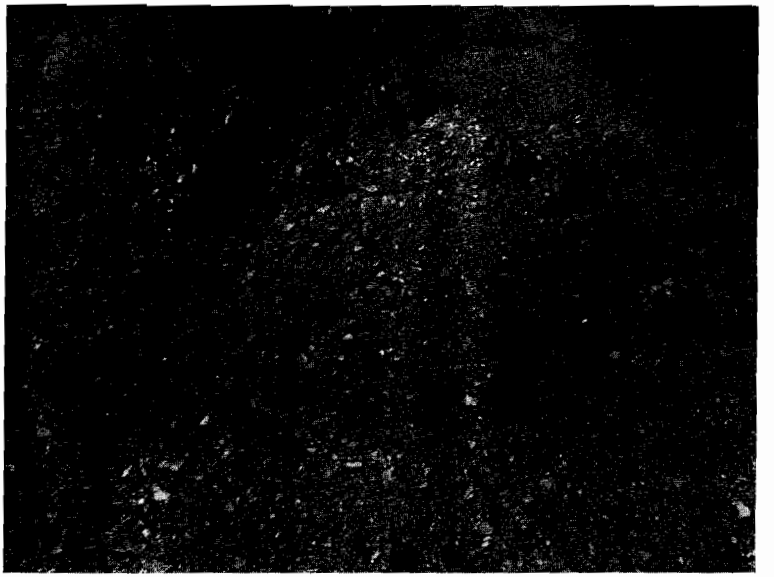
A SOIL SURVEY OF FOUR COUNTIES OF SOUTHERN INDIANA.

BY

CHAS. W. SHANNON,
L. C. SNIDER.

Showing topography and improvements in Upper Coal Measures near where the Patoka crosses the line between Dubois and Pike Counties.



Weathering and disintegration in shales and shaly sandstones of Upper Coal Measures near Duff, Dubois County.

Soil Survey of Dubois, Perry and Crawford Counties, Indiana.

By C. W. Shannon.

The three counties embraced in this report occupy an area in central-southern Indiana of about 1,015 square miles. These counties lie just to the west and south of the area of the former survey made by the State, and to the north and east of Warrick and Spencer Counties a part of which have been included in a soil survey made by the United States Bureau.

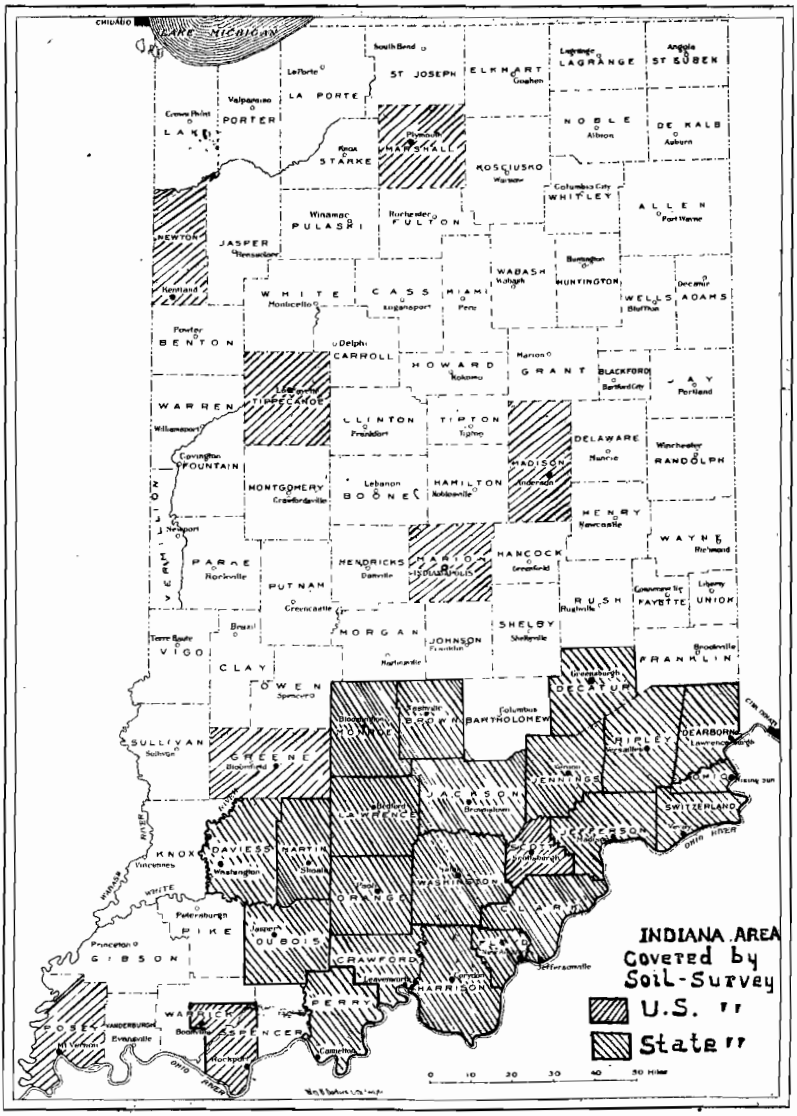
Taken as a unit the transportation facilities of the area are poor. Parts of the area are in good connection by rail with Louisville, Evansville and St. Louis. The southern part of Crawford and Perry have the advantage of a packet line on the Ohio, from Louisville to Evansville.

PHYSIOGRAPHY AND GEOLOGY.

The counties included in this survey lie in the driftless part of the State, with the exception of the northwestern part of Dubois, the topography and soils of which have been greatly influenced by glaciation. With one or two exceptions the same geological formations are found in each of the counties. The variety and distribution of the soils depend upon the geological formations. These formations have been described in detail in former reports, hence the descriptions embodied in this report will deal with little as to the structure and value of the formation. Some discussion, however, of the geological history, and the effects of weathering, erosion and other agencies must be given in order to understand the soil conditions. The soils have chiefly been derived from the underlying rock; and the soils of the same formation show little variation from one part of the area to another. The soil type will receive the fullest description under the county where it is best developed and occurs most extensively.

Area of Mitchell Limestone.—This formation is confined to the eastern part of Crawford County. The stone here is a fine grained,

compact, hard limestone, varying in color from blue to almost white. In places it becomes somewhat coarser and contains considerable chert and other impurities, such as calcite, shaly material and a



staining of iron oxide. In the quarry at Milltown a vertical face of 100 feet is exposed. In the quarry at Marengo over 75 feet are exposed and is fairly uniform in character. In the bluffs along

Blue River are numerous outcrops which show well the texture of the stone. The sink topography is well developed. These sink-holes are basin-like or funnel shaped depressions from a few feet in depth, to more than 50 feet in depth, and ranging in diameter from a few feet to several hundred feet, with an opening at the bottom which leads to underground channels, which form the true drainage lines of the area. Where the underground channels have been abandoned by the streams they may be explored great distances, as in Wyandotte, Marengo and many smaller caves. Long narrow valley-like areas have been formed by the falling in of the roof of subterranean cavities. The topography in the main has been developed by the solution and erosion of the underground waters.

The chief values of the limestone, other than the residual soils are, for the manufacture of lime, railroad ballast, and road metal, and as the limestone ingredient in the manufacture of Portland cement.

The residual soil is primarily a stiff red clay, which soon becomes bleached to a light yellow, by exposure at the surface. Throughout the soil and especially in the subsoil, are found many fragments of chert and fossils. It is lacking in the general fertility and agricultural advantages of the limestone soils farther to the east. Great care must be taken with these soils to keep them up to the standard. Large applications of stable manure render the soil more fertile, and this is due probably to two things, by adding a large amount of humus to the soil, and by rendering available larger amounts of the potash and phosphates contained in the cherty soils. Commercial fertilizers are also used. Sugar, beech, elm, oak, walnut, chestnut, sassafras and cedar make up the principal timber growth. See Crawford County for further description of this type.

Huron Formation.—The members of the Huron Group form the surface rock over large areas in Crawford and Perry Counties, but a very limited area in Dubois, along the streams in the northeast corner and along Anderson creek in the southeast corner. A series of limestones, sandstones and shales make up the formation. In the typical formation three limestones and two sandstones are found, and the total thickness of the formation is about 100 feet. The sandstones of the formation are of fine texture and usually of a gray color except when they become red from the large amount of ferric oxide.

The limestones are very valuable as road metal. The lower lime-

stone resembles very closely the Mitchell. Near Wickliffe in Crawford County, is an outcrop of the limestone of a dark grayish color, medium grained, and having a fair degree of hardness. Also in the vicinity of English, and along Little Blue River are outcrops of limestone of a rather impure quality. These outcrops are in regions where the roads are entirely unimproved and excellent use could be made of the material. In Perry County the stone outcrops are numerous, but at the present time no use has been made of the stone for road metal. The limestone of the Huron have also been used for burning of lime, and for bridge abutments and foundation stone. The sandstones are also used in bridge construction and for foundations, but otherwise have very little economic value.

The topography of the Huron is very rugged, and becomes more broken as the Mansfield area is approached. The drainage is both surface and underground. Springs are numerous along the outcrop, the water coming out between the stone and shales. The differences in elevation between the hills and valleys is from 100 to 250 feet. The line between the Mitchell and the Huron is somewhat sharply marked by a change in vegetation. The varied forest of the limestone soil gives place to those which are chiefly red, black and scrub oak. The uncultivated fields grow up quickly in wild daisies and sassafras. Persimmon trees are very plentiful in this area, although seldom found over the limestone.

Owing to the varied nature of the rocks from which it is derived the soil is not very uniform. Usually the surface soil is a yellowish sandy loam, underlain by a stiff white to yellow subsoil more clayey than the surface, but contains considerable sand. In many places the sandy soils are of a reddish color and are not very productive since they consist of little but quartz and ferric hydrate. The soil is only fairly productive, easily exhausted and washes badly, and most careful cultivation is required on the slopes to prevent destruction.

The Mansfield Sandstone.—The Mansfield Sandstone covers large areas in the three counties included in this report. This formation is also known as the Millstone grit and Conglomerate Sandstone and Division I of the Coal-measures. The formation varies in thickness from 50 to 150 feet. It varies in texture from a fine grained stone to a coarse pebbly conglomerate. The color is commonly yellow or brown, but is frequently found approaching a white color. In some places the massive sandstone comprises the total thickness, while in others, there are shales, coal and iron ores,

at or near the base. The topography of the Mansfield is very rugged. It is a thoroughly dissected plateau. The region is characterized by having but little level land. The drainage lines are well developed. Steep hills, abrupt cliffs, and long, narrow, winding valleys are common. The streams run in deep ravines, from 100 to 300 feet in depth; the banks generally too steep for cultivation, except near the tops or bottoms, where they round out to the summit of the ridge or round outward to meet the bottom lands. As far as possible the roads follow the tops of the ridges, or run along in the valleys, and as shown on the maps are an index to the broken topography of the area. The materials of the formation have little economic value.

The soils of the Mansfield are of a light yellow color, and vary from fine sandy loams to sandy clay loams. The subsoil is of a reddish yellow color, mottled with white, and is more tenacious than the surface. The red color is due to large amounts of iron contained in the original formation. Large areas of these soils are uncultivated, being grown up with second growth timber and underbrush. Much rough stony land, unfit for cultivation is also found. The principal tree growth consists of oaks, beech, maple, walnut and mulberry.

Coal Measures.—In Crawford and to a much greater extent in Perry the coal-measures occupy the tops of the highest elevations and run in tortuous ridges a few rods in width to a mile or more across. In Dubois, however, the formation is better developed, and forms the surface rock over an area comprising about 250 square miles. The formation consists of a series of sandstone, shales, fire clays, iron ores, and thin-bedded limestones. Of these the shales predominate, and the result is that the topography is much more even than in the former area. The surface is of a rolling character, the ridges having been reduced by erosion until they are fairly low, with gentle slopes running to the streams, and are generally suited for farming. The ridges will generally vary from 50 to 100 feet above the streams, and the streams have considerable fall, hence the drainage is good.

The depth of the surface material formed by the disintegration of the underlying material is greater than in the sandstone areas to the east, and rock exposures are generally small. In the eastern part of the area where the coal measures occur as remnants of the high ridges, the ridges are flat topped and afford some good farm land.

The area here included takes in Divisions II, III and IV of the Coal Measures.

Alluvial Soils.—The alluvial soils of this area are chiefly those of the Ohio, White and Patoka rivers, and small areas along Anderson and Blue rivers. The characteristics of the alluvial soils are largely dependent upon the nature of the formations and soils found within the drainage area of the stream, and the relative proportion of the various components is dependent upon the steepness of the slope and the velocity of the current. This is true especially of all alluvial soils of this area found along the smaller streams. The Patoka Valley has been affected somewhat by glacial waters and deposition, but the surface soil is now principally washed from the uplands. The soils of the Ohio Valley have been derived from various sources, and carried considerable distance before being deposited. This has also become greatly modified by the material brought down by smaller streams and the continual wash and creep from the hills.

The Ohio, as it flows along the southern boundary of Crawford and Perry counties, has a meandering course through a rather deep and narrow valley. In fact, this is the chief characteristic of even all the smallest streams of this section of the State. The influence of the geological strata in directing the course of running is well presented by the stream. The general direction of the Ohio as it flows to its outlet is south of west, crossing the outcrop of the geological formation at nearly right angles to the line of strike. Wherever the stream has encountered a stratum of more than ordinary resistance the course of the stream is turned from the general direction and takes a northerly or southerly direction, following about the line of strike until a less resistant part is reached, or until it has acquired sufficient force to break through the rock barrier.

On reaching Perry County the river turns in a southerly direction and flows along the outcropping edges of the lower Carboniferous limestone, and with but little change until near Tobinsport it crosses the edge of the strata and makes it way in the opposite direction across the Mansfield sandstone, until near the mouth of the Deer Creek it swings again to the west and south and is hemmed on its northern side by high perpendicular walls; then, again, before Cannelton is reached, it turns to the northwest and continues in an almost straight line to Troy, where it has reached a level of about 100 feet above the Mansfield formation. Anderson Creek, Deer Creek and Blue River cross the formation in a similar way;

very few of the streams have flood plains at all commensurate with the size of the stream. The streams occupy practically the entire bottoms with the exception of meander curves, which are best developed in the Tobinsport bend.

Glacial Soils.—The glacial soils of the area are confined to the northwestern part of Dubois County and are discussed under that county.

CLIMATE.

The area of survey is not subject to severe winters or to excessive heat in the summer. The winters are mild and short. The growing season comprises about six months of the year, during which time crops are safe from damage from frost. The last killing frost in the spring usually occurs about April 10, and the first in the autumn during the last week of October. The annual normal rainfall is more than 40 inches, an amount equal for all crops if properly distributed; but usually during the early part of the spring excessive rains occur, causing the planting of crops to be very late, and then drought sets in, causing the late-maturing crop to be greatly injured, as was especially true in 1908. Such excessive variations are, however, not common, and the rainfall proves very adequate for the growing crops.

During the excessive spring rains in this region and that farther to the northeast the Ohio is made to overflow and causes large areas to be flooded, and crops are often late, but it has been found in such cases that corn planted late in June usually has time and moisture enough to mature before frost. The weather stations within the area, where accurate records are kept, are few, those of Rome and Marengo having the only available records. For comparison, the results of observation and record of other points with the southern part of the State are also given:

TEMPERATURE AND PRECIPITATION.

MONTH.	EVANSVILLE.		MARENGO.		LOUISVILLE.	
	Temperature, °F.	Precipitation, Inches.	Temperature, °F.	Precipitation, Inches.	Temperature, °F.	Precipitation, Inches.
January	35.4	3.31	33	4.9	35	3.9
February	32.3	2.98	35	6.5	37	3.9
March	44.6	4.84	44	5.3	45	4.3
April	57.0	3.55	56	5.4	56	4.0
May	67.0	4.38	65	5.2	67	3.8
June	76.3	4.67	74	5.4	75	4.3
July	79.6	3.54	77	4.0	79	3.8
August	78.4	2.00	75	4.2	27	3.5
September	71.9	2.48	69	4.0	70	2.7
October	59.2	2.87	57	3.1	59	2.6
November	45.0	3.67	45	5.4	46	4.0
December	35.8	3.02	36	4.2	38	3.7
Year	56.9	41.40	56	57.6	57	44.5

Lowest temperature Marengo for period of 21 years	−28°
Lowest temperature Louisville for period of 21 years	−20°
Highest temperature Marengo for period of 21 years	106°
Highest temperature Louisville for period of 21 years	107°
Average number of rainy days for period at Marengo	97 days.
Average number of rainy days for period at Louisville	128 days.
Average depth of snow for period at Marengo	20.0 inches.
Average depth of snow for period at Louisville	14.4 inches.

The average temperature for Salem, which is farther north than any of the area of this survey, is 53.5°; amount of precipitation, 40.43.

The snows of this area are of short duration, and the ground is seldom frozen so hard but that muddy roads are found throughout the winter. The relatively high humidity of the atmosphere renders the summer heat more oppressive and the sensible temperature of the winter more severe than would the same temperature in less humid regions. The velocity of the wind is more noticeable now than formerly, and spring floods and summer droughts more marked, because of the disappearance of the forests.

DUBOIS COUNTY.

History of Settlement and Agricultural Development.

Dubois County was named in honor of Toussaint Dubois, a Frenchman of Vincennes, Indiana. He was a soldier under General Harrison and had charge of the guides and spies in the Tippecanoe campaign.

When Indiana was first organized as a Territory the land now comprising Dubois County was a part of Knox. Then in 1813, when Gibson County was organized, most of the area was included in that county. In December, 1816, by the formation of Pike County out of Gibson, Knox and Perry counties it was included in Pike and remained as a part of the county until December 20, 1817, when it was organized as a separate county. In 1818 another act affecting the county was passed and a part of it was again annexed to Perry County; and in 1820 Martin County was organized out of Daviess and Dubois counties, this reducing Dubois to about its present bounds.

It is generally believed that the county was settled in 1801, along a route that passed through the county, leading from Vincennes to Jeffersonville, and known as the "Mud hole trace," on account of the mud holes which rendered it almost impassable. It passed south of Portersville and almost parallel with the base line. Near Crystal a few years ago part of the old logs cut and used by General Harrison's men in making the road passable were dug out of the ground so that it might be cultivated.

At the first division of the county into civil townships, five were formed. The present townships are Boone, Harbison, Columbia, Hall, Marion, Bainbridge, Madison, Patoka, Cass, Jackson, Ferdinand and Jefferson. The county seat was located at Portersville, on the northern boundary of the county, on the east fork of White River. The seat of justice was not destined to long remain at this location. During the years from 1820-1830 all the towns along the streams in southern Indiana suffered much from sickness caused from the sluggish and overflow waters. Some of the towns were almost depopulated and Portersville was no exception. This unhealthy condition, together with the unfavorable situation for the central and southern part of the county, led to a change in 1829-30 in the location of the county seat, and the present site of Jasper was selected. So far as the healthy conditions were concerned they were very little improved by the change for some time.

because of the sluggish and malarial influence of the Patoka River. But other considerations were of value: the land was donated and the population was rapidly increasing in that part of the county, so that the new location proved to become a thriving center for trades and business enterprises.

Railway Facilities.—In 1869 several proposals were on foot for the construction of various railroads through the county. "The New Albany and St. Louis Air Line" made the best proposition. Elections were held over the county to determine the question of rating a tax for the new road, the company providing that the road should run within a half mile of Jasper, which proposition was approved almost unanimously by the southern part of the county. After various elections and much trouble the road was finally constructed across the southern part of the county in 1882, with Huntingburg the chief business point within the county.

In the meantime the Cincinnati, Rockport & Southwestern had been agitating the railway question, and after Bainbridge Township had granted aid amounting to more than $20,000 and a number of persons took stock amounting to $17,800, the road was built under discouraging conditions, and the first train came to Jasper on the evening of February 14, 1879.

The east and west line through the county is now known as the St. Louis Division of the Southern Railway and the north and south line as the Indianapolis & Evansville Division, a new road having been completed from Jasper to French Lick in 1907, this giving direct connection with the Monon to Indianapolis. This extension will prove a great benefit to Jasper and the surrounding parts of the county. A number of new developments have already been begun in the northeastern part of the county, and land there has advanced considerably in price.

In the early days flatboats of various dimensions were floated down the Patoka and White rivers during the spring high waters, carrying staves, hooppoles, bacon, beer, corn, flour, dried fruits and other products.

Agricultural Societies.—The first fair association in the county was organized early in the sixties, and one or two exhibitions were held, but the organization was soon disbanded because of the unsettled conditions arising from the war. An association known as the "Dubois County Agricultural Society" was organized and a fair was held in the autumn of each year for several years, but the society was finally disbanded.

The Dubois County fair grounds are southeast of Huntingburg. The fair was established in 1887, and a week's fair is held each year and is of some importance to the agricultural public.

Jasper, the county seat, has a population of 2,500. It is situated near the center of the county and owes its origin to the necessity for a more central location for the county seat than that afforded at Portersville. The ground was donated and the first court house and jail were erected by citizens free of cost to the county. In 1866 the town had a population of 507, and was incorporated in the beginning of that year. The town has several manufacturing establishments, among which are lumber yards, furniture factory, novelty works, veneer works, hub factory, ice plant, machine works, wagon works, creamery, canning factory, and two cigar factories. In the city are many fine residences, one of the largest stone churches within the State, municipal water works and electric light plant, and a parochial school known as Jasper College. There are now six passenger trains daily. The water supply is from the Patoka River.

Ferdinand is situated in the southern part of the county and has a population of 900.

The history of the town bears a close connection with the general settlement in the county, and in addition it owes an interesting part o fits history to its founder, Rev. Joseph Kindeck, who conceived the idea of establishing a town and trading center between Jasper and Troy in Perry County. The town is in the center of a good farming section, and in the early days a large amount of tobacco was raised in that section and it is yet the live tobacco market in the county. It has a foundry and machine shops, manufacturing threshing machines and engines, that gives employment to many men; brick yards, lumber yards and creamery. St. Joseph's Home for the Poor and Benedictine Sisters' Academy are situated here.

Holland, a town in the southwest part of the county, has a population of 200. It is located in a fairly fertile region and affords a good trading center.

Ireland is a site of some of the earliest settlements within the county. It was first called American city. It has a population of 320. It is situated in a very fertile area and should become the center of some industrial enterprises if transportation facilities could be secured.

Birdseye owes its origin as a trading place to the early days of

the county. But its later growth is due to the construction of the Air Line. It is a good shipping place for cross-ties, hooppoles, staves and timber. It has a population of 550.

Schnellville was founded as a school location. It has a flour mill, saw mill, tobacco warehouse, furniture shops, church, school and other evidences of prosperity.

Bretzville, originally known as the "town of New Town," situated on the St. Louis Division of the Southern, is chiefly a trading center and shipping point for that section of the county.

Haysville is a little village east of Portersville and about one and a half miles south of the river.

Hillham is a little country village situated in the northeastern corner of the county.

Portersville, situated on the east fork of the White River, as above stated has the distinction of being the first county seat of Dubois County. At the foot of one of its streets, barges, flatboats and small steamers carried away the products of the surrounding country in the early days.

Crystal has a population of 50. It affords a trading place for the surrounding country, and now has a station on the new line of the Southern Railroad.

Dubois, frequently called Knox, is also situated on the new line of the Southern, and considerable improvements are being made. The old town of Dubois is about a half mile to the east.

Kyana owes its origin to the construction of the east and west line of the Southern Railroad. It was founded by the Louisville mining and manufacturing company, and bears the name of its home State and the termination of the State in which it is located. It has some new improvements, including a new church and a new school building.

Celestine, Ellsworth, St. Anthony, Maltersville, Millersport and Duff are other little villages and stores scattered over the county.

The county was originally covered with a dense growth of walnut, oak, poplar, beech, ash, gum, hickory and other hardwood trees.

The part of the county lying west of the line drawn west of Haysville running about a mile and a half west of Jasper to the Patoka is called the "garden spot" of the county.

Dubois County now has a population of about 25,000, and an estimated wealth of $10,000,000. The rapid growth is shown by noting that the population in 1830 was 1,774 and in 1875 about 5,600.

The county produces annually, according to the statistics of 1907 and 1908, 700,000 bushels of corn, an acreage of about 30 bushels per acre; wheat, 400,000 bushels, averaging from 10 to 15 bushels, and ranks tenth in the State for acreage of wheat; oats, 150,000 bushels, about 12 bushels per acre. A large acreage of timothy is raised and yields 1½ tons per acre. Clover yields about 1¼ tons of hay per acre; about 5,000 bushels of clover seed are produced. In the past two or three years a very little alfalfa has been grown with fair success. About 600 acres are annually planted in potatoes, yielding about 40 bushels per acre. In 1907 about 240 acres were planted in tomatoes, producing 26,800 bushels; in 1908 about 650 acres were planted, yielding about 68,000 bushels. In 1907 25 acres were planted in peas; in 1908 72 acres were planted. A few watermelons and cantaloupes are grown each year. In last year about 10,800 bushels of apples were raised. There are about 80,000 fruit-bearing trees in the county. The county ranks about 10th in the growing of tobacco, about 90,000 pounds being produced.

The number of live stock raised is not large, but there has been a decided increase in the number and quality in the past few years. Dairying is growing to be a leading business. There are now in the county four creameries, located at Jasper, Huntingburg, Ferdinand and Holland; another located at Otwell just across the line in Pike receives much milk from the northwestern part of Dubois County. These creameries produced during the past year about 240,000 pounds of butter, representing a business of over $70,000.

The rapid growth and developments in the county in the past few years has placed the county high among the leading counties of the State. Most of the land is owned by those who live upon it, and most of the citizens are considered well-to-do. A very large percentage of the population are Germans and represents a hard-working, progressive people. The thrift, good management and saving is shown in the economy of the farm land, the permanent improvements and general rural advantages.

There are in the county 700 miles of public roads, with about 40 miles improved. The first roads were improved in 1903. The improvement has been made with crushed stone at a cost of about $3,000 per mile. Dubois is one of the poorest counties in the State for good road material. There is no gravel, and limestone occurs only in the northeast and southeast corner, and in the bluffs of the Patoka seven miles southwest of Jasper. The earth roads through the better parts of the county are kept in good condition.

Physiography and Geology.

Three geological formations are found in Dubois County—Huron, Mansfield and Coal Measures. The rocks of the Huron formation occur only in small isolated areas along Patoka River and its tributaries in the northeast part of the county and along Anderson Creek in the southeast part. The Mansfield covers the greater part of the eastern third, and the Coal Measures about twice the area in the western part.

The topography is very broken, especially in the eastern part, where the hills rise 75 to 200 feet above the valleys, and in the southwest part also; especially in Cass Township the hills rise to considerable height but have more gentle slopes. The northwestern part of the county is comparatively level with the exception of a few hills of the preglacial formation which rise above the general level. The level area is included in Boone Township and is, as above stated, known as the "garden spot" of the county. The area is covered with alluvial and glacial material, and is discussed under the soil types of that area. The highest part of the county occurs in the vicinity of Birdseye and Ferdinand.

The principal drainage of the county is by White River along the northern part of the county, and the Patoka, crossing the county in a very meandering course from northeast to southwest, with its tributaries of Hunley and Straight Creeks from the southern part of the county. Pigeon Creek drains the southwestern corner, and the southeast corner below Birdseye is drained by Anderson River and its tributaries.

In general, the drainage conditions are fairly developed and the topography varies from high hills, narrow, winding ridges, steep bluffs with rock exposures in the east and south to level plains and rolling uplands in the northwest.

SOILS.

Dubois has a greater variety of soils than either of the other counties of this survey. There are five general types, each with various subdivisions. Three of the general types are due directly to the weathering and disintegration of the underlying formation. The alluvial types are those of the Patoka and White River bottoms. The glacial material belongs chiefly to the part of the old glacial lake in the northwest part of the county, and to the till found on the higher elevation between the White River bottom and the Pa-

toka Lake plain. The following table shows the extent of each of the general types:

Huron	3 square miles
Mansfield	106 square miles
Coal measures	230 square miles
Alluvial	32 square miles
Glacial	54 square miles

1. Huron.

The Huron formation within the county is very limited. It consists chiefly of stone outcrops, steep bluffs and slopes leading down to the stream. It has very little value so far as the soils are concerned, but it affords the only limestone supply in the county. The places of occurrence are given under the general description of the Huron formation.

2. Mansfield Sandstone.

The soils of the Mansfield sandstone comprise the second largest area within the county. It makes up practically all the northeast corner, and extends in a strip about two miles wide entirely along the eastern side of the county. It also occurs rather extensively along the streams of the east central part of the county. In general, the topography is very rough, and the agricultural conditions are not the best.

The surface is a yellow, sandy loam from 6 to 18 inches in depth. The subsoil is of a similar color and with depth becomes more clayey and mottled with white and rusty brown.

The soils are not very productive. The improvements grade from poor to fair. Because of the shallowness of the soil corn is often injured by the dry weather, but on the average produces about 25 bushels per acre. Fertilizers are not very extensively used. Much of the land has become worn out by continued cropping. The soils wash badly on the slopes, and much land has been practically destroyed from improper cultivation. Much of the area has a dense second growth of timber, but it is being rapidly removed.

Some noted improvements are being made in the northeast part of the county since the coming of new railroads, and the soil will no doubt be looked upon with more favor than in the past. Land now sells at $5 to $25 per acre. Very little fruit is grown, but the soils are well adapted to this industry and such would prove

paying since transportation facilities are provided. There are three or four little stations along the railroad in this area.

The soil conditions are more fully described under Crawford County. The following table shows the result of mechanical analysis of the soil:

MECHANICAL ANALYSIS OF MANSFIELD SANDSTONE, RESIDUAL SOILS.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
24	Near Crystal	Surface	.0	.3	.5	1.5	10.5	88—
		Subsoil	1.5	.2	.5	2.0	6.4	89.5
24a	Near county line east of Jasper	Surface	3.5	1.5	1.0	2.0	7.0	85.0
		Subsoil	6.4	1.0	1.4	2.5	5.0	84+

No. 24 is the same as that from which the chemical analysis is made, and is a typical sample for most of the area.

CHEMICAL ANALYSIS OF MANSFIELD SANDSTONE SOIL.

Laboratory No	24
Reaction to Litmus	acid
Moisture at 105°C	1.77
Total soil nitrogen	.089

ANALYSIS OF FINE EARTH DRIED AT 105°C.

Volatile and organic matter	3 563
Insoluble in (1.115 sp. gr.) HCl	88.011
Soluble silica	.033
Ferric oxide (FE_2O_3)	4.072
Alumina (Al_2O_3)	2.859
Phosphoric acid anhydride (P_2O_5)	.146
Calcium oxide (CaO)	.573
Magnesium oxide (MgO)	.517
Sulphuric acid, anhyride (SO_3)	.155
Potassium oxide (K_2O)	.327
Sodium oxide (Na_2O)	.340
Total	100.496

3. COAL MEASURES.

The Coal Measures occupy the largest area within the county. The area here is the best developed and largest of any over which the survey has been extended. In the east part the topography is very rugged, the hills rising to great height above the stream levels; in the part south of the Patoka River and west of Huntingburg the hills are not so high and have gentle slopes and soils have greater depth. This part of the area has evidently been influenced by glacial material. "As the ice melted and the glaciers began to recede, it is believed that a part of the material which later formed the soils of the area was released and carried still farther south and deposited on broad flats by streams, then issuing from the glacial front. It was later picked up by the winds and generally redeposited in the form of loam over the surface of the uplands, covering all older geological formations." The underlying formation has, however, much to do with the character of the

In the Patoka Valley near the town of Dubois.

Topography in Coal Measures, between Straight and Hunley Creeks. Large areas of this soil are devoted to wheat growing. To prevent washing is of importance.

soils. There is no great difference in the soils of this region and those derived from the Coal Measures outside of glacial influence. This particular region in the southwest corner of the county is fairly fertile, and, becoming of more even topography, demands higher prices than that of the eastern part. The farms sell at prices ranging from $35 to $60 per acre. The crop productions are good and the facilities for reaching the market are fair.

In general the soil is a light sandy clay loam averaging from 8 to 10 inches in depth and varying in color from a light gray to brownish yellow. The new soils are usually high in organic matter.

The improvements are fair throughout the area. Great care is necessary to keep the soils in highly productive state, and a rotation of crops is very essential in order to secure the best results. The soils wash very badly and large areas of the subsoil are exposed along the slopes.

The soils are adapted to all the ordinary farm products. Wheat, oats, and rye give good yields and large areas are planted. Clover and timothy yield about one and one-fourth tons per acre. Fruit is successfully grown, but so far but little attention has been given to the industry. Tobacco is also grown and produces well. Very little truck farming has been attempted, but there is opportunity for good developments along this line.

The following table shows the results of mechanical analysis of the soils:

Number.	LOCALITY.	Description	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
19	Southwest Huntingburg....	Surface.....	.2	.2	.4	1.5	5.0	93+
19a	Southwest Huntingburg....	Subsoil.....	.0	.4	.2	.5	6.5	94.2
23	Near Calumet.....	Surface.....	.0	.5	.0	5.5	8.0	86.0
23a	Near Calumet.....	Subsoil.....	.5	.4	1.2	3.0	5.0	89+

CHEMICAL ANALYSIS OF SURFACE COAL MEASURE.

Laboratory No	23
Reaction to Litmus	acid
Moisture at 105° C	1.39
Total soil nitrogen	.096

ANALYSIS OF FINE EARTH DRIED AT 105°C.

Volatile and organic matter	3.366
Insoluble in HCl (1.115 sp. gr.)	90.048
Soluble silica	.043
Ferric oxide (FE_2O_3)	2.490
Alumina (AL_2O_3)	2.877
Phosphoric acid anhydride (P_2O_5)	.120
Calcium oxide (CaO)	.418
Magnesium oxide (MgO)	.576
Sulphuric acid anhydride (SO_3)	.035
Potassium oxide (K_2O)	.219
Sodium oxide (Na_2O)	.311
Total	100.503

GLACIAL SOILS.

The glacial soils of Dubois County are those of the northwestern part and may be divided into four types—those of the Patoka Lake plain, the loess-covered areas lying just above the lake basin, the area of till in the northwest corner, and the sand areas, best developed in the region of Portersville.

Patoka Lake Plain.—When the ice sheets moved southward or southeastward, they pushed across the lower courses of many of the streams, damming them, and the ice remained at about the same point until the bodies of water thus made were silted up full. In many cases the streams thus dammed were of considerable size, as the Patoka River above Jasper, and the body of water thus formed was of great size, including many square miles. In many places the higher portion of the preglacial topography project above the level deposits. Examples of such are the uplands just north and west of Jasper and Cooper Hill in the northwest, an irregular ridge rising 60 feet or more above the surrounding levels. Many other small examples occur.

"The line making the eastern and southern limits of this level area, which will be called the Patoka Lake plain, with two embayments of Upper Patoka plain on the east and Middle Patoka or Straight and Hunley Creek plain on the southeast, leaves the present valley of White River in Sec. 27, T. 1 N., R. 5 W., and passes south through Sec. 35, T. 1 N., R. 5 W.; thence south through Secs. 2, 12 and the northeast corner of Sec. 13, T. 1 S., R. 5 W.; thence south across Sec. 18 and into Sec. 19 to the present bottom of the Patoka River. From this point the Patoka River marks the boundary as far south as Frog Island, where the line turns northwest through Sec. 25, crossing the southwest corner of Sec. 24, thence north across Sec. 23 and crossing the southwest corner of Sec. 14, leaving this section at the center of the west side, here turning west and south across Secs. 13, 21 and 28, and thence south and east through Secs. 34 and 35, T. 1 S., R. 5 W., to Patoka River at Jasper. From this point the Patoka River becomes the boundary as far west as Sec. 10, T. 2 S., R. 5 W., where the line turns north and west across the section and Sec. 4, thence west, south of the northern boundary of Secs. 5 and 6, T. 2 S., R. 5 W., where it again strikes the Patoka River, following it to the mouth of Flat Creek, where it turns north along this stream to the Pike County line.

"Upper Patoka plain includes Secs. 11 to 14, inclusive, T. 1 S.,

R. 5 W., and part of Secs. 24 and 25, T. 1 S., R. 5 W., and the southwest corner of Sec. 18 and the northwest part of Sec. 19, T. 1 S., R. 4 W. Straight and Hunley Creek plain includes Secs. 32 and 33 and part of 24, T. 1 S., R. 5 W., and Sec. 3 and part of Secs. 2, 11, 10, 4 and 5, T. 2 S., R. 4 W. The rest of Patoka Lake plain in this county comprises the east half of T. 1 S., R. 6 W., and part of T. 1 S., R. 5 W., T. 1 N., R. 5 W., and T. 1 N., R. 6 W. See accompanying map.

"The names Upper and Middle Patoka are suggested by Mr. Frank Leverett as designating the preglacial drainage of the Patoka. It is evident that in preglacial times the part of the drainage basin above the gorge near Jasper drained northwest across Upper Patoka plain to White River. The name Upper Patoka River is given to the stream draining the area at that time. West of this basin, and between the gorges near Jasper and near Velpen, Pike County, was another drainage basin known as the basin of the Middle Patoka River of preglacial times. Straight and Hunley creeks are part of the Middle Patoka River drainage. According to Mr. Leverett, the main stream flowed northwest to White River, passing close to Otwell. Most of the Patoka basin in Pike County belongs to what Mr. Leverett calls the Lower Patoka basin, which drained northwest into White River in western Pike or eastern Gibson County. The outlet of the Patoka Lake during glacial times appears to have been the low ground near Francisco, in Gibson County, where the old Wabash and Erie Canal crossed the divide between the Ohio and Patoka rivers.

"The drift and alluvial deposits of these plains vary in thickness from a few feet to 26 feet plus, it being impossible to get the maximum thickness, as the wells of this territory are all driven, going down to only the water-bearing strata which lies above the country rock.

"As stated above, it is quite probable that during the preglacial times the Patoka River turned northwest above Frog Island and flowed through what is now known as Buffalo Pond to the headwaters of Mill Creek, and followed down the present valley of Mill Creek and discharged near the present mouth of that stream, and that Hunley Creek and Straight Creek followed northwest along what has been described as Straight and Hunley creek plain, and then probably turned west and northwest across Patoka Lake basin, past Otwell, to the present valley of Beech Creek. This change in the location of these streams was doubtless brought about by the advancement of the ice sheet during the latter(?) part of the

glacial period, when the ice probably pushed as far south as Portersville and the uplands of Secs. 25, 26, 35 and 36, T. 1 N., R. 6 W., damming the streams and forming Patoka Lake. During this period, and previous to the recession of the ice sheet, the drift and alluvial sands and clay were deposited over this part of the country.

"Also during this period, and probably when Patoka Lake reached its greatest extension, the Patoka River broke across the narrow divide one mile north of Jasper, flowing southwest and entering Straight Creek valley south of town. The preglacial gorge through this divide is very narrow, with rather steep and abrupt banks."*

The present soils consist of a modified so-called "loess," containing large percentage of silt, sand and rarely fine gravel. The soil to a depth of 8 to 12 inches is a light brown, loose, loamy soil, but becomes a lighter color and is more tenacious with depth. The subsoil is often mottled with a brown stain of iron oxide.

The soils were formerly very wet, but much tile drainage has been done and practically the whole area is under cultivation. The area is one of great agricultural value. The greater part is considered good for general farming purposes. Farms sell at $75 to $100 per acre. Some very large farms are found within this area. The improvements are all first class and all the most modern methods of farming are used. The soils are well kept up by crop rotation, manuring and the extensive use of commercial fertilizer.

Usually wheat is more extensively grown than any other crop. It produces an excellent growth and yields from 10 to 30 bushels per acre. Corn grows well and produces 30 to 75 bushels per acre. Oats grow but do not give abundant yields. Rye, clover, timothy make good growth and large acreages are raised. Fruit growing is carried on in a very limited way. A number of good stock is raised. Dairying is engaged in and the milk supply sold to creameries in Jasper and Otwell.

The area stands out in sharp contrast to that of the east and promises to hold high rank in crop production and farm improvements in southern Indiana.

The uplands just above the basin level are covered with a soil very similar except that it is of rich brown color, due to the unbleached condition. The mechanical analysis shows practically the same result, and chemical analyses are not greatly different. Its topographic position and productiveness give it great value. The area is rather limited compared with the former.

*J. A. Price, 23d Annual Report of State Geologist, pp. 1099–1102.

MECHANICAL ANALYSIS OF PATOKA LAKE PLAIN SOILS.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
26	Two miles northwest Ireland	White soil	.0	1.0	.0	3.0	15.0	81.0
25	One-half mile	Brown soil	.0	1.5	.1	2.5	12.0	83+

CHEMICAL ANALYSIS OF BROWN SOIL, PATOKA LAKE PLAIN.

Laboratory No	25
Reaction to Litmus	acid
Moisture at 105°C	1.51
Total soil nitrogen	.103

ANALYSIS OF FINE EARTH DRIED AT 105°C.

Volatile and organic matter	3.451
Insoluble in (1.115 sp. gr.) HCl	89.299
Soluble silica	.013
Ferric oxide (FE_2O_3)	2.691
Alumina (AL_2O_3)	3.111
Phosphoric acid anhydride (P_2O_5)	.178
Calcium oxide (CaO)	.358
Magnesium oxide (MgO)	.525
Sulphuric acid anhydride (SO_3)	.045
Potassium oxide (K_2O)	.331
Sodium oxide (Na_2O)	.409
Total	100.411

CHEMICAL ANALYSIS OF WHITE SOIL, PATOKA LAKE PLAIN.

Laboratory No	26
Reaction to Litmus	acid
Moisture at 105°C	1.33
Total soil nitrogen	.089

ANALYSIS OF FINE EARTH DRIED AT 105°C.

Volatile and organic matter	2.819
Insoluble in (1.115 sp. gr.) HCl	91.961
Soluble silica	.083
Ferric oxide (FE_2O_3)	1.415
Alumina (AL_2O_3)	2.447
Phosphoric acid anhydride (P_2O_5)	.093
Calcium oxide (CaO)	.508
Magnesium oxide (MgO)	.440
Sulphuric acid anhydride (SO_3)	.052
Potassium oxide (K_2O)	.213
Sodium oxide (Na_2O)	.305
Total	100.336

Till.—In the extreme northwest corner of the county, lying between the White River valley and the margin of Patoka Lake Plain basin, is an area of several square miles in which the soil is of great thickness, and shows in its contents the result of glaciation. This is glacial till from the Illinoian ice sheet. It is composed of more or less sandy clay, in which are imbedded rock fragments foreign to the region. The soft sandstone and shale underlying the till probably furnish the larger part of the material although but few fragments occur throughout the area of the soil. The texture of the finer portions of the till varies greatly, probably depending upon the nature of the rock from which it is chiefly derived. When

shales appear to have furnished the layer portion of the material the clay contents are high and of a bluish-gray color. Where sandstones have predominated the soil is sandy and varies from buff to red in color. The soil seems to have been but little influenced by limestones. The actual thickness of the till is uncertain, but it may be said to vary from a few feet to 50 feet or more. As the eastern edge of the sheet is reached the till thins out very rapidly and the native rocks begin to outcreep and the till diminishes to a relatively thin sheet covering the local material. It is difficult to ascertain when the till leaves off and the residual soils begin. In the broader areas of the till great fertility is maintained and some well-improved farms occur. In the thin areas there is no marked difference in the productions between the till and residual soils.

Sand Areas.—At Portersville and extending toward Haysville are areas of sand which were very probably deposited with the tills along the ice margin. The sand area is not of sufficient extent to be of agricultural value. Hauling is very difficult throughout the area because of the loose, sandy condition of the roads.

Corn, wheat, tobacco and vegetables are the principal things grown on the till and sand areas. The tree growth includes sugar, walnut, wild cherry, oaks, pawpaw, etc.

5. Alluvial Soils.

The alluvial soils of the Dubois County are those along White River valley and Patoka, with very limited areas along some of the smaller streams.

The soils of White River valley comprise an area from 6 to 8 square miles. It is a sandy loam, containing varying amounts of clay. It grades from a light yellow to dark color. The organic content is usually high. The drainage is good although the area is very level. The land is affected by high waters only during the most excessive flood period. All crops are successfully grown but mot attention is given to corn, clover and timothy. Wheat yields well when the winter and spring rains are most excessive. The grasses make very heavy yields. There are very few buildings located in the bottom, but are mostly on the edge of the uplands. Most of the farms consist partly of bottom and partly of uplands. A considerable number of cattle and hogs are raised.

Along the Patoka the soils are known as the "flats." In some places the area becomes of great width while in others, as in the western side of the county, the streams flow in a very narrow channel. The soils are whitish in color, and are cold, being saturated

with water in the winter and spring months and parched by drought in the summer.

Although portions of the soils have been under cultivation for many years, large areas still remain forested, the most common timber being elm, red maple, gum and water beech, but where the sand content is high, beech, sugar maple, oaks and tulip poplars are found. Within the past few years extensive areas have been reclaimed by drainage. Corn grows fairly well; some wheat is grown in the upper part of the valley in the northeast part of the county. In some places the bottoms are chiefly sloughs and bayous, grown up with cattails, water-lilies, willows and brush. The construction of the new line of the Southern Railroad has ponded large areas north of Jasper.

Drainage and cultivation to restore the organic matter to the soil would make these soils fairly productive. Drainage would be somewhat difficult, because of the low-lying condition of the soils. The Patoka is a very sluggish stream. The slight fall and meandering course produces much ponding in the wet season. The land can be bought at a low price and there is considerable salable timber on large tracts. It makes good pasture land when cleared, some cattle and sheep being raised. Cultivation is chiefly by old methods because of the wet soil and the newly cleared areas being practically covered with stumps.

PERRY COUNTY.

Perry County was organized in 1814 and named in honor of Commodore O. H. Perry. The county contains 383 square miles. The civil townships are Troy, Deer Creek, Anderson, Clark, Tobin, Union, Oil and Leopold. The population in 1830 was 3,378; in 1840, 4,655; in 1850 about 8,000 and at the present time about 18,800.

The principal towns are Cannelton, Tell City, Troy, Derby, Oriole, Dexter, Leopold, Rome and Rono.

Cannelton, the county seat, is located in the southern part of the county on the Ohio River. The town was laid out by the Cannel Coal Company about 1840. The principal part of the town lies above the ordinary high water mark, and extends back to the hill line. The town grew quite rapidly and the improvements were of a substantial nature.

The town has a population of 2,500. A branch of the St. Louis Division of the Southern Railway is extended to this part from Lincoln City; there are six passenger trains daily. The principal industries which give employment are the cotton mills, flouring mills, foundry and machine shops, pottery, bottling works, hub factory and lumber yards. About 400 people are employed, about half of whom are women, principally in the cotton mills. While the recent growth has been slow, the location offers inducements for many business enterprises.

Tell City is located on the Ohio two miles north of Cannelton. It has a population of 4,200. The site was purchased in 1858 by the Swiss Colonization Society, a colony of generous men who were attracted to the locality on account of coal, for cheap fuel, and the forests of good salable timber found in the region. Good improvements were made from the first and many manufacturing establishments have been established. Some of them are: four furniture factories, washing machine, hub, spoke, heading, hame, canning and chair factories; flour, woolen and planing mills, foundry and machine works, brick plant, two distilleries and a brewery. There are various establishments, giving employment to about 1,000 persons, about 100 of whom are women. The pay roll amounts to about $9,000 a week. The city is supplied with good electric light and water plants with about nine miles of mains. Driven wells are source of supply. There is a good sewer system emptying into the Ohio River. School facilities are good.

About four miles down the Ohio River is located the town of Troy with a population of 1,850. The town was settled by a company of English capitalists for the purpose of building extensive potteries, supposing that the clay found with the coal of this region would make the ordinary white queensware, but after extensive preparations were made it was found that such ware could not be made of the clay and the pottery was finally abandoned. Subsequent potteries have done a fair business by making "yellow" or "Troy" ware. The present industries include timber yards and planing mills, tobacco and chair factories.

Rome is located in Tobin Township, on the eastern side, with a population of 250, having decreased rapidly since the removal of the county seat to Cannelton.

The location of the county seat has been changed twice since the organization of the county. It was first located at Troy, and was afterwards removed to Rome and finally to Cannelton, where it no doubt will remain.

Rono and Derby are other small towns on the Ohio below Rome. Oriole, Dexter, Leopold and Siberia are other small country villages.

Perry County was somewhat backward in its early development, but since the extension of the Southern Railway to the towns along the river rapid progress has been made. The Ohio also affords the means of transportation and the L. & St. L. Railroad skirts the river on the Kentucky side, affording direct connection with Louisville. With the exception of the Ohio valley, the greater portion of Perry County is very broken and rather uninviting for agricultural purposes. The rural communities were tilled principally by an industrious class of Germans and French, who, by careful tillage, obtained fair productions of the various crops. Some large orchards were planted early and produced well, and the trees have shown that the soil is of such nature that a long period of fruitfulness may be maintained. Grapes were also grown somewhat extensively and yield well on the slopes.

In the valley of Tobin Township considerable truck farming was carried on at so early a period as the settlement of the county. Statistics show that in 1875 so high as 250 bushels of potatoes were grown to the acre near Rome. A large acreage of cabbage was also grown, and the crop sent to the market by way of the Ohio. Tobacco culture also received some attention both in the bottoms and uplands, but the production of this crop afterwards declined.

The farm area of the county is about 217,316 acres, of which

108,359 acres are improved. Some workable coals of value also occur.

The county now produces about 460,000 bushels of corn, an average of about 25 bushels per acre; 260,000 bushels of wheat, an average of 10 bushels per acre; oats about 20,000 bushels, averaging less than 10 bushels per acre. About 4,000 acres of timothy are grown, yielding about one and a half tons per acre; alfalfa is receiving some attention and 157 tons were grown in 1908. From three to four thousand acres of clover are grown, yielding about one and a half tons per acre, and producing about 1,000 bushels of seed. From 200 to 300 acres of potatoes are planted, with an average yield of about 50 bushels per acre; about 20 acres are devoted to tomatoes, yielding from 60 to 180 bushels per acre. About 300 acres of peas are grown annually, and ten acres of melons. There are in the county approximately 75,000 bearing fruit trees. The raising of live stock has not been a leading industry, but more attention is now being given to this, and especially in the valley farms some good breeds of stock are being produced. The farm lands and improvements are valued at more than $1,400,000. Land sells from $10 to $75 per acre.

There are in the county 800 miles of public road, and the county is well supplied with road material, both stone and gravel, but improvements have just begun. The earth roads are, however, well graded and drained and some excellent roads are found through the better parts of the county.

The extensive forests which formerly covered the county—only a small part of which now remains—consisted of walnut, oak, ash, poplar, wild cherry, sycamore, hickory, elm, hackberry, sassafras, persimmon and buckeye.

Physiography and Geology.

In general the surface of Perry County is very broken, and the hills rising from 250 to 400 feet above the valleys and bluffs of great height and with perpendicular sides are numerous. The only level country is found in the extreme bottom. In places, as in the Tobinsport bend of the Ohio River, the bottom is broad and becomes so extensive as to cover almost the entire bend, and affords some of the best farming land in the State.

The rocks of three geological formations form the surface rock—the Coal Measures, the Mansfield sandstone and the Huron formation. The rocks of the latter cover the eastern half of the county and outcrop in a number of places along the stream in the

western part. The Coal Measure and Mansfield comprise about equal areas in the western half.

The Ohio River forms the boundary of the county for a distance of about 50 miles. Anderson River forms the boundary of much of the western side; its main tributaries are Hurricane, Middle Fork and Brushy creeks. In the central eastern part of the county are Windy, Deer and Little creeks flowing to the south; Poison, Little Poison and Oil creeks flow in an eastern direction. Little Blue River just touches the northeastern corner.

Some of the most picturesque and rugged scenery within the State occurs in Perry County. Perpendicular rock walls, solution cavities, rock houses, deep wooded ravines and the beautiful Ohio and its dotted valley, viewed from the uplands, speaks for the scenery of the county.

SOILS.

The soils of the area are divided naturally into two general groups—upland and bottom land. The two classes are also chiefly divisions as to the origin. Four general types are found with various subtypes. Three of these owe their origin directly to the underlying formations—Huron, Mansfield and Coal Measures—and the fourth, the Alluvial, is of glacial, transported and local origin, thus producing a marked variation in different parts.

The following table shows the extent of each of the general types:

Huron	185 square miles
Mansfield	85 square miles
Coal measure	90 square miles
Alluvial	23 square miles

1. Huron.

The residual soils of the Huron formation are the most extensive of any type within the county, covering about half the area. The greater part of the area is very rough, but the flat tops of the ridges afford some good tillable land and the slopes are well adapted to grasses and fruits. In general, the soil is a sandy clay loam, grading from light yellow to dark brown color. In some places the soil becomes high in silt and contains very little sand, even of the fine grades. In texture the soil grades from the "yellow clay," as it is called, to that of a more loamy texture. The yellow color disappears somewhat from alluvial surfaces and be-

comes a light gray. The deeper yellow color usually occurs on the slopes when the surface is frequently washed away.

The addition of organic matter causes a darker color, and the most fertile tracts are readily selected by the soil coloration. The subsoil usually contains more clay than the surface, except when the soil has been derived from the sandstone alone, in which case the subsoil contains a large percentage of sand and numerous fragments of broken sandstone. A mottled appearance is very common, due to the mixture of material of the various members of the Huron group; the brownish color is due to the presence of iron, and often at considerable depth the subsoil becomes a dark reddish yellow from the high iron content. In the areas of the limestone members, also, the soil becomes a stiff dark red. The many differences in depth of soil, texture and color are due chiefly to topographic conditions. Along the small streams where the soils are composed of wash from the uplands they contain a large amount of broken rock fragments and are designated as "rough, stony land," and in many places scarcely admit of cultivation. Aside from these stony areas some good, rich, loamy soils of small area occur along the streams.

There is a marked deficiency of organic matter in the virgin soils. Corn, wheat, oats, clover and timothy are the leading crops grown. Corn produces on the average from 25 to 40 bushels; wheat, 10 to 12 bushels; oats are short and yield but little; clover and timothy grow very well and yield about one and a half tons per acre.

Rotation of crops and green manuring are beginning to receive much attention. A large amount of commercial fertilizers is also used. Tobacco is grown to some extent and makes a good growth. Potatoes are also grown with good yields. Sugarcane is grown in very small patches and produces a good stalk growth. Some fruit is grown for home use, but present transportation facilities are not favorable for the development of the fruit growing industry.

The rougher parts of the area are better adapted to fruit growing and dairying than to general farming. There is a great deal of land once cultivated now abandoned and a dense growth of shrubbery finds a place. On the steep slopes cultivated soils wash badly, and such places can never be restored to their natural fertility. Great care should be manifested in the care of the virgin soils in order to prevent washing and depletion.

The following table shows the result of mechanical analysis of these soils:

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
17	Northeast corner county....	Surface.....	.3	1.5	1.0	2.5	3.5	91.2
		Subsoil.....	.5	.5	.9	1.5	2.5	94.0
18	Near Rome.....	Surface.....	.5	2.0	1.5	2.0	3.5	86.0
		Subsoil.....	2.0	2.5	1.5	2.5	1.5	90.0

2. MANSFIELD.

The soils of the Mansfield comprise an area of long, narrow, winding ridges and steep slopes, the largest area occurring near the central part of the northern edge of the county. The surface is quite rugged, the hills running from 150 to 300 feet above the surrounding country. High sandstone outcrops are numerous, and in many places the abrupt cliffs have broken up into "rock houses," adding to the picturesque scenery. Along Deer Creek and to the east the sandstone is full of quartz pebbles. At other places throughout the county the sandstone is uniform, massive, medium-grained, and of great thickness. In the central and western part this area is known as "German Ridge." It is occupied by a class of Germans who, having acquired the land at a very low cost, have been able by their energy and thrift to derive good returns from the land. From the general appearance of the topography the area is not inviting to the farmer, and it is true that the soils are not very productive.

The surface soil is chiefly a yellow sand and clay loam from one to two feet in depth. The subsoil is in places very tenacious. Most of the large timber has been removed, but there is an extensive second growth consisting chiefly of oaks. The natural drainage is fair, and little of the land suffers from being too wet, but corn when late is often injured by the dry weather. Corn averages about 25 bushels per acre. Large amounts of fertilizers are used, and it has been found that the fertilizer suited best for the area is not the best for the Huron area below. Some fruits are grown. There are no large farms, but the land cleared for cultivation is well cared for and the fertility maintained. The improvements are fair. Most of the farms are owned by the persons living upon them.

The region is well adapted to fruit growing; the rough parts of the area along the slopes and streams might be used for pasture with good profits. Very few stock are raised except for the farm use.

Tobacco field on Upper Huron soil, north of Millston Creek, Tobin Township, Perry County. "German Ridge" of the Mansfield soil shown in background.

Tobacco field on Huron soil, just above the river bottoms, Section 34, northeast of Tobinsport.

The fertilizer most commonly used contains from 2 to 4 per cent of potash and about 8 per cent phosphoric acid. About 150 pounds per acre are applied for the general crops. The use of commercial fertilizers is rapidly increasing. Very little attention has been given to crop rotation.

The following table shows the result of mechanical analysis:

MECHANICAL ANALYSIS OF MANSFIELD SOIL.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
15	Near Siberia	Surface	.0	.5	.0	.8	1.5	97.2
		Subsoil	.4	.5	.3	1.5	.5	96.8
16	Three miles northeast Troy	Surface	.5	1.5	.2	1.0	5.8	91.0
		Subsoil	2.2	1.6	.5	2.0	2.5	91—

3. Coal Measures.

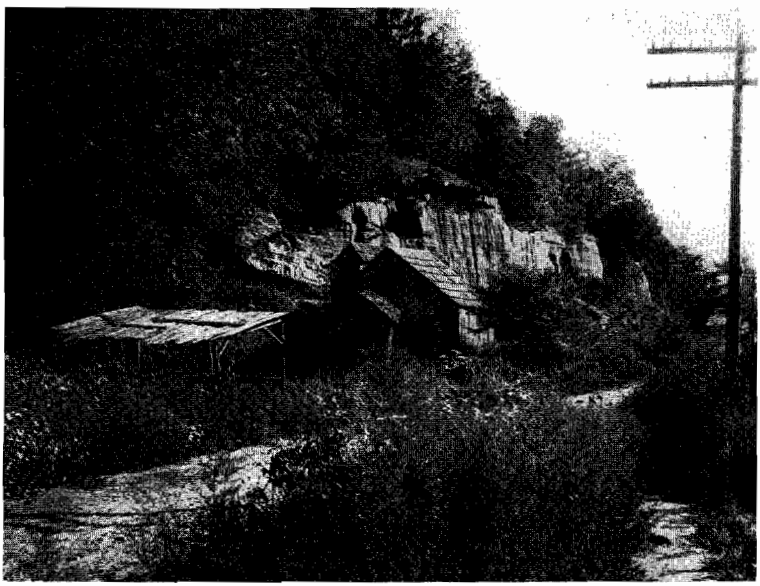
In Perry County the principal part of the Coal Measure formation consists of rather massive sandstone, with the bedded shales and limestone. A large part of the area consists of isolated patches and ridges of the higher elevation. In the region east of Troy and Tell City the soils become better developed and of much more even topography. Here considerable areas of fairly level land are found, but the descent to the lower formations and river valley is rather steep. Some workable coal veins are found, chiefly along the drainage levels and the coal is mined by drifting. The beds are thin and in many places have been exhausted; in other places the veins reach a thickness of five feet.

The surface soil is a sandy clay loam and fairly productive. Iron ore concretions are numerous throughout the soil. Land can be bought at prices from $5 to $50 per acre. See description under Dubois County for further description, and crops production.

4. Alluvial Soil.

The alluvial soils of Perry County are confined almost exclusively to those of the Ohio; the smaller streams having but very limited areas of bottom land. The bottom soils of the Ohio are also of small area considering the distance for which the river forms the boundary. Along the eastern side of the county the high bluffs come down almost to the present channel of the river, with the exception of two or three slight bends in which some bottom is

Weathering in the perpendicular, exposed faces of the Mansfield sandstone along the Ohio, east of Cannelton.



Showing massive structure, and weathering in Mansfield sandstone, east of above view.

formed. The chief areas occur in the Tobinsport and Cannelton bends.

The alluvial soils consist of three chief divisions, which are best and most extensively developed along the western and south side of the Tobinsport area. The area known as the river flats is most extensive and occurs along the entire border of the county, varying in width from a few rods to a mile or more. These soils are flooded annually. The soil consists of a light brown sandy clay loam. The percentage of clay and silt is large, with usually a high percentage of fine sand. With depth the soil becomes more tenacious, grading into a stiff mottled claying subsoil, containing inert concretion of iron, lime, etc., which have been leached from the surface soil by stagnant waters. The area is comparatively level with the exception of small swampy area with the ridges intervening and in some places a low terrace is found very near the present channel of the stream; the soil has become very sandy. In most places the drainage is very good and soils are of good agricultural value. The upper layer of the surface soil is continually being renewed by the overflow of the Ohio. This frequent addition to the soil maintains the production, and excellent crops are grown, except in seasons of excessive rainfall. The area is planted almost exclusively in corn, averaging about 40 bushels per acre; and in better drained areas from 60 to 75 bushels are produced.

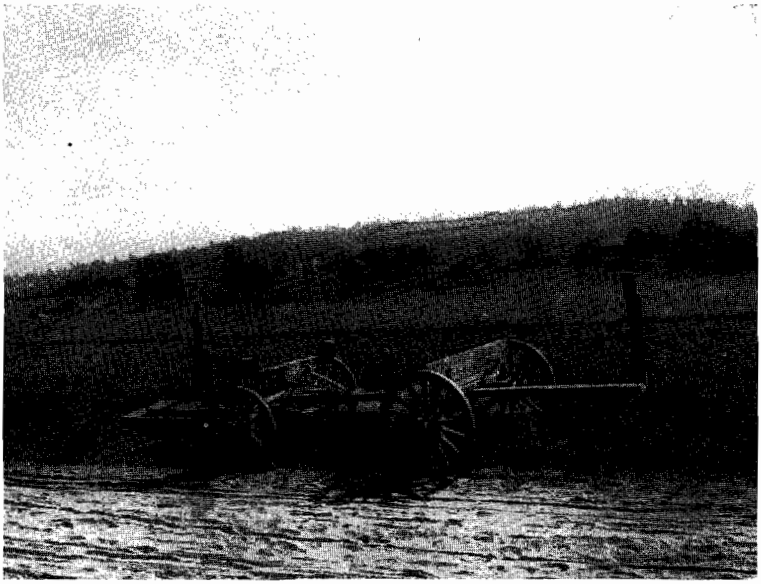
Wheat when not reached by flood waters yields from 10 to 15 bushels per acre. The soil is mostly too wet for oats, but they are grown in a limited way. Grasses grow well and give heavy yields, but are often coarse. In wet seasons meadows and pastures are badly grown over with swamp grasses, whitetop and ragweed. Some tobacco is grown.

The following table shows the result of mechanical analysis of these soils:

MECHANICAL ANALYSIS OF SANDY CLAY LOAM OF RIVER FLATS.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
13	Tobinsport	Surface	.3	1.5	1.0	1.5	8.0	87.6
13a	Tobinsport	Subsoil	.5	1.0	1.5	2.0	34.0	91.0
14	East of Cannelton	Surface	.5	2.0	1.5	2.5	10.0	83.5
14a	East of Cannelton	Subsoil	1.5	1.5	2.5	2.0	6.0	87+

The second division of the alluvial soil is a fine sand loam, consisting chiefly of a narrow rounded top ridge extending along the



Five miles southeast of Cannelton. Well improved farms through the sandy loam areas. In the background the narrow ridge of Mansfield and Huron extending into the Tobinsport bend.

View in Ohio River bottoms, near mouth of Deer Creek. Narrow, unfenced roadway winding through large areas of growing corn.

river, in some places approaching very near the present river bed, but in the widest part of the valley extends back a mile or more from the river. No sharp line of demarcation can be made between this soil and the type above discussed. The summit of the ridge rises several feet above the bottom areas. Its elevation and the sandy texture gives good drainage. The slope next the river is more abrupt than that next the lowland on the opposite side.

The soil to a depth of 12 to 18 inches is a light brown, fine, sandy loam, and becomes heavier with depth. The size of the sand particles and the amount of clay found is varying, because of the assorting power of the water at time of deposition at various levels.

In average seasons the crop productions are good. Oats, corn, wheat, potatoes, melons, beans, cowpeas, clover and alfalfa.

The area while rather limited would be well adapted to truck farming and growing of small fruits.

The improvements throughout the area are excellent. Good farm houses, barns, roads well graded, and the live stock are kept in good condition.

The following table shows the result of mechanical analysis of this type:

MECHANICAL ANALYSIS OF FINE SANDY LOAM.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay
11	Four miles northwest of Tobinsport	Surface	.2	.5	.5	20.0	18.0	59+
12	Four miles northwest of Tobinsport	Subsoil	.3	.5	.8	18.0	10.5	70+

The third type of alluvial soils lies between the sand ridges and the uplands. It is a white clay, becoming very loamy in places. As the depth increases it becomes more tenacious, and is almost impervious to water, hence the drainage conditions are bad. During the floods the area is overflooded, and when the waters have gone down, the land becomes baked and cracked, so that when plowed it is very difficult to pulverize. The soil is derived chiefly from the upland wash, and the small amount of deposition which takes place from the river floods. The organic matter content is very low, and the soils show the leaching effect of ponded, stagnant waters. Many small concretions of various elements are found in the subsoil and the surface soil is greatly lacking in the necessary plant foods. Much "crawfishy" land occurs throughout the area.

View in the alluvial soils of the Ohio, in the Tobinsport bend. Taken from the top of the Huron formation shown in frontispiece.

Just west of the above view. The ridge is on the Kentucky side of the river.

The area is not very extensive, and the yield of the various crops cultivated on the soil depends to a great extent on the thoroughness of the drainage and the care taken in cultivation. Corn produces from 15 to 30 bushels, wheat from 8 to 12 bushels per acre. Some clover and timothy is grown, but good stands are difficult to obtain. The grass growth is coarse and fibrous. Redtop grows well. The larger part of the area is considered a poor soil for general farming conditions. Some areas are used for pasture in connection with the uplands. The uplands rise somewhat abruptly and with extensive stone outcrops.

The following table shows the result of mechanical analysis of this type:

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
9	Northwest of Tobinsport...	Surface.....	.2	1.5	.5	2.5	2.0	93.3
9a	Northwest of Tobinsport...	Subsoil.....	2.5	1.5	.3	1.4	1.5	92.8

The alluvial types above described are of much value among the soils of the county. They represent various stages in the work of the river and much accurate history in the development of the Ohio valley could be worked out from the study of the origin of these soils.

SUMMARY.

Perry County was chosen at an early date as the home of a very energetic and thrifty class of people, so that for a long time it has ranked as one of the important manufacturing counties.

Corn, wheat, oats, clover, timothy, tobacco and potatoes are the chief crops. Stock raising receives comparatively little attention. Since few animals are raised on the farms, most of the produce is sold from the land. The upland soils are very deficient in organic matter, and the same is true in a large part of the alluvial soils. Some of the alluvial soils which carry a high percentage of humus are remarkably fertile.

The river valley is practically all under cultivation, but most of the residences and other buildings are on the higher sand ridges, or on the edge of the uplands.

At least 75 per cent. of the farmers own and cultivate their own land. Some farms are rented for cash at about $4 per acre, but the most of them are grain rent, the landowner receiving from one-third to one-half of the crop production.

The alluvial soils are planted chiefly in corn on account of the spring floods. The corn makes an enormous stalk growth, and yields fairly well. In 1908 the wet spring prohibited early planting and much bottom corn was caught by the early frost. Very few of the farms are fenced along the public highways. The farm improvements as a rule are very good. The farms average from 20 to 160 acres.

Tobacco is grown chiefly on the upland soils, about 200 acres being grown in 1908 and yielding about 170,000 pounds.

In the sandy bottoms many pastures are badly overrun with trumpet creepers, steelweed and ragweed. Wells are easily secured throughout the valley, at depths ranging from 10 to 35 feet. Some driven wells are as much as 75 feet in depth.

Alfalfa has been successfully grown on the various soils. Sorghum is also raised with profit. Large acreage of cowpeas is also grown in the bottoms. Timothy makes a heavy growth in some of the poorly drained areas of the lowlands.

Much profit could be derived from the cheap land in devoting them to special crops, such as tomatoes, pumpkins, sweet corn, etc., for canning factories; vegetable raising and fruit growing could be successfully carried on, should transportation facilities be increased.

A good cropping system such as is being developed in the bottoms would greatly enrich the uplands. As much as possible of the crops produced should be returned to the soil. The soil responds well to large applications of stable manure.

The commercial clubs of Troy, Tell City and Cannelton are endeavoring to have the new line of the E. & E. Traction Company, from Evansville to Rockport, extended on to Perry County towns. These men desire to see the road built and promise a rich, fruitful country greatly in need of traction facilities.

CRAWFORD COUNTY.

History of Settlement and Agricultural Development.

Crawford County was organized in 1818, and was named after the unfortunate Col. William Crawford, the land agent of General Washington in the West, who was taken prisoner by the Indians and burned at Sandusky in 1782. The county was formed from parts of Harrison, Orange and Perry Counties. The only town in the county was Mt. Sterling, and it was named as the county seat. In 1821 the seat of justice was moved to Leavenworth, on the Ohio river, where it remained until a few years ago, when the town of English was decided upon as a more suitable location for the county seat.

The county is very irregular in shape and contains 350 square miles. The county is divided into eight townships, viz.: Jennings, Patoka, Johnson, Union, Sterling, Liberty, Whiskey Run and Ohio. The latter now including the former township of Boone. The population in 1830 was 3,184; in 1840, 5,282; in 1850, about 6,200, and at the present time about 14,000.

The principal towns of the county are English, Marengo, Milltown, Eckerty, Wyandotte, Leavenworth, Alton, Riddle, Grantsburg, and Taswell. Several other little villages and country stores are scattered over the county.

English, the county seat, is situated in the north central part of the county on the St. Louis division of the Southern Railway, and has a population of 750. There are six passenger trains daily, and the general improvements are good. A stave factory is the principal manufacturing concern. The town offers a number of inducements to various enterprises. Limestone and timber are available, and the surrounding country has a fertile soil.

Marengo, with a population of about 800, is situated six miles east of English. It is a thriving town, and with the available supply of limestone near, there is opportunity for great development. A stone-crusher, lime-kiln and canning factory are the principal industries.

Milltown, with a population of 500, is about 2 miles east of Marengo. The stone industry has caused a rapid growth in recent years, and plans are being made for further development. The location is most favorable for growth.

Eckerty, a little village west of English, affords a trading place

for the vicinity. Its only industry is a mill for flour, meal and feed.

Alton, with a population of 350, is located on the Ohio River, 12 miles southwest of Leavenworth. Its only shipping facilities are by boat. A canning factory, wagon factory and lumber yards are the principal industries.

Leavenworth, located on the Ohio in the southeastern part of the county, has a population of 700. Its only transportation facilities are afforded by the Ohio River, the nearest railroad station being Marengo, 13 miles distant. The industries are lumber yards, flour and feed mills, pearl-button factory, machine-shop products and skiffs. Should better transportation facilities be found the location, the surrounding agricultural advantages and the stone suited for road metal and cement, all offer inducements for investment.

General Improvements.—There are in the county 229 miles of public roads, with less than ten miles improved. The first improved roads were built in 1892. The improvement is chiefly with crushed stone, and the original cost per mile has been about $1,700. The county contains an abundant supply of the best road material within the southern part of the State, and no doubt a large amount of improvement will be made in some section of the county in a few years.

The only railroad in the county is the St. Louis division of the Southern, which crosses the northern third of the county from east to west. The Ohio River, on the southern boundary, provides an outlet for the southeastern part of the county. A few rural routes lead out to parts of the county, and others are promised when improved road conditions are brought about.

Agricultural conditions have not reached the highest standard. The surface of the county in general is very broken. It is possible that the ruggedness of the county kept immigrants from seeking homes there at as early a date as in other places. Both the hillsides and valleys were heavily timbered with a great variety of trees, but of chief importance were the oaks and poplars. For the hardy pioneer there were many attractions, but the toil and privations he had to undergo before he could have a farm in readiness for cultivated crops were discouraging; yet he had few needs and these were supplied from nature. The forest and the streams were attractive, and the whole was a paradise for the hunter. The cleared land produced abundantly, but careful cultivation of the soil did not receive much attention at first. The virgin soil was naturally

very productive, and as it declined in value, new areas were cleared and made ready for growing crops. The careless methods of cultivation finally caused depletion of the soil. The fertility was lost, hillsides were badly washed, and now the present generation of farmers must exercise continual care to secure profitable yields.

The past few years have shown that the soils are adapted to a great diversity of crops, and considerable interest has been aroused as to the agricultural possibilities of the county. Very little experiment work has been done in these soils, and the State would be well repaid by giving some time here to soil conditions. The staple crops may be successfully grown, and the region is well adapted to the growing of fruit.

The county now produces, according to the latest statistics, about 480,000 bushels of corn, an average yield of 25 to 35 bushels to the acre; wheat, 200,000 bushels, averaging from 10 to 20 bushels per acre; oats, about 10,000 bushels, yielding from 18 to 30 bushels per acre; timothy and clover both do well, yielding from 10 to 20 bushels per acre; some clover seed is produced, but the yield is usually less than 1 bushel per acre; alfalfa grows fairly well, and about 200 acres are now sown; about 400 acres of potatoes are grown, yielding from 40 to 75 bushels per acre. Tomatoes and peas are now being raised for canning factories, and the yields are very satisfactory. Watermelons and cantaloupes usually have an acreage of 25 acres or more. A few acres are found in tobacco each year. There are about 40,000 bearing fruit trees. The hills are well adapted to the growing of fruit, and the county promises to be one of the great fruit-growing sections of the State.

Physiography and Geology.

In Crawford County four geological formations make up the surface rock. The Mitchell limestone is found in the eastern part. Its topography is described under the description of the corresponding soil. The principal formations of the county are the Huron and Mansfield; the latter being confined to the western third. The Coal Measures also occur on the higher elevations along the line of the Southern railway in the vicinity of Taswell and Eckerty, and becomes better developed to the southwest. The topography of the surface varies from level flood plains and flat-topped ridges, remnants of the old table-lands, to undulating areas with irregular depressions in the region of sinks, to high, steep, winding ridges, and narrow, deep valleys in the central and western

part. The greatest range in elevation is from 250 to 480 feet above the valleys of the Ohio and Blue Rivers.

The limestone outcrops of the eastern half, in the Mitchell and Huron, afford the best road material in southern Indiana. Quarries and crushing plants at Marengo and Milltown are making some good developments in the use of this limestone.

The natural drainage of the county is fairly well developed. The eastern part by Blue River and its tributaries, many of which are subterranean passages from the region of the Mitchell. Wyandotte, Marengo and many smaller caves with their numerous winding arms, and the large number of sinks on the surface show the underground system of drainage well developed.

"The sink holes vary much in size, sometimes being but a rod or two across, and again embracing several acres in extent. They are for the most part, inverted cones or funnel-shaped cavities, and where small, have the sides covered with a matted growth of vines and shrubs. Where larger, trees varying in size are often found growing from the scanty soil on the sides, or from the bottoms of the sinks. If one will examine closely the lowest part of the sink hole he will usually find a crevice or fissure through the limestone, or sometimes a large opening which, if it be possible to enter, will be found to lead to an underground cavity—a cave.

"Both sink holes and caves not only owe their origin, but usually their entire formation to the slow, unceasing action of rain or carbonated water upon the limestone strata in which they occur.

"The action of the rain water upon the limestone is usually hastened by humic acid, with which the former has combined in passing through decaying vegetable matter before reaching the limestone."*

Blue River is a meandering stream with a deep narrow valley. The alluvial soils occupy very small areas within the bends of the stream. The stream was formerly much used for water power. Little Blue River is similar to Blue River except that the valley is not so deep. It receives the surface water from the extreme northern edge of the county. The drainage area is much greater than would be expected from first sight of the stream. Practically all the drainage of the county, with exception of the two northwestern townships, which are drained by tributaries of the Patoka River, is brought through the mouth of these two streams into the Ohio. A very few short streams find their way

*W. S. Blatchley Report 1896, p. 121.

directly into the Ohio. The winding streams with the diversified character of the valley sides, through the different formations present some of the most picturesque scenery. Springs break out in a number of places and afford good water for domestic purposes. In a few places the water contains considerable mineral substances. A number of small lost streams occur in the eastern part.

SOILS.

There are in Crawford County five general types of soil, four of which have been derived directly from the geological formation. The fifth type, alluvial, comprises a rather small area considering the large mileage of river boundary and the materials of which it is composed, are for the most part not far removed from the point of original formation. Showing chiefly the same constituents as the residual types, intermingled to some extent with glacial material brought down from above. There are some local variations in the general types, but the prevailing characteristics are those found in all areas where the same geological formation occurs.

The following table shows the proportion of each general type:

Mitchell	40 square miles
Huron	190 square miles
Mansfield	52 square miles
Coal measure	12 square miles
Alluvial	10 square miles

1. Mitchell Area.

The residual soils of the Mitchell limestone cover about 40 square miles in the eastern part of the county. The topography of the surface is very broken. The underlying limestone with its peculiar characteristics weathering has produced, has a very uneven surface. There are no great variations in elevation over the area, the chief differences being from the general level of the tableland to the bottom of the sinks. The depth of the soil varies from one to several feet.

The surface soil is from 6 to 18 inches in depth and consists of clay loam, grading from a gray or yellow color to red. The difference in color is often very noticeable in the same field giving it a very mottled appearance when freshly plowed. The subsoil is a heavy clay loam varying from a brownish yellow to a dark red as the solid rock is approached, and it usually contains a large

Old mill on Blue River, Crawford County. The high ridge in the background shows the typical wall and narrow valley of Blue River.

View of the Ohio River and valley at Leavenworth, Crawford County.

amount of chert, in some places of sufficient quantity to be termed gravelly. The surface soil with cultivation becomes rather loose and is easily washed away on the slopes, so that in many places the surface has been entirely worn away and the stiff red clay exposed. This subsoil presents a higher fertility than would be judged from its appearance. The soils become more shallow and the amount of chert and other impurities increase as the drainage line of sinkholes is reached. The sides of the sinks are often covered with a matted growth of vines and shrubs, and trees often grow from the scanty soil of the sides or from the bottom. Places where the soils are worn out and washed and become practically covered with sassafras and blackberry briars are known as "the barrens" and cannot be made of much agricultural value.

The drainage is almost entirely by the underground passages and sinks. Generally the soils are well drained and crops sometimes suffer from drought. In other places the soil is of a very compact nature and some artificial drainage is necessary. There are many springs through the area, affording a domestic water supply. Sinkholes clogged either by natural or artificial means are plentiful and furnish water for stock; good wells are difficult to obtain. In few places where sinks of considerable size have been filled with water, and the inwash of soil from the surrounding fields has partially filled them, they present the appearance of marshes. Willow, cattails, water lilies and other water-loving plants grow in abundance in these borders and farther out in the washed lands is the typical growth of sassafras, sumac and briars. The soils in general are fairly productive, but great care is required in cultivation to keep them up to the standard. Large application of stable manure renders the soil very fertile, and this is due probably to two things: by adding a large amount of humus to the soil, and by rendering available larger amounts of the potash and phosphates contained in the cherty soils.

Corn yields on the average from 35 to 50 bushels per acre, and in places where the ground has been carefully fertilized the average has been 50 to 75 bushels. Wheat grows fairly well and yields from 10 to 15 bushels per acre. Clover and timothy are usually in excellent condition and yield an average of one and one-fourth bushels per acre. Some clover seed is also produced. Alfalfa and cowpeas are grown on limited areas; but the yields have been very satisfactory. Potatoes yield about 40 bushels per acre under ordinary conditions. The growing of tomatoes has proved successful and promises to become a leading occupation in this section of the county. All fruits are grown to a limited extent.

The soil produces good pasture, except that when long continued in one place the briars and sassafras spring up and soon produce a thick growth; more attention has been given recently to grazing and stock raising. Some dairying is engaged in, and sheep raising might be made a paying industry. The area is abundantly supplied with the best road material in the State. Some of the roads are now being improved. The stone industry in the area, for road metal, lime and cement offer great opportunities and the further development of these resources will have a marked effect upon the agricultural condition. While the selling price of land has not been much over $10 per acre, it is reported that land has more than doubled in value in the vicinity of Milltown since the opening of the quarries there, causing an increased demand for farms and farm products.

Near the Huron contact the soil contains considerable sand, derived from the sandstone members of this formation. The soil is not greatly affected by this sand except as the hill slopes are approached and the change becomes marked, and such soils will be classed with the typical Huron soil. The sand is slightly colored by iron oxide, and the surface soil over the area varies from gray to brownish yellow. The soil is well adapted to fruit. A considerable number of fruit trees are found here. Strawberries and other small fruits do well and small patches of watermelons and muskmelons show that the soil is well adapted to the growing of such crops. The yield of the areas is about the same as in the general type.

The following table shows the result of mechanical analysis of these soils:.

MECHANICAL ANALYSIS OF MITCHELL SOILS.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
10	East of Marengo	Surface	.5	1.5	1.5	.5	3.5	92.5
10a		Subsoil	2.0	1.5	1.0	.5	2.0	93.5
21	Milltown	Surface	1.0	.0	.4	1.5	.5	96.5
22a		Subsoil	1.8	2.5	.5	1.0	1.0	92.5
22b		Subsoil down to stone	6.4	3.5	.5	2.0	1.5	88.0
8	S. Milltown	Surface	.0	2.0	.5	1.0	4.0	92.6
8a		Subsoil	6.0	3.0	2.0	.5	6.5	82.0
7	Southeast Marengo	Surface	2.0	4.0	2.0	12.0	4.0	76—
7a		Subsoil	8.0	2.0	1.0	5.0	3.5	80.5

The chemical analysis of a sample of Mitchell Limestone from Milltown shows the following composition:

Alumina (AL_2O_3)	.11
Iron oxide (FE_2O_3)	.24
Lime (CaO)	52.10
Magnesium (MgO)	2.48
Insoluble (HCl)	1.82
Loss on ignition	43.45
	100.20

For composition the following analysis is given of a sample of Mitchell limestone taken in Monroe County:

Alumina and iron oxide (AL_2O_3-Fe_2O_3)	.50
Lime (CaO)	55.00
Magnesium (MgO)	Trace
Phosphoric acid (P_2O_5)	Trace
Insoluble (HCl)	1.84
Loss on ignition	42.69
	99.93

The chemical analysis of soil taken near Milltown shows the following composition:

CHEMICAL ANALYSIS OF SURFACE MITCHELL LIME STONE SOIL.

Laboratory No	21
Reaction to Litmus	acid
Moisture at 105°C	2.00
Total soil nitrogen	.119

ANALYSIS OF FINE EARTH DRIED AT 105°C.

Volatile and organic matter	4.081
Insoluble in (1.115 sp. gr.) HCl	87.404
Soluble silica	.013
Ferric oxide (FE_2O_3)	3.265
Alumina (AL_2O_3)	4.379
Phosphoric acid anhydride (P_2O_5)	.116
Calcium oxide (CaO)	.217
Magnesium oxide (MgO)	.481
Sulphuric acid anhydride (SO_3)	.035
Potassium oxide (K_2O)	.210
Sodium oxide (Na_2O)	.304
Total	100.505

CHEMICAL ANALYSIS OF SUB. MITCHELL LIME STONE SOIL.

Laboratory No	22
Reaction to Litmus	acid
Moisture at 105°C	3.35
Total soil nitrogen	.140

ANALYSIS OF FINE EARTH DRIED AT 105°C.

Volatile and organic matter	5.221
Insoluble in HCl (1.115 sp. gr.)	80.535
Soluble silica	.085
Ferric oxide (FE_2O_3)	4.666
Alumina (AL_2O_3)	7.578
Phosphoric acid anhydride (P_2O_5)	.128
Calcium oxide (CaO)	.938
Magnesium oxide (MgO)	.636
Sulphuric acid anhydride (SO_3)	.068
Potassium oxide (K_2O)	.325
Sodium oxide (Na_2O)	.326
Total	100.506

2. Huron.

The soils derived from the Huron formation cover more than half the county. The area is noted for its extreme ruggedness. The formation is composed of a series of limestone, sandstone and conglomerate, and weathers into very steep slopes, hence this portion of the county has a much rougher topography than the limestone area to the east. The formation is generally capped with a layer of hard sandstone; the resistance of this layer to the process of weathering has caused the rough topography. The round topped hills and flat-topped ridges rise more than a hundred feet above the general level of the county, and from 250 to 400 feet above the level of the Ohio River.

The following sections of about 50 feet each will show the varied character of the Huron formation:

Upper Part of Section Exposed North of Leavenworth.

Massive soft sandstone	4 ft.
Covered with sandstone debris	6 ft.
Gray clay, with some sand	1 ft.
Covered	2 ft.
Shaly sandstone	1 ft.
Sandy clay shale	6 ft.
Blue clay shale	5 ft.
Green sand shale with iron ore concretions	6 ft.
Blue clay shale	6 ft.
Sand shale	0 ft. 6 in.
Coarse, irony cross-bedded sandstone	3 ft. 6 in.
Blue clay shale	5 ft.
Limestone	8 ft.

Followed 60 feet below by shales, iron ore concretions, limestone, down to Mitchell limestone.

Part of Section Near Fredonia.

Massive sandstone	9 ft.
Covered	8 ft.
Gray limestone	20 ft.
Massive sandstone	8 ft.
Shaly sandstone	10 ft.
Blue clay shale	3 ft.
Sandstone	7 ft.
Blue clay shale	1 ft.
Limestone	8 ft.

Continuing with similar series down to Mitchell limestone.

From the above it will readily be seen that the soils of the Huron will present a great variety of types, but since they are so intermingled and each type covers only a small area of a given locality, the entire group is mapped together.

In general the soil grades from a brown to yellow sandy loam, underlain by a stiff white to yellow subsoil in the parts where the sandstone and shale predominate, while in the limestone residual the subsoil is of a dark brown to red color and is very tenacious. The darker brown and red color of the surface soil is due to a large amount of ferruginous sandstone and does not indicate a fertile soil. The light-colored soils are as a rule the more productive. In the region of predominating shales the subsoil grades at a depth of 8 to 10 feet into a mucky shale, which has a very sour taste. Many iron ore concretions are found in the subsoil.

The following table shows the mechanical analysis of these soils:

MECHANICAL ANALYSIS OF HURON RESIDUAL SOIL.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
5	Southwest Marengo.....	Surface.....	.0 2.	.5	.8 1.5	12.0	5.0	8.15 .....
5a	Southwest Marengo.....	Subsoil.....	.....	1.	.....	10.0	10.0	75+
4	Southeast English.....	Surface.....	.5	.4	1.0	10.0	14.0	74+
4a	Southeast English.....	Subsoil.....	5.0	.5	3.5	8.0	10.0	73+
3	Northwest Leavenworth....	Surface.....	1.0	1.5	.8	15.	2.5	79+
		Subsoil.....	3.0	1.5	1.0	8.0	10.0	76+
3a	.....	Subsoil						
3b	.....	Third to sixth foot down to rock ...	6.0	2.5	2.0	10.0	5.5	74+

3. Mansfield Sandstone.

The soils of the Mansfield sandstone area occupy the second largest area within the county. There is very little level land throughout the area. Rock outcrops are numerous, and much of the soil contains a large amount of broken sandstone, which makes successful cultivation very difficult. On the eastern and northern boundaries, where the streams have cut down into the Huron, the slopes are very steep and the valleys deep and narrow.

The surface soil is chiefly a yellow sandy loam, from 6 inches to 2 feet in depth. This is underlain by a subsoil of similar color, somewhat mottled with white, but the clay content is higher.

In some places where the soil has been derived from the shaly part of the formation the soils are very tenacious and the subsoil grades into a stiff white and yellow mottled clay. These more

clayey areas are usually wet, or in dry seasons become baked. In other areas the soils are very sandy and of a reddish color, but the color is due chiefly to the disintegration of the ferruginous parts of the sandstone, and as a rule are very unproductive except for wild grasses and shrubbery.

The Mansfield soils have usually been considered of little value for general farming purposes, but this value has been somewhat increased in the past few years. With the exception of the very limited areas along the streams, the best land is found on the higher elevations, consisting of rather broad flat-topped ridges. Much of the area has been planted in corn continually until it has caused a complete depletion of the soil, and in very many places large tracts once cultivated are now abandoned and grown over with briars, sumac, persimmon and sasssafras. Improvements could be brought about by a systematic cropping system, the growing of cowpeas, clover, etc., and returning as much as possible the plants to the soil in order to keep up the humus content.

The improvements throughout the area are of rather poor quality. Much of the large timber has been removed and a large acreage covered with second growth, consisting chiefly of oaks. The transportation facilities are poor, and the public roads are unimproved and are so rough as to preclude economic hauling.

Corn and timothy are the principal crops. Corn yields in fair seasons from 20 to 45 bushels, but the average is much less. Some wheat is grown on the higher levels, and the yield is very good; the straw is rather short, but the heads are well matured. The soils are well adapted to fruit growing, and a large number of trees are being planted yearly.

Farms in this area vary in price from $5 to $50 per acre. Natural drainage conditions are good.

The following table shows the results of mechanical analysis of the Mansfield soils:

MECHANICAL ANALYSIS OF MANSFIELD SANDSTONE RESIDUAL SOILS.

Number.	LOCATION.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
29	Near Eckerty	Sandy loam	.0	.5	.8	1.5	15.0	82—
29a	Near Eckerty	Subsoil	2.0	1.5	1.0	.5	10.0	85
30	Three miles northwest Eckerty	Sandy loam	4.0	1.5	.6	2.0	20.0	72—
30a	Three miles northwest Eckerty	Subsoil down to stone	18.0	1.5	.4	2.5	10.0	68

4. Coal Measure.

The soils of the Coal Measure occupy but a comparatively small area in this county. A large part of the area consists of isolated patches and tortuous ridges of the higher elevation, while in the southwestern part the area of several square miles becomes much more even and of greater agricultural value.

The surface soil is of a sandy clay loam of a fairly productive type. The soils in the larger areas are more easily cultivated than of the Mansfield, and as a rule the yield is greater. Wheat yields from 10 to 25 bushels, corn from 30 to 45 bushels per acre; oats, rye, timothy and clover yield well.

The improvements are of a fair type. Fruits are successfully grown, and might be made a paying business, since the entire area is sufficiently near the railroad to admit transportation from the towns of Taswell, Eckerty and Birdseye. Land sells for about the same prices as that in the Mansfield Very little timber now remains, but there is a large amount of second growth, principally oak, beech, walnut, ash, hickory, mulberry and persimmon.

The following tables show the results of mechanical analysis of Coal Measure soils:

MECHANICAL ANALYSIS OF COAL MEASURE RESIDUAL SOILS.

Number.	LOCALITY.	Description.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
27	Near Taswell.....	Surface.....	4.5	1.5	2.0	4.0	15.0	73.0
27a	Near Taswell.....	Subsoil.....	8.5	1.5	3.5	1.5	8.0	77.5
28	Southwest corner.....	Surface.....	2.0	1.0	2.0	2.5	18.0	74.5
28a	Southwest corner	Subsoil down to rock.....	*0.0	4.0	3.0	5.0	12.0	36.0

*Sandstone fragment.

5. Alluvial.

The Alluvial soils of the county are confined to the limited areas found in the meander curves of Blue River and Little Blue River, and to a few square miles along the Ohio. The soil along the first-named stream is a sandy clay loam grading from a yellow to dark color according to the amount of organic matter present. This is devoted chiefly to vegetable truck and gives very good yield. The Alluvial soil here occupies very small areas, but when some distance from the streams the valleys appear of great width because of the long, colluvial slopes leading down to the streams. These slopes afford some excellent farms in the Mitchell and Huron areas.

Along the Ohio the soil is also a sandy clay loam, of varying color, but chiefly rather dark. A narrow strip along the river suddenly drops off to a lower level. This is more sandy than that which extends farther back. This lower strip is also subject to frequent overflows while the second bottoms are overflowed only by the excessive river floods. A higher terrace also skirts the upland, but there is little difference in the soil except that as the uplands are approached the surface soil contains a larger percentage of clay derived from upland wash. The subsoil of these types is chiefly of glacial origin. The Alluvial soils as a rule are very fertile. Corn is grown extensively and makes an abundant stalk growth, and the yield is from 30 to 75 bushels per acre. Some clover and alfalfa are grown. Cowpeas are also grown in the more elevated part. Some wheat is also grown and yields well when the winter and spring rains are not excessive. Small patches of tobacco are also grown in the second bottom. The drainage conditions are good. The improvements are very good, and a marked degree of thrift is manifest in the agricultural development and in the towns of Leavenworth and Alton, which provide the market and supplies for this area.

Most of the farms are composed partly of upland and partly of bottom land. Considerable fruit has been planted in the south and east slopes leading down to the valley. Where the valley is most narrow the hills rise with precipitous rock exposures to a height of 100 feet, and in many places before the summit of the ridges has been reached the hills have attained a height of 300 or 400 feet. The Alluvial types are practically without timber.

The following table shows the results of mechanical analysis of the Alluvial soils:

MECHANICAL ANALYSIS OHIO VALLEY SANDY CLAY LOAM.

Number.	LOCATION.	Description.	Gravel.	Coarse Sand.	Medium Fine Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
1	Ohio Valley	Surface	.1	.5	1.0	8.0	20.0	69.4
2	Ohio Valley	Surface	.2	1.5	1.5	6.0	15.0	74.8

SUMMARY.

Crawford County has been in a backward condition in its agricultural development, and the farming population has been hampered for lack of proper facilities and improvements to meet its needs. More railroads and improved public roads will add much

to the prosperity of the county. Soil conditions should be carefully studied and a series of investigations made as to their needs. Part of the county is in a prosperous condition, and improved methods of farming are finding a place.

The red patches which occur in cultivated fields of the Mitchell area are principally on the higher elevations, and are due to the surface soil being carried to lower levels and leaving the unbleached soil exposed.

The yellow soils are of a more loamy texture on account of the mechanical action of the roots of plants, and owe their lighter color also to the bleaching action of the plant roots. In places the soils become of a darker color, due to a greater amount of organic matter.

When in a good state of tilth the surface soil is very fine, and contains much flour-like material and also a large amount of fine grit derived from impurities in the limestone and from the sandstone formations which formerly extended over the area.

No analyses have yet been made of the material in the chert beds, but they may in the future prove of some value as rock fertilizers. It has been found that by plowing deep enough to turn up some of the cherty layer and red clay that the fertility of the soil is increased.

The soils are in need of available potash, phosphoric acid and lime. It has been noted in former areas surveyed that when a fire has burned the briars over a given area, the amount of potash made available in the ash causes a very thrifty growth of the new briar.

Large applications of fertilizers are essential in the Mitchell area for hurrying the crops to maturity, because with the drainage conditions produced by the underground system the soils become dry and the crops are likely to suffer from drought in the late summer.

Some experimental work is being carried on to determine the fertilizer requirements of the soils in parts of the Mitchell area of the State, and a marked development of the soils will be brought about in a few years.

All classes of the ordinary fruits are raised on the farms, but no especial attention has been given to fruit-growing.

Each year Indiana pays other States over a million dollars for apples, and large sums for other fruits. Such apples as can be raised on this section of southern Indiana are worth from $1 to $3 per box, and from 100 to 200 boxes can be grown to the acre.

The soils of the Huron are easily tilled, but must be handled

with care to prevent washing and depletion by continual cropping. The slopes and lowlands comprise good grazing lands and fruit-growing areas, while the best corn, wheat and clover are grown on the tops of the ridges.

The creeping of the surface soil from the tops of the ridges down the hillsides is due to a stiff layer of subsoil, which holds the water at the surface, and with the continual freezing and thawing the soil moves to lower levels. This inpermeable layer accounts for the wet soils often found on the higher elevation.

In the Mansfield soils a great deal of commercial fertilizer must be used to produce good crops. Those who have used the commercial fertilizer claim that the soils are, however, soon exhausted. The chief cause for the wearing out of the soils is the fact that all crops are removed from the field, this entirely doing away with the supply of humus.

A steam railway or interurban line from New Albany to Leavenworth would open up a large tract of country well adapted to fruit-raising, truck-farming and dairying.

Considerable wealth may be added to the county by the proper development of its natural resources, including the scenery, caves, rivers, stone, clay, shale and soils. Most of the towns are ready to offer sites and a bonus to industrial enterprises.

There are at present but two canning factories in the county. It has been proved that the soils are well adapted to the growing of tomatoes, peas, sweet corn, etc., and affords excellent advantages for the canning factories.

Much profit could be derived from the cheap lands by devoting them to special crops in the way of truck-farming and growing of small fruits for the market at distant points, as Louisville, Evansville and St. Louis.

Only a limited number of livestock is raised, but the opportunity in this line is good because of the advantages for grazing.

The marked improvements which have taken place during the past ten years in a few places give an encouraging outlook for greater development. Many farmers from the northern and central part of the State are being attracted here by the low-priced lands.

TABLE SHOWING THE RESULTS OF THE ANALYSES.

COLLECTOR, SOIL SAMPLE, DESCRIPTION.	Shannon Surface Mitchell Limestone Soil.	Shannon Sub-Mitchell Limestone Soil.	Shannon Surface Coal Measure.	Shannon Mansfield Sandstone Soil.	Shannon Brown Soil, Patoka Lake Plain.	Shannon White Soil, Patoka Lake Plain.	Lyons Marsh, Sandy Loam.
LABORATORY NUMBER	21.	22.	23.	24.	25.	26.	30.
Reaction to Litmus	Acid.	Acid.	Acid.	Acid.	Acid.	Acid.	Acid.
Moisture from air dry at 105° C	2.00	3.35	1.39	1.77	1.51	1.33	5.68
Total soil nitrogen	.119	.140	.096	.089	.103	.089	.174
ANALYSES OF FINE EARTH DRIED AT 105° C.							
Volatile and organic	4.081	5.221	3.366	3.563	3.451	2.819	8.311
Insoluble in 1.115 HCL	87.404	83.535	90.048	88.011	89.299	91.961	79.335
Soluble silica	.013	.085	.043	.033	.013	.083	.056
Ferric oxide (FE_2O_3)	3.265	4.666	2.490	4.072	2.691	1.415	3.256
Alumina (AL_2O_3)	4.379	7.578	2.877	2.859	3.111	2.447	6.094
Phosphoric acid anhydride (P_2O_5)	.116	.128	.120	.146	.178	.093	.183
Calcium oxide (CaO)	.217	.938	.418	.573	.358	.508	1.453
Magnesium oxide (MgO)	.481	.636	.576	.517	.525	.440	1.049
Sulphuric acid anhydride (SO_3)	.035	.068	.035	.055	.045	.052	.061
Potassium oxide (K_2O)	.210	.325	.219	.327	.331	.213	.300
Sodium oxide (Na_2O)	.304	.326	.311	.340	.409	.305	.327
Total	100.505	100.506	100.503	100.496	100.411	100.336	100.425

NOTE.—These soil analyses were made by Dr. R. E. Lyons, of Indiana University, the same methods being used as in former analyses and described in the 32d Annual Report, Department of Geology, pages 47-55. No. 30 shows the analysis of a marsh sandy loam from west of Bloomfield, Greene County.

PLANT FOODS IN THE SOILS, AND FERTILIZER REQUIREMENTS.

The great mass of soils have been produced by the weathering and disintegration of rock powder under atmospheric influence, and it is generally found in the place where formed. Any weathering rock surface shows us the process of soil making, and the mosses and lichens that grow on the rock surface aid in deepening and enriching the soil. In some places the residual soils are thick and in others they are thin. In the regions of gentle slopes the soils have considerable depth; on the steeper slopes the soil is thin, and on the steepest slopes the rocks are bare and we have a region of waste in which but little vegetation can find a foothold. So the valuable soil must have depth, and must contain more or less organic matter. Residual soils, being derived from formations consisting of one or few ingredients, are readily lacking in some of the plant foods.

In the area under consideration the various limestones, sandstones and shales with their resulting soils are of special interest and importance, both from a geological and an agricultural standpoint, and many questions arise as to the origin, composition, requirements, adaptability and general value. The soil types in the residual soils are varied and numerous. The limestone soils grade from a light or a reddish yellow to a dark red; ferruginous sandstone and shales produce a variety of colors in their soils; the purer sandstone and shale break down into yellow soils. In passing from east to west over the residual soils the topography is varied on account of the succession of hard and soft strata, with their different rates of disintegration. The shale weathers faster than the limestone, and the limestone more rapidly than the massive sandstones.

Some of the things to be considered in regard to the proper cultivation and fertilizer needs of these soils are:

1. Topographic position.
2. Drainage condition.
3. The use of different fertilizers and leguminous crops.
4. The lasting effects of fertilizer.
5. A comparison of the various forms of the plant foods, nitrogen, phosphoric acid, potash and lime, and the amount to be used.
6. The value of commercial fertilizer as compared with stable manure.

7. Injurious effects of fertilizer on various crops.
8. Effect of fertilizer on the land.
9. Adaptability of the soils.
10. Systematic cropping system.

To carry out the above investigation a large number of soil analyses, both mechanical and chemical, are necessary, and extensive experimental work must be carried on. By mechanical analysis the soil particles are separated into different grades, and the various percentage relationship determines the class of soil, as sand, sandy loam, clay, etc.; and in addition to the fine earth the soil contains particles of larger size, it is called gravel, and of still larger called stones, so that it is possible to have gravelly or stony members of the various classes—as a gravelly loam or a stony clay.

The most important things to be considered in the determination of a type, are the texture, which deals with the size of the particles; the structure, which deals with the arrangement; the organic vegetation content, origin, color, depth, drainage, topography, nature vegetation and natural productiveness—all factors that influence the relation of soils to crops must be taken into consideration.

Accurate chemical analyses made by proper methods show much of value in determining the plant food requirements. The analysis may be made as to origin, in which case the total amounts of each element would be given; or as to food requirement, in which the available amount would be shown in most of the constituents. The objection to chemical analysis is that the total amounts of nitrogen, phosphorus, potash and other food materials may be ascertained, but that by far the greater part of the materials shown cannot be secured by the plants, and as the proportion varies greatly in different soils and for different crops, the determination of the total amount is of rather uncertain value as showing the fertilizer needs of a soil.

The experimental plan is to ascertain by the use of a number of fertilizers or the use of the individual plant foods, on the soil itself, the needs of each soil. Such tests must be carefully and systematically carried out if they are to be of any value. The purpose is to judge the effect of fertilizer from the actual increase from their use. The greatest care must be made in selecting the plots and the time of planting. The harvesting and determination of the yields must be carefully performed. Successful experimental

work, requiring care and intelligence, should be performed by intelligent men and not by careless workmen.

All farmers should know that what is commonly called "plant foods" comprise three ingredients: potash, phosphoric acid and nitrogen. Eighteen elements require some consideration in connection with either soil formation or plant growth. But the three substances named above, together with lime, are needed by all plants and crops for food. These are taken up by the roots of plants and are contained in the crop which is harvested and removed from the farm. Hence, by continued cropping, a soil becomes depleted of its plant foods, or "worn out" and unproductive.

For example, as shown in the work of Prof. Wagner of the experimental station of Darmstadt, Germany, clover cut for hay removes from the soil per acre about 184 pounds of potash, 152 pounds of phosphoric acid and 212 pounds of nitrogen. Other investigations show meadow hay to contain about 2 per cent potash, and that under ordinary circumstances in a good soil at least 260 tons of soil water would be required for the hay to give its supply of potash. Clover failure is very common, but the farmer rarely stops to think that exhaustion of the soil in potash and phosphoric acid may be the cause of it.

In addition to the mineral constituents already named, it must be kept in mind that certain other elements have important places, and occur in all plants, chiefly, carbon, hydrogen, oxygen, sulphur and iron. The two groups named occur in all plants, and if any one of them is absent, growth becomes abnormal if not impossible. Plants cannot assimilate their food unless it is in a liquid or gaseous form. Of the gases, carbon dioxide and hydrogen can be freely taken from the air or from water with various substances in solution, but most plants cannot take in nitrogen direct from the air but absorb it from nitrates in the soil, hence the importance of ammonia and other nitrogenous compounds in commercial fertilizer.

Different species and different varieties of plants absorb these substances in varying proportions, and upon this fact depends largely the principle of the rotation of crops.

Potash is necessary for the formation of starch, sugar and woody fiber in plants. Phosphoric acid is needed for the formation of seed, and nitrogen is necessary for the production of leaves and stalks. But when nitrogen is in excess it will cause a rapid and excessive,

watery and unnatural growth of the wood at the expense of fruitfulness.

The Value of Legumes.—The leguminous plants are those which bear on their roots little tubers formed by minute organisms called bacteria, which have the power of extracting nitrogen directly from the free air through the soil. Whenever these tubers bearing legumes are present the soil is found to be enriched with nitrogen in an available form. Such crops are clover, alfalfa, cow peas and soy beans. The ordinary crops do not have the power of taking nitrogen from the air. It has been shown that a 75-bushel crop of corn and stalks removes about 140 pounds of nitrogen from the soil. If the supply of nitrogen be profitably maintained in soils, some other method than commercial fertilizer must be used to secure the supply at an economic cost. By turning under legume crops, the non-leguminous crops, such as corn, wheat, timothy, secure their supply of nitrogen from the decay of the legume plant. The growing of such plants also enriches the soil in organic matter, thus improving the mechanical texture, making soils more retentive of moisture and consequently less subject to the effects of drouth. In order that leguminous plants may accumulate the nitrogen, it is necessary that potash and phosphoric acid be supplied if the soils be deficient in available form. Reference to the adequate amount of nitrogen will be given in a following paragraph.

"The only possible substitute for the use of stable manure is found in green manuring with leguminous crops conjointly with the use of commercial or mineral fertilizers, unless this is done by the use of the latter alone, which ultimately leads to a depletion of humus substances, which renders the acquisition of proper tilth by seed-beds impossible, and causes a compacting of the surface soil which no tillage can remedy."*

Sources of Fertilizers and Methods of Application.—All stable manure contains potash, phosphoric acid and nitrogen, but nearly always too much nitrogen in proportion to the amount of potash and phosphoric acid.

The principal sources of potash are the potash soils of Germany, and the most important of the potash salts are sulphate of potash, muriate of potash and kainit. The former two contain about 50 per cent pure potash, and kainit contains about 12½ per cent. The sulphate is best for tobacco, while muriate is somewhat cheaper and is useful for most crops. Kainit is useful also for killing grub

*Soils, E. W. Hilgard, p. 74.

worms and other insects in the soil. Wood ashes are also a source of potash.

Phosphoric acid is derived chiefly from the large deposits of phosphate rock in South Carolina, Florida and Tennessee. It is also secured from bone, acid phosphate, basic slag and other sources. Rock phosphate is insoluble and must be rendered available by chemical treatment. In chemical analysis the soils of southern Indiana usually show phosphoric acid content great enough to prove adequate, but the available amount is in most cases very low, and the proper supply of the material becomes an essential factor in the crop production.

The most important nitrogen fertilizers are nitrates of soda, sulphate of ammonia, cotton-seed meal and animal refuses, such as dried blood, dried fish, etc. For the permanent improvement of soils it should not be overlooked that time and organic matter are also important and are often deficient.

Fertilizer may be applied broadcast or drilled in. Broadcasting is best when intensive culture is practiced and large quantities are used. Where small quantities are applied it is better to drill, since in this way it comes in closer contact with the growing plants. Fertilizers will produce injury when coming in direct contact with seeds or roots of young plants. To prevent this the fertilizer may be drilled in a diluted state by mixing with a large amount of mellow soil.

Sometimes potash and phosphoric acid are applied in the fall, so that they will become thoroughly mixed with the soil before the seed is planted. Nitrogen is usually a very soluble compound, and will give best results if used at planting time or as a top dressing after planting. Several applications of nitrogen are beneficial, since any amount not readily taken up by the plant is likely to be carried away by the drainage waters.

Injurious Effects of Fertilizers.—It is claimed by many farmers that the use of commercial fertilizer has injured the land. Especially is this said to be true in the case of getting stands of clover on soil where fertilizers have been used. Others think that the purchase of fertilizers for any crop does not pay. In most cases, however, the true cause of poor yields is due to improper drainage condition of the land and careless methods in the use of fertilizers and care of the soil. Fertilizers alone will not produce good crops. Fertilizer crops should be grown and the products returned to the soil as much as possible to keep up the humus supply and improve the texture. Since the soil of southern In-

diana contains very little lime, the use of acid phosphates might cause acidity of the soil, but this could be readily overcome by the application of lime in any of the various forms. A top dressing of manure will often aid in securing a stand of clover. Where fertilizer tests have been made continually for a number of years the use of the fertilizer materials have not proved injurious to the soils.

Plant Food Contents Shown by Analysis of Southern Indiana Soils.—In the soils of Indiana derived from the limestone formations, while they have a marked degree of fertility, the lime content is low. In most cases these soils are "acid" or "sour." At first thought it would appear that soils produced from formations containing about 98 per cent lime carbonate would be strongly calcareous. But since this lime carbonate is highly soluble, the penetrating roots and heavy rainfall have leached these soils of the lime, and one of the things necessary for high productions is the application of lime on the surface. In the presence of high lime content relatively low percentages of phosphoric acid and potash prove adequate, while the same or even higher amounts, in the absence of satisfactory lime percentage, prove insufficient for good production. It has been found by observation and numerous analyses that the higher the clay content of a soil the more lime carbonate it must contain to have the value of a lime soil; and that while in sandy lands growth may follow the presence of only .10 per cent lime, in heavy clay soils not less than about .6 per cent should be present to bring about the same results. The dark-tinted humus characteristics of calcareous lands do not appear in clay soils until the lime percentages rise to nearly 1 per cent, while in sandy lands a much smaller amount, or about 2 per cent, will produce this effect. In heavy clay soils where the lime content falls below .5 per cent, lime vegetation is lacking and a growth of black jack and post oaks is found, which indicates soil too poor for profitable cultivation. While phosphoric acid, potash and nitrogen are the leading plant foods, lime is an important factor in soil fertility and exerts a wide influence upon plant distribution.

The analyses of limestone soils of Indiana show in the surface soil about .50 per cent calcium oxide, and .35 per cent potassium oxide and .15 per cent phosphoric acid anhyd. The first foot below the surface soil shows an average of about .55 per cent calcium oxide, .45 per cent potassium oxide and .18 per cent phosphoric acid anhyd. The third foot down to rock mass shows an average of about 1.5 per cent calcium oxide, .60 per cent potassium oxide

and .17 per cent phosphoric acid anhyd. We see from the above that the lime content is lower than that of true calcareous soil, the amounts of total phosphoric acid and potassium oxide are low and that the amount contained within these percentages of readily obtainable material would be very small, and these soils are likely to call for early fertilization.

The analysis of Indiana soils from the Huron, Mansfield and Coal Measure sandstones show in the surface from .41 to .58 per cent calcium oxide; from .20 to .35 per cent potassium oxide; from .12 to .15 per cent phosphoric acid anhyd, and total soil nitrogen from .089 to .096. Ferruginous sandstones derive no important ingredients from their cementing materials, which are chiefly iron hydrate, and since the sand itself is very siliceous the soils derived from the distintegration of these formations is very poor. Clayey sandstone, or where a series of thin-bedded sandstone and shale occur, the product of disintnegration is usually sandy loam with a fair degree of fertility.

The alluvial and lake plain soils show in the surface soil from .35 to .50 per cent of calcium oxide in Patoka Lake plain soil, to .85 per cent in those of the Ohio valley; potassium oxide varies in the former from .21 to .35 and in the latter to .49 per cent; phosphoric acid, .09 to .17 per cent in the former to .27+ per cent in the latter. The total soil nitrogen is about the same in each, showing from .08 to .10+ per cent. These soils show that they have formerly been subjected to the leaching power of stagnant waters.

Various shale soils show calcium oxide from .52 to 1.30 per cent; potassium, .41 to .85 per cent; phosporic acid about .15; total soil nitrogen about .15 per cent. The shales upon disintegration produce heavy, clayey soils, and are usually fairly rich in the various plant food, but usually the texture of the soil prevents successful tillage.

Iron colors clay, either red, yellow, green or blue; the latter two colors turning to red or yellow upon exposure to the air.

By careful investigation less than one-fourth of one per cent of potash is likely to constitute a deficiency. One-fourth of one per cent is usually high for phosphoric acid content. One-tenth of one per cent of P_2O_5 may prove adequate, but soils showing between .1 per cent and .05 per cent are weak and liable to need phosphate fertilization very early. In soils with a weak phosphoric acid content a high percentage of lime carbonate or the presence of a large supply of humus often produce good results by bringing about greater availability of the phosphates. In the absence of

lime carbonate, ferric hydrates may render phosphoric acid inert by the formation of insoluble ferric phosphate. The nitrogen content in soils is variable and the amount necessary for plant growth depends largely upon other soil conditions, as moisture, etc., and upon the nitrification of the organic matter of the soil. In determining the nitrogen content of soils a great many methods have been used; but all agree that about one-tenth of one per cent (.10) is the ordinary adequate amount. Since the amount of nitrogen in humus is very variable, such cannot be used as a basis of estimation. The total amount of nitrogen in the humus varies from 1.7 to nearly 22 per cent. In dry regions, however, it has been found that one per cent would indicate that the soil would not be in need of nitrogen-fertilization for a number of years. It has also been shown that for the growth of grain a nitrogen-percentage in the humus of 1.7 is wholly inadequate, although a large amount of humus be present. It is impossible to give the exact amount, for all plants and soils, of the nitrogen content necessary; but "it appears to be necessary to keep the nitrogen-percentage of soil-humus near 4 per cent to insure satisfactory production."

SUMMARY.

Southern Indiana soils show marked deficiency in plant food, having been derived from formations containing but few chemical ingredients. They are low in organic content and of such texture as to be difficult of cultivation in many cases.

Rock phosphate is a cheap source of phosphorus where immediate returns are not required. Such might be applied to the land and acid phosphate used for the immediate crops. Large quantities of phosphorus, and potassium and in many places lime will have to be applied to southern Indiana soils if their conditions are to be improved.

To use legumes profitably they must be supplied with potash and phosphoric acid, and the crop turned under as green manure, or used as forage and returned to the soil in the form of manure.

When the crops such as wheat, corn, oats, barley, and potatoes, are sold from the farm, they should be followed by leguminous crops. In corn, wheat and clover rotation, the clover should be plowed under for the corn crop, as it requires more nitrogen than wheat, and is also better adapted to using it in the form of organic matter.

It is usually better for farmers to buy ready-mixed fertilizers but they should also understand the needs of the soils and be sure they are paying out money for the proper ingredients.

Many of the sandy and loamy soils of southern Indiana are well adapted to the growing of potatoes, and this industry should be engaged in far more extensively. A good fertilizer to use on these soils for the growing of potatoes is as follows:

Ammonia	6 per cent.
Available phosphoric acid	7 per cent.
Potash	8 per cent.

The sulphate instead of muriate of potash is recommended.

The growing of tomatoes for canning factories is becoming of importance, and by the proper care and fertilization the crop can be made a most profitable one. Tomatoes should not be grown continuously on the same land, or on that which has been devoted to potatoes or melons, as all of these are subject to blight. Tomatoes respond well to heavy nitrogenous fertilization. About fifty pounds per acre of nitrate of soda should also be used around the plants during the cultivation of the crop.

The following fertilizer is recommended:

Ammonia	5 per cent.
Available phosphoric acid	6 per cent.
Potash	7 per cent.

Or as an equivalent:

Nitrate of soda	200 pounds
Cotton-seed meal	700 pounds
Acid phosphate	840 pounds
Muriate of potash	260 pounds
Total	2,000 pounds

Not less than one thousand pounds per acre of fertilizer should be used for the crop.

Careful cultivation of the soils in this section of the State did not receive much attention. The virgin soil is naturally productive, but by the continual cropping, especially of successful corn crops, the soils were soon depleted. Then the value of fertilizers and crop rotation began to receive attention. The farmer of today must experiment to see what his soil needs. The State would add much to its wealth by carrying on extensive experimental

work on these soils. The work of the present survey and additional information to be gained should prove beneficial to the farming population of that region, and will give to those in other parts of the State, who may be seeking new locations, some idea as to the agricultural conditions, general improvement and facilities of the counties herein discussed.

SOIL SURVEY OF DAVIESS COUNTY.

By L. C. Snider.

History.—Daviess County was settled by immigrants from Kentucky, who located in the hills along the East Fork of White River. The first white settler of whom there is any record came to the county about 1806. The growth of population was tolerably rapid, although retarded somewhat by Indian troubles. During the early years of the settlement previous to the War of 1812, five white settlers and one Indian were killed in the county.

Daviess was originally part of Knox County, but was organized as a separate county in 1816, and named in honor of Colonel Joseph Daviess, who fell at the Battle of Tippecanoe. It then contained all of Greene and Owen counties east of the West Fork of White River and all of Martin County north of Lick Creek. Gosport was at the northeast corner of the county. The formation of Greene County in 1821 and of Martin County in 1820 reduced the county to its present size. The county seat was located at Liverpool in 1817, and at the same time the name was changed to Washington.

Geography and Geology.

Location and Area.—Daviess County is located in the southwestern part of the State, about midway on the line from the center to the southwest corner. It is bounded on the north by Greene County, on the east by Martin County, on the south by Pike and Dubois counties, with the East Fork of White River between, and on the west by Knox County, with the West Fork of White River between. It averages about twenty-five miles in length from north to south and about fifteen miles in width. It has an area of 426 square miles.

Land Surveys.—Practically all of the land is laid off according to the U. S. system of land surveys, but in Washington Township there are several plots that date back to the old French surveys. These are called donations and locations.

In 1771 each head of a family in Vincennes was granted 400 acres of land by the French government. This grant was confirmed by the United States government when it acquired the territory and an additional grant of 100 acres was made to each man of the settlement who had served in the American army or militia.

These lands were surveyed back from the Wabash, one set of boundary lines running at right angles to the general course of the river and the other set at right angles to the first. The rectangles thus formed were called donations.

In laying off the donations previous grants were disregarded, but the owners of these grants were allowed to locate an equal tract of land in an area outside the donation land. These locations may be of any size or shape, but those in Daviess County are all rectangles, with the boundaries running north and south, and east and west. There is a strip of donation land along White River northwest of Washington and several locations, all within a few miles of the same city.

Townships.—There are ten civil townships as follows: North row, Elmore and Madison; second row, Steele, Bogard and Van Buren; third row, Washington and Barr; south row, Veale, Harrison and Reeve.

Drainage.—The county lies between the two forks of White River, and is drained by this river and its tributaries into the Wabash. The principal tributaries of the West Fork are Furst Creek, Indian Pond Creek, Smothers Creek, Prairie Creek, and Veale Creek. Those of the East Fork are Aikman's Creek, Camp Creek, Mud Creek, Sugar Creek, and Slate Creek.

Stratigraphy.—The entire county is underlaid by the rocks of the Coal Measures or Pennsylvania system, and is consequently an important coal producing county. Several layers of coal occur which vary from a few inches to five or six feet in thickness.* The remainder of the Coal Measure exposed consists of shales, sandstones and fire-clays of varying thicknesses. One heavy ledge of sandstone outcrops along the East Fork of White River forming "High Rock," but most of the layers are thin and soft, and do not stand out in relief.

Glacial Action.—The ice-sheet of the Illinois invasion covered the whole county. The surface was leveled to some extent, the hills smoothed down and the valleys filled up, in some instances to the depth of seventy or eighty feet. Many of the smaller streams run in their pre-glacial channels, but at a level of several feet higher than before the ice age. In almost every well and coal bore evidences of this ice invasion are found in the gravels, clays and sands, which are passed through before solid rock is reached. The major portion of this drift is a clay or till which contains many

* For complete report on the coal of Daviess County, see the Report of the Department of Geology and Natural Resources for 1898.

"High Rock," East Fork of White River.

Ferry Southwest of Washington.

pebbles, some of granite and foreign rocks, and other of chert and hard limestone of the Mississippian system to the northeast. In many places leaves, stems and even trunks of trees have been found beneath the blue clay which forms the lowest layer of the drift sheet.

The average depth of the drift is several feet, but over much of the area it is very thin, and in some places altogether absent, and the residual soil derived from the weathering of the bed rock comes near the surface. Spread over the surface of the drift and the residual soil is a layer of fine yellow silt and clay which is from a few inches to several feet in thickness. This is the "loess" or outwash from a later glacial invasion, the Iowan. It covers all the uplands of the county and is the dominant soil type. It will be discussed more fully under "loess" of the soil types.

Elevations and Topography.—The highest elevation is a little over 600 feet, in the northeast part of the county near Raglesville, and the lowest is 396 feet at the extreme southwestern corner. Washington is 484 feet above sea level, and this is about the level for a large part of the county.

The Mansfield Sandstone which outcrops in the northeastern townships gives this section a broken topography, with rather high hills and steep slopes. This portion includes most of Madison and Van Buren townships. The country to the south and west is much more level and there is much prairie land along Smothers and Prairie creeks in Elmore and Bogard townships. Washington and Barr townships are mostly level, becoming rolling in some portions, with a few tolerably high hills. The village of Montgomery is located on one of the highest of these hills. The townships along the East Fork (Veale, Harrison and Reeve) are rolling in the northern portions, but become broken and hilly as one approaches the river.

The West Fork has a valley of from one to three miles in width in the northern part of the county, but it becomes much narrower along the southern third, where in some places the river runs against the bluffs on the east side. The valley of the East Fork is about one mile wide through Veale Township, but farther up the river it is very narrow, seldom reaching a breadth of one-fourth mile.

Cities and Towns.—Washington, the county seat, is located at the intersection of the B. & O. S.-W. and the E. & I. railroads, about three miles back from the West Fork of White River. It was platted in 1817 and made a city in 1871. At present it has a

population of between 9,000 and 10,000. It is the trading center for most of Daviess County and a portion of eastern Knox County. The manufacturing industries include a seating company, two foundries, two grain elevators, a canning company, a sawmill, a planing mill, etc. The shops and roundhouses of the B. & O. S. W. Railroad are located here, and give employment to many men. Coal is obtained very cheaply from mines in the vicinity. Improved roads lead out from Washington in all directions.

Odon (923)* is situated in the southwest part of Madison Township, on the S. I. Railroad. It was platted in 1846, and has grown to be an important mining and trading center.

Elnora (908) is located at the intersection of the E. & I. and the S. I. railroads in Elmore Township. It was platted in 1885 and has enjoyed a very rapid growth. It is the center of the agricultural trade for the northwest part of the county, and has a large canning factory.

Plainville (400), on the S. I. Railroad, in Steele Township, is a great shipping point for watermelons.

Montgomery (600) and Cannelburg (280) are on the B. & O. S. W. Railroad in Barr Township. They are both mining and trading centers.

Alfordsville (254), Raglesville (132), Epsom (106), Glendale (98), Cornettsville (70), Cumback (60), Corning (25), and Waco (20) are small country villages.

Sandy Hook, Jacobs, Thomas, Jordan, Albright, Hyatt and Graham are merely stops with sidetracks along the E. & I. Railroad. They serve as loading points for much of the produce from the West Fork valley.

TYPES OF SOIL.

The soils of Daviess County may be divided into the following general types:

(a) River and stream bottom land.
(b) Prairie or low flat land.
(c) Sand knolls and ridges.
(d) Upland clays and loams.

Each type will be taken up and discussed somewhat fully and the variations noted as far as possible.

(a) *River Bottom Lands.*—These soils cover the low-lying flat lands along the East and West Forks of White River and narrow

* Population according to census of 1900.

belts along the principal streams. They are generally black sandy loams, although in some localities they are more nearly silt or clay loams. The sand is usually more plentiful in a belt following the stream, and in another along the foot of the sand hills. Between these two belts the soil is usually more clayey in texture. However, the percentage of sand may vary greatly within small areas.

The subsoil is ordinarily a stiff, tenacious, black clay, with much sand. This is often underlaid by gravel.

Mechanical analyses of samples of this type of soils show the following percentage composition:

MECHANICAL ANALYSES OF RIVER BOTTOM SOIL.

Number.	LOCATION.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
1	Valley of West Fork, five miles northwest of Washington	0.3	0.8	12.6	28.0	26.8	31.5
16	Subsoil of same	0.8	2.9	18.4	27.8	25.8	24.3
2	Prairie Creek Valley, North of Washington	0.0	0.2	0.8	17.0	50.6	31.4
2b	Subsoil of same	0.0	0.4	1.8	19.2	51.4	27.2
3	Valley of West Fork, two miles southwest of Plainville	0.0	0.0	1.6	40.0	38.8	20.0

The principal crop on the bottom lands is corn, which usually does very well, producing from sixty to eighty bushels per acre. Much wheat is raised and yields well unless injured by overflows. The present season was a very hard one on this type of soils. There was a general overflow in May, and since that time there has been practically no rain, so that the ground became extremely hard and difficult to tend.

As a rule there are few improvements on the bottom lands, and these are not first class. The people who farm these soils mostly live on the sand or clay uplands farther back from the river in order to avoid the floods and bad roads as much possible.

The soil in the lower parts of the valleys of the smaller streams is very much the same as in the river bottoms, except that it contains less coarse sand. Nearer the heads of the streams it grades into a white clay or "crawfish" land. This occurs only where the valleys are narrow and there is not a great amount of it. The largest areas are along Furst Creek and in the upper part of the Prairie Creek valley.

(b) *The Sand Areas.*—The principal sand area is a broad belt averaging about a mile in width which extends almost parallel to the West Fork of White River and lies between the bottom lands

and the clay soils. The width of the belt varies greatly. Near Elnora it is over three miles, while south of Veale Creek there is a place where the sand is absent, and the clay soil comes directly up to the river bottoms. There are many small knolls of sand occurring occasionally through the bottom land, most of which are too small to be mapped, although some of the larger ones cover several acres.

As shown by mechanical analysis this soil is almost a pure sand, over eighty per cent grading as fine sand and very fine sand. The sand is usually of a brown or reddish color on the knolls and ridges, while on the level places and in the small troughs or valleys it is black and contains a larger percentage of silt and loam. There is little difference between the surface soil and the subsoil, except that the surface is darker in color due to the presence of organic matter. The sand is of different thicknesses, often being several feet in depth along the side next to the river, but becoming very thin on the hills along the eastern side of the belt.

The sand is a very productive soil and is very easily tended. All crops do well except during excessively dry seasons, when they are liable to be more or less injured on account of the drying of the soil to a considerable depth. Corn and wheat are grown extensively and fine crops of hay are produced. The soil is unequaled for the growing of watermelons and there are usually between 800 and 1,000 acres planted to this crop.

As the soil contains a relatively small amount of fine material (silt and loam) it is easily exhausted and must be cropped judiciously to be kept in good condition. Nearly all the farmers practice crop rotation to accomplish this result. Clover is used extensively as a rest crop and for hay, but in the last few years cowpeas have replaced it to some extent on this soil. By many farmers they are considered preferable to the clover both for their effect on the land and for feed. Hundreds of acres are grown in the county, the greater part on this soil. Little commercial fertilizer is used and this is sown with wheat to insure a good stand of clover. As a rule the improvements on the sand are fair, much better than those in the bottoms.

There is one large sand area along the East Fork in the southeastern part of Veale Township. It seems to be similar in every way to the sand belt of the West Fork except that it is usually of a more pronounced red color. A few narrow strips of sand occur farther up the river, but they are too small to be mapped.

Another area which is mapped as sand, but which varies some-

what from the area just described, lies in the western part of Bogard Township, north and west of Cornettsville. This soil is almost a prairie soil, the flat, level portions are black in color, but the low, rounded knolls and ridges are covered with sand which is almost white. It is seldom over a few feet (two or three) in thickness, and is underlaid by the yellow clay. The black portions are also very sandy, being apparently the same as the white, but with a higher percentage of organic matter. It is a very productive soil except where the white sand is too thick. The sand is very fine and seems to have been carried by the wind from the large sand belt lying to the west, and spread as a thin mantle over the level land.

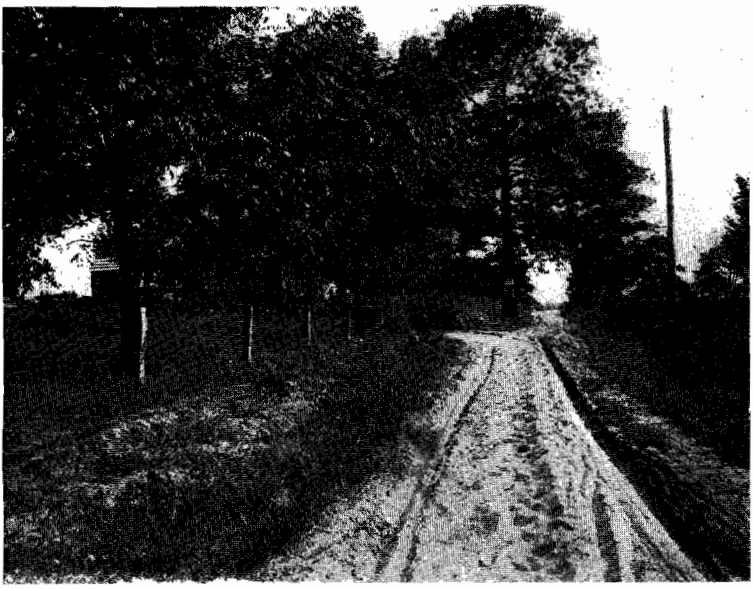
The origin of the sand of the large belt has not been worked out definitely, but it is probably due to wind action during and following the Wisconsin glacial epoch, while the wind was prevailingly from the northwest and before the land was extensively covered with vegetation. This seems to be borne out by the obscure stratification of the sand which may be noticed on steep faces of road cuts and similar localities.

Mechanical analyses of the sand show the following percentage composition:

Number.	LOCATION.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
4	N. W. Cor. Sec. 5, Washington Tp., southwest of Washington	.0	.0	.1	17.8	65.0	16.4
4b	Subsoil of same	.0	.0	.3	22.4	72.2	8.1
5	S. W. Cor. Sec. 31, Elmore Tp.	.0	.0	1.0	36.2	56.0	6.8

(c) *The Prairie Areas.*—"The Marsh." This is an area of ten or twelve square miles lying in southeastern Elmore Township and the north row of sections of Bogard Township. It is a level, low-lying tract of land, most of which was formerly covered with water during much of the year, but which has been drained by the dredging of Smothers Creek and by the digging of many tributary ditches. At present the crops are somewhat injured by wet seasons, but there is little or none of the area which is not tillable.

The soil is of a black color and of varying texture. The lowest portions are mucky with very little sand. There are many small sandy knolls scattered through the area, but the prevailing type is intermediate between the sand and the muck, a sandy black loam. Along the eastern side is a rather narrow belt of white clay. This



Road Through the Sand Land, 2½ Miles Northwest of Washington.

Showing Contact of Lighter Colored, Fine Textured Loess with the Coarser Underlying Drift, 3 Miles Southeast of Washington.

soil is very productive, corn yielding sixty to eighty bushels per acre, and wheat from twenty to thirty bushels. Clover and timothy meadow both produce very well. Wet seasons are the worst on this soil, but it can withstand long drouths.

"Alkali Land."—Throughout this marsh region are many spots varying in size from a few square feet to five or six acres, which are called "alkali land." These spots produce fair yields of wheat and other small grains, but will not produce corn. The corn usually comes up and starts well, but soon turns yellow and stops growing. It seldoms reaches over two feet in height and rarely bears even a "nubbin."

Although called alkali these spots are probably acid, due to the incomplete oxidation of the vegetable matter of the old marsh. They are also poorly drained as is shown by the fact that the soil in these spots is wet and "mushy" at the depth of a few inches, even in very dry seasons. The methods of improving this condition are to improve the drainage which may often be done by tiling, and by adding postash either by plowing under straw or by giving a dressing of kainit or some other potash fertilizer. These plans have been used very successfully in reclaiming similar soils in the northern parts of the State.

"The Lagoon."—This is an area of approximately one and one-half square miles, principally in section 23 in the south part of Steele Township. The soil seems similar in every way to that of the marsh.

(d) *The "Loess" or Upland Clay.*—This soil, which covers by far the greatest area of any of the soil types, is the outwash and wind blown deposit from the last or Wisconsin glaciation. The ice-sheet did not reach this far south, but the wind and the high waters caused by the melting of the glacier, spread this soil as a covering over the land for some distance in advance of the ice.

The soil is classed as a silt loam. It is of fine texture, containing no gravel and only a small percentage of sand. It has a yellow to brownish color where not exposed to the action of the atmosphere and of vegetation. Cultivated fields when dry are of an ash-gray color. Owing to its fine clayey texture the soil holds moisture well, and where it is sufficiently deep the crops are seldom injured by drouth. The depth of the soil varies greatly. On the hills in the northeast part and in the southern part of the county it is not over two or three feet in depth, and on the steeper slopes is often lacking. In the broad level belt which extends across Washington and Barr Townships it often reaches a much greater depth.

The "Loess" is well suited to the general crops and produces very good yields of them. Wheat on the level lands yields from twenty to thirty bushels per acre, corn from forty to seventy bushels, and hay does well. Clover is used extensively for hay and to keep the land in good condition. On the more hilly regions, where the loess is thinner the yields of the grains are much lower, wheat producing from ten to twenty bushels, and corn from twenty to forty bushels per acre. There is little done in the way of attempting to grow diversified crops.

In the eastern part of Barr Township, this soil lies very low, and has been leached out until it is a white instead of a yellow clay. It is not quite so productive as the yellow clay, and is more injured by wet weather, but is otherwise the same, and as the boundaries are not well defined no attempt was made to separate them in mapping.

Following are several mechanical analyses of the loess:

Number.	LOCATION.	Gravel.	Coarse Sand.	Medium Sand.	Fine Sand.	Very Fine Sand.	Silt and Clay.
6	Near R. R., one mile north of Sandy Hook	0.1	0.2	1.2	1.0	7.2	90.8
6b	Subsoil of same	0.3	0.2	2.8	9.8	20.0	66.4
7	North part of Sec. 20, Barr Tp., north of Cannelsburg	0.0	0.0	0.7	3.5	6.5	89.2
7b	Subsoil of same	0.0	0.0	0.8	3.4	12.6	82.4
8	South of Veale Creek in Sec. 16, Veale Tp	0.0	0.0	0.2	1.0	3.4	95.2
8b	Subsoil of same	0.0	0.0	0.8	2.0	4.2	93.0
9	Three miles north of Oden, Madison Tp	0.0	0.2	1.2	4.8	8.6	84.6
9b	Subsoil of same	0.0	0.2	0.8	5.0	7.4	85.8
10	Northeast Cor. Bogard Tp. (white clay)	0.2	0.4	0.8	1.2	10.0	87.4
11	East part of Barr Tp., southwest of Loogootee (white clay)	0.0	0.0	0.4	1.2	6.8	92.4

Drift and Residual Soils.—As has been said the drift and residual soils underlie the surface soils of the whole county, but are too deeply buried to affect agricultural conditions very much except in a few localities. In northeast Madison Township the loess is very thin, and the soil and conditions resemble those of the Mansfield residual area to the east. Along the East Fork of White River is another area of thin loess and on the slopes it is often removed and the drift exposed or this may be removed and the residual soil be at the surface. These areas are small and mostly uncultivated so they are not mapped separately. Although the drift and residual soils do not affect the grains and grasses very extensively there is no doubt that they are a prominent factor in determining the tree growth over much of the county.

Areas of Each Type.—The approximate area in square miles of each of the types described is as follows:

River and stream bottoms	90
Sand areas	50
Prairie areas	25
Loess or yellow clay	260

Names of Types.—The names selected for the different types in this report are those in common use by the residents of the county. No attempt has so far been made to bring the soils under the classification adopted by the Bureau of Soils of the U. S. Department of Agriculture. However, it may be well to bring the types under this classification for the purpose of comparison with other sections of the country. The following table is believed to give the relations between the common names and those of the Bureau of soils.

Name in This Report.		*Bureau of Soils Survey Name.*
Loess or yellow clay		Miami silt loam
River Bottom	Sandy	Yazoo sandy loam
	Silts	Yazoo clay and Yazoo loam
Sand areas		Miami sand
Prairie and Marsh Soils	Sandy	Waverley sandy loam
	Silts	Waverley silt loam
White clay (of small streams)		Memphis silt loam

Agricultural Statistics.—Daviess is a leading county in many agricultural products. The following statistics are for 1906, the latest complete reports available:

Corn, 52,836 acres, average yield 37.96 bushels; oats, 15,898 acres, average yield 24.54 bushels; wheat, 38,471 acres, average yield 15.57 bushels; timothy, 16,264 acres, average yield 1.16 tons; clover, 4,424 acres, average yield, 1.18 tons.

Of what may be called special crops the acreage was as follows: Potatoes, 328 acres; tomatoes, 59 acres; peas, 438 acres; watermelons, 648 acres; canteloupes, 52 acres; tobacco, 27 acres.

Live stock statistics were as follows: Horses sold in previous year 1,069, horses on hand 7,188; mules sold in previous year 689, mules on hand 1,289; dairy cattle on hand 6,176, beef cattle 3,606, cattle sold in previous year 4,076; hogs on hand 22,182, hogs sold in previous year 37,122, hogs died of disease 2,486; sheep on hand 4,364, sheep sold in previous year 2,695; wool clip, 27,046 pounds.

In 1906 Daviess ranked seventh of the counties of the State in

average yield of clover hay, seventh in acreage of peas, fifth in acreage of watermelons, and ninth in number of bearing apple trees.

ECONOMIC CONDITIONS.

Improvements.—The general conditions on the farms of Daviess County compare favorably with those in other parts of the State. On the level clay around Washington the houses and other buildings are far above the average, and the fencing and general appearance correspond. As has been said there are very few improvements on the bottom lands. Those on the sand land and the hilly clay are fair to good as a rule.

Land Values.—As nearly as could be ascertained the range of prices for land of the different types is as follows: Level, yellow clay, $90 to $100 per acre; bottom land, $70 to $90; sand land and level white clay, $50 to $80; hilly clay, $15 to $30; rolling clay, $30 to $50; "marsh" land, $90 to $110. The price naturally depends largely on distance from market, improvements, roads, etc.

Transportation.—Daviess County is tolerably well supplied with railroads. The Evansville & Indianapolis crosses it from north to south, following the line of the old Wabash and Erie Canal, parallel to the general direction of the West Fork of White River. The Baltimore & Ohio Southwestern crosses from east to west a short distance south of the middle, and the Southern Indiana crosses the northern part from northwest to southeast. The greatest distance from a railroad station is about fifteen miles, in the southeast corner of the county.

Although the county is practically without material for the construction of improved roads, much is shipped from other places and many of the roads are in good condition. Most of the improved roads are built of river gravel shipped from Vincennes on the Wabash River or from Elliston on the West Fork of White River. In the northern half of the county there are some limestone roads, the material being brought in over the Southern Indiana from the quarries near Bedford.

The expense of building these roads is very great, as the gravel costs from sixty to seventy cents on board cars at Washington and then must be hauled as high as ten or twelve miles. In many localities the cost would be considered prohibitive, but the people of the county seem to be impressed with the value of the improvement and are willing to pay the price.

All the roads leading from Washington are improved for sev-

eral miles into the country and many of the "feeders" are improved for some distance from the principal roads. Reeve Township is the only one with no improved roads.

Of the natural roadways little need be said. Those in the bottoms are little better than lanes between the fields. The sand roads are fairly good in wet weather. In dry season, however, the roadbed becomes a mass of loose sand several inches deep, which makes traveling tremendously laborious. The clay roads are very muddy when wet, very rough when frozen and very dusty in dry weather.

Water Supply.—In no section of Daviess County is there any great difficulty in obtaining a good supply of water. In the valleys, good veins are found at the level of the water in the streams and rivers. Where the drift is thick over the level and rolling portions good veins are usually found in some of the sand or gravel layers. In the sand areas the water usually lies a short distance below the bottom of the sand. The extremely hilly regions are not so fortunate, but even here water is often obtained in one of the loose textured sandstone layers of the coal measures at a moderate depth.

Fruit and Special Crops.—Fruit growing for market does not receive the attention it deserves. The soil is fitted for almost any kind of fruit and the transportation facilities for most of the county are fair. Apples and peaches do very well and the yield of both is far above the average for the State. Many of the peach trees are of selected varieties, but the majority are seedlings which produce only a fair quality of fruit.

Of what may be called special crops, watermelons are of greatest importance. All of these are grown on the sand land near the E. & I. Railroad. The cost and labor of raising them are considered to be about twice that of an equal acreage of corn. There are usually between 600 and 1,000 acres planted. Cowpeas are used in rotation with watermelons to keep the land in good condition.

There are cainning factories at Washington and Elnora and at Loogootee, just over the line in Martin County. These use the tomatoes from about 500 acres annually. The yellow clay is good for tomatoes, but they seem to do best on the white clay in the eastern part of Barr Township and in a belt around the eastern edge of the marsh. No effort is made to utilize any products other than tomatoes.

Use of Fertilizer.—While large quantieies of commercial fertilizer are used, it is not depended upon to nearly so great an extent as in the counties farther east. Practically none is used in

the bottoms or on the sand. On the clay it is often used to insure a good stand of clover. A few farmers use it with corn. When it is used there is little care taken in selecting a fertilizer of the proper composition to suit the soil or the crop for which it is intended. Great attention is paid to crop rotation and as a result most of the land is in fair producing condition.

Ditching.—Much of the valuable land of the prairie and marsh areas was formerly too wet to be of any value, but with the dredging of Smother's, Indian Pond and Prairie creeks the water level was made low enough to make these lands some of the most productive in the county. Several branches to these streams were also dredged. Two of these branches occupy the bed of the old canal, one draining into Smother's Creek and the other into Prairie Creek. The "sugar lands" were also improved by the construction of a branch to the Prairie Creek ditch.

The land lying along these big ditches is fairly well provided with smaller open and tile ditches. A good deal of the level clay is ditched, but much more could be greatly improved by tiling.

Renting.—By far the greater number of farms in the county are of moderate size, and are farmed by the owners. However, there are a few large land holders and, especially in the bottoms, the land is farmed by renters. The usual terms are for the renter to give two-fifths of the crop and haul it to market. A farmer's union has been formed in the south part of the county to have the owners share reduced to one-third.

Native Trees.—The common trees of the uplands are chestnut, white, post, yellow and Spanish oak, shagbark hickory, black walnut, yellow poplar, sassafras, wild cherry, sugar and black maples, black gum, persimmon, and white ash. Those of the lower lands are white walnut, shellbark hickory, willow, cottonwood, paper birch, beech, bur, red, pin, water, and swamp white oaks, slippery and white elm, sweet gum, sycamore, silver and white maple, and red and black ash.

General Summary.—Daviess easily ranks as one of the leading agricultural counties of the south part of the State. There are four general soil types, the river and stream bottoms, the sand, the marsh or prairie areas, and the upland clay. The predominance of the last type makes the production of the staple crops (corn, wheat, hay and live stock) the leading feature. The transportation facilities are fair. The most encouraging feature is the interest the farmers take in improving their condition and in the betterment of the soil.