# Soil Survey of Jay County.

By Allen David Hole.

## LOCATION.

Jay County is located on the eastern margin of Indiana, a little farther north than the central part of the State. It is bounded on the north by Wells and Adams counties, on the west by Blackford and Delaware counties, on the south by Randolph County and on the east by the State of Ohio. It includes about 375 square miles lying in Townships 22, 23 and 24 N., Ranges 12, 13, 14 and 15 E., of the United States land survey.

## HISTORY.

So far as known, the earliest settlement by white men within the limits of the present boundaries of the county was made on the south bank of the Wabash River at New Corydon, in the extreme northeastern part of the county. Other settlers followed in the succeeding years, until in 1834 there were white settlers in sufficient numbers to organize the territory into a county. At first the area now included in Jay County was, with other adjacent territory, known as Randolph County. The following year the area now included in Jay and Blackford counties was laid out, and on January 30, 1836, the act organizing the present county was approved and the name of Jay was given in honor of John Jay, the first Chief Justice of the United States Supreme Court. The first election of county officers was held in August, 1836, and in 1837 the area now included in Blackford County was set off, leaving Jay County as it is today.

As is the case with much of the adjacent territory in Ohio and Indiana, the area now constituting Jay County was, before the coming of white settlers, claimed by various tribes of Indians. It is impossible to state exactly the boundaries separating the hunting grounds of one of these tribes from those of another, since accurate boundaries of this sort did not in many cases exist among the Indians; but the principal tribes occupying that part of Indiana and Ohio adjacent to Jay County were the Miamis, Wyandottes, Potta-

watomies, Senecas and Shawnees. Before these various tribes were ready to give peaceable possession and allow the settlers to clear the land and make permanent homes, at least three separate treaties were made affecting the land in Jay County. One was made at Greenville, Ohio, August 3, 1795; another at St. Mary's, Ohio, October 6, 1818; and finally the last, by the terms of which the reserve known as the Miami Reserve, two miles west of Portland, was ceded to the United States, which was made with the Miami tribe on October 23, 1834, at a point on the Wabash River below Bluffton. At least one of these treaties was signed by Gen. Anthony Wayne and the chiefs of the tribes named above, together with the chiefs of a number of other smaller tribes.

There still remains geographical evidence of one of these treaties on the road extending in a northeast-southwest direction across the southeastern part of the county, a part of which has been abandoned, but which originally passed about one-half mile southeast of Salamonia. The village named Boundary City is also a record of the fact that this line was established as the fixed boundary line between the land ceded to the white men and that retained for the time being by the Indians.

As was the case with other large areas, especially in the northern part of the State, a large proportion of Jay County was originally a swampy wilderness. Forests covered almost the entire surface and over much of the area water was standing for a considerable portion of the year. This condition caused the prevalence of malarial diseases when white men first began to make their homes within the borders of the county, but at the present time nearly all of the former marshes and swamps have been well drained, and as shown by the census of 1910, about 85 per cent. of the land in the county is improved farming land. This means that the waters no longer stand on the surface for a sufficient length of time to prevent the successful growth of farm crops. Not only has the drainage of the swamps and marshes been accomplished, but throughout the county generally good roads have been made, crushed stone or gravel being in most cases used, so that now practically every portion of the county can be reached on good roads at any time of the year.

The chief line of travel across the county after the coming of the white settlers to the State, was in a north-south direction between the cities of Richmond and Fort Wayne. This road or trail was known in the early days as "The Quaker Trace," the name being given because it was the road travelled by settlers in Wayne

County, who were at that time mostly Quakers, on their way to Fort Wayne, which was the point most accessible to them for selling their produce and buying such supplies as were needed. With the increase of population, however, roads were constructed in various directions and in December, 1871, the first railroad was completed across the county called then the Cincinnati, Richmond and Fort Wayne Railroad, now known as the Grand Rapids and Indiana, which passes in a north-south direction a little to the east of the center of the county. Later, the Lake Erie and Western Railroad was completed, passing in an east-west direction from the southwest corner of the county to a point a little south of the center on the east side; and later still the Cincinnati, Bluffton and Chicago Railroad, which enters the county from the northwest and has been completed as far as Portland. In more recent years, a traction line connecting Portland with Muncie by way of Red Key and Dunkirk has added greatly to the facilities for travel across the southwestern part of the county.

As has already been indicated in the statement concerning the percentage of improved farming land, there is no considerable area within the county that is not under cultivation. The majority of the population, which numbers about 25,000, live on farms, most of which are well improved.

## GEOGRAPHY AND GEOLOGY.

The topography of Jay County is in general determined by the uneven deposits of the drift left upon the withdrawal of the successive sheets of ice which once covered this area, together with the erosion which has taken place since that time. The drift constitutes the surface formation at all points in the county except two, where limestone of Silurian age outcrops. These two points of outcrop are located about two miles west of Portland, and in the northeast part of the county near Jay City, respectively. At other points in the county, limestone in place is encountered only after the drift has been penetrated to depths averaging perhaps seventy-five or a hundred feet, the maximum reported being about two hundred and twenty feet.

## GEOGRAPHY.

For the most part, the surface in Jay County is level to gently rolling. The general slope of the surface is toward the west and northwest. All streams which drain any part of the county finally

discharge their waters into the Wabash River or into some tributary of the Wabash River. The largest stream in the county is the Salamonia River, which takes its rise in the southeastern part of the county and makes its way in a meandering course with low gradient northwestward to the Wabash River, leaving the county, however, before joining that stream. The gradient of this stream is so low that in many places it has been dredged in order to give sufficient freedom of flow to permit its tributaries to be used as main lines of drainage for the adjacent farming lands. To the north of the Salamonia River the drift has been left with the surface somewhat higher than on the south, so that the tributaries from the Salamonia on the north are mostly short, while those from the south have on the average a length four to five times as great. This general arrangement of the drainage lines on the surface can best be understood when the surface of the counties to the north and to the south are also considered. By observing a map of the State, it will be seen that the course of the Salamonia is roughly parallel to that of the upper part of the Wabash River, which crosses the northeast corner of the county, and to that of the Mississinewa River, which crosses the northern part of Randolph County, at Ridgeville, being about one mile south of the Jay County line. In the case of each of these three rivers, the drift occurs as a well marked ridge on the north side of the stream; that is, the elevation of the surface of this drift is greater near to the north side of these streams, thus causing the tributaries in each case which come in from the north to be short, while those coming from the south to each of these streams are relatively long. As determined by geologists of the United States Geological Survey, these ridges or drifts which lie on the north side of the streams referred to, constitute respectively recessional moraines of the last glacial epoch. These moraines have slightly different configurations in different parts of the county, but the cause in each case of the peculiarity in drainage which gives short streams coming in from the north and long ones from the south is the deposition of these successive recessional moraines, as the lobe of ice which covered this part of the State gradually withdrew at the close of the last glacial epoch. Considered as a whole, the belt of drift in the south part of the county which constitutes a part of the moraine lying north of the Mississinewa River has a greater elevation and is more rugged and uneven in topography than the moraine lying to the north of the Salamonia River. This greater height and greater irregularity of surface was recognized by the early observers in the county and the fact is

recorded in the term "Mountain" as applied to a part of this moraine by the geologists who first prepared a report on the county for the Department of Geology of the State of Indiana. However, the relief in any given square mile is rarely as much as eighty or one hundred feet and in most cases does not reach more than one-half or one-third that amount. Little can be said in the way of classifying the irregularities of the surface of these morainal tracts since they possess the usual characteristics of drift deposits everywhere, namely, the extreme irregularity of arrangement due to the uneven distribution of the materials carried by the ice, causing hillocks of different sizes and shapes, alternating in the most irregular manner with depressions equally irregular and uneven in form and size.

## GENERAL GEOLOGY.

Considered in its more strictly geological aspects, the drift is observed to furnish excellent illustrations of some of the topographic and structural forms characteristic of deposits left after the retreat of a glacier. Chief among these may be mentioned the following:

(1) *Recessional Moraines.* This term has already been used and, as noted above, refers to the broad belts of hilly country, of which the most prominent and noticeable parts are the rounded hills of light colored soil carrying in some places a few boulders. The entire belt in each case extends in a direction somewhat north of west and south of east, parallel to the general course of the main streams which drain the area. Within Jay County there are two of these recessional moraines, namely, (1) the Mississinewa moraine, extending from the southeast corner of the county northward almost to the Salamonia River and then to the north of west to the western boundary of the county, and (2) the Salamonia moraine, extending from the central and south central part of the east side of the county likewise in a direction north of west to the northwest and northern boundaries of the county.

(2) *Ground Moraine.* The term ground moraine may properly be applied to a considerable part of the area already referred to as recessional moraine, but the distinction would in general be made by limiting the term recessional moraine to the more pronounced hills lying near the south line of the county and again lying on the north side of the Salamonia River, but within two or three miles from it, while the term ground moraine would refer (a) to the

more nearly level area lying south of the Salamonia River and extending for a distance of from five to eight miles from its banks, and (b) to areas likewise nearly level lying across the north and northeastern part of the county at a distance of more than three or four miles from the Salamonia River. This ground moraine portion in each of the two belts referred to, while it contains numerous low hills of light colored soil with some pebbles and boulders intermingled, has also a very considerable total area of soil that is very dark or black in color, occupying depressions between the numerous low round-topped hills. With respect to conditions existing at the time of formation, the part indicated as recessional moraine must have been deposited at a time when the edge of the ice remained more nearly in the same position for a considerable period of time, while the ground moraine must have been formed at times when the ice front was being melted away more rapidly, so that the edge of the ice was retreating to the northward at a rate more nearly uniform, thus not permitting the debris carried to accumulate in ridges so pronounced as when the recessional moraine proper was being formed.

(3) *Undrained Depressions.* The map accompanying this report showing the kinds of soil present in the county indicates clearly certain areas which for a long time following the withdrawal of the ice, must have been filled with water throughout a large part of each year, if, indeed, many of them were not the site of permanent ponds or small lakes up until about the time that white settlers came to the county. Early settlers in the county report that at numerous places in the areas here referred to as ground moraine, water stood in same cases the year round, in some cases in only the winter and spring, to a depth of five or six feet; places where now no water stands at any time.

Geologically, these depressions belong to the class called "kettle holes" where they are well developed. In most parts of this county these undrained depressions are, however, very shallow in proportion to their extent, and at the present day most of them would not be recognized as places where the water could possibly stand the year round. It is to be remembered, however, that with every rain, the water that runs off in smaller or larger streams, carries a certain amount of clay, sand and gravel, and it can readily be seen that many depressions which were originally basins in reality have had the rim cut through at one point, so that now the water runs off soon after the rain has fallen. Again, it is to be remembered that at the time when a thick growth of trees and underbrush covered most

of the surface, fallen trunks and an accumulation of leaves could easily form dams which would cause the water to stand in places where the surface of the ground alone would not have permitted it. Besides these two systematic causes there is also to be taken into account the work of animals, particularly that of beavers, which were abundant in some parts of the county before white men came, and, by their work, dams were constructed which held back additional amounts of water, thus causing areas large in proportion to height of the dam to be covered, since the slope of the land is in general very slight.

(4) *Kames and Eskers.* Accumulations of glacial drift deposited in the form of typical eskers are not well represented. There are, however, at a few points, deposits which probably should be classed as eskers, although their extent is not sufficiently great and the exposure is not sufficiently good to put this matter beyond question. Specific illustrations of deposits of this kind are located as follows:

(A) Southwest quarter of Section 11, Township 22 N., Range 15 E., extending southward into the northwest quarter of Section 14. The area covered by this esker is a little more than one-half mile in length with a width varying from one or two to five or ten rods. This deposit lies near the middle line of the two sections referred to and consists of brownish sand and gravel sufficiently free from clay as a general rule to make it suitable for use as road metal. In places the deposit shows distinct signs of stratification; presumably the stratification exists throughout the greater part of its extent, but as excavation had not been made throughout this is not a matter of direct observation.

(B) East side of Section 31, Township 23 N., Range 15 E., another elongated area about three-fourths of a mile in length in a north-south direction, varying in width as before, from one to two rods to possibly two or three times that distance. This area shows characteristics almost precisely like the one already named in abundance of sand and gravel, in direction and extent of area and in color of the deposit.

At other points in the county deposits are found which at the surface consist of a sandy, gravelly loam precisely similar to the two areas just named, but which do not show at the surface a shape of outcrop which would suggest deposition in a channel. Some of these may be the tops of small eskers, or they may be merely deposits of gravel which should be classified as kames or small outwash plains.

By far the best illustrations coming within the general class of kames are found in Penn Township in the neighborhood of Pennville. The deposits in this area have been described by every careful observer who has visited the county, but the interpretation has varied somewhat, the latest being given by Leverett in Monograph 41 of the United States Geological Survey. He does not suggest the term kame for these deposits, though he does consider and reject

Figure 1. View in gravel pit south of road in n. w. ¼ of s. w. ¼ of sec. 25, T. 24 N., R. 12 E., one and one-half miles northeast of Pennville. Looking northwest. Note the unstratified drift at the surface resting unconformably on strata of sand dipping steeply (25°) to the southwest.

the name esker. It is no doubt true that some parts of the deposits to which he refers are too well stratified throughout to deserve the name kame. This is particularly true of the very prominent gravelly hills located in the southwest quarter of Section 24, Township 24 N., Range 12 E., known locally as "Twin Hills." Excavations for the removal of gravel from this deposit almost universally expose excellent stratification, the peculiarity being, as indicated by Leverett, that the planes of stratification are at high angles with each other. In the large area, however, lying to the south and west

of Twin Mound and covering an area of four or five square miles, there is a very considerable portion of the deposit that is not well stratified, mingled with much that shows excellent stratification. In the work referred to, Leverett suggests that at least that part of the deposit which consists of a "sharp belt of hills" has been deposited by subglacial waters. This interpretation seems to be supported by the general field relations, yet it is also probably true that much of

Figure 2. Detail in same pit as shown in Figure 1. Looking northward. Note the frequent change in direction of dip in the cross-bedded layers.

the sandy, gravelly deposits in the larger area referred to should be classed as kames. Figures 1 to 3 show some of the more striking structures found in the gravel hills which lie within the kame area. It is to be noted particularly that in many places the angle of dip is high and in some places, as shown in Figures 2 and 3, layers having a considerable angle of dip are truncated by layers having a different angle. It is, of course, probable that these very striking changes in direction of dip may have been produced by currents of water alternating in direction, but they also strikingly resemble cross-bedding produced by the wind in the formation of sand dunes. It seems possible that in some cases the sand may have been

rearranged by the wind after the first deposits had been made, but certainly, in a considerable number of the cases where high dips are found, the inclination must be due to currents of water carrying sediment from shallower to deeper portions, aided perhaps in some cases by readjustments in the entire mass after deposition had been completed; such adjustments, for instance, as might occur because of the settling of beds due to the melting out of huge bodies of ice, such settling being so uniformly in one direction as not to

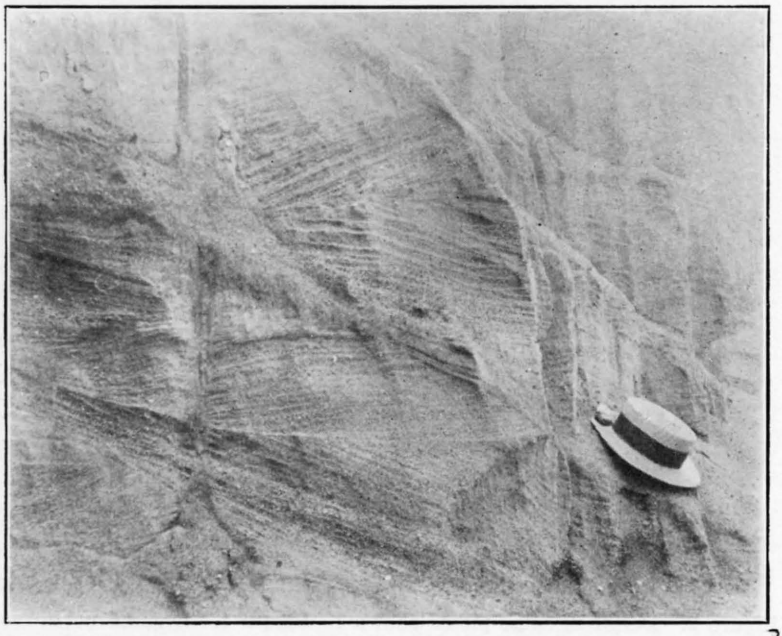

Figure 3. Detail in same pit as shown in Figure 1. Looking south. Note the abrupt changes in amount and direction of dip.

cause much faulting or bending of the beds. In some cases, such readjustments have resulted in faults, as shown in Figure 4, giving the appearance of the stratification planes in the gravel pit at the south end of Twin Mound, where in a number of places faulting has taken place, the maximum amount shown being about one foot or fifteen inches.

(5) *Subglacial Channels.* In the work by Leverett already referred to, namely Monograph 41 of the United States Geological Survey, the valley in which the Twin Hills gravel deposits are found, is thought to have been formed by a subglacial stream, the

reason assigned being that the gravel hills as now found could not have been deposited except there had been present containing walls of ice to make possible the peculiar structural forms found in the material which has been deposited. This main subglacial channel extends from about the center of the north side of the county in a westerly and southwesterly direction to the valley of the Salamonia River near the point where that stream leaves the county. The northern part of this channel has been until recent years a swampy

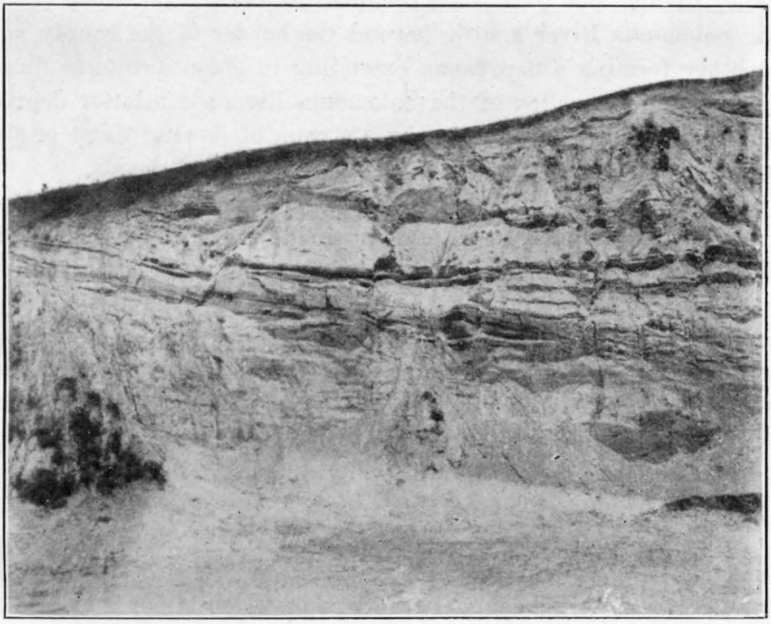

Figure 4. View in gravel pit on south side of "Twin Hills", in the s. w. ¼ of sec. 24, T. 24 N., R. 12 E. Looking northeast. Note a slight dip of the faulted layer to the northeast, that is, toward the center of the hill.

area and only since the drainage has been perfected has it been possible to bring under cultivation the muck which forms the surface in the lowest part of this area. As shown by the map accompanying this report, the area covered by muck is irregular in shape, sometimes dividing and again reuniting, thus enclosing areas that are to be classed as ground moraine, and finally ending in a westerly direction at the point where the valley becomes notably narrower. The western limit of the area of muck just referred to is at about the middle of the north-south line marking the boundary

between Sections 8 and 9 of Township 24 N., Range 13, E. From this point southwestward and westward there are no areas of muck large enough to be represented on the map until a point is reached about two miles west of north from Pennville, where there is another very considerable area much smaller, however, than the first; here, again, the valley is broader and the low lying areas, which are for the most part covered by muck, include certain "islands" of typical ground moraine. Just beyond the area of muck the valley divides, one part being occupied by the stream which enters the Salamonia River a little beyond the border of the county and th other forming a depression extending in a southwesterly direction to join the valley of the Salamonia River; this latter depression, however, is not occupied by a stream of flowing water of size greater than can be carried by small underground drains.

In this connection it is instructive to note that the large area referred to as a kame area lies to one side south of this subglacial channel, and there would thus seem to be some added probability that this considerable body of sandy and gravelly material north and east of Pennville is in reality a deposit which has been made at least in part by waters escaping from the edge of the ice instead of being deposited altogether by subglacial streams. This does not conflict with the interpretation given by Leverett for the particular hills to which he refers, known locally as Twin Hills.

The map accompanying this report does not make clear what is readily seen when the observations are made in the field, namely, that there are a number of valleys which connect with or branch off from this main subglacial depression, most of them being located to the west of the area of muck first described. The position of some of these valleys is, however, indicated on the soil map by an area of black soil extending in a west-southwest direction in Sections 7 and 8, Township 24 N., Range 13 E., continuing into Section 13 of Range 12 E.; and another lying nearly a mile north and almost parallel to it in Section 7 of Range 13, and Sections 11 and 12 of Range 12. These two areas of black soil lie in well marked valleys and there is but a small amount of ground moraine between them and another well marked valley in which there is black soil together with some small sandy hills which are probably to be classed as kames. This valley is a tributary to the valley in which the second area of muck referred to is found near the western portion of the county. The probabilities seem strong that a number of the valleys in this part of the county owe their origin primarily to the action

of water flowing under the ice, though no doubt a part of their depth may be due to erosion since the ice withdrew.

The plain inference from the presence of these subglacial channels, together with the direction of flow of the various streams draining the area included in Jay County, is that at the time of the withdrawal of the ice the waters were moving in general in a westerly and northwesterly direction; and evidence from the counties adjacent to Jay on the west indicates, as suggested by Leverett, that the edge of the ice lobe probably dammed the lower course of the Salamonia for awhile, so that the drainage was for a time not directly to the northwest to the Wabash, but from the western part of Jay County southwestward through the continuation of the subglacial channel referred to above, till the withdrawal of the ice permitted the water to find its way along the south margin of the Salamonia moraine into the Wabash River.

(6) *Other Physiographic features.* In addition to the physiographic features already named, mention should be made of the fact that good illustrations are found in the county yof numerous minor physiographic features, such as are to be found associated with the drift or such as appear as the result of agencies acting on the drift since it was deposited. The more important of these are:

(a) *Alluvial Fans.* These are to be found in almost every square mile of the area studied wherever a considerable amount of soil has been loosened on a slope that is unusually steep, or wherever, by means of excavation or agricultural operations, the drift deposit is left with a slope steeper than twenty or thirty degrees. In such places, the small rivulets formed by showers carry down a larger amount of sediment from the steeper portion of the slope than they are able to carry when the more level portion is reached, and deposits are therefore made which, in many cases, offer perfect illustrations on a small scale of alluvial fans. In a few places fans of larger dimensions have been formed, but these are mostly in process of being eroded, so that their real nature is not so easily seen.

(b) *Flood Plains.* There are also found in almost all parts of the county adjacent to all brooks which are in valleys of size sufficient to allow the waters at time of flood to spread out in a broad sheet, and sufficiently permanent to cut a channel in the material deposited. These flood plains have in many places been destroyed by the work of dredging and straightening the natural channels to form ditches; but wherever undisturbed in this way, the larger streams are forming typical flood plains.

Many other forms might be mentioned, such as deltas, sandbars, and the like, which are educationally of value in illustrating the work of erosion, as these subjects are taken up in the various courses of geography and related sciences in the schools; but for the most part, these minor features are easily identified and require no further mention.

## The Composition of the Drift.

The details of the composition of the drift are discussed in this report in detail under the heading of the different soils found. These descriptions, however, refer only to the surface and the materials present to a depth of three feet. Well borings, and in a few places, excavations show that the drift often varies considerably in composition with depth, alternating without any definite regularity from typical glacial till to stratified deposits of glacial materials of various forms, including "clay," fine sand, gravel, etc. In some places, borings show that the ground moraine is continuous to bed rock. In other places layers of stratified sand and gravel are encountered at various depths, and sometimes a number of different layers of sand and gravel are found separated by layers of till. It therefore seems that a correct understanding of the drift in Jay County gives the conception of the drift material as being made up chiefly of till, that is to say, (1) of very fine mineral matter, made up partly of clay and partly of finely ground rock mixed in varying proportions with sand of different amounts of fineness, and (2) of coarser particles (gravel) most of them well rounded, but some subangular and bearing glacial striations, with here and there (3) some boulders in size up to five or six feet in diameter, all mixed together in most irregular fashion.

The kinds of rock found in the drift are indicated by the following table of analyses, which show the average of determinations made on the gravels at various points:

TABLE I.

*Analysis of Gravel.*

| | |
|---|---|
| Dolomite (Magnesian Limestone) | 65 per cent. |
| Limestone (Calcareous) | 20 per cent. |
| Igneous rocks | 7 per cent. |
| Metamorphic rocks | 6 per cent. |
| Sandstone and shale | 1 per cent. |
| Cherts and quartz | 1 per cent. |
| Total | 100 per cent. |

This table shows that the main proportion of material in the drift, namely about 80 per cent. to 85 per cent., is of limestone, which has been broken up and the fragments rounded by the action of running water, and that the remaining 15 per cent. more or less is made up of fragments of the various igneous and metamorphic rocks found in Canada, together with a small percentage of sandstone, shales, cherts, flints, quartzes and such like.

## Economic Geology.

(1) *Limestone.* As already stated, limestone in place is found at only two points in the county, and the total value of the product obtained from this source is therefore small. The outcrop in the northeastern part of the county is not being used at present, the quarries in that vicinity which are open being across the line in Adams County. Limestone is, however, at the surface in the northeastern part of the county and if the demand were sufficiently great, stone valuable for road materials could be taken out.

The quarry which has been most largely worked in the county is located about two miles west of Portland in the southeast quarter of Section 24, Township 23 N., Range 13 E. The surface of the limestone at this point is but a few feet above the level of the water in the Salamonia River nearby, so that it is necessary to keep the quarry free from water by means of pumps in order to obtain stone of value for the production of lime and for road materials. The plant at this place was not in operation in the summer of 1914 because of changes to be made in the process of producing lime; changes which have been made necessary on account of the failure of the supply of natural gas, which was formerly used as fuel. It is the plan of the company to resume operations when the necessary changes have been made, and when this is done lime of good quality can be produced from the quarry at this point.

(2) *Gravel.* Beds of sand and gravel suitable for use in the construction of roads, as ballast for railroads, in the making of cement blocks, and for building purposes in the making of mortar, etc., are found at various points at the surface and also at different depths beneath the surface. The gradient of the streams of the county is, however, so slight that gravel of value is to be found at but a few points in the beds of streams. In general, the southern and eastern parts of the county are not well supplied with good gravel except in the areas already referred to as eskers or kames, and these areas are relatively very small. In a few places, how-

ever, within these parts of the county, gravel is obtained by pumping or by some process of dipping. In other words, gravel deposits occur at a few points sufficiently near the surface to be taken out economically, but too far below the surface to avoid trouble on account of the presence of ground water. Points from which gravel is taken in this way are usually near the bottom of the valley, while in the case of gravel taken from the eskers and kames, the deposit is usually above ground water level, and the only difficulty encountered is the depth of soil to be removed, which, in some cases, is as much as eight to ten feet in thickness. When the thickness of soil reaches this amount the gravel cannot be taken out economically, and so in many parts of the county crushed stone has been shipped in for the making of macadam roads. The part of the county best supplied with gravel is the northwestern part near Pennville, where the deposits referred to as kames have already been described. Some of the gravel in this area is of number one quality for use as road metal, but much of it is not of the best grade on account of the presence of too large a proportion of fine material such as clay and silt. The sand found in this area is, for the most part, of the very vest quality for use in making cement blocks and for use in making martar and plaster. Sand and gravel from this region is shipped by rail in considerable quantities.

No sufficiently accurate record has been kept of the amount of sand and gravel taken from the various pits opened in the county to permit an estimate to be made which can be relied upon as even fairly satisfactory. The total amount, however, must be very large and the value in dollars to the county from deposits of this kind must be considerable.

(3) *Water Supply.* In practically all parts of the county water in abundance for the use of stock is found, either on the surface or at a depth beneath the surface so slight as to make the securing of it by means of pumps a very small task. Much of the water easily accessible in this way is, however, not astisfactory for drinking purposes because of the ease with which it becomes contaminated. Much of the sickness in the county in the early days was no doubt due to the unwholesome drinking water as well as to the malaria found in the regions where large areas of swamp and marsh exist. On account of the unsatisfactory character of the surface water for drinking purposes, a very large proportion of the

farmers throughout the county have wells which are deep enough to reach a supply which is free from impurities found at the surface. These wells are, for the most part, tubular wells put down either by driving or boring, and in many cases they go entirely through the drift to the surface of bed rock. Water derived from depths of fifty to two hundred feet its of the highest quality and diseases due to impure drinking water are becoming rare.

The methods used for obtaining water from deep wells varies from the use of pumps by hand to the use of power in the form of wind mills or gasoline engines. The number of pumps driven by power of some kind is continually increasing.

(4) *Clay Products.* In many parts of the county deposits of the finer parts of the drift are found to be suitable for the making of brick and drain tile. The great need of efficient drainage in the county has stimulated the development of the drain tile industry, and while exact data as to the amount of his product manufactured is not at hand, it can be said that thousands of rods of drain tile are annually made, and so far as materials are concerned, the industry could be developed to a much higher degree. The absolute necessity which faces all farmers in Jay County of greatly increasing the amount of tile drain put in if the lands of the county are to be brought to their highest degre of productiveness would suggest that a further development of the clay industry and the making of tile would be profitable for both the manufacturer and the farmer.

## CLIMATE.

The general characteristics of the climate of the county are shown in the following tables, data for which have been supplied by J. H. Armington, Section Director, United States Weather Bureau, Indianapolis, Indiana. The data concerning temperature and precipitation are taken from observations made at Farmland, in Randolph County, as the nearest point at which records have been kept for a sufficient length of time to establish a normal.

TABLE II. *Mean temperature and average precipitation at Farmland.*

| *Month.* | *Mean Temperature. Degrees F.* | *Average Precipitation. Inches.* |
|---|---|---|
| January | 27.2 | 2.73 |
| February | 28.3 | 2.90 |
| March | 39.2 | 3.35 |
| April | 50.2 | 3.30 |
| May | 60.8 | 4.30 |
| June | 69.8 | 4.09 |
| July | 73.4 | 3.41 |
| August | 71.2 | 3.66 |
| September | 64.9 | 3.47 |
| October | 61.4 | 2.37 |
| November | 40.6 | 3.09 |
| December | 31.9 | 2.67 |
| Annual | 50.8 | 39.34 |

TABLE III. *Maximum and minimum temperatures at Farmland in 1914.*

Highest.....100°F. on July 11
Lowest.....7°F. on December 15.

TABLE IV. *Average dates of killing frosts at Salamonia, from a record of nine years.*

Last in spring.....May 8
First in autumn.....October 5

## AGRICULTURE.

Of the 240,000 acres in the county, about 90 per cent., or 235,191 acres, is in farms varying in size from less than three acres to 500 acres or more. Of the farms including more than 500 acres there is, however, but one within the county; and of the 2,836 listed by the census of 1910, 1,080 contain between fifty and a hundred acres.

In the ten years from 1900 to 1910, the farming lands in the county increased nearly 130 per cent. in value, being listed in the latter year at a total valuation of $16,247,188, or an average of nearly $70 per acre, while the total valuation of farming property, including buildings, implements, domestic animals, etc., adds over $6,500,000 to this amount, making an average of land and farm property together of about $100 per acre. It is to be understood, of course, that the better of the improved farms cannot be bought for this figure.

The following tables taken from the report of the census of 1910 show in condensed form of the principal crops raised, the

acreage and the yield per acre and the number and valuation of the domestic animals and poultry. These figures are for the year 1909; no doubt the production in 1914 is considerably higher.

TABLE V. PRINCIPAL CROPS.

| *Crop.* | *Acres.* | *Bushels.* | *Tons.* |
|---|---|---|---|
| Corn | 60,209 | 2,659,277 | ..... |
| Oats | 41,724 | 1,121,280 | ..... |
| Wheat | 7,585 | 83,816 | ..... |
| Timothy hay | 19,577 | ..... | 24,701 |
| Clover alone | 1,897 | ..... | 2,189 |
| Timothy and clover mixed | 7,344 | ..... | 9,256 |

TABLE VI. DOMESTIC ANIMALS AND POULTRY ON FARMS.

| *Name.* | *Total Number.* | *Total Value.* |
|---|---|---|
| Cattle | 15,571 | $472,852 |
| Horses | 11,696 | 1,338,572 |
| Mules | 211 | 26,889 |
| Swine | 56,051 | 365,507 |
| Sheep | 26,104 | 130,530 |
| Poultry | 229,188 | 121,678 |

It will be seen from the table giving the figures for the principal crops that the average yield for corn is about 44 bushels per acre; for oats, 27 bushels per acre; for wheat, 11 bushels per acre; and for hay, about 1¼ tons per acre. It is to be understood, however, that on many farms the yield is much higher than this. For instance, in 1914, ten acres of land near Pennville, Indiana, on Rodman silt loam soil, yielded an average of 49 bushels per acre. This particular field of wheat was sown on clover sod and fertilizer was used. Figure 5 is from a photograph of this wheat field as it was being harvested and shows how close together the shocks had to be set, indicating thus the great number of stalks per square foot which must have been grown in order to produce this unusual yield. The year before, 1913, on the same kind of soil, a field of twenty-five acres yielded an average of 38 bushels per acre. It is, of course, to be said that this soil is much better adapted to the growing of wheat than much of the soil in Jay County, yet it is also true that a large proportion of the soil in this county could, with proper treatment, be put in a condition almost as favorable for the growing of heavy crops of wheat as the Rodman soil.

In general, the same remarks would apply to the kinds of soil on which corn, oats and hay are grown, for the soil seems to have all the essential elements of fertility, and needs now more than any-

thing else careful treatment in order to make it produce on the average perhaps fully 100 per cent. more than at present. Suggestions in regard to methods of treatment which are most important for the soils of Jay County are given at the close of this report.

## Origin of the Soils.

The soils of this county are, for the most part, derived from the weathering and disintegration of mineral matter carried by the glaciers which formerly covered the entire northern part of the United States. As already noted, these minerals include calcite,

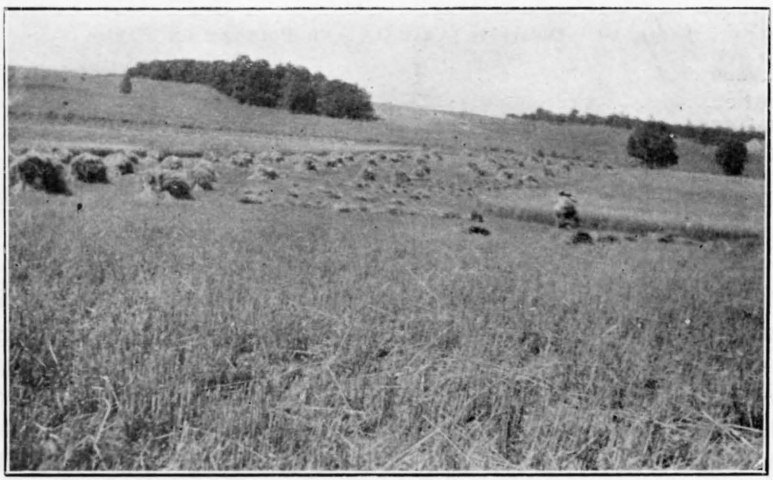

Figure 5. Wheatfield on Rodman silt loam soil, which in 1914 yielded 49 bushels per acre. Located in n. w. ¼ of sec. 25, T. 24 N., R. 12 E. Photo by A. B. Crowe.

dolomite, quartz, feldspar, hornblende, mica and various weathered products, of which the more noticeable are clay, sand, gravel and, in some cases, a sufficient amount of brown, yellow or red coloring matter to indicate the presence of oxides of iron. There are in addition, of course, very small quantities of a number of other minerals, and in the depressions in the surface occupied formerly by marshes and swamps there is a very considerable admixture of carbonaceous matter, which once existed in the form of tissue of plant growth and has been left by the partial decay of this vegetable matter. In some places the predominance of this vegetable matter together with an unusual amount of moisture produces soils that are described under the term muck or peat. The amount of soil forma-

tion which deserves the name of peat is very small, indeed so small as to be negligible in this county.

## Soil Types.

The principal soil types found in this county are nine in number, as follows:

Miami Silt Loam.
Clyde Silty Clay Loam.
Genesee Loam.
Genesee Silty Clay Loam.
Muck.
Rodman Silt Loam.
Miami Sandy Loam.
Marsh Swamp.

The map accompanying this report indicates the location of each of these soil types with as much accuracy as was possible to be secured in the time which could be devoted to the work. In some places, boundaries between the different adjacent soil types have been drawn arbitrarily, as for instance, in the area lying next to the Salamonia River where the Genesee Loam alternates with the Genesee silty clay loam, as shown, for instance, about three miles east of Portland in Sections 22 and 23, of Township 23 N., Range 14 E., and also at various points between Pennville and Portland. The areas indicated on the map show the approximate location of areas in which the character of the soil is predominantly that of the name given for the respective locations. The change, however, from one of these soil divisions to the other is often very gradual and the boundary lines cannot be marked with distinctness at many places; nevertheless the line of division is placed on the map approximately at the place where a marked change in soil character occurs. The same thing can be said of the grading off of soils of the Genesee loam type into those of the Clyde silty clay loam type along the Salamonia River and along some of the other larger streams.

It is also to be understood that within areas mapped as of a certain type, there may be and often are included areas of other soils too small in area to be shown on the map of the scale necessarily used in this work. For example, the Miami silt loam is mapped as covering large continuous areas; yet in many places these Miami silt loam areas, which are in general light in color, include many small irregular patches of black or dark brown soils of other types. An especially noticeable instance of this is in the neighborhood of

the city of Portland. As shown on the map, the city of Portland is built on Miami silt loam soil and this in general is true; yet at a number of places in the city of Portland there are irregular patches of dark colored soil which belong to the Clyde silty clay loam type, or even perhaps to some sandy and silt loams; but these areas are in general small and discontinuous and cannot therefore well be shown on the map.

### Miami Silt Loam.

The general description of this type of soil as given in publications of the United States Bureau of Soils, is as follows:

*Miami Silt Loam.* This is a light brown, yellowish brown or grayish silt loam, from eight to twelve inches deep, underlain by a compact, yellowish or brownish mottled silt loam or silty clay. The type occupies rolling to hilly areas and was originally timbered. It is the result of the weathering of glacial till, with the admixture, in places, of small amounts of loessial material.

This general description applies to the areas mapped in Jay County as Miami silt loam, but certain peculiarities should also be mentioned. In general it may be said that in Jay County the depth of the soil is rarely more than eight inches, and that the presence of loess is indicated only by the presence of a very high percentage of silt, as shown by physical analysis. Notice should also be taken of the presence of a small percentage (usually less than one per cent.) of pebbles, the amount increasing in the subsoil. Boulders also are present at the surface occasionally, though in cultivated fields they have for the most part been removed; in size these boulders are found up to five or six feet in diameter.

Soil of this type is now lighter in color and more extensive in area than at the time when the land was first put under cultivation, owing to the exhaustion of a large percentage of the carbonaceous matter that had accumulated while the land was covered with forests. As a result of this depletion of organic matter, the yield of the various crops has grown constantly less except in those cases in which special care has been taken to improve the conditions for plant growth by tile drainage, and to increase the fertility by the addition of humus or fertilizers.

The original forest growth on the Miami silt loam included as the principal kinds of trees, oak, beech and walnut; sugar maple where the proportion of sand is larger; and elm, hickory and ash in places where the drainage was not well established. The principal crops now raised on this soil are corn, timothy and clover

hay, with a smaller acreage of oats and wheat. In a few places, apple orchards are found to do well, but in general the soil without underdraining seems to be too compact and cold to promise returns sufficiently large in proportion to the price which such land brings. Corn does not grow as vigorously or produce as large a yield on this type of soil as upon the black soils, but with proper treatment this difference in productivity can be overcome; indeed, experience seems to show that careful management will secure a proportionately larger increase in productivity from the Miami silt loam than from any other type of soil found in the county.

### Clyde Silty Clay Loam.

The general description of this type of soil is given in publications of the United States Bureau of Soils, as follows:

*Clyde Silty Clay Loam.* This is a dark brown to black silty clay loam, ranging from six to ten inches in depth and underlain by a drab or gray usually mottled clay subsoil. The topography is level and the drainage is naturally poor, so that ditching is necessary before crops can be profitably grown. When reclaimed through drainage, the type is strong and productive, and good yields of corn and general farm crops are secured. Such crops as cabbage and onions are also very well adapted to it. Timothy and redtop produce from one to two and a half tons per acre on reclaimed land.

As shown by the map accompanying this report, the Clyde silty clay loam occurs usually in irregular belts and patches surrounded by the Miami silt loam. These areas of "black land" are invariably on a lower level than the light colored soil around, and mark the sites of former ponds or marshes where water formerly stood for the greater part or all of the year. Because of their lower position topographically these areas have received by deposition from sheet wash and rivulets after every rain much of the finer materials originally left on the surface of the more elevated points of the moraine near by, thus producing a surface soil of silt and clay almost wholly free from pebbles. In the subsoil, however, at a depth corresponding perhaps to the level of the original surface, some pebbles are found. The color, too, changes with depth, due largely to the decrease in percentage of carbonaceous matter. In some cases, especially near the boundary separating the soil of this type from the Miami silt loam, the subsoil is found to be identical with that of the latter soil. This is evidently explained by the fact that at the edges of the ponds in which the Clyde silty clay loam was formed the accumulation of material to form the soil

could not reach a great depth, leaving, therefore, the original morainal surface to be the subsoil.

Soil of this type ranks as the best corn-producing soil in the county. It is in most places, however, susceptible of much improvement by underdrainage, as it is inclined to be rather too compact and to hold the water too long after the rain has fallen. Exceptions to this are of course found in some places where a larger proportion of sand causes the type to approach a loam in composition.

In the subglacial channel, the position of which is indicated on the accompanying map by a strip of Clyde silty clay loam extending in a northeast-southwest direction along both sides of the stream, from Section 8, Township 24 N., Range 13 E., to Section 24, Township 24 N., Range 12 E., there are frequent deposits of sand and gravel. In some places these deposits are not noticeable at the surface, but in other places they are quite prominent. It is to be understood, therefore that in this particular area there is a much greater variation in the soil and subsoil than is usually found in the areas of Clyde silty clay loam in this county.

The original forest growth on this type included some varieties of oak, ash, maple and hickory with button bush in very moist locations, and often wild roses after the larger trees had been removed.

### Genesee Loam.

The description of this type as given by the United States Bureau of Soils is as follows:

*Genesee Loam.* The soil consists mainly of a mellow friable, brown to dark brown medium loam to silty loam about eight to twenty inches deep. The subsoil is a fine loam to clay loam ranging in color from light brown to yellowish brown. In places a substratum of coarse material is encountered below three feet. The type mainly occupies level first bottoms subject to overflow. Artificial drainage is generally necessary to insure best results in the lower lying phase. When protected from overflow and thoroughly drained, this is a good soil for corn, wheat, grass, oats, onions, carrots and cabbage. Corn yields from forty to upwards of a hundred bushels per acre, oats about forty bushels, hay one to three tons, onions from 500 to 800 bushels, and carrots as high as 1,000 bushelss per acre. Potatoes and tomatoes do well. Celery, asparagus, beets and sugar corn produce fair to good yields.

The Genesee loam is represented in the county by but a small acreage, consisting of narrow belts along the larger streams. Although the areas mapped as Genesee loam have a general agreement

with the description given above, yet the Jay County areas cannot be considered as typical for this type of soil. The reason for this is probably the low gradient of the streams of the county, which prevents the waters even at flood from having a sustained velocity sufficient to carry away a large enough proportion of the finer particles to produce a typical loam. Indication of this condition is found in the alternation along the Salamonia River between soils classed as loam and silty clay loam.

Where best developed, however, the type as found in this county has the characteristics named above, though the depth of the soil rarely exceeds ten or twelve inches. Owing to the small acreage of this type, it is not possible that any great addition to the resources of the county can come from better management of the soil or a choice of crops from which larger yields can be expected than from those now usually grown. Nevertheless, for individual farmers owning the larger part of this kind of soil, the suggestions made above as to the most profitable crops to choose, deserve careful consideration.

### Genesee Silty Clay Loam.

The Genesee silty clay loam differs from the Genesee loam in containing a larger percentage of fine mineral particles, thus making the soil more compact, and more impervious to moisture. The depth of the soil is usually not more than nine or ten inches, and its color is a lighter brown that that of the Genesee loam. The subsoil is usually grayish or blue-gray with an occasional stain of brown due to the presence of iron oxide, and when exposed to the air as in the sides of excavations, it cracks, upon drying, into small cubical blocks, one-quarter to one-half inch on an edge.

As noted at another place in this report, this type grades into the Genesee loam on the one hand, and into the Clyde silty clay loam on the other. It is found almost universally adjacent to the Salamonia River; the only exception being a few areas in other parts of the county too small in size to be indicated on the map.

The type seems to be adapted to such crops as may be successfully grown on the Clyde silty clay loam; especial care needs to be taken, however, to see that it is well drained.

The description of this type given by the United States Bureau of Soils follows, which is on the whole a good summary of characteristics for the type as found in Jay County:

*Genesee Silty Clay Loam.*—This type is composed of a dark-brown or grayish-brown silty clay loam soil from nine to ten inches

deep, overlying a plastic silty clay of a gray, bluish gray, or mottled gray and brown color. The natural underdrainage of the type is deficient, on account of the heavy character of the subsoil. The soil is found along streams and is subject to overflow. Following reclamation by drainage, it is well adapted to the heavier types of farm crops, and especially to grass.

### Rodman Silt Loam.

The surface soil to a depth of about eight inches is a light brown silt loam, grading downward sometimes into a silty, sandy clay, but more often into sand and gravel at a depth of three feet. On the steeper slopes the finer materials have been washed away leaving the surface strewn with sand and pebbles, in which case the soil becomes a sandy loam or a gravelly loam. At depths greater than three feet, there are found in many places lenses and pockets of sand and gravel in which cross-bedding at high angles is commonly to be observed. Figures 1 to 4 show typical illustrations of this structure.

The topography is usually rolling to very hilly. Where most nearly level, the crops ordinarily grown on Miami silt loam are found to be successful, though in places, the underlying sand and gravel reduces the ground water level to such an extent that crops suffer in time of drought. The highest yield of wheat per acre in the county was realized in 1914 from ten acres of soil of this type. In places where the slopes are steepest, the soil is not valuable for cultivation, but is used only for pasturing.

As already stated, the soil of this type owes its origin to deposits of sand, gravel and boulders carried by waters flowing under the ice or issuing from its margin, the deposits belonging to the groups known as kames or eskers.

For the most part the soils of this type are well drained naturally, and increased yields can be secured chiefly through a judicious use of fertilizers and a wise choice of crops in proper rotation carefully put in.

### Miami Sandy Loam.

A few small areas of sandy loam for the most part within a distance of one or two miles northwest from Pennville are classed here as Miami sandy loam. The chief difference between these areas and the Miami silt loam is the increased percentage of sand found at the surface. The areas are small, and the type, therefore,

not of great importance, but the difference is too great to permit their classification as silt loam.

In general, a sandy loam is a more open, looser, warmer soil than silt loam, and is usually also better drained. The origin of the two is, however, the same, and the crops successfully grown are not in general greatly different.

## Muck.

Muck is the name applied to very black, spongy soil in which the percentage of organic material is high. With increase of organic matter, muck grades into peat; with increase of mineral constituents it becomes a loam, a silt loam, a clay or some other type of soil.

As shown by the map accompanying this report, considerable areas of muck occur in this county, most of which are now under cultivation. The principal crop raised is corn, since experience has shown that no other grain crop is as likely to succeed. No doubt some other crops, such as celery, peppermint, and onions would yield much larger returns in proportion to acreage and time spent, but the experiment has apparently not yet been tried except in a very limited way.

The chief condition necessary to successful production on soils of this kind is the lowering of the water level. This is in general thoroughly understood, and the only reason that the muck areas were allowed to remain uncultivated so long was because of the difficulty encountered in securing a satisfactory outlet for the water. Since the areas of muck are the lowest of the region in which they occur, the greatest care must continually be exercised to keep the drainage lines open to their full depth. If this can be done, and if crops of vegetables adapted to the soil should be grown instead of the cereals, there can be no doubt that the total returns would be increased several hundred per cent.

## Marsh.

At a few points in the county marsh land exists, but at one point only is the area sufficiently large to be mapped, namely in Section 4, Township 24 N., Range 13 E.

These marshes are undrained depressions, filled usually with shallow water in which grow plants adapted to such a location, the cat-tail flag being one of the most common. In course of time, these marshes will be filled up by wash from the surrounding land, and

so may become valuable for agricultural purposes, even though they may at present be too low to be drained.

### Swamp.

But one area of swamp was mapped in the county. This is found in Section 2, Township 24 N., Range 13 E., though some other small areas are found at various points, especially adjacent to or included in areas of muck. As in the case of muck and marsh, swamps depend upon the presence of ground water near the surface for their existence. When this condition ceases to exist either through drainage or filling, they become valuable for agricultural purposes.

### Suggestions.

As a result of the observations made in this county, the following suggestions are offered as indicating the directions in which especial effort should be made in order that the soils of the county should produce the maximum amount of the various crops raised. The general lines of work which demand particular attention are (1) drainage and (2) certain farm methods.

### Drainage.

The greatest need of the soil in this county is an increase in systems of drainage, and the especial kind of drainage most needed is tile drainage. Some farther work, to be sure, must be done to provide means for the removal of the excess of water remaining on the surface. There must be constant care exercised that the numerous open ditches already constructed shall be kept free from growth of weeds and shrubs, and that they be kept sufficiently free each season from the sand and silt deposited in their bottoms so that tile drainage depending on these open ditches for outlet may be successful. But in the main, the necessary open ditches are already constructed and are being well cared for so that now there is relatively but a small portion of the county from which the surplus surface waters do not readily drain away. It is also true that there have been put in thousands of rods of tile drainage, especially in the areas of lower ground, so that in many places channels which at one time were occupied for a part of the year by flowing water are now regularly cultivated because the water is carried away beneath the surface so rapidly that the erosion of even the lowest parts of the areas is prevented. All of this work which has been done to remove the excess of water standing upon the surface is in-

dispensable, for the first step in the proper drainage of any nearly level area is to provide means by which the excess of water due to precipitation may readily be taken away. And the farmers of the county are to be congratulated that this first necessary work has been so well and so fully done in the fifty to seventy-five years which have elapsed since the work of reclaiming the soil of this county began in earnest.

But valuable and necessary as this preliminary work has been, the soil of the county can never reach its maximum productivity until the matter of drainage is carried still further on a large scale. Specifically, the thing which must next be done is to lay a network of tile drains across the higher points and ridges of land which have hitherto been for the most part neglected because the water did not stand there. Up to this time, the most valuable soil of the county has been supposed to be the black or dark brown soils, while the points and ridges of lighter colored ground have been considered less valuable. This judgment is, of course, correct with the conditions of the soil and methods of farming as they have existed; but it has been fully demonstrated in the case of the soils of the Miami silt loam type that if an adequate system of tile drains is put in the charcater of the soil is so changed that the total production may be increased 50 per cent. to 100 per cent. or more, and not only may the yield per acre of the ordinary farm crops be thus increased, but when the soil is thus thoroughly supplied with lines of tile drainage, it becomes possible to introduce other valuable farm crops, for which there is no opportunity whatever until this extension of drainage has been completed.

Some few farmers in Jay County already understand fully the value of an adequate system of tile drainage, and they are improving their lands as rapidly as possible in this way. In the course of the survey in the summer of 1914, four or five such cases came especially under the notice of those who were engaged in the work, and while it may be possible that still other farmers have undertaken improvements of this kind in a systematic way, it is undoubtedly true as learned by information gained when questions were asked concerning the matter, that by far the greater majority of the farms in the county are not yet adequately drained in this way.

What constitutes adequate drainage will vary somewhat with the topographical location and with the particular variety of the soil, but in general it can be said for soil of the Miami silt loam type, which includes practically all the soils which form the sur-

face of knolls and ridges and which is of a light brown to grayish color, that the lines of tile drainage should be not farther apart than two to three rods, and should be placed at a depth of not less than thirty inches, and, except in rare instances, not more than forty-two inches in depth. It is to be understood, of course, that in putting in lines of drainage in this way, the utmost care must be used in order to be sure that there is a sufficient amount of fall in every part of the system, that the tile put in is of good quality, and that the outlet shall be so arranged that not only shall the water that accumulates have an opportunity to flow away, but that the air shall have access to the system, so that the oxygen contained in the air shall penetrate to the end of the remotest tributary line. This will require, of course, that the open ditch or stream which is the outlet of the system of tile drains shall be kept sufficiently deep so that the level of the water in the ditch shall be below the bottom of the tile; and furthermore, precaution must be taken that animals such rabbits, muskrats, etc., shall not have an opportunity to enter these tile drains from the outlet, since there is danger that they may never find their way out again and so obstruct and render almost valueless the entire part of the system above the point where their bodies may be lodged. This means that at the outlet of each tile drain, there shall be constructed, preferably of cement and iron bars, a protective structure that will accomplish the ends referred to. If, however, this and all other precautions are taken and the system of drainage is thus properly installed, the value of the land will steadily rise for a period of from ten to twenty years until the maximum productivity is reached. The initial expense of this kind of improvement is of course large, but the increased value of the crops secured from this improvement alone will in a few years repay all the expenses incurred and leave the land permanently of a higher value.

It is because of the certainty that systematic drainage of the kind referred to here will yield satisfactory results that the matter is referred to at this length, and the author of this report is so fully convinced of the paramount importance of this kind of improvement that he is ready to say that as a means of increasing the productivity of the land of Jay County that of a systematic extension of systems of tile drainage should receive first consideration. Information in regard to the various methods to be used in establishing such a system should be secured from the agriculture experiment stations and from the few men in the county who have

already seen the need and have begun to improve their farms in this way.

Because there has been a lack of understanding of the valuable results which come from an extension of systems of tile drainage the following points are mentioned as being the most important benefits which accrue from carrying out this plan. It is understood, that the points here named are in addition to the necessary removal of the water which would otherwise stand on the surface.

(1) Tile drainage changes an impervious closely packed soil to a more porous and open granular one.

(2) Tile drainage is a safeguard against drought for the reason the soil will become more porous and much of the water which falls as rain will be held in the openings in the soil and while it sinks far enough below the surface to allow the soil to be tilled, it does not entirely leave the subsoil and so remains as a reservoir within reach of the roots to be taken up when the lack of moisture near the surface on account of dry weather threatens to dwarf or destroy the life of the plants.

(3) Tile drainage provides for the aeration of the soil, that is. the entrance into the soil of the atmosphere, which supplies the oxygen needed for growth of the organisms in the soil which in turn are needed for the growth of plants.

(4) Tile drainage makes soils warmer. This comes about because the excess of water is removed and air fills the pores making it possible for the soils to become warm earlier in the spring and so the growing season for plants is lengthened.

(5) Tile drainage, by reducing the amount of water in the soil, reduces the probability of damage to winter crops on account of freezing; reduces, or in some cases prevents, the washing of soils on slopes.

These and other beneficial results accomplished by tile drainage are fully discussed in bulletins issued by the various agricultural experiment stations, and every farmer who wishes to undertake the improvement of his land in the way to secure the greatest and most permanent results, should at once make plans for the extension of his system of tile drainage.

## Farm Methods.

Under the topic "Farm Methods", are, of course, included all those questions of farm management such as the matter of rotation of crops, the proportion of farming land which should be devoted

to each of the crops raised, the value of live stock on the farm, etc. It is not the intention in this report to discuss these matters, but only such questions of farm methods as are more directly related to the soils and to the means by which the maximum crops may be secured.

During the progress of the work in the county, two of these general topics which may be included under farm methods came into prominence so frequently that it seems that mention should be made of them by way of suggestion.

(1) *Use of Fertilizers.* As shown by the 1910 census, 204 farmers in Jay County reported in regard to the use of fertilizers. The amount expended by these 204 farmers is given as $5,295, which is an average of something more than $25 per farm. It was impossible to collect data from every farmer in regard to the fertilizers used in 1914, but it is no doubt true that the amount of money expended in fertilizers in that year is far in excess of the amount reported by the United States census in 1910. As noted above, the largest yield of wheat in the county in 1914, namely 49 bushels per acre, was on land on which fertilizer was used. Many different farmers were interviewed in regard to the kind and the amount of fertilizer chosen, but it is impossible to make any general statement as to the amount or kind for a given soil or for a given crop which could be considered as a safe guide for farmers who have the same kind of soil and wish to raise the same kind of crop. In other words, the reports given were so various for the same kind of soil and for a given crop that it is impossible to make a summary which can be offered as certainly of value. There can be no doubt, however, that a judicious use of fertilizer of known composition is in some cases profitable. On the other hand, it is equally true that much money is spent for fertilizers for which no adequate return is received. All careful farmers, however, agree that the very best fertilizer which can be used on any kind of soil is stable manure; and those farmers seem to be able to secure the best results who sell but little hay or grain, keeping a sufficient amount of stock to eat the surplus which they may raise, and by this means, not only receiving full value for hay and grain, but also producing a considerable amount of fertilizer of the very best kind. This method, of course, cannot be pursued by all farmers, but wherever this plan can be followed, there is general agreement that it is the best course. Careful experiment should be made with the various commercial fertilizers offered, and without doubt in-

creased yields on most kinds of soils can be secured when such experimenting is carefully done.

(2) *Choice of Seed.* The necessity of choosing good seed applies, of course, to any crop whatever. Observations made in Jay County in the progress of the survey on which the report is here made touches, however, only one crop, corn. The observations referred to began soon after the work opened, for it was noticed that in most of the corn fields entered, the stand of corn was notably incomplete. Attention was therefore centered upon the matter and throughout the time in which the work was done, frequent observations were made in fields in all parts of the county in regard to the perfection of "stand". In making the observations in the somewhat general manner that was necessary, it was impossible to keep statistics with mathematical accuracy, but as a result of the series of observations through the weeks in which the survey was made, it was found that not more than one-fourth of the acreage in corn in Jay County could be said to have a complete or nearly complete "stand". For the most part, corn in the county is planted in drills, and the average distance apart when the stand was complete is perhaps fifteen to sixteen inches. In probably three-fourths of the fields in which observations were made, the number of stalks in the rows was often but two-thirds to three-fourths of the number which should have been present if the stand had been complete. This means that in perhaps three-fourths of the fields of the county the yield can be only two-thirds to three-fourths of what it might have been provided the full number of stalks possible had been present.

Some inquiry was made as to the method by which the seed corn was selected, and while the information gained included too few cases to arrive at a general conclusion which could be absolutely depended upon, it was nevertheless true that it was the exception to find a man who tested his seed corn by the sprouting method before choosing a given ear for use as satisfactory. Many rely on their ability to judge of the value of the corn for seed by its general appearance, by its firmness, etc., but those farmers who have been sufficiently careful to test a few grains from each ear which they propose to use for seed, have found that many ears are rejected when this method is used, which appear to be as perfect as others which are shown to be satisfactory by the sprouting test.

It is, of course, to be recognized that many causes may operate to reduce the stand in corn rows beside that of choosing poor seed;

yet from all the information which could be secured, it seems extremely probable that the total yield of corn in Jay County would be increased by not less than 25 per cent. or 30 per cent., that is, by about one-fourth if the sprouting method of choosing seed corn were universally used.

It is, of course, unnecessary in a report of this kind to give detailed instruction in regard to this method of determining whether a given ear of corn will make good seed corn, but information on this point can be supplied by any of the state agricultural schools, and unless some other method which is known to be equally accurate and satisfactory is being employed, this particular method should be investigated, and if put into practice, it would no doubt cause a marked increase in the total production of this one cereal.