WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
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BULLETIN NO. XLIX. SOIL SERIES NO. 14

SOIL SURVEY

OF

COLUMBIA COUNTY

WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, AND GUY W. CONREY

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

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OF THE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES
DEPARTMENT OF AGRICULTURE BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

MADISON, WISCONSIN
PUBLISHED BY THE STATE
1916

Wisconsin Geological and Natural History Survey

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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 cooperation 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, work ability, 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.

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 dif-

ferent soils constitute merely a graduation 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, and where the material occurs as outwashed 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 name of the *soil class,* which refers to texture, with the name of the *soil series,* which refers chiefly to origin, 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 COLUMBIA COUNTY, WISCONSIN

CHAPTER I

GENERAL DESCRIPTION OF THE AREA

Columbia County is located in the south-central part of Wisconsin. It is bounded on the north by Adams, Marquette, and Green Lake Counties, on the east by Dodge County, on the south by Dane County, and on the west by the Wisconsin River and Sauk County.

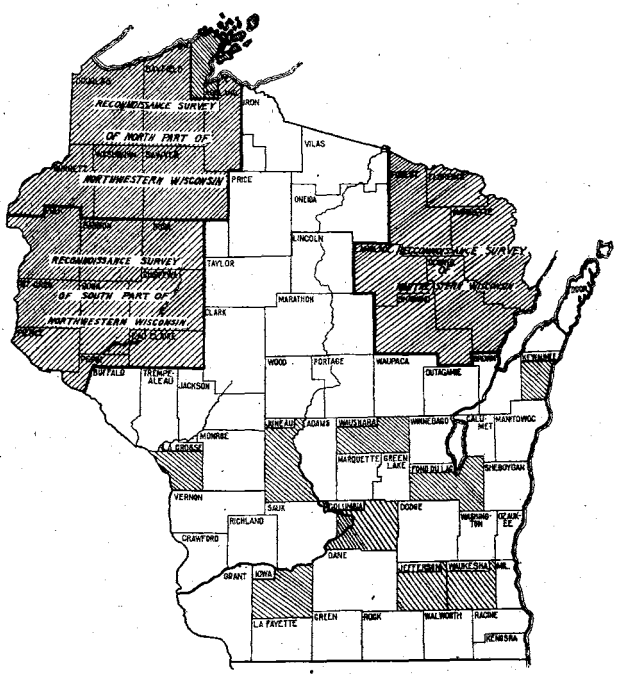

FIG. 1. Sketch map showing area surveyed.

The county has an extreme length east and west of about 39 miles and a width north and south of 25 miles. It embraces about 799 square miles, or 511,360 acres, some of which is of the finest agricultural land in the State.

The topography ranges from broad, level to undulating, black prairies rising from 200 to 300 feet above the Wisconsin River,

to the rough and rugged hills of Caledonia Township, where the steep slopes are broken by ravines and numerous rock out-crops. An area intermediate between these two extremes comprises a region of some 70 square miles lying between Fall River and Randolph, and embraces a number of long, narrow, parallel ridges with intervening poorly drained areas of Peat and Muck.

The Wisconsin River flows through the western part of the county. In the northwestern corner its course is between steep sandstone cliffs from 30 to 100 feet high, frequently cut by tributary stream valleys. Below this point the river course continues through a broad flat valley until Dekorra is reached, beyond which point the valley then narrows, the steep slopes being dotted with outcrops of Potsdam sandstone. The remainder of the county is gently rolling to rolling, broken in some places by hills, with rock outcrops and marked in others by moraines, lakes, marshes, and many flat, poorly drained areas.

Columbia County is drained by three river systems, the Wisconsin, Fox, and Rock. The Empire Prairie, between Leeds and Arlington, which forms the watershed, continues northeast to the Portage Prairie, south of Cambria, where it swings to the east for several miles, crossing into Green Lake County, in a northerly direction about 2 miles from the corner of Columbia County. All of the territory east and south of this line drains into the Rock River system. North and west of this line the country drains into the Fox and Wisconsin Rivers.

The Fox and Wisconsin Rivers are separated by a drainage divide beginning in the high prairie north of Cambria and extending in a southwesterly direction to a point near Pardeeville, where it swings westward, continuing through Portage, and then northwest to a point about 2 miles south of Lewiston, leaving the county about 3 miles northeast of Kilbourn. The Wisconsin River and its tributaries drain about one-half of the county, the remainder being drained equally by the Fox and Rock Rivers. At Portage the Fox and Wisconsin Rivers are within 2 miles of each other. The water in the Wisconsin River is normally about 10 feet higher than in the Fox, a lock canal permitting boats to pass from one river to the other. During floods the Wisconsin River is with difficulty kept from cutting through the levees and pouring some of its waters into the Fox River.

Another interesting feature in the drainage of the county is that the numerous marshes, ponded valleys, lake beds, and lakes act as drainage basins for waters carried from the uplands by creeks and

gullies, the water from these low-lying areas being carried by sluggish streams to the larger streams and rivers.

White men first entered this region between 1670 and 1675. Marquette and Joliet ascended the Fox, crossed the "portage," and went down the Wisconsin in 1673. The first permanent settlement was made near Poynette in 1836. The county was organized in 1846, and Portage made the county seat in 1857. The population consists mostly of people of foreign extraction, including Germans, Norwegians, Welsh, Irish, Scotch, English and Dutch, and numbered 31,129 in 1910.

Portage, the county seat, is the largest city in the county, with a population of 5,440. It is an important railroad center and shipping point, with some manufacturing interests. Columbus, the second town in size, has a population of 2,523. A large canning factory is located here, and the city is in the center of a good farming country. Other towns and villages in the area are Kilbourn, Lodi, Randolph (partly in Dodge County), Cambria, Rio, Poynette, Wyocena, Pardeeville, Fall River, and Doylestown.

The county is well supplied with railroads, the main line of the Chicago, Milwaukee & St. Paul Railroad, between Chicago, Milwaukee, and Minneapolis, crossing it from southeast to northwest and passing through Columbus, Portage, Kilbourn, and intervening points. One branch of this line extends south from Portage to Madison through Poynette and Arlington, while another runs east through Pardeeville, Cambria, Randolph, and on to Beaver Dam and Horicon Junction, where it joins a branch extending to Milwaukee. The main line of the Chicago & North Western from Chicago to Minneapolis and St. Paul crosses the southwestern corner of the area, passing through Lodi. A new line direct from Milwaukee to the Twin Cities crosses the northeastern corner of the county. A branch of the Soo Line extends north from Portage to Grand Rapids and Stevens Point. It is 93 miles from Portage to Milwaukee and 178 miles to Chicago via the Chicago, Milwaukee & St. Paul. From Lodi to Chicago it is 158 miles via the Chicago & North Western.

The towns within the county furnish a market for considerable farm produce and offer excellent shipping facilities to more distant points. Most of the live stock and creamery products are shipped to Chicago, Milwaukee, or other outside points. Tobacco is usually sold at the local warehouses.

The wagon roads of the county are in good condition, except in the north-central part of the area, where the sand is quite deep. Considerable attention is now being paid to road improvement. The

school system is excellent, and the rural free delivery and telephone reach all parts of the county.

SOILS

The soils of Columbia County, Wisconsin, have been grouped into 10 soil series, comprising 29 types,* including Rough stony land, Muck, and Peat. Two of the types are residual and of minor importance, and with the exception of these and Muck and Peat all of the soils owe their origin to the weathering of glacial debris of the Late Wisconsin ice sheet. Much of this material has been influenced during and since its deposition by wind and water action and the accumulation of organic matter.

The underlying rock of the county has contributed very largely to the formation of the soils, much of the material carried by the ice sheet being deposited near-by. The eastern and southern parts of the county are underlain by limestone, the greater proportion of which is Lower Magnesian. In the extreme northeastern and southeastern corners of the county are small areas, over which the surface rock is the Trenton lime stone. Immediately beneath this and overlying the Lower Magnesian limestone is the St. Peters sandstone, which forms the surface rock over only a very small area about the margin of the Trenton. The central, northern, and most of the western parts of the county have the Potsdam sandstone as the surface rock, while west of the Wisconsin River in Caledonia Township a considerable tract of pre-Cambrian rocks, mostly quartzite, constitute the surface rock. These last-named rocks have contributed but slightly to the soils of the area, because of their hardness and the fact that they occur near the point where the ice sheet stopped. The action of the glacier was, therefore, not nearly as pronounced in this section as over other formations in the county. Some material foreign to this region, including stones and bowlders of various kinds from the north, has also been brought in and mixed with the local glacial debris.

According to origin, the soils of Columbia County may be divided into eight general groups. The first includes the Miami fine sand, fine sandy loam, and loam, the Coloma fine sand, fine sandy loam, and the Carrington loam and fine sandy loam, all of which have been derived through weathering of the drift laid down by the late

*The Carrington silt loam as described in this report includes what was mapped and described in the Bureau of Soils' edition of the Columbia County report as Carrington silt loam, deep phase.

The Fox silt loam covered by this report includes what was described in the report of Bureau of Soils as Plainfield silt loam.

Wisconsin ice sheet. The Miami series comprises only the light-colored, timbered, glacial soils carrying a considerable amount of the parent limestone material. Gravel beds in the Miami regions frequently contain over 95 per cent of limestone gravel. The Coloma series includes light-colored, timbered glacial soils, carrying little or no limestone, and largely derived from the Potsdam sandstone. The Carrington series includes dark-colored, prairie, glacial soils.

The second general group includes the Miami silt loam, and Miami and Carrington silt loams which owe their origin chiefly to the weathering of a silty loesslike covering of the glacial till.

In the third group are the Plainfield fine sandy loam, fine sand, sand, and sandy loam, and the Genesee sand and fine sand. These types owe their origin to glacial drift stratified by running water. The Plainfield series includes light-colored and stratified, non-calcareous glacial material, occurring as overwash plains, terraces, or filled-in valleys, while the Genesee series is confined to the light-colored, water-laid material within the present flood plains of streams.

In the fourth group are found Fox silt loam, fine sandy loam and fine sand. This series includes light-colored water-laid material, occurring as overwash plains, terraces, or filled-in valleys. It differs from the Plainfield in being derived largely from limestone material.

The fifth group includes the Clyde silt loam, loam, fine sandy loam fine sand, Dunning loam and fine sandy loam and some Muck, all of which were formed from modified drift material with accumulations of organic matter. The Clyde series includes the black, low-lying calcareous soils of the glacial regions. The Dunning series is similar to the Clyde except that the material is non-calcareous and the soils are acid. These soils are high in organic matter. When the organic-matter content is high, but not sufficient to class the material as Peat, it is called Muck.

The sixth group contains the Peat derived almost entirely from the accumulation of partially decomposed vegetation.

The seventh group includes the Boone sand and the Rough stony land, both of which are largely residual soils, derived from the weathering and disintegrating of the Potsdam sandstone.

The eighth group includes the Knox silt loam. The series of this name embraces the light-colored silty soils, seemingly due to wind action. The silt loam is the only representative of this series in the county.

The following table gives the names and extent of each of the soils mapped in Columbia County:

Areas of Different Soils.

Soil	Acres	Per cent
Miami fine sandy soil	110,400	21.6
Miami silt loam	44,800	19.8
Miami silt loam, deep phase	56,320	
Carrington silt loam	70,464	13.8
Peat	51,264	10.0
Miami fine sand	43,584	8.5
Clyde silt loam	19,712	3.9
Plainfield fine sand	19,264	3.8
Carrington loam	11,840	2.3
Coloma fine sand	11,648	2.3
Clyde fine sandy loam	11,520	2.3
Fox fine sand	9,344	1.8
Muck	8,448	1.7
Carrington fine sandy loam	6,720	1.3
Coloma fine sandy loam	6,592	1.3
Genesee fine sand	5,504	1.1
Clyde loam	4,096	.8
Dunning fine sandy loam	3,520	.6
Dunning loam	2,560	.5
Plainfield fine sandy loam	2,560	.5
Plainfield sand	2,240	.4
Fox silt loam	1,728	.3
Rough stony land	1,664	.3
Miami loam	1,536	.3
Boone sand	768	.2
Knox silt loam	768	.2
Fox fine sandy loam	704	.1
Plainfield sandy loam	640	.1
Clyde fine sand	640	.1
Genesee sand	512	.1
Total	511,360	

CHAPTER II

GROUP OF HEAVY, LIGHT-COLORED SOILS

MIAMI SILT LOAM

Extent and distribution.—The Miami silt loam is the most important type of soil in the county, occupying a total of 19.8 per cent of the entire area surveyed. The type as mapped in Columbia County has been divided into the typical soil and the deep phase. The deep phase, which is described later, is very similar to the deep phase as found elsewhere in the State. The portion of the type referred to as the typical soil, however, differs somewhat from the material which has heretofore been included with this type. The differences are due to topography and to the fact that the soil here is found near the border of the glaciated region, and was therefore not acted upon by the ice to so great an extent as most of the soils of the Miami series.

The portion of the type referred to as the typical soil covers an area of approximately 70 square miles and is confined to the western and southwestern portions of the county. By far the greater proportion of the country west of the Wisconsin River in Columbia County is made up of this soil. Another extensive tract occurs extending west from Lodi, along the south county line, to the Wisconsin River.

Description.—The surface soil to a depth of 8 or 10 inches consists of a light brown, friable silt loam containing only a moderate amount of organic matter. The subsoil is a yellowish-brown silt loam usually becoming heavier with depth and grading into a silty clay loam at 16 to 20 inches. This material may grade abruptly into a mixture of sand, gravel and clay at a depth of 20 to 24 inches or it may extend to bed rock, which is sometimes encountered at from 2½ to 4 feet. Over the bed rock which is usually sandstone there is frequently a layer of residual sand in place of glacial material, and over such areas the deep subsoil grades into sandy material. On steep slopes the underlying rock sometimes outcrops. In Caledonia Township the soil section is deeper than east of the river and rock can seldom be reached with the soil auger.

Topography and drainage.—The surface of this portion of the type varies from rolling to hilly. West of Lodi the surface becomes

quite rolling, while in Caledonia Township, west of the Wisconsin River, it is very rough, being broken by extensive ridges and hills. Differences in elevation of 600 feet within one mile are common. On some of the steep slopes there is danger of erosion, although up to the present time damage from this source has been comparatively small. On account of the uneven surface features the natural drainage is excellent. In a few places where the sandy material in the subsoil comes nearer the surface than usual the type may suffer somewhat from drought for short periods. Such areas, however, are of limited extent.

Origin.—The Miami silt loam has been derived from the weathering of a loess-like mantle overlying the glacial till, and to a greater or less extent from the weathering of the till itself. In addition to this, residual material from the underlying rocks has probably influenced the type to some extent. Under most of the type Potsdam sandstone is the bed rock, but there are also a number of small tracts where limestone forms the bed rock. Outcrops are frequently seen east of the river. In Caledonia Township the Huronian quartzite forms extensive ridges and outcrops were seen in places.

The amount of true glacial till in this region is much more limited than in the eastern portion of the county, and in places appears to be entirely lacking. At such points the loessial covering seems to have been laid down upon the bed rock, or upon material residual from the rock. It therefore has much the appearance of the Knox soils, which are loessial, although it is found entirely on the glaciated side of the terminal moraine.

There is not as much calcareous material in the subsoil as is typical for Miami silt loam, and in some places both soil and subsoil were found to be slightly acid.

Native Vegetation.—The type was originally covered with white, red, and burr oak, basswood, butternut, hickory and maple. Most of the land is now cleared and under cultivation, the uncleared portions being confined to the steepest slopes. The amount of saw timber remaining is limited, but there is a considerable amount which may be used as fuel.

Present Agricultural Development.—The Miami silt loam is one of the leading agricultural soils of southeastern Wisconsin. In this county the portion of the type in question is devoted chiefly to general farming with dairying, livestock raising, and feeding as the most important branches. The chief crops grown are corn, oats, hay, barley, and wheat, all of which produce profitable yields. Special crops, including beans, peas, tobacco, and sugar beats, are

VIEW OF MIAMI SILT LOAM, SHOWING CHARACTERISTIC TOPOGRAPHY, TYPICAL BUILDINGS AND HIGHLY IMPROVED FIELDS.

There are over 100,000 acres of this type of soil in Columbia County. It includes a large proportion of the best farming land in the area surveyed.

sometimes grown but not to so great an extent as on the deep phase.

Because of steep slopes and rough land included in this type, especially in Caledonia Township, there is not as large a proportion of the soil highly improved as is the case with the deep phase.

MIAMI SILT LOAM, DEEP PHASE

Extent and distribution.—The Miami silt loam deep phase is one of the important soils of Columbia County, and with the Carrington silt loam it comprises the finest, and most highly improved land in the present survey. The largest tract is found in the southeastern corner of the county in the vicinity of Columbus. Other smaller tracts are found in the vicinity of Cambria and Randolph in the eastern part of the survey. All of the phase is confined to the eastern half of the area, and a considerable proportion of it is closely associated with the Carrington silt loam.

Description.—The surface soil of the Miami silt loam, deep phase, consists of a light-brown, friable silt loam about 10 inches deep, with a limited content of organic matter, but high in silt. The color of the soil varies with the moisture content, the surface presenting an ashy appearance when dry. The subsoil is a yellow silt loam, becoming heavier with depth and grading at 20 to 24 inches into a yellowish-brown silty clay loam. This material continues to a depth of 3 to 6 feet, where the true glacial till, consisting of a mixture of sand, silt, clay, and gravel, is encountered. The upper subsoil sometimes contains small lenses of very fine sand, while the lower subsoil may be slightly mottled with yellowish-red or brown, due to unequal oxidation of the material. There is a sharp line of demarcation between the loess-like material and the underlying true glacial till, stones, bowlders, or gravel being almost or entirely lacking in the upper portion, but rather numerous below. The gravel in the till consists chiefly of limestone.

While the phase as a whole is very uniform, there are some variations worthy of note. Where associated with the fine sand or fine sandy loam, the surface soil contains considerable fine sand and the subsoil may be a sandy clay at depths ranging from 16 to 36 inches, approaching more closely the subsoil of the Miami fine sandy loam than that of the true silt loam. Bordering Carrington silt loam, the Clyde soils, or where encountered on lower slopes and in depressions the surface and subsoils are somewhat darker than typical. The subsoil along the border of areas of Clyde silt loam is frequently pale yellow, with ferruginous mottlings. On the tops

and upper slopes of hills and ridges the surface soil is often more shallow than typical, while along the lower slopes the soil frequently reaches a depth of 12 to 16 inches.

The Miami silt loam, deep phase, resembles the Knox silt loam quite closely in color and texture and frequently has a loess-like structure. It is underlain, however, by true glacial till and derived in part at least from that source. The Miami silt loam, deep phase, also resembles the Carrington silt loam, in texture and structure and has nearly the same origin. It is light colored and was originally forested, while the Carrington soils are dark colored and are found chiefly in prairie regions.

This soil is comparatively easy to cultivate and when worked under favorable moisture conditions no difficulty is experienced in securing a good seed bed.

Topography and drainage.—The surface of the deep phase of Miami silt loam varies from gently undulating to gently rolling and sometimes rolling. Between Columbus and Randolph the type occupies the tops and sides of Drumlins, while for some distance west and southwest of Columbus it occupies all of the surface except the low, poorly drained areas, and the topography is only undulating to gently rolling. As a type the surface is sufficiently uneven to insure excellent natural surface drainage. There are a few draws and low places of small extent where tile drains could be installed to advantage.

Origin.—The deep phase is derived mainly from the weathering of the loessial mantle overlying the glacial till, and to a slight extent from the weathering of the till itself. The former shows no reaction with hydrochloric acid for limestone material, while the latter does. The surface shows traces of acidity, from which the till is free. This till bed, which varies in thickness from 2 to 100 feet, consists of a heterogeneous mass of bowlders, gravel, rock fragments, silt, sand and clay. About 90 per cent of the gravel and almost all of the rock fragments and bowlders are of limestone.

Native vegetation.—The type was originally covered with a growth of white, red, and bur oak, basswood, butternut, hickory, and maple. Most of the land is cleared.

Present agricultural development.—A large part of the soil is under cultivation, the nonarable land representing less than 1 per cent of the phase. General farming and dairying are the prevailing forms of agriculture. All of the general farm crops common to the region and several special crops are successfully grown. Corn, oats, barley, wheat, clover, and timothy give excellent results. From the standpoint of quality of the crops, the Miami silt loam, deep phase, is not

excelled by any of the other types in the county, although the Carrington silt loam and the Clyde silt loam will produce larger yields of some of the farm crops.

Corn, which is the leading crop, averages about 40 bushels to the acre, while oats, which rank next in importance, yield an average of 35 bushels. Barley has been extensively grown, but both the acreage and the average yields are on the decline at present, only about 20 bushels per acre being secured. Wheat is grown only to a limited extent and the yields are small.

A number of special crops on this type are yielding the growers satisfactory returns. In the vicinity of Columbus, Randolph, and Fall River peas for canning are being grown, yields ranging from 1,800 to 2,000 pounds per acre. When they are allowed to mature, the seed peas average about 15 bushels per acre. Beans are grown quite extensively and average about 20 bushels per acre. The yield of sugar beets ranges from 10 to 15 tons per acre of good quality, the sugar content being higher than from beets grown on the Carrington soils. Some tobacco is grown, yielding from 1,000 to 1,500 pounds per acre. Potatoes are grown to a limited extent and give fair yields.

The best farmers on this soil use a rotation consisting of corn followed by a small grain, such as oats, barley, or wheat, and then seeding with clover and timothy. Small grain may be grown for two years. Hay is cut for one or two years and may be pastured a year, after which the field is manured and again plowed for corn. When there is not sufficient manure a crop of clover or clover and timothy is frequently plowed under, which not only adds to the fertility but also increases the water-holding capacity of the soil. Although a number of farmers attempt to practice a definite rotation, there are many who do not make any special effort in this direction.

MIAMI LOAM

Description.—The surface soil of the Miami loam consists of a grayish-brown loam about 10 inches deep, carrying considerable fine sand and silt. The subsoil is a yellowish-brown sandy clay, becoming heavier with depth and continuing to about 2 feet, where the underlying till bed, consisting of sandy clay, gravel and bowlders is encountered. This bed extends to a depth of many feet. Crystalline and limestone bowlders and rock fragments occur throughout the soil section and on the surface, but never in sufficient quantities to interfere with cultivation.

Where the type borders the Miami and Carrington silt loams the soil is silty and darker than usual.

Extent and distribution.—The type is not extensive and is confined to a few small areas in the eastern one-third of the county. The largest of these is found north of Cambria along the county line.

Topography and drainage.—The topography is for the most part gently rolling, and the natural drainage is good.

Origin.—The type has been derived from the weathering of the glacial till underlying this region. The surface soil is frequently in an acid condition which does not exist in the subsoil.

Native vegetation.—The original forest growth consisted of white, red, and bur oak, elm, basswood, butternut, and some hickory and poplar. Practically all of the best timber has been removed.

Present agricultural development.—About 70 per cent of the Miami loam is under cultivation, the remainder being mostly in pasture or gently rolling woodland.

The type is a very good general farming soil, and all of the crops common to the region can be grown upon it with satisfactory yields. Although tobacco, beans, and peas have been grown very little on this type, they give good yields.

The methods of farming are essentially the same as those practiced on the Miami silt loam.

FOX SILT LOAM

Extent and distribution.—The Fox silt loam is not extensive, occupying an area of only about 3 square miles. It occurs as a continuous body from one-half to 1 mile wide along the Baraboo River in the northern part of Caledonia Township. At a number of places this type grades into the Clyde silt loam. It resembles the Clyde in texture, but has a much lighter color.

Description.—The surface soil of the Fox silt loam consists of a brown silt loam, about 12 inches deep, having an extremely smooth feel. There is more organic matter present than is typical for this soil. Under normal moisture conditions the soil is quite friable, but when wet it becomes slightly sticky. The subsoil is a yellowish-brown silty clay loam, extending to a depth of 30 to 36 inches. The upper portion is high in silt and in many cases might be classed as a heavy silt loam. The clay content, however, increases with depth, and at about 2 feet the material is a silty clay loam. At 30 to 36 inches the heavy subsoil grades abruptly into a bed of fine sand of undetermined depth.

Over a small part of the type the surface has a yellowish to grayish-brown color and varies in depth from 10 to 14 inches. In places the underlying fine sand is encountered at 2 feet, although over most of the type it lies below the reach of a 3-foot auger.

Topography and drainage.—The topography is level, the only variation being a few old sloughs formed when the Baraboo River flowed at higher levels and through channels which changed from time to time. Natural drainage is somewhat defective. The river channel and the old sloughs, however, afford an excellent outlet for tile drains, which if properly installed would satisfactorily drain the entire type. The underlying bed of sand may furnish fair underdrainage, but it is often too deep to be of much help in this respect. The type is not subject to overflow, except during periods of extremely high water, which occur at intervals of 6 to 10 years. Such inundations affect only the portion lying immediately along the the river.

Origin.—The type represents sediments deposited by the waters of the Baraboo and Wisconsin Rivers when they flowed at higher levels than at present. The underlying sand was probably deposited by the Wisconsin River and the silty material by the Baraboo.

Native vegetation.—The original native vegetation consisted chiefly of elm, ash, hickory, and oak. Most of the good trees have been cut.

Present agricultural development.—Probably about 40 per cent of the type is under cultivation, the remainder being in forests and pastures. All of the type could be tilled if cleared, though the uncleared portion is in more danger of being flooded than the part now cultivated. The principal crops grown in the order of the rotation generally followed are corn, oats, and hay. No special attention is given to the selection of rotations best suited to this particular soil. The yields secured are reported to be slightly lower than on the Miami silt loam, deep phase, and the type is considered somewhat less desirable, chiefly on account of the danger of floods. The methods of cultivation and fertilization compare closely with those followed on the Miami silt loam, deep phase.

Under normal moisture conditions the type is comparatively easy to cultivate, although there are times in the spring when it becomes necessary to delay cultivating and planting until the land has drained. Less trouble and delay are experienced in this respect, however, than on the Clyde silt loam, with which the type is associated in the Baraboo Valley.

KNOX SILT LOAM

Extent and distribution.—The Knox silt loam is of very small extent, occupying a little over 1 square mile. It is confined to the vicinity of Kilbourn, in the northwestern corner of the county.

Description.—The surface soil of the Knox silt loam consists of a smooth, light brown to grayish silt loam, about 10 inches deep,

containing only a comparatively small quantity of organic matter. The subsoil consists of a yellowish-brown silt loam, becoming slightly heavier with depth and grading into a light silty clay loam below 18 inches. Below 2 feet small white mottlings are quite common. The underlying rock is not encountered within the 3-foot section at any point. The type is free from gravel, stones, and bowlders and is quite uniform throughout, although considerable fine sand is incorporated with it along the borders of adjoining sand types.

Topography and drainage.—The surface of the type is gently rolling. It is cut by several narrow gorges form 10 to 50 feet deep and gullied on the slopes. The natural drainage is good. On account of the silty character of the soil and the position which it occupies, the type is subject to erosion, and gullies once started advance rapidly during heavy rains.

Origin.—The type consists mainly of wind-blown loess material resting upon the Potsdam sandstone or residual sand from this rock. It is identical with the light-colored upland soils throughout the southwestern part of Wisconsin, and the same type has been mapped in Iowa and La Crosse Counties. The surface soil is usually in an acid condition.

Native vegetation.—The original forest growth consisted chiefly of white and red oak, hickory, and some basswood, with a few other varieties of hardwood. Practically all of this growth has been removed, except from some of the steeper slopes.

Present agricultural development.—Nearly all of the type is devoted to general farm crops or dairying. Yields compare favorably with those obtained on Miami silt loam. No systematic crop rotation is followed, but the same crop is seldom grown on the same field for more than two years in succession. Clover is grown every 7 or 8 years. All of the stable manure produced on the farm is applied to the soil, and some is hauled from Kilbourn. The soil works into a mellow seed bed without difficulty; if cultivated under the proper moisture conditions, though it will clod somewhat if plowed while too wet.

CHEMICAL COMPOSITION AND IMPROVEMENT OF MIAMI SILT LOAM, MIAMI LOAM, FOX SILT LOAM AND KNOX SILT LOAM

In texture, structure and color the soils of this group are quite similar, and in chemical composition they are also closely related. The total amount of phosphorus per acre in the surface 8 inches is somewhat lower than the amount found in highly productive soils,

it averaging about 1,200 pounds in all types, except the Fox silt loam where the total amount is considerably higher.

The total amount of potassium present is sufficient for the demands of growing crops for a long period of years, and ranges from about 30,000 to 40,000 pounds per acre. The problem of the potassium supply is to have a sufficient amount of decaying vegetable matter to produce the necessary chemical changes in the inert potassium compounds to make them available to plants.

This group of soils has a rather small amount of organic matter, and consequently a comparatively small amount of nitrogen, the average being about 3,000 pounds per acre in the surface 8 inches. In the Fox silt loam the amount of nitrogen is somewhat higher than the average of the other types.

The amount of lime or lime carbonate in these soils is variable. As a rule, many of the fields, especially those which have been cropped for a long period of years, have lost nearly or quite all of the lime originally contained in the surface soil, and have in numerous instances become acid. The subsoil, however, often still contains large amounts of this material, but for the insurance of a good growth of plants requiring lime, especially alfalfa, this will have to be supplied in all cases where the surface shows a distinct acid reaction, as indicated by the use of the litmus paper test, or the Truog* test for soil acidity.

In the improvement of this group of soil the factor which may well be given first consideration is a means for increasing the amount of organic matter and the supply of nitrogen. As the supply of stable manure is usually inadequate, it should be supplemented by green manuring crops, of which the legumes are best. Plowing under a second crop of clover once during each rotation will greatly assist in increasing the productivity of the soil. This will not only increase the supply of nitogen in the soil but it will also improve the physical structure. The presence of a large amount of organic matter will also assist in making available for the plant a larger amount of potassium, which is present in sufficient amounts in these soils, but which is often in such a form as to be of little use to the plant.

A number of tests have been conducted which indicate that these types of soil will respond readily to the use of ground rock phosphate. This may be applied at the rate of from 500–1,000 pounds per acre, for the first application and somewhat smaller amounts once during each rotation. It may be applied with a fertilizer distributor

* The "Troug Test" for determining soil acidity is a new method which has just been perfected by E. Truog of the Soils Department of the University of Wisconsin, by which the relative degree of acidity can be accurately determined in the field or laboratory in a few minutes time. For a detailed description of this method write the Soils Department, College of Agriculture, Madison, Wis.

the same as ground limestone is sometimes applied, or it may be sprinkled on top of a load of manure in the manure spreader and scattered over the field in this way. It may also be sprinkled in the stables during the winter and taken up and hauled out with the manure. Phosphorus in this form is only slowly soluble so that there will be but little if any loss if larger applications than indicated are given.

Where an acid condition is found to exist on any of these soils this should be corrected by the use of some form of lime. Ground limestone rock will be found very effective, and this may be applied at the rate of from 1,000–2,000 pounds per acre or even more, depending upon the degree of acidity. The limestone may be applied at any convenient time as it is slowly soluble and will remain in the soil for a number of years.

Another factor of importance to be considered in the permanent improvement of these soils is that of thorough cultivation. Plowing should be done when the moisture conditions are favorable, and before a crop is planted the soil should be thoroughly pulverized, and the seed bed in a loose, mellow condition. All after cultivation of intertilled crops should be sufficiently frequent to keep down the weeds and also to maintain a good surface mulch to conserve the moisture and to permit the free circulation of air through the soil.

Attention should be given to the selection of crop rotations best suited to these soils and to the types of farming followed. A rotation in common use consists of corn, followed by a small grain for one or two years with which clover and timothy are seeded, and hay cut for two years. Another rotation which is suggested as being well suited to numerous farms consists of two years corn, one year oats or barley, and from three to four years of alfalfa, after which the field should be plowed and again put into corn. Stable manure when available should be applied to the sod land to be plowed for corn.

This group of soils makes up about 20 per cent of Columbia County, and includes some of the finest agricultural land in the area. It is important, therefore, that the fertility of these soils should be kept up and increased. These questions may well be given the careful consideration of every farmer on these types of soil.

CHAPTER III

SOILS OF THE PRAIRIE REGION

CARRINGTON SILT LOAM

Extent and Distribution.—Carrington silt loam is one of the leading agricultural types of southeastern Wisconsin, and is extensively developed in Fond du Lac, Dodge, Dane, Rock, Walworth, and Racine Counties and to a more limited extent in some of the other counties in this section of Wisconsin. The main area of the type in this county, comprising about 60 square miles, is found in the vicinity of Arlington and is known as Empire Prairie. Other areas are found northwest of Columbus and in the vicinity of Cambria.

Description.—The surface soil of the Carrington silt loam consists of a dark-brown to almost black friable silt loam, having a smooth feel and containing a large amount of organic matter. The subsoil consists of a dingy brown silt loam in the upper portion, becoming lighter in color and heavier in texture with depth, until at 20 to 24 inches it grades into a brownish or yellowish-brown silty clay loam or silty clay changing to yellow with traces of red at depths of 3 to 4 feet. The typical glacial till, consisting of clay, silt, sand, and bowlders, is found at depths of 4 to 6 feet. The line of demarcation between the yellow silty clay and the unassorted till is well defined, the upper portion being free from bowlders and gravel and leached free of calcium carbonate. The depth to bedrock ranges from 2 to 30 feet.

With the exception of a few small areas, the Carrington silt loam, is uniformly developed throughout its extent. Along the border of the fine sandy loam and loam members of the series both surface and subsoil contain considerable fine sand. Along the contact of the Miami silt loam, deep phase, the texture remains typical, but the color is lighter than usual. Where the Carrington silt loam is associated with the Clyde silt loam a number of steps appear in the weathering of the subsoil, grading from the dark or drab subsoil of the Clyde to the dingy brown or yellow of the Carrington. The water table becomes lower and soil oxidation more marked with improved drainage conditions. Over some of the limestone hills the soil is shallow, the soil mantle consisting of 7 to 10 inches of the dark-

colored silt loam, resting upon a dingy-brown silt loam which becomes heavier but lighter in color with depth. Both soil and subsoil in such areas contain limestone fragments with some outcrops of the bed rock, and over the eskers crystalline and limestone bowlders and gravel are encountered.

The type resembles the Miami silt loam, deep phase, in texture, structure, and, to a certain extent, in mode of origin. It differs from the Miami, however, in that it is much darker in color, contains more organic matter, has a more nearly level topography, and occupies prairie regions instead of forested sections.

Topography and drainage.—The topography varies from level to gently undulating, the only exception to this is found in a few isolated groups of limestone hills which rise abruptly from 20 to 50 feet above the general level of the country, and in a few winding eskers filled with bowlders and gravel.

Because of the undulating topography and long, gentle swells or slopes, erosion is not a factor of importance. There are but very few marshes within the areas of the Carrington silt loam, the drainage waters being largely carried beyond the limits of the prairies. The high organic-matter content and level surface of the type facilitates the rapid absorption of water, making cultivation easy under ordinarily careful management, and renders the soil more retentive of moisture. The underlying till and the gently undulating surface give fairly good natural drainage, though there are a number of places where tile could be installed to advantage.

Origin.—The material composing this type is derived from the weathering of the loess-like covering overlying the glacial till. The prairie regions were doubtless in a poorly drained condition before the streams and gullies had an opportunity to produce the present surface drainage and when the ground water stood at a higher level. The resulting moist condition prevented the growth of trees, but was suitable for grasses and sedges. The residue from the partial decay of this growth accounts for the high organic-matter content and the dark color of the soil. The calcium carbonate has been quite thoroughly leached from this soil, and the surface material is now in an acid condition.

Native vegetation.—Carrington silt loam is a prairie type, and the only forest growth upon it was confined to the borders of the prairies and on the limestone hills and ridges. The original growth consisted of some oak, hickory, and other hardwoods.

Present agricultural development.—With the exception of a very few isolated hills and ridges, all of the Carrington silt loam is under cultivation. It is highly improved and farming communities have

VIEW OF CARRINGTON SILT LOAM NEAR ARLINGTON, SHOWING CHARACTERISTIC LEVEL TO GENTLY ROLLING TOPOGRAPHY AND HIGHLY IMPROVED FARMSTEAD.

There are over 70,000 acres of this black prairie soil in Columbia County, and with the Miami silt loam it includes the best and most highly improved land in southern Wisconsin.

an appearance of thrift and prosperity. The type of agriculture followed consists chiefly of general farming, in conjunction with which a number of special crops are grown. The dairy industry is developed only to a limited extent, although present indications apparently favor its further development, with a corresponding reduction in some of the special crops, notably tobacco.

Of the general farm crops, corn yields about 42 bushels, oats 38 bushels, barley 30 bushels, wheat 15 bushels, and mixed timothy and clover hay about 2 tons to the acre. Some clover and timothy are grown separately, and the seed is occasionally allowed to mature. Only a very small amount of alfalfa is grown.

Tobacco is among the most important of the special crops grown, yields ranging from 1,000 to 1,600 pounds per acre, and the product selling for 2½ to 14 cents per pound, according to quality and market conditions. Beans are grown quite extensively, yielding from 15 to 25 bushels per acre. Potatoes are grown only to a limited extent, chiefly for home use. The quality is not so good as when grown on the light-colored soils. The average yield is about 130 bushels per acre. Sugar beets are grown extensively in the vicinity of Arlington and south of the county line, yields ranging from 13 to 18 tons per acre. The sugar content averages about 14 per cent, which is 2 per cent below the average test of beets grown on the deep phase of the Miami silt loam. Larger yields on the Carrington silt loam, however, make this a more desirable soil for this crop. Cabbage does well on this type, and in the vicinity of Cambria, where extensively grown, yields of 12 to 14 tons per acre are secured. Seed peas average about 15 bushels per acre. A few peas are also grown for canning, but this industry is confined mainly to other soil types.

Comparatively few farmers follow a carefully worked out crop rotation, although where corn is followed by small grains, and the land then seeded to clover and timothy, and this sod well manured before again being plowed for corn, a marked improvement in the soil results. The special crops grown are usually inserted in the rotation without much thought as to their place. Tobacco is often grown on the same field for at least two or three years, and is usually followed by corn, potatoes, or beans. Owing to heavy applications of manure on the tobacco crop, good yields of the crops which follow are secured.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of Carrington silt loam:

Mechanical analyses of Carrington silt loam.

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	0.0	1.0	2.2	5.0	7.5	62.9	21.1
Subsoil	.4	1.5	4.2	11.5	5.5	58.1	18.5

CARRINGTON LOAM

Extent and distribution.—The Carrington loam is much less extensive than the Carrington silt loam with which it is associated. The largest areas are located several miles south and southwest of Rio, south of Cambria, and in the northeastern section of the county.

Description.—The surface soil of the Carrington loam is a dark-brown to black friable loam, from 10 to 12 inches deep, containing an appreciable amount of silt and fine sand and considerable organic matter. The upper portion of the subsoil consists of a dark-brown loam, grading at 16 inches into a compact, yellowish-brown sandy clay loam, which continues to a depth of 22 to 30 inches, where more sandy material is usually encountered, grading at 36 inches into a sandy clay. Small limestone fragments about the size of a pea are common at depths ranging from 20 to 36 inches. Limestone fragments and crystalline bowlders occur throughout the soil section. The clay content is variable, in some cases being sufficient to make plowing difficult, except under favorable moisture conditions.

Topography and drainage.—The surface is undulating to gently rolling, the main body of the type being crossed by several gravelly ridges. Numerous small streams and gullies have formed an almost complete drainage system throughout the type. None of the type is sufficiently steep to suffer from erosion.

Origin.—The type has been derived from the weathering and disintegration of the underlying glacial till, which is encountered at depths of from 6 to 40 feet. The loess-like silty mantle overlying the till which is so conspicuous in the Carringtom silt loam is not developed over this soil, except to a very small extent, the silt being insufficient to justify the classification of the type as a silt loam. Tests with litmus paper show a strong acid reaction.

Native vegetation.—As the type occupies an open prairie, there was practically no forest growth originally, the native vegetation consisting entirely of grasses.

Present agricultural development.—Although nearly all of this soil could be cultivated, the percentage of the area in farms is considerably less than is the case with the Carrington silt loam. Where the type is farmed the methods are poor and many of the fields are allowed to remain idle. About the same crops are grown as on the silt loam, but the yields are lower.

Probably a larger proportion of the farms on this type are devoted to dairying than on the silt loam, although the industry can not be said to be extensively developed.

No definite crop rotations are practiced on this soil. Rye is sometimes sown in the fall as a winter cover crop, and plowed under in the spring. Seeding is usually with oats or barley, as the amount of wheat now grown is small.

CARRINGTON FINE SANDY LOAM

Extent and Distribution.—This type is of minor importance in the county. It is associated with the Carrington loam and silt loam and the Miami fine sand and fine sandy loam.

Description.—The surface soil of Carrington fine sandy loam to an average depth of 11 inches consists of a dark-brown to black fine sand, containing considerable organic matter, which gives it a slightly loamy character. It is underlain by a lighter-colored fine sand, becoming sticky at a depth of 16 inches and heavier in the lower section, until at 2 or 3 feet it grades into a yellow friable fine sandy clay with a reddish tinge. Variations in depth occur over limited areas. Limestone fragments and crystalline bowlders are common throughout the soil section.

Topography and drainage.—The topography varies from undulating to gently rolling, and the surface is broken somewhat by small gravelly ridges. Natural drainage is good, although the type may be droughty over areas where the sandy clay is over 3 feet below the surface. It is less susceptible to drought than the Miami fine sandy loam under similar conditions, on account of the greater amount of organic matter in the surface soil.

Origin.—This type, like the Carrington loam, is derived from the weathering of the glacial till. The surface has probably been influenced to some extent by wind action. Tests indicate that the soil is acid and in need of lime.

Native vegetation.—The native vegetation consists chiefly of grass, with some bur oak, white oak, and poplar.

Present agricultural development.—Most of the general farm crops common to the region are grown upon this type, with fairly good

results. Corn averages about 35 bushels to the acre, oats 30 bushels, and hay 1½ tons. Of the special crops, potatoes yield about 125 bushels, beans 15 bushels, and tobacco 1,000 to 1,200 pounds per acre. Farming methods are similar to those employed on the Carrington loam. Little attention is paid to the question of crop rotations best suited to the soil.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SOILS OF THE PRAIRIE REGION

In texture and structure the soils of this group are quite similar to those in the group of heavy light-colored soils, but they differ somewhat in their chemical composition. The amount of phosphorus is somewhat larger in the Carrington loam and silt loam than in the Miami silt loam, averaging about 1,600 pounds per acre in the surface 8 inches. The fine sandy loam contains a smaller amount of this element. The supply of potassium is large and practically the same as found in the heavy, light-colored group of soils. The supply of organic matter and nitrogen is often twice as large as is found in the light colored soils of the same texture. The larger amount of organic matter characterizing this type is probably the cause of the accumulation of somewhat larger amounts of phosphorus than contained in other types of soil having less humus. But it must be remembered that soils of this character which had originally a high degree of fertility on account of this large amount of organic matter, a considerable portion of which would decompose readily after the land was broken, lose this marked fertility as the result of a number of years of cropping, even though they still have a relatively large amount of humus. The humus remaining is of an inert resistant character which does not decompose readily and therefore does not serve the purpose of fresh vegetable matter. The phosphorus, although large in total amounts, is very commonly less available than in the lighter colored soils so that some form of fertilizer containing this element is usually needed to enable these soils to produce the best results.

On account of the large amount of organic matter which has decomposed in this soil it is almost universally acid, at least in the surface soil, and frequently this acidity is very considerable so that the use of relatively heavy applications of lime will be needed to fit such land for the growth of alfalfa and often even of medium red clover. Applications of from 2,000 to 4,000 pounds of ground limestone per acre will usually be sufficient to correct the acidity, but in some cases a larger amount than this may be necessary. There is

an abundant supply of limestone close at hand throughout the regions covered by this soil, and by cooperation among the farmers it may be crushed at a very small cost.

The use of ground rock phosphate, as a source of phosphorus, has been found to give good results on Carrington silt loam. Its use should be extended to all areas of this soil, since by supplementing the stable manure with this commercial fertilizer the productivity of the soil can be materially increased. About 600 pounds per acre will usually be found sufficient for the first application. Smaller applications can be made once during each succeeding rotation. As the phosphorus in this form is only slowly soluble it will remain in the soil for a number of years, and but little will be carried away by the drainage waters.

As indicated by the analyses made of this soil, and referred to above, there is a large amount of organic matter present but the humus remaining is of an inert resistant character and as in this form it decomposes slowly it is of little value to growing crops. The organic matter supply of this type should therefore be supplimented by fresh vegetable matter in the form of green manuring crops, of which the legumes are best. As the fresh vegetable matter decomposes it will also assist in making available larger amounts of potassium. It will be found that by supplementing the stable manure with green manuring crops and rock phosphate that the fertility of Carrington silt loam will be greatly increased, and the margin of profit in farming this soil will be considerably larger.

Another factor which may well be considered in the improving of this soil type is the question of tile drains. There are a number of places where the surface is nearly level or undulating, and where the subsoil is sufficiently heavy so that the internal movement of water is sluggish. This frequently delays planting and cultivation in the spring, and keeps the ground cold so that plant growth is checked and crop yields reduced as a result of this condition. Tile drains are not at all common on this soil, but their use should be encouraged, since they will greatly assist in improving the physical condition of the soil, permit low places to warm up and dry out quickly in the spring, and permit the uniform development of a crop over all parts of fields.

The following rotation is one which gives good results on this soil, and may well be followed as given here, or it may be used as a basis for working out other rotations to fit special needs. Small grains consisting of oats, barley, or wheat may be grown the first year and seeded with a mixture of clover and timothy. The second year the first crop of clover may be cut for hay, and the second left for

seed. The third year a crop of mixed clover and timothy can be harvested. The field may then be pastured a year, or manure may be applied to the sod either before the land is plowed in the fall or on the plowed land during the winter. The following year corn may be grown. When it is desired to plow under a crop of clover this may be done by following a three year rotation. In this case only clover should be seeded with the grain. The first crop of clover should be cut for hay, and the second plowed under. The following year corn or some other cultivated crop may be grown. Two grain crops may be used in such a rotation, extending it over 4 years.

The dairy industry has not been developed to as great an extent on these soils in Columbia County as in some other portions of the State. This industry could be profitably extended, and with it should be extended the growing of alfalfa.

When the soil is limed and inoculated, and in a good state of fertility this crop does very well. Special crops such as peas and cabbage as are now being grown in certain localities could well be grown on a larger scale. The Carrington silt loam may well be considered one of the best agricultural soils in the State, and it is doubtless well adapted to a wider range of crops than are now being grown. It is therefore desirable and important that the questions of crop adaptation and methods of improvement should be given careful consideration by all who are interested in this type of soil.

CHAPTER IV

GROUP OF FINE SANDY LOAM SOILS

MIAMI FINE SANDY LOAM

Extent and distribution.—The Miami fine sandy loam is the most extensive type in the county and is important from an agricultural standpoint. Large areas are found in the central and north-central parts of the county. One area extends from a point a few miles north of Portage eastward to within 4 or 5 miles of the northeast corner of the county. Another large area occurs in the vicinity of Doylestown, extending westward to the Wisconsin River and north to Duck Creek. Other smaller areas are scattered throughout the county, with the exception of the extreme northwest and the extreme southeast corners and the prairie regions.

The type may be said to represent a gradation from the silty-soils of the southern, eastern, and western parts of the county toward the fine sand types with which it is associated. Its continuity is frequently broken by low, level, and poorly drained areas embracing Peat, Muck, and the Clyde soils, and also by level sandy areas where soils of the Plainfield and Fox series are encountered.

Description.—The surface soil of the Miami fine sandy loam consists of a loose, porous, light-brown fine sand or light fine sandy loam about 10 inches deep, containing only a small amount of organic matter. The material is usually rather loose and the downward movement of water through the surface soil is rapid. The subsoil consists of a yellowish or yellowish-brown fine sand, slightly sticky at depths of 15 to 20 inches, and which grades into a compact reddish-brown or dark-brown sandy clay at 20 to 36 inches. The deeper portion consists of a mixture of sand, gravel, stones, and clay and extends to considerable depths, as indicated by road cuts and well borings. Bowlders, rock fragments, and pebbles of limestone origin are found throughout the soil section, but rarely in quantities to interfere with cultivation.

On the lower slopes of hills and ridges and the lower-lying portions of the type where the water table approaches the surface the soil is darker in color, due to accumulations of organic matter. The underlying sandy clay occurs at depths of 1 to 3 feet. At a few points along the northern boundary of the county a red clay similar

to the Superior clay was encountered at a depth of 2 to 3 feet. All of these variations are of comparatively small extent, as compared with the area of the whole type, and while they affect to some degree the agricultural value of the type the difference is not great enough to justify their separation.

Topography and drainage.—The topography varies from gently rolling to rolling. This feature, in conjunction with the sandy nature of the soil and the sand and gravel in the subsoil, accounts for excellent natural drainage. Over the deeper areas of sand the type is inclined to be droughty, but where the underlying sandy clay approaches the surface the ability of the soil to withstand drought is nearly equal to that of the Miami silt loam.

The rainfall is readily absorbed by the sandy soil, except during unusually heavy precipitations when there is some surface run-off through regular drainage channels. No damage from erosion results except on the steepest hillsides.

Origin.—The type has been derived from the weathering of the unassorted glacial till modified by lateral and recessional morainic material. Where the sand is deepest the surface has been influenced somewhat by wind action, although this feature is not so pronounced as on the Miami fine sand. Although there is considerable limestone material mixed with the gravel, the type shows traces of acidity over much of its extent.

Native vegetation.—The original forest growth consisted chiefly of white, red, and bur oak, hickory, maple, and butternut, with some elm in the lower areas. Practically all of this has been removed and the land placed under cultivation.

Present agricultural developments.—With the exception of a few pasture woodlots on the rougher areas the Miami fine sandy loam is practically all under cultivation. The prevailing type of agriculture consists of general farming and the growing of a few special crops. Dairying, though gradually extending, is still of minor importance.

The general farm crops most commonly grown are corn, which averages 35 bushels; oats, 30 bushels; barley, 30 bushels; wheat, 17 bushels; rye, 20 bushels; and timothy and clover mixed, about 1½ tons per acre.

Of the special crops beans yield from 20 to 35 bushels, Irish potatoes about 125 bushels, and tobacco from 1,000 to 1,300 pounds per acre. The quality of the tobacco grown is superior to that produced on the Carrington silt loam.

There is a wide variation in methods of cultivation on this soil, and as yet no definite rotation has been worked out which proves

VIEW OF MIAMI FINE SANDY LOAM, NORTHEAST OF POYNETTE, SHOWING CHARACTERISTIC GENTLY ROLLING TO ROLLING SURFACE, AND TYPICAL FARM BUILDINGS

This is the most extensive type of soil in Columbia County, there being over 110,000 acres, but it is not equal in productiveness to, nor as extensively developed as, the Miami and Carrington silt loams.

especially adapted to local conditions. It is customary to plant corn or potatoes on fields which have been in sod. If potatoes are planted first this crop may be followed by corn, after which a small grain, such as oats, barley, wheat, or rye, is grown, followed a second year by a small grain with which timothy and clover are seeded. Hay is cut for one or two years, or the field pastured the second year, before being plowed again. Beans are usually sown in fields following sod to which a good supply of manure has been added.

Stable manure is the only fertilizer used on this soil to any extent. A crop of clover is plowed under occasionally, but the practice of green manuring is not at all common. When tobacco is grown manure is liberally applied and frequently at the expense of the remainder of the farm.

COLOMA FINE SANDY LOAM

Extent and distribution.—This type is confined to Newport and Lewiston Townships, in the northwestern part of the county, where it is associated with the Coloma fine sand. It is of comparatively small extent, having a total area of only 6 or 8 square miles.

Description.—The surface soil of the Coloma fine sandy loam consists of a light-brown to gray light fine sandy loam or fine sand, about 10 inches deep. The material is open and loose in structure and low in organic matter. The subsoil is a light-yellow or pale reddish-yellow fine sand, which becomes sticky at 15 to 20 inches and grades into a compact reddish or yellowish-brown sandy clay at 22 to 36 inches. Crystalline rock fragments, gravel, and bowlders and some chert and sandstone fragments occur on the surface and throughout the soil section, but not in quantities sufficient to interfere with cultivation. The gravel and rock fragments are more plentiful in the subsoil than in the surface section, being sufficiently numerous in places to interfere with boring.

The lower slopes and depressions bordering the lowlands show a darker surface soil, due to accumulations of organic matter. In small areas on some of the narrow hilltops and steeper slopes the sandy covering has been eroded, leaving exposed the sandy clay subsoil. In other places the sandy covering is shallower than typical. In a few places the sticky sandy subsoil was not encountered above 24 to 28 inches, but all of these variations are of small extent and could not be indicated separately. A small area of sandy soil underlain at a depth of 2 feet by Superior clay was found along the northern boundary in Lewiston Township. This area was too small to be separated on the map.

The Coloma fine sandy loam is similar in texture, structure, and topography to the Miami fine sandy loam, but differs from that type in that it does not contain any appreciable amount of limestone material.

Topography and drainage.—The surface of the type is gently rolling to rolling and dotted with marshes and depressions into which the drainage waters find their way. On account of the topography and the texture of the soil, the natural drainage is excellent. There is sufficient silt and clay in the subsoil to make the type quite retentive of moisture, and it seldom suffers from drought except during the most extended dry periods. On the steeper slopes the surface has been eroded in places and small gullies formed, though the damage from this source is slight.

Origin.—The Coloma fine sandy loam is derived from the weathering of glacial till, some of which doubtless represents terminal and recessional moraines. The material is unassorted, the rock fragments and bowlders consisting of granite, gneiss, quartz, sandstone, and a number of other rocks. Limestone is found in this drift only in small quantities. In most places Potsdam sandstone constitutes the parent rock. Litmus tests indicate that the soil material is acid.

Native vegetation.—The original forest growth consisted chiefly of white, red, and bur oak, with some hickory and other varieties of hardwood. There are still some woodlots on this type, but all of the best trees have been removed.

Present agricultural development.—With the exception of some of the steeper slopes, kettle basins, and woodlots, which are all of small extent, the type is largely under cultivation, and all of the general farm crops common to the region are grown. The methods of cultivation, fertilization, and crop rotations followed are similar to those practiced on the Miami fine sandy loam, though as a whole this type is somewhat less productive than the Miami.

The chief type of agriculture followed consists of general farming, with a tendency toward an increase in the dairy industry, which at present is not extensively developed.

FOX FINE SANDY LOAM

The only area of this soil in the county lies south of Pardeeville and covers a little more than a square mile.

The Fox fine sandy loam, to an average depth of 10 inches, consists of a brown fine sandy loam, containing enough silt and clay to make it slightly sticky when wet. The organic-matter content

is higher than in the fine sand type. The subsoil is lighter in color than the soil and is a fine sandy loam in texture, becoming heavier in depth to a light sandy clay at 2 feet. Below this the texture becomes lighter again, becoming fine sand at less than 5 feet, though the details of texture in the subsoil are not uniform.

The topography is smooth and the natural drainage good, this being effected mainly through the soil.

In origin this soil seems to be derived from an area of glacial outwash material. It lies from 10 to 15 feet above the level of Fox River.

All of the area is in cultivation and gives fair yields of the general farm crops.

The methods of cultivation, crop rotation, etc., are practically the same as on the Miami fine sandy loam.

PLAINFIELD FINE SANDY LOAM

Extent and distribution.—The type is of small extent, comprising less than 4 square miles. The largest area lies directly south of Portage, on the south side of the Wisconsin River.

Description.—The surface soil of the Plainfield fine sandy loam to an average depth of 10 inches consists of a brown fine sandy loam containing enough silt and clay to make it slightly sticky when wet. The organic-matter content is higher than in the fine sand type. The subsoil is a fine sandy loam, lighter in color than the soil, and gradually becoming heavier in texture until a light sandy clay is encountered at a depth of 2 feet. Below this the material again becomes lighter and grades into a bed of fine sand at less than 5 feet. The type is subject to some variation, especially in the character of the subsoil. The surface soil is uniformly a fine sandy loam, but frequently the subsoil below 16 or 18 inches is a fine sand.

Topography and drainage.—The topography is level or slightly undulating and the natural drainage is good. South of Portage there are low-lying areas where the water table is comparatively near the surface, so that there is frequently an excess of moisture, especially in the spring and early summer.

Origin.—The soil represents stream-laid material deposited when the river flowed at higher levels than at present. All the areas occur within the Wisconsin River Valley, but the largest area, the one south of Portage, is protected from overflow by a levee. Litmus tests indicate that the soil is acid.

Native vegetation.—The original forest growth consisted chiefly of white and red oak, with some hickory and other hardwoods.

Much of the type along the Wisconsin River is now in wood lot or pasture.

Present agricultural development.—About one-third of the type is under cultivation to the general farm crops. South of Portage much of the type is wet early in the season. It is used chiefly for hay and pasture.

Average yields are lower than on Miami fine sandy loam.

CHEMICAL COMPOSITION AND IMPROVEMENT OF FINE SANDY LOAM SOILS

Chemical analyses indicate that the soils of this group contain smaller amounts of all the essential plant food elements than are found in the group of heavy, light-colored soils, and that these types are deficient in most of the elements required by growing crops. The phosphorus content in the Miami and Fox fine sandy loams will average 900 pounds per acre in the surface 8 inches, while the amount present in Coloma and Plainfield fine sandy loams is somewhat smaller. In highly productive soils there is usually nearly twice this amount.

The supply of potassium in this group of soils may be considered as a fair amount in most cases and possibly sufficient for the demands of growing crops when proper methods of cultivation are followed. The amount usually ranges from about 25,000 to 35,000 pounds per acre, with the Coloma and Plainfield fine sandy loams frequently falling below these figures.

The amount of organic matter and nitrogen in most of these types is small, the average being about 1500 pounds per acre or about half the amount found in Miami loam and silt loam. The Fox fine sandy loam contains a somewhat larger amount than the average for this group, but is still deficient in nitrogen.

In the Miami and Fox soils the lime content was originally high, many of the coarser particles being made up of limestone. The surface soils, however, have been leached to a considerable extent so that in places an acid condition is found to exist. The Coloma and Plainfield soils are usually acid. An acid condition may be readily corrected by the use of ground limestone. One ton per acre will doubtless be sufficient to correct the acidity, except where it is most pronounced.

One of the greatest needs of the soils in this group is a larger supply of organic matter. This may be supplied by supplementing the stable manure, the amount of which is usually limited, with green manuring crops of which legumes are best. This decaying vegetable

matter will increase the water-holding capacity of the soil and it will also assist in making available for the plants some of the potassium and phosphorus which is securely locked up by various chemical combinations.

The phosphorus supply may be increased by the use of ground rock phosphate, which should be applied at the rate of about 500 to 600 pounds per acre for the first time, followed by smaller applications once during each rotation.

Careful attention should be given to the selection of crop rotations best suited to these soils. Where the location is suitable, and where there are adequate facilities for marketing, the trucking industry could be developed on a commercial scale. Bush berries and strawberries thrive and their culture should be encouraged. Where general farming and dairying are the chief lines of agriculture followed, as is usually the case, the growing of alfalfa should be extended, after the soil has been fertilized, inoculated, and limed where necessary.

CHAPTER V

GROUP OF SAND AND FINE SAND SOILS

MIAMI FINE SAND

Extent and distribution.—The Miami fine sand is most extensively developed in the central part of the county, in Pacific and Wyocena Townships, with scattered areas in Fort Winnebago, Marcellon, Lowville, Dekorra, and the northern part of Lodi Townships. There are only a very few areas in the eastern third of the county or along the southern border, where the Carrington silt loam and Miami silt loam predominate. The type is associated with the Miami fine sandy loam and its continuity is frequently broken by areas of Peat, the Clyde series, or in some places by level, sandy tracts of Plainfield or Fox soils.

Description.—The Miami fine sand consists of a light-brown, loose, fine sand, which is low in organic matter. At about 9 to 10 inches the material is light yellow, becoming lighter with depth, until at 30 to 36 inches it is an almost white fine sand of loose and open structure. The till bed, consisting of a mixture of sand, gravel, silt, and bowlders, is encountered at depths of 4 to 6 feet. Small quantities of limestone, gravel and bowlders occur on the surface and throughout the soil section but are seldom sufficiently numerous to interfere with cultivation.

The type is subject to some variation, though none of the phases were of sufficient extent or importance to indicate separately on the map. On the lower slopes and in depressions the surface is darker and contains a larger amount of organic matter than the typical soil. Such areas are slightly loamy and have a somewhat higher agricultural value than the rest of the type. In a few places a sticky sand is encountered at a depth of 30 to 36 inches. A few gravel beds are scattered throughout the type, such deposits having only a shallow surface covering of soil. Exposed areas are sometimes wind-drifted, small dunes being formed. In general the Miami sand is lighter in texture and lower in agricultural value than the Miami fine sandy loam, with which it is closely associated.

Topography and drainage.—The topography of the type varies from gently rolling to rolling. The surface is sometimes broken by sand dunes and depressions, though rarely to such an extent as

to render cultivation impracticable. Owing to the loose open structure of the material and to the surface configuration, the natural drainage is excessive and the soil as a whole is droughty. There are only a few kettle basins and dune depressions which are not connected with drainage channels, and even in these places the drainage is usually sufficient, owing to the sandy nature of the deeper subsoil. Except during the heaviest rains, storm waters are rapidly absorbed by the soil, and danger from erosion through surface run-off is reduced to a minimum.

Origin.—The type is largely of glacial origin and has been derived from the weathering of the glacial till, somewhat modified by wind and steam action. The weathering of the limestone fragments in the underlying till has a tendency to correct any acidity existing in the soil material, though this is often counteracted by leaching, leaving the type more or less acid.

Native vegetation.—The original forest growth consisted chiefly of white, red and bur oak, with some hickory, and hazel brush. All of the merchantable timber has been cut, but the scrubby growth of oak and hazel bushes has been allowed to remain on a few of the poorest portions of the type.

Present agricultural development.—About 75 per cent of the type is under cultivation, while approximately 22 per cent remains in untilled pasture land. About 2 per cent consists of sand dunes and about 1 per cent of moraines, kettle basins, and regions too stony and rough to be of any value except for pasture.

The general farm crops common to the region are grown. Corn under normal conditions will average 25 bushels to the acre, oats 22 bushels, rye 12 bushels, and timothy and clover about 1 ton. Potatoes yield as high as 150 to 175 bushels per acre when given special attention, though the average is lower than this for the whole type. Beans and tobacco, which are grown quite extensively on the fine sandy loam, are not grown to any great extent on the fine sand, and the yields are considerably lower. Cucumbers do well and satisfactory yields are secured, though the crop is not grown very extensively.

No definite crop rotation is practiced on this type as a whole. Where manure is available is it usually applied to the sod. Green manuring is not practiced to any extent and commercial fertilizers are seldom used. A rotation which has given success consists of potatoes, followed by a small grain, such as rye or oats, and the land seeded to clover. The first crop of clover may be cut for hay and the second plowed under for green manuring. If sufficient manure is available the second crop of clover may be left for seed. Corn may be grown in place of potatoes if desired.

COLOMA FINE SAND

Extent and distribution.—This type is confined to the northwestern part of the county, in Newport, Lewiston, and Fort Winnebago Townships. All of the type lies west of the Fox and north of the Wisconsin Rivers. It is closely associated with Coloma fine sandy loam.

Description.—The surface soil of Coloma fine sand, to an average depth of 9 inches consists of a loose, light-brown fine sand, containing but little organic matter. The subsoil is a loose, fine sand, 3 feet or more in depth, and grading from a light brown to a light yellow as the lower portion is approached. Crystalline and sandstone gravel and rock fragments occur in both soil and subsoil, but in quantities too small to interfere with cultivation. A few gravel beds covered by a thin mantle of surface soil are found throughout the type. This type differs from the Miami fine sand in the absence of limestone gravel or rock fragments.

The organic-matter content varies over different sections of the type, being higher in the depressions where the moisture conditions have favored the accumulation of humus-forming material. Where lenses of clay in the underlying till occur at depths of 3 to 5 feet below the surface the type is not quite so droughty as where the sand is of greater depth. Small dunes formed by wind-blown sand are occasionally found.

Topography and drainage.—The surface of the type varies from gently rolling to rolling. On account of its loose, open structure the natural drainage is somewhat excessive and the type is likely to suffer from drought, except during seasons of excessive rainfall. Erosion is not a serious problem on this type, the rainfall being rapidly absorbed and the surface run-off reduced to a minimum.

Origin.—The material composing Coloma fine sand consists of glacial debris, most of which occurs in the form of lateral and recessional moraines. The glacial debris here is very largely made up of fine sand, due to the fact that prior to this deposition the ice passed over the Potsdam sandstone, grinding off the rock and transporting the material for some distance. The soil and subsoil of Coloma fine sand contain no limestone material and are usually more acid than the corresponding type of the Miami series.

Native vegetation.—The original forest growth consisted chiefly of white, red, and bur oak, with some hickory and other hardwoods. Part of the area is now overgrown with hazel brush. A few woodlots remain, but most of the forest has been cut.

Present agricultural development.—About 60 per cent of the Coloma fine sand is under cultivation to the general farm crops common to this region.

Over most of the type but little attention is given to the selection of a rotation particularly adapted to this soil. The methods of cultivation are similar to those followed on the other sandy types of the county. The soil is loose and open and very easily cultivated. Average yields are low.

It may be said of this type as a whole that the methods now followed upon it are not such as tend to increase its productivity, although there are exceptions where more up-to-date methods are being practiced.

The following table shows the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Coloma fine sand.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Soil	0.2	9.5	22.4	56.7	3.8	4.6	2.5
Subsoil	.0	6.2	19.4	64.0	5.3	3.4	1.6

PLAINFIELD SANDY LOAM*

Extent and distribution.—This type is inextensive and of little importance. The most important area, containing about 1 square mile, is found in the northern part of Newport Township, along the county line, 5 miles east of Kilbourn. A small patch one-half square mile in extent, occurs directly across the river from Portage.

Description.—The surface soil of the Plainfield sandy loam consists of a brown to dark-brown sand, of loose, open structure about 8 inches deep. The subsoil is a brownish-yellow sand, to a depth of 2 feet, where it becomes sticky and slightly coarser, often grading into a sandy clay, which becomes heavy and plastic at 30 to 36 inches. Gravel beds and lenses of sand and gravel are found in the subsoil and evidences of stratification are frequently apparent.

Topography and drainage.—The topography is level to undulating, the surface having been influenced somewhat by wind action, which has formed low ridges. The intervening depressions are sometimes without surface drainage, but the ridges are well drained and in places droughty. The area near Portage is level and a part of it is in need of tile drainage.

* This type has been grouped with the sands and fine sands because of its limited extent, and because it is quite similar in agricultural value to the fine sand types.

Origin.—The type has the same origin as the Plainfield sand and represents valley fill of the old Wisconsin River. The area east of Kilbourn lies at about the same elevation as the Plainfield sand area in that region, while the tract south of Portage is much lower. The litmus test indicates that the surface soil is acid.

Native vegetation.—The original forest growth was similar to that found on the Plainfield sand.

Present agricultural development.—Most of the type is under cultivation to the general farm crops. Few farmers continue the same crop for more than two years and clover is grown every 6 to 7 years. The soil, particularly on the higher areas, does not seem to be well suited to grasses, but truck crops do well. The soil is easy to cultivate, and with careful methods good yields are secured.

PLAINFIELD FINE SAND

Extent and distribution.—The largest bodies of this type are found in Lewiston Township along the headwaters of the south branch of Neenah Creek, and occupy the level lands southward to the Wisconsin River. The other areas occur along both sides of the Wisconsin River to the west and south of Portage both in and out of the river valley.

Description.—The surface soil of the Plainfield fine sand is a loose, light-brown fine sand, about 10 inches deep. It is free from gravel and stones and contains very little organic matter. The subsoil is a yellow fine sand. The material is loose and becomes lighter in color with depth. It contains lenses or thin beds of stratified gravel. At depths of 2 to 3 feet large gravel beds are sometimes encountered. The lower lying areas are darker in color, owing to accumulations of organic matter.

Topography and drainage.—The topography is comparatively level, with some undulations, due chiefly to wind action which has formed low sand ridges and dunes. On account of the loose, open structure of the soil, the natural drainage is complete and sometimes excessive, especially on the higher portions of the type.

Origin.—The Plainfield fine sand consists chiefly of reworked glacial material redeposited by water action in old valley flood plains, old valley fills, and outwash plains. The parent rock, from which most of the material has been eroded by glacial action, consists chiefly of Potsdam sandstone. The surface soil of this type shows acidity when tested with litmus paper.

Native vegetation.—The original forest growth consisted largely of oaks and poplar, with some sycamore, elm, and willows in the

VIEW SHOWING CHARACTERISTIC LEVEL SURFACE OF THE PLAINFIELD FINE SAND. EXTENSIVELY FOUND IN THE VICINITY OF LEWISTON.

The surface features are characteristic of the Fox soils as well as of the Plainfield types. This soil requires careful management, but when properly cultivated and fertilized profitable crops can be grown

lower situations where the water table approaches the surface more closely than usual.

Present agricultural development.—More than half of the type is under cultivation to the general farm crops, of which corn yields an average of 25 bushels, oats 20 bushels, rye 15 bushels, potatoes 100 bushels, wheat 12 bushels, buckwheat 15 bushels, and hay about 1 ton per acre. Of the special crops, tobacco yields from 1,000 to 2,000 pounds per acre and beans average about 12 to 15 bushels. Some trucking is practiced over a part of the type. Where a heavy dressing of stable manure is applied, cucumbers yield as high as 125 to 150 bushels per acre. Very little has been done in the line of selecting crop rotations adapted to this particular type and present farming methods are not such as tend to increase the productivity of the soil.

PLAINFIELD SAND

Extent and distribution.—This type is of limited extent and confined to the northwestern corner of the county, east of Kilbourn, where it covers an area of some 3 square miles. Another small tract of less than a square mile is found on the south side of the Wisconsin River at Portage.

Description.—The surface soil of the Plainfield sand consists of a light-brown, loose sand of medium texture extending to an average depth of 9 inches and containing only a very small amount of organic matter. The subsoil consists of a yellow, medium sand, becoming lighter in color with depth. The material is loose and becomes coarser at depths of 18 to 30 inches, and lenses of gravel are encountered at 3 to 4 feet. No stones of over a few inches in diameter are present in either soil or subsoil, and limestone fragments are absent, the gravel consisting chiefly of quartz, flint, chert, quartzite, argillite, gabbro, and a few other rocks.

Topography and drainage.—The surface of the type was originally level or nearly so, but has been modified by wind action until at present it consists of drifts, hummocks, and intervening depressions with some level stretches. Differences in elevation rarely exceed 30 feet and are usually considerably less. The depressions have no surface drainage, but over the remainder of the type the natural drainage is good, frequently being excessive. The area south of Portage is level.

Origin.—At Kilbourn the type represents a river fill of the old Wisconsin River from 160 to 190 feet above its present level. The area south of Portage is only a little above the present level of the

river. All of the soil material has been reworked and deposited by water action when the river flowed at higher levels. The parent rock from which much of the sand was derived is the Potsdam sandstone. The type as a whole is in an acid condition.

Native vegetation.—The original forest growth consisted chiefly of burr, white, and red oaks, hickory, and poplar.

Present agricultural development.—Not over 35 per cent of the type is under cultivation. During favorable seasons, and when properly fertilized and cultivated, fair yields are obtained. Average yields are low and the type as cultivated is not well adapted to general farm crops, being droughty and of low fertility. Potatoes do fairly well and truck crops give fair returns when properly cared for.

FOX FINE SAND

Extent and distribution.—This type occurs rather well distributed in a north and south belt extending across the central part of the county. The largest area lies in the vicinity of Pardeeville and down Fox River from that place. It is closely associated with Clyde soils and areas of Muck and Peat.

Description.—The Fox fine sand consists of a loose, light-brown fine sand to a depth of about 10 inches. It is free from gravel and stones, and its organic-matter content is low. The subsoil consists of a yellow fine sand. The material is loose and becomes lighter in color with depth. Lenses and beds of gravel occur in places in the subsoil. Low-lying areas are dark in color.

Topography and drainage.—The topography is level except where the sand has been blown into low dunes. These, however, are usually absent from areas of this soil.

The open texture of the subsoil insures thorough drainage, notwithstanding the level topography. In places the subdrainage is so complete that crops suffer from drought.

Origin.—The type is derived from the weathering of glacial outwash sands. The lenses and beds of gravel present contain considerable limestone. By the litmus paper test the soil is acid.

Native vegetation.—The original forest growth consisted largely of oaks, with softwood trees in low, moist places.

Present agricultural development.—By far the larger part of the area is under cultivation, being utilized for the growth of the general farm crops. Average yields are somewhat lower than those obtained on Fox fine sandy loam. This soil may be classed as having fair agricultural value.

BOONE SAND

Extent and distribution.—The type is confined to the northwestern part of the county, where it is associated with the Knox silt loam, occupying the lower slopes, bordering the Wisconsin River valley. It is of very limited extent, occupying only about 1 square mile. The type occurs on steep slopes, and is often badly eroded.

Description.—The surface soil of the Boone sand consists of a gray or grayish-brown fine sand about 8 inches deep, somewhat darker over the lower slopes, due to accumulations of organic matter. The subsoil consists of a light-yellow fine sand, becoming slightly darker with depth. In some places a reddish tinge is noted below 20 inches, and the deep subsoil is frequently mottled with red iron stains. In some places the underlying Potsdam sandstone is within reach of the auger and often outcrops.

Topography and drainage.—The type occurs on steep slopes and is often badly eroded. Owing to the sandy nature of the soil and its topographic condition, the natural drainage is excessive.

Origin.—The material composing this type has been derived from the weathering and disintegrating of the Potsdam sandstone.

Native vegetation.—The forest growth consisted of pine, fir, spruce, oak, and hickory. A large part of the type is still forested, though most of the valuable wood has been removed.

Present agricultural development.—With the exception of a few small gardens in the northern part of Kilbourn, the type has not been used for growing crops, but is mainly in pasture.

GENESEE FINE SAND

Extent and distribution.—This type is confined chiefly to the valley of the Wisconsin River, where it occupies islands and low sand flats bordering the stream. All such areas are subject to overflow. An area several square miles in extent is found due west of Portage, with other tracts to the south on both sides of the river. The type is of minor importance, occupying in all only about 8 square miles.

Description.—The surface soil of the Genesee fine sand consists of a loose, grayish to light-brown fine sand about 8 inches deep, containing only a small amount of organic matter. The subsoil is a yellowish fine sand of the same texture and structure as the soil and considerably more than 3 feet in depth.

The type is subject to considerable variation in color, texture, and depth. The surface soil has been wind blown in places into low

dunes. On the crest of such dunes the soil is light, while in the depressions and old sloughs the material is loamy and darker colored, owing to the accumulation of organic matter in varying amounts. Small areas of peat, silt, sand, and gravel are encountered, although none of these variations are large enough to be indicated on the soil map.

Topography and drainage.—The topography is level, except for the undulations caused by wind action and some old stream channels which cut across the type in a number of places. The surface is low, subject to annual overflow and usually wet during the spring and early summer months. During dry spells when the river is low the soil is well drained.

Origin.—The material forming this soil is of alluvial origin, modified somewhat by wind action. The parent rock is the Potsdam sandstone, although in many places this has been influenced by glacial action. The soil of this type is usually in a slightly acid condition.

Native vegetation.—The forest growth consisted chiefly of swamp oak, sycamore, basswood and willow, with some ash and elm. The best of this growth has been cut, but there is still a fair stand of trees and considerable undergrowth over most of the type.

Present agricultural development.—All of the type is subject to overflow. Some of it lies between the levee and the river, though most of it occurs where no levees have been constructed. Little attempt at improvement has been made for this reason. Aside from the marsh hay, which can be cut from a portion of the type, and the pasture which it affords, it has but little present agricultural value.

GENESEE SAND

Extent and distribution.—This type is of limited extent and confined to the Wisconsin River valley. One area occurs about 5 miles west of Portage, while another is found 7 miles to the south, on the east side of the river.

Description.—The surface soil of the Genesee sand consists of a loose, sand about 8 inches deep, varying in color from a light brown to gray or pale yellow, according to moisture conditions and organic-matter content. The subsoil is a light-yellow, loose, medium sand extending to a depth of 3 feet or more and frequently carrying lenses of coarse sand and gravel. The type is very similar in texture to the Plainfield sand, but differs from that type in that it lies within the present flood plain and is subject to annual overflow.

Topography and drainage.—The topography is level, except where broken by undulations due to wind action and depressions representing old sloughs. The type is low and subject to overflow. The water table is comparatively near the surface, but the soil becomes droughty during the dry summer months when the river is low.

Origin.—The material forming the Genesee sand is all of alluvial origin and has been deposited by the Wisconsin River during times of high water. The parent rock contributing most largely to this material is the Potsdam sandstone, in most cases first influenced by glacial action.

Native vegetation.—The forest growth consists of swamp oak, willow, sycamore, elm, and ash. All of the best trees have been cut.

Present agricultural development.—The type is used principally as pasture, being very sandy. Protection from flood waters will be necessary before it can be devoted to cultivated crops.

If protected this type would be of the same value agriculturally as the low-lying phase of the Plainfield sand found along the Wisconsin River. It is doubtful if its extent and value would justify the construction of levees to prevent flooding.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SANDS AND FINE SANDS

As is generally true with sandy soils the types of this group are deficient in all of the essential elements of plant food. This does not mean that they cannot be profitably farmed, but it does indicate that before satisfactory crops can be grown from year to year it will be necessary to build up the fertility of such soils. The sand types are found to be somewhat more deficient in the essential elements than are the fine sands and sandy loams, but because of the limited extent of the sand types they are all included in this one group. The supply of phosphorus in the fine sands will average about 800 pounds per acre, which is less than half the amount found in good, productive silt loam soils. The amount in the sand types is somewhat smaller. The amount of potassium present is also small and ranges from 15,000 to 25,000 pounds per acre in the surface 8 inches, this is about half the amount found in Miami silt loam. The supply of organic matter and nitrogen is small, the amount of nitrogen averaging about 1,500 pounds per acre. The soils of this group belonging to the Miami and Fox series are only very slightly acid, but the other soils of the group are usually acid, so that lime is a factor which should be considered in their improvement.

In order that the fertility of these soils may be increased it will be necessary to increase the supply of organic matter. This may be done by applying stable manure, peat, by growing legumes, or by green manuring, or by following a combination of these methods. One may well go to considerable expense and trouble in getting a good stand of clover, for when clover can be grown the fertility of a soil can be maintained and increased. To get clover started the use of lime and commercial fertilizers containing both potash and phosphorus may be necessary. Clover is not the only legume which can be used in building up the soil, but soy beans, yellow lupines, and cowpeas are also good soil improvers.

When the acidity is corrected by the use of ground limestone, or by some other form of lime, and a moderate amount of potash and phosphorus supplied it should be possible to get legumes started, which when plowed under will supply the needed organic matter. When a supply of active organic matter has thus been developed the need for applications of potash will largely disappear, though the need of phosphorus will doubtless continue. Most of these types are better adapted to growing potatoes or truck crops than they are to the production of general farm crops. A rotation consisting of clover, rye, and potatoes, where the second crop of clover is plowed under, usually gives good results on sandy soils. Potatoes, strawberries, cucumbers, melons, tomatoes, and the like could be profitably grown to a much greater extent than at present, especially in those sections where the shipping and marketing facilities are adequate.

CHAPTER VI

GROUP OF POORLY DRAINED SOILS

CLYDE SILT LOAM

Extent and distribution.—The Clyde silt loam is found associated with the Miami silt loam, deep phase, and to a lesser extent with the Carrington silt loam, deep phase. It covers approximately one-third of Columbus Township, in the southeastern part of the county. The type occurs throughout the eastern third of the county as long, narrow bands bordering stream courses. A well-developed area is found along the Baraboo River, to the south and west of Portage, while smaller tracts occur along Spring Creek between Lodi and the Wisconsin River and in various other parts of the survey.

Description.—The surface soil of the Clyde silt loam consists of a black or dark-brown smooth silt loam extending to an average depth of 14 inches and containing a large quantity of organic matter. The subsoil becomes lighter in color and heavier in texture with depth, until at 18 inches a drab silty clay loam showing a few yellow iron oxide stains is encountered. At 2 feet the subsoil approaches a clay loam and at 3 feet shows yellow or light drab, with iron stains.

Lenses of fine sand, crystalline bowlders, and limestone fragments are frequently found throughout the soil section. Over limited areas the bowlders are sufficiently numerous to interfere with cultivation. The variations which occur in the type, however, are of minor importance.

Topography and drainage.—The surface of this type is level to undulating, with a gentle slope toward the stream along which it occurs. In the larger areas there are a few old sloughs and abandoned stream channels, which produce a slight irregularity in the surface. On account of its low position, even surface, and the heavy character of the soil the natural drainage is very defective, and the establishment of drainage systems is essential before the type can be successfully used for the growing of cultivated crops. Very little of this type is subject to overflow, but it occupies low situations and is generally wet, especially in the spring and early summer.

Origin.—The type represents old ponded valleys, lake beds, and other shallow depressions due to the uneven distribution of glacial

till, and the soil is in part of alluvial origin. Its low position and moist condition have favored the accumulation of organic matter, which has imparted a dark color to the soil. As the type is derived partly from calcareous drift, it is rarely acid.

Native vegetation.—The original forest growth consisted chiefly of elm, ash, soft maple, willows, and other moisture-loving trees and shrubs. There is still considerable timber standing.

Present agricultural development.—Comparatively few areas of the Clyde silt loam are under cultivation, but wherever adequate drainage has been provided excellent crops are being grown. Corn yields an average of 50 bushels per acre, while yields of 80 bushels are often reported. Grass makes a rank growth, and timothy hay yields 1½ to 2 tons per acre. Alsike clover does well. Small grain is apt to lodge, but yields of 25 to 40 bushels per acre are obtained. The quality is inferior to that raised on the Miami soils. Peas are grown to a limited extent, but run too much to vine to give the best results. Sugar beets yield from 12 to 18 tons per acre, but the sugar content is lower than from beets raised on the lighter-colored upland types. Cabbage also does well on this type.

The most common system of cropping consists of hay for one or two years, after which the sod is plowed for corn, sometimes being manured first, and followed a second year by the same crop. A small grain is usually sown after the second corn crop and the field again seeded to timothy or a mixture of timothy and alsike.

Where drainage is well established and the soil worked under favorable moisture conditions but little difficulty is experienced in securing a good seed bed. The soil is rather heavy, however, and if worked when too wet or too dry is apt to prove refractory. Considerable forest is still standing, and uncultivated areas are used for pasture.

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

Mechanical analyses of Clyde silt loam.

Description.	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Soil	0.0	0.2	0.8	6.1	8.8	63.9	19.9
Subsoil	.0	.3	.8	4.1	7.7	73.9	13.1

CLYDE LOAM

Extent and distribution.—The Clyde loam in Columbia County is of very limited extent and does not cover more than 3 or 4 square miles. It is seldom that an area of more than 160 acres is found and most tracts are much smaller. It is fairly well distributed throughout those portions of the county where the upland consist of soils of the Miami series.

Description.—The surface soil to an average depth of 10 inches consists of a black loam or light textured silt loam, containing a large amount of organic matter; a few inches of peat or muck may cover the surface. The subsoil is a drab, bluish, yellowish, or mottled material, variable in texture, though usually being a loam or heavier. Coarse sand or fine gravel often gives the subsoil a gritty characteristic.

Topography and drainage.—The surface is level to very gently sloping, and on account of the low position the natural drainage is poor. The subsoil is of such a character as to permit tile drains to draw for a long distance when properly installed.

Origin.—The material composing this soil is partly alluvial and partly lacustrine. It occupies the beds of old lakes and ponds and sometimes it occurs as narrow strips of low land along stream courses. The gritty material in the subsoil is largely limestone and, while the surface soil may be slightly acid in places, the subsoil is usually quite calcareous.

Native vegetation.—The original timber growth consisted of elm, ash, sycamore, willow, and a few other water-loving trees. In some places a heavy growth of grass was found where the tree growth was sparse.

Present agricultural development.—Only a small percentage of the Clyde loam is improved and under cultivation at present where well drained excellent crops of corn, hay, and small grain are secured. Small grains are apt to lodge and the quality is not equal to grain grown on Miami silt loam. Sugar beets can be profitably grown but the acreage on this type is very small.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE SILT LOAM AND CLYDE LOAM

These two types of soil occupy a combined area of about 26,000 acres or a little over 5 per cent of the county. They are important, not because of their present state of development, but because of their possibilities for future development. They are low lying, and

at present poorly drained, but with the establishing of proper drainage systems, which in most cases could be installed at a comparatively low cost, they can be developed into highly productive soils.

Since these soils are formed along the border line between upland light colored soils and peaty and muck marsh soils, they they are intermediate in chemical composition between these two extremes. Moreover, their position is such that they have received a considerable deposition of fine silt from the higher land with its larger content of plant food. These soils have in the surface 8 inches approximately 2,000 pounds of phosphorus per acre; from 30,000 to 40,000 pounds of potassium; and approximately 10,000 pounds of nitrogen. Since they are surrounded by highland, the subsoils of which are rich in ground limestone which is being continuously dissolved and carried to the lower lands by percolating waters, they are as a rule not acid, and in fact usually contain considerable quantities of lime carbonate.

In spite of their large content of both phosphorus 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 Stations.*

The most important question in the improvement and management of these soils is one of drainage. Practically all areas are in need of drainage, and tile drains will be found most practical in the majority of cases. When properly drained and well managed, very satisfactory yields can be secured. Cabbage, onions, and sugar beets are some special crops which can be successfully raised on these soils, aside from the general farm crops, such as timothy, alsike clover, corn, and small grain. Grain crops usually make a rank growth but are apt to lodge. Stable manure should not be applied to these soils as the nitrogen is not needed. The mineral elements, where needed, may be supplied in the form of commercial fertilizers, as indicated above.

*For more information write to Wisconsin Experiment Station for bulletins on drainage and fertilization of low, poorly drained tracts of land.
For special information on drainage, see Bulletin No. 229 of the Wisconsin Experiment Station.

CLYDE FINE SANDY LOAM

Extent and distribution.—This type is of comparatively small extent and is found in the lowlands associated with other soils of the Clyde series. In all about 24 square miles were mapped. The type occurs in small areas in many parts of the county. These are most numerous in Otsago and Fountain Prairie Townships.

Description.—The surface soil of the Clyde fine sandy loam consists of a loose and open fine black sand to fine sandy loam, 12 inches deep, containing considerable organic matter. The subsoil is a dark-drab fine sand, becoming lighter with depth, and grading at about 18 inches into a sticky fine sand or a light sandy clay. The texture then becomes heavier, and at 2 feet a sandy clay is encountered.

The type is subject to considerable variation, though as a whole it conforms more closely to a fine sandy loam than to any other type. The surface is frequently covered with 2 to 3 inches of Peat or Muck, which becomes incorporated with the soil as soon as the type is put under cultivation. Areas of limited extent often have a surface covering approaching a loam in texture, though where this is found the type is always shallow and underlain by fine sand.

Topography and drainage.—The topography is level, the low position of the type and the proximity of the water table to the surface making natural drainage poor.

Origin.—The type is derived from the deposition by stream action of the fine sand and other material washed from the adjoining higher-lying land. Accumulations of organic matter, favored by abundant moisture and decaying vegetation, have imparted a darker color to the soil. Being associated with glaciated limestone soils and having been derived from this source, the material contains varying amounts of lime carbonate. The surface is seldom acid and the subsoil is usually calcareous.

Native vegetation.—The original forest growth consisted of swamp oak, willows, elm, sycamore, quaking aspen, and sumac. Little valuable forest remains, though most of the type is still uncleared. Some marsh grasses are also found.

Present agricultural development.—Not over 10 per cent of this type is under cultivation, although where open ditches have been constructed and the land drained, yields of 30 bushels of corn, 25 bushels of oats, 20 bushels of buckwheat, 100 bushels of potatoes, and about 1½ tons of timothy and clover hay to the acre have been secured. Little, if any, attempt has been made to specialize on this

soil, and rotations best suited to local conditions have not been worked out.

CLYDE FINE SAND

The type is inextensive and of minor importance, occupying a total area of 1 square mile. It is associated chiefly with the Clyde fine sandy loam. One small area lies immediately east of Pardeeville, with another about 5 miles to the east, and smaller patches in other parts of the county.

Clyde fine sand consists of a fine black sand about 12 inches deep, containing a large amount of organic matter and underlain by a loose, drab, fine sand, showing mottlings of yellow in the lower part of the soil section. Variations from the typical soil occur over limited areas, but are not important enough to show on the map.

The surface of the type is low and flat, and on account of its position and the proximity of the water table to the surface the natural drainage is poor.

The material composing the type has been washed from the higher lands adjoining the Miami soils and deposited in low places. The darker color is caused by accumulations of organic matter resulting from the partial decay of vegetation in the presence of moisture.

The native vegetation consists principally of grasses and sedges, with a few willows.

Only a very small part of the type is cultivated, but where properly drained fair crops can be secured. It is adapted to about the same crops as the Clyde fine sandy loam and requires similar treatment.

DUNNING LOAM

Extent and distribution.—The type is of small extent, occupying less than 8 square miles in the county. It occurs principally in Fort Winnebago and Lewiston Townships. The type is associated with the Coloma soils.

Description.—The Dunning loam consists of about 12 inches of black loam containing considerable silt and organic matter and underlain at a depth of about 20 inches by a drab clay loam, mottled with yellow and containing lenses of fine sand. This material becomes heavier and the mottling more pronounced at depths ranging from 20 to 36 inches.

The type is subject to considerable variation. In places the subsoil is a drab loam grading into a sandy clay loam, underlain at 2 feet or more by a sticky fine sand, becoming loose in the lower por-

tion. In places from 5 to 6 inches of fine sand may be found immediately underlying the surface soil. A covering of 4 to 5 inches of peat is found over a few small areas, the subsoil being a mixture of sand and clay. None of the phases were of sufficient extent to map separately.

Topography and drainage.—The topography is level, which, with the low position of the type, makes the natural drainage poor. The water table is usually within a few feet of the surface, and during the spring the soil is almost completely saturated. At times portions of the type are several inches under water.

Origin.—This soil is similar in origin to that of the Clyde silt loam. It occupies low, flat areas and depressions representing old lake beds or swamps and ponded valleys, and contains some alluvial material along present streams. The dark color is due to the accumulation of organic matter resulting from decaying vegetation in the presence of moisture. The parent material was largely from sandstone and the soil and subsoil are acid, thus differing from the Clyde soils which are usually not acid.

Native vegetation.—The original forest growth consisted chiefly of willow, quaking aspen, swamp oak, and other water-loving trees, shrubs and grasses. Nearly all the trees have been removed, only a scant growth remaining over the type.

Present agricultural development.—Where properly drained the type is suited to a number of general farm crops. Most of it, however, is unimproved and in its present undrained condition is of value chiefly for the pasture it affords, and the marsh hay which can be cut.

DUNNING FINE SANDY LOAM

Extent and distribution.—The Dunning fine sandy loam is a type of minor importance in Columbia County, occupying a total area of less than 5 square miles. The largest tract is found occupying the low ground at Portage. The next largest area occurs along the Wisconsin River in Newport and Lewiston Townships. Other smaller tracts are scattered throughout the northwestern part of the county. The type is confined chiefly to those regions where the upland soils belong to the Coloma and Plainfield series.

Description.—The surface soil to an average depth of about 8 inches consists of a dark brown to black fine sandy loam, over which there may be a few inches of peat or muck. The subsoil usually consists of a gray, drab, or mottled fine sand, which at 18 to 24 inches grades into a sticky fine sandy loam. In a few places a sandy clay

was found at about 3 feet. The subsoil is quite variable, but because of its limited extent no phases were mapped.

Topography and drainage.—The surface is level or only very gently sloping, and because of its low position the natural drainage is poor. The water table is usually within 3 feet of the surface and for portions of the year parts of the type may be covered with a few inches of water. Open ditches have been constructed in a few places.

Origin.—This type is of similar origin to the Clyde fine sandy loam, being in part alluvial and part lacustrine. The parent material came largely from glaciated sandstone debris. Practically all of the type is acid and this is the chief point of difference between it and the Clyde soils.

Native vegetation.—Where timbered the original growth consisted of a sparse growth of willow, elm, ash, and a few water-loving shrubs. A considerable portion of the type was treeless and supported a heavy growth of coarse marsh grass.

Present agricultural development.—Only a very small proportion of this type is sufficiently well drained to permit growing cultivated crops. Where drained the general farm crops common to the region are grown and fair yields obtained. Most of the type is unimproved and undrained. Over some undrained tracts marsh hay can be cut, and grazing is afforded in some places.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE FINE SANDY LOAM, CLYDE FINE SAND, DUNNING LOAM, AND DUNNING FINE SANDY LOAM

These soils are quite uniform in their content of mineral plant food elements, and nitrogen, but because of their sandy nature they contain relatively lower amounts of phosphorus and potassium than do the heavier Clyde soils. The total phosphorus averages about 1,000 pounds, in the surface 8 inches per acre, while the supply of potassium is about 25,000 to 30,000 pounds, and the amount of nitrogen approximately 5,000 pounds. These soils are quite variable in their content of lime. The Clyde soils occur in regions where limestone material has entered largely into the formation of the soils, and these types are seldom acid, or only slightly so at the surface, while the Dunning soils occur in regions where no limestone has entered into the formation of the soils, and the types are always found to be acid.

The first step in the improvement of these soils is drainage. When this has been thoroughly established they will usually require the

use of commercial fertilizers containing potassium and phosphorus. In nearly all cases there is a sufficient amount of nitrogen, so that the stable manure can be applied to the upland to better advantage than to these low lying soils. Where the soils are acid the use of ground limestone to correct this condition will be found profitable.

CHAPTER VII

MARSH SOILS

PEAT

Extent and distribution.—Peat soils make up a total of 10 per cent of Columbia County.

Extensive areas of Peat are found in the lowlands in the vicinity of Portage, along the Wisconsin and Fox Rivers, in Pacific and Fort Winnebago Townships. Other large areas lie along Duck Creek, between the Wisconsin River and Cambria, and in Lewiston and Newport Townships, while smaller patches occur in nearly all parts of the county, except in the prairie regions and the hilly section of Caledonia Township.

Description.—The material mapped as Peat consists of black or dark-brown vegetable matter in varying stages of decomposition, with which there has been incorporated a small amount of mineral matter. This varies in depth from 2 to 20 feet, with an average of 3½ to 4 feet. The upper portion of the peat beds is usually quite fibrous, the material becoming more thoroughly decomposed with depth, forming in the lower portion a soft mass which is sufficiently tenacious to be molded into different forms by the hand. When dry this decomposed Peat somewhat resembles a black carbonaceous clay. Where encountered in areas of sandy soils the underlying material is frequently sandy, while in the region of heavy upland soils the underlying material is clayey.

Topography and drainage.—The peat beds occupy low, flat areas, and on account of their position and the fact that the water table is so close to the surface the natural drainage is very poor.

Origin.—The Peat has been formed through the growth and partial decomposition in the presence of water of a rank vegetation, the black or dark-colored material being formed largely from grasses and sedges, while that having a brown color was formed chiefly from sphagnum moss. About the margin of the larger marshes and over the greater part of many of the smaller ones varying quantities of soil from the adjoining higher land have been washed in and incorporated with the vegetable matter. Wherever this has been sufficient to materially change the texture and structure of the material it has been separated and mapped as Muck.

The peat beds occupy old lake basins, ponded valleys, kettle basins, glacial sloughs, and other depressions in the uneven surface developed by the ice sheet. Peat may also be found within the flood plain of many of the present streams.

Many of the peat marshes are in an acid condition, especially those in the region where the upland soils contain little or no lime carbonates.

Native vegetation.—The native growth over Peat is confined to several varieties of grasses, sedges, and some arrowhead, cattail, and various reeds and rushes. On the sphagnum-moss peat beds are found tamarack, sumac, huckleberry, and quaking aspen. Where the Peat is shallow elm and ash are sometimes found.

Present agricultural development.—In Columbia County scarcely any of the Peat has been improved beyond ditching in order that marsh hay may be secured. On a large number of farms the peat marshes are the chief source of hay, and in many cases they are used as pastures. The hay is cut from early in July to early in September. One ton per acre is about the average yield.

MUCK

Extent and distribution.—The Muck is not nearly as extensive as Peat, the largest tract being found along the headwaters of the Fox River, northeast of Pardeeville. The type is confined largely to the eastern part of the county. It occupies low, flat areas in old lake beds, kettle basins, stream channels, and ponded valleys, all of which abound in this glacial region.

Description.—The material mapped as Muck consists of partially decomposed vegetable matter, with which there has been incorporated a considerable quantity of mineral matter. The Muck is black or nearly black and extends to a depth of 8 to 24 inches. The underlying material consists for the most part of a drab or grayish fine sand. Variations in the type are numerous, though comparatively inextensive. The most common of these is where the sand or silt from the upland has been washed down and deposited over a peat bed, thus developing a phase of Muck having a high content of mineral matter near the surface, but underlain by Peat. In places small peat beds have been drained for a long period, allowing the surface soil to decompose in the atmosphere, bringing about a concentration of the mineral matter of the Peat and producing a black Muck, containing some fine sand underlain by Peat, which becomes comparatively pure with depth. The surface of such muck beds when dry and under cultivation is subjected more or less to wind

erosion. In a few places the material underlying the Muck is a clay or silty clay.

Topography and drainage.—The surface of the Muck is level, or only very gently sloping, and because of its low position and the nearness of the water table to the surface, the natural drainage is poor.

Origin.—The origin of the largest muck beds in the area is identical with that of the Peat, except that in general the Muck has been exposed to the atmosphere, has undergone a more thorough decomposition, and has a much higher mineral-matter content.

Litmus tests indicate that a part of the type is in an acid condition.

Native vegetation.—The vegetation of the muck beds consists of willows, quaking aspen, sumac, ash, swamp oak, and various wild grasses. Where the grasses abound there is usually no other growth, except a few scattered willows.

Present agricultural development.—Except for the production of marsh hay, this type has been improved only to a limited extent. A small amount of drainage work has been done, including the construction of a few open ditches, but the greater part of the Muck is still undrained. Where drained and properly cultivated satisfactory yields of corn, oats, onions, cabbage, and a number of other crops can be secured.

CHEMICAL COMPOSITION AND IMPROVEMENT OF MARSH SOILS

Approximately 12 per cent of Columbia County consists of Peat and Muck soils, about 10 per cent being Peat and 2 per cent Muck. Only a very small amount of this marsh land has been improved, but since the greater proportion of it can be drained and successfully farmed its reclamation is of great economic importance.

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is low in earthy matter, often running from 80 to 95 per cent of organic matter, though whenever it contains over 50 per cent of organic matter it can be justly classed as Peat. In Muck the amount of organic matter falls below 50 per cent, and there is a correspondingly larger amount of mineral matter. This is the chief point of difference between Peat and Muck. As the amount of earthy matter in the Peat is low the supply of mineral plant food elements is also small, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches, and of potassium, about 700 pounds. In Muck these amounts are somewhat higher.

It will be seen, on comparison of these statements with those made on the composition of such soils as Miami silt loam and Fox silt loam, that the total amount of potassium, in particular, is extremely small, the amount in Peat often being less than 2 per cent of that found in the upland silt loam soils. While 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 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 Peat, 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 or Muck land and upland soils, the stable manure should be used on the upland, and commercial fertilizers containing phosphorus and potash, if needed, on the lower land, unless, indeed, there is sufficient manure for the entire farm, which is rarely the case. These marsh soils are rarely acid throughout the limestone regions, on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid Peat are found on the larger marshes. Where there is no limestone material in the upland soils, as is the case in the northwestern portion of the survey, the marsh soils are acid. 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 the 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 so well adapted physically.

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.

When properly handled Peat and Muck will produce profitable crops of corn, alsike clover, timothy, small grains, and other general farm crops, as well as special crops such as peppermint, celery, etc.

*For special information concerning drainage and the improvement of marsh soils, write the Soils Department of the Wisconsin Experiment Station.

ROUGH STONY LAND

The areas mapped as Rough stony land consist of steep, rocky slopes, upon which the covering of soil is very thin and where rock fragments and outcrops are numerous. The soil on these slopes is usually a fine sand, which in the absence of the rocks could be mapped as Boone fine sand. The type is confined to the southwestern part of the county, where it occurs as long, narrow bands along the steepest hill slopes. In a few instances it extends over the tops of hills.

Because of the steepness of the slope and the sandy nature of the soil, the natural drainage is excessive and the vegetation suffers from lack of moisture.

The sandy soil has been derived from the weathering and disintegration of the Potsdam sandstone, which forms the walls of the old preglacial valleys on the slopes of which the Rough stony land is found. Most of the outcrops are also Potsdam sandstone, although a few of the hills are capped with Lower Magnesian limestone. Limestone fragments are sometimes mixed with the sandstone.

Where a forest growth occurs on these slopes it is usually scrubby oak or hickory. Many of the steeper slopes are bare except for some grass.

The Rough stony land is a nonagricultural type and of value only for the small amount of pasture which it affords. Its only other possible use is for forestry, and it is doubtful if this could be made successful, because of the shallow, droughty nature of the soil.

CHAPTER VIII

GENERAL AGRICULTURE OF COLUMBIA COUNTY

Agriculture in Columbia County dates back to 1836. The pioneers, accustomed to the forested lands of the East, were not favorably impressed with the long stretches of open prairie, and started their farming operations in the timbered regions or in the openings, where they thought the soil would be more productive than on the prairies. Later the prairies were also put under cultivation with very good results. Settlement of the county was quite rapid and portions of it early became agricultural regions of importance. Grain crops, including wheat, oats, barley, rye, and flax, constituted the larger part of the farm products for a number of years, wheat being the most important.

The severity of the winters on the open prairies caused the early settlers to plant their winter wheat in the clearings and the spring wheat on the prairies. Continued cropping under this system with no effort on the part of the owners to maintain the soil by the use of fertilizer caused yields to decline to a point where wheat was no longer profitable. The chinch bug also appeared and wheat farming gradually gave way to a more diversified system of agriculture. Corn and oats came to be more important, and stock raising, stock feeding, and dairying gradually developed. Potatoes were early found to be adapted to the sandy soils and soon became an important crop. Barley production also increased to considerable proportions. Tobacco was introduced in Dane and Rock counties in 1858, and this crop soon spread to the surrounding regions, including Columbia County. The yields were excellent and the crop sold for cash. The tobacco grower became a stock feeder rather than a dairy farmer, and larger numbers of sheep and cattle were raised on the farms which produced the tobacco. When the natural meadows became inadequate to supply pasture tame grasses were seeded on the uplands. Continued cropping was the common practice, and it is only within about the last 20 years that any careful attention has been given to crop rotation. General farming is the prevailing type of agriculture in the county, supplemented in some sections by dairying, the production of special crops, or stock raising, depending upon local conditions.

The general farm crops of the region consist of corn, oats, barley, wheat, rye, clover, timothy, buckwheat, and some alfalfa. The corn crop of 1909 from 58,957 acres amounted to 2,014,287 bushels, or an average of about 34 bushels per acre. White and yellow dent corn are the types generally grown, although some farmers prefer the flint. Several improved varieties are being introduced by the Wisconsin Experiment Station, with marked improvement in the quality of seed and gradually increasing yields. The corn is usually cut with a harvester and husked from the shock, the stalks being shredded or stacked for winter feed. The silo is coming into more common use, and considerable corn is now being preserved in the form of ensilage for winter feed. Corn is grown in all parts of the county, but the acreage is greater and the yields are larger in the prairie regions and on the Miami silt loam, deep phase, than over the sandy portions of the county.

The oat crop is also important, the acreage frequently exceeding that devoted to corn. In 1909 the crop from 59,695 acres amounted to 1,864,154 bushels, or an average of 31 bushels per acre. Comparatively little of the crop is sold, most of it being fed to stock on the farms. Swedish Select, New Kherson, and Big Four are among the varieties most extensively grown. The best oats are grown on the Miami silt loam, deep phase, though larger yields are often obtained upon the black prairie soils.

Barley is still an important cash crop, though the acreage is considerably below that of corn and oats. The crop of 1909 from 16,102 acres amounted to 438,827 bushels, or an average of about 27 bushels per acre. At present the acreage is decreasing, due to a decline in yields as the result of continued cropping, as was the case with wheat. On the heavy soils of the area barley gives very satisfactory yields when grown in rotation with other crops.

Wheat is being grown to a slightly greater extent at present than was the case a few years ago, although the acreage is still very small. The crop of 1909 from a total of only 1,970 acres amounted to 36,234 bushels, or an average of about 18 bushels per acre. Of this approximately one-fourth was winter wheat. The yields from this variety exceeded the spring wheat by nearly 4 bushels per acre. Danger of winter killing is given as the reason for the larger acreage of the spring wheat.

Rye is grown chiefly in the sandy portions of the county. It is produced as a grain crop, for green manuring, and for pasture. When the rainfall is sufficient fair crops are secured, though the average yield is low. The crop of 1909 from 11,255 acres was 141,199 bushels, or about $12\frac{1}{2}$ bushels per acre. When used for

green manuring the rye is usually sown on corn or potato land and plowed under the following spring. It may be pastured in the fall and early spring.

Timothy and red clover are the most common of the grasses and clovers used for hay and pasture. Considerable difficulty has been experienced during the past few years in securing a good stand of clover, due in part to winter killing during the late winter when the snow is melting and the ground freezing and thawing alternately, and partly to the hot, dry weather during the late summer. An acid condition of the soil is not favorable for the best development of legumes, including the clovers. The sourness of the soil weakens the development of the clover plant and makes it more susceptible to frost and drought. During the progress of the survey frequent litmus tests were made, and it was found that soil acidity was quite prevalent in varying degrees over different soil types. On the heavier soils alsike clover is being grown to a considerable extent. Mammoth clover is used for pasture and also for hay on the lighter soils, but on the heavier types it becomes coarse and is not as satisfactory as the medium red clover. Timothy is being seeded by itself to some extent and cut for seed as well as for hay. Over the marshy parts of the area many tons of marsh hay are cut every year, furnishing an abundance of feed of inferior quality.

Alfalfa is being grown to a limited extent throughout the county. At least three cuttings can be secured, 3 tons per acre being about the average yield per year. This crop has passed beyond the experimental stage and can be grown successfully wherever the soil is kept in the proper condition. Liming is often necessary, and to insure a good stand the field should be inoculated and also well supplied with stable manure.

Some buckwheat is grown, but the crop is of minor importance. Only 577 acres were planted in 1909, from which 7,546 bushels were harvested, averaging about 12 bushels per acre. It is grown chiefly in the low, sandy portions of the county.

Aside from the general farm crops common to this region, a number of special crops have been found well adapted to the soils of the area, and which have added materially to the profits of farming. Chief among these crops grown at present are potatoes, tobacco, beans, peas, and sugar beets. The acreage of most of the special crops raised could be profitably extended.

The potato is the most extensively grown of the special crops, the annual output for the county in 1909 from 7,098 acres amounting to 1,350,775 bushels, or an average of about 181 bushels per acre. The crop is confined largely to the sandy soils of the area, to which it

is well suited. Yields are satisfactory as a rule and the tubers of good quality. A large part of the crop is sold soon after digging, although a number of warehouses have been constructed and some potatoes held for the late winter market. Some farmers store their own crop in cellars or pits and place them on the market in the spring. The most progressive farmers use modern machinery in planting cultivating, and harvesting the crop. The Early Ohio is the most popular of the early varieties, while the Rural New Yorker, and Peerless are preferred as the later varieties.

Columbia County ranks fourth among the counties of the State in tobacco production. In 1905 the crop amounted to 3,142,475 pounds. Most of the tobacco grown is of the Comstock Spanish variety. About 85 per cent of the crop is sold as binder tobacco and the remainder, consisting of broken leaves and stems, as filler. The average yield is about 1,100 pounds per acre. Binder tobacco commands prices ranging from 6 to 14 cents per pound and filler about 2 cents per pound. The crop is usually contracted for in the fields to be delivered after curing, the contract price depending upon the condition at time of delivery. An average price of 10 cents per pound is considered necessary to make the crop a profitable one. Tobacco is grown most extensively on the silt loam and fine sandy loam types. Because of the uncertainty of the crop and prices and owing to the labor required the acreage is being reduced and many of the tobacco growers are engaged in the dairy industry. The crop is fertilized with stable manure, as nearly every tobacco grower is a stock feeder and hence has a supply of manure on hand. Applications range from 20 to 40 loads per acre, but in spite of this heavy fertilization yields are reported to be on the decline. Generally speaking, tobacco is grown on the same field year after year, receiving the greater part of the manure, and as a result the remainder of the farm suffers. Commercial fertilizers have been used to a limited extent, but are not in favor with the farmers. Most of the farmers produce their own tobacco seed, but too often fail to use care in its selection.

Beans have been found to be well adapted to some of the soils of the area, especially the silt loam and fine sandy loam types, there being at present about 5,000 acres planted each year to this crop. In 1908, 69,000 bushels were produced, representing a little more than half the total production of the whole State. Beans are grown on nearly every upland soil type in the county, but probably do best on the silt loam and fine sandy loam. Yields average from 16 to 20 bushels per acre, sometimes running as high as 28 or 30 bushels. Prices range from $1.50 to $2 per bushel. The common practice is

for the growers to sell their crop to seed houses for a definite price, the seed being furnished them and later deducted from the proceeds of the crop. The White Navy is the chief variety grown, though the Early Refuge and Brown Swede are also grown to some extent. Beans do best on a rich, friable soil and are most frequently planted after sod.

The growing of peas for canning purposes and for seed has developed into an important industry in some parts of the county. The four canning factories in the area are located at Columbus, Fall River, Randolph, and 2 miles north of Randolph. The Columbus plant is one of the largest of its kind in the country. In 1911 this factory handled the output from 1,500 acres, of which about two-thirds were grown in Columbia County. Yields range from 2,000 to 2,200 pounds per acre of shelled peas, the farmers receiving an average price of 2 cents per pound. To save long halls, viners are located throughout the pea-growing districts, making possible the extension of the industry beyond the immediate locality of the factory. A large seed company has located a warehouse at Columbus for milling and cleaning peas, and they have built up an extensive business in handling seed peas. In 1911 they contracted for about 1,300 acres in the vicinity of Columbus. This same company is also using 50 acres in seed tests and stock-improvement work. The canning companies also contract for seed peas in districts too remote from factory and viners. Yields of seed peas range from 15 to 20 bushels per acre and the price obtained ranges from $1.50 to $2 per bushel. The varieties grown are the Alaska, a very early pea, and the Advance, Admiral, and Horsford, which mature later. The crop is planted to mature continuously throughout a considerable period. Peas are reported to be a very profitable crop. Being a legume, they tend to build up the soil in the same manner as clover and it has been noted that oats or barley yield heavier and produce grain of better quality after peas than following corn or other grain crops. During the season of 1911 the late peas were attacked by the pea louse, which did considerable damage. Early planting usually allows the crop to be harvested before this pest makes its appearance.

The Miami silt loam, deep phase, appears to be better adapted to pea growing than any other soil in the area. The crop does well on the Carrington silt loam, deep phase, but the quality is not as good as on the Miami silt loam, deep phase. When planted on Clyde soils the crop makes a rank growth of vine.

Sugar beets are grown to a considerable extent on the Carrington and the Miami silt loams. The farmers usually put in the crop and

attend to the horse cultivating, while the sugar-beet companies furnish laborers to do the handwork, such as weeding, thinning, and topping, making an acreage charge of approximately $20 for this work. The crop is harvested and hauled to the shipping point by the farmer. Yields range from 10 to 18 tons per acre, for which a flat price is paid or settlement made according to test. The price averages about $5.50 per ton. Tests are usually a little higher on the Miami than on the Carrington silt loam but the tonnage is usually higher from the latter soil.

Two salting stations have been established in the county to handle the cucumber crop, the growing of which has come to be quite an important industry on some of the sandy types of the area. About 15,000 bushels were harvested in 1911. A large pickling concern furnishes the seed and contracts for the entire crop. The cucumbers are planted in hills about 1½ feet apart, with 7 to 9 feet between the rows. Liberal applications of stable manure greatly increase the yields. The average yield per acre is 150 bushels. The cucumbers are graded according to size. Those under 3¾ inches bring 75 cents and larger ones 35 cents per bushel. The crop runs about 60 per cent small and 40 per cent large cucumbers. Because of the large amount of work required in gathering the crop, there is seldom more than an acre put in by any one farmer. The White Spine is the most common variety grown.

Cabbage is being grown most extensively in the vicinity of Cambria. About 150 acres were planted in 1911. This crop does best on a rich, moist soil, and it is therefore confined mainly to the heavier types. The Holland variety is most commonly grown. The plants are ordinarily set out with a transplanting machine similar to that used in setting tobacco plants. Frequent cultivation, with some handwork, is necessary. When the crop is harvested the outside leaves and stems are returned to the field. Cabbage is generally considered a paying crop, yields averaging from 10 to 15 tons per acre and the price ranging from $4 to $6 per ton. The cost of production is placed by some farmers at about $2 per ton, though this is only a rough estimate. A large proportion of the crop is shipped to the wholesalers in the fall, but two warehouses have been built at Cambria for storing the crop for winter market.

Attempts have been made to grow cabbage on the same fields year after year, but cabbage rot soon appears, sometimes the second year, and this directs attention to the question of rotation. It is not advisable to take more than one crop of cabbage from a field during the rotation.

Considerable sorghum is grown on the sandy soils of the area, the quality being influenced to a certain extent by the texture of the soil. As this becomes heavier and the organic matter increases, the sirup becomes darker and less desirable. The output from the area in 1905 amounted to 3,746 gallons.

Trucking on a commercial scale has not been developed to any extent, though nearly every farmer has a garden in which most of the common vegetables are grown for home use. Near some of the towns small commercial truck gardens give good results. The sandy soils of the area are well adapted to a variety of truck crops, and where shipping facilities are adequate it would seem that this industry could well be extended.

Fruit growing has not been developed on a commercial scale to any appreciable extent. Apples do fairly well on many of the soils and there are a number of small home orchards scattered throughout the county. Cherries, raspberries, blackberries, currants, plums, grapes, and strawberries are grown to a limited extent, chiefly for home consumption. It would seem that most, if not all, of these fruits could be profitably grown to a greater extent than at present. Many of the slopes in Caledonia Township are well suited to apple orchards.

Dairying is an important industry, but should be developed to a much greater extent than it is at present. There are some purebred herds of Holsteins, Jerseys, and Guernseys, but the greater proportion of the dairy stock consists of grade animals, largely Holstein and Shorthorn. A number of the herds are headed by a purebred sire and in this way the stock is gradually being improved. In 1913 there were 13 creameries and 15 cheese factories in the county. Many of the farmers have cream-separators, hauling the cream to the creamery and feeding the skim milk to hogs on the farm. The dairy industry should be further developed. The silo is just beginning to be introduced, and with the extension of dairying the number should increase rapidly. Alfalfa should be grown on every farm in the county, as it furnishes an excellent feed and is a soil builder.

Beef cattle are fed quite extensively in the south-central and southwestern parts of the county. They are shipped in from northern and western points, fattened for the winter market, and sold after the holidays. The Shorthorns seem to be the most popular breed. In sections where feeding is carried on about 10 to 15 head per 100 acres are turned off every year.

Sheep are raised in nearly every section of the county and in the southern and western border districts, particularly in Caledonia Township, feeding for market is carried on quite extensively. West-

ern sheep are shipped in during the fall to points near Lodi, where they are pastured until winter sets in, and then housed and fed until ready for market.

Hog raising is quite general in all parts of the county, being carried on in conjunction with general farming and dairying. From 20 to 40 hogs are kept on the average farm, except on the lighter soils of the northern part of the county, where 10 to 20 is the average number. The Poland-China seems to be the favorite breed, though Berkshires, Duroc-Jerseys, and Chester Whites are also raised.

Horses are not raised to any extent in the county, though a number of the farmers plan to breed their working mares and raise enough work stock for their own farms.

It is generally recognized throughout the county that many of the crops grown are much better adapted to certain soil types than to others. Potatoes produce higher yields of better quality on the sandy types than on the heavier soils. Sugar beets do much better on the Miami and Carrington silt loams than on the sandy types. Peas appear to do best on the Miami silt loam, deep phase. Corn does well on the Carrington silt loam and the Clyde silt loam. On the latter type grains are apt to lodge and the quality is not as good as on the Miami soils. Cabbage requires a rich soil and is grown entirely on the Carrington and Miami silt loam. Although the adaptation of certain soils to particular crops is recognized, the present farming practices do not always permit the realization of plans best suited to prevailing conditions.

A common rotation on the heavier soils consists of corn one year followed by oats, barley, or wheat with which clover and timothy are seeded for two years. Hay is cut for one or two years and the field frequently pastured for one year before being again plowed for corn. On the lighter soils potatoes are grown one year and followed by grain (rye and oats) for two years and then seeded to clover and timothy. Frequent failures with clover have interrupted the rotations of many farmers, but the usual plan is to have grass on the land every 4 or 5 years. Attempts at continual cropping on the same field with such crops as cabbage, peas, and tobacco are still common, but the average farmer has learned that this is not a profitable system and is not conducive to continued fertility of the land or profitable yields.

In general, however, more attention is being paid each year to the selection of crop rotations best suited to local conditions and soil types throughout the county. Methods of cultivation, fertilization, seed selection, etc., are also being given more consideration, with the

result that agriculture is being placed upon a more scientific basis, with a tendency to adopt such practices as will maintain and increase the productivity of the soil.

Among the weed pests most common in Columbia County the Canada thistle, quack grass, and wild mustard are probably the most troublesome. The amount of damage caused by such pests is not fully appreciated, and all efforts looking to their eradication should be encouraged.

The buildings on the average farm in Columbia County are well constructed and substantial. Besides a frame or brick house, there is usually a barn with hay loft, a corn crib, shelter for cattle, hogs, and other stock, and where tobacco is grown, a large shed for curing this crop. The tobacco shed may also serve as a place for storing farm machinery. Although many farmers have their machinery kept under cover, there is room for improvement along this line.

Windmills are quite common, supplying water for stock and the home. Gasoline engines are being installed on many farms and used for pumping, grinding feed, sawing wood, churning, running washing machines, and sometimes an electric-lighting plant. Most of the fields are well fenced, many with barbed wire, though woven wire fencing is coming into more common use. Farm improvements vary in different sections of the county, being best on the Carrington and Miami silt loams and poorest on the sand and fine sand types.

An inadequate supply of farm labor often makes it necessary for the members of the family to do large proportions of the farm work. This condition frequently determines the type of farming practiced. On a monthly basis hands receive from $30 to $35, with board and washing included, and frequently the hired man's driving horse is cared for in addition. During haying and harvest time the day wage varies from $1.50 to $2. Wherever possible modern machinery is used, doing away with considerable manual labor.

The census of 1910 reported 3,327 farms in Columbia County, including 94.5 per cent of the total area of the survey. Of these 76.8 per cent are operated by the owners, and the remainder being nearly equally divided between share and cash tenants. The average size of farms is 141 acres, with an average of 92 acres improved. There are 585 farms which have 175 acres or more, 29 farms of 500 acres or more, and 3 farms which contain 1,000 acres or more. The value of farm lands varies greatly on the different types of soil. Much of the Miami and Carrington silt loam, deep phase, types is held at prices ranging from $125 to $150 an acre, while the poorest farms on the sand and fine sand types are worth only $15 to $25

an acre. Variations between these extremes depend upon location, character of the soil, and improvements.

While agriculture in the area as a whole is well developed, and while this area compares favorably with other parts of the State having the same soil conditions, there are, nevertheless, several lines along which further general improvements could be made. One great need of most of the soils of the area outside of the prairie regions and bottom lands is a larger supply of organic matter. This may be had by supplementing the stable manure with green manuring crops. Legumes are best for this purpose. Peat may also be used where bogs are convenient and no long hauls are necessary. The added organic matter will also increase the water-holding capacity of the soil. Nearly all of the soils are more or less acid, a condition which can be corrected by applications of ground limestone.

Crop rotations should be more carefully considered, with a view to securing combinations best suited to the various soils and increasing yields. The cultivation of intertilled crops could be improved by keeping a fine dust mulch on the surface during the growing season to conserve moisture and assist in carrying crops over dry periods, which are common, especially during late summer. Tests should be made to determine the value of commercial fertilizers in connection with the special crops which are grown in different parts of the county. This use of commercial fertilizers containing potash and phosphoric acid may be necessary in getting a good stand of clover on some of the sandy soils of the area.

There is a tendency in some parts of the county toward farming too large tracts. A number of farmers are working from 200 to 300 acres, where if only 80 to 100 acres were cultivated and care given every feature of the work the net returns would be greater.

The question of drainage should also receive attention. Thousands of acres of lowland in the county could be reclaimed at small cost and made to produce excellent crops. On many of the farms in the upland tile drains could be installed to advantage. Up to the present time comparatively little tile drainage work has been done in the county, but in view of the high land values the expense would be more than repaid by increased producing acreage and larger yields.

Cooperation among farmers in marketing their produce through a central agency would tend to secure larger and more uniform prices.

CHAPTER IX

CLIMATE*

"Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall." Any one of these factors may determine the type of farming which can be followed to best advantage.

"The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, and the Dundee Valley. As compared with other portions of this country, Wisconsin has a total rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, Northwestern New York, or the Puget Sound Basin of Washington. But owing to its northerly location, the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois, or Virginia."

The local distribution of rainfall varies, however, from year to year, some sections receiving more rain one year, and other sections more in other years. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire State during the driest year was 21.4 inches, and for the wettest year 37 inches.

"Of equal importance, in agriculture, to the total rainfall, is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70% from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is slight; December, January and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the state during winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches and during

* This chapter has been taken largely from Wisconsin Bulletin 223 on The Climate of Wisconsin and its Relation to Agriculture. This bulletin should be consulted if more information is desired concerning climate. All quotations indicated are taken from this bulletin.

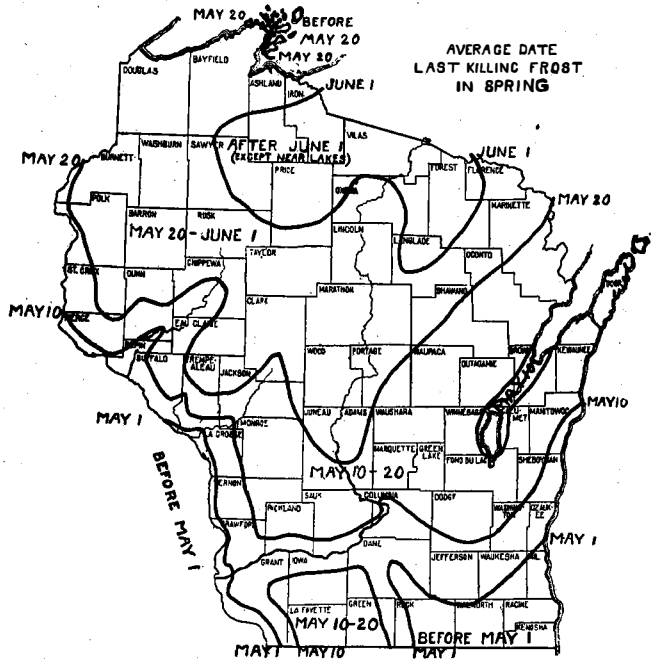

FIG. 2. LAST KILLING SPRING FROST.

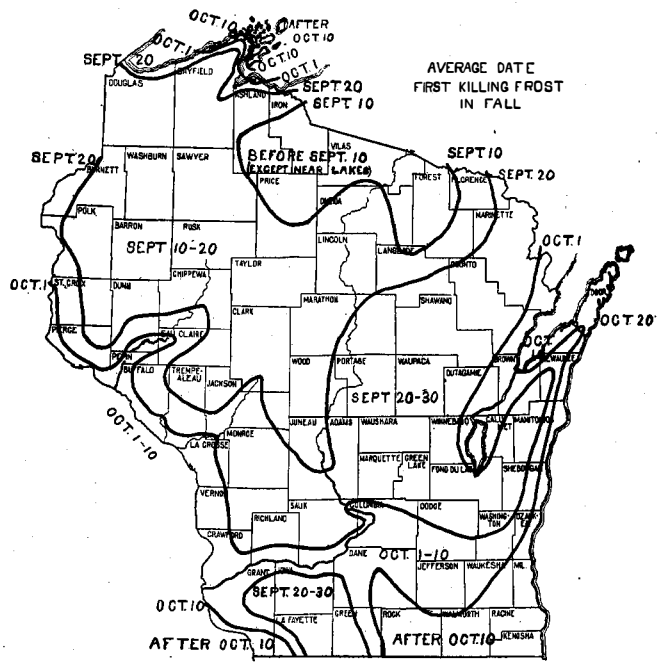

FIG. 3. FIRST KILLING FALL FROST.

These maps have been prepared from the original monthly reports of the observers of the U. S. Weather Bureau covering 12 years, supplemented by private records.

autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin receives during the growing season, April to September, inclusive, an average of 21 inches of precipitation, which is as much rain as that received during the same months by eastern Texas, Illinois, Ohio or eastern New York. The small winter precipitation in Wisconsin mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil, or erosion."

Another phase of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for one to four weeks and occasionally longer. Observations taken at Madison by the Weather Bureau over a period of 30 years from 1882 to 1911, inclusive, show that there are on the average three ten-day periods during each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil (Miami silt loam) actually suffer from the lack of moisture. In Columbia County the conditions are practically the same.

The following table, compiled from the records of the Weather Bureau station at Portage, shows the normal monthly, seasonal, and annual temperature and precipitation for a period of years:

Normal monthly, seasonal, and annual temperature and precipitation at Portage.

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year	Total amount for the wettest year
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*
December	21.2	53	—30	1.56	1.95	2.05
January	18.2	52	—28	1.15	2.04	1.23
February	17.4	53	—27	1.02	0.40	2.39
Winter	18.9			3.73	4.39	5.67
March	31.1	75	— 7	1.81	0.44	2.30
April	46.3	89	12	2.81	1.65	2.96
May	58.7	95	25	4.01	2.26	7.13
Spring	45.3			8.63	4.35	12.39
June	66.7	102	31	4.11	0.82	9.98
July	71.4	106	44	3.35	2.05	1.79
August	68.7	97	43	3.23	2.80	3.17
Summer	68.9			10.69	5.67	14.94
September	61.3	92	25	2.83	1.65	3.90
October	50.0	85	13	2.13	0.50	1.29
November	35.8	71	—19	1.54	1.50	2.86
Fall	49.0			6.50	3.65	7.05
Year	45.6	106	—30	29.55	18.06	40.23

It will be observed that the normal winter temperature is 18.9°; spring, 45.3°; summer, 68.9°; and fall, 49°. The mean annual temperature is 45.6°.

The average rainfall of 29.55 inches is well distributed throughout the year, the average for the summer months of June, July, and August being 10.69 inches.

Three of the eight climatic provinces of Wisconsin are represented in Columbia County. The western portion of the county is included in the Wisconsin River Valley; the southeastern part lies within the drainage basin of Rock River; while the northern and north central portion of the area drains into the Fox River, and thus forms a part of the Fox and Wolf River basin province. The average temperatures are hardly typical of any one of these three provinces, but rather represent an average of climatic conditions as they prevail throughout these various sections. The shortest growing season between killing frosts is in the extreme northwestern portion of the county, where the range appears to be from 130 to 140 days. In the southern and southeastern parts records indicate that the season ranges from 150 to 160 days between killing frosts. At Portage, where records have been kept by the U. S. Weather Bureau for a long period of years the average length of growing season is 150 days. The average date of the last killing frost in the spring being May 3, and that of the first killing frost in the fall being October 4. Figures No. 2 and 3 indicate the average dates of the first killing frost in the fall and the last in the spring in all parts of the State. From the date given on the two maps the average approximate length of growing season for any point may be readily determined.

In general it may be said that the conditions prevailing throughout Columbia County are representative of a considerable area in south-central Wisconsin. The climate is healthful, though subject to marked changes in temperature. The winters are long and severe, the temperature sometimes falling as low as 30° F. The snow usually remains on the ground from December to March, and this affords protection to such crops as alfalfa, clover and wheat. The summers are pleasant and all growth is rapid. The mercury sometimes reaches 100°, but extremes of both heat and cold are rare and of short duration. The hottest periods during the summer months seldom continue for more than a few days, and it is unusual for the temperature to remain below zero for more than a few days at a time during the winter. The water supply is abundant and of very good quality.

SUMMARY

Columbia County is located in south-central Wisconsin and comprises an area of approximately 799 square miles, or 511,360 acres.

The surface features vary from broad, undulating prairies to steep rolling lands, the roughest section being found in Caledonia Township and in the extreme southwestern corner of the county. There are but few places where modern farm machinery can not be readily used. The greater part of the surface is undulating to gently rolling. Low, marshy tracts are numerous throughout the county, especially in the valleys of the Wisconsin and Fox Rivers. These streams, with the headwaters of the Rock River, receive the drainage waters of the entire survey.

The county was visited by white men as early as 1673, though the first settlement was not made until 1836. It was organized in 1846, with Portage as the county seat. The county had a population of 31,129 in 1910.

Columbia County is well supplied with railroads, which provide excellent transportation facilities. It is but 93 miles from Portage to Milwaukee and 178 miles to Chicago. These cities provide excellent markets for farm produce.

Ten soil series, including 29 soil types, were recognized and mapped in the area. Of these the most important are the Miami soils represented by a silt loam, loam, fine sandy loam, and fine sand. The series includes the light-colored, timbered glacial soils carrying considerable limestone material. The silt loam and fine sandy loam members are extensively developed and are important agricultural soils.

The Carrington series is represented by three types, the silt loam, loam, and fine sandy loam. The silt loam is the most extensively developed and constitutes some of the best agricultural land in the State.

The Coloma series includes the light-colored upland timbered areas where the soils have been derived largely from glaciated sandstone material. The types mapped in this county are the Coloma fine sandy loam and fine sand.

The Plainfield series represents light-colored soils of alluvial origin, occupying level terraces or outwash plains, where the parent material is largely of sandstone origin. The types mapped are Plainfield fine sandy loam, sandy loam, sand and fine sand. These soils are all easy to work, but require careful management.

The Fox series is similar to the Plainfield but differs from it in having been derived largely from glacial material containing limestone. The types mapped are the Fox silt loam, fine sandy loam, and fine sand. All of these types are of limited extent.

The Genesee series represents light-colored soils occupying first bottom lands which are subject to overflow. The Genesee sand and fine sand were mapped. These are both of limited extent and low agricultural value.

The Knox series includes light-colored soils supposed to be largely of loessial origin. The silt loam is the only type mapped in this area and it is of very limited extent.

The Boone series includes light-colored soils derived from the weathering of sandstone. Only one type—Boone sand—was mapped. It is of very limited extent and low in value.

The Clyde series includes dark-colored poorly drained soils in old lake and pond beds and along stream channels, where there are varying amounts of lime carbonate present, especially in the subsoil. The types mapped are Clyde silt loam, loam, fine sandy loam, and fine sand. When drained these lands will make porductive soils.

The Dunning series is similar to the Clyde but differs by containing little or no lime carbonate. Soil and subsoil are usually acid. In their undrained condition the soils of this series have a low value. Two types, the Dunning loam and fine sandy loam, were mapped.

Peat includes decaying vegetable matter in varying stages of decomposition, with which there is only a small amount of mineral matter present.

Muck is similar to Peat, but differs by containing a much larger percentage of mineral matter. It is usually more thoroughly decomposed than Peat. Both Peat and Muck are undrained and but little attempt has been made to utilize this kind of land.

Rough stony land is of little use, except for pasture. It includes rough rocky land which cannot be cultivated.

General farming in conjunction with dairying is the prevailing type of agriculture, although a number of special crops are grown. Wheat growing was at one time the leading industry of the county, but its production has declined and at present corn, oats, and hay are the most important crops. Of the special crops potatoes, tobacco, beans, peas, and sugar beets are the most important. The industrial development of the county has been such as to encourage the production of truck crops and fruits.

Stock feeding and the improvement of dairy and beef stock is receiving more attention throughout the county.

The adaptation of certain of the soil types to particular crops and the question of crop rotations. while quite generally recognized, should be more carefully studied. Potatoes are best adapted to the lighter soils. The sugar content in beets grown on the Miami silt loam is higher than of those grown on the Carrington or Clyde soils. The grain produced on the deep phase of the Miami silt loam is also of better quality than that grown on the black soils. Various other types are recognized as well suited to certain special and general farm crops. The farm improvements are more substantial on the heavier types than on the sandy soils. As a whole the farming communities are in a prosperous condition. The average size of farms is 141 acres, and more than 75 per cent of the farms are operated by the owners.

Agriculture in the county could be improved through the extension of the dairy industry, the growing of more alfalfa, the increase of the organic-matter content of the soil, the use of lime to correct soil acidity, more thorough cultivation, a more careful selection of seed and a better system of crop rotations.

The climate is healthful, and while there is a range of 130° in temperature throughout the year, the extremes are infrequent and of short duration. The mean annual temperature is 45.6° and the average annual rainfall 29.55 inches.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time, dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.