

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF INDIANA DEPARTMENT OF GEOLOGY,
EDWARD BARRETT, STATE GEOLOGIST.

SOIL SURVEY OF GRANT COUNTY, INDIANA.

BY

LEWIS A. HURST, IN CHARGE, W. I. WATKINS, AND W. E.
THARP, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND
EARL HERTENSTEIN AND PHILIP MIDDLETON,
OF THE INDIANA DEPARTMENT OF GEOLOGY.

W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1915.]



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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 26, 1916.

SIR: In the extension of the soil survey in the State of Indiana during the field season of 1915, a survey was made of Grant County. This work was done in cooperation with the State of Indiana Department of Geology, and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript and map covering this survey and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1915, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL SURVEY OF GRANT COUNTY, INDIANA.

By LEWIS A. HURST, In Charge, W. I. WATKINS, and W. E. THARP, of the U. S. Department of Agriculture, and EARL HERTENSTEIN and PHILIP MIDDLETON, of the State of Indiana Department of Geology.—Area inspected by W. E. McLENDON.

DESCRIPTION OF THE AREA.

Grant County, with an area of 412 square miles, or 263,680 acres, is located somewhat north and east of the geographic center of Indiana. It is rectangular in outline, and is 19 miles wide from north to south and 22 miles long from east to west. It is bordered by Wabash and Huntington Counties on the north, Wells and Blackford on the east, Delaware and Madison on the south, and Tipton, Howard, and Miami Counties on the west.

The surface of the county is essentially a plain, dissected by the Mississinewa River, and its many tributaries. The only surface relief developed is due to the gradual deepening of the various stream valleys and gullies and the constant lowering of the surface by erosion. Hence, the rougher topography occurs in the vicinity of the stream courses, particularly along the Mississinewa River and along the larger creeks, which have cut their valleys 50 to 100 feet deep through the glacial drift to the river level. The topography here may be described as undulating to hilly, with the crests of the hills on a level with the plains back from the river. The western, southwestern, eastern, and northeastern parts of the county are comparatively level. The central and northern parts are more broken and are naturally better drained.

The elevation of the county ranges from 805 feet above sea level at Marion to 939 feet at Upland, the average elevation being approximately 845 feet. Swayzee, in the western part of the county, has an elevation of 862 feet, and Fairmount, in the southern part, an altitude of 880 feet. Vanburen, in the northeastern part, is 842 feet above sea level.

The Mississinewa River and its tributaries form the main drainage system of the county. The river enters the county at the south-

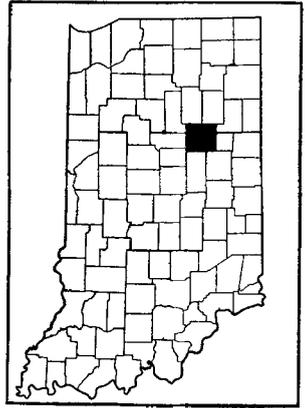


FIG. 1.—Sketch map showing location of the Grant County area, Indiana.

eastern corner and traverses it in a general northwesterly course. The chief tributaries include Jocinah, Hummel, Lugar, and Walnut Creeks on the east, and Deer, Boots, and Cart Creeks on the west. Black and Little Black Creeks drain the northeastern part of the county, and Grassy and Middlefork Creeks the southwestern part. Pipe Creek and its main tributary, Taylor Creek, drain the western and northwestern parts and flow in a general northwesterly course out of the county. Many of these streams head in former lake beds, ponded areas, or old filled-in valleys which were formerly in a semi-swampy condition. By means of dredging, the original winding and sluggish watercourses have been converted into deep and comparatively straight channels, which form the main outlets for the poorly drained sections of the county.

The first white settlers in the territory now included in Grant County came chiefly from North Carolina, South Carolina, and Ohio. The county was formed in 1831. From that time forward there was a steady growth in population until 1900, since which year a decline has taken place. The census of 1880 gives the total population as 23,618. The discovery of natural gas in 1887 caused a rapid growth of the towns, and the census of 1900 reports 54,693 inhabitants, as compared with 51,426 reported in 1910. The falling off in population is attributable to a change not so much in rural as in industrial conditions. Upon the depletion of the natural-gas supply, which afforded cheap fuel, some of the factories in various towns throughout the county ceased operations, although many important plants are still operated. Natural gas is at present used chiefly by the farmers for domestic purposes, but is not available in sufficient quantity to supply the needs of the city of Marion and the other towns of the county, which draw a large part of the present supply from West Virginia.

The rural population of Grant County comprises 51.2 per cent of the total, the inhabitants of towns of less than 2,500 population being classed as rural by the census. The 1910 census reports the total population in the various towns and villages of the county outside Marion as 14,030, and the farming population is thus placed at 18,037. The combined population of Marion and the smaller towns and villages is almost double the farming population.

Marion, the county seat, with a population of 19,359, is the largest town in Grant County. It is situated on the Mississinewa River, near the center of the county. It is the center of a rich agricultural region and has a number of manufactories. Gas City, Fairmount, Jonesboro, Vanburen, and Upland are other important towns and are shipping and trading centers for the rich agricultural territory surrounding them. These towns also have manufacturing interests. There are a number of small towns and villages throughout the county.

The first railroad, the Pennsylvania line, was constructed through Marion in 1868, and the Cincinnati, Wabash & Michigan (now the Big Four) in 1875. Since then two other railroad lines have been built and the county has adequate transportation and shipping facilities in all sections, being served by four trunk lines of steam railroad and two electric lines. The county has good traffic connections with Indianapolis, Logansport, Muncie, Chicago, Cincinnati, and other large cities.

Toll roads connecting the principal towns were the first improved highways. Within recent years the pikes have been opened by the county to public use and supplemented by an excellent sectionized public-road system, giving every farm easy access to towns, markets, schools, and churches. Gravel is abundant for constructing and repairing the roads and very few miles of unimproved road remain, most of the highways having been surfaced with this material and put in excellent condition. Some macadamized roads have been built in recent years and at the time of the survey surfacing with a commercial preparation was becoming general. The streams are spanned by modern steel bridges.

The principal markets for produce sold outside the county are Indianapolis, Chicago, and Cincinnati. Marion is 69 miles from Indianapolis, 151 miles from Chicago, and 133 miles from Cincinnati.

CLIMATE.

The data shown in the table below, giving the normal and extreme temperature and precipitation by months and seasons and for the year, are compiled from the Weather Bureau records at Marion, and are representative of the climatic conditions throughout the county.

Normal monthly, seasonal, and annual temperature and precipitation at Marion.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1895).	Total amount for the wettest year (1892).	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	30.7	66	-12	2.44	3.27	1.60	5.3
January.....	28.9	68	-25	2.47	1.84	1.41	9.0
February.....	26.4	67	-20	2.30	0.51	3.21	7.7
Winter.....	28.0	68	-25	7.21	5.62	6.22	22.0
March.....	38.7	85	- 2	3.51	2.16	2.87	6.1
April.....	50.7	80	17	3.14	1.71	5.63	1.1
May.....	61.2	96	26	3.96	0.81	10.65	0.1
Spring.....	50.1	96	- 2	10.61	4.68	19.15	7.3

Normal monthly, seasonal, and annual temperature and precipitation at Marion—Con.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1895).	Total amount for the wettest year (1892).	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
June.....	70.2	100	35	4.21	1.37	7.52	0
July.....	74.2	105	37	2.89	0.80	6.18	0
August.....	72.3	101	40	3.10	1.37	5.46	0
Summer.....	72.2	105	35	10.20	3.54	19.16	0
September.....	66.0	101	29	2.95	2.46	5.53	0
October.....	53.9	91	15	2.02	0.91	T.	0.1
November.....	39.9	75	2	3.13	5.42	4.52	2.0
Fall.....	53.0	101	2	8.10	8.79	10.05	2.1
Year.....	50.9	105	-25	36.12	22.63	54.58	31.4

The county is not subject to frequent occurrences of marked extremes of heat or cold. High temperatures are not uncommon in July, August, and September, but are seldom of long duration. Snow in severe winters sometimes remains on the ground for several weeks, but usually the ground remains frozen only a few weeks.

The average annual rainfall of 36.12 inches is very uniformly distributed throughout the year. May and June generally have somewhat the greatest rainfall. The average annual fall of snow is 31.4 inches.

The length of the average growing season is about 5 months. The average dates of the last killing frost in spring and of the first in the fall are May 9 and October 4, respectively. The earliest recorded killing frost in autumn occurred September 5, and the latest in spring, June 7.

AGRICULTURE.

Agriculture in Grant County began with the planting of small patches of maize and other crops by the Indians, but real development dates from the time the white immigrants began to clear and improve their homesteads. Progress was necessarily slow because of the lack of capital, labor-saving implements, and adequate facilities for clearing and draining the land, and the absence of markets and roads. The early settlers found the land covered with a dense growth of hardwood, interrupted only occasionally by an open, swampy prairie. Small woodlot pastures of 10 to 40 acres upon the average farm are all that remains of the forest growth. Much of the forested area also was in a poorly drained condition throughout

the greater part of the year. The lack of drainage outlets and the cost of installing artificial drainage in the wet areas prohibited their use for cultivation, and for several decades after the first settlements were made only land having good natural drainage could be cultivated. For this reason, the rolling lands near the Mississinewa River and the larger creeks were the first to be homesteaded. The rich alluvial lands, giving large yields of corn, were a further inducement to the early settlers to locate near the river. Rafts or flatboats gave access to outside markets. The clay soils of the uplands were better suited to wheat and oats and were utilized largely for the growing of these crops. Corn, wheat, oats, rye, flax, and potatoes were important among the early crops grown in the county. Hay was cut from the open prairie.

The development of the county was very gradual until the late seventies or early eighties, when the so-called black lands or wet areas became available for cultivation through the installation of adequate drainage outlets, the channels of the smaller creeks and branches being deepened, straightened, and widened to serve as such. The drainage of individual farms was effected through open ditches, but the disadvantage of having the fields cut up with ditches led later to the laying of tile drains. Thousands of dollars have been expended for drainage, but the rapid increase in land values has offset the expense many times, the rise in price being commensurate with the increased crop yields. Land values have advanced from about \$40 an acre in 1880 to \$100 to \$200 or more an acre at the present time. The building of improved roads, the construction of good farm buildings, schools, and churches, and the excellent shipping and marketing facilities have all contributed to this advance in land values.

Corn, oats, and wheat are at present, as in the past, the staple crops of the county. Corn has always been the leading crop. Wheat remained second in order of production until after 1900, the 1910 census, however, showing a production of oats nearly three and one-half times that of wheat. The total value of all cereals produced in 1909 is reported by the census as \$2,285,982.

The census statistics from 1850 to 1910 show a steady increase in the production of corn from 361,318 bushels in 1849 to 3,299,221 bushels in 1909. No acreage statistics are available for census years previous to 1880, but beginning with that year, the average yield per acre has been 32, 30.1, 43.8, and 49 bushels, respectively, for each succeeding census year. The increase in production is due for the most part to the higher yields obtained from the "black lands" (Clyde soils), which have contributed a large percentage of the increase in acreage from 47,871 acres in 1879 to 67,391 acres in 1909. Careful seed selection and better cultural methods have also contrib-

uted to the increase in corn yields. The average yield of corn per acre for 1914 is reported by the county agricultural agent as 40 bushels. It is estimated that the "black lands" yield on an average 10 to 20 bushels per acre more than the "clay lands" (Miami and Crosby series). As corn locally is the most profitable of the cereal crops, naturally more attention is given to its production than to that of other crops. Without the large production of corn, the \$1,683,609 of revenue received from the sale or slaughter of live stock, as shown by the 1910 census, would hardly have been possible or would at least represent a smaller proportion of profit. It is estimated by the county agricultural agent that two-thirds of the corn crop is fed locally, three-fourths of the quantity used for local feeding being used for hogs. The tendency is to limit the production of corn only by the acreage of land adapted to its requirements.

The production of oats is now next to that of corn. In the period from 1849 to 1909 the production of oats increased from 40,973 bushels to 985,806 bushels, this increase being nearly three times the per cent of increase in corn production for the same period. The fluctuation in the acreage yield of oats has been less than $2\frac{1}{2}$ bushels in the four census years from 1879 to 1909, the yields being 31.6, 30.2, 32.6, and 32.2 bushels per acre, respectively. The effect of the increase in the cultivated acreage of "black land" has been to increase the production of corn rather than that of oats. One reason for which the "black lands" are given preference for corn is that a much larger proportion of the oat crop is destroyed by lodging upon these lands than upon the lighter soils. Oats have never been rated as a money-making crop, but this grain fits in well with the customary rotation and is especially valued for the straw, which is used as bedding for stock or is baled and sold to the strawboard mill at Marion. The grain is used to some extent locally or on the farm where grown, for feed, but the bulk of it is disposed of at the grain elevators situated in all parts of the county. The introduction of cowpeas, soy beans, and alfalfa should tend to decrease the acreage of oats and wheat in the future, since these legumes will to an extent supplant clover, for which oats and wheat, especially the latter, have been largely grown as nurse crops.

The acreage in wheat remained fairly constant from 1880 to 1900, as far as shown by the three censuses included, the area in wheat being 30,753 acres in 1879, 32,823 in 1889, and 29,396 in 1899. The 1910 census shows a decrease to 16,840 acres. The average yield per acre as shown by the census reports is so variable as to admit of no definite deductions regarding a general increase or decrease in yield from 1880 to 1910. The average yield in the four census years was 20, 12, 8.7, and 17 bushels, respectively. It is generally considered that there has been a gradual decline in the average yield of wheat, except

where commercial fertilizers have been used. The use of wheat as a winter cover crop and as a nurse crop for clover warrants its retention in the usual rotation of corn, wheat or oats, and clover, but commercially wheat is generally rated as unprofitable where the yield is less than 20 bushels per acre. As a nurse crop wheat is considered better than oats, since the straw is lighter and shades the clover less, and wheat is not so likely to lodge. Practically the entire crop, aside from that saved for seed, is sold to the local milling companies or shipped through the local dealers, the bulk of the production being consumed outside the county. The screenings and the wheat of poorer grades are usually fed to poultry.

Minor crops grown in the county include the cereals rye and barley. The greatest production of rye, as far as is shown by the census reports, was in 1889, when the 876 acres seeded to this crop produced 14,544 bushels. The census of 1910 records 636 acres, with a production of 9,627 bushels. Barley and buckwheat also had their maximum production in 1889, the area in barley being 444 acres and the production 9,779 bushels. For 1909 only 16 acres are reported in barley. The 144 acres in buckwheat in 1889 produced 1,560 bushels, or about 11 bushels per acre. For 1909 the census reports only 2 acres of buckwheat in the county.

The census of 1880 records a production of 80,432 bushels of flaxseed. By 1890 the production had declined to 109 bushels, and the 1910 census does not show that any flax was grown in the county. Of the minor grains and seeds there is a small production of dry peas and edible beans, in addition to green peas grown to some extent for the local canneries.

Of the hay and forage-crop production, which according to the 1910 census amounted to 41,037 tons from 28,617 acres, 22,244 tons were of timothy alone. Timothy yields an average of about 1.4 tons per acre. Of clover alone 4,140 tons were produced from 3,161 acres, and of clover and timothy mixed, 10,111 tons from 7,133 acres, the yield in this case also averaging about 1.4 tons per acre. Millet or Hungarian-grass production declined from 335 tons in 1899 to 251 tons in 1909, although the average yield per acre remained about the same, 1.7 tons.

In the censuses prior to 1910 no mention of alfalfa is made, although it has been grown in a small way for many years. From the 160 acres devoted to this legume in 1909, 499 tons, or an average of 3.1 tons per acre, was obtained. The growing of this crop is being rapidly extended, particularly by dairymen. Both the county agricultural agent and the State agricultural experiment station are engaged in efforts to increase the acreage in alfalfa. On account of their porous subsoils the second-bottom or high-terrace lands are especially well suited to the crop, but with proper preparation of the land it can be grown

successfully on almost any soil in the county except Muck and Peat. Its value as a nitrogen-storing crop and as a money crop favor its culture, especially upon the lighter colored Miami soils, which are low in organic matter. The land for alfalfa should be well drained, limed, and thoroughly inoculated, and should be free from weeds.

Only a small amount of hay of any kind is shipped into the county and no considerable quantity is disposed of in outside markets except in the immediately surrounding country. The greater proportion of the crop is fed to stock upon the farms where it is produced, the hay sold being chiefly that produced on leased farms where cash rent is paid or a division of the crops is made. The total value of the hay and forage crops produced in the county in 1909 was \$350,826.

The acreage in special crops is comparatively small, but in the vicinity of Marion and some of the smaller towns the growing of special crops, chiefly potatoes and tomatoes, forms an important interest. In 1909 the production of potatoes was 223,409 bushels, the yield averaging about 110 bushels per acre. The bulk of the potato crop is consumed locally, and there is not sufficient production to supply the local demand, hundreds of bushels of potatoes being shipped in annually from Michigan and eastern districts. The tomatoes are grown chiefly for the local canning factories. The net income from this crop ranges ordinarily from \$50 to \$100 an acre, but the profit is quite variable with the season, and tomatoes are sometimes grown at a loss.

The growing of sugar beets has been carried on experimentally within the last few years by many farmers, particularly those with small farms. The industry promises to increase in importance. The beets are grown under contract with a sugar-manufacturing company, which has a plant located at Decatur, in Adams County, 46 miles east of Marion. The company provides seed, implements, and labor, making a stated charge per acre for these essentials. The grower furnishes and prepares the ground and cultivates and aids in harvesting the crop. The cost of production varies, but is ordinarily \$20 to \$25 or somewhat more an acre, not including the grower's labor and the value of use of land. The contract price has averaged about \$5 per ton f. o. b. cars at the shipping point. The returns are said to net the growers from \$25 to \$40 or \$50 an acre. In some cases the growers are unable to give the sugar-beet crop the required attention and yields are below the average, frequently being unprofitable.

Trucking and fruit growing are carried on in the vicinity of the larger towns and largely meet the local requirements. Only very small quantities of fruits and vegetables are shipped into the county except from southern or subtropical regions. A home garden fur-

nishes most of the farmers with fresh vegetables throughout the growing season, and any surplus is disposed of in the local markets. The total value of vegetables, including special crops, produced in 1909 was \$194,184. Fruit growing is restricted almost entirely to small orchards of apple trees, with some pear, cherry, peach, and plum trees, on practically every farm. There are only a few commercial orchards in the county, and these are not important. The census shows 10,967 apple trees in the county in 1890, the number increasing by 1900 to 82,601. The census of 1910 reports 65,380 apple trees, 22,094 cherry trees, 20,063 plum trees, 15,964 peach trees, and 15,049 pear trees. The production in 1909 of other fruits enumerated includes 127,652 pounds of grapes from 8,156 vines; 19,950 quarts of strawberries from 24 acres, and 11,548 quarts of raspberries and loganberries. The total value of all fruits and nuts produced in 1909 is reported by the census as \$65,285.

The apple is not considered a commercially profitable crop, since the average farmer can not devote the time required to spray, prune, and properly care for the orchards. The crop of 1915 was one of the largest in the history of the county. In some cases the apples were hand picked and prepared for the market, but for the most part only those were hand picked which were intended for home storage, the remainder being made up into cider, fed to stock or allowed to rot on the ground. Hogs were in most cases turned into the orchards to eat the fallen fruit, but even then hundreds of bushels of apples went to waste.

The value of live stock and live-stock products in Grant County for 1909 totaled \$2,352,619, which is \$66,637 more than the value of all cereals produced and is more than double the value of live stock and live-stock products for 1889. The total includes \$1,683,609 in animals sold or slaughtered; \$273,919 in dairy products, excluding those used in the home; \$370,971 in poultry and eggs; and \$24,120 in wool. Animals sold or slaughtered on farms included 85,284 hogs, 3,026 calves and 7,230 other cattle, 7,729 sheep and goats, and 1,661 horses and mules. The principal live-stock industry consists of the raising and fattening of hogs, cattle raising being of minor importance in comparison. The fattening of cattle was carried on extensively prior to the increase in the price of feedstuffs, the cattle being imported from the West and kept for 30 to 60 days, but in recent years cattle feeding has become unprofitable and is gradually being displaced by sheep raising. State and local laws protecting sheep against the ravages of dogs and safeguarding the industry in other ways have done much to encourage sheep raising.

A large proportion of the live stock raised is marketed outside the county, going mainly to the larger packing plants in Chicago, Cincinnati, and Indianapolis, although animals are also disposed of at

several local plants, the largest being located at Marion. Only a very small percentage of the meat retailed in the cities and towns is obtained directly from the farmers. On the other hand, a very large proportion of the beef consumed on the farms is obtained through the retail merchants, particularly during the summer and at harvest time. The pork products consumed on the farms are chiefly produced at home.

Animal diseases are continually menacing stock raising, but through the cooperation of the farmers with various Government and State institutions the losses have been greatly reduced. Cholera was prevalent in some parts of the county at the time of the soil survey, but every effort was being made to isolate and control the disease. In 1915 more than 3,000 head of hogs were inoculated against cholera.

Poultry and eggs and dairy products not only produce a large part of the farm income, but are also important items in the food supply of the farm. Very few farmers make a specialty of dairying or poultry raising, but practically all have a production above that required for home needs, and this is usually disposed of at the local markets or to collectors of dairy or poultry products who call regularly at the farms throughout the year. A few dairies located near the larger towns deliver milk and cream at retail, mostly in units of bottled pints and quarts, the products being generally sterilized or pasturized.

The local creameries and ice-cream factories utilize the greater part of the cream and milk collected on the daily rounds among the farmers. In most cases the cream is separated on the farm, the separated milk being fed to the young stock. The practice is quite general among the farmers to buy butter in exchange for cream, in the interest, it is said, of economy as well as of reduction in farm work.

The principal adaptation of crops to certain soils is that of wheat to the lighter colored soils and of corn to the black soils. No attempt is made to confine these crops to any particular type of soil. The yield of corn upon the lighter colored soils averages about half that upon the black soils, but the grain is conceded to be better in quality. Tomatoes are grown usually upon the dark soils, because of the heavier yields obtained.

Breaking of the land seldom, if ever, precedes the seeding of oats, as the crop is almost invariably drilled in on the stalk land of the preceding year's corn planting. Disking and harrowing constitute about the only preparation given the land. Breaking is sometimes done in advance of the sowing of wheat, but for the most part wheat is drilled between the corn rows. With breaking of the land the stand is more certain, and the crop is less susceptible to injury by extremes of wet or drought. Often the desire to get the crops in

early leads to plowing before the ground has attained the proper physical condition, or when it is too wet, and clods are formed which can not be reduced readily by subsequent cultivation. This undesirable condition is more often encountered on the so-called clay lands.

The harvesting of corn is done largely with labor-saving devices, the most popular being the corn binder. Practically no corn is cut by hand. The harvesting of wheat and oats is done exclusively with self-binders of the most improved type. Grain is thrashed under cooperative methods, a number of farmers combining their labor. Several harvesting machines are used to cut, rake, and load hay, and the unloading and storing of hay in the barn are also done with labor-saving machinery. Little hand labor is used in the handling of hay and the other farm crops.

Rotation in some form is practiced by most farmers. The one usually followed includes corn, wheat or oats, and clover, the purpose being to produce as much corn as possible without reducing the productiveness of the soil. The growing of cowpeas, soy beans, and alfalfa does much to maintain the organic-matter supply. The phosphatic fertilizers are more often applied to the lighter colored soils and usually contain 6 to 8 or 10 per cent phosphoric acid. Applications range from 150 to 200 pounds per acre, and are usually used for wheat. It is generally conceded that the use of these fertilizers improves both the yield and quality of the grain. Fertilizers high in potash or muriate of potash at the rate of 100 to 150 pounds per acre are sometimes applied to corn on the "black lands," particularly where the soil is high in organic matter, or "chaffy." The application of lime in the form of ground limestone at the rate of 2 to 4 tons per acre has been especially beneficial to the Miami and Crosby soils in the correction of acidity. In 1909, a total of \$12,580, or an average of \$40.98 for each of the 307 farms reporting outlay, was expended for fertilizers in Grant County.

The total number of farms in the county in 1909 was 2,886, of an average size of 85.5 acres. The value of all property on each farm averaged \$10,629, of which 74.3 per cent represented land, 14 per cent buildings, 2.2 per cent implements, and 9.5 per cent domestic animals. The more improved farms exceed this valuation many times. The farmhouses in Grant County are commodious. The barns and other outbuildings afford ample room and convenience for handling the crops and live stock. The farms in the oil-producing section, or the eastern and southeastern parts of the county were neglected during the more prosperous years of the oil boom, when returns from leasing the lands for oil were far in excess of the profits obtained from farming. These farms are gradually being brought up to a higher standard of improvement.

Wages of farm hands vary with the character of the work and length of service. Harvest hands are paid \$1.50 to \$2 or more a day. Labor hired by the month receives from \$25 to \$30, in addition to board or a house, the keep of a horse and cow, and a garden patch. The labor is generally efficient and laborers are expected to handle all kinds of farm machinery. A large percentage of the farm work is done by the owner and his family. The total expenditure for labor in Grant County in 1909 was \$264,670, an average outlay of only \$176.92 for each of the 1,496 farms reporting.

The census of 1910 shows 64.4 per cent of the farms of the county to be operated by owners, practically all the remainder being operated by tenants. The average rental for improved farms is \$6 or \$8 an acre. In many cases two-fifths or one-half of the grain goes to the owner, with a cash consideration for the use of pasture and hay lands. Usually, however, when a farm is operated on a share basis the net proceeds are divided equally between tenant and owner.

The price of land varies with its location and state of improvement. The average value in 1910 as given by the census was \$92.32 an acre, but it is doubtful if any improved land can be bought for that price at the present time. Land values range from \$125 to \$250 an acre, the average improved farm bringing \$150 to \$175 an acre. Not many farms are offered for sale.

SOILS.

The upland soils of Grant County are derived directly from glacial till, while the alluvial or bottom lands include reworked, stream-deposited material from the uplands. On account of the depth at which the country rocks lie they have added but little to the various soil materials, other than that which they contributed originally to the ice-ground mantle of glacial drift which covers the area to a depth ranging from about 10 to 200 feet. This heterogeneous mass, which consists chiefly of silt and clay interspersed with sand and gravel, was left as a surface mantle upon the recession of the ice sheet at the close of the late Wisconsin epoch. The material of the drift naturally varies with the character of the rocks over which the glacier passed. These include granite, gneiss, limestone, sandstone, and shale. Niagara limestone of the Upper Silurian age underlies the glacial drift throughout the county, and exposures occur along the banks of the Mississinewa River and in the stream bed, particularly north of Marion. Well borings indicate its existence in other sections of the county. At various times limestone quarries have been opened along the river, particularly in the vicinity of Marion, though only a few are now in operation.

Through the various agencies of weathering the glacial drift or till has been reduced to its present condition. In Grant County to an average depth of 18 to 20 inches the till is a rather uniform silt loam or silty clay loam passing into a silty to sandy clay substratum. Below a depth of 3 feet the material is usually more friable, and composed of a mixture of silt, clay, sand, gravel, and angular stone fragments, more or less calcareous, as shown by effervescence in hydrochloric acid. Where the drainage is well established the surface material is generally light colored. In other places it ranges from dark brown to black. The upland soils are in the Miami, Crosby, Bellefontaine, and Clyde series. The first two are light-colored, well-drained soils, generally deficient in organic matter. The last named comprises dark-colored, flat, low-lying, naturally poorly drained soils, with high organic-matter content.

The terrace soils, classed in the Fox series, include some of the best drained and most highly oxidized types in the county, excepting perhaps the Bellefontaine soil of the uplands, the latter being very similar to the Fox in character of material and color, but somewhat more irregular in surface relief.

The first-bottom soils, which are classed in the Genesee series, are formed largely of wash from the uplands and necessarily have some characteristics in common with the upland soils. They are predominantly rather fine textured. The texture of the material, however, is variable over short distances, particularly along the Mississinewa River, and the general uniformity of the upland soils forms a marked contrast to the lack of uniformity in texture in the case of the reworked stream-deposited material of the overflow lands.

The soils of Grant County are thus grouped in six series—the Clyde, Miami, Crosby, Bellefontaine, Fox, and Genesee. Nine distinct soil types, not including Muck and Peat, occur.

The surface soils of the Miami series are light to medium brown or grayish in color and are underlain by brownish-yellow or dull yellowish brown, heavier textured subsoils. The Miami soils are derived through weathering from glacial till, in general of calcareous nature, and usually the subsoil below a depth of 18 to 30 inches is distinctly calcareous. The surface drainage is usually good, but owing to the low content of vegetable matter the soil material tends to run together and become compact if plowed when wet, this property being especially characteristic of the silt loam and silty clay loam, the only two members of the series mapped in Grant County. It is due to this tendency of the soil to become compact that the term "clay land" is applied to the Miami types. The topography of these soils is comparatively level to undulating, but in places somewhat hilly.

The surface soils of the Crosby series are light gray or light brownish gray in color, rather compact in structure, and of an acid character. Below the surface soil is a subsurface layer somewhat heavier in texture than the material above and of a light ashen gray color. This stratum is specked and streaked with brown and black iron stains or the gray may be mottled with yellowish brown. It is decidedly acid, as shown by tests with litmus paper. Below 12 to 16 inches a dull yellowish brown, compact, tough subsoil, consisting usually of heavy silty clay, is encountered. In the lower depths, generally at 2 to 3 feet, the subsoil is rather friable and more or less calcareous. The Crosby series is developed in level to gently undulating country where both surface run-off and underground drainage are deficient. The Crosby series is derived from the same calcareous till that in the better drained situations usually gives rise to the Miami soils and under poorly drained or stagnant water conditions develops the Clyde soils. Of the Crosby series two types, the silt loam (mapped as Miami silt loam, flat phase, in the soil surveys of Delaware and Tifton Counties) and the silty clay loam, are mapped in Grant County. The term "clay lands" is applied locally to the Crosby soils as well as to the Miami, the material showing an even greater tendency to become compact when wet or to break up into large clods if plowed in this condition than is true of the Miami soils.

The soils of the Bellefontaine series are brown at the surface, with yellowish-brown to reddish-brown subsoils. The substratum below 3 or 4 feet is generally composed of alternate layers of sand and gravel, or of a mixture of these. The topography is undulating to slightly rolling, and the drainage, both surface and subsurface, is good. Only one type of this series, the loam, is mapped in Grant County.

The surface soils of the Clyde series are dark gray to black in color, and are underlain by gray or drab subsoils, mottled with yellowish or rusty-brown streaks. The soils are developed in former lake beds and ponds or low, poorly drained areas within glacial regions, through the accumulation of organic matter and the influence of poor drainage acting either upon the original glacial till of the basin or upon accumulations of water-laid material deposited over the floor of the basin. The surface is always level or depressed, the Clyde soils naturally having poor drainage, but where they are reclaimed they are highly productive and include some of the best farm lands in the Middle West. Only one member of the Clyde series is mapped in Grant County, the silty clay loam.

The Fox series, like the Bellefontaine, has brown surface soils and yellowish-brown to slightly reddish brown subsoils. Below 30 to 36 inches the substratum is loose and friable, usually consisting

of interbedded sand and gravel. The Fox soils have typically a level topography, being drained here and there through potholes or by valleys eroded since the deposition of the material as outwash plains or as terraces along streams within the glacial area or flowing out of it. The soil material consists largely or wholly of glacially derived material. Only one member of the series, the Fox loam, is mapped in this county.

The Genesee series includes dark-brown to grayish-brown alluvial soils occurring as first-bottom lands along the Mississinewa River and its tributaries. The soils of this series are subject to annual or at least frequent overflows. For the most part, however, the overflows occur between the harvesting and the planting seasons. Of the Genesee series the loam and silt loam types are mapped in Grant County.

The materials mapped as Muck and Peat form widely scattered areas of small extent. They consist wholly or largely of organic matter representing plant remains in varying stages of decomposition.

The following table gives the name, acreage, and proportional extent of each type mapped.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clyde silty clay loam.....	89,472	34.0	Fox loam.....	3,648	1.4
Crosby silt loam.....	53,568	20.3	Genesee loam.....	3,008	1.1
Miami silty clay loam.....	48,832	18.5	Bellefontaine loam.....	704	.3
Miami silt loam.....	38,336	14.5	Muck and Peat.....	640	.2
Crosby silty clay loam.....	20,608	7.8			
Genesee silt loam.....	4,864	1.9	Total.....	263,680

MIAMI SILT LOAM.

The surface soil of the Miami silt loam, to a depth of 6 to 8 inches, is a light-brown to brownish-gray silt loam, passing rather abruptly into a yellow to brownish-yellow, friable silt loam which extends to a depth of 8 to 12 inches and is in turn underlain by a brown silty clay loam, mottled with drab. This grades into a darker brown silty clay. Below 20 to 24 inches the typical dark-brown silty to sandy bowlder clay is encountered. This, although stiff and heavy, readily breaks up under pressure, owing to an appreciable content of coarse sand and fine gravel. The coarser material increases with depth to about 30 to 36 inches, where a more heterogeneous mass of clay, sand, gravel, and rock fragments of a gray to drab color, is encountered. The rock fragments are generally calcareous, effervescing readily in hydrochloric acid. In the vicinity of stream courses pockets of stratified

sand and gravel occur, which are commercially developed as gravel pits.

The type is in general quite uniform except where erosion has been sufficiently active to expose the coarser subsurface material, in which case small rock fragments may occur in patches along with the boulder-clay exposures, as is the case at the heads of certain gullies and along some of the steeper stream slopes.

The Miami silt loam is most typically and extensively developed in the vicinity of the Mississinewa River, particularly in the northern and northwestern parts of the county. It also occurs extensively along the general course of Pipe Creek. The type occurs in every township in the county except Van Buren, and covers a large proportion of Pleasant, Richland, Mill, Jefferson, Center, and Fairmount Townships.

The topography of the Miami silt loam varies from almost level or slightly undulating to rolling or hilly, the greatest relief being developed in the bluffs along the river and the larger creeks. The typical Miami silt loam is undulating to rolling, but it also occurs in flat areas lying near deeply cut stream channels, where the subsurface drainage is sufficient to give good oxidation, a feature distinguishing the type from the Crosby silt loam, which occurs in similar situations but with poor internal drainage.

The Miami silt loam includes some of the best drained upland in the county, and in general the drainage is adequate for the growing of all crops. The steeper slopes along the streams occasionally need protection from erosion by terracing, but for the most part the type is not excessively drained.

Practically all the Miami silt loam is under cultivation, the exceptions being the occasional patches of forest or woodlots which are preserved on most farms for shaded pasture and as a source of wood for domestic use. These wooded areas frequently include land of rougher topography.

Wheat, oats, and hay are the principal crops on the Miami silt loam. The type embraces some of the most productive wheat lands in the county, although the present yields are considerably lower than those which were obtained from the early clearings. Corn is not so generally grown as wheat and oats, as it gives lower yields than on the darker colored soils, although the lower yield is said to be compensated for in part by better quality or higher feeding value. The use of the type for corn has increased in the last few years, since corn has become the most profitable crop in the farming system of the county.

The Miami silt loam is adapted to a wide range of agricultural use, and when properly handled the yields over an extended period

compare favorably with those of any other type in the county, as this type is not so readily affected by extremes of wet and drought. The Miami silt loam is well drained and crops mature earlier and more fully than on the more poorly drained soils.

The ordinary yield of wheat is from 20 to 25 bushels per acre,¹ although where commercial fertilizer is used yields are generally higher. The wheat grown is of good quality. Oats produce from 35 to 50 bushels per acre. Oats are not so likely to lodge on this type as upon the darker soils and the quality of the grain is better. Timothy and clover, mixed, produce 1 to 2 tons of hay per acre, the average yield being about 1½ tons. Corn yields on the average about 37 bushels per acre, although a return of 50 bushels per acre is not uncommon in favorable seasons on wheat land to which fertilizer was applied.

The Miami silt loam, next to the Bellefontaine loam, is the easiest of the upland soils to cultivate, and a loose, mellow seed bed can be obtained if care is taken to plow when the moisture content of the soil is favorable. If it is plowed when too wet large clods are formed which can not be easily reduced by subsequent cultivation. This unfavorable tendency, however, is not so great as with the Miami silty clay loam, which has a higher content of clay and is more deficient in organic matter.

The resulting increased yields and better quality of the grain where fertilizers have been applied have led to their more extensive use. As upon the other, lighter colored soils, fertilizers containing from 8 to 10 per cent of phosphoric acid, are applied at the rate of 150 to 200 pounds per acre.

Few transfers of farms of this type have been made in recent years. Land is held at \$100 to \$150 an acre. In the vicinity of the towns and villages, and where the farms are exceptionally well improved, \$200 an acre or more is asked.

The Miami silt loam is well adapted to alfalfa, soy beans, and other legumes, particularly where ground limestone is applied to the soil to correct any acid condition which may exist, and their culture could well be extended. Clover, though valuable as a soil-enriching crop, does not meet the full requirements for maintaining maximum crop yields. It has been shown by local tests that alfalfa turned under is more beneficial than clover for soil enrichment.

MIAMI SILTY CLAY LOAM.

The surface soil of the Miami silty clay loam, to an average depth of 7 or 8 inches, is a brownish-gray, compact, heavy silt loam. When dry the immediate surface is light gray. The subsoil in turn, to a

¹ The statements made in this report as to yields of crops are in part based upon estimates obtained from farmers.

depth of 10 or 12 inches, is a friable silty clay loam, whence it grades into stiff, heavy, rather plastic silty clay, dull yellowish brown, streaked with gray and rusty brown. Below 16 to 20 inches the color is predominantly brown, and the material is calcareous. In the lower depths brown to black shale and occasional limestone fragments are encountered. The term "clay land," applied to all the lighter colored soils, is particularly applicable to this type, the type probably carrying a higher content of clay than any other in the county.

The Miami silty clay loam occurs chiefly in the north and east-central parts of the county, being confined almost-exclusively to the region east of the Mississinewa River. Its main development is in Washington, Center, Monroe, and Jefferson Townships, where it occurs as the dominant type. It occupies a large proportion of the rolling to hilly uplands and for the most part is more broken in topography than the Miami silt loam, although the slopes are precipitous only in the immediate vicinity of, or adjacent to, stream channels. The uneven character of the surface usually assures ready drainage, and drainage for the most part is adequate for the general farm crops to which the type is adapted. The tough nature of the sub-soil retards somewhat the downward movement of any excess of moisture, so that the underground drainage is not always so good as the surface would suggest. In wet seasons the soil is sometimes saturated upon the slopes, in situations where the Miami silt loam or Bellefontaine loam would be adequately drained. The pale-yellowish and gray mottling of the upper layer of the subsurface material is the result of this water-logged condition.

In point of extent the Miami silty clay loam ranks third in the county. Practically all the land is cleared and is in use for general farming purposes. Only a small proportion of the type is too rough for cultivation, and this is used for pasture. Some of the steeper slopes that were formerly cultivated have been given over to permanent bluegrass pasture. The type is used largely for wheat, oats, and hay, timothy being the main hay crop. Corn also is extensively grown, the yields, however, being considerably lower than upon the darker soils, particularly in wet seasons.

The agricultural use of the Miami silty clay loam is restricted almost entirely to general farming, although two of the largest-dairy farms in the county are located upon this type in the vicinity of Marion.

The yield of wheat ranges from 15 to 25 bushels per acre, the average being about 19 bushels. Oats average about 30 bushels per acre, although larger yields are frequently obtained. The yields of corn vary from 25 to 40 bushels per acre, with an average of about

35 bushels. Timothy, the main hay crop, yields 1 to 1½ tons of hay per acre.

Commercial fertilizers, as in the case of the other lighter colored soils, are applied to part of the wheat lands on the Miami silty clay loam, and it is believed their use could be extended with profit.

Prices of land in the eastern part of the county were unstable for several years following the discovery of petroleum and farms were rated above their present value for agricultural purposes. During the period of the oil boom many of the owners abandoned their farms to live in Marion and the smaller towns. Now that the oil is largely exhausted land values have again become stable and \$100 to \$150 an acre is asked for farms located upon this type.

CROSBY SILT LOAM.¹

The soil of the Crosby silt loam, to an average depth of about 8 inches, is a compact silt loam of a "leached" or light-gray color when dry, but darker or brownish gray when moist. The subsurface material to 12 or 15 inches is somewhat heavier in texture, a light silty clay loam, typically is characterized by a mottling of pale yellow or yellowish brown and gray, and is decidedly acid. Below this, to an average depth of 24 to 30 inches, the subsoil is a yellowish-brown to rusty-brown, compact, tough silty clay, streaked somewhat with gray, and grading in the lower depths into a more friable silty to fine sandy clay, darker brown in color. This stratum below 3 feet becomes still less compact and lighter in color, and contains an appreciable amount of sand and fine gravel. The latter material is distinctly calcareous, as shown by its effervescing with hydrochloric acid.

The Crosby silt loam is confined almost exclusively to the western and southwestern parts of the county, or that portion west of the Mississinewa River. It occurs for the most part in irregular, disconnected bodies a few acres to several hundred acres in extent, and is widely distributed. The largest development of the type is in Pleasant, Richland, Green, and Liberty Townships. Where the Clyde silty clay loam is most extensively developed the areas of Crosby silt loam are small, and very irregular in outline, with a flat surface, and the type is but slightly elevated above the surrounding Clyde soil. It is in these situations that the typical Crosby silt loam is developed, which is naturally poorly drained. Where the bodies are more extensive the topography usually is somewhat undulating, the soil is better drained, and the line of demarcation between the Miami silt loam and the Crosby silt loam is less distinct.

Owing to the extent and wide distribution of the Crosby silt loam it is one of the most important soils of the county. Practically all

¹ Mapped as the Miami silt loam, flat phase, in Delaware and Tipton Counties.

the type is under cultivation, being used for growing grain crops, as well as clover and timothy, but except in the case of wheat, yields are considerably lower than upon the darker soils. This grain is better adapted to the lighter soils and so far as practicable the Crosby soils are used for it. When first brought under cultivation the soil was richer in organic matter and much more productive than at present. The natural store of organic matter has been depleted by continued cultivation without rotation of crops. Owing to the acid condition of the soil and the inadequate drainage, difficulty is sometimes encountered in getting a full stand of clover. The acid condition may be corrected by applications of finely ground limestone or burnt lime.

The type is used largely for general farming, though some special crops, including fruits, are grown.

The average yield of corn upon the Crosby silt loam is from one-third to one-half less than upon the Clyde soil, being between 35 and 45 bushels per acre. The yields of wheat vary from 15 to 30 bushels per acre, with an average of about 19 bushels. The ordinary yield of oats is about 30 to 35 bushels per acre, although larger returns are frequently obtained. The hay produced upon this type, particularly from timothy, is of good quality. The yield ordinarily is 1 to 1½ tons per acre.

A commercial fertilizer containing from 8 to 10 per cent of phosphoric acid and 1 to 2 per cent of nitrogen, with a somewhat higher percentage of potash, is sometimes applied to wheat at the rate of 100 to 150 pounds per acre, but for the most part only barnyard manure is used, the latter being generally turned under with the clover sod.

The farms composed wholly or in part of the Crosby silt loam are generally well improved. The type is closely associated with the Clyde silty clay loam and has about the same value, the usual selling price ranging from \$125 to \$200 an acre. Even at these prices there are few farms for sale.

CROSBY SILTY CLAY LOAM.

The surface soil of the Crosby silty clay loam, to a depth ranging from 5 to 10 inches and averaging about 8 inches, is a gray, heavy silt loam or light silty clay loam. The surface material when dry has a leached or grayish-white appearance, indicating deficiency in organic matter, sluggish internal drainage, and low state of oxidation. The upper subsoil is a dull yellowish brown, mottled with gray, silty clay loam, passing into a heavy silty clay which at a depth of 16 to 20 inches becomes tough and impervious. Below 24 to 30 inches the structure becomes somewhat more friable. This lower stratum is calcareous, in contrast to the overlying material, which gives a de-

cided acid reaction with litmus paper. This type, with the other lighter colored soils, is locally called "clay land."

The Crosby silty clay loam is more typical and more extensive in Van Buren Township than elsewhere in the county. This region of its occurrence extends into Monroe and Washington Townships. There are smaller detached areas in Jefferson, Center, and Mill Townships. No areas of the type are mapped west of the Mississinewa River. As the topography is level or only slightly undulating the natural drainage is in few places adequate for the full development of the type, although the water table has been lowered and better drainage established through the drainage of the depressions, or flats and sloughs, occupied by the associated Clyde silty clay loam type. Frequently the Crosby soil is elevated only a few inches, or at most a few feet, above the surrounding more poorly drained Clyde soil.

Owing to its extent and wide distribution, the Crosby silty clay loam is one of the important soils of the county. Practically all the type is under cultivation. Although it is largely used for corn the soil is better adapted to the small grains, wheat or oats, which are used largely as nurse crops for clover and timothy.

The type is used entirely for general farming, to which use it is best adapted.

The yields upon the Crosby silty clay loam are about the same as those on the other lighter colored soils, or, in the case of corn, from one-third to one-half lower than upon the Clyde silty clay loam. The ordinary yield of wheat is from 15 to 20 bushels per acre, although a return of 30 bushels is not uncommon. Oats yield from 30 to 35 bushels per acre, and the average yield of hay is 1 to 1½ tons.

Practically the only fertilizer used is barnyard manure, although commercial fertilizers are sometimes applied to wheat lands at the time of seeding. The fertilizer used generally contains 8 or 10 per cent of phosphoric acid and is applied at the rate of 100 to 150 pounds per acre.

The value of land of the Crosby silty clay loam can not be definitely determined from transfers of real estate, since the farms include varying proportions of the Clyde soil. The price of land in the section of the county in which this type is predominant ranges from \$100 to \$175 an acre.

Improvement of the physical condition of this soil by the addition of organic matter is probably the most important step to be taken to improve it.

The growing of alfalfa and soy beans or other legumes for this purpose would be better than to use crops that do not gather nitrogen from the air. Although the soil is acid, the subsoil is calcareous and

favorable to deep-rooted legumes when once established. To obtain a good tilth on this type it is necessary to select carefully the time of plowing, as it clods badly if stirred when too wet.

BELLEFONTAINE LOAM.

The surface soil of the Bellefontaine loam, to a depth of 10 or 12 inches, is a brown to slightly reddish brown sandy loam to loam or silty loam, underlain by a similar or brighter reddish brown, compact silty clay loam or clay loam. This in turn grades into a lighter or coarser textured friable clay loam, which at 30 to 36 inches is loose or incoherent, generally giving way rather abruptly to beds of sand and gravel, brown to light brown in color, and markedly calcareous.

The type is developed only in the vicinity of the Mississinewa River, frequently including some of the higher bluffs. The most extensive and typical areas are found southeast of Marion, east and northeast of Matthews, and 2 miles southwest of Upland.

The Bellefontaine loam occupies high, rolling areas with good surface and subsurface drainage. The type is all under cultivation, being used principally in the production of corn, wheat, and hay. The yields are about the same as on the Miami silt loam. Crops are not so susceptible to injury from either excessive rainfall or drought the yields being about the same year after year where similar methods of cropping are followed.

The yield of corn ordinarily ranges from 45 to 50 bushels per acre. Wheat and oats give an average yield per acre of 20 and 30 bushels, respectively. The type is well adapted to small fruits, tomatoes, potatoes, and other garden vegetables. Apples not only yield well, but are of good quality.

Farms upon which this type occurs are valued at \$125 to \$175 an acre, according to the location and improvements. Very few sales, however, have taken place in recent years.

For the commercial growing of apples or peaches there is no better soil in this section of the State than the Bellefontaine loam. It should be well adapted to alfalfa, although no alfalfa fields were seen on it during the survey.

CLYDE SILTY CLAY LOAM.

The surface soil of the Clyde silty clay loam is a grayish-black to black, heavy silt loam or silty clay loam, grading at an average depth of 8 inches into a bluish-black silty clay loam. This in turn quickly passes into a slate-blue to drab silty clay. Below this, from 12 or 15 to 30 inches, the subsoil is light to medium, somewhat stiffer and more plastic than the overlying clay, gray in color, and mottled with rusty-brown streaks or iron stains, the mottling being more pronounced below 20 to 24 inches. At 30 to 36 inches the heavier clay gradually

gives way to a more friable silty to fine sandy clay, which in turn may be underlain by a whitish marl or by sand and gravel, the latter occurring at various depths, but usually at 6 to 8 feet.

The sand, gravel, and marl are all highly stained with iron. The gravel beds usually follow the course of the natural drainage and are not infrequently exposed in dredging.

The type is fairly uniform throughout the county, but owing to differences in position, natural drainage, and local treatment, it has certain variations in color, texture, and depth of soil. The texture is naturally heaviest where the depth of the soil is least, as in the larger, shallower basins, while the color is darkest in the deeper basins, or in the situations where conditions have been most favorable for the accumulation of organic matter deposited largely by surface waters carrying in suspension decomposed vegetation from the uplands. Small mucklike areas are not infrequently developed in the lower situations. Cultivation tends to alter both the color and the texture of the soil. From the dark color of the soil the term "black land" is applied to the type in contrast to the associated lighter colored "clay lands."

The Clyde silty clay loam occupies irregularly outlined depressions in the uplands. It is the most extensive and widely distributed soil in the county, but its main development is in the southern and southwestern parts, particularly in Franklin, Liberty, and Sims Townships, about half the area of which is occupied by this type. It is also extensively developed in Fairmount and Green Townships.

The surface of the Clyde silty clay loam is low lying and flat, the areas having little or no natural drainage. The type was originally in a semiswampy condition throughout the wet season, but in summer usually dry, except possibly for the small "buttonwood" ponds, which were permanently swampy. This type was generally too wet for cultivation under natural drainage conditions, a fact which accounted for its slow development. Its farming possibilities were not understood until in the early eighties, when adequate drainage outlets were constructed, giving the individual farmer an opportunity to drain his land. The building of good roads through the type permitted the farmers to handle their crops to better advantage. Artificial drainage was first effected by open ditches, but as these interfered with the cultivation of the type in large tracts they have largely been replaced in recent years by underground tile drains. The drainage outlets, which have followed the general course of creeks and branches, have been made more effective by the deepening and straightening of the stream channels. The larger streams are left open and carry off more readily the flood waters and accumulated discharge from the tiled ditches. The drainage of the type in the western part of the county is largely through Pipe and Deer Creeks,

while in the eastern part Black and Walnut Creeks are the main drainage ways.

The Clyde silty clay loam is not only the most extensive but also one of the most productive types in the county, and as practically all of it is under cultivation, it ranks first in agricultural importance in the county. Its especial adaptation to corn has increased its value. The ordinary yield of corn is from 10 to 30 bushels more than the yields usually obtained on the lighter colored soils. Tomatoes in favorable seasons produce their largest yields upon this type, though their firmness and keeping quality may not be so good as the product of certain other soils. Larger yields of oats, cowpeas, soy beans, clover, and sugar beets are also obtained. The type, however, is not so well adapted to wheat as the light-colored soils. The large yields of forage crops and grasses, and of corn for ensilage on the Clyde soil insure better returns from dairying and stock feeding than in the case of "clay lands."

Crops grown upon the Clyde silty clay loam usually mature later than upon the lighter colored soils, chiefly because of the ranker growth of vegetation due to the higher content of nitrogen or organic matter and the moister conditions. Lateness in maturity is particularly noticeable in growing tomatoes, which never mature a full crop. Frequently not more than half the fruit is ripened before the vines are nipped by frost. Wet seasons still further retard the development of the fruit, and causes much of it to rot.

Next to the first-bottom lands, the Clyde silty clay loam is generally considered the best corn soil in central Indiana, if not in the State, and its use as far as practicable is restricted to this crop. The increasing demand for corn for stock feeding and other purposes has led to the extensive planting of this grain, not infrequently to the exclusion of other crops and the neglect of crop rotations, with a resulting decline in the productiveness of the soil. The practice of this "one-crop" system is naturally more general with the tenants than with the farmers who operate their own land. The tenant system is being extended as capitalists from the towns and cities invest in farm holdings. The "black lands" are among the most attractive investments of this kind, because of their suitability to the production of corn and hogs, the leading income products of the farms.

The yields of corn upon the Clyde silty clay loam vary from 40 to 80 bushels or more per acre, with an average of about 55 bushels. The yield of wheat seldom exceeds 18 or 20 bushels per acre and the crop is more subject to heaving and is more likely to be injured by ice and standing water than upon the better drained "clay lands." The heads also do not fill as well, although a heavier straw is produced. Oats yield from 30 to 50 bushels per acre, and the straw is

heavier than upon the lighter colored soils. In wet seasons, however, the crop lodges badly, and there is considerable loss unless the growth can be utilized for hay or pasturage. Alfalfa can be successfully grown on this type if proper attention is given to draining and liming the soil. Although the quality of the hay may not be so good, heavier yields will apparently be obtained from this type than from the lighter colored soils. More careful curing of the crop, however, will be required.

The Clyde silty clay loam if properly handled is capable of being reduced to a fine, mellow tilth, but if deep plowing is done while the subsoil is more or less saturated, clods are formed which can not always be broken down by subsequent cultivation. Late springs, with excess of rainfall, too often tempt the farmers to work this soil before it becomes dry enough to turn and pulverize properly, and in this way the physical condition of the soil is frequently impaired for even more than one season.

Where commercial fertilizer is applied to this type it is generally in the form of muriate of potash and at the rate of 100 to 200 pounds to the acre. Its use, however, is more general upon the "mucky" variations of the type, locally called "chaffy land," where the corn tends to burn or turn yellow and the crop does not properly mature.

The rapid increase in land values in this and adjoining counties has been due largely to the wide distribution of the productive Clyde silty clay loam throughout this part of the State. The value of individual farms is not infrequently determined by the included area of this "black land," which is valued at \$150 to \$200 or more an acre, according to the proximity of the land to town or city and the character of the farm improvements.

FOX LOAM.

The surface soil of the Fox loam, to a depth of 12 or 15 inches, is a brown loam or light silty loam, underlain by a somewhat lighter brown, heavy silty clay loam or clay loam which becomes more friable or sandy below 20 to 24 inches. At about 30 inches the change to lighter material becomes more rapid, a loose, friable, sandy to fine gravelly loam being encountered here. This in turn passes into stratified layers of sand and gravel below 3 or 4 feet. In color and character of material the Fox loam is very similar to the Bellefontaine loam, the main differences being in their topography and respective positions upon the river terraces and the uplands.

The Fox loam is known locally as second-bottom land, although it occurs upon both the second and third terraces above the river. Before the type was cleared of its native forest growth it was commonly called "sugar-tree flats." It includes some of the first land to be cleared, and is a strong, well-drained soil. The type is confined

almost exclusively to the terraces of the Mississinewa River and Jocinah and Walnut Creeks. It is most extensively and typically developed along Jocinah Creek and the Mississinewa River in Pleasant Township, although small areas are scattered along the river throughout its course in this county. The city of Marion is in part located upon this soil.

The surface of the Fox loam is generally level, or slightly undulating if the terrace has been eroded, but it is never rolling. It has sufficient relief to insure ample surface drainage and the open, porous nature of the substratum admits of the ready downward movement of any excess of moisture.

The Fox loam, though less extensive than some of the lighter colored upland types, is more productive and is well adapted to a wide range of crops. It is especially well suited to the growing of alfalfa. If its adaptation to this legume is understood, however, it is not taken advantage of, as no fields of alfalfa were observed upon this type during the course of the survey. Corn is the main crop, although wheat and oats are also grown extensively. Crops are not so likely to be injured by excessive rainfall or drought as upon the heavier upland soils, and full maturity of the crop is generally assured.

The type is largely used for general farming, although it is equally well adapted to the growing of truck, including potatoes, tomatoes, peas, and beans, and to fruit growing.

Commercial fertilizers containing from 8 to 10 per cent phosphoric acid, 1 to 2 per cent nitrogen, and about the same percentage of potash are sometimes applied to wheat, but for the most part the productiveness is maintained by crop rotation, and an occasional application of barnyard manure.

The crop yields are fairly uniform from year to year, the ordinary yields of corn being about 40 to 45 bushels per acre, of wheat 20 to 25 bushels, and of oats 30 to 40 bushels.

The Fox loam is more sandy and friable than the silt loams and silty clay loams of the uplands and is easier to cultivate. Good tilth is readily maintained.

Land of this type, with the first-bottom lands or adjacent uplands, is valued at \$125 to \$250 an acre, according to the improvements and the proximity to Marion.

GENESEE LOAM.

The surface soil of the Genesee loam, to a depth ranging from 10 to 15 inches and averaging about 12 inches, is a brown to dark-brown fine sandy loam to loam or silty loam. The upper subsoil is very similar to the surface soil in texture, but is usually lighter brown in color. Below 18 to 20 inches the substratum is frequently made up of horizontal beds of clay and sand.

Since the Genesee loam is an alluvial soil, both the surface soil and subsoil are quite variable over short distances, owing to differences in the movement of depositing stream currents at various flood stages. In the immediate vicinity of the streams and across the sharper bends where the currents are swift, coarser particles have been deposited, the soil in many places consisting of a medium to fine sand. Along the larger bends or in settling basins where the currents are slow the deposition of the finer sediment gives rise to the heavier or silty variations of the type. In the latter areas the soil is usually somewhat darker than elsewhere.

The type includes all the overflow bottoms of the Mississinewa River and part of the first bottoms along some of its tributaries. These flood plains are generally flat or level, and dissected by numerous creeks and branches tributary to the main stream. The drainage is fair to good throughout the greater part of the year, and for the most part the land may be cultivated. In the low-lying areas ditches are used to carry off the excess water.

The Genesee loam is less extensive than most of the upland types, but its productiveness makes it an important type. It is used largely for grain crops, especially corn. In the vicinity of Marion and some of the larger towns it is used to some extent for trucking. The largest truck farm is situated in the northwestern corner of section 19, Washington Township. Uncultivated areas are used for pasture.

The lighter, sandy variations of the type are more often selected for trucking. Melons, cucumbers, potatoes, and tomatoes are among the most profitable truck crops. Only those crops are grown which can be matured between the flood periods, but overflows seldom occur during the season of the year when truck crops are grown. Corn is a profitable crop; the largest yields in the county are not infrequently obtained from the bottom lands. Yields of 50 to 70 bushels are common, though the yield varies considerably with the character of the season and the cultivation which the crop receives, the latter being somewhat dependent upon the lateness of the spring floods.

Some commercial fertilizers are used upon the truck crops where it is desired to force them to early maturity. The annual deposition of alluvium, however, tends to maintain the productiveness of this soil. Crop yields have shown some decline since the land was first cleared and drained, where corn has been grown to the exclusion of other crops.

The farms are in no case so constituted as to include exclusively first-bottom land, so that accurate selling values can not be given. In association with adjacent soils it sells at \$100 to \$200 an acre,

according to the location and the proportion of the type suitable for cultivation.

With proper farm methods it is possible to bring practically all the type under cultivation. It is said that the clearing of the bottom lands and the adjacent slopes is responsible in large measure for the destructive effects of floods in recent years. Surveys of the bottom lands and a study of the effect of clearing them of the native forest growth have been undertaken by the State. Some of the larger cities also have sent out engineering corps to study the effect of straightening and deepening the channels of the river.

GENESEE SILT LOAM.

The soil of the Genesee silt loam, to an average depth of 8 to 10 inches, is a brown to dark-brown, heavy silt loam, or, in places, silty clay loam. This grades into a very dark brown to almost black silty clay loam, and this in turn into a drab to slate-blue, stiff, plastic clay, mottled with shades of brown or with iron stains. The color of the substratum becomes lighter with depth. The brown stains are due in part to the decay of roots, which have penetrated the subsoil to various depths. The dark color of the soil is due to the accumulation of organic matter from decayed vegetation, these bottom lands having been originally low and semiswampy in many places.

Where this type merges into the Clyde silty clay loam the boundary drawn is frequently an arbitrary one, owing to the similarity of these two soils in color and the very gradual change in texture. Where the type occupies old, partially filled-in valleys, its origin is not unlike that of the Clyde silty clay loam where the latter type occupies elongated or ponded areas. Adjacent to the stream channels and in the narrow necks of the valleys the surface soil is usually of lighter texture than is typical.

The Genesee silt loam is most extensively developed in the bottoms along Lugar, Walnut, Black, Deer, Pipe, and Back Creeks. Other less extensive areas are found along the smaller creeks and branches. It occurs in narrow strips, even in the larger valleys seldom being one-fourth mile in width.

Originally the areas were poorly drained. They have now, for the most part, been reclaimed, by deepening and straightening the natural drainage outlets and leading properly placed tiled laterals into them. The greater proportion of the type is now under cultivation.

Corn is the chief crop and some of the largest yields in the county are obtained on the land. The average yield, however, is about the same as that obtained from the Clyde silty clay loam, approximately 55 bushels per acre, although returns of 70 to 80 bushels per acre are

not uncommon. Oats are grown to some extent and produce heavy yields, but frequently the full crop can not be harvested because of lodging. Owing to the low position of the areas, wheat is likely to be injured by overflows and is seldom grown. The type is one of the best grass soils in the county, giving yields of $1\frac{1}{2}$ to 2 tons of hay per acre. On the better drained areas heavy yields of tomatoes are produced.

Owing to the large yield of corn and the slow depreciation in productiveness of the soil, the tendency is to grow corn to the exclusion of all other crops. Rotation is practiced to only a small extent.

When the season is favorable a good tilth can be maintained, but too often when the spring planting has been delayed by late overflows or other conditions the soil is plowed too wet and breaks up in large, compact clods which can not be broken down readily by subsequent cultivation. The physical condition in such cases may be impaired for even more than the one season.

No fertilizer is applied to this soil, the deposition of sediment supplying the only added fertility aside from that obtained by plowing under oats and corn stubble and the native vegetation. In many cases it is believed that the addition of potash would increase the corn yields.

Land of the Genesee silt loam is valued, in association with the adjacent uplands, at \$100 to \$200 an acre, according to the location and the condition of drainage, or the general possibilities of development.

MUCK AND PEAT.

In the areas mapped as Muck and Peat, Muck greatly predominates. The material consists of dark-brown to black accumulations of organic matter in different stages of decomposition, mixed with small quantities of mineral matter, of the grades sand, silt, and clay. Most of the soil mass, however, consists of the remains of cat-tails, rushes, mosses, sedges, grasses, and other water-loving plants which originally occupied and gradually filled up shallow lakes and ponds. Muck and Peat are alike in origin, but are distinguished from each other by the state of decomposition of the vegetable matter of which they are composed. The Muck is darker in color than the Peat, and finer or smoother textured. The latter is more fibrous, consisting of a less decomposed mass of vegetable matter than the Muck, and is found where the organic material is deepest, generally near the center of the depressions. The depth of the deposits varies from a few inches near the margin of the area to several feet in the interior. The organic material is generally underlain by a bluish-black, stiff, plastic clay, which grades below into a lighter colored or grayish,

mottled clay. In some places strata of shell marl occur in the underlying material.

The bodies of Muck and Peat mapped are relatively small and their occurrence is confined to the eastern half of the county. The largest and most typical area is between Fairmount and Fowlerton. There are smaller areas skirting Lake Galatia; 2 miles southwest of Fowlerton; south and southeast of Gas City; 2 and 3 miles southeast of Upland and $3\frac{1}{2}$ miles southwest of that town; and 3 and 4 miles northwest of Vanburen and 3 miles southeast of that place.

The type occupies old filled-in valleys and shallow lakes and ponds which had no natural drainage outlets. Most of the areas have been improved with tile drains and can now be used for cultivated crops or as pasture. These were formerly swamps throughout the greater part of the year. The native grasses which grew in the better drained places were used by the early settlers for hay.

The areas of Muck and Peat are at present of little agricultural importance in the county aside from their local value, owing to the small acreage and lack of use for purposes other than general farming. No efforts have been made to develop them for production of special crops, such as celery, onions, and other vegetables to which the soil is well adapted. Of the area under cultivation the greater part is used for corn, oats or timothy. The growth of oats is rank and the straw lodges badly. Corn sometimes "burns" or turns yellow without fully maturing, a tendency which can be largely corrected by liberal applications of barnyard manure and by applying potash salts at the rate of 150 to 200 pounds per acre. Lime judiciously applied is also beneficial.

The Muck and Peat lands are never sold separately, but farms upon which they occur are held at \$125 to \$175 an acre.

SUMMARY.

Grant County is situated a little northeast of the geographical center of Indiana. It has an area of 412 square miles, or 263,680 acres.

The country consists of a level to undulating till plain broken only along the streams, particularly the Mississinewa River and its larger tributaries, whose valleys are generally deep and narrow.

The Mississinewa River is the chief drainage outlet of the county. Artificial drainage has been installed extensively in the more poorly drained sections of the county.

The population of the county is reported by the 1910 census as 51,426, of which 51.2 per cent is rural. Marion, the county seat and largest town, has a population of 19,359 and is an agricultural and industrial center. Gas City, Fairmount, Jonesboro, Vanburen, and Upland are other important towns.

An excellent system of graveled public roads extends over the entire county. Four steam railroads and two electric interurban lines provide adequate transportation facilities.

The mean annual temperature is 50.9° F., and the mean annual rainfall about 36 inches. The precipitation is well distributed throughout the year. Five months is usually the duration of the growing season.

The agriculture of Grant County is in a highly developed state. Corn, oats, wheat, and hay are the main crops.

The greater part of the corn and hay produced is fed to stock upon the farm or sold locally; the oats and wheat are usually sold. The special crops include potatoes, tomatoes, and sugar beets. Live stock, particularly hogs, is the main source of farm income, and the farming operations are usually centered upon the animal industries. The value of live stock and live-stock products for 1909 totaled \$2,352,619, or \$66,637 more than the value of all cereals produced.

The cultivation and harvesting of crops are done largely with the most improved labor-saving machinery.

Crop rotation in some form is practiced by most farmers, the rotation usually followed including corn, wheat or oats, and clover.

Commercial fertilizers are used to some extent, usually in growing wheat.

The total number of farms in the county in 1910 was 2,886, of an average size of 85.5 acres each.

The ordinary wage of farm labor ranges from \$25 to \$30 a month. Harvest hands receive \$1.50 to \$2 a day. The total expenditure for farm labor in the county amounted to \$264,670 in 1909.

The average rent for improved farms is \$6 to \$8 an acre. Only 34.4 per cent of the farms are operated by tenants.

The average assessed value of the land is given by the 1910 census as \$92.32 an acre. Well-improved farms sell for \$125 to \$200 or more an acre.

Six series of soils are recognized and mapped in Grant County.

The Miami, Crosby, Bellefontaine, and Clyde soils occur upon the uplands, the Fox upon the terraces, and the Genesee in the first, or overflow, bottoms.

The upland soils are derived directly from glacial till of the late Wisconsin stage, while the bottom-land and terrace soils are derived from reworked and redeposited material representing wash from the uplands.

Of the Miami series two types are mapped, the silt loam and silty clay loam. These are best adapted to wheat and oats.

The Crosby series includes the lighter colored, more poorly drained upland soils. Two types are mapped in this series, the silt loam and silty clay loam. These soils are decidedly acid.

The Bellefontaine loam is somewhat rolling and well drained. It is adapted to a wide range of crops, and is especially well suited to fruit.

The Clyde silty clay loam is extensively developed. It is especially well adapted to corn. Good yields of oats and hay are also obtained.

The Fox loam occupies the higher terraces. It is well drained and is adapted to a wide range of crops, being particularly well suited to alfalfa.

Of the Genesee series two types are mapped, the loam and silt loam, the latter in places being really a silty clay loam. These soils are best suited to corn, although they also give good yields of oats and hay. They are subject to overflow.

Muck and Peat are limited in extent and unimportant.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Indiana.

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