in need of potash than clay and loam soils. 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 sometimes been criticized, yet such analyses can more often be correlated with crop production than can analyses of the total elements of the soil. For this reason acid solutions have been employed in these analyses.

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 subsoil and the surface soil, and the previous treatment and management of the soil are all factors of greatest importance and should be taken into consideration. Pot tests indicate that nitrogen and phosphorus are much less available in the subsurface layers and subsoils than they are in the surface layers. On the other hand, potash 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 higher analysis soil. The better types of soils and those containing large amounts of plant-nutrient elements will endure exhaustive cropping much longer than soils having a low 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. Soils which are very acid will not produce well, even though there be no lack of plant-nutrient elements. Though nitrogen, phosphorus, and potassium are of some value on acid soils, they will not produce their full effect where lime is deficient. Table 8 shows the percentage of nitrogen and the acidity of the various soils.

TABLE 8.—*Percentage of nitrogen in and acidity of Rush County, Ind., soils*

Soil no.	Type of soil	Depth	Nitrogen	pH	Average depth to neutral soil material	Indicated lime requirement per acre
		Inches	*Percent*		*Inches*	*Tons*
1	Avonburg silt loam	0-7 7-18 18-36	0.11 .04 .03	5.0 5.2 4.6	120	3
54	Delmar silt loam	0-7 7-14 14-38	.17 .07 .04	6.0 5.5 6.5	40	1-2
13	Fincastle silt loam	0-7 7-14 14-38	.15 .07 .05	5.7 5.5 5.7	52	1-2
13.1	Fincastle silt loam, shallow phase	0-7 7-15 15-32	.14 .07 .05	5.4 5.3 6.0	32	1-2
57	Bethel silt loam	0-7 7-17 17-36	.13 .06 .04	6.3 5.6 6.0	36	1-2
15	Crosby silt loam	0-7 7-15 15-33	.13 .07 .05	5.8 5.8 6.5	33	1-2
24	Homer silt loam	0-7 7-15 15-31	.14 .07 .05	5.9 5.7 6.0	31	1-2
6	Milton silt loam	0-7 7-18 18-37	.13 .07 .06	5.8 5.1 5.1	40	1-2
31	Russell silt loam	0-7 7-17 17-44	.15 .08 .05	6.7 5.6 5.0	60	1-2
25	Russell silt loam, shallow phase	0-7 7-16 16-32	.14 .08 .05	6.1 5.2 6.3	34	1-2
2	Miami silt loam	0-7 7-16 16-32	.14 .11 .06	6.6 5.9 6.2	32	1-2
44	Bellefontaine silt loam	0-7 7-15 15-36	.17 .10 .05	6.0 6.3 5.3	36	1-2
8	Fox silt loam	0-7 7-15 15-35	.13 .10 .06	5.8 6.1 6.0	43	1-2
17	Fox silt loam, deep phase	0-7 7-17 17-44	.16 .09 .05	5.8 6.1 5.0	49	1-2

TABLE 8.—*Percentage of nitrogen in and acidity of Rush County, Ind., soils*—Continued

Soil no.	Type of soil	Depth	Nitrogen	pH	Average depth to neutral soil material	Indicated lime requirement per acre
		Inches	*Percent*		*Inches*	*Tons*
43	Fox loam	0- 7 7-17 17-37	0.12 .10 .05	5.7 6.0 5.8	42	0-1
21	Brookston silty clay loam	0- 7 7-12 12-36	.26 .19 .07	7.2 7.2 7.3	0	0
51	Homer silt loam, dark-colored phase	0- 7 7-15 15-38	.18 .05 .05	7.0 7.0 7.1	0	0
58	Millsdale silty clay loam	0- 7 7-19 19-36	.28 .20 .04	7.4 7.6 8.0	0	0
11	Westland silty clay loam	0- 7 7-16 16-30	.29 .14 .05	7.0 7.0 7.7	0	0
35	Clyde silty clay loam	0- 7 7-16 16-37	.28 .15 .06	7.2 7.2 7.3	0	0
56	Abington silty clay loam	0- 7 7-13 13-36	.30 .17 .06	7.2 7.2 7.5	0	0
10	Eel silt loam	0- 7 7-18 18-30	.22 .13 .06	7.3 7.4 7.3	0	0
18	Eel loam	0- 7 7-18 18-36	.14 .15 .07	7.6 7.6 7.6	0	0
14	Genesee silt loam	0- 7 7-18 18-30	.17 .15 .06	7.3 7.4 7.4	0	0
47	Genesee loam	0- 7 7-18 18-30	.14 .11 .10	7.8 7.8 7.8	0	0
60	Edwards muck	0- 7 7-18 18-32	1.42 .34 .32	7.2 7.3 7.4	0	0

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 is more than 7, there is some excess of lime. From pH 6 to pH 7 indicates slight acidity, and from pH 5 to pH 6 shows medium acidity. If the pH runs below 5 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 7 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. Furthermore, the more organic matter and nitrogen a soil contains and the greater the depth to which these elements extend, the less will be the need for lime. The slighter the depth of acid soil, the less it is apt to need lime. Therefore, in determining how badly an acid soil may need lime, it is necessary to know the pH, or intensity of acidity, also the amount of nitrogen and organic matter it contains. The less phosphorus, calcium, and magnesium the soil contains, the more apt it is to need lime. It is well to remember that sweetclover, alfalfa, and red clover need more lime 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 will grow.

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

SOIL MANAGEMENT

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

LIGHT-COLORED SILT LOAM SOILS OF THE UPLANDS

The group of light-colored silt loam soils of the uplands includes the silt loams of the Miami, Crosby, Bethel, Bellefontaine, Milton, Russell, Fincastle, Delmar, and Avonburg series. The Miami, Crosby, Russell, and Fincastle soils occupy about 50 percent of the total area of the county. The other soils of the group are relatively unimportant and occupy less than 2 percent.

The practical problems in the management of these soils, with the exception of drainage, are more or less similar. They are all naturally deficient in phosphorus, nitrogen, and organic matter. In many places, especially on the gray flats, they lack available potash, and liming is generally needed.

DRAINAGE

The Bellefontaine and most of the Miami, Milton, and Russell soils have fair or good natural drainage. Some areas of the Miami, Russell, and the deeper Milton soils, especially the more level areas, would be benefited by tile drainage. Wherever there is a tight subsoil the land should be tiled, as without underdrainage surface erosion is more apt to occur. Surface run-off should be prevented as far as possible, because it carries away large quantities of available plant nutrients which should go into the production of crops. Rain water should be absorbed by the soil, and the surplus should pass away through underdrains. Tile drainage increases the capacity of the soil to absorb water, lessens surface erosion, and also facilitates soil aeration which helps to render the plant nutrients in the soil available, and it encourages deeper rooting of crops, enabling them to better withstand drought as well as to obtain more plant nutrients.

The Bethel, Crosby, Delmar, Fincastle, and Avonburg soils are naturally poorly drained and are more or less urgently in need of artificial underdrainage by means of tile. Their generally flat surfaces and tight subsoils cause the natural drainage to be very slow and difficult. A mottled subsoil is a further indication of insufficient natural drainage. Without tile drainage these soils cannot be satisfactorily managed, and no other beneficial soil treatment can produce its full effect. Results on experiment fields on other soils of similar texture and relief indicate that tile lines laid 30 inches deep and not more than 3 rods apart will give satisfactory results. Where the land is very flat, great care must be exercised in tiling in order to obtain an even grade and uniform fall. Grade lines should not be established by guess or by rule-of-thumb method. Nothing less accurate than a surveyor's instrument should be used, and the lines should be accurately staked and graded before the ditches are dug, to make sure that all the water will flow to the outlet with no interruption or slackening of the current. The rate of fall may be increased toward the outlet, but it should never be decreased, as checking the current may cause the tile to become choked with silt. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with straw, weeds, or grass. 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.

LIMING

Most of these soils will respond satisfactorily to liming. The Avonburg soil is particularly acid. A very acid soil will not respond properly to other needed treatments until it has been limed. A strong indication of the need for liming is the failure of clover to do well on land that is otherwise in a fair state of fertility. The need for liming is so easily determined, however, that a test should be made in each particular case. If the farmer himself cannot make the test, he should have it made by the county agricultural agent or by the agricultural experiment station at La Fayette. Ground limestone is the most economical form of lime to use in most places. Where lime is needed, the first application should, as a rule, be about 2 tons to the acre. After that a ton to the acre every second or third round of the crop rotation will keep the soil in good condition for most crops. Where alfalfa or sweetclover is to be grown on acid soil, heavier applications of lime may be needed.

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 has made 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 easily becomes puddled and baked. This condition, in large measure, accounts for the more frequent clover failures and the greater difficulty in obtaining proper tilth where the land has been cropped for a long time without adequate returns of organic matter.

Wherever these evidences of lack of organic matter and nitrogen occur, the only practical remedy is to plow under more organic matter than is used in the processes of cropping. Decomposition is constantly going on and is necessary in order 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 as much as possible of the organic matter to be plowed under. To do this satisfactorily, the land must first be put in condition to grow clover and other legumes. This means liming wherever the soil is acid. Wet lands must also be tile drained. 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 by livestock; and all produce not fed to livestock, such as cornstalks, straw, and cover crops, should be plowed under directly. 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 plowed under, either directly or in the form of manure. Wherever clover-seed crops are harvested, the haulm should be returned to the land and plowed under. Cover crops should be grown wherever possible, to supply additional organic material for plowing under. Seeding rye as a cover crop in September on cornland that is to be plowed the following spring is good practice for increasing organic matter and conserving nitrogen. It is important to have some kind of a growing crop on these soils during the winter, in order to take up the soluble nitrogen which would otherwise be lost through leaching. Without living crop roots to take up the nitrates from the soil water, large losses will occur between crop seasons through drainage. In this latitude the ground is not frozen much of the time during the winter, consequently frequent heavy rains cause much leaching, especially of nitrates. The winter rains also cause much soil erosion on slopes and hillsides where the ground is not well covered with vegetation. Both of these losses may be greatly lessened by a good cover of winter rye on all land that would otherwise be bare during the winter. The rye should be run down with a heavy disk and plowed under before heading.

CROP ROTATION

With proper fertilization, and liming and tile drainage where needed, these soils will economically produce all the ordinary crops adapted to the locality. On account of the prevailing shortage of organic matter and nitrogen, every system of cropping should include clover or some other legume to be returned to the land in one form or another. Corn, wheat, and clover constitute the best short rotation for general use on these soils, especially when the corn can be cut and the ground disked and properly prepared for wheat. In this position in the rotation, wheat needs a high-analysis complete fertilizer, and the quantity applied should be sufficient to help the clover also. Corn, soybeans, wheat, and clover constitute an excellent 4-year rotation. The two legumes in the rotation will build up the nitrogen supply. The soybean straw should be spread on the wheatland in the winter. It will not only help the wheat and lessen winter injury, but it will help to insure a stand of clover. Oats are not well adapted to climatic conditions here, and, as a rule, are not a profitable crop. The soybean is not only a more valuable crop than oats, but it also adds some nitrogen to the soil and improves the land for the wheat which follows. If more corn is wanted, as on livestock farms, the 5-year rotation of corn, corn, soybeans, wheat, and clover may be used satisfactorily where the second corn crop can be given a good dressing of manure. A cover crop of rye, for plowing under the following spring, should be seeded in September on all the cornland. Where, owing to climatic conditions, clover is uncertain in any of these rotations, it has proved to be a good plan to sow a mixture of seeds made up of about 4 pounds of red clover, 3 pounds of alfalfa, 2 pounds of alsike clover, and 1 pound of timothy to the acre.

Alfalfa and sweetclover may be grown on the better drained and more friable soils of the group, if the soils are properly inoculated and sufficiently limed to meet the needs of these crops. The brown soils of this group are better adapted to these crops than the gray soils. 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 can be obtained from the Purdue University Agricultural Experiment Station at La Fayette.

FERTILIZATION

All the soils of this group are naturally low in phosphorus, and in most of them the available supplies of this element are so extremely 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 of 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.

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 means of supplying the greater part of the nitrogen needed by crops, and they should be largely relied on for this purpose. A system of livestock farming, with plenty of legumes in the crop rotation, is, therefore, best for these soils. It will generally pay, 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 nitrogen in the fertilizer applied at seeding time to start the crop properly, because the nitrogen in the residues of any immediately preceding legume does not become available quickly enough to be of much help to the wheat in the fall. The material must first decay, and that does not take place to a great extent until the following spring.

Phosphorus is the mineral plant-nutrient element in which all these soils are most deficient. The only practical way to increase the supply is through the application of purchased phosphatic fertilizers, and it will prove profitable to supply the entire phoshorus needs of crops in this way. In rotations of ordinary crops, producing reasonable yields, it may be counted that 20 pounds of available phosphoric acid to the acre are required each year. It will pay well to apply larger quantities at first, so as to create a little reserve. 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 5 pounds of phosphoric acid; therefore a correspondingly smaller quantity need be provided in the form of commercial fertilizer.

On the soil-fertility experiment field on the Herbert Davis Forestry Farm, belonging to Purdue University and located on Crosby silt loam in Randolph County (which is like the Crosby silt loam in Rush County), highly profitable returns have been obtained wherever available phosphate has been applied. During the 8 years since this experiment was begun, applications of 75 pounds to the acre of 16-percent superphosphate in the row for corn and 225 pounds for wheat, in a corn, wheat, and clover rotation, have produced crop increases averaging 8.3 bushels of corn, 8.6 bushels of wheat, and 555 pounds of hay to the acre, at a cost of $3.60 for the phosphate. Manure applied for corn at the rate of 6 tons to the acre has produced crop increases averaging 12.7 bushels of corn, 4.5 bushels of wheat, and 278 pounds of hay. But manure alone is not sufficient to produce the most profitable returns. On land receiving 6 tons of manure to the acre, 225 pounds of superphosphate applied for wheat only has increased the crop yields over manure alone by 3.6 bushels of corn, 7 bushels of wheat, and 362 pounds of hay. These experiments demonstrate the importance of using liberal applications of phosphate on this type of soil, both with and without manure. Where manure is not available, a good complete fertilizer should be used for wheat and a phosphate-potash mixture for corn. On this experiment field, applications of 300 pounds to the acre of a 2–12–6 fertilizer for wheat have produced crop increases averaging 11.7 bushels of wheat and 771 pounds of hay. One hundred pounds of 0–12–6 fertilizer to the acre, in the row for corn, has produced an average increase of 8.2 bushels.

The quantity of potash that should be applied as fertilizer depends on the general condition of the soil and the quantity of manure used. The flat poorly drained areas of the gray soils are the ones most likely to be in need of potash fertilizer. On soils that have become run down, any program for their improvement should include potash fertilizer, at least until such time as considerable quantities of manure can be applied or until the general condition of the soil has materially improved. Although there are large total supplies of potassium in these soils, the readily available potash is low in many places. Its availability may be increased by good farm practices, including proper tillage, tile drainage, 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 fertilization of these soils, the manure should usually be plowed under for the corn crop, but a part, about 2 tons to the acre, may be applied profitably on wheat as a top dressing during the winter. Such use of a part of the manure 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. As a rule, the land manured for corn should also receive some available phosphate in the hill or row at a rate ranging from 100 to 150 pounds to the acre. Without manure, a phosphate and potash mixture may be preferable. Wheat should always be given from 200 to 300 pounds to the acre of a high-

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analysis complete fertilizer, such as a 2–12–6 mixture at seeding time. A top dressing ranging from 15 to 20 pounds to the acre of soluble nitrogen, applied in April when the wheat is 2 or 3 inches high, may be expected to produce an increase of 5 or 6 bushels. Where properly fertilized corn and wheat are included in the rotation, there will be little need for fertilizer on other crops.

LIGHT-COLORED SOILS OF THE TERRACES

This group of soils includes the silt loams of the Fox and Homer series, and Fox loam. Fox silt loam, including its phases, is of considerable importance and occupies about 5 percent of the total area of the county. The rest of the soils of the group occupy a very small acreage. These soils are usually extensive enough, on the farms where they occur, to warrant special consideration.

DRAINAGE

Being underlain by gravel and sand at a comparatively slight depth in most places, these soils are inclined to be droughty. Only a few low-lying areas of the Homer soils and the deep phase of Fox silt loam are in need of more drainage, and even in them it is generally difficult to obtain satisfactory outlets.

LIMING

For the most part, these soils, except the deeper Homer soils, will respond satisfactorily to liming, especially for such crops as alfalfa and sweetclover, which are less acid tolerant than the common clovers.

ORGANIC MATTER AND NITROGEN

The organic matter and nitrogen requirements of these soils are practically the same as those mentioned for the light-colored soils of the uplands. The lighter colored soils and those in the shallower areas are especially in need of more organic matter, in order to improve their water-holding capacity and to make them less droughty. Legumes, cover crops, and other special green-manure crops, as well as manure, should be used as much as possible for plowing under.

CROP ROTATION

For the most part, these soils are adapted to the same crops as the soils of the uplands, although corn often does not do so well on account of summer droughts. The small grains usually escape serious injury from this source. Soybeans, because of their ability to resist drought, are especially well suited to these soils. Grass as a rule does not do well, but deep-rooted legumes, such as red clover, alfalfa, and sweetclover, will thrive if supplied with sufficient quantities of available phosphate and potash, especially after liming, and these crops should be grown more extensively.

FERTILIZATION

These soils should be fertilized in about the same way as the light-colored soils of the uplands. Nitrogen should be supplied largely through legumes and manure. Considerable quantities of available phosphate should be supplied for all crops, and when manure is scarce some potash fertilizer will be necessary. Wheat should always receive a good complete fertilizer. For alfalfa, a half-and-half phosphate-potash mixture will give good results.

DARK-COLORED SOILS OF THE UPLANDS AND TERRACES

This group includes the silty clay loams of the Brookston, Clyde, Abington, Westland, and Millsdale series. The Brookston is by far the most important dark-colored soil of the uplands in Rush County and occupies 28.5 percent of the total area. The Abington and Westland soils are the most important soils on the terraces and occupy 5.6 percent of the total area of the county. The practical problems in the management of all these dark-colored soils are similar. A common natural defect is poor drainage. All the soils are well supplied with nitrogen. The Millsdale soil is rather low in available phosphorus, and both the Millsdale and Westland soils will respond satisfactorily to some potash fertilizer.

DRAINAGE

All these soils are more or less in need of artificial drainage. Their dark color indicates a swampy origin where natural drainage was poor. To a large extent artificial drainage has been provided, and surplus water is fairly well taken care of. In many places, however, there would be good response to more tiling. Where this is needed, the same procedure should be followed as that suggested for the light-colored silt loam soils of the uplands.

LIMING

Tests for acidity of these dark-colored soils do not show any need of lime.

ORGANIC MATTER AND NITROGEN

For the most part, these soils are naturally supplied with sufficient organic matter and nitrogen to meet the needs of most crops, and, with reasonable care in their management, no special provisions for supplying these constituents will be necessary for a long time. Such crops as wheat, however, should generally receive some readily available nitrogen in the fertilizer.

CROP ROTATION

These dark-colored soils are among the best in the county and will produce all the ordinary crops adapted to the locality. They are especially well suited to corn, and this should generally be the major crop. Among the rotations that may be satisfactorily employed are the following: Corn, wheat, and clover; corn, corn, wheat, and clover; corn, soybeans, wheat, and clover; and corn, corn, soybeans, wheat, and clover. A good seed mixture for hay or pasture in any of these rotations, where clover alone is not dependable, is about 4 pounds of red clover, 3 pounds of alfalfa, 2 pounds of alsike clover, and 1 pound of timothy to the acre. Where sufficient drainage has been provided, these soils are suited to alfalfa and sweetclover.

Whenever clover fails, soybeans make a satisfactory substitute crop for legume hay.

FERTILIZATION

These soils are naturally fairly well supplied with nitrogen, and, with a legume included in the crop rotation, the fertilizer need not contain nitrogen, except for wheat. As a rule, wheat should receive a good complete fertilizer, such as 2–12–6, to start it properly in the fall. Corn should generally receive some available phosphate in addition to manure. On farms having both light-colored and dark-colored soils, however, the manure should generally be applied to the light-colored soils which are more in need of the organic matter and nitrogen contained in the manure. Without manure, it will ordinarily prove profitable to use a phosphate and potash mixture for corn on these dark-colored soils, especially the Westland and Millsdale, which seem to be lowest in available supplies of these important constitutents.

SOILS OF THE BOTTOM LANDS

The bottom lands include the loams and silt loams of the Genesee and Eel series. The silt loams predominate, comprising 7 percent of the total area, and the loams occupy only about 0.4 percent.

The greatest difficulty in the management of these soils is to provide adequate drainage and to prevent damage from flooding. The heavier areas should be tiled wherever suitable outlets can be provided, in order that surplus water may drain away more readily. With the exception of some areas of Eel silt loam and Genesee silt loam, these soils are sufficiently supplied with organic matter and nitrogen. On the lighter colored areas provision should be made for increasing the organic matter and nitrogen supplies by applications of manure and by the incorporation of other organic material, such as crop residues and especially grown cover crops or intercrops. Liming is not required.

Most of this land is best adapted to corn; but wherever excess water is not troublesome, some other crop, such as wheat, clover, and soybeans, should be occasionally included in the cropping system.

Much of this land receives rich sediments from periodic overflows and hence requires little fertilizer. The poorer areas, however, will respond to applications of available phosphates.

MUCK

There are only about 64 acres of muck soil in the county. The muck is of the nonacid type. Drainage and some potash fertilizer are all the land requires to make it profitably productive.

U. S GOVERNMENT PRINTING OFFICE: 1937

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