

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF RACINE COUNTY, WISCONSIN.

BY

GROVE B. JONES AND ORLA L. AYRS.

[Advance Sheets—Field Operations of the Bureau of Soils, 1906.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

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

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., October 3, 1906.

SIR: The attention of the Bureau was called by the Hon. H. A. Cooper to the desirability of a soil survey of Racine County, Wis., on account of the intensive character of the market-gardening interests in that county, and because of the presence of large areas of undrained land, the crop adaptabilities of which had not heretofore been ascertained. This survey was carried on and completed during the summer of 1906, and I transmit herewith the report and map covering this county, and recommend that they be published as advance sheets of the Field Operations of the Bureau of Soils for 1906 as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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MAP.

Soil map, Racine County sheet, Wisconsin.

SOIL SURVEY OF RACINE COUNTY, WISCONSIN.

By GROVE B. JONES and ORLA L. AYRS.

DESCRIPTION OF THE AREA.

Racine County is situated in the southeastern part of Wisconsin, and is bounded on the north by Waukesha and Milwaukee counties, on the west by Walworth County, on the south by Kenosha County, and on the east by Lake Michigan. It embraces an area of 208,576

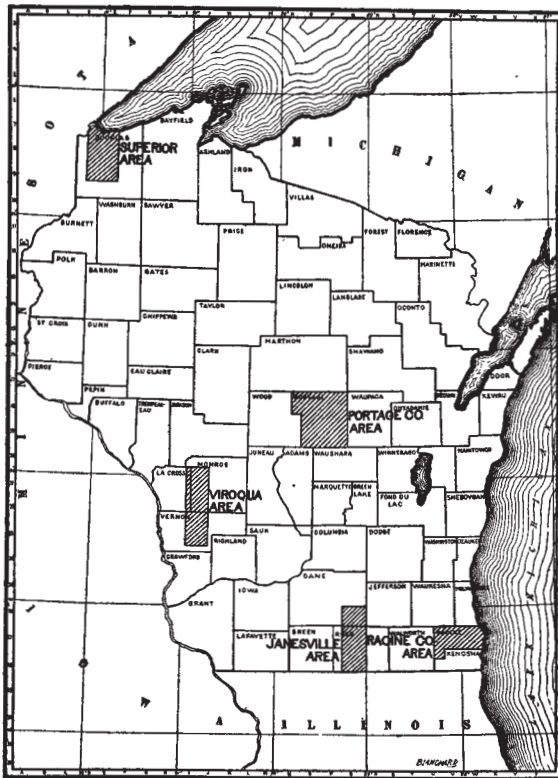


FIG. 1.—Sketch map showing location of the Racine County area, Wisconsin.

acres, or approximately 326 square miles. The western part of the county presents the appearance typical of a glaciated region, being crossed by a range of morainic hills, which have imparted to this section a varied and attractive topography. Among the hills and

ridges are miniature lakes, swamps, and kettle holes, conclusive evidence of the presence of the great ice sheet. East of these hills and extending to Lake Michigan the surface of the country varies from level to gently rolling, the northern part being more rolling than the southern.

Fox River crosses the county from north to south near the western boundary and empties into the Illinois River. The greater part of the county, however, is drained directly into Lake Michigan through Root River and its tributaries and two or three smaller streams. Wind Lake, Browns Lake, Tichigan Lake, Bohner Lake, and Long Lake constitute the principal inland bodies of water and are ideal summer resorts.

Racine County, taken as a whole, is not well drained. Many of the small lakes and swamps, the latter marking an advanced stage of the shallower glacial lakes, are inclosed by hills and have no natural outlets. Where there is a natural outlet from a swamp there is often insufficient fall thoroughly to drain the area.

The first permanent settlement in what is now Racine County was made in the fall of 1834, on the present site of Racine. Other settlements rapidly followed, and by 1840 settlements were scattered throughout the county. The greater number of the pioneers came from Ohio, Indiana, New York, and the New England States. In 1840 a few families from Norway settled near Wind Lake, within the present borders of Norway Township, forming the nucleus of the first Norwegian colony within the State. These were quickly joined by others from Norway, Sweden, and Denmark. Later many Germans settled within the county. The census of 1900 gives the total population of the county as 45,644, a large percentage of which are either foreign born or of foreign parentage.

Racine, the county seat, is situated on Lake Michigan, and contains about 30,000 inhabitants. It is a prosperous manufacturing center, agricultural implements being one of the chief products. Burlington, in the western part of the county, has a population of about 2,800, and a few factories are also located here. Corliss is a small manufacturing point, located at the junction of the two lines of the Chicago, Milwaukee and St. Paul Railway; Union Grove, Kansasville, and Franksville are prosperous towns, and Waterford and Rochester, situated on the Fox River, are thriving villages.

The county is provided with excellent transportation facilities, both by land and water. Chicago and Milwaukee are the markets for a large part of the exports of the county. The Chicago, Milwaukee and St. Paul Railway and two lines of the Chicago and Northwestern Railway cross the eastern part of the county north and south. A

second line of the Chicago, Milwaukee and St. Paul Railway crosses the county east and west, furnishing an outlet to Mississippi River points. The western part of the county has direct communication with Chicago over the Wisconsin Central Railway. No part of the county is over 10 miles distant from a railroad, while the majority of the farmers can reach a shipping point within 5 miles. The Barry and the Goodrich steamship companies have docks at Racine and furnish passenger and freight service to Chicago and Milwaukee. An electric road connects Racine with Milwaukee on the north and Kenosha on the south. An electric line in progress of construction and running just west of Racine will, when completed, connect Chicago and Milwaukee. In the western part of the county another electric road will connect Milwaukee and Burlington and furnish transportation facilities for Waterford and Rochester. This road may be extended to Lake Geneva, 10 miles southwest of Burlington.

The gravel hills in the western part of the area furnish an abundance of desirable road material, and the public highways in this section are kept in good condition. In the central and eastern parts there is no desirable road material and the roads are usually muddy during the winter months. A few of the main highways leading out of Racine have been macadamized, the material being secured at the limestone quarries about 3 miles north of the city.

CLIMATE.

Lake Michigan, forming the eastern boundary of the county, has a more or less modifying effect upon its climate, serving as a regulator, so that sudden changes are not pronounced. The prevailing winds are from the west, and the winters are not so severe as might be expected. The summers are pleasant.

The figures in the following tables, showing the normal monthly and annual temperature and precipitation and the dates of the first and last killing frosts, are compiled from records of the Weather Bureau stations at Racine and Waukesha, the latter being 11 miles north from the northwestern corner of Racine County. It will be noticed that the winter months are colder at Waukesha, while the summers have about the same average temperature at both places. The difference in annual rainfall is about 2 inches more at Racine.

As recorded at the Racine station, the last killing frost in spring varies from April 7 to May 31, and the first in fall from September 30 to November 7. During a period covering seven years, from 1897 to 1903, the first killing frost occurred as early as September 30 only once. The length of the growing season is essentially the same at Waukesha.

Normal monthly and annual temperature and precipitation.

Month.	Racine.		Waukesha.		Month.	Racine.		Waukesha.	
	Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.		Temper- ature.	Precipi- tation.	Temper- ature.	Precipi- tation.
	°F.	In.	°F.	In.		°F.	In.	°F.	In.
January	20.2	2.20	19.0	2.05	August	71.0	2.21	69.9	2.66
February	23.0	1.90	19.9	1.40	September ..	64.0	3.50	64.9	2.90
March	31.8	2.50	30.0	2.22	October	54.4	1.69	51.3	1.67
April	44.3	2.90	46.0	3.00	November ..	39.7	2.10	35.2	1.71
May	53.0	3.30	56.0	3.40	December	25.2	1.29	24.0	1.42
June	64.3	4.09	67.5	4.15	Year	46.9	31.65	46.3	29.87
July	72.1	3.97	72.1	3.29					

Dates of first and last killing frosts.

Year.	Racine.		Waukesha.		Year.	Racine.		Waukesha.	
	Last in spring.	First in fall.	Last in spring.	First in fall.		Last in spring.	First in fall.	Last in spring.	First in fall.
1897	May 31	Oct. 9	May 31	Oct. 29	1901	Apr. 20	Oct. 4	Apr. 21	Oct. 4
1898	Apr. 7	Oct. 15	Apr. 7	Oct. 15	1902	Apr. 20	Nov. 7	May 10	Nov. 7
1899	Apr 16	Sept. 30	Apr. 16	Sept. 29	1903	May 1	Oct. 18	May 1	.....
1900	May 3	Nov. 7	May 5	Nov. 5	Average	Apr. 27	Oct. 17	Apr. 30	Oct. 20

AGRICULTURE.

Corn and wheat were the first crops grown by the early settlers. Wheat was extensively grown until about 1860, when the yields fell so low as a result of continuous cropping that the farmers turned their attention to other crops, especially oats, corn, and flax. Diseases and pests also helped to decrease the wheat yield, and in 1900 only 935 acres were planted to this crop. Until the wheat yields began to fall off the advantages to be derived from rotation of crops were not recognized. Flax took the place of wheat for a while, the acreage steadily increasing until 1879, when it reached its maximum production. It continued to be grown quite extensively until 1887, when the acreage began gradually to decline. In 1900 the area planted to flax was 1,318 acres, but during the survey only a few fields were noticed.

Although the soils of Racine County are well adapted to diversified farming, the variety of crops produced up to 1860 was quite small. Prior to that date very little attention was paid to dairying, but some stock was fattened for the markets. After the decline in the yield of wheat, however, the dairying industry was introduced and grew rapidly, the conditions being highly favorable for its development. Cheese factories were first introduced, and later creameries were established, and at the present time the county has nearly 20 of them. They are all supplied with milk produced within the

county, and some of the milk is shipped to outside markets. Some of the creameries are operated by individual capitalists, while others are run upon the cooperative plan. There is a large malted milk plant in Racine and a condensed milk factory at Burlington. Some fine herds of dairy cattle were seen, the Holstein and Jersey breeds being preferred.

The Racine County farmers, as a rule, feed the greater part of the products of the farm and return the manure to the soil, thus keeping the land in good condition. Though dairying has become general and has reached a high stage of development, the silo has not come into general use. Some have recognized its importance, and upon the better improved dairy farms ensilage is fed the dairy herd. It has also proved to be an excellent food for fattening beef cattle. While it is the usual custom to cut corn while green for storing in silos, some prefer to let it ripen, claiming that it gives better results. No dairy or stock farm is complete without a silo, for the best results are obtained by feeding ensilage.

Very little commercial fertilizer is used in the county, but considerable stable manure is shipped from Chicago. The manure itself is not charged for, but the cost of drayage and the freight on a car containing from 15 to 18 tons ranges from \$13 to \$16. It is used almost exclusively upon the trucking areas.

At present the principal farm products of the county are grain, hay, and live stock. Oats and corn are the main crops, and the yield for the county will average from 30 to 40 bushels per acre. Hay yields from $1\frac{1}{2}$ to 2 tons per acre. Timothy and clover are sown for hay, but the latter is sometimes killed during severe winters. When a stand of clover is secured, it seldom persists for more than three or four years. Alfalfa is being grown on the upland soils with satisfactory results, yielding from 4 to 6 tons per acre annually, and is a valuable addition to the forage crops of the county for both general farming and dairying. Barley, rye, flax, sugar beets, and buckwheat are grown to a limited extent. The barley grown belongs to the malting variety and its acreage is constantly increasing. There is a home market for the barley, which is used in the manufacture of malted milk. A part of the product is shipped to Milwaukee for malting purposes.

The soil and climatic conditions here are well suited to sugar beets. The quality of the beets is good and the yields range from fair to good. The beets are usually shipped to Menomonee Falls, where the nearest sugar factory is located. There would seem to be no reason why this crop should not be more extensively grown than it is at present.

Rotation of crops is practiced and its importance recognized, but there is no general rotation that applies to the county as a whole.

Where dairying is practiced a common rotation consists of corn two years, followed by oats, and one year of clover. Barley or rye is sometimes included. Where cabbage is grown it is included in the rotation, which consists of cabbage or potatoes, oats, and clover.

While cabbage has been grown to a limited extent for the past fifteen or twenty years, it is only within the past six or eight years that it has been produced upon a large scale. The success in growing this crop is attested by the constantly increasing acreage. One field of 70 acres was seen during the survey. The bulk of the product is shipped to the Southwest. There is a tendency to grow cabbage continuously for too long a period on the same piece of ground, which results in the crop becoming affected with disease. While this diseased condition of the crop may occur on soil planted to cabbage for the first time, it is more common and pronounced where the crop has been grown for several years in succession. Local experience has shown that cabbage should not be grown upon the same piece of soil for more than four years in succession.

Onions are extensively grown and are a profitable crop. They would be more generally grown if the proper labor could be secured. "Weeders" are paid from \$1.50 to \$2 a day.

The sandy soils in the eastern part of the county are particularly adapted to truck and small fruits and are almost exclusively used for these crops.

Agriculture in Racine County is in a prosperous condition, the general appearance of the fields and buildings being one of neatness and thrift. Diversified farming combined with dairying constitutes the prevailing type of agriculture, a combination which if carefully managed is almost certain to bring profitable returns.

For the most part the farms are operated by their owners, which accounts in large measure for the prosperous appearance and careful management. The average size of the farm is about 95 acres. Farm labor is not plentiful, and while generally efficient, can not always be secured when most needed. Many farm hands object to the labor connected with the dairying industry. From \$25 to \$30 a month with board is the usual wage.

According to the twelfth census, the value of farm lands and improvements, except buildings, was \$10,608,840, the value of the farm buildings amounting to \$3,112,430. There is a total of 200,387 acres in farms. With the exception of the gravel and muck soils, farm land ranges in price from \$50 to \$100 an acre.

The future growth of agriculture of the county depends principally upon specialization in crops. Cabbage has become an important special crop and, as pointed out, its acreage is being increased each year. Onions are profitable and might be more extensively grown. The county possesses excellent potato soils, and the extensive produc-

tion of potatoes is recommended. The undrained Muck areas should be reclaimed, as they are especially valuable for growing celery, peppermint, cabbage, and other vegetables.

SOILS.

Wisconsin lies within that section of the country which was in comparatively recent geological time covered by the great continental glacier, 1,000 feet or more in thickness, which spread over the northern part of the continent. During its slow advance southward the glacier picked up and carried great quantities of earth and rock, which were deposited when the ice melted. Slowly descending with its great load of debris, old valleys were filled up, new ones gouged out, hills planed off and new ones formed, and in many cases the natural features of the country were entirely altered. The earthy material which was thus deposited over the surface of the country varies in depth from a few inches to 300 feet and more. In Racine County the soils are, with few exceptions, the result of glacial action.^a

During the final advance of the ice sheet a part of the Lake Michigan glacier passed over the county in a westerly direction and deposited the drift or ground moraine, with low ridges and nearly level areas. The gently rolling topography of the central and eastern parts of the county is thus accounted for. At the same time a second lobe of the Lake Michigan glacier is supposed to have passed over the western end of the county in a southerly to westerly direction. At the point of meeting of these two lobes a terminal or interlobate moraine was formed, each glacier contributing material to its formation, and thus the range of hills in the western part of the county was formed. These hills have a rough, irregular topography, and contain numerous glacial kettle holes. There are frequent intervening low, level areas, which were once occupied by glacial lakes. Geological analyses of the drift show it to be composed of from 70 to 90 per cent of local material belonging to the Hamilton and Niagara formations.

As the ice receded it acted as a barrier to the north, so that all drainage outlets were to the south. As a result Lake Michigan was held at a much higher stage than at present, as is evidenced by the presence of an old beach line across the eastern end of the county nearly 60 feet above the present lake level. During this period the many low-lying areas were occupied by glacial lakes and the area east of the old beach line formed a part of Lake Michigan. The drainage was very much restricted and, with the exception of the highest elevations, the county was in a wet or swampy condition. This re-

^a See Professional Paper No. 34, United States Geological Survey.

sulted in an accumulation of organic matter which became incorporated within the glacial material, giving it the characteristic dark color. At the same time the waters flowing from the glacier were depositing their sediments in the small glacial lakes and along the shore of Lake Michigan, thus forming lacustrine deposits. As the glacier made a series of advances and retreats the level of the lake was constantly raised and lowered. A second beach line was formed along the top of the present lake bluff, producing a strip of sandy soils.

After the final retreat of the ice Lake Michigan assumed its present level; the smaller lakes were either drained or reduced in size and the drainage conditions of the whole country greatly improved. These formative and modifying processes have resulted in soils belonging to three series, namely, the light-colored drift soils, the dark-colored drift soils, and the glacial lacustrine deposits. The light-colored drift soils belong in the Miami series, the dark-colored drift soils in the Marshall series, and the glacial lacustrine deposits in the Clyde series. In all twelve types were mapped, the name and the actual and relative extent of each being shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Marshall clay loam.....	70,528	33.8	Dunkirk fine sandy loam....	5,568	2.7
Miami loam.....	40,192	19.3	Marshall loam.....	3,200	1.5
Miami clay loam.....	31,040	14.9	Wabash loam.....	3,136	1.5
Muck.....	21,760	10.4	Sioux sandy loam.....	2,304	1.1
Clyde clay loam.....	12,224	5.9	Clyde fine sandy loam.....	1,216	.6
Meadow.....	11,328	5.4	Total.....	208,576	.....
Miami gravel.....	6,080	2.9			

MIAMI GRAVEL.

The soil of the Miami gravel consists of a reddish-brown sand or sandy loam, with a depth ranging from 8 to 16 inches. Underlying the soil is a heterogeneous mixture of sand, gravel, and boulders. The gravel is nearly always waterworn, while some of the larger blocks and boulders show but little rounding. In some exposures both Galena and Trenton limestone boulders are present. There is little or no evidence of assortment or stratification in any of the numerous exposures in the county.

The Miami gravel is found only in the western part of the survey and is usually associated with the Miami loam. It occurs as well-rounded hills and knolls and also as narrow, choppy ridges. In a few cases the material of which it is composed outcrops beneath the Miami loam in the bluffs along Fox River. The surface soil is often

lacking, the knolls or ridges forming a huge heap of unsorted gravel and boulders.

The Miami gravel is of glacial origin and consists almost wholly of morainic material. Knolls too small to be shown on the map occur in the areas of Miami loam and Muck in the western part of the county.

The character of the material and its topographic position render the Miami gravel practically nonagricultural. The greatest part of the type remains timbered with hardwood and is used chiefly for pasturage. It supports a natural growth of June grass, which affords good pasturage during the early summer, but later fails on account of the soil being so unretentive of moisture. Grapes might do well on this soil. The gravel affords an excellent road-surfacing material, and the boulders found in the coarser gravel beds are used in constructing foundations and buildings.

MIAMI LOAM.

The Miami loam is a loam or silty loam from 10 to 14 inches deep, underlain by a brownish-yellow loam or clay loam. The heavy subsoil is underlain by unsorted gravel beds which may approach to within 2 feet of the surface, but gravel seldom occurs in the soil. The type contains only a small percentage of organic matter and is light brown or gray in color. A lighter phase of this type occurs in small isolated areas surrounded by Muck. Here the soil to a depth of from 14 to 24 inches is a fine sandy loam with an occasional sprinkling of fine gravel, while the subsoil resembles that of the typical areas.

The Miami loam is confined to the western part of the county and is the predominating soil in Burlington, Rochester, and Waterford townships. It also constitutes about one-half of the upland soil of Norway Township, and a few small scattered areas were mapped in the southwestern part of Raymond Township.

The surface of the Miami loam varies from gently rolling to hilly. Glacial kettle holes are not an uncommon feature and boulders of varying size frequently occur upon the surface. The drainage is very good, and on the ridges and steep slopes, where it is excessive, the soil has been removed and the underlying clay or gravel exposed. The Miami loam is a glacial soil formed by the weathering of the till. The soil is not difficult to cultivate; a good seed bed is easily secured, and sufficient moisture is retained for maturing crops.

Corn is the principal crop and yields from 30 to 75 bushels per acre. Oats yield from 30 to 60 bushels and barley from 20 to 50 bushels per acre. Alfalfa is successfully grown and yields between 4 and 6 tons per acre. Timothy does very well and clover is grown,

but the latter is sometimes killed by severe winters. Alsike clover does well on this soil and yields 2 tons of hay per acre.

Up to the present time barnyard manure is the only fertilizer that has been used on this soil.^a By its liberal application, combined with green manuring, which should be more extensively practiced, the deficiency in organic matter would be gradually corrected. No specific rotation of crops is practiced. Growing oats or barley for two to four years, then fertilizing with about 12 tons of stable manure to the acre and planting to corn is a common practice. Small fruits, truck crops, and potatoes do especially well upon this type and should be more extensively grown. The Miami loam ranges in price from \$50 to \$75 an acre.

The following table shows the average results of mechanical analyses of samples of this type:

Mechanical analyses of Miami loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15281, 15283.....	Soil	0.4	5.1	6.1	10.8	14.0	44.4	18.5
15282, 15284.....	Subsoil.....	.5	3.1	3.5	9.1	11.4	41.5	30.3

SIoux SANDY LOAM.

The soil of the Sioux sandy loam consists of a reddish-brown, medium sandy loam about 15 inches deep. The subsoil is a lighter brown, sticky sand. Both soil and subsoil contain coarse sand and fine gravel, the larger quantity being found in the subsoil.

The type is very limited in extent, the main body occurring as a narrow connected ridge, about 4 miles long and one-fourth mile wide, extending in a northwesterly direction from Racine. It consists of the sands and gravels which formed the beach line of Lake Michigan while it occupied its highest stage during the Glacial period, and is about 20 feet above the country lying to the east of it, the former

^a In a test of the Miami fine sandy loam by the wire-basket method applications of stable manure were followed by very satisfactory increases in plant growth. The use of nitrate of soda and sulphate of potash in combination also proved valuable, the increase from this source being greater than that derived from the use of complete fertilizer either with or without lime. The use of such stable manure as is made upon the farm with the addition of small amounts of the salts above named would seem to be a rational method of treatment for this type. The use of acid phosphate seems at this time inadvisable upon the field from which the sample was taken and to which the test is held to apply strictly, though since the agricultural practices are so similar throughout this section it is probable that the treatment indicated would be valuable on much of the Miami fine sandy loam area.

lake bed. South of Racine the type occurs as low ridges and knolls, the general trend, however, being parallel to the present lake shore. North of Linwood two small areas of the Sioux sandy loam were mapped.

This type is a desirable truck and small fruit soil, and potatoes, cabbage, asparagus, and onions are successfully grown. Apple trees present a healthy appearance. General farming is not practiced on this type.

The following table gives the results of mechanical analyses of fine earth samples of this soil:

Mechanical analyses of Sioux sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15279.....	Soil	9.7	13.1	16.2	26.9	6.9	16.1	11.1
15280.....	Subsoil.....	9.7	12.2	15.7	31.0	4.4	14.7	12.5

MIAMI CLAY LOAM.

The Miami clay loam consists of a light-brown or gray loam to silty loam 8 to 12 inches deep, resting upon a subsoil of heavy yellowish-brown clay loam or clay. Glacial bowlders were originally abundant, but have been mostly removed from the cultivated fields.

The largest body of Miami clay loam extends across the county in a north-and-south direction just west of Racine. This strip is 3 miles across at the widest point and is continuous, with the exception of a break of one-half mile west of Racine, where it gives way to the Marshall clay loam. The ridge is hilly in the north, undulating in the center, and rolling at the southern boundary. Other good-sized areas are scattered through the northern part of the county and extend west to the Muck area east of Wind Lake.

The surface of the type is gently rolling to hilly, and the Miami clay loam is most typically developed on the rougher areas. On these elevations the soil has an ashy appearance and carries a low percentage of organic matter. On the less rolling areas and in small depressions organic matter has given the soil a brownish tinge, and in these areas it usually contains a higher percentage of fine sand. The topographic features of the Miami clay loam insure good natural drainage, with the exception of draws and slight depressions. The type is glacial in origin and is derived directly by weathering from the glacial till.

If handled at the proper time the Miami clay loam is not a difficult soil to cultivate. If plowed when either too dry or too wet it has a tendency to clod. Some farmers disk the soil before plowing,

thus securing a more desirable seed bed. This type is cultivated to general farm crops. The yield per acre of oats ranges from 30 to 50 bushels, of corn from 25 to 40 bushels, of barley from 25 to 40 bushels, and of hay from 1 to 2 tons. No commercial fertilizers are used, but stable manure is liberally applied and there is some green manuring, though this could well be more generally practiced.^a Where field peas are sown broadcast and plowed under, and oats are drilled in a week later, between 4 and 5 tons of cured hay per acre are produced. This affords an excellent roughage, besides enriching the soil, and also makes a very nutritious and desirable green feed for dairy cattle.

As is the case upon the other types of the county, no particular rotation of crops is practiced. A good rotation consists of corn one year, barley one or two years, oats or rye one year, and then clover. The steeper areas are used for pasture and are left timbered. The natural growth consists of oak, hickory, and other hardwoods.

The following table gives the average results of mechanical analyses of fine-earth samples of the Miami clay loam:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15275, 15277.....	Soil.....	0.8	4.0	4.0	11.5	12.4	43.2	23.2
15276, 15278.....	Subsoil.....	.5	2.0	2.2	8.4	6.8	44.0	36.1

The following sample contains more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 15278, 12.9 per cent.

DUNKIRK FINE SANDY LOAM.

The Dunkirk fine sandy loam consists of a gray to light-brown fine sandy loam or fine sand, from 10 to 15 inches deep, underlain by an incoherent fine yellow sand or sandy loam. The soil contains sufficient organic matter to give it a loamy appearance, and constant cultivation combined with heavy applications of fertilizers has materially increased the humus content. The sand consists of fine, well-rounded particles of feldspar, hornblende, mica, and other minerals.

The largest and most typical body of the Dunkirk fine sandy loam

^a A test of a sample of this soil by the wire-basket method indicates that the mineral fertilizers are not markedly effective on this type of soil. Good results, however, followed the application of green manure and barnyard manure, owing, no doubt, to the improvement in physical condition following the use of these substances, and it would appear that considerable improvement could be made by a systematic use of the green manure if stable manure is not available in sufficient quantities.

is located along the lake front. It occupies the bluff rising 20 to 40 feet above the water's edge and is lacustrine in origin. When Lake Michigan was much larger and extended west to the ridge of Sioux sandy loam—the former beach line—a thick deposit of clay was laid down. Later the sandy material was deposited upon the drab-colored clay foundation, the line of contact being very sharp. The sandy deposition consists of fine yellow stratified sands ranging in depth from a few inches to 6 feet or more. The smaller areas are of glacial origin.

While occupying only 2.7 per cent of the land surface of Racine County, the Dunkirk fine sandy loam is one of the most important soils of the area. It is a typical early-truck soil, its loose loamy structure and thorough drainage adapting it to market-garden produce. Its comparatively porous texture causes it to dry out early in the spring, while the relatively high content of organic matter which has been worked into it makes it a warm soil, so that it is at least a week or two earlier than the heavier soils of the county. All the variety of vegetables adapted to the climate are grown and do well. Most of the produce is sold to local markets, but some is shipped outside. Besides trucking and the growing of a few sugar beets, some general farming is carried on. Oats, grass, and buckwheat produce fairly good yields.

The Dunkirk fine sandy loam is naturally deficient in organic matter, and heavy applications of stable manure are required to conserve moisture and add humus. Barnyard manure is almost universally used and is generously applied to the trucking areas, the quantity ranging from 12 to 18 tons per acre. Truckers sometimes use a limited amount of commercial fertilizers in addition to stable manure to force some particular crop, but its use is not general.

The following table gives the average results of mechanical analyses of fine-earth samples of this type:

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15259, 15261.....	Soil	0.3	2.6	9.8	54.1	17.4	9.1	6.3
15260, 15262.....	Subsoil.....	.1	3.8	22.7	58.0	7.9	3.6	3.7

MARSHALL LOAM.

The Marshall loam is a dark-brown or black, heavy sandy loam, from 8 to 14 inches deep, resting upon a subsoil of light-brown sandy loam containing some fine gravel.

This type occurs only in the western part of the county, where it occupies three limited areas. The largest of these occurs in the vicinity of Caldwell Prairie, the next in size just west of Waterford, and the smallest at Burlington. It occupies gently rolling areas and slopes bordering the Miami loam. It is of glacial origin, the greater part consisting of reworked material from the uplands. In the depressions the soil contains more sandy material and is darker in color.

The Marshall loam is recognized as a very desirable trucking soil. It is the lightest soil in the western part of the county and is conveniently located to markets, so the greater part of it is devoted to market gardening. Both vegetables and small fruits are extensively grown and give good yields. Besides supplying the home market, much of the produce from the Caldwell Prairie area is marketed in Milwaukee. The Marshall loam is also a desirable soil for general farming. Hay averages 2 tons per acre and as much as 4 tons per acre has been secured. Barley yields from 30 to 40 bushels per acre. Popcorn, which sells for from \$1 to \$1.50 per hundred pounds, yields from 40 to 50 bushels per acre. The custom of applying barnyard manure liberally is practiced upon the Marshall loam.^a

The following table gives the average results of the mechanical analyses of fine-earth samples of this type:

Mechanical analyses of Marshall loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15269, 15271	Soil	1.1	10.5	11.5	16.8	12.7	24.1	22.5
15270, 15272	Subsoil	1.0	8.1	8.1	13.7	16.0	29.4	23.2

MARSHALL CLAY LOAM.

The soil of the Marshall clay loam is a dark-brown or black loam or heavy sandy loam, with a depth of 14 inches. When wet it resembles a heavy loam or clay, but when dry it becomes mellow and friable. Immediately beneath the soil is a brown loam, more compact than the soil, which becomes heavier as the depth increases. At a depth of 2 feet a clay loam or clay is encountered. There is little

^a That the chief need of this soil is the restoration of its organic matter was clearly brought out in a test by the wire-basket method to determine its manurial requirements. Much of this type is devoted to growing cabbages, some fields having been in that crop for upward of twenty years consecutively. The growing of an occasional crop, preferably a legume, for green manure presents itself as the most feasible way of increasing the organic content of this soil, and such a course should be followed by those interested in the cabbage industry in this vicinity, the amount of stable manure available being generally inadequate for the purpose.

or no coarse material in either soil or subsoil. Originally glacial boulders were scattered over the surface of this type, but for the most part these have been removed. The soil has a loamy structure, is friable and easily worked, and only in depressions where the drainage is inadequate is there any danger of clodding or baking. It contains a relatively high percentage of organic matter, which gives the black color characteristic of the type.

The Marshall clay loam is the predominating soil type of Racine County and is found throughout the eastern two-thirds of the county. It occupies gently undulating to rolling country and is, as a whole, well drained. In the gently rolling sections there occur many depressions from 2 to 20 or more acres in extent which have no natural outlet for the drainage waters. These areas are a hindrance to the farmer, and often could be drained at a moderate cost. Many swampy areas have been tiled and reclaimed, but much valuable land still remains in a condition too wet for farming.

The soil is derived primarily from glacial till which at some former time was in a wet or swampy condition, thus favoring the growth and decay of water-loving vegetation and giving the soil its high organic matter content.

The Marshall clay loam is the most important soil type in the area, both in extent and agricultural value. General farming is practiced and the soil is adapted to a wide variety of crops. Corn yields an average of 40 bushels and hay about $1\frac{1}{2}$ tons per acre. A large acreage of oats is sown each year on this soil and the average yield is about 40 bushels per acre. Barley is being more extensively grown, while rye and buckwheat are grown in less quantities. Some wheat and flax are produced, but in limited quantities compared with earlier years. Flax is grown both for seed and fiber, the average yield of seed being about 15 bushels per acre.

Besides general farming, the Marshall clay loam has within the last few years come to be used extensively for growing cabbage. For the last eight or ten years the acreage has steadily increased, and at the present time thousands of acres are devoted to this crop. For the growing of cabbage it is necessary to have the soil in good tilth. From 12 to 15 tons of stable manure are applied to the acre, and after plowing the soil is harrowed until thoroughly pulverized. Cabbage plants are set by a planter from about June 20 to July 10. The average yield is from 12 to 15 tons per acre. The crop is shipped to outside markets in carload lots. The "Danish Baldhead" is considered best for shipping purposes, while common varieties are used for kraut and home consumption.

On account of the scarcity of labor sugar beets are not grown extensively. The soil is well adapted to this crop, the quality of the

beets being excellent and the yields ranging from 8 to 12 tons per acre.

No set rotation of crops is practiced upon the Marshall clay loam, each farmer planting crops according to his own judgment. It is the universal custom, however, to apply barnyard manure in liberal quantities, with the result that the soil maintains its productiveness. The price of this type of soil ranges from \$75 to \$100 an acre.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Marshall clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15263, 15265	Soil	0.8	2.3	4.0	10.1	9.4	44.1	29.1
15264, 15266	Subsoil. ....	.5	2.8	3.7	11.1	16.4	37.0	27.7

The following sample contains more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 15266, 9.9 per cent.

CLYDE FINE SANDY LOAM.

The Clyde fine sandy loam is a fine sand or sandy loam from 10 to 14 inches deep, resting on material of the same general character extending to a depth of 3 feet or more. The soil contains a high percentage of organic matter, and in the low-lying areas has the texture of a sandy muck. It varies in color from black to brown, and there is no coarse material in either soil or subsoil.

The chief occurrence of this type of soil is in the eastern part of the county, where it forms a long, narrow strip north of Racine. It occupies a physiographic position intermediate between the Dunkirk fine sandy loam and the Clyde clay loam, and has the loamy structure of the former and the color of the latter. It also occurs in depressions in areas of the Dunkirk fine sandy loam, with which it is closely associated, the origin of these two soils being the same. The fine sands composing these soils were deposited upon the ancient lake floor at the same time, but the material constituting the Clyde fine sandy loam remained in a swampy condition for a greater period and more organic matter was incorporated with the soil.

The type occupies level to slightly undulating areas and is generally well drained, and with its loose, loamy structure and porous subsoil does not require artificial drainage, except in depressions and draws.

The soil is admirably adapted to small fruits and truck, and is mostly devoted to the production of these crops. Some general farm crops are grown, but only to a limited extent.

The average results of mechanical analyses of samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Clyde fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15255, 15257	Soil	0.3	1.6	3.4	53.0	20.1	12.9	8.1
15256, 15258	Subsoil .....	.1	1.1	3.4	67.4	19.5	4.2	4.1

CLYDE CLAY LOAM.

The soil of the Clyde clay loam is a dark-brown or black loam from 8 to 14 inches deep, resting upon a yellow or drab-colored clay, often streaked with iron stains. The clay subsoil is a plastic silty material when wet and contains very little coarse sand or fine gravel, excepting along stream courses, where coarse material may be encountered within the third foot.

The Clyde clay loam occupies level areas and the drainage is very poor. It occurs throughout the county in bodies of varying size, the larger areas being found in the eastern part. The poor drainage has given rise to some variation in the surface soil. In the poorly drained areas the soil possesses properties resembling a clay or clay loam, while in the better drained areas, and also where there is an accumulation of organic matter, the soil becomes loamy and mellow. The type is found occupying glacial lake beds and smaller depressions and is derived from reworked glacial till.

Comparatively few of the Clyde clay loam areas are under cultivation, and where not artificially drained the type is used for hay and pasture. Some sections of the long body of this type north of Racine have been drained, and here general farming is practiced. Corn yields from 40 to 60 bushels, oats from 30 to 50 bushels, and hay from 1 to 2 tons per acre. In the vicinity of Racine the type is quite extensively devoted to the cultivation of cabbage and onions. Cabbage produces from 10 to 15 tons per acre, onions from 400 to 700 bushels, and potatoes from 150 to 250 bushels per acre. Celery also does well on this soil. Onions are planted the latter part of May, after from 12 to 15 tons of stable manure per acre have been applied and the soil has been thoroughly prepared. The crop is harvested the last of September and brings an average price of 30 cents per bushel. Cabbage should follow onions, and not the reverse. No special rotation of crops is followed on this type of soil.

Nearly all of the Clyde clay loam is capable of improvement through drainage, and when reclaimed will prove one of the best soils of the area for general farming and trucking. In droughty

seasons crops planted upon the Clyde clay loam have an advantage over those on other soils, but in wet seasons the reverse is true.

The average results of mechanical analyses of samples of this type are given in the following table:

Mechanical analyses of Clyde clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
15251, 15253	Soil	0.2	1.5	2.7	11.2	5.4	52.0	26.9
15252, 15254	Subsoil .....	.1	1.0	1.4	9.1	5.9	46.6	35.6

The following sample contains more than one-half of 1 per cent of calcium carbonate (CaCO_3): No. 15252, 11.1 per cent.

WABASH LOAM.

The Wabash loam consists of a black to brown medium loam or heavy sandy loam from 10 to 16 inches deep, resting upon a subsoil composed for the most part of loam, though sometimes of sandy loam containing fine gravel.

The type as it occurs in Racine County is of minor importance. It occupies low, level areas along the Fox and Root rivers and is alluvial in origin. The type is not well drained, and at least two-thirds of it is devoted to pasture. The soil is productive, but a great deal of it is subject to overflow during high water and is not generally used for farming. Near Racine it is devoted to small truck patches, and all vegetables apparently do well.

MUCK.

Swampy and marshy depressions in which a quantity of organic matter has accumulated are characteristic features of Racine County. The material in such depressions, which have been mapped as Muck, ranges in depth from a few inches to 3 feet or more. It consists of a black loam high in organic matter, underlain in the shallow phases by a gray or mottled sandy clay or sand. In a few instances where decomposition of the organic matter has not advanced far enough to produce a true Muck the accumulated material has more the nature of Peat. In the vicinity of Wind Lake some peat beds occur, which might be developed and the product used for fuel.

The larger bodies of Muck are confined to the western half of the county, while isolated areas are scattered throughout the various soil types. Numerous areas occur which are too small to be shown on the map.

The largest body of Muck is found bordering the southeastern shore of Wind Lake and at one time was covered by water. Attempts

have been made to drain this area by constructing large open ditches. Wind Lake has no natural outlet and in times of high water the ditch leading south from the lake serves this purpose, the water emptying into Fox River above the dam at Rochester. The present drainage system does not give sufficient fall thoroughly to drain the Muck area, and the sluggish currents soon fill the ditches with sediment, and redredging is necessary. At comparatively little cost the drainage canal could be constructed to empty into the river about $1\frac{1}{4}$ miles south of Rochester, at the point where the outlet to Eagle Lake joins the river. The canal could be extended through the narrow Muck area 1 mile east of Rochester and by making a cut of about 20 feet for a quarter of a mile could be made to follow the depression mapped as Meadow. By thus conducting the ditch below the dam at Rochester the fall would be increased at least 10 feet, which would be sufficient to insure thorough drainage of this extensive Muck area. At present the area is adapted only to grass.

The area southeast of Caldwell Prairie is the second largest in the county. Its present swampy condition prevents farming and is due in part to backwater from Fox River caused by the dam at Waterford. Muck areas lie along some of the stream courses, and in many cases a stream will have its source in an area of Muck. Nearly all the Muck areas support a luxuriant growth of wild grass, which is harvested when conditions permit. While the wild hay may not be as nutritious as timothy, it is readily eaten by stock.

Thousands of acres of typical Muck lie within the borders of Racine County and when reclaimed will prove its most valuable and productive soil.^a Some of the smaller Muck bodies have been artificially drained and produce abundant yields of corn. In many sections of the United States large profits are being realized from the growing of special crops upon the Muck soil. Celery, cabbage, onions, peppermint, and carrots are especially adapted to this type. Timothy also grows well upon thoroughly drained Muck.

MEADOW.

Under Meadow is included all the low-lying, flat, and poorly drained strips along the streams. Such areas are usually subject to overflow, and are composed of soils of variable character. Meadow was also mapped in the uplands in small undrained areas where decomposition of the organic matter had not produced Muck. Such areas, often too small to be shown on the map, occur through most of the soil types of the area, but are especially common in the areas of

^a In a test by the wire-basket method of the manurial requirements of this soil type, the most satisfactory increases were obtained by the use of potash, its good effects being shown when this salt was used singly or in combination.

Marshall clay loam. While some of these Meadow areas could not be drained without considerable expense, the majority are capable of being economically reclaimed by proper drainage. They are rich in organic matter and produce abundantly when drained. The native growth consists of wild grass—sometimes cut for hay—reeds, and willows.

SUMMARY.

Racine County is situated in the southeastern part of the State. The western part of the county is rolling to hilly, while the central and eastern sections are undulating to gently rolling.

The summers are short and the winters long and usually quite severe. The average yearly rainfall ranges from 30 to 35 inches. The drainage is mostly into Lake Michigan.

The population of the county is about 45,000, two-thirds of which is either foreign born or of foreign parentage. The central and eastern parts of the county are the more thickly settled.

The agriculture of Racine County is in a prosperous condition. The principal products are grain, hay, milk, cheese, and butter. Dairying is an important industry and is steadily increasing. The quality of the cattle is being steadily improved. The milk output is utilized by creameries and factories located within the county. Some hay and barley are marketed, but for the most part nearly all the farm produce is fed on the farm.

The importance of crop rotation is recognized and is practiced, but no definite rotation exists. Stable manure is widely used and is generously applied. Farm labor is not plentiful and is paid from \$25 to \$30 per month, with board.

Twelve soil types, including Muck and Meadow, were recognized and mapped. These soils range from a clay loam to light sandy loams. The heavier soils are used for general farming, while the light-textured soils are devoted principally to trucking. This wide variation in the soils of Racine County permits of diversified farming, and nearly every type of agriculture is practiced to a greater or less extent.

The Miami loam is a productive soil and is well adapted to general farming. Specialization of crops has not been attempted upon this type and the extensive growing of potatoes is recommended.

The Marshall clay loam, the most extensive type of the area, besides being a fine soil for general farm crops, is particularly well adapted to the growing of cabbage, and this industry might be profitably extended.

The Miami clay loam is the heaviest soil of the county. It occupies rolling country, is well drained, and is an excellent soil for hay. It is devoted to general farming. Apples do well.

The Miami gravel is a nonagricultural type and is used only for woodlots and pasture. It occupies hills and ridges, and is confined to the western part of the county.

The Sioux sandy loam is limited in extent, occurring as an old beach line in the eastern part of the county. It is used for trucking and market gardening. Apples do exceptionally well.

The Marshall loam is another soil type of limited extent, occurring in three separate areas in the western section of the county. It closely resembles the Marshall clay loam, but is more sandy. It is used principally for trucking and market gardening, but some of it is devoted to general farming. The crop yields are good.

The Clyde clay loam is a heavy, poorly drained soil, and in dry seasons produces fine yields of corn, hay, and oats. It requires artificial drainage, but when thoroughly tilled it produces abundant yields. It occurs in areas of varying size, the largest body running parallel to the lake bluff about a mile to the west.

The Dunkirk fine sandy loam occurs principally along the lake front and is a recent lake deposit. It is a fine loamy sand and is an ideal soil for early truck. It is especially adapted to vegetables and small fruits.

The Clyde fine sandy loam is an intermediate type between the Clyde clay loam and the Dunkirk fine sandy loam. It has the characteristic dark color of the Clyde series and the texture and structure of the Dunkirk fine sandy loam. It is devoted to trucking and is well adapted to vegetables and small fruits.

The Wabash loam is an indeterminate type, occurring in low-lying areas along the larger stream courses. The greater part is subject to overflow and is devoted principally to hay and pasture. Near Racine it is used for truck crops.

The Muck areas when reclaimed should prove remunerative for growing special crops. Celery and peppermint should prove especially profitable. Wild grass produces from 1½ to 2 tons per acre.

Meadow is usually too wet to permit of farming and is devoted to hay and pasture. A great deal could be reclaimed by artificial drainage.

Green manuring should be more extensively practiced, especially upon the Miami clay loam and Miami loam on account of their deficiency in organic matter.

Alfalfa is an ideal forage crop and a splendid soil renovator and should be more extensively grown. The dairy farmer will find it of inestimable value.

More care should be taken to prevent the spread of noxious weeds. The Canada thistle is especially numerous and troublesome, yet little attention is given by the average farmer to combating it.

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