WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
H. L. RUSSELL, Dean

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SOIL SURVEY

OF

RACINE AND KENOSHA COUNTIES

WISCONSIN

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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the state, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: First, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis,* which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

The textural classification is the most important since it has to do with the water holding capacity of the soil. It also determines the ease with which a soil can be worked, and has much to do with the crops to which the soil is best adapted.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

Soils Containing Between 20–50% of Silt and Clay

Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay. Less than 20% silt.

Soils Containing over 50% of Silt and Clay

Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a gradation in texture of otherwise uniform material, such a group is called a *soil series.* It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey. By uniting the soil class and the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF RACINE AND KENOSHA COUNTIES, WISCONSIN

CHAPTER I

DESCRIPTION OF THE AREA

Racine and Kenosha counties are located in the southeastern corner of the state with Lake Michigan forming the eastern boundary, and the state of Illinois the southern boundary. The total area is about 606 square miles or approximately 387,840 acres.

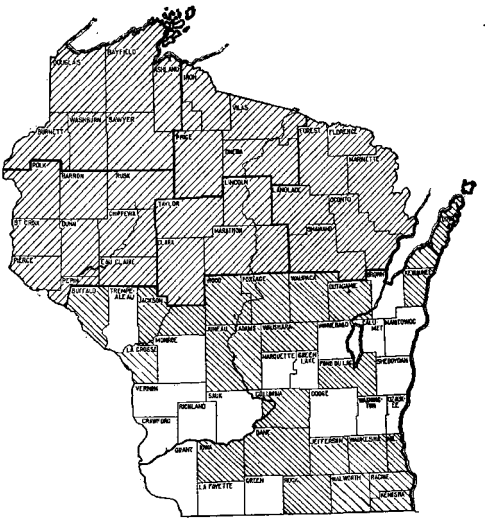


FIG. 1.—Sketch map showing progress of soil survey. Cross lined counties in north half of state have been covered by a prelimnary survey while ruled counties in south half have been covered by detailed survey of the soils.

The surface features of the region fall naturally into several divisions, each of which is fairly distinct. Beginning along the Lake Michigan shore the first feature of interest is the narrow belt of bench or terrace land which extends back from the lake for from nearly a mile to several miles, and runs parallel with the lake across both counties. The lake has an elevation of 581 feet above sea level and the terrace at Kenosha is 612 feet and

at Racine 629 feet in elevation. The surface is level or very nearly so. The western border is marked in a number of places by a more or less continuous low ridge of gravelly sandy material which represents an old beach line and marks the shore line of the lake when the water stood at a much higher level than at present.

West of the lake terrace is an extensive belt of gently undulating country where the soils are for the most part very heavy and where the surface consists of a series of very broad, low, flat, ridges, or swells. The slope is so gentle that because of the heavy soils the natural drainage is somewhat deficient in places. The region is somewhat higher than the terrace, the town of Union Grove being 780 feet and the town of Bristol being 782 feet above sea level. The belt is from 14 to 20 miles wide and its western border terminates in a line just west of Wind Lake in Racine county and just east of Paddock's Lake in Kenosha county.

The extreme western end of the two counties, including nearly a fourth of the total area is a belt of gently rolling to hilly country which presents a marked contrast to the other two regions just described. It consists of country having an uneven surface which ranges from gently rolling to rough, bumpy, broken and hilly, and contains a great variety of soils. Most of the lakes of the area are found in this belt. It is known to geologists as a recessional moraine of the Late Wisconsin Ice Sheet, and is a part of the Valpariso Moraine.

Within this belt and also along the western border of the two counties there are a number of water laid or alluvial deposits where the surface of the land is level. These are usually found bordering streams or lakes. The total area of such tracts is small but the areas are distinct and readily recognized by their flat surfaces.

In addition to these various divisions there are scattered throughout the region, numerous areas of low lying land where there has been an accumulation of organic matter, in many places sufficient to be classed as peat. Associated with the peat and usually bordering the drainage ways there are also rather numerous areas of heavy, black soils, which are poorly drained, where there is also a large accumulation of organic matter but not sufficient to be classed as muck or peat.

The area surveyed has two drainage systems. The first includes that part of Kenosha county, except a small area along the Illinois line, lying east of the Chicago, Milwaukee and St. Paul Railroad, and almost all of Racine county lying east of Dover and Norway townships, with the exception of a small area near Sylvania. It is drained into Lake Michigan by the Root and Pike Rivers and their tributaries, and also by a number of short intermittent streams, which have their heads along the eastern slope of the most easterly ridges of the region bordering the lake terrace.

The second system is drained by the Desplaines River and the Fox River into the Illinois River. The Desplaines and Fox are separated by a divide extending from east of Cross Lake north through Salem and Klondike to the north central part of Brighton township. The large number of lakes, swamps, and marshes in this region indicate a very young topography, so young that practically all of the lowland has very poor drainage or no drainage at all. The streams have not had time to develop valleys sufficiently deep to ramify all sections with their tributaries to provide drainage for those low areas.

Racine county was formed in 1836, and Kenosha county was set off from it in 1850. The early settlers were of Anglo-Saxon descent, and came largely from New York and New England. Later there was a great influx of Germans, Norwegians, Irish, Scotch and English. All parts of the area are now thickly settled and well developed. The population of the two counties is given in the 1920 census as 130,245, of which 27,554 is classed as rural, averaging 45.0 persons to the square mile.

The city of Kenosha on Lake Michigan in the east central part of Kenosha county is the county seat of Kenosha county, and according to the census of 1920, it has a population of about 40,472. Kenosha is a manufacturing center of considerable importance and is provided with both steam and electric railroad and water transportation facilities to Chicago and Milwaukee. Other towns and shipping points in Kenosha county are Somers, Truesdell, Bristol, Salem, Silver Lake, Wheatland, Trevor, Bassetts and Twin Lakes.

Racine is the county seat of Racine county. It is one of the leading manufacturing cities of the state, and has splendid steam, electric and water transportation facilities. Its population at the last census was 58,953. Burlington, with a popula-

tion of 3,626, is located in the extreme west-central part of this county. It supports condensary, canning factory, sauerkraut factory, blanket factory, and basket factory. It is on two steam railroads, and has one electric road running to Milwaukee. Union Grove has sauerkraut and hemp factories, Franksville has a sauerkraut factory. At Rochester there is the County Agricultural School. Other towns in Racine county include Waterford, Wind Lake, Corliss, Sylvania, Kansasville, Dover and Honey Creek.

The area as a whole is very well provided with rail and water transportation facilities.

The area is provided with a very good road system. A number of concrete roads extend out from Racine and Kenosha, and all of the more important roads are kept in good condition. Under the present road making system all of the public roads receive some attention. For a time during the spring and fall many of the cross and secondary roads are not in good condition. Practically all parts of the area are reached by rural mail delivery routes and by telephone lines.

Racine and Kenosha are the principal home markets and Milwaukee and Chicago are the leading markets outside of the area.

SOILS

Kenosha and Racine counties in common with most of southeastern Wisconsin owe the general character of their surface material to several distinct methods of accumulation. These materials may be glacial, lacustrine (lake deposited) and alluvial. To these important agencies may be added the accumulation of organic matter in low places under poor drainage which has resulted in the formation of peat.

This area was covered by one or more ice sheets during the glacial period. At that time snow and ice accumulated in the region of Labrador and to the west of Hudson Bay to such an amount that it pushed outward from these centers, especially southward, until a point was reached where the ice melted as rapidly as it advanced. In moving across the country, the ice gathered up all sorts and sizes of material, including clay, silt, sand, gravel, boulders, and even large masses of rock. Many of these materials were carried for hundreds of miles and rubbed against surface rocks or against each other until ground

into sand and silt. When, through the melting of the ice, the limit of advance was reached, this transported material accumulated in a terminal moraine, a broad undulating ridge, usually with a steep outer slope and with the inner slope longer and more gradual. The width of these moraines varies from a half mile to three or four miles. When the ice melted away more rapidly than the glacier advanced, the terminus of the glacier would recede and leave this material deposited somewhat uniformly over the area previously covered by the ice sheet. The glacier advanced and receded a number of times, and with each advance another moraine was formed. The intervening tracts are now occupied chiefly by level, undulating, or slightly rolling plains.

The material transported by the glacier varied with the character of the rocks over which it passed. Granites, limestones and sandstones were mixed and ground up together. This mixture of all kinds of material-boulders, clay, sand, silt and gravel is called boulder clay, till, glacial drift or simply drift. The grinding action and denuding power of glaciers is enormous. A mass of ice 100 feet thick exerts a pressure of forty pounds per square inch and this ice sheet may have been several thousand feet in thickness. The material carried along in this mass of ice, especially the boulders and pebbles, became powerful agencies for grinding and wearing away the surface over which the ice passed. Pre-glacial ridges and hills were rubbed down, valleys were filled in with the debris and the surface features were changed entirely.

Since first deposited these various materials have undergone changes due to the action of water, wind, freezing and thawing, and the accumulation of various amounts of organic matter. In the work of the soil survey this material has been classified according to its texture, color, structure, origin, organic matter content, topography, etc., into various groups known as soil series and soil types. Within the present survey 8 series and 24 types were recognized and mapped. Differences with some agricultural significance but not important enough to designate as types are recognized as phases of the types to which they are most closely related.

The Miami series is characterized by light brown to brown surface soils, and yellowish-brown to slightly reddish brown heavier subsoils, resting at depths of 18 to 36 inches, upon a

porous mass of stony and gravelly till, considerably weathered but carrying a high percentage of limestone material. In this series the surface soils are seldom in an acid condition and often do not require applications of lime for maximum crop development. The areas are frequently rolling to irregular, ridgy and bumpy in topography and the natural drainage is good to excessive. Soils of this series have developed under forest cover. They form the dominant soils of the irregular morainic uplands in the western end of the area. Three types are mapped, the silt loam, fine sandy loam and loam.

Soils mapped as a phase of the Miami series are brownish-gray to light brown with a grayish tinge. The subsoil is heavier than the soils in texture, compact and rather tough in structure, yellowish brown in the lighter textured areas where drainage is best to dull yellowish-brown mottled slightly with gray and brown in the areas of heavy texture. A moderately friable to heavy compact, calcareous till, only slightly weathered, forms the substratum at depths of 2 to 3 feet, or in some places at a slightly greater depth than 3 feet. The surface soils are usually in an acid condition and respond favorably to application of lime. These deep Miami soils have developed under conditions of fair to good drainage in forested areas, usually of ground moraine, where the till does not carry excessive quantities of gravel and stone. The silt loam, deep phase, and clay loam members are mapped.

The Carrington series includes types with very dark brown to black soils and a heavier textured, compact, yellowish-brown subsoil that rests upon partly weather calcareous till at depths of 2½ to 3 feet. The silt loam and clay loam members of the series are mapped. There are a few scattering areas of the loam and fine sandy loam of mapable size but these are included with the silt loam on account of their small total extent. These soils developed under prairie conditions.

The soils in the Clyde series are black and the subsoil is gray, mottled with yellow and brown, heavier than the soils in texture, and compact to tough and somewhat plastic. Below depths of 2 to 3 feet the subsoil becomes calcareous and gives way gradually to calcareous till having the same general character as that underlying the Carrington and Miami soils.

With the Clyde series as correlated in this report are the Maumee series and the Newton series as previously mapped by the U. S. Bureau of Soils. The material classed as Maumee series is similar to the Clyde, except that it is waterlaid and is underlain at from 30 inches to 4 feet by lighter material. Its natural drainage is poor. The Newton series recognized by the Bureau of Soils is also similar to the Clyde but it occurs as part of the old Lake Michigan terraces, and is also similar to the Waukesha, except that it is more poorly drained. In the Clyde series, as it appears in this report we have the types, Clyde clay loam, silt loam and fine sandy loam.

The types included in the Rodman series are characterized by brown soil overlying at shallow depths porous beds of stratified gravel and sand carrying a high percentage of limestone material. In many places the surface soils are quite gravelly and give way to beds of gravel without any intervening subsoil layer. The topography is very broken, consisting of kames, eskers and terrace escarpments and the drainage is excessive. The gravelly loam is the only type mapped.

In the Fox series the surface soils are brown and the subsoil is yellowish brown to slightly reddish brown, heavier than the soil, and compact to rather tough in character. The subsoil gives way at depths of 2 to 3 feet, or in some places at greater depth, to stratified beds of gravel and sand in which there is a high percentage of limestone material. The surface soil is neutral to only slightly acid, except in some of the areas in the heavy subsoil phase of the silt loam, where, the stage of soil development corresponding closely to that of the Miami series of the uplands, the acid condition of the soil is more pronounced. The topography is flat to slightly undulating and there are also included some long narrow gravelly low ridges representing beach lines. The natural drainage is good. The series is represented by the loam, silt loam and gravelly loam.

The types of the Plainfield series have light brown soils and a brownish-yellow subsoil, as light as the soil in texture. The substrata are similar in texture to the subsoil or may be lighter in the upper layers and heavier at greater depths. The surface is level to undulating and the natural drainage is good. The series has been formed from material of a noncalcareous character laid down by water and probably modified subsequently to

some extent by wind action. The fine sand occurs in small areas on the Lake Michigan Terrace.

The Superior series consists of types with brown to yellowish-brown surface soils, underlain by a mottled yellow and gray upper subsoil and pinkish-red heavy clay lower subsoil. The heavy underlying clays are moderately calcareous, but the surface soils are in an acid condition. This series occurs in lake terraces occupying flat areas with poor drainage. The types mapped are the fine sandy loam and clay loam with small areas of the loam included as a heavy phase of the fine sandy loam.

The surface soil of the types included in the Waukesha series are very dark brown and the subsoil is yellowish-brown, somewhat heavier and more compact than the soil, and underlain at depth of 2 to 3 feet, or in the deep subsoil phases of the types at greater depths, by stratified beds of gravel and sand carrying a high percentage of limestone material. The surface soils have been leached of excess lime and usually give an acid reaction. The areas are level to slightly undulating in topography and have good natural drainage. Like the Carrington soils, the Waukesha soils have developed under prairie conditions. Four types are represented, the loam, silt loam, with a deep phase, fine sandy loam, and fine sand.

The Genesee soils are not typically developed in Kenosha and Racine counties. As mapped, the surface soils are brownish gray to brown and the subsoil is yellow and gray mottled to light brown. There is no important textural change from the surface downward. These soils are developed in the flood plains of the Fox River and other larger streams of the area where considerable deposition of material still takes place during overflows. The loam is mapped and small areas of the fine sandy loam, too small in extent to show as a separate type, are included as a sandy phase.

Peat and a shallow phase of the peat were mapped. The peat consists of decayed vegetable matter in varying stages of decomposition with which there has been mixed small amounts of mineral matter. In some places of small extent this has been sufficient to make a muck soil.

The names of the different soils with their actual and relative extent are given in the following table:

AREAS OF DIFFERENT SOILS *

Soil	Acres	Per cent
Carrington clay loam	112,320	29.0
Miami clay loam	56,384	14.5
Clyde clay loam	40,128	10.3
Miami silt loam—deep phase	31,808	8.2
Clyde silt loam	34,688	9.0
Peat	23,552	6.5
Shallow phase	1,664	
Fox silt loam	15,616	4.0
Miami silt loam	15,488	4.0
Carrington silt loam	9,920	2.5
Rodman gravelly loam	8,512	2.2
Miami loam	6,272	1.7
Gravelly phase	320	
Waukesha silt loam	3,840	1.4
Deep phase	1,600	
Fox loam	4,608	1.2
Waukesha loam	3,648	.9
Waukesha fine sand	2,908	.8
Waukesha fine sandy loam	3,264	.8
Miami fine sandy loam	3,200	.8
Clyde fine sandy loam	2,368	.6
Plainfield fine sand	1,984	.5
Superior fine sandy loam	960	.3
Muck	832	.2
Fox gravelly loam	832	.2
Dune sand	384	.1
Genesee loam	320	.1
Superior clay loam	320	.1
Total	387,840	.....

*In comparing this report with the soil survey report of the same area published by the U. S. Bureau of Soils. it will be noted that there are differences in the soil type names. Some of the names are different and there are more types described by the Bureau of Soils than are described and shown on the map in this report.

The reason for this difference is that because of the small extent of some of the soil types as described by the Bureau of Soils, and because of the similarity of some soils to others, some combinations and correlations have been made in the state edition for the purpose of reducing the number of types and simplifying the map and report.

The following table gives the names of the various soil types which were recognized and mapped in the soil survey of the Racine-Kenosha area.

Soil Type Names Used in the Report Issued by The Wisconsin Geological and Natural History Survey	Soil Type Names Used in the Report Issued by the U. S. Bureau of Soils
GROUP OF HEAVY SOILS	
Carrington clay loam	Carrington silty clay loam
Carrington silt loam	Carrington silt loam
Waukesha silt loam	Waukesha silt loam
	Waukesha silt loam, deep phase
Fox silt loam	Fox silt loam
	Fox silt loam, heavy subsoil phase
	Fox silt loam, gray sandy phase
Miami clay loam	Miami silty clay loam
Miami silt loam	Bellefontaine silt loam
Miami silt loam, deep phase	Miami silt loam
Superior clay loam	Superior silty clay loam

GROUP OF LOAMS AND FINE SANDY LOAMS

Miami loam	Bellefontaine loam
	Bellefontaine loam, gravelly phase
Miami fine sandy loam	Bellefontaine fine sandy loam
Fox loam	Fox loam
Waukesha loam	Waukesha loam
	Newton loam
Waukesha fine sandy loam	Waukesha fine sandy loam
Superior fine sandy loam	Superior fine sandy loam
	Superior fine sandy loam, heavy phase

GROUP OF SANDY AND GRAVELLY SOILS

Fox gravelly loam	Belmore gravelly fine sandy loam
Rodman gravelly loam	Rodman gravelly loam
Waukesha fine sand	Waukesha fine sand
	Newton loamy fine sand
	Newton loamy fine sand, heavy phase
Plainfield fine sand	Plainfield fine sand
Dunesand	Dunesand

GROUP OF POORLY DRAINED SOILS

Clyde clay loam	Clyde silty clay loam
	Clyde silty clay loam, marsh phase
	Maumee silt clay loam
	Newton clay loam
Clyde silt loam	Clyde silt loam
	Clyde silt loam, marsh phase
	Maumee silt loam
	Maumee silt loam, marsh phase
	Newton silt loam
Clyde fine sandy loam	Maumee fine, sandy loam
	Clyde silt loam, sandy phase
Genesee loam	Genesee silt loam
	Genesee silt loam, sandy phase
Peat	Peat
Peat, shallow phase	Peat, shallow phase
Muck	Muck

CHAPTER II

GROUP OF HEAVY SOILS

CARRINGTON CLAY LOAM

Extent and distribution.—The Carrington clay loam is the most extensively developed soil of the area, covering 112,320 acres. It is the predominating soil in all townships except those bordering Lake Michigan and those bordering Walworth county.

Description.—The surface soil of the Carrington clay loam consists of 12 inches of dark brown to almost black heavy silt loam, or clay loam containing a large quantity of organic matter. The upper subsoil is a brown silty clay loam grading into a brownish-yellow plastic clay which is slightly mottled with yellow and gray. At a depth of about 2 feet the material is a heavy plastic pale yellowish gray clay, interspersed with white splotches of calcium carbonate. At this depth there is a strong reaction with hydrochloric acid, but both Truog and litmus tests indicate that the surface soil is usually acid.

As mapped, this type is subject to some variation. On steep slopes and narrow ridges, where there has been wash, the surface soil is a clay loam of a rather stiff and plastic structure. Along the lower parts of slopes, where there has been an accumulation of washed material, the dark brown silt loam layer may extend to a depth of 18 inches. Where the Carrington clay loam is associated with the Carrington silt loam or the Miami silt loam, as is often the case in Dover and Norway townships, the surface soil is lighter and somewhat more friable and the subsoil is less plastic than typical. There are some inclusions of Miami silty clay loam, Miami silt loam, Carrington silt loam and Clyde silt loam.

Topography and drainage.—The topography ranges from almost level to undulating and gently rolling. Drainage is somewhat deficient on account of the heavy compact nature of the subsoil and tile drains have been installed in a number of places. Little serious erosion is apparent as the run-off is usually gentle. All of this soil has been derived from glaciated material

formed by the grinding action of ice upon limestone rock. The lime carbonate has been leached from the surface soil in almost all places and an acid condition is not uncommon.

Present agricultural development.—This is a prairie soil and the native vegetation was chiefly prairie grasses, the only timber occurring near the contacts with other types and along a few of the streams. The forest growth in such places consisted of oak, maple, basswood, elm and hickory. Practically all this type is or has been under cultivation. The prevailing system is based upon general farming combined with dairying, although sugar beets are grown extensively and cabbage to a less extent in the central and eastern parts of the area. Corn, hay, oats, and barley are the leading crops, corn and hay occupying the largest acreages. Many farmers have a few acres in wheat and a few in alfalfa, buckwheat and hemp. Hemp is grown chiefly in the vicinity of Union Grove where there is a hemp factory. There is also a pickling and canning station there, and cucumbers and cabbage are grown to a considerable extent also. The yields of the general farm crops on this soil equal or exceed the average yields on the other soils in the county.

By far the greater proportion of farmers on this soil do not follow any definite system of crop rotation. The most common rotation consists of corn, followed by a small grain for 1 or 2 years and then by timothy and clover. Hay may be cut for 2 years and the field pastured for a year before again being manured and plowed for corn. Another rotation sometimes followed consists of sod manured and broken for corn, followed by sugar beets or cabbage, then by a small grain, and followed in turn by grass or hay. Stable manure is about the only fertilizer used for general farm crops. For special crops, such as sugar beets and cabbage this is frequently supplemented with commercial fertilizer at the rate of about 150 pounds or more per acre for sugar beets and 500 to 700 pounds per acre for cabbage. The use of commercial fertilizers is gradually increasing.*

Farms on the Carrington clay loam have a selling value of $75 to $250 per acre, depending upon drainage, location, improvements, and character of the soil.

*For a discussion of the chemical composition and management of this type of soil see page 36.

CARRINGTON SILT LOAM

Extent and distribution.—The principal occurrences of the Carrington silt loam are southwest of Pleasant Prairie, northeast of Bristol, northwest of Waterford, and northwest of Corliss. Small areas are mapped in all parts of Kenosha county, except in the southwest corner and in the extreme eastern part. It occurs in all the townships of Racine county except Waterford, Rochester, Burlington, Dover and Mt. Pleasant. Its total extent is 9,920 acres. A few acres of loam and fine sandy loam are included with the silt loam types.

The loam areas lie in the townships of Wheatland, Brighton, Pleasant Prairie, Yorkville, Mt. Pleasant, Raymond and Burlington, and the fine sandy loam areas in a few small patches in the townships of Wheatland, Brighton, Pleasant Prairie, Waterford and Norway.

Description.—The Carrington silt loam to an average depth of 12 inches consists of a dark brown or nearly black friable silt loam, containing a comparatively large amount of organic matter. This layer according to the litmus test is in an acid condition. The subsoil consists of an upper layer of a dark yellowish brown silty clay loam extending to a depth of about 18 inches and a lower layer of yellowish brown clay, in many places carrying small quantities of limestone gravel. The subsoil becomes quite calcareous below 27 to 30 inches and normally in this layer there is a slight mottling of grayish color caused by the excess calcium carbonate present.

Along the boundary lines between the Carrington silt loam and the Carrington loam or fine sandy loam the surface soil normally carries considerable more fine sand than away from these boundaries and the clay subsoil is comparable to that of the Miami silt loam, being much more sandy and porous than is typical. Where this type is associated with the Carrington clay loam, as is the case in the townships of Bristol and Mount Pleasant. The subsoil is heavier and is more mottled in the lower part than typical, and where it borders the Miami soils it is lighter in color and runs lower in organic matter.

Included with this type are mapped small areas of Miami clay loam, silt loam, Carrington clay loam, and Clyde silt loam. All of these, however, are in areas too small to be indicated on the soil map.

Several small areas of the Carrington loam and Carrington fine sandy loam also are included with the Carrington silt loam, because their size do not warrant showing them as separate types.

The surface soil in these loam areas consists of 10 inches of a dark brown to almost black friable loam, containing a comparatively large amount of organic matter and relatively large proportions of fine sand and silt. The upper part of the subsoil is a dull brown to lighter colored clay loam, passing at about 18 inches into a yellowish brown sandy clay that becomes heavier with increasing depth. This continues to a depth of 36 inches or more. Considerable quantities of fine gravel are encountered in both soil and subsoil.

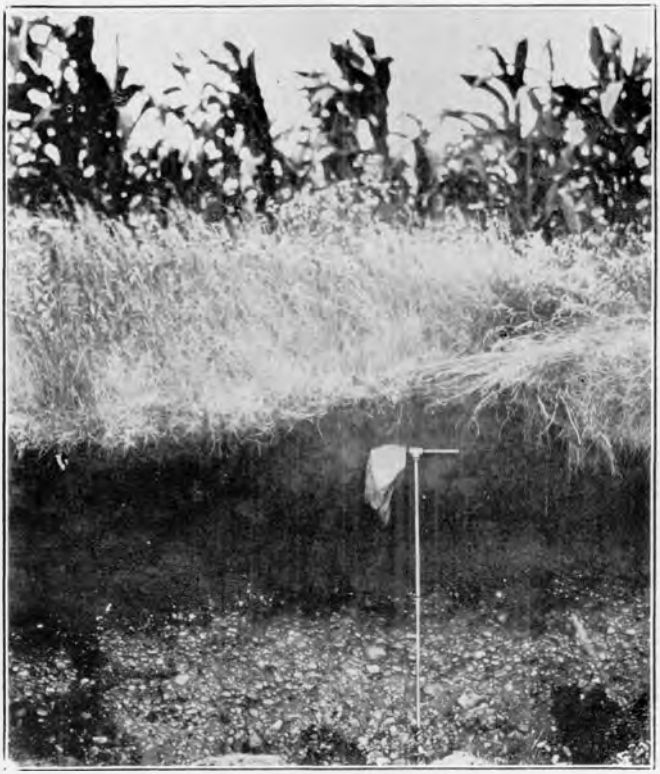
In the fine sandy loam areas, the surface soil to a depth of 8 to 10 inches is a dark brown fine sandy loam, like the loam rich in organic matter. A small quantity of gravel is scattered over the surface of many areas. Tests indicate that the soil is in an acid condition. The upper subsoil is a yellowish brown fine sandy loam grading at about 20 inches into a yellow clay or sandy clay loam. In the lower subsoil a yellowish sandy clay is often encountered.

Topography and drainage.—The topography of this soil and of the included loam and fine sandy loam is gently rolling to rolling. The drainage is usually well established, though in some of the more level areas it is somewhat deficient and tiling is needed. The structure of both the soil and subsoil is usually favorable for the retention of moisture. Although comparatively inextensive, the Carrington silt loam is an important type. It has been derived from the glaciated limestone material which covers the region. The dark color is due to an accumulation of organic matter resulting from the decay of rank vegetation in the presence of considerable moisture.

*Present agricultural development.**—Almost all of this type, and small inclusions of other types occurring in the western part of the area, is devoted to dairying in conjunction with general farming, and about 10 per cent of it occurring in the townships of Mt. Pleasant and Bristol is used for the production of sugar beets and cabbage.

As in the case of the Carrington clay loam, this is a prairie soil, the native growth consisting almost exclusively of prairie grasses.

*For chemical composition and methods for the improvement of this soil see page 36.



A SOIL SECTION IN WAUKESHA SILT LOAM

This view shows the underlying beds of gravel at a depth of about two feet.

A well constructed storehouse on a truck farm in southeastern Wisconsin. Such buildings are used for storing such crops as cabbage, onions, etc.

Corn, hay, oats, barley, wheat, sugar beets and cabbage are the leading crops, with yields slightly higher than on the Carrington clay loam.

Land of the Carrington silt loam type sells for $100 to $250 an acre, the price varying with the location, improvements and condition of the soil.

WAUKESHA SILT LOAM

Extent and distribution.—The Waukesha silt loam, which is not extensively developed in this area has its chief occurrences between Twin and Powers Lakes, in the terrace or bench lands along the Fox and Desplaines Rivers and their tributaries. It is also mapped on an outwash plain west of Waterford. Other very small patches are found in practically all townships of the area. It covers an area of 3,840 acres.

Description.—The surface soil of the Waukesha silt loam, which has an average depth of 12 inches, consists of a dark brown to black, friable silt loam containing a relatively large proportion of organic matter. The upper subsoil is a yellowish brown silt loam grading into silt loam or silty clay loam. At about 20 inches a layer of sandy clay is encountered and this at 20 to 30 inches passes into gravelly sand loam. From 30 to 36 inches, there occurs stratified beds of gravel and sand in which limestone material predominates. In places, the dark brown silt loam of the surface grades at about 10 inches into a yellow sandy loam which passes at 16 to 24 inches into stratified beds of gravel and sand. The Waukesha silt loam as mapped includes patches of Waukesha loam too small to warrant separation.

Topography and drainage.—The surface of the Waukesha silt loam varies from level to very gently undulating, and the natural drainage is good.

*Present agricultural development.**—Practically all the type is under cultivation. It is used chiefly for general farming combined with dairying. It is comparatively easy to plow and a very good seed bed can be prepared without difficulty.

Corn, hay, oats and barley are the chief crops, corn occupying the largest acreage. Wheat and potatoes are grown on a small scale. Corn yields an average of about 40 bushels, oats

*For chemical composition and methods for the improvement of this type of soil see page 36.

45 bushels, barley 40 bushels, and clover and timothy hay from 1 to 1½ tons per acre.

The selling price of this land ranges from $100 to $200 an acre, depending upon the location, improvement and condition of the soil.

Waukesha silt loam, deep phase.—The surface soil of the Waukesha silt loam, deep phase, consists of dark brown to almost black smooth silt loam, high in organic matter and relative high in silt. The upper subsoil is a dull brown silt loam grading downward into a yellowish brown silt loam. This may continue to a depth of 3 feet, but ordinarily a yellow silty clay loam is encountered at about 30 inches. At depths ranging from 3½ to 7 feet beds of gravel and sand occur.

The only important development of this phase is found in a comparatively large area lying between Twin Lakes and Powers Lake. This area represents a part of a rather extensive glacial outwash plain. Other areas lie northwest of Waterford and southeast of Browne Lake. This phase covers 1600 acres.

The surface like that of the typical soil, is flat to very gently undulating and the natural drainage is for the most part good, but there are places where tile drains would be beneficial.

Practically all the phase is under cultivation. It is devoted to general farming in conjunction with dairying. Corn, hay, oats and barley are the leading crops. Sugar beets and cabbage are important special crops. Small amounts of wheat and potatoes are produced. Corn yields 30 to 70 bushels, barley 30 to 50 bushels, oats 30 to 65 bushels and clover and timothy hay about 1½ tons per acre. Sugar beets produce from 8 to 22 tons per acre, and cabbage from 8 to 20 tons.

Comparatively few farmers follow a carefully worked out crop rotation. Where corn is followed by small grain, the land then seeded to clover and timothy and this sod is well manured before plowing again for corn, there is a marked improvement in crop yields. Sugar beets and cabbage commonly take the place of corn in the rotations.

MIAMI CLAY LOAM

Extent and distribution.—The Miami clay loam is the second soil, in point of extent, and one of the most important types in the area. It is widely distributed throughout the two counties,

except in the western morainic region, and immediately along the lake shore on the lake terrace. It covers an area of 56,384 acres or 14.5 per cent of the two counties.

Description.—The surface soil of the Miami clay loam consists of a light brown heavy silt loam, which gradually becomes yellowish in color and somewhat heavier in texture with increasing depth. At 8 to 12 inches it is underlain by a rather plastic and compact yellow silty clay loam slightly mottled with gray and at 15 to 24 inches by a very compact calcareous clay with yellow, brown, and gray mottlings. This may continue to a depth of more than 3 feet, but in many places a rather friable, silty, calcareous clay occurs below 24 inches. This type differs from the Miami silt loam in that the subsoil is heavier, is freer from coarse material and quite uniformly mottled.

Topography and drainage.—The surface ranges from undulating to gently rolling. Because of the heavy character of the subsoil the internal drainage is somewhat deficient. The surface drainage prevailing is usually adequate, although in places artificial drainage is essential to the best results, and the use of tile drains would prove profitable over a considerable proportion of the type.

Origin.—The Miami clay loam has been derived from glaciated limestone debris deposited chiefly as ground moraine. The percentage of clay in this deposit is much higher than in most of the glacial material in this part of the state. The deep subsoil is normally well supplied with lime carbonate and in places the subsoil at 24 inches shows an appreciable amount present, but in many places the surface soil has been leached to such an extent that it now gives a slight acid reaction.

*Present agricultural development.**—The original forest growth consisted of several varieties of oak, hickory, basswood, maple, some walnut and cherry. Practically all of the merchantable timber has been removed from and approximately 80 per cent of the land is now under cultivation. General farming combined with dairying is the leading type of agriculture. The chief crops and the unusual yields obtained are as follows: Corn 25 to 70 bushels, oats 32 to 75 bushels, hay from three-fourths to 2 tons, sugar beets from 6 to 16 tons with an average of 8 tons, and cabbage from 6 to 17 tons with an average of 8 or 9 tons per acre.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 36.

Comparatively few farmers follow a carefully worked out rotation, although corn is followed by small grain and the land then seeded to clover and timothy. The clover sod is well manured before being plowed for corn. This results in a marked improvement in the yields of following crops. The special crops often take the place of corn in the rotation.

Farms on this soil range in value from $75 to $200 per acre, depending upon the location, improvements and condition of the soil.

SUPERIOR CLAY LOAM

The Superior clay loam to a depth of 6 inches consists of brown silt loam containing sufficient coarse material to make it feel slightly sandy. This material grades into a yellowish brown silty clay loam, sometimes mottled and at about 14 inches into the heavy pinkish red clay characteristic of the Superior subsoils. The clay, which extends to an undermined depth, is uniform throughout the soil section below 18 inches.

Only one small tract of 320 acres was mapped. This lies along the Root River in Caledonia township. The surface is level and the natural drainage is somewhat deficient. The subsoil is calcareous, but the surface may be slightly acid in places. A forest chiefly of oak, hickory and maple formerly covered this type. Most of this now has been removed. Probably 80 per cent of this soil has been placed under cultivation. The crops common to the region are grown with success, but the type would be improved by the installation of tile drains. The other methods of improvement mentioned for the heavy soils of the Miami series are well suited to this soil.*

MIAMI SILT LOAM

Extent and distribution.—With the exception of a few small areas in the western part of Norway, Dover, and Brighton townships this soil is confined to Waterford, Rochester, Burlington, Wheatland and Randall townships. It occurs principally in the terminal and recessional moraine areas and covers a total area of 15,488 acres.

Description.—The Miami silt loam to an average depth of 10 inches, consists of a light brown friable silt loam with a relative

*For a discussion of the chemical composition and methods for improvement of this soil see page 36.

large proportion of fine sand and an appreciable admixture of gravel. The content of organic matter is low. Where the silt content is highest the soil is usually fairly free from gravel and sand.

Truog and litmus tests show that this soil is slightly acid at the surface. The upper subsoil is a yellowish brown sandy silt loam which passes at about 16 inches into a reddish or yellowish brown sandy or gravelly clay loam. At about 24 inches yellowish and reddish gravelly sandy clay is found, and this is uniformly calcareous. In a number of areas the lower subsoil consists of a gravelly fine sandy loam. In the SW¼ of the NE¼ of Sec. 32, T. 4 N., R. 19 E, the subsoil below 24 inches consists of a gravelly fine sand or gravelly sand. As mapped the type has many inclusions of Miami loam and Miami silt loam, deep phase.

Topography and drainage.—It has for the most part a rolling surface. In places it is decidedly hummocky and ridgy. Both the surface drainage and underdrainage are good. In some of the small areas occurring on narrow ridges or kames, or where beds of sand or gravel are present in the lower subsoil, the type is droughty.

*Present agricultural development.**—The silt loam is of minor importance in this area. About 75 per cent of it is under cultivation, the remainder being forested. The principal trees are white, red and black oak, maple, hickory, and basswood, and there is some walnut and cherry.

Corn, oats, alfalfa, clover, timothy and barley are the leading crops. Wheat and buckwheat are grown by a few farmers. Sweet corn for the Milwaukee market is an important crop in Waterford township.

Stable manure is the only fertilizer used. The rotation followed by a number of farmers is corn planted on sod land, followed by a small grain for one year, and then, after manuring, corn for another year. This is succeeded by a small grain, and this by hay for two years.

This type has a value of $60 to $200 an acre, depending upon the location, extent of improvements and topography.

*For a discussion of the chemical composition and methods for improvement of this soil see page 36.

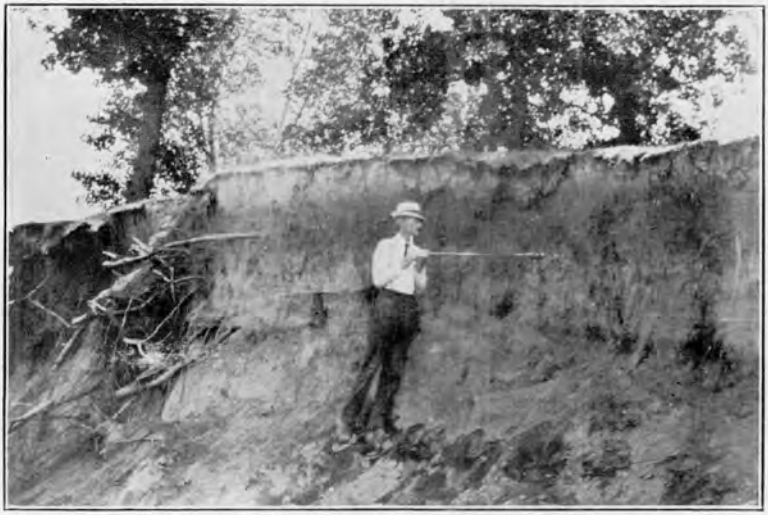
MIAMI SILT LOAM DEEP PHASE

Extent and distribution.—The Miami silt loam deep phase is confined chiefly to the morainic parts of the area, and cover 31,808 acres. The most extensive developments are in the western tier of townships. Other areas occur in Norway, Dover, Brighton, Salem, Bristol, Mt. Pleasant and Somers townships.

Description.—To a depth of 10 inches the Miami silt loam deep phase consists of a light brown or grayish brown friable silt loam, containing a comparatively small quantity of organic matter. In places it carries an appreciable amount of fine sand, but typically it has a smooth velvety feel. Where the silt content is high the material is usually free from stones and fine gravel. The lower part of the surface soil becomes yellowish, and at 12 or 13 inches the material passes into a pale yellowish silt loam, and this at 16 inches into a yellowish silty clay loam, carrying some fine gravel and sand. At a depth of 24 inches a clay loam is encountered, and this continues to a depth of more than 3 feet. The subsoil below 30 inches may be moderately calcareous.

A notable variation is found in the early Wisconsin drift east of Twin Lakes, where the surface soil consists of a light brown, friable silt, 12 to 14 inches deep. When dry the surface presents an ashen appearance, and the proportion of gravel, bowlders and fine sand is noticeably less than in the typical soil. The subsoil here consists of a yellowish silt loam which becomes heavier with increasing depth, grading at 24 inches into a silty clay loam, which at about 36 inches shows in many places a slight mottling of gray. In this variation no lime reaction can be had in the material within 40 inches of the surface.

Where this type is associated with the Miami silty clay loam or Carrington silty clay loam the subsoil at depths ranging from 15 to 20 inches is a rather heavy, compact, yellow clay which continues to a depth of 3 feet or more, and the lower subsoil shows more or less mottling. In depressions, lower slopes, and over level tracts the soil is deeper than typical, while on steep slopes, ridges and knolls more or less of the soil has been washed away and the sandy clay may be exposed. In the western part of the area small bodies of the type are included which have a reddish brown soil and a reddish yellow subsoil.



VIEW SHOWING SECTION OF MIAMI SILT LOAM, DEEP PHASE

In this phase the unassorted gravelly glacial till is found at a depth of over three feet. In places the silty covering is over five feet deep.

VIEW SHOWING SECTION OF THE SOIL IN MIAMI SILT LOAM

In the typical soil the covering of silty material over unassorted till is much thinner than in the deep phase. Both the typical soil and the deep phase comprise good farm land, and this is one of the important types of soil in the area.

Topography and drainage.—The surface features of this type range from undulating to gently rolling, and the natural drainage is good. The internal drainage is much better than in the Miami clay loam areas. Along some of the lower slopes and in depressions between hills and ridges there is some land that would be benefited by tile drains, but the type as a whole is not in need of artificial drainage.

Origin.—This soil is derived from glaciated limestone material. Because of lime rock entering into its composition the deep subsoil is not acid, but the surface and upper subsoil, having been subjected to long periods of leaching in many places show a slight acid reaction.

*Present agricultural development.**—The native forest growth consists of several varieties of oak, maple, hickory, basswood, walnut and cherry. Practically all of the merchantable timber has been cut and probably 75 per cent of the land is under cultivation. General farming in conjunction with dairying is the prevailing type of agriculture. Corn, hay, oats, barley and wheat are the leading crops, ranking in importance in about the order named. Irish potatoes, rye, alfalfa, and buckwheat are grown in a small way. There are some apple orchards but none of commercial size. The fruit is usually of an inferior quality, owing largely to neglect to prune or spray the trees properly.

The yields of the general farm crops are as a rule fairly satisfactory and range a little higher than on the clay loam. The rotation most commonly followed consists of corn, followed by a small grain crop for two years, and then by timothy and clover. Hay may be cut for two years, before the land is plowed again for corn. Sometimes the field is pastured a year following the taking off of the hay crops.

The value of land of this character ranges from $75 to $200 or more per acre, depending upon the location, improvements and condition of the soil.

FOX SILT LOAM

Extent and distribution.—This soil covers a total of 15,616 acres.

*For a discussion of the chemical composition and methods for improvement of this soil see page 36.

The largest areas of this type occur in the glaciated outwash plains west of Wilmot, in the vicinity of Powers Lake, west of Waterford, and north of Burlington. There are many other areas, ranging from a few acres to several hundred acres, scattered throughout Kenosha county and in the western half of Racine county. These areas also occupy glacial outwash plains or stream or lake terraces.

Description.—The surface soil of the Fox silt loam consists of 10 inches of light brown or grayish brown friable silt loam. This is underlain by a yellow silt loam which grades at about 15 inches into a silty clay loam. At about 24 to 30 inches a brown gravelly or sandy clay loam is often present and at from 32 to 36 inches this is underlain by beds of sand or gravel which carry a high percentage of limestone material. In many cases a fine sandy loam is found at 2 to 3 feet below the surface, and in other cases the yellow clay loam changes to a silty clay loam at about 22 inches and extends to a depth of about 30 inches.

The Fox silt loam where it is associated with the Carrington silty clay loam and Miami silty clay loam is heavier than typical and the subsoil is often a yellow clay loam passing into a rather compact sandy clay that shows some brown and yellow mottling in the lower depths.

Topography and drainage.—The surface of this type is flat to very gently undulating and the natural drainage is good. In places where the subsoil is heavier than typical the underdrainage is sometimes slightly deficient in which case tile drains could be used to advantage.

*Present agricultural development.**—The original forest growth on this soil consisted of several varieties of oak, hickory, basswood, elm, ash, and some maple. Most of the merchantable timber has been removed.

Although of comparatively small extent, the Fox silt loam is an important type. Practically 95 per cent of it is under cultivation. General farming in conjunction with dairying is the type of agriculture. Some trucking is done on this soil on the Lake Michigan terrace near Berryville.

The leading crops are hay, corn, oats, barley and wheat. Some special crops, chiefly cabbage and onions are grown on

*For a discussion of the chemical composition and methods for the improvement of this soil see page 36.

the lake terrace areas. The yields of most of the farm crops are as a rule satisfactory and compare favorably with those on the types of the same texture in the Miami and the Carrington series. The methods of cultivation, the crop rotations, and the use of fertilizers are essentially the same as on the Miami silt loam.

Fox silt loam heavy subsoil phase.—The surface soil of the Fox silt loam, heavy subsoil phase consists of 10 to 12 inches of light brown friable silt loam, low in organic matter. Below this the material passes into a yellow silt loam, which at about 16 inches grades into a yellowish silty clay loam. This becomes heavier with depth, grading at 26 to 30 inches into a silty clay. At about 3 feet or a little less heavy yellow compact clay is encountered. This may be slightly mottled. Stratified beds of sand and gravel occur at varying depths below 4 feet.

This phase is not extensively developed, and on the map is included with the typical soil. It has its chief occurrence on the glacial terrace between Powers and Twin Lakes. A few small areas occur east of Paris, north of Burlington, south of Caldwell, and southwest of Pleasant Prairie.

The surface is level to very gently undulating and natural drainage is good, although in some places tile drains would be beneficial.

The materials forming this phase are all waterlaid, having been deposited as glacial, as outwash plains, or as terraces along streams. Practically all of the merchantable timber has been removed and a large proportion of the land placed in cultivation. Under normal conditions this phase gives slightly higher average yields than the typical soil. The methods of cultivation followed, the rotations, and fertilizer practices are the same as on the Miami silt loam. As with other light colored soils of the region this phase of the Fox silt loam is deficient in nitrogen, organic matter and phosphorus.

Fox silt loam, gray sandy phase.—The areas mapped as the gray sandy phase of the Fox silt loam are in reality the Fox fine sandy loam but were given a phase designated on account of their small extent. On the published map this phase is included with the typical soil.

The surface of this soil to a depth of 8 inches consists of a light brown or grayish fine sandy loam. This is underlain by

a pale yellowish fine sandy loam that extends to about 14 inches, gradually becoming heavier with depth. The subsoil ranges from a heavy pale-yellow fine sandy loam to a sandy clay loam. In places this material extends to a depth of 3 feet or more, but commonly a bed of sand and gravel is found at depths between 2 and 3 feet. In the northeastern part of Sec. 1 and the north-central part of Sec. 13, T. 2 N., R. 22 E., there are included with this type some small ridges that might have been mapped as gravelly sandy loam, had they been of sufficient extent.

The Fox silt loam, gray sandy phase is of very small extent. It is developed mainly on the terraces of Rock River, although small areas lie on the Lake Michigan Terrace and other terraces, as well as in the outwash plains in some parts of Kenosha county and the northern part of Racine county. The surface of the areas is flat to very gently undulating. The drainage is good, except in a few small areas where the water table lies near the surface.

The soil is all of alluvial origin, having been deposited by water issuing from beneath the ice or on terraces along streams. While most of the material has come from glacial limestone debris, the surface layer is in many places slightly acid, owing to the long period during which it has been subjected to leaching.

Probably 50 per cent of this soil is under cultivation. Of the remainder being used for grazing, some of the land being in the unimproved state, with a scattered growth of oak, maple hickory and basswood. Most of the merchantable timber has been removed. General farming in conjunction with dairying is the chief type of agriculture. Corn, hay, oats, barley and some wheat are grown, and fair to good yields are obtained.

CHEMICAL COMPOSITION AND IMPROVEMENT OF GROUP OF HEAVY SOILS

This is by far the most important and extensive group of soils in Kenosha and Racine counties. The group covers about 64 per cent of the area or a total of approximately 247,000 acres. The Carrington and Waukesha soils include the prairie lands and the soils are dark colored, and high in organic matter, while the Miami, Superior and Fox soils are light colored and include land which was originally timbered, and which is usually de-

ficient in organic matter and nitrogen. The clay loam types are of course heavier in texture and somewhat more difficult to handle than the silt loams, but from the standpoint of chemical composition and methods of improvement the soils of the group are closely enough related so that they may be discussed as a group rather than as individual types.

The four elements of plant food with which the farmer is most concerned in his farming operations, and the ones which are the most apt to be deficient are nitrogen, phosphorus, potassium and lime or calcium. He should know the part which each plays in the development of the plant, and what are the best methods of maintaining an adequate supply in the soil.

The soil has been leaching for a large number of years, and has lost some of the lime which it contained. Varying degrees of acidity have developed over the region. The loss of lime from the soil is caused by two distinct factors, both of which are important. Crops require lime in their growth. A 5 ton crop of alfalfa requires 185 pounds of lime and 2 tons of red clover remove 61.6 pounds. A much larger amount is removed by leaching each year and when the total supply is limited, these losses must be made up by the application of lime in order to maintain the fertility of this soil.

While it will be seen from tests that a considerable part of this land shows some degree of acidity it does not mean that all of the land is in immediate need of lime. In fact plot tests show that much of the land does not respond profitably to liming. In most cases the subsoils are well supplied with lime and frequently the surface is only slightly acid or not acid. The dark colored soils usually show more acidity than the light colored types. Where such crops as alfalfa, sugar beets, tobacco, peas, cabbage and other garden crops are grown and where the acidity is medium from 2 to 3 tons per acre of ground limestone may be used with profit.* Where a liberal supply of manure is available the need for lime will not be so great. The second application which may be needed after 4 or 5 years will be less than the first.

Where such crops as corn, clover and oats are grown with manure once during each rotation a smaller amount of lime will be needed. On parts of the farm where manure cannot be

*For a more complete discussion of the subject of liming see page 79.

applied the lime can be used with profit on such soils and may be actually necessary for economic production.

It has been quite definitely established that the need for lime in these soils runs practically parallel with the need of phosphorus. In the improvement of these lands, which are acid, therefore, provision for the use of both lime and a phosphate fertilizer should be made whenever the soil shows a lack of fertility.

Phosphorus exists in all soils in Wisconsin in small amounts. Many of the best types in the state contain only 1,200 pounds to the acre eight inches deep, and this is in a form which becomes available to crops very slowly. This amount is considered a medium supply and it is desirable to increase it. Phosphorus is constantly being lost from the farm in crops, milk and in the bones of animals sold. It is well understood that when grain, hay, potatoes or other cash crops are sold, this element is removed from the farm. This element cannot be supplied from the air and in the long run the loss must be made up through additions of phosphorus fertilizer in some form.

Analysis of eighteen samples of Carrington clay loam from this area gave an average of 1,555 pounds of phosphorus per acre. In 9 samples of Miami silt loam the average amount of phosphorus present was 1,091 pounds per acre. Three samples of Miami clay loam averaged about 1,000 pounds per acre each. The lowest amount found in any of the samples was 840 pounds per acre. The number of pounds of phosphorus in the soil, however, cannot be taken to indicate the immediate need for phosphate fertilizer. The system of farming followed, crops grown, type of soil and conditions relative to acidity are all important factors in determining the need for phosphorus. It should also be borne in mind that where soils are acid the phosphorus which they do contain is not so readily available to plants as in soils which are not acid.

On good upland soil where dairying or general farming is practiced the use of 200 pounds of 16 per cent acid phosphate or 75 pounds of 44 per cent super-phosphate to the acre every 3 or 4 years will maintain the phosphorus supply. If much grain, potatoes or other crops are sold, more phosphate should be used. A number of demonstrations of the use of limestone

and phosphate fertilizers have been made in Wisconsin by the experiment station.*

If considerable amounts of bran or cottonseed meal are fed, which are relatively high in phosphorus, the supply of this element may be maintained. It would usually be necessary to feed at least one-half ton of bran or cottonseed meal to each cow on a dairy farm per year to maintain the phosphorus supply of the soil. Since comparatively few farmers do that some phosphate fertilizer should be used.

Potassium exists in these soils in large amounts, but in relatively unavailable form. Chemical analyses show that these heavy soils often contain from 30,000 to 40,000 pounds an acre eight inches, while these same soils will contain only one-eighteenth as much phosphorus. On most soils of fairly heavy texture, when live stock is maintained, and the manure carefully used so there is considerable actively decomposing organic matter in the soil, a sufficient amount of potassium will become available from year to year to supply the needs of general farm crops. There are some crops that need relatively large amounts of potassium such as potatoes, tobacco and cabbage and they will often be benefited by some addition of potash in the form of commercial fertilizer.

Nitrogen is chiefly responsible for the dark green, healthy color and rapid growth of corn or other crops on well manured land. It is important to have sufficient amounts in the soil, but when in excess it is detrimental for some crops. The quality of the grain may be injured by too much nitrogen. When the grain lodges the kernels do not fully mature.

Virgin soils contain large amounts of nitrogen but if they are cropped continuously to such crops as corn, oats and timothy without the addition of fertilizer material containing nitrogen the nitrogen supply is gradually exhausted and the yields are reduced.

The supply of organic matter and nitrogen in the prairie soils is higher than in the light colored timber soils. Four samples of Carrington clay loam averaged about 6,000 pounds of nitrogen per acre. This amount is considered a very good supply. A question of importance in connection with the nitrogen of this soil, however, is its availability to plants, and in the soils

*See review of the results of these tests on page 81.

which have been under cultivation for a long number of years, this nitrogen is somewhat inert, and when in this condition, decaying vegetable matter, green crops, or manure plowed under will give a more readily available suply of nitrogen. Nine samples of Miami silt loam averaged 3,060 pounds per acre or about one-half the amount in Carrington clay loam. Four samples of Miami clay loam showed practically the same amount as in the silt loam. Efforts should be made to increase the nitrogen and organic matter content of these light colored soils.

The clover, alfalfa, peas and beans have bacteria on their roots that take the free nitrogen from the air and store it in the plant. This is the cheapest method of obtaining nitrogen and one which the farmers should use to the fullest extent. On the ordinary dairy at least one-fourth of the land under cultivation should be seeded to clover or alfalfa. This should be fed to stock or plowed under as green manure to insure keeping up the supply of nitrogen and organic matter.

A rotation with a legume plowed under will secure nitrogen and reduce danger from diseases, and when supplemented with phosphorus and lime the legumes thus treated will take the place of manure, which can then be used for other crops on the farm.

Certain crops, such as tobacco, potatoes and vegetables, are grown by farmers who do not keep much livestock and who do not rotate these crops with legumes. This is not a good practice.*

*Reasons why this is not a good practice are discussed under crop rotations on page 76.

CHAPTER III

GROUP OF LOAMS AND FINE SANDY LOAMS

FOX LOAM

Extent and distribution.—The Fox loam is distributed in small areas in the western, southern and eastern parts of the survey. It occupies a total area of 4,608 acres. Most of these occur in the glacial outwash plains between Wilmot and Powers Lake, on the terraces of the Fox and Desplaines Rivers and on the Lake Michigan terrace.

Description.—The Fox loam to an average depth of 10 inches, consists of a light to medium brown loam. Below this depth the material takes on a yellowish color and becomes a friable sandy clay loam, which normally carries some gravel. At 20 inches a gravelly sandy clay is encountered and this grades into beds of gravel or sand, at from 26 to 30 inches. In some places the underlying coarse material lies within 18 inches of the surface; in others it is not found within the 3-foot section. The underlying gravel and sandy layers carry a high percentage of limestone material. There are some included areas of fine sandy loam and silt loam that are too small to map.

Topography and drainage.—The surface of this type is level to gently undulating and the drainage is good. The soil is open and porous and readily absorbs the normal rainfall.

The Fox loam is of alluvial origin, having been deposited by water issuing from beneath the ice sheet or as terraces along swollen streams. The material comes from the glaciated limestone debris which forms the adjoining uplands.

*Present agricultural development.**—Though nearly all of the Fox loam is under cultivation, it is inextensive and, therefore, of little importance. It is a good soil and is devoted to the production of most of the general farm crops common to the region. The methods of farming followed and the fertilization and rotations used are practically the same as on the Miami soils

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

of similar texture. The Fox loam is easy to cultivate and a mellow seed bed is readily formed.

MIAMI LOAM

Extent and distribution.—The Miami loam is of rather small extent covering 4,592 acres. It occurs in the extreme western part of the area in Wheatland township, and in that part of the area which borders Walworth county. It also occurs in the western parts of Salem, Brighton, Dover and Norway townships.

Description.—The surface soil of the Miami loam consists of 8 or 10 inches of a light brown loam containing relatively large proportions of silt and fine sand. The subsoil is a yellowish brown loam which grades into a silty clay loam at about 14 inches. This may continue to a depth of 3 feet or more, or it may change at any depth within the 3 foot section below sixteen inches into a yellowish fine sandy loam. Gravel is common below 30 inches. In some places the subsoil is composed entirely of clayey fine sandy loam. Included areas of silt loam and fine sandy loam too small to map are very common.

Topography and drainage.—The surface varies from gently rolling to rolling and the natural drainage is good. The structure of both soil and subsoil is usually favorable for the retention of moisture. However, there are places on narrow ridges and knolls where the gravel is near the surface and the soil droughty. On some of the areas erosion is severe and deep gullies and ravines have developed.

*Present agricultural development.**—General farming in conjunction with dairying is the principal type of agriculture. Probably 75 per cent of the type is cultivated. The remainder is used as permanent pasture or is in forest consisting of several varieties of oak, maple, hickory, basswood, elm and walnut. All of the common farm crops of the region do well on this soil. Corn, hay, oats and barley are the principal crops. Alfalfa is well adapted to this soil and is grown on many farms. Wheat and buckwheat are produced in a small way. The methods of handling this soil and the yields obtained are essentially the same as in the case of the Miami silt loam.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

The selling price of this land ranges from $60 to $125 an acre, depending largely upon the proportion of cleared land, the topography, erosion, location and improvements.

Gravelly phase.—The surface soil of the Miami loam, gravelly phase, consists of 6 to 8 inches of a light brown loam or fine sandy loam, carrying varying quantities of rounded limestone, quartz, chert, and crystalline rock gravel. The upper subsoil is a yellowish-brown loam also with some gravel. At about 14 to 16 inches this passes into a gravelly sand clay loam and in many places at 30 inches into a gravelly loam or beds of gravelly sand.

The phase is of very small extent covering about 320 acres. It is found chiefly in small areas southwest of Rochester and north of Bolmer Lake. The surface ranges from rolling to broken. Except in kettle holes and other basins the drainage is good to excessive. The material forming this type has been derived from glaciated limestone debris which has been deposited as moraines. Inasmuch as there is a large amount of lime present the soil is not acid and the subsoil is strongly calcareous. Probably 20 per cent of this type is under cultivation. The remainder is covered with a growth of oak and hickory. Corn, oats, rye, alfalfa, clover and timothy are the principal crops. The yields obtained, methods of handling and fertilization are about the same as employed on the Miami fine sandy loam. Only the least rolling parts of the gravelly loam should be cultivated; the remainder should be seeded to grass or alfalfa, which does especially well on this soil. The maintenance of the supply of organic matter requires special attention.

MIAMI FINE SANDY LOAM

Extent and distribution.—Miami fine sandy loam is of limited extent in Kenosha and Racine counties, being confined almost entirely to a number of small areas well scattered throughout the western half of the area. The total area is 3,200 acres.

Description.—The surface soil of this type to an average depth of from eight to ten inches consists of a light brown fine sandy loam which contains only a small amount of organic matter and is often in an acid condition. This is underlain by a yellow fine sandy loam which gradually becomes heavier with increased depth until a sandy clay loam is reached at from 15 to 24 inches.

This continues to a depth of three feet or more. There is often some gravel in both the soil and subsoil.

The type as mapped is not uniform. Frequently in small areas, particularly along the crest of ridges and on steep slopes where the wash has carried away the surface soil the fine sandy loam extends to a depth of only a few inches and rests on a yellowish sandy clay, and at the bases of these slopes where the wash materials have been deposited there is often a surface soil of much greater depth.

Topography and drainage.—The topography is gently rolling to ridgy and very broken and the drainage because of the surface features and the sandy nature of the soil and subsoil, is usually well established. In the more sandy places, the drainage is often excessive.

*Agricultural development.**—Probably 60 per cent of this type is cultivated while the remainder is used for pasture. The timber growth consists of several varieties of oak, hickory, maple, and some walnut and basswood. The crops grown and methods of farming followed are practically the same as on the Miami silt loam and crops mature somewhat earlier.

SUPERIOR FINE SANDY LOAM

The Superior fine sandy loam occurs chiefly in small areas in Caledonia township along Root River, and near Wind Point on the Lake Michigan Terrace. Its total area is only 960 acres.

The Superior fine sandy loam consists of a brown fine sandy loam or very fine sandy loam, underlain at about nine inches by a yellow fine sand. This at about 20 inches passes into a purplish to reddish elastic clay, which at about 26 inches grades into a very calcareous red clay with white seams or splotches of calcium carbonate interspersed through it. From 26 to 36 inches there is no important change. There are shallow basins where the surface soil is a dark brown to almost black fine sandy loam, like the Poygan fine sandy loam. In these basins the upper subsoil is a mottled gray and yellow fine sand grading at about 20 inches into a mottled purple and gray clay, which becomes red at about 26 inches. The surface of these areas is level or only very gently undulating and the natural drainage in places is somewhat deficient.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

The Superior fine sandy loam is of mixed origin. The heavy red clay subsoil is doubtless lacustrine, but has been modified more or less since its original deposition, by the action of the ice sheet. The surface sandy material is probably mostly of glacial origin. The subsoil is usually well supplied with lime carbonate, but the surface is in places slightly acid, owing to its thorough leaching.

Probably 80 per cent of this soil is under cultivation at the present time. The remainder is covered with a growth of oak, maple, elm and hickory. The chief crops grown are corn, oats, barley, hay, sugar beets and cabbage. Where well drained this is a very good soil. It is not difficult to cultivate, a good seed bed being prepared with little effort. Moisture is also retained well because of the heavy subsoil. In the improvement* of the type the same methods may be used as in case of the best Miami soils.

Superior fine sandy loam, heavy phase.—The Superior fine sandy loam, heavy phase, consists of a brown loam about six inches deep underlain by a yellow or yellowish brown material of the same texture to about 10 inches. Below this the material grades into a mottled yellow, brown, and gray silt loam or silty clay loam and then at about 14 inches into a pinkish red plastic clay which extends to depths greater than three feet, becoming redder with increase in depth. This is the typical subsoil of the Superior series, as found in other parts of Wisconsin. Only a small area of this phase exists in the present survey. It is found chiefly in small patches along Root River in Caledonia township. These areas are fairly typical of the Superior loam, but were mapped as a phase of the Superior fine sandy loam on account of the limited extent.

The surface is flat and the natural drainage is somewhat deficient. The original forest growth was chiefly maple, oak and hickory. About 70 per cent of this land is under cultivation, and where drainage is adequate it is an excellent soil, well adapted to most of the crops common to the region. Because of its small extent no farms are located entirely upon it, and no system of rotation or cultivation has been worked out especially for this type. The practices followed upon it are those followed on the more extensive adjoining soils.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

In its improvement drainage is of importance. The supply of organic matter is somewhat deficient, and the phosphorus content is below normal. Suggestions made for the improvement of the heavy Miami soils will also apply to this land.

WAUKESHA LOAM

This soil is of somewhat limited extent, covering a total of 3,648 acres, but it is widely distributed. It consists of small tracts of from a few acres to one-fourth square mile. The most numerous areas are found upon the Lake Michigan Terrace, and along the Des Plaines and Fox Rivers.

The surface soil to a depth of about 10 inches consists of a dark brown to nearly black loam which contains considerable more organic matter than the light colored soils of the uplands adjoining. The subsoil is variable and ranges in texture from a fine sandy loam to a silty clay loam of a yellowish color, which at about 18 inches grades into a sandy yellowish clay. At about 30 inches stratified beds of sand or gravelly material are often found. In the eastern part of Caledonia township in Racine county the surface of this soil is heavier than typical and approaches a clay loam.

The surface of this type is level and is found on terraces along Lake Michigan and also along some of the larger streams of the area. Some of these areas are rather low, but not subject to overflow. The drainage, however, in places is not as good as on Waukesha soils as found in some other parts of the state. This accounts for a slightly mottled condition which is found in the subsoil over limited tracts.

Most of the type is under cultivation.* The portion on the Lake Michigan terrace is devoted largely to trucking while the remainder of the soil is given over mostly to general farming. The same crops are grown as on the Waukesha silt loam. Among the special crops grown are sugar beets, cabbage, onions, carrots, parsnips, tomatoes, melons, etc. In the trucking district commercial fertilizers are used quite extensively to supplement manure, most of which is shipped in.

*For a discussion of the chemical composition and methods for the improvement of this soil see page 47.

WAUKESHA FINE SANDY LOAM

The type is developed most extensively on the Lake Michigan terrace where it forms long narrow strips, extending parallel with the lake shore. Other areas occur on the terraces of the Fox, Desplaines, and Root Rivers, and their tributaries. It includes 3,264 acres of land.

The surface soil of the Waukesha fine sandy loam has an average depth of 10 or 11 inches and consists of a dark-brown or almost black fine sandy loam, containing a relatively high percentage of organic matter. The subsoil is a brownish-yellow fine sandy loam, which at about 16 to 20 inches is underlain by a yellow sandy clay loam. This becomes lighter in texture with increasing depth and passes into a bed of stratified sand and gravel at 30 to 36 inches.

As mapped the type is quite variable. The surface soil of included areas ranges from fine sand to loam. The stratified beds of gravel and sand may be within 12 inches of the surface or may not be encountered within the 3-foot section.

The surface is level to very gently undulating, and the drainage is good, except in a few cases where the ground water level is very near the surface.

Practically all the Waukesha fine sandy loam is under cultivation. On the Lake Michigan terrace it is devoted to trucking and in other localities to general farming in conjunction with dairying. Cabbage yields from 6 to 15 tons per acre, corn from 28 to 38 bushels, oats from 25 to 45 bushels, barley from 25 to 40 bushels, rye 15 to 20 bushels, buckwheat from 12 to 18 bushels, wheat 15 to 20 bushels and timothy and clover hay 1½ tons per acre, potatoes about 100 bushels. The rotations followed are practically the same as on the Waukesha silt loam, deep phase, and the methods of improvement suggested for that type are applicable to this soil.

CHEMICAL COMPOSITION AND IMPROVEMENT OF LOAMS AND FINE SANDY LOAMS

In this group of soils there are five separate types all of which are of minor importance individually but collectively the group is important since it covers a total area of 19,072 acres or about

5 per cent of the area. These soils are lighter in texture than the silt loams but where general farming is carried on similar methods of improvement can be followed as outlined on page 36.

While there is some variation in the texture, structure and color of the types of soil in this group there is a sufficient similarity so that general methods of improvements discussed here will apply to the entire group.

Tests and observations which have been made on these soils indicate that most of the types are in need of lime. The dark colored prairie soils show a greater need than the light colored soils. There are a few exceptions to this need.

The supply of organic matter in the dark colored types such as the Waukesha loam and fine sandy loam is somewhat greater than the light colored types but in older cultivated soils this organic matter is in an inactive form so that the introduction of decaying vegetable matter will greatly aid in the improvement of these types regardless of color.

The supply of phosphorus in these loams and fine sandy loams is lower than in the heavier types and these soils show a marked deficiency in this element. The actual number of pounds of phosphorus which these soils contain, however, is not a true index of the actual need of this element. Some of the soils which show a small total amount do not respond as well to an application of the phosphorus fertilizer as do the types which have a large amount present so that the behavior of the crop is a more important indication of the need of phosphorus than the chemical analysis.

Regarding the supply of potassium in the soil the total amount is approximately 25,000 pounds per acre or fully 20 times as much as the supply of phosphorus. Where general farming is conducted and where there is maintained a good supply of vegetable matter in the soil this will doubtless be sufficient. Where special crops are raised which require a large amount of potassium this element may be supplied to advantage in the form of a commercial fertilizer.

The principal characteristics of these types is that they hold somewhat less water than heavier soils do and they warm up more quickly in the spring. This together with the readiness with which they can be worked adapts them to truck and spe-

cial crops, the growing of which requires more hand labor than is involved in the growing of staple crops. It is necessary to give them somewhat more attention to maintain fertility partly because of the fact that they are lower in fertility than the heavier soils but more because of the fact that these special crops require a higher degree of fertility to produce satisfactory yields. When these soils are used for the production of special crops their fertility can be maintained either through the use of rather heavy applications of stable manure or through the use of a rotation in which a legume is grown as the means of securing the necessaray nitrogen and organic matter while the other elements, chiefly phosphorus and potassium, are supplied in commercial fertilizers. When this latter system is followed one-third or one-fourth of the land should be sown to a legume such as clover or soy beans which have large powers of gathering nitrogen from the air, and a part of the phosphorus and potassium should be used for the growth of different green manuring crops. The fertility used in this way will become available for the succeeding crops through the decomposition of the legume when plowed under and the remainder of the fertilizer to be used should be applied on this ground at the time of fitting it for the succeeding crops.

CHAPTER IV

GROUP OF GRAVELLY AND SANDY LOAMS

FOX GRAVELLY LOAM

The type is found in several parts of the Lake Michigan terrace, where it occupies old beach lines that usually extend in a north and south direction, roughly parallel to the present shore line of the lake. There are only 832 acres of this land in the area.

The surface soil of the Fox gravelly loam consists of 6 to 10 inches of a brown gravelly fine sandy loam. This layer is underlain by a yellowish brown material of about the same texture. At 15 to 20 inches the texture in many places becomes heavier, but there may be no change, or in some places the change may be to a gravelly fine sand or gravelly sand. There are many included patches of Fox fine sandy loam the extent of which did not warrant their separation on the soil map. The gravel in this type is small and well rounded and mostly of limestone. The underlying gravelly and sandy beds are highly calcareous.

The loose open structure of the soil and the small quantity of organic matter present tend to make the drainage excessive, and even during normal seasons crops are apt to suffer from lack of moisture.

The soil is of very small extent. It is used principally in the production of early truck crops, but the yields are usually rather low except where large quantities of fertilizer are used.

An area of the Fox gravelly fine sand occurs in the old beach line at the southeastern corner of Kenosha county. It is not extensive enough to show as a separate type. The soil, to a depth of 6 inches consists of a brown to dark brown gravelly fine sand. This is underlain by a brownish yellow fine sand that grades at about 18 inches into a loose yellow fine sand. The area is from 200 to 600 feet wide and about 2½ miles long and extends approximately north and south. Probably 75 per cent of the area is devoted to trucking. With heavy applications of

VIEW SHOWING THE SURFACE FEATURES OF RODMAN GRAVELLY LOAM

This is land of low agricultural value. Much of it is too rough and broken to be cultivated.

VIEW OF ONE OF THE FINE DAIRY BARNS IN SOUTHEASTERN WISCONSIN

The dairy industry is the most important branch of farming followed in this region. Some small grains are also grown, partly for feed and partly as a cash crop.

manure and commercial fertilizers fairly good yields are obtained. The suggestions offered for the improvement of the Waukesha fine sand will apply equally well to this soil.

RODMAN GRAVELLY LOAM

The surface soil of the Rodman gravelly loam consists of 6 inches of a brown, or grayish brown gravelly sandy loam of fine to medium texture. In places there is present a relatively large proportion of silt. With increasing depth the color of the material becomes lighter, and at about 12 inches gravelly sandy clay is encountered. At about 15 inches this grades into a bed of stratified gravel and sand. The surface inch of the soil is in many places quite dark, owing to the accumulation of organic matter. The layer of soil material over the gravel is commonly shallow, but varies considerably. Along the lower slopes the layer is thickest and may reach 2 feet or more. In such places it is the steep topography, rather than the character of the soil itself that determines the grouping of the material with this type. The gravel consists of about 95 per cent limestone, 1 per cent chert, 2 per cent granite-gneiss and 2 per cent other crystalline rocks.

Included with the Rodman gravelly loam are numerous areas which if of sufficient extent would have been mapped as Miami loam, silt loam and fine sandy loam.

The Rodman gravelly loam is confined largely to the western tier of townships. The topography is rough and broken and is usually so steep that modern farm machinery cannot be used.

This soil is derived from glacial debris deposited by the ice sheet in the form of kames, eskers, and very rough moraines.

The native vegetation on this soil consist chiefly of oaks, with some hickory and a few other hardwoods. Only small patches here and there are cultivated. The crops common to the region are grown, usually with indifferent success. Alfalfa does fairly well and is probably the best crop for this type of land. Only the less broken parts of the type should be cultivated, on account of the danger of erosion. This rough land is best suited to grazing and should be kept in permanent pasture. It is a question if much of it could not well be devoted to forestry.

WAUKESHA FINE SAND

The Waukesha fine sand consists of 9 to 12 inches of a dark brown loamy fine sand, underlain at about 12 inches by a rather incoherent yellow fine sand which continues to a depth of more than 3 feet.

The type is developed chiefly on the Lake Michigan terrace. The typical soil is found from Kenosha south to the Illinois-Wisconsin state line. The topography is level to very gently undulating, with low narrow ridges extending approximately north and south and parallel with the lake shore. The drainage is excessive, and the type is somewhat droughty. The material forming this soil was deposited in the lake when that body of water stood at a much higher level than at present. The total area including several variations amounts to 2,908 acres.

Probably 70 per cent of the typical soil is now under cultivation, and is devoted chiefly to truck farming combined with general farming. Sugar beets yield from 6 to 12 tons per acre, potatoes about 125 bushels, cabbage from 6 to 12 tons per acre, onions from 200 to 500 bushels, corn from 15 to 35 bushels, oats from 20 to 40 bushels, rye 15 to 25 bushels, and clover and timothy hay about 1 ton per acre. Tomatoes, parsnips, beans, carrots and melons are also grown with success.

No systematic rotation of crops is followed.* Onions are commonly grown on the same fields for several years in succession. Onion, potato and cabbage land receive from 15 to 20 tons of horse manure per acre. Stable manure is usually not used on sugar beets. Commercial fertilizer of the formula (2-10-2 or 1-8-1) is usually applied to sugar beets, potatoes and cabbage at the rate of 500 to 1,000 pounds per acre, although much heavier applications are sometimes made. Commercial fertilizer is seldom applied for such crops as corn and small grains, the residual effect of application in growing the truck crops being depended on.

The selling price of this land ranges from $50 to $300 or more per acre, depending upon improvements, condition of soil, and location.

There is considerable variation in this type. It includes small areas of Waukesha loamy fine sand and also some tracts of Waukesha fine sandy loam too small to be shown on the soil

*For a discussion of the chemical composition and methods for the improvement of this soil see page 55.

map. In the eastern part of Caledonia township on the Lake Michigan terrace is another phase which is similar to typical Waukesha fine sand except that the subsoil consists of a gray, yellow and brown mottled fine sand, showing a poorer condition of natural drainage than is found on the typical soil.

The surface of this phase, which has been mapped by the Bureau of Soils in other states as Newton fine sand, is level or gently sloping. Adequate drainage has been provided and in places the drainage is excessive. Most of this phase is under cultivation and devoted chiefly to trucking and special crops. It is being farmed the same as the typical Waukesha fine sand, and the same methods of improvement will apply.

In the extreme southeastern corner of Kenosha county on the Lake Michigan terrace, is a small area where the surface is flat to slough-lake and the drainage is very poor. None of the area is used for agricultural purposes on account of its water logged condition.

The surface soil in this area is a dark-brown to almost black fine sand, 9 inches deep running rather high in organic matter. The subsoil is a mucky gray fine sand throughout the subsoil section, but in places it consists of two layers, an upper one of yellow fine sand, and a lower one of gray fine sand, extending from 24 or 30 inches to 36 inches.

Waukesha loamy fine sand, muchy phase.—Only one area of this soil was mapped in Racine county, and none at all in Kenosha county. The total extent is about 40 acres. The area lies on the north shore of Wind Lake. The soil consists of a layer of grayish loose sand 16 to 30 inches deep, overlying a bed of peat. Except in having a peaty substratum this soil is very similar to the Calumet fine sand mapped in Lake county, Indiana.

The surface is level, and only a few feet above the waters of the lake, and the natural drainage is only fair. In the spring when the water in the lake is high the drainage is poor, as the watertable is then quite near the surface.

The peat, subsoil consists of decaying vegetable matter in varying stages of decomposition. The surface soil is sandy material that has been deposited over peat beds in quite recent time. Heavy rains carry considerable quantities of soil material from the surrounding region into this lake. It is evident that the

lake at one time, not many years ago, completely covered all this soil.

The vegetation on this soil consists of coarse grasses, which afford some grazing. The soil has never been placed under cultivation.

PLAINFIELD FINE SAND

This type occurs on the Lake Michigan terrace, where it is confined to long low narrow belts running parallel with the lake shore. It covers an area of approximately 2,000 acres.

The Plainfield fine sand consists of 6 to 8 inches of a brown to yellowish brown, loose, fine sand grading into a yellow fine sand that extends to a depth below 3 feet. In basin-like areas lying between sand ridges or sand dunes the surface material has a darker color than elsewhere, owing to the accumulation of more organic matter.

The surface is level to gently undulating, but everywhere there is evidence of wind action, and in many places a dune topography has developed. Because of its loose, open structure the drainage is excessive.

Only a small part of this soil is under cultivation. Its chief use is for trucking. With heavy applications of stable manure, supplemented by commercial fertilizers, fair yields are obtained. The soil is deficient in nitrogen and the mineral plant food elements and requires very careful management to show a profit. It is doubtless better suited to trucking than to any other sort of farming.

Plainfield fine sand, loamy phase.—The Plainfield fine sand, loamy phase, consists of 9 inches of a somewhat loamy fine sand, underlain by a yellow fine sand that extends to a depth of more than 3 feet.

This soil is well distributed along the lake front on the Lake Michigan terrace. Its surface is level to gently undulating. In many places it occurs as low, broad ridges with gentle slopes, having their long axes roughly parallel with the shore of the lake. Owing to the loose character of the material the natural drainage is excessive.

Probably 90 per cent of the type is under cultivation and devoted to trucking and light general farming.* The soil is

*For a discussion of the chemical composition and methods for the improvement of this soil see page 55.

deficient in organic matter and nitrogen and low in the mineral plant food elements. It is a soil, however, that responds readily to fertilization, it warms up quickly in the spring, and so is well adapted to the quick growing truck crops, which can be forced to an early maturity.

CHEMICAL COMPOSITION AND IMPROVEMENT OF WAUKESHA FINE SAND AND PLAINFIELD FINE SAND

While these soils occupy only a small proportion of the total area of the two counties in question they are so situated in relation to markets as to be of especial value for the production of truck crops for the cities of Racine and Kenosha, even though they are somewhat lighter in texture than is desirable. Their sandy nature permits them to warm up early in the spring, cultural operations are easy and they respond to fertilization readily. They are therefore utilized largely for the growing of special crops.

The two soils are quite similar in texture and chemical composition except that the Waukesha fine sand has a larger supply of organic matter and nitrogen than the Plainfield fine sand.

From a limited number of analyses made here and in other counties it has been found that in soils of this nature the phosphorus runs between 700 and 900 pounds per acre 8 inches. The potassium runs from 20,000 to 30,000 pounds per acre. The nitrogen of the Plainfield fine sand will average about 1,000 to 1,400 and the Waukesha fine sand will run a little higher.

In the improvement of these soils the first step is to supply the lime which is needed. This will require from 2 to 3 tons of ground limestone per acre. This should be applied to a plowed field and be disced or harrowed into the soil to insure thorough mixing and an intimate contact between the soil grains and the limestone.

The management of these soils to maintain the fertility will depend, to a considerable extent, on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other livestock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium and nitrogen. But even when stock is maintained it is very probable

that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soy beans or clover, occasionally, to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

While the larger proportion of these soils are now used for trucking, it is probable that the total area will ultimately be utilized in this way. The use of commercial fertilizers will thus become more common, and a more intensive system be developed. The manure now used is largely purchased, and this practice must continue if manure is to be used. It is becoming more difficult to obtain, however, and so legumes may have to be depended upon more largely than in the past for the source of organic matter, and some of the nitrogen. This when supplemented with mineral fertilizers will maintain the productivity of these lands and insure large yields. In the growing of special crops which are forced, the use of a complete commercial fertilizer is found to be profitable. The various crops require slightly different combinations of plant food in the fertilizers, but the element which predominates is phosphorus. A discussion of the use of commercial fertilizers will be found under the chapter on Agriculture on page 81.

DUNESAND

Dunesand consists of yellowish-brown loose fine sand, passing at 4 or 5 inches into a yellow fine sand of the same general character, extending to a depth of 3 feet or more. In basinlike areas lying between ridges the surface has a dark-gray color, as a result of a larger content of organic matter.

Areas of Dunesand lie immediately along the Lake Michigan shore, between Kenosha and the Illinois state line. It consists of a series of broken ridges extending parallel with the lake. Because of the loose open structure, of the soil and subsoil the drainage is excessive.

Dunesand is extremely droughty and is constantly being shifted by the wind. It is not farmed, but affords a little grazing.

In the northeastern quarter of Sec. 28, Waterford township, is an area consisting in part of Dunesand and in part of Coloma

fine sand. Except in the freshly formed dunes the soil consists of a light brown sand, 5 to 7 inches deep, which grades into pale yellow loose fine sand extending to a depth of 3 feet or more. In a few places the subsoil contains sufficient clay to make it somewhat sticky.

Probably 50 per cent of this area is cultivated, the remainder being covered with scrub oak and used as pasture. The crops grown are corn, oats, rye and hay, but the average yields are low.

CHAPTER V

GROUP OF POORLY DRAINED SOILS

CLYDE CLAY LOAM

Extent and distribution.—The Clyde clay loam is one of the three most extensive soils in Racine and Kenosha counties. It is quite widely distributed, occuring in every township, but its distribution is quite varied in some respects. Throughout the central part of the counties it occurs chiefly as small areas of from a few acres to 80 or 160 acres as depressions in the upland. Along the Des Plaines and Root Rivers farther east it occurs in quite extensive areas tributary to these streams. Along the Lake Michigan terrace it also occurs in tracts of considerable size. They are usually long and narrow. In the extreme western part of the county there is less of this soil than in other portions of the area. In all there are 40,128 acres of this type of land.

Description.—The surface soil of this type to an average depth of 8 or 10 inches consists of a very dark or almost black heavy silt loam, or clay loam, which continues its black color or very dark gray shade to a depth of 12 or 14 inches—the lower portion of this section being a silty clay loam. The surface soil grades into subsoil of dark gray material mottled with brown which usually becomes a lighter gray with depth and at 30 inches is a very calcareous plastic clay mottled with yellow.

There are a number of variations which occur in this soil. Where the type borders Miami soils the surface is somewhat lighter than usual. Bordering some of the peat marshes the surface may be covered with a few inches of decaying vegetable matter making the supply of organic matter higher than typical. Where the soil is associated with Carrington clay loam it often grades into this type very gradually. Throughout the central portions of the region it is associated chiefly with Carrington clay loam and Miami clay loam.

The portion of the type which occurs in the valley of the Desplaines and Root Rivers and tributary to these streams differs

somewhat from the typical clay loam in that there is frequently a layer of sandy material in the deep subsoil. This, however, is usually at a depth below the reach of the auger and seldom comes within three feet of the surface. About 17,000 acres of the type belongs to this phase.

Another phase occurs on the Lake Michigan terrace and represents material which is very similar to the Waukesha soils except the drainage is more deficient. There is also sandy material in the deep subsoil on this terrace phase. The 3-foot section, however, on all of these soils is so nearly identical that all of the low black heavy material has been included in the Clyde series.

Topography and drainage.—The entire area covered by this soil is low and naturally poorly drained. The areas which are associated with the Carrington and Miami soils consist of small depressions in the upland many of which can be drained by the use of a single line of tile. Most of these areas are small being long and narrow as a rule. In origin this material is made up of glacial till and its poor drainage is simply due to its position which is relatively low.

The portion of the type which occurs along the Desplaines and Root Rivers and a few other streams is partly alluvial material and is in part subject to overflow and naturally poorly drained. Some of this material immediately adjoining these streams is difficult to drain until the channel of the stream has been lowered and straightened. These areas are quite extensive and their reclamations frequently require the organization of drainage districts.

The portion of the type occurring on the Lake Michigan terrace is level and low but not quite as low as the type along the streams and its drainage is intermediate between the portion of the type just described and the Waukesha soils. However, over the entire type tile drains are needed before cultivated crops can be grown safely from year to year.

There are two degrees of drainage which were especially noted in the field. Where no tile drains have been installed and where the surface is quite low a marshy condition frequently prevails. Over portions of the type which are somewhat higher or where tile drains have been installed the soil at present can be cultivated successfully and has a somewhat different appearance be-

cause of its improved condition. There is no difference in the soil itself, however, and so all of this material has been classed as the same type.

*Present agricultural development.**—Clyde clay loam is one of the most productive soils of the region when thoroughly drained and cultivated. Probably 60 to 75 per cent of it is under cultivation and most of the remainder is in permanent pasture. Corn, sugar beets, hay and cabbage are important crops. Oats and barley and other grains make a good growth but because of the rank growth of the straw are apt to lodge. The quality of the grain is not equal to that grown on light colored upland soils. Alsike clover and timothy do well on this soil. Hemp to which this soil apparently is well adapted is an important crop in the vicinity of Union Grove. The type is especially well adapted to corn and with the Clyde silt loam probably forms some of the best corn land of the state when drained. On the Lake Michigan terrace practically all of the type is under cultivation and devoted to truck crops. Sugar beets, cabbage, onions, potatoes, tomatoes, carrots, strawberries and beans are among the products grown. Hay, barley and oats are also raised but general farming is of secondary importance on the lake terrace. Along the lake shore large quantities of stable manure are shipped in from the Chicago stock yards; from 15 to 20 tons per acre frequently being used. Some commercial fertilizers are also used especially on the onions, sugar beets and cabbage.

CLYDE SILT LOAM

Extent and distribution.—The Clyde silt loam is one of the important and extensive soil types in Kenosha and Racine counties. It covers a total area of 34,688 acres. In the western part of the area where it is associated with Miami silt loam this soil occurs as rather small areas in depressions in the upland. Tributary to the Desplaines and Root Rivers are found the most extensive areas of this soil. About 27,000 acres out of the 34,000 is located tributary to these streams. About 4,000 acres are distributed over the Lake Michigan terrace in the extreme eastern part of the county.

Description.—The surface soil of the Clyde silt loam is a dark brown or black silt loam very high in organic matter and extend-

*For a discussion of the chemical composition and methods for the improvement of this soil see page 62.

ing to a depth of 12 inches or more. The upper subsoil is a brown or dark silty clay loam and in the lower part below 24 inches a gray clay is found which is often mottled with brown and yellow.

As mapped this type is subject to many variations. Over the lower portions of the type there may be a surface layer of one to six or eight inches which consists of peaty material. Over some portions of the type where there has been considerable surface wash a similar peaty layer is found at a depth of 1 or 2 feet over very limited areas. Out of New Munster and at a number of other places in the western part of the area the surface is a dark colored Marly silt loam which passes at about 14 inches into a gray material which is largely Marl and silt. This continues to a depth of over three feet.

On the broad terraces along Lake Michigan and tributary to the Fox and Desplaines River beds of sand and gravel are in many places present at depths of 18 to 36 inches. The surface soil sometimes carries considerable sand and gravel. In such cases there are many included patches of clay loam. In the eastern part of the township of Summers there are inclusions of superior silt loam. There are also a few places where the texture of the surface soil is a loam instead of a silt loam.

Topography and drainage.—The surface of this type is low or depressed, level and naturally very poorly drained. There are two rather distinct degrees of drainage, one where a condition approaching marsh is found and where the land is entirely too wet for cultivation at present and the other where the soil occupies a slightly higher position or where it has been artificially drained and where cultivated crops can now be grown with a fair degree of safety. The soil in both instances is identical, the only difference being in the condition of drainage. Many times a fence line will form the boundary between such conditions.

In the western part of the area where most of the tracts of the soil are small the land is seldom subject to overflow and can usually be drained with one line of tile. Along the Fox, Root and Desplaines Rivers the areas are much larger in some places, the soil is subject to overflow and drainage must usually be developed cooperatively. The establishment of drainage districts being necessary where the ownership is distributed among sev-

eral farmers. A portion of the land tributary to these streams is of alluvial origin while that in the west part of the county is a part of the glacial till material. Along Lake Michigan the material is part of a terrace formation and is somewhat better drained than other portions of the type.

Present agricultural development.—When drained the Clyde silt loam is probably the best corn soil in Wisconsin. It is also well adapted to a large number of other crops, such as hay, root crops, cabbage, sugar beets and the truck industry is quite highly developed upon it in the eastern part of this area. Much of the land has been tile drained and is now highly improved. Probably 60 per cent of the type is under cultivation. The portion which is in use is chiefly that which is subject to overflow. A portion of the type which is not improved is used largely for pasture. Where general farming is carried on and small grains are grown, lodging is quite common. The grain does not fill out as well and is lighter in weight than grain grown on the light colored upland soils. On the portion of the type occupying the Lake Michigan terrace the soil is devoted chiefly to trucking, sugar beets, cabbage, onions and potatoes being grown. This portion of the type has a higher value than in the central and western parts. The selling price ranging from $250 to $500 per acre where improved. Cabbage yields from 10 to 20 tons per acre, sugar beets from 12 to 30, corn from 35 to 90 bushels, onions about 400 bushels with a range of from 150 to 1,000 bushels per acre. Potatoes yield from 125 to 150 bushels per acre. Commercial fertilizers are used quite extensively and stable manure from the stock yards at Chicago and Milwaukee is also utlized, though not to as great an extent as in former years because of the increasing price and the difficulty of securing an adequate supply of this fertilizer.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE CLAY LOAM AND CLYDE SILT LOAM

These two types occupy a total of about 19 per cent of the two counties, and form a substantial part of the best agricultural land in the region. They are characterized by having relatively large amounts of organic matter, accumulated as a result of poor

drainage. The supply of organic matter is quite variable since the soil grades into muck and peat on the one hand and into upland mineral soils on the other. Chemical analysis show that the nitrogen content varies from 4,000 to 10,000 pounds per acre 8 inches. The supply of phosphorus runs from 1,000 to 2,460 pounds per acre while potassium usually runs from 25,000 to 40,000 pounds per acre or more. Where the soil has a thin covering of peat the phosphorus and potassium are present in the surface soil in smaller amounts.

The portion of these soils found on the Lake Michigan terrace usually show some need for lime and ground limestone in such places can be used to advantage. Over most of the region, however, these soils do not need lime. They are so situated that they receive the wash from higher lands, which contain lime material, and this lime-bearing water has prevented the development of an acid condition in these lands. Where acidity is found it is usually so slight that but little if any lime is needed, except as indicated above.

The most important step and the first step in the improvement of these soils is to supply adequate drainage. Many miles of tile drains and some open ditches have been installed and the major portion of the land is now devoted to cultivated crops. Considerable areas, however, are still undrained, and are used chiefly for pasture and hay. The drainage of these lands frequently requires the development of drainage districts, but there are numerous tracts which are so situated that they can be reclaimed by individual efforts.

A condition which sometimes develops on this soil is shown when corn turns yellow on areas of small extent. In such cases the use of some form of potash or strawy horse manure is helpful. There is relatively a much larger supply of nitrogen than phosphorus and potassium. For this reason it is a good practice to use the manure on the upland soils which are deficient in nitrogen and apply mineral fertilizers to the low land when these are needed. In many cases which show a marked need of potassium during the first few years of cropping, usually where the soil is high in organic matter to a depth of a foot, this lack of potassium frequently disappears after a few years of cropping as a result of the settling of the surface so that deep plowing mixes up some of the soil high in potash.

In spite of their large content of both phosphorous and potassium,* it is not infrequently true that these soils show low availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthy part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the experiment station.

These soils are capable with thorough drainage and proper fertilization and cultivation of being made among the most productive lands in the state. Within easy hauling distance of Racine and Kenosha they are being utilized to some extent for trucking, but this industry could be developed to still greater proportions. All of these lands not now being farmed should be drained and put to work, for it is an economic loss to have them idle.

CLYDE FINE SANDY LOAM

The surface soil of this type consists of a dark brown to almost black fine sandy loam, about 10 inches deep. The upper subsoil is a yellowish-brown fine sandy loam, which at about 15 inches passes into a yellow fine sandy loam, fine sand, or a gravelly fine sand. The lower subsoil, from 26 to 36 inches, is a gray fine sandy loam, mottled with yellow, or a bluish drab sandy clay. Included with this type as mapped are small areas of Clyde fine sand and Wabash fine sandy loam.

This is an unimportant soil occurring chiefly along the Fox and Desplaines Rivers and their tributaries. It covers 2,368 acres. The areas have a flat or basinlike surface and poor drainage.

The Clyde fine sandy loam is a water-laid soil deposited largely by stream action. The material comes from glaciated limestone debris but some of the type is in an acid condition.

The native vegetation consists of elm, ash, sycamore, willow, soft maple, alder, and coarse grasses and other water-loving plants.

*For a more thorough discussion of the exact amounts of commercial fertilizers to use, and for methods of application, see the section on the Use of Fertilizers, on page 81. Attention is also directed to the Bulletins of the Wisconsin Experiment Station, which deal with this subject.

Probably 10 per cent of this type is in cultivation; the remainder is used for cutting marsh hay and as a range for cattle. Where open ditches have been constructed and the land drained fair crops of corn, oats and timothy and clover hay can be obtained. Cabbage, onions, and sugar beets should also do well on this type of land where it has been provided with adequate drainage.

Chemical composition and improvmeent.—This soil is somewhat variable in its physical properties. Its supply of nitrogen, phosphorus, and potash is somewhat smaller than in the silt loam, but it contains more organic matter than do the light colored upland soils and contains a fair amount of phosphorus and potash. In its improvement drainage is the first and most important step. When this has been supplied, this soil is well adapted to the growing of general farm crops, but it is also well suited to special truck crops. Where favorably located, it should be devoted to these special truck crops rather than to the growing of general farm crops. When well drained, it warms up readily, is easy to cultivate and therefore very desirable for the growing of crops which require intensive cultivation.

PEAT

Peat areas are most extensive in the vicinity of Powers, Camp, Lily and George Lakes, southwest of Wheatland, north of Brighton, east of Paris, along the state line in the townships of Salem and Brighton, northeast of Burlington, southwest of Caldwell and southeast of Wind Lake. Small beds are scattered throughout the remainder of the area, but are most numerous in the western part.

In the morainic western part of the area the beds occupy old lake basins, ponded valleys, kettle basins, glacial sloughs, and other depressions in the uneven surface developed by the glacial ice sheet. Along the Fox and Desplaines Rivers and tributaries the beds occur mainly in the flood plains.

Peat consists of a black or dark-brown fibrous to rather finely divided vegetable matter mixed with a small proportion of mineral matter, mainly of the grades silt and fine sand. The deposits range in depth from 18 inches to about 20 feet, with an average depth of about 4 feet. Over the greater part of the

deposits the material is fibrous, though in a number of places it is fairly well decomposed, and sticky so that it can be moulded into forms by the hands. When dry this well-decomposed peat somewhat resembles black clay. In regions of sandy soil, the underlying material is usually of a sandy nature, and in regions where heavy upland soils occur the underlying material is heavy in character. Fully 90 per cent of the peat in this survey is underlain by material as heavy as a loam or heavier.

The peat areas are low, level and very poorly drained. During each spring many of the marshes and swamps occupied by the soil are entirely covered with water but during the summer many of the tracts are sufficiently dry and firm to bear the weight of farm animals, so that they can be pastured or where there is a growth of wild grasses cut for hay.

The peat has been formed through the rank growth of vegetation and its partial decay in the presence of water. The black or dark colored material is formed largely from the remains of grasses and sedges, and that having a brown color chiefly from sphagnum moss. About the margin of larger marshes and over the greater part of the smaller ones, varying quantities of soil from the adjoining higher land has been washed in and incorporated with the vegetable matter. Although the peat beds of this area occur within a region where the upland soils are made up in part of limestone material, some of it is in an acid condition. This is usually the case in the center of the large marshes; many of the smaller ones are not acid.

The native vegetation on the peat consists of several varieties of grasses, sedges, arrowhead, cat-tail, various reeds, rushes and sphagnum moss. The amount of tamarack in these two counties is very small, though some of the marshes supported such a growth. Alder and willow also are present in places.

Only a small proportion of the peat of this area has been ditched and reclaimed. Where thoroughly drained, well fertilized, and properly handled such beds in other regions produce good yields of corn, potatoes, onions, celery, sugar beets, cabbage and peppermint. Potatoes grown on peat are not as good as those grown on sandy soils, and small grains are likely to lodge and to be of somewhat lower grade than where grown on upland soils.

Peat, shallow phase.—The shallow phase of peat is essentially the same as the typical soil except in depth of peaty material which is only from 10 to 18 inches instead of several feet.

Areas of this phase are small, but occur in practically every township of Racine and Kenosha counties. They occur around the margin of all the marshes, but usually are so narrow that they cannot be indicated on the map. There are, however, many that consist entirely of the shallow phase.

In topography, drainage, character of vegetation and origin, this phase is similar to typical peat. The methods of improvement and the fertilizer requirements for the first few years after reclamation from the undrained state would be the same as for typical peat, but the material underlying the organic soil is heavy, and where the roots of plants will reach this in their growth the need for potash and phosphate fertilizers is less. When drained the material settles and with but 18 inches or less to begin with, this layer will in time be sufficiently thin to allow the plow to turn up some of the underlying material. Mixing this with the organic layer will greatly increase the value of the land for production and to some extent do away with the need for fertilization.

METHODS OF IMPROVEMENT*

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is very low in earthy matter, running from 80 to 95 per cent of organic matter. The amount of the mineral elements is consequently low, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches, and of potassium, 700 pounds. It will be seen, on comparison of these statements with those made on the composition of such soils as Miami clay and silt loams, that the total amount of potassium, in particular, is extremely small, the amount in peat being often less than 2 per cent of that found in the upland silt and clay loam soils. While the the total amount is small, a large proportion of it is available to plants, especially if the surface has been burnt over, and the supply may be sufficient for from 1 to 3 crops. It is to be expected, therefore, that profitable cropping is possible over a long period of years, only by the use of some form of potassium fertilizer, either barnyard manure, wood

*For a more complete discussion of methods for the improvement of Peat lands see bulletins of the Experiment Station which can be secured free by writing to Wisconsin Experiment Station, Madison, Wis.

ashes, or the usual commercial fertilizers containing this element. The total supply of phosphorus is rather low, though the difference between the amounts present in peat and upland soils is very much less than in the case of potassium. In view of the enormous quantity of nitrogen contained in these soils, the average amount of which is over 15,000 pounds per acre 8 inches, it is unnecessary to use stable manure, the most valuable element of which is the nitrogen, so that, on farms including both peat land and upland soils, the stable manure should be used on the upland, and commercial fertilizer containing phosphorus and potash on the lower land, unless, indeed, there is sufficient manure for the entire farm. These marsh soils are rarely acid on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid peat are found on the larger marshes. This acidity, however, is not so detrimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on higher lands to secure nitrogen but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not physically so well adapted.

In the improvement of peat the question of drainage is the first step to be considered. Both open ditches and tile drains can be utilized in reclaiming the marshy tracts. The major portion of the peat can be profitably drained and improved. When properly handled the peat will produce profitable crops of corn, alsike clover, timothy, and a number of other general farm crops, as well as special crops such as peppermint, celery, etc.

MUCK

The material mapped as muck consists of partly decomposed vegetable matter with which there has been incorporated a considerable quantity of mineral matter. The most common occurrence in the present area is where from 1 to 5 inches of silty material has been deposited over beds of peat. Other areas consist of peat beds that have been drained for a long time, with further decomposition of the fibrous organic matter and a concentration of the mineral constituents sufficient to produce muck. In other places there is a mixture of a marly substance and peat throughout the 3-foot section.

Only a small total area of muck occurs in the survey. Small scattered areas are mapped in all townships bordering Walworth county, and the soil also lies along the bottom lands of the Desplaines River. The areas are low lying and have a level surface, and are naturally poorly drained.

None of the muck is under cultivation at the present time but it is used for pasture and for the production of marsh hay. In places there is a growth of willow, aspen, sumac, ash, soft maple and elm.

When drainage is well established this soil will be well suited to the production of a number of crops. It may be considered somewhat better than peat land, because it is more thoroughly decomposed and also because it contains more mineral matter, and hence larger quantities of the mineral plant food elements. Its improvement can be made along the same lines as suggested for peat but its need for mineral fertilizers is not quite so great. Where suitably located it can be profitably utilized for trucking after being thoroughly drained.

GENESEE LOAM

The Genesee loam forms only a small area in the present survey. It occurs chiefly in the flood plains along the Root River in Caledonia township.

The Genesee loam consists of an upper layer of a brownish gray to brown loam to silt loam, 12 inches thick, resting upon a layer of yellowish gray silty clay loam passing at about 20 inches into a silty clay, mottled with various colors and extending to a depth of 3 feet or more. In some places the lower heavy layer is underlain with beds of sand or gravelly sandy loam. As is likely to be the case with alluvial soils this type is somewhat variable, including small patches of loam, clay loam and fine sandy loam texture. The surface is level and the natural drainage poor. The soil is frequently flooded, and because of this very little of it has been placed under cultivation. With adequate drainage it would be an excellent soil, but this will involve in many cases diking or lowering the bed of the streams, and cost of such work would hardly be justified for the reclamation of this soil at the present time.

DRAINAGE

Racine and Kenosha counties have approximately 104,832 acres of land over which the natural drainage is deficient, according to the classification of the soil survey, and which must be provided with some form of drainage before cultivated crops can be safely grown from year to year. Of this poorly drained land about 25 per cent consists of peat land, while most of the remainder is low, poorly drained land belonging to the Clyde series, with a very small amount in the Genesee series.

The larger proportion of the peat marshes is confined to the western half of the area, while the majority of the poorly drained land other than peat is confined chiefly to the eastern half of the two counties.

The following table, taken from the 1920 census, gives statistics covering the extent to which the development of drainage enterprises have been carried in this region.

DRAINAGE STATISTICS RACINE AND KENOSHA COUNTIES

	Racine County Acres	Kenosha County Acres
All land in operating drainage enterprises	61,847	11,803
Improved land in drainage enterprises	47,205	10,273
Per cent of improved land in farms	32.3	9.2
Open ditches completed—Miles	95.3	14.5
Tile drains completed—Miles	31.7	10.0
Maximum size of tile—Inches in diameter	24.0	30.0
Area drained by open ditches and tile—Acres ..	54,847	11,763
Capital invested in projects completed	$406,000	$100,100
Acres on which corn was principal crop grown on reclaimed land	39,173	10,249
Total area of land in both counties which is naturally poorly drained	104,832 acres	

As will be noted from this table there are over 70,000 acres of low land in drainage enterprises, and in these there are about 110 miles of open ditch and over 50 miles of tile, the largest of which is 30 inches in diameter.

The types which offer the greatest opportunity for drainage are the soils of the Clyde series. When thoroughly drained these soils make excellent corn land, and they are also well suited to many other special crops such as sugar beets and cabbage. Trucking is carried on to a considerable extent on these soils, and there is room for much more extensive development along this line. On the lighter soils of this series onions are grown quite extensively.

The drainage of the peat land offers opportunity for agricultural development, but the problems in the improving of this type of land are more numerous and difficult than in the case with the Clyde soils. The peats require the use of commercial fertilizers, as indicated elsewhere and special methods of cultivation are also called for, but with proper handling the peat lands can be made to produce profitable crops, and their drainage will add materially to the productive acreage within the two counties. If all the poorly drained land in the area were sufficiently drained so that the gross income would be only $10 per acre there would be added over $1,000,000 to the farmers' income of the two counties each year. Such an important project is worthy of the most careful study by every public spirited citizen of the region. The best results can be secured only through cooperation of all parties concerned.

Where areas of low land include land owned by several people the owners can readily form a drainage district and borrow money on bonds to pay for the improvement. This is the method which has been used, and a number of drainage districts have already been established in this region. In this way the cost can be spread over a period of years, and can actually be paid for from the products of the improved acres. Assistance for the development of such projects can, and in fact must, be secured from the state authorities, who pass upon the feasibility of the project before the courts will permit the organization of a district. Where areas of marsh are small and confined to one farm from which there is an outlet the drainage can be installed without cooperation of neighbors. This has been done in a number of places and small systems of tile drains are not uncommon, yet there are thousands of acres in small tracts which have not been improved, but which would make good productive land when drained.*

*For additional information on drainage see Bulletins of the Wisconsin Experiment Station.

CHAPTER VI

GENERAL AGRICULTURE AND CLIMATE OF RACINE AND KENOSHA COUNTIES

PRESENT STATUS OF AGRICULTURE

The principal form of agriculture in the area at present consists of general farming combined with dairying. The chief crops are corn, oats, barley and hay. Potatoes, wheat, rye and buckwheat are grown to a limited extent. Among the special crops are sugar beets, cabbage and onions.

Corn is the most important crop in the area. In 1909 there were in this crop 50,515 acres, producing 1,923,477 bushels. In 1919 only 23,744 acres with an average yield of 48 bushels in Kenosha and 56 bushels in Racine county, but there is also reported 27,083 acres in silage crops, a distinction not made in the census of 1910, which may be assumed to be almost entirely corn; so that the total acreage in this crop has changed but little if any during the last decade. The Wisconsin No. 8 and the Golden Glow, or Wisconsin No. 12, are the most popular varieties. About 75 per cent of the farms of this area have silos and over 50 per cent of the corn is used for ensilage. Corn is grown most extensively on the prairie soils, though its distribution is quite general over all well drained types.

Hay ranks next to corn in importance, the acreage in tame grasses cut for hay being somewhat larger than for corn. The hay is used almost entirely on the farm for feeding stock.

Of the hay crops a mixture of timothy and clover is the most common. These are usually sown with some small grain as a nurse crop. Medium red clover is the most popular clover.

Alfalfa is becoming an important crop especially in the region where the soils are somewhat gravelly in the western part of the area. The 1919 acreage was 5,576 acres and the production 12,043 tons. Three cuttings are usually obtained annually with an average yield of about 3 tons per acre per season. Alfalfa does well on several of the different types of soil when proper

care has been devoted to the preparation of the seed bed, inoculation, fertilization and the supplying of lime needs. Miami gravelly loam, loam and silt loam are among the soils best adapted to alfalfa.

Considerable difficulty has been experienced in obtaining a good stand of clover, owing apparently partly to winter-killing during the late winter when the snow is melting and the ground freezes and thaws alternately, and partly to the dry weather during the late summer and also to acidity of the soil in places.

With the exception of some of the Clyde and part of the Miami soils a more or less acid condition exists which is detrimental to the best results with clover. The heavy types in the Miami and Carrington series are best for tame hay. Clyde soils also make good hay land when drained. Some alsike clover is grown on the more poorly drained types of soil. Mammoth clover does well on the lighter soils, but on the heavier types it is coarse and not as satisfactory as the medium red. Over the low marshy tracts many tons of marsh hay are cut each year, but this is of inferior quality.

Oats follows the hay in importance and this crop is used mainly for feed on the farm. It is grown most extensively on the medium and heavy soils. In 1919 the wheat acreage was over ten times as great as in 1909. This marked increase is the result of the high prices of the war period. Wheat does best on the heavy, well drained soils. Barley is grown on all heavy soils; with a number of farmers it is the chief cash crop. The acreage is only about one-fourth that of oats. In 1919 there were 1282 acres in rye. In addition to these cereals, a little buckwheat is grown. It is confined largely to sandy soil and rather poorly drained land.

Dairying is the leading agricultural industry and is carried on throughout the area except in the extreme eastern part of the Lake Michigan terrace where the trucking industry has developed. The dairy farmers usually have from six to thirty cows, but the number of larger herds is considerable. The milk is shipped mainly to Chicago and other cities. There are bottling plants at Woodworth, Bristol, Wheatland and Bassetts, a condensary at Burlington, and a malted milk factory at Racine. There are a number of purebred herds in the area. The Holstein breed predominates with Guernsey probably second. There are also some Jersey and Brown Swiss cattle. The

great majority of the dairy cattle is made up of grades, with Holstein and Shorthorn blood predominating. Many of the herds now are headed by purebred sires.

Some steers are shipped into the area from Chicago and from the west for finishing. On a number of farms from 10 to 50 of these animals are fed for several months and then sold for beef.

Hog raising is carried on in all parts of the area. The Poland China, Chester White and Duroc Jersey are the predominating breeds. There are also some of the Berkshire and a few of the Hampshire breeds.

Some farmers raise horses for their own use and there are a few horse breeders who ship out of the area. Clydesdale and Percheron are the leading breeds.

Sheep raising is carried on by a small proportion of the farmers. In the western half of the area where the land is somewhat rolling, the Shropshire is the leading breed. Many sheep are shipped in from the west, fed at Burlington and Trevor, and later sold in Chicago. The manure secured from these feeding activities is an important item as some is used on land in the vicinity. Some, however, is sold to fertilizer concerns and shipped away.

Of the special crops grown potatoes, cabbage, sugar beets and onions are the most important. Cabbage growing is carried on in the eastern half of the area and also in the vicinity of Kansasville, Bristol and Salem. In 1920 the yield from 5,480 acres was 58,437 tons. The crop is shipped mainly to Chicago and Milwaukee. Sugar beets are grown more or less throughout the eastern part of the area and most extensively on the Lake Michigan terrace. They are also grown in the vicinity of Salem, Bristol and Kansasville. Drained Clyde soils are well adapted to this crop although other types are also used to good advantage. The beets are shipped to sugar factories at Janesville, Menomonee Falls and Madison, Wis., and at River Dale, Ill.

According to the 1910 census the acreage of sugar beets in the two counties in 1909 was 1,390 acres, which produced 18,421 tons. In 1919 the acreage was 3,879 and the tonnage was 49,516. It is customary for the farmer to put in the crop and tend to the implement cultivation, while the factory furnishes labor

HARVESTING PICKLING ONIONS

The trucking industry frequently calls for the employment of large amounts of hand labor.

VIEW SHOWING THE HAND CULTIVATION OF ONIONS

This is an important special crop in Kenosha and Racine counties.

to do the hand work, such as thinning, weeding, pulling and topping.

Potatoes are grown on a commercial scale on the Lake Michigan terrace. In other parts of the area, practically all the farmers produce their own supply and many have some for the local markets. The best potatoes are produced in the sandy sections. In 1919, 5,091 acres yielded 217,787 bushels. The Early Rose, Early Ohio, Rural New Yorker and Peerless are among the varieties most commonly grown.

Onions are grown extensively on the Lake Michigan terrace between Kenosha and Racine. About 95 per cent of the crop consists of a variety known as the Red Globe. The product is shipped to all parts of the United States east of the Rocky Mountains. In 1920 there were 580 acres in the two counties.

Commercial gardening is important on the Lake Michigan terrace, most of the produce being sold in Kenosha and Racine or shipped to Chicago and Milwaukee.

Apples are grown in small orchards on many of the farms, but there are few commercial orchards within the area. Very few farmers prune or spray their trees. Strawberries, blackberries, raspberries, currants, plums and grapes are gown to a small extent, chiefly to supply the home. Hemp is a new crop and 400 acres were grown in Racine county in 1920. There is a hemp mill at Union Grove.

METHODS

The tendency throughout the area is toward better and more improved methods of cultivation, the use of fertilizers, and seed selection and as a result of this advance, crop yields are gradually increasing.

Where the land is droughty and not subject to wash fall plowing has been found helpful in the conservation of moisture and in the improvement of tilth. Sometimes the heavy soils are plowed in the fall, usually as much being plowed as labor and weather conditions will permit. It is customary to apply stable manure on land intended for corn. If the land is plowed in the fall, the manure is often hauled out during the winter and scattered over the plowed surface. If not plowed in the fall, the manure is plowed under in the spring. Where stubble land is plowed

in the latter part of the summer, manure is frequently applied before plowing. Throughout the area most of the farmers plan to seed their land to grass at least once every four or five years.

ADAPTATION OF CROPS TO SOILS

Most of the farmers in this region recognize the difference in the adaptation of certain crops and varieties of crops to soils and very many are guided in their general farming operations by such knowledge, but only a few carefully select the crops to which their soils are best adapted. Farmers in general realize that the soils of the Miami series and the Rodman soils when not too rough are best suited to alfalfa. Corn is known to do best on the well-drained and rather heavy types of the Clyde. It also does well on the heavier dark-colored soils of the Carrington and Waukesha series. The Wisconsin No. 8 corn is more suitable for the heavier poorly drained clay loam soils which occur in the eastern half of the county, while the Wisconsin No. 12 is most popular in the western part of the county where the soils are better drained and have lighter texture. The Wisconsin No. 8 requires from 8 to 14 days less time to mature than does the No. 12.

On the dark soils having a large percentage of organic matter small grains are likely to lodge. The quality of the grain is not as good on these soils as on the light colored heavy soils of the county. Potatoes of the best quality are grown on the sandy soils. The sugar content of beets grown on the heavier Carrington, Clyde and Waukesha soils is lower than of those produced on the Miami and Fox soils, but the yield is enough higher on the dark soils to give slightly better net returns.

On the Lake Michigan terrace the light-textured soils of the Fox, Plainfield, Waukesha and Clyde series are the earliest of the truck soils, but the heaviest yields are obtained from the heavier members of some of these series. Cabbage gives the best yields on the Clyde clay loam, silt loam and loam, and on the Carrington soils. Onions do best on the fine sandy loam of the Waukesha and Fox series.

DIVERSIFICATION AND CROP ROTATIONS

It is of great importance in selecting crops to grow that careful consideration be given to the question of climate. This is about the only factor which the farmer absolutely cannot control.

A poor soil may be improved, better markets may be found, and better labor secured; but the farmer is powerless to change climatic conditions. He must, therefore, select such crops as are suited to his climate.

The soil is also a factor of great importance. As a general rule, small grain crops do better on heavy than on light soils, and the same is true of grasses grown for hay. On the other hand, the same variety of corn requires shorter season for maturity on light than on heavy soil. Rather light soils and those of intermediate texture are better adapted to potato growing and root crops. Therefore, on lighter soils the greater acreage should be devoted to cultivated crops than on heavy types.

Shipping and marketing facilities must also be considered in planning a rotation. The farmer located on a sandy loam farm close to a railroad station or home market will often find it profitable to include potatoes in his rotation. If he is located six or seven miles from a station, the profits from growing potatoes will be much lessened. It will then pay him better to raise more corn for stock feeding, and to convert his crops into dairy products which are less bulky, and which for the same bulk have a greater value.

Some of the other things which we should keep in mind regarding a good rotation are that it helps to control weeds. It also aids in controlling plant diseases, and serves to check insect pests. Following a good rotation increases the humus supply in the soil, and insures maintaining a good amount of available nitrogen in the soil. It helps to distribute the labor efficiently throughout the year. A good crop rotation means that the proper crops will be grown at the proper time and in the proper place, and this will aid in keeping the soil in proper sanitary condition. It will also increase net returns from each acre, and improve the general appearance of the farm.

A three-year rotation is very popular on many of the dairy farms. It consists of grain seeded to clover, and the clover followed by corn or some other cultivated crop. Much the larger portion of the corn in this region is cut as silage to be fed to dairy animals. The clover is made into hay, and fed to stock. It is often possible to get two crops of medium red clover in one season. The second crop may be cut for hay or may be pastured. Pasturing is advisable on well-stocked dairy farms. This three-year rotation may be lengthened into a four-year ro-

tation by the addition of timothy so that hay can be cut two years instead of one year, or the land can be pastured the second year instead of cutting for hay.

Potato raising when properly managed is a profitable industry in many parts of the state. Although good crops may be grown on heavy clay soils, the sandy loams are especially well adapted to potato production. For best results, this crop should be grown in rotation with other crops, and should always follow a legume of some kind. Potatoes should not follow corn, or corn potatoes, as both crops draw heavily on the fertility of the land. In the rotations which have been given, potatoes can be planted as one of the cultivated crops. It is better to apply manure to the clover crop rather than just before planting to potatoes, for scab is more common when potatoes are planted on freshly manured land. The three-year rotation just described is excellent for sections where potatoes are grown extensively. As a rule cropping to potatoes oftener than once in three years is not recommended.

The growing of peas for canning is important in some sections, and this crop may be introduced into the rotation very readily. A four-year rotation may consist of small grain, clover, a cultivated crop, followed by peas. This may be made a five-year rotation by adding timothy and cutting hay two years.

The growing of sugar beets is also an important industry, and beets may also be introduced into the rotation without difficulty. It is best not to have the beets follow or precede the corn, but the crop may follow barley or other small grain. Beets may simply take the place of corn in a three or four-year rotation. Cabbage may be substituted for beets without difficulty.

Hemp is coming to be an important crop in Wisconsin. The most satisfactory place in the rotation for this crop is after corn. The corn should have been preceded by clover sod, well manured and plowed in the fall. Hemp may also follow potatoes, cabbage, or any other cultivated crop. Hemp should not follow timothy meadow, bluegrass sod nor pasture in Wisconsin; neither should hemp follow any small grain unless the soil is very well supplied with manure. Hemp will leave the soil in splendid physical condition for any spring sown small grain. It also leaves the land relatively free from weeds, and it is, therefore, a good crop to precede sugar beets, or canning peas. The fol-

lowing rotations with hemp have been found applicable to Wisconsin:

Small spring grain crop (seeded down to clover);
Clover for hay and pasture (manured and fall plowed);
Corn, potatoes or similar crops;
Hemp (then back to small grain and clover).

Another rotation covering three instead of four years is as follows:

Small grain crop (seeded to clover);
Clover (manured and fall plowed);
Hemp (then back to small grain and clover).

LIMING

Racine and Kenosha counties are located within the glaciated limestone region of Wisconsin, and a considerable proportion of the soil forming material has been derived in part at least from limestone. The subsoil of most of the types is well supplied with lime and the surface soil in many places is neutral or only very slightly acid. In fact, many tests have been made where the soil does not show any reaction whatever. The types which are most apt to show acid reaction and which seem to be in need of lime are soils of the Carrington and Waukesha series and Plainfield fine sand. The lighter soils of the Miami series also show slight acidity in places. The peat soils are also slightly acid in places but there is less acidity in the low lands of this region than in the central and northern parts of the state.

The degrees of acidity on any farm may be quite variable. It is quite important therefore that before an expenditure is made for lime that the soil should be tested and the crops observed to determine the actual need for lime.

It should be kept in mind that when a soil is acid according to a laboratory test, it does not necessarily mean that that soil will respond profitably to the use of lime, for acid soils are frequently in need of other plant food elements. The story which the crop tells should be considered. Failure of clover and alfalfa, or a growth of sorrel may be an indication of the need for lime. When there appears to be a medium need for lime, from 2 to 3 tons of finely ground limesetone should be applied per acre. The amount to be used will usually vary with the degree of acidity, the character of the soil and the crops to be grown. Such crops as alfalfa, sweet clover, peas, cabbage, onions, and

lettuce have a high lime requirement. Clover, garden beans, barley, bluegrass, hemp, turnips, and radishes have a medium lime requirement while vetch, white clover, oats, rye, potatoes, sorghum and others have a low requirement for lime.

Ground limestone and marl are doubtless the most economical forms of lime which can be extensively utilized. Lime should be applied the year previous to planting the crop which is to be benefited. It should be applied to plowed land and thoroughly worked in by harrowing. Either fall, winter or spring applications may be made.

The best way to apply lime is with a regular spreader made for this purpose, and there are a number on the market. A manure spreader may also be used by first putting in a thin layer of manure and spreading the limestone evenly on top of the manure. Where several farmers are so situated that they can work together, a lime spreader may be secured jointly for this purpose. The end-gate type of spreader has given good reseults in spreading dry or moist limestone.

After making a first application of two or three tons per acre, it is not likely that another application will be needed for four to six years, and the need should be determined by the story which the crops themselves tell.

It should be remembered that most acid soils are also deficient in available phosphorus, but applying lime will not add to the total amount of phosphorus in the soil. The need of phosphorus* may be so great that but little result will be secured from liming until phosphorus is also added. Frequently the application of phosphorus alone to an acid soil will result in larger increases than the use of lime alone, and for this reason it is important that both deficiencies should be corrected to secure the most economical production.

Several demonstration plots on which lime and phosphate fertilizers were tried out in Kenosha and Racine counties bring out the relation between the needs of lime and phosphorus. In several instances it was observed that where lime alone was applied to Carrington clay loam, for example, that there was no increase in yield, but where acid phosphate was also added a very liberal increase in yield was secured. The acid phosphate when used alone did not give so great an increase. It is ap-

*The question of fertilizers is more fully discussed on page 81.

parent, therefore, that these materials must sometimes be used together, and the only way to determine this accurately is by actual field tests.

COMMERCIAL FERTILIZERS AND MANURES

Analyses of the soils of Racine and Kenosha counties show that much of the land is somewhat deficient in phosphorus. The light colored upland types are low in nitrogen and organic matter, the black prairies are usually somewhat acid and may need limited amounts of lime, and the peat marshes are low in both potash and phosphorus but are usually not acid.

The correction of these defects is a very important problem which cannot be solved except after making a very thorough study of the soils and types of farming followed.

The chemical and physical analyses show that these soils vary greatly in their composition and they also vary greatly in their needs. Some require all three of the most essential elements of plant food to keep up their productivity, while others require only one element. As compared with other soils of the state the land in this region may be considered of very good quality and no more in need of fertilization than the other highly developed agricultural regions of the state. To correct minor defects, however, and to keep up and increase the fertility, certain lines of improvement should be followed.

In supplying fertilizer materials to the soil the most economical sources available should be drawn upon. The supply of stable manure is greater in a dairy region than in a grain raising region, but even here the supply is not always sufficient to meet the needs of the land. In this region a great deal of trucking is carried on and large quantities of manure are shipped in from the Chicago and Milwaukee stock yards. This is used chiefly immediately along the lines of railroad for here long hauls are avoided. The price of this manure is now so high that many feel they cannot afford to use it. Several years ago it could be secured for $20 per car f. o. b., but during the past two seasons the price has reached as high as $70 per car f. o. b.

The readily available plant foods in the form of commercial fertilizers are now being used quite commonly in this region, and in fact these two counties use more than any other two counties in the state. In 1919 there were 1,134 farms report-

ing the use of commercial fertilizer in these counties and for this the sum of $168,425 was expended. This material is used largely on trucking crops. In 1920 there were 580 acres in onions which represents about one-half of the acreage in the entire state. The same year there were 5,193 acres of cabbage, which represents about one-third of the crop of the state. General farm crops are sometimes given applications of commercial fertilizer.

Where general farming is followed and there is a fair to good supply of stable manure the greater part of the nitrogen and potash needed by the crops will be supplied by the manure. When this manure is supplemented by acid phosphate the usual plant food needs of the general farm crops will be provided for. Where a more intensive system of farming is followed, however, and such crops as cabbage or onions are grown there is a much greater need for nitrogen and potash and limited amounts of manure will not fully supply the plant food requirements. Under these conditions the manure should be supplemented with a complete commercial fertilizer rather high in nitrogen and potash.* A 5-8-7 mixture is one which has been used quite commonly by truck farmers. Some are coming to use commercial fertilizers even higher in potash, where trucking is the main type of farming followed.

The analysis of the soil will give some indications as to the need of certain fertilizers, but the growth and behavior of the crop itself will be a more certain guide as to the needs of the soil.

From soil analyses, crop studies, and field tests it has been clearly demonstrated that one element in which many of the soils are deficient is phosphorus. This can best be supplied in the form of acid phosphate, which is readily available, or it may be applied in the more slowly available forms of raw rock phosphate or bone meal. In the trucking region where crops are forced, and where large amounts of readily available plant food must be at hand the complete fertilizers are most commonly used, and applications run as high as 1,000 pounds per acre. Frequently liberal applications of mixed fertilizers are used to supplement stable manure, and it is usually such combinations which produce the largest and most economical yields. In the improvement of the peat marshes in this region potash alone is

*Information on Fertilization of Special Crops may be secured from the Wisconsin Experiment Station.

required first, but after a number of years cultivation it is probable that phosphorus will be needed also. This is especially true of the marshes which do not need lime. Where lime is needed, usually potash and phosphorus are both required.

For general farm crops the usual application of acid phosphate is from 300 to 400 pounds of 16 per cent material per acre when sown broadcast. If applied in the row or hill about half this amount is sufficient. Subsequent applications should be at the rate of about 200 pounds every three or four years thereafter. If treble super-phosphate is used about one-third the above application should be given the land.

The most satisfactory way to apply commercial* fertilizers is with a fertilizer spreader, or with a fertilizer attachment to a grain drill, or planter. If sown broadcast it should be put on the plowed ground, evenly distributed and worked well into the soil. Commercial fertilizers may also be applied by spreading them over the top of a load of manure in the manure spreader. An application should be made at least once during each rotation, and preferably on the small grain crop. When so applied the clover following the grain is benefited and since it makes a better growth it fixes more nitrogen, thus adding to the supply of that element on the farm.

In supplying nitrogen to the soil, the most economical form is through the growth of legumes which may either be fed to stock and the manure applied to the land or the crop itself may be plowed under for green manure.

In order that reliable information concerning the use of fertilizers might be made available for the farmers of this and other sections, the College of Agriculture has undertaken a number of experiments and demonstrations in cooperation with various farmers on several different types of soil.

As many of the soils in the state respond to the use of phosphate fertilizers the results which have been secured with phosphate fertilizers will be of interest in connection with this soil survey report. Most of these tests were made on heavy soils and the results will apply to most of the types in Kenosha and Racine counties.

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*For more information on the use of commercial fertilizers write the Soils Department, University of Wisconsin. Wisconsin Experiment Station Bulletin No. 341 deals especially with the Use of Fertilizers on the Dairy Farm.

Twenty-six trials with oats showed an average yield with phosphate of 58.4 bushels, and without phosphate of 49.8. In several of these cases lime had been applied with the phosphate because the land was being seeded to clover and this lime had the effect of reducing the availability of the phosphate to the oats. Had the lime been applied when the land was put in corn the year previous the influence would have been greater.

In twelve trials with barley, phosphate treatment gave an average yield of 38.5 bushels, while that without the phosphate yielded 32.9.

In seven trials with alfalfa the average yield with phosphate was 4,056 pounds per acre, and without phosphate 3,185 pounds.

In eleven trials with medium red clover the average with phosphate was 3,407 pounds, and without phosphate 2,771 pounds. In the case of both the alfalfa and the clover the phosphate treatment was applied to the previous nurse crop so that the expense of the fertilizer should be divided between the grain and the hay crops.

In four trials with corn, the average yield with phosphate was 47.9, and without phosphate 30.1. One of these fields was on very sandy soil on which the yield with phosphate was 30 bushels to the acre, while without phosphate the yield was only 20 bushels per acre. In another case on what had been originally excellent silt loam soil, the field had been without manure for a number of years and the influence of phosphate was much more marked, having the effect of raising the average effect of phosphorus.

In a single trial on dark silt loam near Dodgeville, the yield of silage with phosphate was 15.8, and without phosphate 8.7.

In six trials with potatoes the average yield with phosphate was 187 bushels, and without phosphate 141 bushels.

In the tests above referred to the treatment used in most instances was 300 pounds per acre of 16 per cent acid phosphate.

A careful study of these experiments shows some interesting results. The results are somewhat variable and not always consistent. Variation may be due in part to variations within the soil, since the types are subject to numerous variations and the plots used were not in all cases composed of soil uniform throughout the test plots. These facts should be kept in mind when the results are being interpreted.

In addition to the above a large number of tests were made on the Kenosha county farm near Pleasant Prairie. Where oats were grown on 20 plots without treatment the average yield per acre was 66 bushels. Where 3 tons of lime were used the average from 3 plots was 66.4 bushels, showing only a slight increase from the use of lime on this heavy Miami soil. Where 3 tons of lime and 400 pounds of acid phosphate were used the yield was at the rate of 78.5 bushels per acre.

As a result of these tests it seems safe to say that the soils tested are in need of both lime and phosphate fertilizer, and the best results are secured when these materials are used together.

Considering the effect of phosphate on oats and clover, it will be seen from 26 trials on oats that the increase due to phosphate was 8.6 bushels of oats, which at 40 cents a bushel, would be worth $3.44, and of 636 pounds of clover, from 11 trials, which at $12.00 a ton would be worth $3.82, making a total of $7.26 increase in value of crop due to an application of about $3.00 worth of acid phosphate. It should be borne in mind, however, that the benefit secured from the application of this phosphate is not limited to the immediate crops of oats and clover. The phosphorus taken up in these crops not only makes better feed but two-thirds of it is left in the manure produced from this feeding and is used over again by the crops grown on the soil to which the manure is applied. In other words, the phosphate applied becomes a part of the revolving fund of soil fertility on the farm. After the first application of 300 pounds of 16 per cent acid phosphate or 100 pounds of treble superphosphate per acre, a general practice of applying 150 pounds of 16 per cent acid phosphate, or 50 pounds of treble superphosphate per acre once in four or five years in the rotation when oats or barley are being sown as a nurse crop for clover or alfalfa, will return the cost of the treatment many fold.

Farmers should distinguish carefully between the phosphate fertilizers containing this much needed element alone, and the so called mixed, or complete fertilizers containing nitrogen and potash, as well as phosphorus, which greatly increases the price of the fertilizer. Nitrogen, which can be secured by the growing of legumes, costs in fertilizer form, 25 to 30 cents a pound, while phosphoric acid, the substance in these fertilizers which contains the phosphorus, costs but 6 cents a pound. One ton of 16 per cent phosphate contains 320 pounds of phosphoric acid and costs

about $20.00 a ton, while a ton of a common complete fertilizer, represented by the formula 4-8-6 and containing only 160 pounds of phosphoric acid, costs about $45.00 a ton on account of the nitrogen and potash it contains, for the purchase of which there is no necessity on the part of the average Wisconsin farmer.

Some of the above fertilizer tests will be continued from year to year and others will be started from time to time. The results secured will doubtless be published in bulletin form when the tests have been completed. Those who desire information concerning the progress of this work can secure specific information by writing to the Soils Department, University of Wisconsin, Madison, Wisconsin.

EQUIPMENT

The farm buildings, including dwellings, are generally large and substantial. The barns are large and usually have a concrete or stone foundation. The silo forms a part of the equipment of most of the dairy farms. The fences are usually good, many of them being of woven wire. The work stock consists of draft horses of medium to heavy weight. The farm machinery in general use includes 2-horse to 4-horse turning plows, smoothing harrows, disk harrows, large riding cultivators, mowing machines, tedders, loaders and binders.

Many farmers have tractors; about 10 per cent of the plowing in the county is done with tractors. Machines for threshing grain travel about the county serving the farmers soon after harvest. Many farmers have their own ensilage cutters, but it is quite common for a number to cooperate in owning such equipment.

LABOR, FARM TENURE AND LAND VALUES

The supply of labor is limited, and the members of the farmer's family do most of the work. Farm laborers are paid from $25 to $75 a month. During haying and harvest day laborers are paid $2.50 to $3.50 per day. Where sugar beets are grown labor is supplied by the factories at a cost to the farmer of about $25 per acre.

In 1919 the number of farms in the area was 3,598 comprising 90.4 per cent of the total land area. The average size of farms is 100.6 acres, of which 73.6 acres or about 74 per cent is improved. The percentage of farms operated by owners is 69.8,

by tenants 27.8 and by managers, slightly over 2 per cent. Where renting on shares is practiced the land owner supplies the work stock, tools, etc., and receives two-thirds of the crop. Where the tenant supplies these in addition to his labor, the land owner receives one-half of the crop. Cash rents range from $4 to $15 an acre, depending upon the location with respect to Racine and Kenosha, transportation facilities, the character of the soil and improvements.

The selling price of the better grades of farm land in the area range from $125 to $400 per acre, the valuation depending upon the quality of the soil, the topography, improvements, distance from markets, railroad transportation, and the condition of the public highways. The highest priced land, excluding locations near cities and towns, consists of the heavy types, and especially the silt loams and clay loams, where the surface ranges from level to gently rolling and where the underdrainage is good. The most rolling land, the sandy loam areas, and poorly drained areas range in value from $50 to $125 an acre, and the deeper sand types, some peat beds, and soils subject to overflow are valued at from $30 to $50 an acre.

AGRICULTURAL HISTORY

The history of the agriculture in Racine and Kenosha counties, Wisconsin, began with the earliest settlement which as already stated was made at the mouth of the Root River in 1835. Rumors of the fertility of the soil of Wisconsin spread rapidly through the older states and started a tide of immigration to the northwest, and within one year from the time that the first cabin was built there were more than one hundred settlers in what is now Racine and Kenosha counties.

The early farming consisted largely of the growing of wheat as a cash crop, and of corn, oats, hay, potatoes and vegetables for subsistence. As more settlers entered the country the growing of wheat was extended into various sections of the area and particularly into the large open prairies and oak openings. About 1845, in the period of more general settlement and farm development, it was reported that the land yielded an average of thirty bushels of wheat per acre. In succeeding years considerable difficulty was experienced in raising wheat on account of blight and in 1862 a reduction of acreage was caused by the

chinch bug. Corn and oats proved to be profitable and the raising and feeding of stock gradually developed into an important industry.

The growing of hops was a very important industry in this region during the sixties and seventies. In 1857 the price of hops was 40 to 50 cents a pound, and in many cases a single crop paid for the land and all improvements. So many went into raising hops, however, that the over-production resulted and in 1869 the price was only 10 to 15 cents a pound, hops of poor quality bringing only 3 cents a pound. The low prices and the hop louse finally caused the complete abandonment of the industry.

Flax was an important crop in the seventies reaching its maximum production in 1879. It continued to be grown extensively until 1887 when the acreage began gradually to decline.

According to the 1880 census, there were 30,386 acres in corn producing 1,180,525 bushels. The oats acreage was 62,670 acres with an output of over one and one-fourth million bushels. There were slightly over 19,000 acres in wheat with a production of 289,000 bushels. The barley acreage was 3,321 acres, rye, 2,375 and hay 81,230 acres.

In addition to these crops 139,438 bushels of flaxseed and 259,180 bushels of potatoes were produced in 1879.

CLIMATE

A considerable part of Kenosha and Racine counties is included within what is known as "The Michigan Shore," which is one of eight climatic provinces in Wisconsin.* This province stretches along the western shore of Lake Michigan and extends inland as far as the influence of the lake modifies the climate to any appreciable extent. This seldom exceeds the width of a county.

The Michigan Shore. The Michigan shore possesses the most equable climate in Wisconsin. The winters are mild (22 degrees), and somewhat moister than elsewhere in the state, resembling those of the coast of Maine, or eastern Michigan; the springs (42 degrees) are retarded and cool, like those along the coasts of New England and British Columbia; the summers (67 degrees) are mild and pleasant, averaging over 2 degrees cooler than the Wisconsin or Rock River Valleys and 4 degrees cooler

*For a more complete discussion of the climate of Wisconsin and its relation to agriculture see Wisconsin Bulletin No. 223.

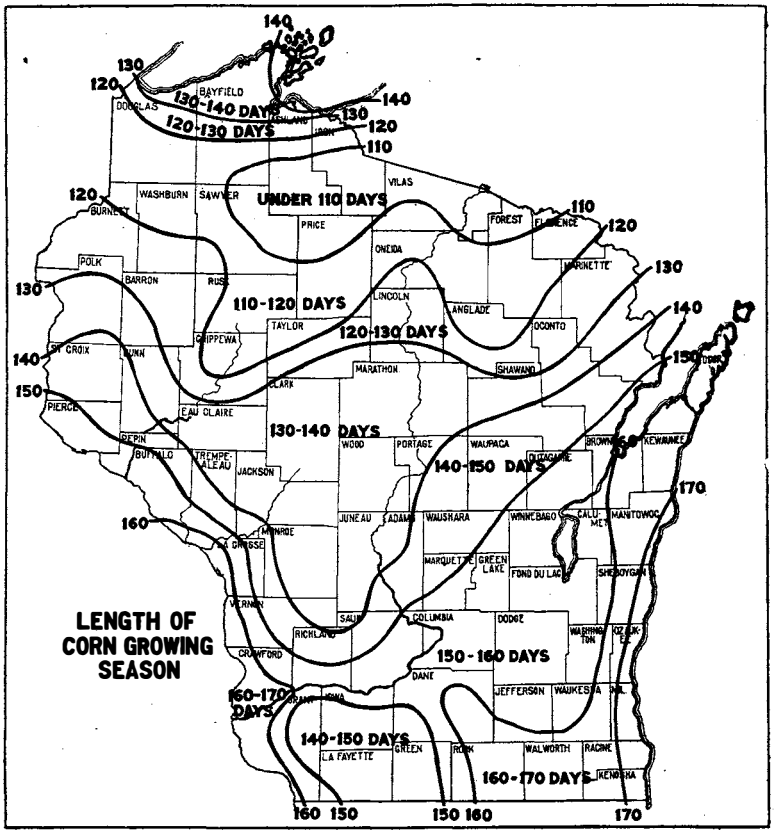

FIGURE II

than the Mississippi Valley; while the autumns (50 degrees) are warmer than farther west, the temperature being about the same as that of eastern Massachusetts, the Hudson Valley, or the Lake Ontario shore of New York. During the winters an average of five days shows a temperature lower than 10 degrees below zero, while on seven days in the year the thermometer registers 90 degrees or more. The lake shore is not a distinctive corn region, but is splendid for pasture, peas, and hay, the growing season extending from about May 1st to October 10th, thus resembling southern Ontario and northwestern New York. The average rainfall (30.3 inches) is slightly less than that of the state in general and a larger proportion is precipitated in winter (5.2 inches) and less in summer (9.6 inches).

The Michigan Shore Province gradually grades into the Rock River basin on the west, and this last named region is the best corn section of the state, while the lake shore country is not especially well adapted to this crop.

This region has a growing season of from 160 to 180 days, which with the Rock River basin has the longest growing season of any part of Wisconsin.

Normal Monthly, Seasonal, and Annual Temperature and Precipitation at Racine, Wisconsin. Elevation of Station 633 Feet Above Sea Level

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Snowfall	Prevailing winds
		Degrees F			Inches	
December	26.0	59	—17	1.39	5.5	NE
January	22.4	60	—24	1.52	9.7	NW
February	22.2	61	—21	1.38	9.2	NW
Winter						
March	34.5	81	— 5	2.35	4.4	NW
April	44.8	83	10	2.47	1.0	NE
May	54.9	96	26	3.55	T	NE
Spring						
June	64.9	102	37	3.08	0	NE
July	71.5	107	45	3.10	0	SE
August	70.7	104	42	2.72	0	NE
Summer						
September	64.2	98	28	3.84	0	NE
October	52.8	88	19	2.56	0.1	SW
November	39.5	74	— 3	1.78	0.5	SW
Fall						
Year	47.4	107	—24	29.74	30.4	NE

Following figures are based on twenty-five year record:
Average date, last killing frost in Spring, April 23d.
Average date, first killing frost in Fall, October 22d.
Latest killing frost in Spring, May 23d.
Earliest killing frost in Fall, September 30th.
Average length of growing season at Racine, Wis., 182 days.

From the table given it will be seen that the mean average temperature for the year at Racine is 47.4 degrees and the average precipitation 29.7 inches. The average snowfall is 30.4 inches. The prevailing wind during the three winter months is from the northwest. The wind during the Spring is mostly from the northeast, as is also true of two of the summer months, while two of the fall months show the wind mostly from the southwest. For the year the average is indicated as being from the northeast.

The average date of the last killing frost in the spring is April 23d and the average date of the first killing frost in the fall is October 22d, giving a growing season at Racine of 182 days free from killing frost. This report is based on records covering twenty-five years.

SUMMARY

This area comprising Racine and Kenosha counties is located in the southeast corner of Wisconsin. It has an area of about 606 square miles.

The topography ranges from level or gently undulating, as on the prairie, terraces and outwash plains, to broken, as in the kame, kettle-basin, and terminal moraine country. The eastern part of the area drains into Lake Michigan and the remainder, through the Fox and Desplaines Rivers, into the Illinois River.

Racine county was established in 1836 and Kenosha county was cut off from it in 1850. Settlement began in 1834. The population of two counties is given in the 1920 census as 130,245 of which 27,554 is classed as rural. The two largest cities, Kenosha and Racine, have populations of 40,472 and 58,953, respectively. These counties are well provided with railroads and public highways. All sections are well settled, the average density of population, 45.0 persons to the square mile.

The climatic conditions are favorable for the development of general farming and dairying. The mean annual temperature as reported at Racine is 47.4 degrees F., and the mean annual precipitation is 29.65 inches. There is a normal growing season for the area of approximately 170 days free from frosts.

The agriculture consists of general farming combined with dairying. A considerable trucking industry has developed in the vicinity of Racine and Kenosha. The common farm crops are corn, oats, barley, clover, timothy, alfalfa, rye and buckwheat. In addition a number of special crops are grown, including cabbage, sugar beets, potatoes and onions.

The sale of dairy products in 1919 amounted to nearly $3,000,000. In addition to dairying, the raising of hogs, and the feeding of beef cattle and feeding of sheep in the western part of the area, are all more or less important.

Land values range from $30 an acre in the sandy and more broken areas to $300 or more an acre in the sections having the best soils and most highly improved farms.

The soils of the area are derived from glacial drift, water-laid materials, and cumulose deposits. Ten distinct soil series, twenty-six soil types, and soil phases, including peat, muck, and dunesand, are recognized and mapped in this area.

The Miami series occurs chiefly in the western part of the area. The material composing the soils of this series consists largely of glacial limestone debris deposited in the form of moraines, kames and eskers. The series as a whole is very well drained. The typical silt loam is rather extensive, and is the leading alfalfa soil of the area. Other general farm crops do well on this soil. The loam and fine sandy loam give fairly good yields of corn, alfalfa, oats and barley. A smoother phase of the Miami series consists of light-colored forested glacial soils carrying some limestone material. The silt loam, deep phase and clay loam occur in large areas and are well adapted to all farm crops common to the region.

The Fox series consists of light-colored forested soils mainly in the glaciated limestone regions. They are derived from outwash plains, deposited as stream terraces, or lake terraces. The silt loam and loam are well adapted to the production of the general farm crops. The gray sandy phase of the silt loam and the gravelly loam are well suited to truck farming.

The Plainfield series consists of light-colored, light textured, terrace soils. With heavy applications of fertilizer they can be used successfully in the production of truck crops. The fine sand was mapped in this area.

The Superior soils occur in only a few small areas, all in Caledonia township. These soils are well adapted to general farming. Clay loam and fine sandy loam were mapped.

The Rodman series includes light-colored forested glaciated limestone soils occuring chiefly in the form of kames, eskers and terrace escarpments. The Rodman gravelly loam is best suited to the growing of alfalfa, to grazing or to woodlots. The areas as a whole are extremely rough and broken and there is but little of this soil under cultivation.

The soils of the Carrington series include dark-colored upland prairie glaciated limestone material. The clay loam and silt loam are extensively developed and constitute some of the best agricultural soils of the state.

The Waukesha series comprises the dark-colored prairie soils derived from reworked glacial material deposited as outwash

plains or terraces. The silt loam constitutes some of the best agricultural land in the area. Corn, oats, wheat, sugar beets and cabbage do very well on this soil. The loam and fine sandy loam are used for general farming and also for trucking. The fine sand is used only for trucking.

The Clyde soils include dark-colored glacial till material occurring in shallow basins and poorly drained depressions. When drained the silt loam and clay loam are among the best soils of the region for corn, sugar beets and cabbage. Two phases of this series in addition to the above were recognized, one includes dark-colored soils that have developed from water laid material within the glaciated limestone region under conditions of poor drainage. They include a silt loam, clay loam and fine sandy loam. The other phase is confined to the dark soils of the Lake Michigan terrace and includes clay loam, loam and silt loams. These soils are devoted largely to trucking. These soils are all so similar in color, texture, average value that in this report they have all been included in the Clyde series.

The Genesee series includes soils derived from the lighter colored materials occupying the flood plains of streams. In the present survey only the loam is mapped. It covers a very small area and is used only for pasture.

Peat consists of vegetable matter in various stages of decomposition, mingled with varying proportions of mineral matter. On well drained, well-fertilized, and properly cultivated areas good yield of corn, timothy and alsike clover (mixed), oats, potatoes, onions, sugar beets and cabbage have been obtained.

Muck is partially decomposed vegetable matter with which there has been incorporated a considerable amount of mineral matter. It contains more mineral matter than peat and has the organic matter in a more advanced stage of decay. Muck is a somewhat better soil than peat. Most crops common to the region can be successfully grown on the reclaimed muck. In Milwaukee county for example the trucking industry is highly developed on similar areas of peat and muck.