

# Soil Survey of Starke County, Indiana.

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BY E. J. GRIMES, in Charge, and Wendell Barrett, of the Indiana Department of Geology, and T. M. Bushnell, of the U. S. Department of Agriculture.

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## DESCRIPTION OF THE AREA.

Starke County, Indiana, is in the northwestern part of the state; it is one county south of Michigan, and two counties east of Illinois. It is bounded on the north by Laporte and St. Joseph Counties, on the east by Marshall County, on the south by Pulaski County, and on the west by Jasper and Laporte Counties. The northwestern boundary follows the Kankakee River. Roughly, it has the outline of a right angle truncated triangle. Its eastern border is 18 miles, and its southern border 24 miles in length. The county has a total area of 314 square miles, or 200,960 acres, including about 2,000 acres of water surface.

The surface of the county is predominantly flat and smooth, and characteristic of an old lake plain. The only pronounced irregularities are the sand ridges of dune-like hills, which are of common occurrence, and a weak morainic belt in the southeastern part.

The ridges roughly form three irregular belts extending in a general north and south direction; in no place are these ridges continuous, but they are frequently broken by smooth areas. The most prominent ridges are 30 to 40 feet high. The majority are less than 10 feet high, and many are only slightly elevated above the surface of the plain. The average width of the ridge belts is 1 to 2 miles.

One belt occurs along the eastern boundary of the county, extending from Eagle Lake north to St. Joseph County. This section embraces some prominent isolated hills and a rather continuous rolling area about Koontz Lake. Another belt, consisting of a series of long, disconnected ridges, extends from Ora northwestward to Knox. It roughly parallels the outer border of the morainic belt to the east. The third belt lies east of North Judson and reaches from the Pulaski County line north to the

Kankakee marsh. The surface is gently rolling, consisting of a series of low, irregular swells, or ridges.

The morainic belt occurs in North Bend Township. Its most prominent feature is a high ridge east of Bass Lake. The plain to the east of this is dominantly level, varied occasionally by low mounds. In the southeastern corner of the county the gaps between the morainic undulations are filled with prominent sand ridges.

Throughout the remainder of the county, the monotonously level sand and muck areas are interrupted in only a few places by an isolated sand ridge or swell.

The drainage of the greater part of Starke County is into the Kankakee River. North Bend Township, however, and a small part of California Township are drained by the Tippecanoe River, which enters and leaves the county near the southeastern corner, forming a small loop.

The natural drainage was at one time through Yellow River, which flows through the center of the county, and Eagle Creek (Walker Ditch), Bogue River, and Pine Creek which flowed into the Kankakee. South of the Kankakee River for a distance of 20 miles there is not sufficient relief for the development of drainage ways, and the county at the time of its first settlement was a vast marsh. The drainage now is accomplished entirely by an extensive system of dredged ditches.

The average elevation of Starke County is about 700 feet above sea level. The Kankakee River has a fall of about 15 inches to the mile. A few years ago this stream would overflow its low banks and spread far out over the broad, level lands that bordered its channel, giving them the appearance of a vast morass. The river was dredged and straightened, and now flows freely through an artificial channel. The ditches generally have a fall about 6 to 12 inches per mile; farther back from the river there is sometimes a fall of 1 to 5 feet.

When the early missionaries, traders, and trappers came to this region, they found it in possession of the Pottawattomie Indians, a friendly tribe. By the treaty of 1832, these lands were ceded to the Government. The United States land survey was made in the years, 1833-1835. The first permanent settlement in the area now known as Starke County was made about 1840 near Ober, and was known as Osborn Settlement. The area was then a part of Marshall County. The adjoining counties were settled several years prior to the opening of Starke County.

The old Government land office was located at Winamac. The only bridge over the Kankakee River as late as 1850 was on the road leading from Walkerton to Laporte. There were only a few permanent settlers in the county as late as 1851. In the early fifties, however, a number of settlements were made, mainly north of Knox. The Monon Railroad was completed across the southwestern corner of the county in 1852, and the Nickel Plate and Pennsylvania Railroads were constructed in 1856. These railroads encouraged the settlement and development of the region.

Starke County was organized in 1852. When organized, it measured 18 miles square, but subsequently its boundaries were changed, the section northwest of the Kankakee River being annexed to Laporte County.

The population of the county has increased steadily. In 1860 it was reported as 2,195. The largest rain occurred in the decade 1890 to 1900. The early settlers were mainly from Ohio and southern and central Indiana, while the later settlers were mainly from Illinois and Iowa. In the 1910 census the population is given as 10,567. The entire population is reported as rural, only the population of towns of more than 2,500 inhabitants being classed by the census as urban. The population averages about 35 per square mile.

A large part of the farming population consists of Austrians, Scandinavians, Bohemians, Germans and Russians. The Austrians apparently pre-dominate.

Knox, the county seat, is located near the center of the county, on the Nickel Plate and the Chicago, Indiana & Southern Railroads. It has a population of about 1,800. It is 72 miles south-east of Chicago. The town has paved streets, electric lights and water works. A large pickle and canning factory is in operation at this place. North Judson is an important railroad town. A creamery is located here. The town has a population of about 1,500.

Hamlet is near the center of a rich farming section, and is a shipping point mainly for potatoes and onions. It has a population of about 600. San Pierre is an unincorporated town of about 300 inhabitants, in the southwestern corner of the county. Other towns of local importance are Grovertown, Ober and Ora. Davis, Alldine, Rye, Lena Park and Bass are small settlements and railroad station.

Starke County is fairly well supplied with good roads. In

1915, there was a total of 731 miles of roads, 303 miles of which were improved with gravel and stone. The gravel has largely been imported, as very little is found in the county. Many miles of road are built on dredge banks.

Several railroads afford adequate shipping facilities. The northern part of the county is crossed from east to west by the Pittsburg, Ft. Wayne & Chicago, the central part by the New York, Chicago & St. Louis (Nickel Plate), and the southern part by the Erie. The Chicago, Indiana & Southern extends from the extreme southwestern corner diagonally across the county through the northeastern corner. The Pan Handle division of the Pennsylvania System, the Chesapeake & Ohio, and the Michigan City division of the Monon crosses the southwestern corner of the county.

With two exceptions, the lakes of the county are small and of little importance. Bass Lake, 5 miles south of Knox, and Koontz Lake, in the northeastern corner, are popular summer resorts. The shores of these lakes are dotted with cottages and hotels.

#### CLIMATE.

The climate of Starke County is healthful and fairly well suited to farming. The winters are rather long and cold, and as a rule there is considerable snow. There is no weather bureau station in this county, but the records of the station at Laporte, Laporte County, are fairly representative of local climatic conditions. The mean annual temperature is reported at Laporte as 49 degrees F. The mean temperature for the winter months, December, January and February, is 24.7 degrees F., and for the summer months, June, July and August, 71.2 degrees F. The mean temperature for the spring months is 47.6 degrees F., and for the fall months, 52.4 degrees F. The maximum temperature recorded is 108 degrees F., occurring in the month of July, while the minimum is -21 degrees F., recorded in February. Long periods of hot weather seldom occur, though occasionally for two to four days the temperature ranges from 95 to 100 degrees F. Zero weather seldom lasts for more than three to five days. It is usually accompanied by snow.

The mean annual precipitation is reported at the Laporte station as 35.6 inches. For the winter months the precipitation averages about 7.61 inches; this is largely in the form of snow. For the spring months, the average precipitation is 9.85 inches, for summer months, 9.92 inches, and for fall months, average

8.31 inches. In general, the rainfall is quite evenly distributed throughout the growing season, the greater part of it occurring in the spring and summer months. Crops seldom suffer from drought or from excessive rainfall. The total amount of rainfall for the driest year recorded is 26 inches, and for the wettest year, 45.76 inches. The average annual snowfall is reported as 49.2 inches, of which 40.9 inches is recorded for December, January and February.

The average date of the last killing frost in the spring is May 1, and of the first in the fall, October 5. This gives a normal growing season of 156 days, or a little over 5 months. The date of the latest killing frost recorded in the spring is May 21, and of the earliest in the fall, September 14.

The water supply of the county is obtained mainly from shallow wells. Water is ordinarily reached at depths ranging from 10 to 30 feet. Most of the wells are in sand. Mosquitoes are quite troublesome, on account of the large areas of standing water. Apparently, however, they are gradually disappearing as their breeding places are eliminated by drainage and cultivation.

The data in the following table are compiled from the records of the Weather Bureau station at Laporte:

## NORMAL MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT LAPORTE, LAPORTE COUNTY.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December.....	26.3	65	—12	2.48	1.40	3.09	13.0
January.....	25.1	63	—10	2.25	2.66	0.96	12.8
February.....	22.6	61	—21	2.88	3.24	1.85	15.1
Winter.....	24.7	65	—21	7.61	7.30	5.90	40.9
March.....	37.8	82	— 2	3.13	4.70	4.22	3.6
April.....	46.6	94	10	2.61	1.37	2.25	1.3
May.....	58.3	93	23	4.11	2.25	7.04	T.
Spring.....	47.6	94	— 2	9.85	8.32	13.51	4.9
June.....	68.5	103	36	3.30	1.25	8.68	0
July.....	73.7	108	45	3.40	0.94	5.01	0
August.....	71.4	101	40	3.22	3.04	2.75	0
Summer.....	71.2	108	36	9.92	5.23	16.44	0
September.....	64.3	103	29	3.17	3.10	5.26	0
October.....	53.2	92	8	2.36	1.22	1.38	T.
November.....	39.7	76	2	2.78	0.83	3.27	3.4
Fall.....	52.4	103	2	8.31	5.15	9.91	3.4
Year.....	49.0	108	—21	35.69	26.00	45.76	49.2

## AGRICULTURE.

The interests of Starke County are primarily agricultural. The various soils are easily cultivated, and are well suited to the production of a wide range of crops. The great obstacle to agricultural development has been the poor drainage of all the county except the sand ridge areas. With the establishment of artificial drainage, mainly within the last 20 years, agriculture has increased

in importance; as drainage is provided, the area devoted to agriculture is extended.

The principal occupations of the inhabitants of the county prior to the last 12 to 20 years were hunting, spearing muskrats, fishing, cutting timber for railroad ties, picking huckleberries and cranberries, with which the county once abounded, and cutting marsh or prairie hay in the drier areas. This last industry was of considerable importance until only a few years ago.

Only the sand hills or higher lands were farmed, no thought being given to ever farming the swamps. The small tillable tracts were fenced and the cattle and hogs had free range. Corn, wheat, potatoes, buckwheat and sorghum were the chief crops grown. The first surplus product sold was potatoes. Very little grain was shipped prior to about 1895. Most of the corn used was shipped into the county. The early markets were Plymouth and Walkertown. The first wheat was sold at Michigan City.

The following table gives the acreage of each of the staple crops of the county as reported by the census for 1880, 1890, 1900 and 1910, by the Indiana Department of Statistics for 1913, and by the County Agricultural Agent School Census for 1915:

ACREAGE OF STAPLE CROPS.

Year.	Corn.	Wheat.	Oats.	Rye.	Potatoes.
1880	7,555	3,954	1,259	1,003	291
1890	7,828	3,097	3,367	2,386	674
1900	26,460	2,736	7,022	3,164	906
1910	28,435	5,191	7,373	3,519	2,147
1913	29,351	5,423	11,883	3,364	1,464
1915	21,304	8,722	9,626	3,173	2,218

In addition to the above staples, the 1910 census reports a total of almost 15,000 acres in hay and forage crops. Of this, 5,721 acres are reported in tame or cultivated grasses, consisting mainly of timothy, with 7,165 acres in wild, salt, or prairie grasses, and 1,319 acres in coarse forage. Grains are cut green from small acreage, and some clover, millet and alfalfa are grown.

Buckwheat was reported in 179 acres in the 1880 census, and later became an important crop, the acreage increasing to 1,036 in 1899. In the 1910 census, however, it is reported on only 688 acres. Dry peas are reported on 462 acres in 1909, and some barley and beans are grown. In addition to potatoes, all other

vegetables are reported on 1,416 acres in the 1910 census. In the 1890 census about 10,500 apple trees and about 1,000 peach trees are reported. The 1900 census reports about 24,000 apple trees and barely 2,000 peach trees, and the 1910 census a total of 23,042 apple trees and almost 10,000 peach trees, with 6,583 grape vines. Berries are grown on a few acres.

The 1910 census reports 1,291 other cattle and 2,304 calves sold or slaughtered. A total of 8,863 hogs, and 389 sheep and goats are reported sold or slaughtered, with 395 horses and mules sold.

The following table gives the relative value of farm products, arranged by classes, according to the census of 1910:

Cereals.....	\$584,241
Other grains and seeds.....	6,781
Hay and forage.....	98,922
Vegetables.....	149,978
Fruits and nuts.....	13,367
All other crops.....	33,968
Live stock and products:	
Animals sold and slaughtered.....	220,571
Dairy products, excluding home use.....	99,761
Poultry and eggs.....	107,028
Wool, mohair and goat hair.....	1,347
Total value.....	\$1,316,064

About 15 to 20 per cent of the total area in cultivation is devoted to the production of corn. The average yield for all types of soil is something less than 30 bushels per acre. The general increase in the corn acreage is due in part to the reclamation of large areas of the Clyde soils, which are favored for corn, and to the fact that it is the most profitable of the grain crops. Commonly a large part of the corn fails to mature properly in unfavorable years. It is practically all drilled in, in order to insure a stand. In places the sprouting corn is seriously injured by the striped gopher. Most of the corn is husked by hand, although an increasing acreage is used for ensilage each year. About one-half the crop is sold; the remainder is used on the farm. The average farmer considers it more profitable to use the corn for feed.

Wheat is considered a profitable crop. Yields range from about 25 to 35 bushels per acre. Oats are uncertain. The average yield is about equal that of wheat. Both crops cost about the same for production, but the selling price of wheat is generally



almost twice that of oats. At the time for seeding oats, the farmer is busy preparing the land for corn. Wheat, on the other hand, is planted and harvested at times when the farmers are not busy with the corn crop. Under these conditions, oats are often grown at a loss. This crop is sometimes cut green and used for hay.

Rye is a crop of some importance, mainly on the light sandy soils. Generally it is sown at some convenient time in the fall on the oats and wheat stubble, at the rate of 1 1-4 bushels to the acre. Where grown for soil improvement, it is pastured in the fall and early spring and plowed under, the land then being used for corn or cowpeas. The thrashed grain is largely marketed. Rye is sometimes cut green for hay.

Throughout the history of the county, potatoes have been an important crop. Starke County ranks third or fourth in the state in total production of potatoes. In 1915 there were 2,218 acres reported. They are grown either as a truck crop or in a system of mixed farming. The better quality of potatoes are grown on the Clyde soils, but larger yields are obtained in areas of Muck. Most of the growers have 30 to 35 acre tracts; occasionally larger fields are grown. The average farmer has from 1 to 10 acres in potatoes. The yields range from 75 to 250 bushels per acre. All the potatoes, except those kept for home consumption and for seed, are marketed. They sell for 25 to 75 cents per bushel.

Hay is of considerable importance in the agriculture of Starke County. Besides the wild or marsh hay which has been an important source of income since the earliest settlement of the county, timothy, clover, timothy and clover mixed, cowpeas, alfalfa and millet are grown. Clover has never been a very important crop. It is confined mainly to the Griffin and Miami soils, although it is grown to a small extent on the better drained Clyde soils. Alfalfa is grown successfully in a small way on the well-drained soils.

Buckwheat is said to be a fairly profitable crop, and may be grown on any type of soil, but does best on the Clyde soils or Muck. It is used only where the land can not be brought into condition for corn. Like oats, it is not fertilized. The average yield is 15 to 20 bushels per acre.

Cowpeas were introduced about 8 years ago, and are extensively grown, mainly in Washington, Oregon and Center Townships. During the last three years, the acreage has been doubling. In 1912, 797 acres, in 1913, 2,393 acres, and in 1915, 6,856 acres are

reported. This crop does well on the Plainfield fine sand. The yield ranges from 8 to 15 bushels per acre. The cowpea seed is all marketed, except the damaged or cracked grain, which is fed to chickens or hogs. In 1915 the average yield was only about 3 to 4 bushels per acre. The peas lodged and were badly damaged by cold, wet weather. Cowpea hay sells for \$8 to \$10 per ton; the thrashed hay sells for \$4 to \$6 per ton. The price received for the seed ranges from \$1.40 to \$2.50 per bushel. A small area is in soy beans; perhaps 100 acres were devoted to this crop in 1915. They are grown like cowpeas, and yield from 12 to 20 bushels per acre. They require inoculation. Vetch has been grown, either with rye or alone, but it is not popular with the farmers.

Onion growing started about 12 years ago, and since 1910 the industry has reached relatively large proportions. Starke County ranks first in the state in the production of onions. In 1912, 1,526 acres were reported in onions, with a production of 457,485 bushels. The low prices received in 1912 served to discourage many growers, and caused a number to discontinue the business. In 1913 only about 800 acres were devoted to onions. In 1915, however, there were about 2,000 acres. While the prices are subject to wide fluctuations, those who have remained in the business continuously have made a good margin of profit. There are three large onion storage houses at Knox one each at Hamlet, North Judson and Rye, and a few small individual storage houses at other places.

Peppermint was introduced about 10 years ago, and is receiving considerable attention. In the last two years the acreage has doubled. In 1915 about 1,000 acres were devoted to peppermint, with 370 acres on one farm. The price of the oil varies considerably, but the industry is profitable to those who remain in the business for any length of time.

Cucumbers are grown on several types of soils. Pickling sizes sell for 75 cents to \$1 per bushel. Most farmers grow from 1 to 4 acres. Harvesting begins about August 1 and continues until frost. About 800 acres of cucumbers were grown in 1915, but the crop is not grown so extensively as formerly, because of the labor required in picking. There is a pickle factory at Knox, and salting stations at Grovertown, San Pierre and Alldine.

Sunflowers were introduced in the county in 1914. In 1915 about 300 acres were grown, mainly on Muck, with very promising results. Sugar beets were grown with success at one time on

the Clyde soils, but lack of a local market prevented the development of this industry.

Watermelons and cantaloupes can be successfully grown upon the light sands, especially with heavy applications of fertilizer.

A large number of vegetables, including celery, cabbage, tomatoes, turnips and peas, do well, but are grown only for home use or to supply the local market.

Peaches and apples are grown successfully on the Plainfield and Miami soils. Farm orchards generally receive little attention, and there are only two or three commercial orchards in the county. Small fruits, according to the census of 1910, are grown on only about 35 acres. Blueberries and dewberries grow wild throughout the county.

A considerable number of cattle are fed in the county. It is generally recognized that live stock is needed to maintain the productiveness of the soils. This is a stock feeding rather than a stock raising section.

The stockers are purchased from Chicago, fattened, and marketed at the same place. There is very little purebred stock within the county. Scrub or grade cattle are used almost entirely. Dairying is practiced more extensively than stock feeding. The average farmer keeps from 4 to 6 milk cows. The milk and cream are sold at North Judson or shipped to Plymouth and Chicago.

Hog raising receives some attention, but the extension of this industry offers excellent opportunities. It is profitable where carried on in conjunction with dairying, and large quantities of concentrated feed are produced on most farms in the form of cowpeas and soy beans. A number of farmers are engaged in poultry production. The climate, soils, and crops favor a greater development of the poultry industry. Considerable feed for live stock is purchased from outside the county. The census of 1910 reports an expenditure of \$41,468 for feed.

In the agricultural development of the county, considerable recognition has been given to the adaptation of various soils to particular crops. The corn crop is confined very largely to the black soils of the Clyde series and to the Griffin loam, which is a very productive alluvial type. Corn is grown to some extent on the Plainfield fine sand, but the yields are light and the crops on this soil is being displaced by cowpeas. Corn is also grown on the shallower areas of Muck with fair to good results, but frosts are troublesome and two or more successive plantings are not advisable unless applications of potash salts are made. Wheat and

oats are grown chiefly and give best results on the Griffin loam, the Clyde soils, and the Miami fine sandy loam. Only fair yields of these crops are secured on the Plainfield fine sand, and on Muck, the yields are rather uncertain. Rye and cowpeas are confined almost entirely to the Plainfield fine sand, potatoes to the Clyde soils and Muck, and onions and peppermint to Muck and the mucky areas of the Clyde soils.

(Note to Inspector.—*Methods* of producing staple crops of county, *Corn, wheat, oats, and rye*, should be discussed briefly.)

Potatoes are planted in rows, 3 to 3 1-2 feet apart, after danger of frost is past. The Early Ohio and Rural New Yorker are the most popular varieties. A few growers treat the seed for scab. Potatoes are given three or four cultivations. Most of the growers use acreage applications of about 200 pounds of muriate of potash and occasionally 300 pounds of acid phosphate. Many farmers use the same fertilizers for onions, except that the applications are about one-half as heavy. On the better Muck farms, the potato industry is highly developed. Planting and digging are done by machinery. The ground is prepared with plow and rollers pulled by oil tractors. Potatoes are considered a profitable crop. They are grown in some cases in rotation with onions.

Cowpeas are seeded as soon as the ground warms up, usually about May 1 to 20, the peas being drilled in with a corn planter, in rows 3 to 3 1-2 feet apart. Where grown for seed, one-half bushel per acre is used, while 1 1-2 bushels per acre are broadcast where intended for hay. Three or four shallow cultivations are given. The vines are cut with specially devised implements that are intended to sever the vine near the ground, but oftener the plant is uprooted. They are cut before there is danger of shattering, allowed to cure, and placed in small cocks or stacked. Harvesting for seed is done usually about September 1 to 15. While there may be some improvement on the land where the cowpeas are cut and thrashed and the straw is removed from the land, better results in the way of soil improvement are secured where the cowpeas are hogged off or the vines plowed under about the time the pods begin to form, or if harvested, where the crop is fed to live stock and the manure returned to the land. Cow peas are a valuable hay crop.

(Note to Inspector.—In one or two paragraphs here *methods* of growing buckwheat, soy beans, vetch, alfalfa and clover, and cucumbers should be mentioned.)

Onions are planted between the middle of April and the first of May. Muck land intended for onions is generally plowed in

the fall and allowed to freeze and settle during the winter. In the spring the ground is thoroughly worked until a good seed bed is obtained. Onions usually are grown on land that has been used for the same crop the preceding year. This is one of the few crops that give better results where grown continuously, unless the soil becomes infected. Four pounds of seed are used per acre. Most of the seed is secured from Ohio. The seed is sown with a garden drill, usually one inch deep and in rows 13 inches apart.

In most cases, onions are grown in fields of 1 to 5 acres; in some instances they are grown on 10 to 30 acres, and in one case on 90 acres. Onions fit well into the farm rotation, as the ground can be prepared the preceding year, and the crop planted in the spring earlier than the other farm crops. It is harvested earlier than corn, and before wheat planting time. The Red and Yellow Southport Globe are the varieties most commonly grown. Cultivation begins as soon as the rows can be followed. Hand cultivators and weeders are used, and wheel-hoe and hand weeding are done alternately until the onions start to bulb, usually about August 1. Commercial fertilizers for onions are in general use. Most growers use 150 to 200 pounds of muriate of potash per acre, and a large number also use 200 pounds of acid phosphate or basic slag with the potash. Some farmers use 500 to 700 pounds of a 10-10 mixed fertilizer. The fertilizer is broadcasted before seeding, and worked in. A few farmers apply nitrate of soda after the onions are up, but its use apparently is not profitable. The principal enemies of onion culture are thrips, onion maggot, blight and mildew. Young onions occasionally are destroyed by the drifting of the soil. Cold wet seasons also are injurious. Harvesting is done about the last week in August to the last of September. The onions are pulled and thrown into windows and allowed to cure, which requires from 7 to 10 days. Topping is done either by hand or machinery. After topping, the onions are allowed to further cure in crates or in cribs built for this purpose. They are then either marketed or placed in winter storage. The onions sell for 25 cents to \$1 per bushel. The cost of production averages about \$75 per acre.

The land intended for peppermint, is cleaned by growing well-cultivated crops the year before, plowed, leveled and marked off in furrows 35 to 42 inches apart and 4 to 6 inches deep. The runners are dropped by hand, and the furrows are then filled in by a drag. Planting is usually done before May 1. Seventy-five to 100 pounds of muriate of potash per acre is broadcasted.

Harrowing is repeated at frequent intervals until the sprouts are too high to be further disturbed, after which corn cultivators are used between the rows until July, when the tops and runners interfere. Hand weeding is also practiced from the first appearance of the sprouts. The peppermint is cut with a mower and allowed to cure like clover hay. It is then raked in windows and hauled to the stills. Harvesting begins with the old plantings about the middle of July, and for the younger plantings about a month later. The plants after distilling are dried and used for hay, averaging 1 to 1 1-2 tons per acre. This is considered a good winter roughage for live stock, and sells for \$4 to \$10 per ton. After the crop has been harvested, the second growth is plowed under before cold weather. Before the growth starts the following spring, the soil is loosened with spike-tooth harrows. Cultivation is continued until the sprouts are too tall to be gone over without injury. The plantings last from 3 to 12 years.

The roots required to plant an acre of peppermint are secured at a cost of about \$10. The yield of peppermint oil ranges from 15 to 60 pounds; the young mint averages 40 pounds per acre, and old plantings about 30 pounds. The total cost of production is about \$37 per acre. Peppermint oil sells for 75 cents to \$5 per pound; \$2.50 is considered a good price. A number of distilleries are in operation in the mint growing section. Oil is distilled for 25 cents per pound for some of the smaller growers.

In the last few years, there has been a rapid increase in the use of commercial fertilizers. Large quantities of potash and mixed fertilizer are used, and there is a decided tendency toward the use of raw materials and home mixing. Potash fertilizers are needed in the type of farming that prevails in this county. A large quantity of limestone is being used. Limestone now costs \$1.10 to \$1.50 per ton, delivered to various points in the county. Most of the soils of the county are in need of lime, especially the Clyde and Plainfield soils. Muck is not generally considered to be benefitted by lime. Phosphatic fertilizers are needed and are widely used in both truck and general farming. Light applications are made on all the corn lands. The 1910 census reports an expenditure of \$11,467 for fertilizers, as compared with \$1,100 reported for the county in 1900.

Satisfactory farm labor is rather scarce. Owing to the large number of special crops grown, there is a great demand for labor at certain seasons. Onions and peppermint require considerable hand work. Boys and girls are mainly used for this work, and

receive \$1 to \$1.50 per day. Men are paid \$1.50 to \$2.00 per day for work in the onion fields. Ordinary farm labor is paid about \$20 per month and board, and extra help is hired at an average rate of about \$2 per day. A large number of women perform light farm labor. The 1910 census reports an expenditure of \$83,175 in the county for labor. In the 1900 census an expenditure of \$48,070 for labor is reported.

According to the 1910 census, there are 961 farms in the county with an average size of 114.3 acres. In 1913 a total of 1,552 farms of 5 acres or more is reported. In the system of mixed farming that prevails in this county, the farms are necessarily small, and there are many small holdings, with but few large farms. The only large estates are in the undrained sections along the Kankakee River. The census reports about 81 per cent of the county in farms, and of the farm lands, 67 per cent is reported improved.

As compared with many counties of the state, there is little tenant farming. The census of 1910 reports about 30 per cent of the farms operated by tenants, and practically all the remainder by the owners. Land is generally rented on the share basis. The tenant furnishes the work stock, has a half interest in the other live stock, supplies working capital, and clears and fences the land, cuts weeds, etc. The owner receives one-half of the proceeds from the crops produced.

Land values vary considerably, depending mainly on the character of the soil. In the past 5 or 6 years, land prices have rapidly advanced. Twenty years ago land was selling for \$5 to \$6 per acre. Improved land in areas of the Plainfield fine sand now sells for \$50 to \$75 an acre. Land of the Clyde fine sandy loam is valued at \$90 to \$140 per acre. Well drained Muck lands sell for \$75 to \$100, and the improved Muck farms are held for \$150 per acre. The average value of farm land in this county is reported in the 1910 census as \$40.64 per acre.

There has been considerable speculation in real estate in recent years, and many farms change hands frequently. Immigrants from Chicago, mainly foreign born, acquire farms in the county, but in most cases, owing to lack of experience or of capital they are unsuccessful in farming, and after one to five years give up the land to their creditors. Under this condition, inferior land often sells for high prices. New settlers usually cannot farm the light sandy Plainfield soil or the shallow areas of the

Clyde fine sand with profit, and after a short time give up their farms.

Improvements in different parts of the county vary widely. Davis and Oregon Townships are highly developed to agriculture, while in Washington, California and Railroad Townships the farmers apparently are less prosperous.

The agriculture of the county is rapidly improving, but it cannot be said to be anywhere near its highest development. The extension of agriculture is largely dependent upon the extension and improvement of drainage. The future of Starke County seems to lie in the intense development of its vast areas of Muck land for both special and mixed farming.

#### SOILS.

Starke County lies within the glaciated region of the United States. During the latter part of the glacial period, and for some time following, the formerly glaciated region from a point north of the Kankakee River southward seems to have been occupied by a rather extensive lake or marsh. It is said that this "lake" apparently consisted not of any general body of water but of small, shallow-marsh areas, but very different from those of the present Kankakee marsh.

*Leverett, Monograph 53, U. S. Geol. Survey.*

The great accumulation of sand is thought to have been derived from the adjacent ice lobes—the Lake Michigan ice lobe bordering the area on the north, and the Erie-Saginaw lobe to the east. It is thought that much of the sand was brought into the great Kankakee basin by glacial streams that discharged through the St. Joseph River during the melting of the ice to the north. Throughout this area the sand is uniformly fine, and appears to have been deposited by streams with rather sluggish currents.

The underlying deposits consist of grayish-blue calcareous boulder clay, with many abrupt changes from clay to sand. The depth of the sandy mantle is unknown, but perhaps averages over 40 feet. Bedrock everywhere is deeply buried. From near San Pierre to the Kankakee River the depth to rock is only 40 to 50 feet; elsewhere it ranges from 100 to over 200 feet.

There is an area extending eastward from Bass Lake into Marshall County in which the material was laid down by the ice as a moraine. Its elevation is perhaps well above the level of the



ancient lake, plain. The area is marked by patches of boulder-strewn gravelly clay or till. This moraine is possibly a part of the great Maxinkuckee moraine which is encountered in Marshall County and which belongs to the Saginaw lobe of the ice sheet.

The sandy water-laid deposits, together with a small area of ice-laid material, constitute the parent material of the soils of the county. While the lake was in existence it received material carried into it by various streams. The coarser particles were laid down as delta deposits near the mouth of the streams, or thrown up by the waves as beaches, islands, or sand bars along the shores. The finer particles were carried into the deeper, more quiet portions, and deposited as layers of silt and clay.

When the lake finally drained away westward, the same or other agencies of deposition became more active than before. Some of the material was further assorted and drifted by the wind. Much of the old plain remained swampy, favoring the accumulation of large quantities of vegetable matter. The lacustrine material has been weathered only to a slight extent. This large amount of carbonaceous material present and the consequent dark color constitute the most distinctive characteristics of the soils of this region. The higher lying areas of water-deposited sand as well as the more pronounced knolls and ridges resulting from wind action have good to excessive drainage and only a low content of organic matter.

The ice-laid material, because of its topography, has accumulated but little organic matter. The soils are gray to very light brown. The subsoil and till are calcareous.

The dark soils as a rule are not heavily forested. The early settlers found them treeless, or in what is known as "wet prairie." Little, if any, of the county had reached the dry prairie stage.

On account of the very small extent of valleys caused by erosion on this plain, the alluvial soils are not typically nor extensively developed. The alluvium appears to have been deposited directly on the old sand plain, as the material is underlain at about 3 feet by the lacustrine deposits. The source of the alluvium was the fill plain that forms the eastern limit of the ancient lake.

The soils of Starke County are uniformly fine textured, and the structure of both soil and subsoil is rather light and open, but they are not generally doughy or leachy, owing to the relatively high water table.

The dark-gray and black soils are classed with the Clyde and

Newton series, the light colored soils from water-deposited material with the Plainfield series, and the light colored till soils with the Coloma and Miami series. The alluvial soils are classed with the Griffin series. Muck is one of the extensive and important soils of the county. In addition to Muck, a miscellaneous classification, nine distinct soil types are recognized in Starke County. These represent six series.

The Clyde series is characterized by dark brown to black surface soils and gray, drab or mottled gray and yellowish subsoils, the dark color of the surface soils being due to the high percentage of organic matter resulting from the decay of plants under swampy conditions. The topography is level and the soils are naturally poorly drained, but when reclaimed they are highly productive and valuable for corn, grass, sugar beets, cabbage and onions. Three types, the fine sand, fine sandy loam, and loam, are recognized in Starke County. The Clyde soils are extensive, and dominate the agriculture of this county.

The Newton soils are intermediate between the Clyde series on the one hand and the Plainfield or Dunkirk series on the other. The surface soil is dark brownish gray, with a yellow to yellow and gray mottled subsoil of similar to somewhat heavier texture. The topography is flat to slightly undulating, and the natural drainage is poor.

The Plainfield series includes the light colored well-drained soils derived from water-deposited material. The surface soils range from brown to gray in color, and the subsoil from light brown to yellowish. The topography is level to undulating and ridgy. One type, the fine sand, is mapped, and is one of the most extensive soils in Starke County.

The Coloma series includes brownish gray to brown surface soils with a brownish yellow subsoil, which is not heavier than the soils in texture and is non-calcareous to a depth of 3 feet or more. The topography ranges from undulating to rolling, and good natural drainage prevails. The soil-forming material is till, derived largely from sandstone and crystalline rocks. The chief difference between the Miami and Coloma series is in the subsoil. Only the fine sand member of the Coloma series is mapped in Starke County, and this type is of very small extent and is unimportant agriculturally.

The soils of the Miami series are brown, light brown, or brownish gray, and are underlain by yellowish brown, heavier textured subsoils, which are distinctly calcareous below a depth

of 2 to 3 feet. These soils are undulating to gently rolling, and have good natural drainage. The series is represented by a single type in this county, the Miami fine sandy loam. The soils are in the main derived through weathering, from glacial till of a generally calcareous nature.

The soils of the Griffin series are brown to dark brown. The subsoil is mottled gray, yellow, and rusty brown. These soils are alluvial in origin, and are developed in the first bottoms of streams. They are subject to overflow. When properly drained they are well suited to corn and grass. In this county, two types are mapped, the Griffin fine sandy loam and loam.

The name and actual and relative extent of each soil type mapped in Starke County is given in the following table:

AREAS OF DIFFERENT SOILS.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Plainfield fine sand.....	42,752	} 31.0	Clyde loam.....	7,104	3.6
Rolling phase.....	18,240		Griffin loam.....	6,464	3.3
Clyde fine sand.....	34,240	17.4	Coloma fine sand...	4,416	2.2
Clyde fine sandy loam..	33,792	17.1	Miami fine sandy loam.....	3,136	1.6
Muck.....	28,992	} 16.7	Griffin fine sandy loam.....	2,816	1.4
Shallow phase.....	3,136		Total.....	197,120	.....
Sandy phase.....	768				
Newton fine sand.....	11,264	5.7			

## CLYDE FINE SAND.

The surface soil of the Clyde fine sand consists of a black loamy fine sand, to an average depth of 9 inches, the depth ranging however, from 8 to 20 inches. It contains large quantities of organic matter. Where the drainage has been very poor, the organic matter content is so high that the soil is more or less mucky, but in the better drained areas the percentage is proportionately lower, in some cases being so small that the soil is hardly dark enough to be mapped as Clyde. The organic matter is responsible for the loamy texture; in most cases it consists of black, well decomposed, carbonaceous material, but in some areas the vegetable fibres remain.

The subsoil is quite variable. Usually it is a brown or grayish brown fine sand or loamy fine sand in the upper 8 to 12 inches, underlain by gray fine sand, sometimes mottled with yellow or

highly stained with iron. In places the subsoil is incoherent to a depth of 3 feet or more, but generally it is sticky. In other places, the upper subsoil is noticeably heavier than the surface soil. Usually the top layers contain a very small quantity of clay. Invariably below about 30 inches, the material is a compact or water-logged fine sand. In only a few instances is gravel present in the subsoil.

The substratum is a gray fine sand, extending to undetermined depths. It usually is highly streaked or stained with yellow from iron. The material excavated from drainage ditches contains some coarse gravel and rock fragments. After exposure, it is light gray and quite compact.

Where the Clyde fine sand occupies open glades, hay marshes or "oak openings," the surface 9 to 15 inches is a dark brown or black fine loamy sand, underlain by grayish compact fine sand. The water table is encountered at about 20 inches.

The Clyde fine sand is the most expensive type in Starke County (?), and is found in all sections. Its greatest development is in California Township. This type is spoken of locally as "black sand" or "black sandy soil." It is not popularly separated from the Clyde fine sandy loam. For agriculture it is considered somewhat less valuable than the Clyde fine sandy loam, but more valuable than the Plainfield fine sand.

The topography is characteristic of an old lake plain, being level to very gently undulating. The natural drainage is poor; the slope usually is so slight that water stands in places for long periods after rains. In general, the surface is so flat that large dredge ditches are necessary to drain the type properly. Artificial drainage has been provided for nearly all of this soil. There are a few small ponds or swampy depressions. The undrained areas are mainly used as hay marshes. The water table over a considerable part of the type lies within 3 feet of the surface. The soil is easily drained because of its open, porous nature, and where tile is installed it is not necessary to place the drains very close together.

A large part of this type originally was forested, mainly with swamp pine, oak, and red oak, with a sprinkling of quaking aspen, birch, and elder in the lower situations. The open glades or hay marshes are broken by low sand ridges covered with white oak; these places are known as wet prairies, or "oak openings." The thick growth of sedges and grasses are cut for hay or used for pasturage. Land that has been cleared or burned over and

allowed to revert to its natural condition is occupied by an almost impenetrable growth of quaking aspen.

The Clyde fine sand is used for both general and mixed farming, and a large part of the type is under cultivation. Corn, wheat, oats, hay and potatoes are the principal crops grown. Corn yields about 20 to 40 bushels per acre. Wheat does fairly well, but not so well as on the fine sandy loam. Oats average less than 25 bushels per acre. This is an excellent soil for potatoes and yields of 125 to 200 bushels per acre are obtained. Some cucumbers are grown on this type, and do well in years of low rainfall, but wilt and blight are considered more troublesome on this type than on the Plainfield fine sand. Buckwheat is an important crop, being grown on newly cleared areas, or when the corn fails. Cowpeas are sometimes grown, but with little success, averaging about 5 to 10 bushels per acre. Clover is uncertain. Soy beans are grown in a few fields, and the results indicate that this is the legume best suited to this type.

Fertilizers high in potash are generally used on the Clyde fine sand, and are considered necessary for profitable yields of all crops. About 200 pounds per acre of muriate of potash is used as an initial application for corn and wheat, and the beneficial effects of this last for 3 to 5 years, after which 50 to 100 pounds per acre are used for each crop, or 150 pounds is applied every other year. The use of fertilizers containing 6 to 8 per cent phosphorus and 10 to 12 per cent potash, at the rate of 200 pounds per acre for corn and 300 pounds for wheat, is popular. For potatoes and other intensive crops from 500 to 1,000 pounds per acre is used.

A large part of the Clyde fine sand is in an acid condition. Some limeston is applied, but its more extensive use is needed. Well improved areas of this type sell for \$50 to \$90 per acre.

#### CLYDE FINE SANDY LOAM.

The surface soil of the Clyde fine sandy loam is a black loamy fine sand or fine sandy loam. It ranges from 8 to 18 inches in depth with an average of about 12 inches. The soil contains a high percentage of mucky, organic matter, and to this is due the characteristic dull brown or black color. The subsoil is a brown or grayish brown fine sandy loam to sticky fine sand or fine sandy loam extending to a depth of 30 to 42 inches and underlain by a gray, loose find sand.

The greatest variation in this type is in the texture and color of the subsoil. In many areas the material is uniformly loamy and contains sufficient clay to make it sticky or coherent. A part of the type is underlain at 15 to 30 inches by a grayish or grayish brown fine sandy loam or fine sandy clay. Iron occurs quite frequently in the soil and subsoil of this type in layers or as concretions or irregular masses. Where the iron is present at or near the surface, it sometimes interferes with cultivation. As a rule the iron-bearing layer is found at depths of 10 to 20 inches. The ferruginous spots vary in size from a fraction of an acre to 5 or 6 acres. They are not large enough to be satisfactorily indicated on the soil map. The largest occurs in sections 27 and 34 T. 32, R. 3.

This type is extensively developed in the Kankakee and Tippecanoe valleys, and includes some of the best farm land of the county.

As mapped in Railroad Township, a large part of this type is a dark brown or black fine sandy loam, grading at 8 to 10 inches into a dark fine sandy loam or sandy clay loam, which extends to a depth of 15 to 20 inches. Usually this lower section is highly mottled with yellow and rusty stains. In places it gives way to a gray or drab heavy sandy clay, which also is usually mottled. Along the Jasper County line, the subsoil is bright yellow or buff colored, much like that of the Carrington series, and some gravel and a large number of boulders are present.

In Davis Township and in Center Township, north of the Yellow River and west of Knox, the subsoil of this type is much heavier than the typical. The surface soil generally is a grayish brown to black fine sandy loam 8 to 12 inches deep, resting upon a grayish sandy loam or sandy clay loam, slightly mottled with yellowish brown or rusty spots. This material may vary to a drab or bluish clay loam or silty clay, but gives way to a gray sand in the lower part of the 3 foot section. In this location the type is closely associated with the Griffin soils, and it is difficult to draw sharp boundaries between the purely lacustrine deposits and the alluvium, as they occupy similar topographic positions.

In North Bend Township, the Clyde fine sandy loam is developed in the low-lying areas of the out lying weak morainic belt. Some gravel and boulders are scattered over the surface. The subsoil is generally dark gray or brown and mottled with gray and yellow or iron stains. It may contain some sand and gravel. It is much heavier than the typical subsoil, approaching a heavy

loam to clay loam. Its impervious nature renders the drainage poor. As a whole, the type in this locality, sections 2, 11 and 14, T. 32, R. 1, apparently is less productive than the Clyde fine sandy loam as mapped in other parts of the county.

There is a variation of this type, occurring in the lower situations, which closely approaches the characteristics of Muck in the surface portion. This variation is encountered mainly along the Kankakee River.

The natural drainage of the Clyde fine sandy loam is very poor. At the time of the settlement of this county, nearly all the type was in a marshy condition, and the establishment of extensive systems of drainage was required to reclaim the land. The drainage has been greatly improved in recent years by the use of tile. Most of this type has been put under cultivation in the last 15 years; large areas in Davis Township have been cultivated only about 4 to 7 years. Many areas near the Kankakee River do not have sufficient fall to afford adequate drainage, and are in a swampy condition or are cultivated only in dry seasons. Most of this type was wet prairie land, little of it was ever forested.

The surface configuration varies from nearly level to very gently undulating. At some places along the banks of drainage ditches water-bearing gravel is encountered at 8 to 10 feet below the surface, but as a rule such material, if present, occurs at much greater depths.

This type is so closely associated with the Clyde fine sand that definite boundaries can not always be drawn. The higher content of clay in the subsoil insures good capillarity and enables this type to withstand drought better than the fine sand.

Corn is the most important crop grown on this soil, and yields of 60 to 70 bushels per acre frequently are obtained. The average yield is about 50 bushels. Oats do well except in wet seasons when they usually produce a heavy growth of straw and are likely to lodge. This type is considered the best wheat soil in the county, with the exception of the Griffin loam. The average yield is about 20 bushels, though as much as 35 to 40 bushels per acre are obtained. Dawsons Golden Chaff and Michigan Amber are the most popular varieties. The application of about 200 pounds of potash per acre is considered beneficial in stiffening the straw. The potatoes are an important crop on this soil. Acreage yields of 150 to 250 bushels of potatoes of good quality are obtained. Onion and peppermint are occasionally grown in the

mucky areas. Clover, timothy, and alfalfa are produced successfully.

Land of this type has an average value of about \$100 per acre. In some cases it is sold for \$60 to \$125, but the best improved land is held for \$135 to \$150 per acre.

Where a legume is needed, soy beans should be grown; cowpeas do not do so well on this soil. Some areas of the Clyde fine sandy loam are slightly acid, but it is not so generally in need of lime as the Clyde fine sand. Potash salts are needed for best results. When a fertilizer is used, a mixture of 10 per cent each of phosphoric acid and potash is recommended.

#### CLYDE LOAM.

The Clyde loam consists of a black loam or heavy fine sandy loam 8 to 15 inches deep, underlain by a grayish or brownish mottled heavy loam or sandy clay. The mottlings are mainly iron stains, and are yellow, red or brownish red. In the heavier material they are very pronounced. At 30 to 36 inches a gray fine sand is encountered, and this extends to a depth of several feet.

In the areas of this type north of San Pierre the soil to a depth of 8 to 10 inches is a black fine sandy loam, underlain by gray, drab or brown sandy clay or fine sandy loam, highly mottled with yellow and red. Frequently at 20 to 30 inches there is a layer of yellow iron concretions or drab and yellow sandy clay, and below 30 inches a gray fine to coarse sand usually is encountered. Iron concretions and gravel frequently are present in the soil and subsoil. Large granite boulders are abundant, but these have been generally removed from the cultivated fields.

A few areas are included with the Clyde loam that consists of distinctly heavier material. The area in sections 27 and 34, T. 33, R. 1, includes clay loam underlain by mottled drab or gray and yellow, plastic silty clay, generally grading into sand in the lower part of the soil section. This area formerly was subject to overflow. Other spots of clay loam are scattered through the type in Davis Township.

The largest area of the Clyde loam is in Davis Township, north of the Pennsylvania Railroad, along the Kankakee River. Another area is mapped in Railroad Township. Small scattered areas occur throughout the county.

The surface varies from flat or depressed to very slightly undulating. This type was wet or marshy before artificial drain-



age was provided; a part of it is swampy at the present time. The area south of English Lake is not thoroughly drained. The greater part of this type has been under cultivation within the last 4 to 6 years. The improvements are good.

Corn, wheat, oats and hay are the principal crops grown, and of these corn is the most important. The average yield of corn is about 60 bushels per acre. Yields of 70 to 80 bushels are common. As a rule wheat is not fertilized, and yields of 20 to 35 bushels per acre are obtained. Clover does well. Timothy makes a rank growth.

No fertilizers are used on this soil. Owing to the rather large percentage of organic matter present it granulates and breaks up into a mellow condition, and is easily kept in good tilth. Where handled too moist, it has a tendency to clod. This condition readily distinguishes it from the other members of the Clyde or Plainfield series.

Well-drained land of this type is held for \$100 to \$150 per acre.

#### NEWTON FINE SAND.

The surface soil of the Newton fine sand is a dark grayish brown to black fine sand or loamy fine sand. The subsoil is encountered at 9 to 20 inches, and generally consists of a brownish or grayish, incoherent fine sand, low in organic matter. This grades into a yellow or orange colored, loose fine sand. A gray fine sand is frequently encountered below 10 inches, extending to depths of several feet. Small quantities of clay are sometimes present in the lower part of the subsoil, as in the case of the Clyde fine sand.

The Newton fine sand is uniform in the rather shallow depth of the surface soil and the light color of the incoherent subsoil. The widest variation in this type occurs in sections 2 and 3, T. 33, R. 2, where the material to a depth of 8 to 12 inches is a brown fine sand. This grades into a grayish brown, loose fine sand, which at 14 to 20 inches is underlain by a yellow, incoherent fine sand. This sometimes passes into a bright yellow or highly iron stained sand.

The surface of this is generally smooth and depressed, and the type is naturally poorly drained. There are a number of sand hills or swells which are entirely surrounded by soil of this type. Large areas of this soil occur between sand ridges.

A part of the Newton fine sand is forested with a dense growth

of swamp pine and red and black oak; the undergrowth is mainly huckleberry. The open areas support a sparse growth of sedges, brake fern, dewberries, blueberries and pine weed. Usually there is an extensive growth of moss. In cultivated fields, dewberries, pine weed, and sorrel are troublesome. The type is frequently referred to as "dewberry land."

This soil occurs usually in areas of only a few acres, but there are a few large bodies. Perhaps less than 20 per cent of the type is cultivated. When first broken, this soil apparently is as productive as the Clyde soils, but much of it will not produce profitable crops without special treatment, even after thorough drainage and liberal manuring and fertilization. A large area of similar soil lies between LaCrosse and Wanatah, Indiana, and experiments which have been conducted by the Purdue Experiment Station for a number of years on a farm one mile east of Wanatah, have shown that the yields of crops can be materially increased by the application of 3 to 4 tons per acre of ground limestone with liberal applications of fertilizer rich in available phosphates and containing some potash. The soil was not found to be in need of nitrogen. In the case of corn, the yield was increased from 7 bushels per acre on untreated land to 60 bushels per acre on land which was limed and fertilized, although these results were obtained about 2 years after the limestone was applied.

This type should receive at least 3 tons per acre of ground limestone or marl, and a fertilizer containing 10 to 12 per cent phosphoric acid and 6 to 8 per cent potash should be used. About 200 pounds per acre should be drilled in the row for corn, and 300 to 400 pounds for wheat. With proper treatment this soil is adapted to the same crops as the Clyde fine sand. Soy beans do better than cowpeas, for the reason that they will tolerate more acidity.

Note—Bulletin 170, Ind. Exp. Station.

#### PLAINFIELD FINE SAND.

The surface soil of the Plainfield fine sand is a brownish gray to light brown fine sand. It is 6 to 15 inches deep, with an average depth of 7 or 8 inches. The subsoil is a yellowish brown to yellow, incoherent fine sand, extending to a depth of more than 3 feet. The surface soil is dark brown when moist; when dry, it has a grayish cast. In flat situations and the local depressions, the subsoil is bright yellow, iron stained or orange colored, or may be stained reddish with iron. In these areas, the surface soil is

generally gray and the upper part of the subsoil grayish yellow. Distinct mottlings are rarely found. In forested areas only 2 to 4 inches of the surface soil is dark colored, and the underlying material is yellowish brown. The substratum, which extends to great depths, is a gray or yellow incoherent sand.

The surface soil is generally free from coarse material, although scattered gravel is present, with occasional bowlders. An area in section 16, T. 32, R. 4, carries some gravel, and the soil in the region north of Grovertown to Koontz Lake contains more gravel than the typical. An area of this soil north of the Tippecanoe River in section 34, T. 32, R. 1, occurs as a terrace. The surface soil is a brownish gray sand to a depth of 8 to 9 inches, and the subsoil is a yellowish brown coarse or medium sand. Some coarse sand and gravel is distributed over the surface and throughout the soil and subsoil. The substratum is mainly gravel.

The Plainfield fine sand is an extensive soil in Starke County, and is widely distributed. The largest area is in Washington Township, north of Yellow River. Another large area is encountered at Rye, extending southward toward Albine and Lena Park. A large part of the type consists of gentle swells or island-like areas in the Clyde soils. The crests of many of the elevations are only 1 to 5 feet above the level of the surrounding darker land.

The surface, as a rule, is smooth and generally flat or level. The largest area with very flat surface is found about Oak Grove Church, in Washington Township. A portion of the type has a gently undulating or wavy topography, but never decidedly ridgy. However, a few smaller isolated areas occur as low ridges, seldom over 3 to 4 feet above the surrounding Clyde soils.

The natural drainage ranges from fair to good with little that is excessive, but not so pronounced as in the Plainfield fine sand, rolling phase. Consequently there is less leaching and the organic matter is retained longer.

About 60 per cent of the Plainfield fine sand is under cultivation. The remainder is covered with scrub, white, and black oak. A part of the forested area is in woodlots, and a part is used for grazing.

A mixed system of farming is employed on this type. The soil is rather light for general farming. The greater part of the type is used for cowpeas, rye and corn. Cowpeas do best, and a large and increasing acreage is devoted to their production. The crop is grown mainly for seed (?), and the yield is 8 to 15 bushels

with a maximum of about 20 bushels per acre. Corn is not considered profitable; it averages about 20 bushels to the acre. The crop matures well, and the quality is good. Wheat does fairly well, and average yields of about 15 bushels per acre are obtained. Rye is a very successful crop, yielding 10 to 20 bushels per acre. Timothy and clover are uncertain. Oats do not give satisfactory yields. Alfalfa, with proper preparation of the soil, does well. Vetch is grown to a small extent. Cucumbers constitute the principal truck crop. Where well manured, this is considered the best soil in the county for this crop, although it may suffer from drought in years of low rainfall.

Frequently severe windstorms in the spring or early summer months, before the ground is well covered by growing crops, destroy young vegetation. Corn, cowpeas, and potatoes planted in hills are often more severely injured in a few hours by these storms than by heavy frosts.

Owing to the open, porous nature of this soil and its thorough drainage, it warms up early in the spring, and is well suited to truck crops and garden vegetables. Strawberries, blackberries, peaches and grapes are grown to some extent. Watermelons and muskelons and potatoes are produced successfully.

Commercial fertilizers are in general use on this soil. Most of the manure produced on the farm is applied to this land. The soil shows marked response to the use of lime.

Improved land of the Plainfield fine sand sells for \$5- to \$75 per acre. Some areas sell for \$35 to \$50 per acre.

The Plainfield fine sand is primarily in need of vegetable matter and nitrogen, and should first be improved by growing and plowing under cowpeas, rye, etc., and by applying ground limestone and manure. The type is deficient in phosphoric acid and potash, and the use of fertilizers containing 10 to 12 per cent of phosphoric acid and 6 to 8 per cent potash is highly beneficial. Acreage applications of 200 to 300 pounds of a 10-5 fertilizer drilled in the row are recommended by the Indiana Experiment Station for corn and cowpeas, and 500 to 1,000 pounds of the same mixture for potatoes. Rotations used successfully in the improvement of this type are; (1) cowpeas followed by rye turned under for corn or potatoes, (2) cowpeas and potatoes in alternation, (3) rye followed by cowpeas turned under for corn.

*Plainfield fine sand, rolling phase.*—This soil consists of 6 to 15 inches of yellowish brown or light brown fine sand, underlain by yellowish brown to orange yellow fine sand. In general, the sub-

soil is lighter yellowish brown than the surface soil, and the color becomes lighter with depth. As a rule, the yellow gives way to orange, and in rare instances the material is reddish. In many places there is little or no change in color from the surface downward.

The soil and subsoil are very smooth in texture, and are comparatively free of stone, coarse grit, and gravel, with the possible exception of a few high ridges near Bass Lake and Ora, where scattered angular fragments of igneous rocks are sometimes present. This phase contains only a small percentage of organic matter, and is so loose and incoherent that it is easily drifted where not protected by vegetation. In forested areas, the surface material to a depth of 2 or 3 inches is grayish, and immediately underlain by golden yellow or orange colored material which may continue to depths of more than 3 feet.

The substratum is a pale buff or yellow, loose fine sand, composed largely of well rounded quartz, but a number of other minerals are present. The sand is uniformly fine.

The rolling phase of the Plainfield fine sand has a large total area, and is distributed throughout the county. The largest areas occur along the eastern boundary of the county, north of Eagle Lake. A large area is mapped east of North Judson, extending from the Pulaski County line north to the Kankakee marsh. The greatest ridge development occurs in a series, or broken chain of sand hills extending from Ora to Knox.

The topography varies from gently rolling to dune-like. The phase occurs as low ridges, rounded hills, and knobs from 4 to 40 feet in height. A large part of the phase has no distinct ridge development, consisting of a series of swells or undulations. The ridges usually have a general north and south trend. They are generally long and narrow, varying in breadth from 50 feet to one-fourth mile. The ridges invariably occur along the borders of sand or Muck flats. The tops of the ridges are well rounded, and the sides adjoining the flats are frequently abrupt while the opposite sides slope gradually to the plain. The east and north sides are more often abrupt. In places the ridges enclose Muck swamps or nearly level areas, which frequently are not so productive as the greater part of the phase, the soil being a shallow brown or black sand overgrown with dewberries and other acid tolerant plants. A part of the phase occupies small ridges surrounded by the Clyde fine sand or Muck. Often, however, there is a strip of the typical Plainfield fine sand between this

phase and the Clyde soils. As a rule, no sharp line of separation can be drawn between the rolling phase and the more undulating areas of the typical Plainfield fine sand, and small patches of the phase are included with the main type. The topography, combined with the open, porous nature of the subsoil, give the phase excessive drainage. In the central part of the east half of section 6, T. 32, R. 3, there is an extensive gravel pit within this phase.

About 35 per cent of this phase is under cultivation; the remainder is either used for pasture or is covered with a dense growth of scrub oak. Areas of a few square miles in which this phase is the predominating soil are largely under cultivation. The steeper ridges and small isolated knolls are not farmed and mainly support a growth of scrub black oak. The greater part of the phase can be safely cultivated, but the prominent ridges are not desirable farming land. Owing to the low water-holding capacity of the soil on the ridges, crops are subject to drought except in seasons of well distributed rainfall. In addition, the soil is often lacking in productiveness, and subject to drifting, which frequently causes injury to crops.

Cowpeas and rye are the principal crops grown on this phase. Rye produces an average of about 10 bushels per acre. Cowpeas are grown with good results in favorable years, averaging 8 to 15 bushels of seed, with maximum yields of about 20 bushels per acre, and 1 to 2 tons of hay after thrashing. Most of the crop is cut and thrashed. The yields of corn are light, averaging less than 20 bushels per acre. Wheat does fairly well, averaging about 15 bushels. Alfalfa is grown on a few acres, and does well. Clover is grown, with varying results. It is difficult to obtain a stand of grass on this type. A mixture of Redtop, sheep fescus and alsike has been grown experimentally with success. Sunflowers are being grown in an experimental way. There are a number of peach orchards on this type, and the fruit apparently does well.

Drifting is a serious problem in the cultivation of this soil. The incorporation of large quantities of organic matter, plowing at right angles to the prevailing direction of the wind, and trampling by stock, together with the use of limestone or marl will lessen the injury from this source. A wind-break of pines or other trees is highly beneficial. Another effective plan is to lay out in long, narrow fields the areas that are seriously affected by wind action, and have the fields used for cultivated crops alternate with fields in which early crops, such as rye and clover, are grown.

This phase can be rapidly and permanently improved by growing cowpeas either to be turned under or to be fed and the manure returned to the land. Many acres of the phase on sand hills and ridges, now lying idle, could be profitably used for cowpeas.

#### COLOMA FINE SAND.

The Coloma fine sand is a brownish gray or light brown fine sand or loamy fine sand to a depth of 8 to 15 inches. Some cherty gravel and occasionally small granitic boulders occur on the surface. The subsoil generally is a yellowish brown fine sand. In places the color changes to light gray below a depth of about 2 feet. In many places the subsoil resembles that of the Plainfield fine sand, but usually there is a pale, pinkish tint in the material, which is not present in the Plainfield subsoil. The substratum is encountered at varying depths, and consists of gravelly and stony till. In most places it is not reached within the 3 foot section. In some places when this type adjoins areas of the Plainfield soil, the original character of the surface has apparently been modified by material being transported by wind from the surrounding land. In most places it is distinguished from the Plainfield by the generally gray surface soil and by the presence of gravel. The type as mapped includes a few areas of Miami fine sandy loam, where the boulder till is encountered within the 3 foot section. These areas are too small to be indicated satisfactorily on the soil map. They are locally referred to as "clay spots," and are naturally more productive than the surrounding Coloma fine sand. They contain more stony material than the typical Coloma soil.

This type is confined to North Bend Township, with the exception of an area north of Eagle Lake. The best developed area occupies a morainic belt just east of Bass Lake, extending in a northeast-southwest direction. This belt is about 4 miles long and its average width is about 1 mile. The north half is a succession of billowy ridges rising well above the general level of the plain; the southern part is level to undulating, much like the surrounding country. The other areas of the type vary from level to gently undulating. The drainage is good to excessive. The only poorly drained areas occur in small depressions.

Over 90 per cent of this land is under cultivation and is devoted to general farming. A large part of this type is closely related to the Plainfield fine sand and is handled in about the same way.

Its average productiveness is above that of the Plainfield soil. Clover thrives on most of the type, indicating some limestone influences. All the Coloma fine sand originally was forested with oak, hickory and walnut.

This type is valued at \$60 to \$90 per acre.

#### MIAMI FINE SANDY LOAM.

The soil of the Miami fine sandy loam is a grayish brown to light brown fine sandy loam from 8 to 18 inches deep, with an average of about 10 inches, underlain by a yellowish brown or brown, heavy or sticky sand clay loam. Varying quantities of gravel and stone are scattered over the surface and throughout the soil section.

The area of this type on the crest of the moraine just east of Bass Lake is a gray fine sandy loam from 8 to 12 inches deep, passing into yellowish brown fine sand. At 18 to 30 inches a yellowish brown clay loam is encountered. The substratum consists of yellow sandy clay till underlain by blue calcareous clay till.

In the area bordering Marshall County, the heavy, compact, brown or yellowish brown subsoil is encountered at 8 to 12 inches. In a few fields, the soil approaches a loam, and locally the surface soil is underlain by yellowish brown fine sand, which extends to depths of more than 3 feet. In such places, the gravel content is low.

This type occurs almost entirely in North Bend Township, and is best developed in an area along the Marshall County line. It occurs in a strip about 1 mile wide, extending from Martz (?) Lake northward to the Nickel Plate Railroad. Probably the most typical area occurs in sections 1 and 12, T. 32, R. 1. Another area is found on the summit of the moraine east of Bass Lake in sections 5, 8 and 17, T. 32, R. 1. The remainder of the type occurs mainly on the plain near these areas. It generally occupies low swells or mounds, or island-like areas surrounded by darker colored soils.

The surface is mainly level or gently undulating, except on the high moraine where, owing to its position on the crest of the moraine, the soil is subject to some washing. The greater part of the type has good natural drainage because of the favorable character of the substratum.

The Miami fine sandy loam is one of the strongest soils in the county; the subsoil is heavier than that of any other type. Prac-



tically all the type is under cultivation and devoted to general farming. The small forested area supports a growth of white and red oak. This was the first soil in the county to be farmed.

Corn does well, and yields of 50 to 60 bushels, with an average of about 40 bushels per acre, are reported, although 18 or 20 bushels per acre is considered a good average yield. Cowpeas have been grown with success, but soy beans do not do so well. Oats are grown to only a small extent. Clover and timothy are grown extensively and make a rank growth, probably because of the calcareous nature of the subsoil. The surface soil shows some acidity. Some difficulty has been experienced in securing a stand of clover in recent years. Acreage applications of 1 ton to 3 tons of marl or ground limestone have proven very beneficial. Alfalfa thrives on this soil, and good stands are easily obtained. Limed land produces 5 tons of alfalfa hay per acre, and unlimed land something less than 3 tons. There are a few good orchards on this soil. Apples and other fruits do particularly well on this type.

No commercial fertilizers are used. A marked increase in yields follows the application of manure, even in small quantities, or the plowing under of clover or timothy sod. Such treatment, accompanied by the use of lime, seems to be the most effective means of improving this soil.

The improvements of the Miami fine sandy loam are much above the average of the county. Very little of the land can be bought for less than \$100 per acre.

#### GRIFFIN FINE SANDY LOAM.

The Griffin fine sandy loam is a brown to rather dark brown, mellow fine sandy loam or loamy fine sand, 6 to 12 inches deep, overlying a loose fine sand, which is highly stained with red, brown, gray or some combination of these colors; throughout most of the type, the subsoil is widely variable.

In some places west of Knox, the type consists of 7 to 8 inches of brown fine sand or fine sandy loam, grading into a white or gray and red, clean sand; this rests upon a dark brown, heavy fine sandy loam. Commonly the material throughout the 3 foot section is a gray or light colored, loose fine sand. The type includes small areas of the Griffin loam.

The Griffin fine sandy loam is not extensive in this county. It occurs as first bottoms along the Yellow River. Most of the

type is well drained. Only a small part of it is under cultivation; the remainder is forested or is used for pasture. Good yields of corn and wheat are obtained on this soil.

#### GRIFFIN LOAM.

The soil of the Griffin loam to a depth of 8 to 10 inches, is a dark brown loam to silty loam. The subsoil is a clay loam to silty clay loam. It is mottled deep brown and gray, and brown and red iron stains are common. Below 18 or 20 inches is grayish sandy clay loam, slightly mottled with red, brown, and dark gray, is encountered. This grades into gray or highly iron stained fine sand at depths of 2 feet or more. Small iron concretions are rather abundant on the surface and throughout the soil and subsoil. The soil is generally quite friable and easily cultivated. In some areas there is only a slight difference in color between the soil and subsoil.

This is the heaviest soil mapped in Starke County. Some spots, too small to be shown separately on the soil map, have a clay loam surface soil. There are also a few small areas, of about 2 to 4 acres, of the Griffin fine sandy loam.

The Griffin loam occupies the first bottoms along the Yellow and Kankakee Rivers. It occurs as a continuous strip along Yellow River, but its development along the Kankakee is irregular. Much of the land along Yellow River has been in cultivation since the dredging of the river, but the areas along the Kankakee is irregular. Much of the land along the Yellow River has been in cultivation since the dredging of the river, but the areas along the Kankakee River are forested. The boundaries between these areas and Marsh are marked by the tree line. All the type originally was heavily forested with elm, silver maple and oak.

The type has a nearly level topography, but the surface is very uneven, being dissected by many old stream channels. The natural drainage is good. This land, before the deepening and straightening of the river, was subject to frequent overflow.

The Griffin loam is one of the best soils in the county for the production of wheat, corn and hay. Wheat does particularly well. Average yields of 35 bushels per acre are common, with an occasional maximum production of 45 bushels. The growth of straw is very heavy, and the use of mineral fertilizer probably would be beneficial. Corn yields 50 to 70 bushels per acre. Clover does better on this soil than on any other type in the county, and a large acreage is grown. It is grown both for

hay and for seed. No commercial fertilizer is used on this soil. Some of the type is devoted to pasture. Blue grass does well.

Well improved areas of the Griffin loam sell for \$100 to \$150 per acre. Little of this land is for sale.

#### MUCK.

Muck consists very largely of vegetable matter. The material is so far decomposed that no evidence of the original fibrous structure remains. It ranges from a soft, finely divided soil to a sandy muck or to black mud, depending upon the stage of decomposition and upon the amount of moisture present. The color ranges from dark chocolate brown to black, and the depth generally from a few inches to 12 or 15 feet. The greater part probably averages about 5 or 6 feet in depth, although in places the Muck is said to extend to much greater depths. The most extensive shallow areas of Muck is that northeast of Hamlet, along the county line, where the average depth is less than 2 feet. This region was formerly known as the "sinks".

Very often, below a depth of 18 inches to 3 feet, light brown Peat is encountered. Usually, however, there is no change in the material with depth. Some sand, silt and clay has been washed or blown into the depressions during the formation of this material.

The material underlying practically all the Muck in Starke County is a gray or whitish fine sand. In spots, this sand is stained yellow by iron or black by vegetable matter. Occasionally small quantities of gravel are present in the sand. In places, the Muck is underlain by a grayish marl or gravelly marl, and in rare instances a drab silty clay is encountered under the shallow Muck.

The area mapped as Muck on the site of Manitou Lake, in sections 13, 24 and 25, T. 32, R. 1, comprises a good development of peat. It was drained by a dredged ditch to the west a few years ago. The depth of the deposit ranges from 8 to 20 feet. The material is not sufficiently decomposed to make good farm land. The north and south ends of the area are forested with tamarack, while the remainder is an open marsh.

In general, the Muck as mapped, includes many small patches of Peat and mucky Peat. Some of the large areas mapped as Muck south of North Judson very closely approach the character of Peat, particularly in sections 21, 27, 28, 31 and 32, T. 32, N. Range 3 W.

The areas now recognized as Muck or marsh lands were once shallow lakes or shallow marshes. They were mainly treeless, and when the county was first settled a part of them supported a growth of marsh hay. The marshes and lakes were at one time popular for fishing and hunting. Several areas in the eastern part of the county support a heavy growth of tamarack. In the early history of the county, many of the Muck areas were used as cranberry marshes.

Muck is very extensive in Starke County. There are many areas of 4 or 5 acres or less. A large number of areas of 100 to 200 acres are common, and many that are much more extensive, ranging from 600 acres to a few sections. The largest bodies are in Jackson, Oregon, North Bend and Wayne Townships. The Muck areas are well distributed over the county.

The surface is practically level. In some areas, it has a hummocky appearance, owing to the occurrence of small tufts of grass, which seldom exceed 12 inches in height. Sometimes the surface is interrupted by small sand islands, only a few feet above the level of the marsh.

It is only within the last few years that any thought has been given to the cultivation of these marshes. They produced marsh hay, which was cut by machine if dry enough, but if too wet for a mowing machine, the hay was cut by hand and "poled", that is, piled up on two long poles so that it could be carried by two men. In the last 15 years, a comprehensive system of drainage has been established. Most of the Muck areas have been freed of the surface water, and the water table has been lowered, and a large part is successfully farmed. These lands are rated as the most valuable of the general region.

Muck is used quite extensively for the production of onions, peppermint and potatoes, and to a smaller extent for corn, oats and wheat. The average yield of onions under favorable conditions is about 300 bushels per acre. In 1915 the average yield was about 150 bushels. In many cases yields of 500 to 600 bushels are obtained.

Potatoes are grown to a considerable extent, and yield from 100 to 250 bushels per acre. The quality is somewhat below that of the potatoes grown on the Clyde soils. Cabbage, celery and other vegetables are grown to a very small extent, mainly in tracts of 1 to 4 acres. Sunflowers are a new crop on this soil; about 300 acres were grown in 1915. The yields ranges from 500 to 1,000 pounds of seed per acre.

Corn and oats yield about 40 bushels per acre. In growing corn, about 200 pounds per acre of muriate of potash is broadcasted the first year and about 100 pounds each year afterward. Many farmers are unsuccessful in growing oats on Muck, usually because they sow too early and do not plant deep enough. Good results are reported where the crop is drilled in about 2 inches deep on well compacted soil. Good wheat yields are obtained where the Muck does not exceed 3 feet in depth, and where the Turkey Red variety is grown.

Blue grass does well, and its use for pasture is considered profitable. Timothy, Japan millet, and alsike all give good yields. Soy beans are becoming popular as a hay crop on Muck.

Raw Muck land is valued at \$50 an acre or more; cultivated Muck sells for about \$100 an acre, and some of the well improved areas are held for \$150 per acre.

In growing onions on Muck, larger quantities of fertilizer, particularly phosphate, should be used. Muck soils which are overrun with such plants as huckleberries and dewberries, and which do not produce cultivated crops satisfactorily after being drained and plowed, even where treated with manure and potash, are acid, and require the addition of 3 or 4 tons per acre of ground limestone or marl together with liberal applications of phosphate and potash. However, the extent of unproductive Muck in Starke County is very small and usually no treatment other than the addition of potash is needed.

The first requirements in bringing the Muck under cultivation, is drainage. After drainage has been established, the cost of plowing the new land is estimated at about \$2 per acre, using a tractor for motive power. By this means, the heavy growth of weeds and shrubs is turned under at the first operation.

Compacting the new Muck soils by means of heavy engines and rollers is highly beneficial. It renders the soil firmer, prevents drifting, lessens evaporation from the surface, and reduces the danger of injury to crops by frosts.

The practice of burning over Muck land is not to be recommended except under certain conditions. In many instance, the burning of Muck, especially the shallow areas results in great damage; very often the burned spots are made unproductive. After Muck is burned over, it grows up in the willows, buttonwood, and dogwood. Muck fires are not troublesome at present in this county.

A great many of the Muck areas remain unreclaimed and

uncultivated, and there is yet room for the more extensive production of the special crops to which the soil is admirably adapted.

*Muck, sandy phase*—This phase consists of soil that is too mucky to be classed with the Clyde fine sand or fine sandy loam and yet contains so much fine sand that it does not have the properties of true Muck. The material to a depth of 12 to 18 inches is quite black and loose; the underlying material usually consists of grayish fine sand. The mucky layer does not exceed 3 feet in thickness. In places, the phase is similar to the typical Muck except that it has a higher percentage of light gray fine sand; it was formed under similar conditions, but larger quantities of sand have accumulated in the areas mapped as the phase. In a few places, the mineral matter had been washed in by overflows from drainage canals.

The Muck, sandy phase, occurs as small, isolated areas scattered throughout the county. The largest body occurs in sections 10 and 3, T. 32, R. 1. The areas of the phase usually adjoin areas of Muck, grading imperceptibly on the other side into the Clyde fine sandy loam. The surface is flat, and all the areas originally were marshy. Most of the phase has been reclaimed by deredging, and is now farmed. Under cultivation, it gives good results with wheat, onions, potatoes and peppermint, but as a corn and oats soil it is inferior to the Clyde types. Timothy does well.

*Muck, shallow phase*.—The Muck shallow phase, comprises a large area in Jackson Township along the Kankakee River. It is essentially different from the typical Muck, and can not be classed with the Clyde soils on account of the small quantity of mineral matter in the surface section. To a depth of 8 to 20 inches, the soil is a black Muck or fine sandy Muck or Peat. In places some silt and clay are present. Usually the vegetable fibers can be distinguished in the material. The subsoil consists of a fine sandy loam of gray or bluish gray color with brownish mottlings. The material becomes lighter in texture with depth, grading in places into sand or fine sand.

The surface is firm and can be driven over without miring, except in saturated spots. This phase was once a part of the extensive Kankakee marsh. It was generally inundated and was largely inaccessible before the dredging of the Kankakee River. It is now free of surface water, but is either subject to inundation or the water table is too near the surface for the land to be farmed successfully. The only agriculture practiced is the cutting of

marsh hay. The hay is composed mainly of sedges, which reach a height of 4 or 5 feet and grow very luxuriantly. The hay is cut with mowers from the last of September until cold weather. It sells for \$6.50 to \$7 per ton.

Most of this land is held for \$40 or more an acre.

With the deepening of drainage outlets, this should become a valuable soil for farming.

#### DRAINAGE.

Drainage is and always has been the basic problem of this general region. From Marshall County westward along the south side of the Kankakee River there is insufficient relief for the development of drainage ways for a distance of 20 miles or more south of the river. Most of this area was inundated, either permanently or a part of the year, and presented a forbidding waste of marshes and sand ridges to the early settlers.

In the fifties, considerable ditching was done by the State from money obtained from the sale of the lands, but most of this work was ineffective because of the lack of sufficient outlet. The Kankakee River overflowed each year and spread over a wide area. It is said that the country from Hamlet westward to the Kankakee as late as 1890 was a shallow lake.

The first successful large drainage project was the Robbins Ditch, which was completed about 1892, and provided drainage for some of the best land in the county. The Kankakee River was dredged and deepened in 1901. At that time it was dredged from its source in St. Joseph County to the western boundary of Starke County, a distance of about 46 miles. The average bottom width of the river as improved is 50 feet; its depth in water averaged 9 feet. Another stretch of the river, extending about 27 miles from the western boundary of the county, is being improved. The bottom width of this part of the river as improved is 70 feet.

Most of the drainage work in Starke County has been accomplished in the last 15 years. The cost of the public drainage and river improvement thus far accomplished and in contemplation, borne by the land owners, is approximately \$2,500,000. The State of Indiana appropriated \$65,000 for the removal of a rock barrier in the channel at Momence, Illinois. The attempt to remove the Momence rock, however, was unsuccessful. There is a general belief that this rock will have to be removed before a satisfactory drainage system can be developed.

Yellow River, Eagle Creek and Bogus River have been dredged, and many miles of dredged ditches have been completed. The main laterals and sublaterals are 16 to 20 feet wide and 6 to 10 feet deep, with banks having a slope of 45 degrees. There are some small laterals of 2 to 6 feet bottom width, and 6 feet in depth. The fall near the river is 6 to 12 inches per mile, but farther from the river there is a fall of 1 to 5 feet per mile. Laterals more than one-half mile apart are not considered satisfactory in providing thorough drainage. Most of the ditches apparently do not draw from a distance of more than 500 to 600 feet. The dredging costs from 5.6 to 7 cents per cubic yard, or about \$900 to \$1,000 per mile. The drainage assessment is \$5 to \$10 per acre drained. The cost of drainage has been so heavy that at present the landowners do not favor the extension of expensive reclamation projects.

Some difficulty is experienced in keeping the dredges open. They fill with sand and muck and in many cases require cleaning 1 year to 4 years after they are dug. This work is done mainly by floating dredges carrying long looms which throw the excavated material over the original banks.

Some tile drainage has been installed within the past five years, with varying degrees of success. Much remains to be done in perfecting the tile drainage systems. The soils are comparatively easy to drain, if good outlets are provided. The tiles ordinarily are placed about 3 1-2 to 4 feet deep and about 10 rods apart, leading to the ditches. Tile is laid near the sand ridges to catch the drainage from the higher areas.

In some Muck areas it is thought that the water table has been lowered too far, so that the crops are likely to suffer from drought. The installation of concrete drains with control gates at the main canals, to prevent excessive drainage and form a supplemental subirrigation system has been advocated, but this would add materially to the present cost of drainage, and it is doubtful whether the plan would prove profitable. In some Muck areas, the closing of the drains in midsummer by inserting sheet iron between the tiles near the outlet or at several places in the drain has been recommended. This would no doubt prove advantageous especially in growing celery, cabbage and other shallow rooted crops.

To drain the average land in the county costs about 30 cents per rod, or \$5 to \$6 per acre. The elaborate drainage system is being extended each year. About 20 miles of dredging is to be



done in 1916. There are several hundred acres bordering the Kankakee and lower Yellow River that can not be used for agriculture and other areas that can not be cultivated with a reasonable degree of safety except under particularly favorable seasonable conditions. Approximately 35 to 40 per cent of the county is unreclaimed. This land is overrun with scrub oak or is undrained. This land is overrun with scrub oak or is undrained and marshy, and is unsuited to agriculture in its present condition. In 1913 a total of 25,477 acres of timber land is reported in this county. The average cost of clearing scrub oak land is \$5 to \$10 per acre. Owing to the nearness of the Chicago markets and the good railroad facilities available, the development of these unreclaimed lands apparently offers excellent opportunities.

Drainage authorities are of the opinion that the most feasible and complete solution of the drainage and flood problems of this region lies in the construction of a permanent system of levees along the Kankakee River, with an adequate channel between.

#### SUMMARY.

Starke County is situated in the northwestern part of Indiana. It has an area of 200,960 acres, or 314 square miles.

The county lies almost entirely within the Kankakee plain, a region of very flat topography except for scattered dune-like ridges and irregular areas of sand which rise from 5 to 40 feet above the plain level. A small morainic area occurs near Round Lake, just east of Bass Lake, and along the Marshall-Starke County line.

Practically all the flat lands throughout the county originally were in a poorly drained condition; large tracts were little more than open morass, and the Kankakee River, the main drainage outlet, was a shallow, sluggish stream which frequently overflowed its banks and spread out over large areas along its course. In recent years the Kankakee River has been dredged, also the Yellow River flowing westward through the center of the county, and numerous large dredged ditches have been constructed to drain areas not reached by natural drainage ways. The cost of the drainage work completed and in contemplation approximates \$2,500,000. A large total area is yet unreclaimed.

The average elevation of the county is about 700 feet above sea level.

The county was organized in 1852. A few settlements had been made as early as 1840, but the main development of the county has taken place since 1890 when the drainage of the flat or black lands was undertaken on an extensive scale. The population in 1860 is reported as 2,195, while in 1910 it is given as 10,567 or an average of 24 persons to the square mile. The greatest increase occurred between 1890 and 1900. The entire population is reported by the census as rural. Knox, the county seat and largest town, has a population of about 1,800. North Judson is an important railroad town, with a population of about 1,500.

The transportation facilities are exceptionally good. Two main lines of the Pennsylvania system; the New York, Chicago & St. Louis, the Chesapeake & Ohio, and the Erie, all through lines from Chicago to east and south, and a branch of the New York Central Railroad cross the county.

The county has an extensive system of public roads, and nearly half of them are improved with gravel and stone.

The climate is healthful and fairly well suited to farming. The average annual precipitation is about 36 inches; it is well distributed throughout the year. The mean annual temperature is reported as 49 degrees F. The average growing season is 156 days, or a little over 5 months.

The resources of the county are purely agricultural. The early settlements were made on the well drained morainic lands in the southeastern part and some of the elevated sandy areas through the Kankakee plain, as at that time the flat lands were undrained and considered worthless for agriculture. Later, with the development of artificial drainage, the flat or black lands were rapidly taken up, and now a very large percentage of these lands are improved, and support a prosperous agriculture. Corn is the chief crop. Oats are next in importance, with about half the acreage of corn, and wheat ranks third in acreage. Cowpeas and rye are the most extensive crops on the light sandy lands, while onions and peppermint are important crops on Muck. The county ranks third or fourth in the state in the production of potatoes and first in the production of onions. Stock feeding is followed to some extent, but has not yet developed into an extensive industry. Dairying and hog raising are of considerable importance.

The use of commercial fertilizers has rapidly increased in the last few years. It is considered advisable to use potash fertilizers on all the black lands of the county, including Muck. Phosphatic

fertilizers are widely used for both truck and general farm crops. Liming is becoming popular.

According to the 1910 census, about 81 per cent of the county is in farms, and of the farm land 67 per cent is improved.

Satisfactory farm labor is generally scarce.

The average size of farms in the county is reported as 114.3 acres. The census reports about 70 per cent of the farms operated by the owners, and the remainder by tenants, who rent mainly on the share basis. Land values have rapidly increased in recent years. Improved areas of the light sandy lands sell for \$50 to \$75 an acre, the Clyde soils from \$50 to \$140 an acre, and well improved Muck for about \$150 an acre.

Throughout the Kankakee plain portion of the county, the soils are derived from water-laid deposits or water-deposited material subsequently drifted by the winds, as in the dune-like ridges and elevated sandy areas. In the flat areas, the soils are high in organic matter, ranging from dark gray to black in color. All the dark soils are classed with the Clyde and Newton series and Muck. The lighter, better drained soils from water-laid material are classed with the Plainfield series, and the till soils of the morainic areas with the Coloma and Miami series. The alluvial soils are classed with the Griffin series.

The Clyde series is represented by the fine sand, fine sandy loam, and loam members. These are dark gray to black soils resting upon gray mottled subsoils of similar to somewhat heavier texture. The fine sand and fine sandy loam are extensive types, and constitute a large part of the best improved land of the county. Corn, wheat and oats are the chief crops.

The Newton series is characterized by dark gray surface soils and the yellowish subsoils, representing an intermediate condition between the Clyde and Plainfield soils. Only the fine sand type occurs in this county. It is not extensive, and a large proportion of it is undeveloped scrub-oak land. In spots, it is in a highly acid condition, and large applications of lime are required to make it productive.

The Plainfield series includes brownish gray to light brown or yellowish brown surface soils, with yellow to light orange colored subsoils of similar texture. The fine sand member is extensively developed in Starke County. Most of the rolling phase and probably not over 50 per cent of the level areas are cultivated. Cowpeas and rye are the main crops. Corn and oats give light and uncertain yields.

The Coloma series includes only one type, the fine sand. In color and structural characteristics it is very much like the Plainfield fine sand, but differs from that type in being derived from ice-laid material and in having a distinct morainic topography and more or less stone on the surface and throughout the soil section. It is of small extent, and occurs near Round Lake, east of Bass Lake, and along the Marshall County line. Nearly all the type is cleared and under cultivation, and gives light to fair yields of corn, cowpeas and the other crops grown. The average yields are somewhat higher than on the Plainfield fine sand.

The Miami series includes till soils of brownish-gray to light brown color with yellowish brown, heavier subsoils. The material is calcareous at depths of 2 to 3 feet. The fine sandy loam is the only member mapped, and it is not extensive. Practically all this type is under cultivation and highly improved. Corn, wheat timothy and clover are the main crops.

The Griffin loam and fine sandy loam are brown soils with gray and brown mottled subsoils, developed along the Yellow and Kankakee Rivers. The loam is highly productive. Most of the area along the Yellow River, where the drainage is fairly good, is cleared and produced heavy crops of corn, wheat, oats, clover and other crops. Only a small part of this soil is under cultivation.

Muck is very extensive in Starke County. A large acreage is improved and used for the production of onions, peppermint, and potatoes. Corn, oats and wheat are grown to some extent with varying degrees of success.