Soil survey of Waushara County, Wisconsin. Bulletin No. XXVIII, Soil Series No. 2 1913

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
E. A. BIRGE, Director. W. O. HOTCHKISS, State Geologist
A. R. WHITSON, In Charge, Division of Soils.
SOIL SURVEY IN COOPERATION WITH COLLEGE OF AGRICULTURE
H. L. RUSSELL, DEAN

BULLETIN NO. XXVIII SOIL SERIES NO. 2

SOIL SURVEY

OF

WAUSHARA COUNTY

WISCONSIN

BY
A. R. WHITSON, W. J. GEIB, GUY CONREY AND A. K. KUHLMAN
OF THE
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY,
AND
J. W. NELSON
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, WIS.
PUBLISHED BY THE STATE
1913

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INTRODUCTION.

Before the highest efficiency in agriculture can be attained it is essential that the farmer should have a thorough knowledge of the soil. The degree of success which it is possible to gain on any farm is in direct proportion to the practical knowledge of the soil possessed by the farmer.

The state, working in co-operation with the United States Department of Agriculture, is making a careful study of the soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and reports of all counties in the state. A soil map shows the location and extent of the different kinds or types of soil. All tracts of ten acres and over are mapped and often areas of smaller extent are indicated. Such a map is prepared by trained men who go over a county thoroughly and examine the soil by taking sufficient borings to a depth of 36 inches to keep account of all variations. The report is based upon a careful study of the soils and 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 the farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management. These recommendations for improvement of the soil types are based upon the soil survey work within the area and upon the results of field tests made by the Experiment Station.

SOIL CLASSIFICATION

Soil fertility depends in part upon the physical characteristics of the soil, such as water holding capacity, workability, etc. It also depends upon the chemical composition, which is determined largely by the source of material composing the soil and its mode of origin.

The water holding capacity and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of individual soil particles. A coarse sandy soil for example will not retain moisture as long as a loam or clay loam, because the finer the soil grains, the greater will be the total surface area to which moisture may adhere and the stronger the capillary movement. The texture of a soil is determined by making a *mechanical analysis,* which is 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 must also be made to determine the amount of elements essential to plant growth which are present in the soil.

In classifying and mapping soils the soil type is the unit. A *soil type* 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. It is also uniform in the source of material from which derived and the mode of origin which, taken together, determine the chemical composition.

Soil types are grouped according to texture into soil classes, a *soil class* being made up of types having the same texture, though differing in other respects. Thus we have different kinds of clays, clay loams, loams, sandy loams, sands, etc. As shown by the following table, the percentage relationship of the amounts of different sized grains determines the class to which any soil belongs:

CLASSIFICATION OF SOIL MATERIAL

Soils Containing less than 20% Silt and Clay

Soil Classes

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 Together

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 30% silt.
Clay—Over 30% clay.

Soil types may also be grouped in another way. Where soils are closely related through source of material, mode of origin, topographic position, etc., so that the different types constitute merely a gradation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series for example includes light colored glacial material where the soils have been derived largely from the underlying limestone, and the types in this 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 outwash plains or river terraces. The types in this series have a wide range in texture. The name used for a series usually indicates the locality where that particular series was first recognized and mapped.

By uniting the name of the *soil class* with the name of the *soil series* we get the *soil type.* Therefore when a soil is found to be in the silt loam class, and belongs to the Miami series this constitutes the soil type known as Miami silt loam. 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 types on his farm and their leading characteristics.

SOIL SURVEY OF WAUSHARA COUNTY, WISCONSIN.

CHAPTER I.

GENERAL DESCRIPTION OF AREA.

Waushara County is located a little to the south of the central part of Wisconsin and covers an area of 643 square miles, or 411,520 acres.

The area may be divided into three natural divisions. The western division embraces nearly all of Plainfield, most of Hancock, and the northwestern two-fifths of Coloma townships. This division lies entirely within the Wisconsin River Valley and has a level to very gently undulating topography. It consists mainly of open country, with many narrow belts of Muck soils entering the western boundary and extending from one-half mile to several miles into the county. These belts of Muck usually follow the courses of streams which flow in a westerly direction and drain this part of the county. Very few bowlders occur in this division and the only sandstone outcrop covers a few square rods in section 31 of Hancock Township.

The central division embraces a series of glacial hills crossing the area from north to south and from the Wisconsin River Valley eastward nearly to Bloomfield, Poy Sippi, and Warren townships. It is made up of numerous hills, pothole depressions, and narrow, irregular ridges and valleys. The hills vary in height from 30 to 100 feet or more above the Wisconsin River Valley. This rough rolling topography is most pronounced in the northern part and breaks up into more gentle slopes and more open valleys southward and eastward. The largest of

these valleys, lying almost entirely within Oasis Township, was doubtless at one time a lake with its outlet to the southwest. Several small terraces, their slopes southward, cross the valley from east to west. This valley is nearly all under cultivation. It is locally known as the "Great Prairie".

The smaller valleys of this division opening to the south and east were old drainage channels for the swollen streams of water issuing from the melting glaciers. The streams flowing through these valleys now drain this division. Many beautiful small lakes are scattered through this belt, and areas of Muck are found along most of the streams. Many of the pothole depressions are 100 feet or more in depth, have quite steep slopes, and are usually dry. Most of this division is under cultivation, though considerable areas are still covered with scrubby oak. The soil for the most part is very sandy and numerous granitic glacial bowlders are scattered over its surface.

The eastern division embraces the Lake Poygan and Pine Creek valleys, which are included in Warren and the three eastern townships. The topography of this division is level to gently rolling, and most of the land is under cultivation and highly improved. The drainage is eastward into Lake Poygan.

Fox River, which cuts off the southeastern corner of the county, is the largest stream in the county. It flows in a northeast direction and no streams enter it within the limits of the county. Pine Creek, which drains the northeastern third of the area into Lake Poygan, is the second largest stream. It affords fair water power at different points along its course. Willow Creek, the third stream in importance, drains the central and southeastern parts of the area. Its outlet is in Lake Poygan near that of Pine Creek.

White River and smaller streams tributary to the Fox drain the southern part of the area. Most of these streams have sufficient fall to furnish good water power for manufacturing. The lakes in the morainic belt vary in size from one-half acre to more than a section. Prominent among these are Silver, Pine, and Fish lakes.

Two railroads cross the county from north to south—the Chicago and Northwestern at about the center, with a branch extending to Redgranite, and the Minneapolis, St. Paul, and Sault

Ste. Marie (Wisconsin Central Railway) through the western part of the county. Wautoma, Wild Rose, Glenrock, Springlake, and Lohrville are situated upon the former line, and Coloma, Hancock, and Plainfield upon the latter. These two systems offer good transportation facilities, though the sandy nature of the roads and the many hills make hauling of farm products heavy work. The important markets—Chicago, Milwaukee, Madison, Oshkosh, and Fond du Lac (the first named only 200 miles distant and the others near by)—afford advantageous outlets for the products of the county. Many other small towns are found throughout the county. Good schools are found in every township, and rural free delivery of mail and telephone service extend to all parts of the county.

The area is settled by a mixed population of Germans, Welsh, English, Danes, Norwegians, Poles, and Swedes, most of whom came from the adjoining counties to the south and east; a few, from the Eastern States and from Europe. Nearly all were homeseekers who began to till the land as soon as they settled upon it. The Germans are now the predominant nationality.

SOILS

Waushara County lies almost entirely within the glaciated region, and its soils are the product mainly of ice and water action upon the Potsdam sandstone formation, which underlies the surface soils of most of the county. Several outcrops of granite occur in Marion and Warren townships. This granite underlies the sandstone and sometimes projects through it. The only exposure of the Potsdam sandstone is a very small outcrop in section 31 of Hancock Township.

The soils of the uplands consist of a heterogeneous mass of glacial material in which porphyries and granites are prominent, but which has been derived chiefly from the sandstone formation. Over the hilly and rolling division of the county the soils, which have not been reworked by streams, are members of the Coloma series.

The soils of the Wisconsin River Valley and of the valleys to the east and south were carried down from the uplands and deposited near the close of the ice age when the waters were high

and moving rapidly. These soils have been acted upon by water to a great extent, have been laid down in comparatively uniform layers as river terraces or overwash plains, and are classified as belonging to the Plainfield series.

The heavy soils of the eastern fourth of the county are lacustrine in origin, having been deposited in a lake made by ponded waters against the glacier front. These soils were carried by the water issuing from the glacial deposits and laid down in quiet water. They have been classified as Poygan and Superior soils.

Fourteen types of soil are mapped in the county. The name of each type and its actual and relative extent are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Coloma sand	156,928	38.1	Waukesha sand	5,504	1.3
Muck	68,480	16.6	Superior loam	3,328	.8
Plainfield sand	58,048	14.1	Coloma stony sand	3,008	.7
Coloma sandy loam	50,944	12.4	Coloma gravelly sand	2,880	.7
Poygan clay loam	23,232	5 6	Coloma loam	2,880	.7
Waukesha sandy loam	17,600	4.3	Superior clay loam	1,152	.3
Poygan clay	9,600	2.5			
Superior sandy loam	7,936	1 9	Total	411,520	

CHAPTER II

GROUP OF SANDY SOILS.*

Coloma Sand

Description. The surface soil of the Coloma sand to an average depth of 8 inches consists of a light brown, loose sand of medium texture. The surface soil contains only a small amount of organic matter, and the water-holding capacity is low. A small amount of gravel may be found scattered over the surface and mixed with the soil in places, but this is never in sufficient amounts to change the value of the type.

The subsoil consists of a brownish-yellow, or yellow loose sand of medium texture which extends to a depth of more than 48 inches. The subsoil frequently becomes coarser below and a small amount of gravel may occur at any depth. Some gravel beds are found within this soil type, frequently within 3 feet of the surface. Rock outcrops occur in a few places, especially along the Red Granite Branch of the Northwestern Railroad. These outcrops occupy from 30 to 60 acres and are extensively quarried.

Coloma sand as found in Waushara County is somewhat variable, and two phases, one heavier and the other lighter than the typical soil, were recognized but not separated on the soil map. The heavy phase is slightly loamy in the surface, and the subsoil is a little heavier than typical. At 30 to 36 inches a sticky sandy loam is frequently found. This phase occurs chiefly in Wautoma and Deerfield Townships and ranks next to the light Coloma sandy loam in producing power. Glacial bowlders are found scattered over the surface of this portion of the type.

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*For methods of improvement and the management of sandy soils see page 25.

The light phase has a lower agricultural value than the typical soil. It contains only a very small amount of organic matter in the first few inches, and throughout its depth it is loose and incoherent. The surface material is influenced to a greater extent by wind action than the remainder of the type. The light phase is extensively found in Richford, Dakota, Springwater, Saxeville, and Leon Townships, and small patches occur through the region of glacial hills.

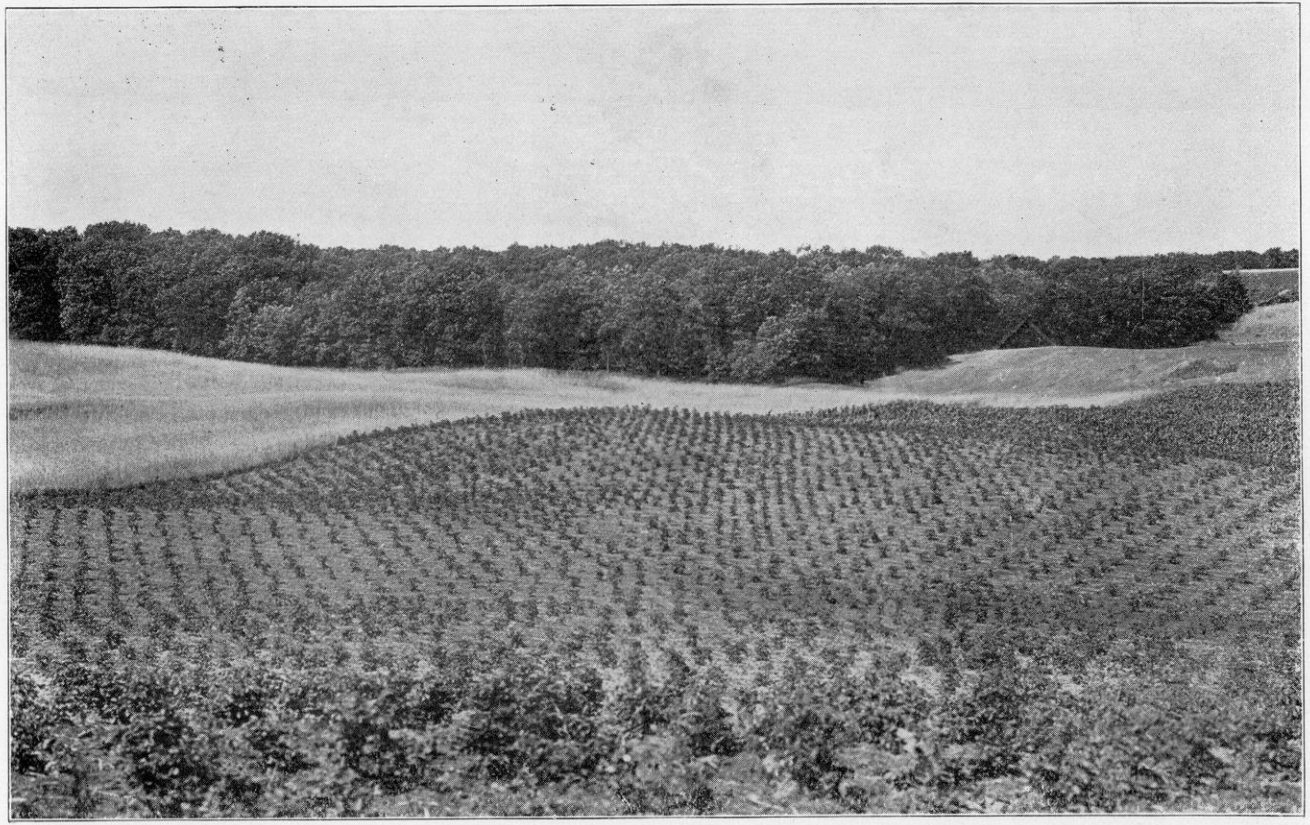
Extent and distribution. Coloma sand is the most extensive type in the county and occupies 38.1% of the area. It is the predominating soil throughout the central portion of the county and extends from the Soo Line on the west to a line drawn through Lohrville, Red Granite, Poy Sippi, and the north-central part of Saxeville Township on the east.

Topography and drainage. The surface of the type as a whole varies from gently rolling to rolling. The light phase occupies gentle slopes to rolling ridges and sometimes rounded hills, while the heavy phase, is on the whole, more rolling. On account of the coarse texture, loose, open structure, and the topography, the natural drainage is often excessive, and crops frequently suffer from drought. The lower the sticky sandy loam subsoil stratum under the heavy phase, the more droughty is this portion of the type.

Origin. Coloma sand consists of glacial material derived chiefly from Potsdam sandstone, which is the underlying formation throughout the greater part of the area. The sand grains consist mainly of rounded quartz particles. The type is deficient in humus and shows acidity when tested with litmus paper.

Native vegetation. The native vegetation consists of oak trees and hazelnut bushes. On the heavy phase the oak is thrifty and tall, but on the light phase it is scrubby and spreading.

Agricultural development. A large percentage of the type is under cultivation. It is easily tilled, and in years of normal rainfall, moderate to good yields are obtained, except on the light phase, which is still largely in a wild state. Some fields of this character have been abandoned, after many attempts to produce satisfactory crops upon them.



VIEW OF COLOMA SAND SOUTHEAST OF HANCOCK, SHOWING CHARACTERISTIC TOPOGRAPHY.
Potatoes and rye are the two crops most extensively grown.

Dairying is followed to a limited extent and does fairly well where there are included in the farm areas of Muck that can be used for hay and pasture. In general farming, potatoes, corn, rye, and hay make up the rotation followed. But little success has been attained in the production of hay, except where especially good methods of soil management have been followed. Potatoes yield from 75 to 125 bushels per acre, and in exceptionally favorable years as high as 250 bushels have been obtained on fields of the heavy phase. Corn yields 20 to 35 bushels, rye about 10 bushels, and hay about ½ to 1 ton per acre. Potatoes grown on Coloma sand are of medium size, smooth and mealy. They are generally superior to those grown on the heavier soils or on soils very rich in humus. Sweet corn, beans, and garden peas are crops well suited to this type. From 6 to 10 car loads of beans, mainly grown on Coloma sand, are shipped from Wautoma each year.

The following table gives the average results of mechanical analyses of typical samples of the soil and subsoil of a Coloma sand:

Mechanical analyses of Coloma 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.....	0.4	12.7	18.1	43.2	4.5	6.2	4.9
Subsoil.....	1.1	13.1	29.7	43.3	4.0	4.9	3.8

COLOMA SANDY LOAM

Description. The surface soil of Coloma sandy loam to an average depth of 8 inches consists of a brown, medium sandy loam, which contains only a moderate amount of organic matter and is usually rather loose and open in structure. The subsoil consists of a yellowish-brown, sticky, sandy loam containing enough stones to make boring difficult. Below 26 inches it is quite common to encounter a mixture of sand and gravel which extends to a depth of 3 to 4 feet. In a few places the subsoil is

a gravelly sand to 36 inches where a sticky sandy clay is reached.

There are a number of variations in the type, though none are of sufficient extent to be separately indicated on the map. In a few localities the surface soil becomes heavier than typical and is a heavy sandy loam. Where the morainic topography is prominently developed the surface is strewn with granitic bowlders, and the soil contains enough stones to interfere somewhat with tillage. Over a few very small areas, very large granitic bowlders were found. Where of sufficient importance such stony tracts were indicated by smybols. On the margin of some of the more rolling areas, and on the brows of some of the knolls, small areas of gravelly sand occur with a thin layer of heavy material near the surface.

Extent and distribution. The Coloma sandy loam is closely associated with the Coloma sand, though it is of much smaller extent, occupying only 12.4 per cent of the county. The largest areas occur in Marion, Springwater, Rose, Deerfield, and Hancock Townships. Other smaller areas are scattered throughout the Coloma sand type. In Marion and Mount Morris townships the surface soil is somewhat lighter, and crop yields are not quite equal to those on the typical soil. As the depth to the heavier subsoil increases, the producing power of the type is decreased.

Topography and drainage. In topography the area of Coloma sandy loam is gently rolling to hilly, with steep slopes and numerous pothole depressions, some of which are 100 feet or more in depth. The type frequently occupies ridges and hilltops, with irregular, narrow intervening valleys of Coloma sand. The potholes were originally small lakes, but with rare exceptions they are now dry. The soil in these depressions is somewhat heavier and contains more humus than that of the type proper, but these bottoms seldom occupy more than a few square rods. They are, however, tilled regularly with the less broken surrounding areas and are frequently used for gardens because of the greater amount of moisture in the soil.

The rolling nature of this type gives it very good, though not excessive drainage. The water table lies at considerable depth

below the surface; but during seasons when the rainfall is well distributed, the type suffers but little from drought.

Origin. The soil is of glacial origin and is composed of a heterogeneous mass of sand, silt, gravel, and clay, with many bowlders, brought from the north and mixed with material derived from the local disintegration of Potsdam sandstone. The sand content of the type consists of rounded particles of quartz and some other rocks. The soil shows a moderate degree of acidity.

Native vegetation. The native vegetation of this type is oak with a heavy underegrowth of hazelnut bushes. From Wautoma eastward scattered hickory is found. The oak is much more thrifty, with longer and more slender trunks, than that found on Coloma sand.

Agricultural development. Where not too stony the soil is easily tilled, and nearly all of it is under cultivation. Potatoes, corn, oats, rye, and hay are the main crops. Potatoes yield from 80 to 150 bushels per acre and under very favorable conditions 300 bushels per acre have been obtained. Corn yields 25 to 40 bushels, oats 30 to 40 bushels, rye 12 to 15 bushels, and hay an average of about 1½ tons per acre. Dairying and potatoes are the two leading specialties on this type. Corn or potatoes, oats or rye, clover, and timothy is the rotation usually practiced. The soil shows a moderate degree of acidity and on account of this some difficulty has been encountered in growing red clover. Fall plowing for rye and spring plowing for all other crops is the usual practice.

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

Mechanical analyses of Coloma Sandy 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	0.6	12.8	20.0	33.0	10.6	17.3	5.9
Subsoil	.6	9.8	18.5	40.2	7.2	10.4	12.8

COLOMA GRAVELLY SAND

Description. The surface soil of this type consists of a loose, coarse to medium, gravelly sand of practically the same texture from the surface to a depth of over three feet. The surface 2 to 3 inches contains a little light brown organic matter, otherwise the surface and subsoil are alike. Gravel occurs upon the surface in most places, though few bowlders are found, the rock fragments varying in size from that of a pea to that of a hen's egg. The gravel and sand deposits extend to a depth of many feet. Frequently strata of medium sand, free from gravel, occur through the material at varying depths, showing the action of water in its deposition.

Extent and distribution. This type is of very limited extent, occupying only 2880 acres. The largest area is found 3½ miles north of Red Granite in the vicinity of Pearl Lake. A small patch occurs 1½ miles northwest of Wild Rose, and another is found 3 miles north of White River Mill Pond.

Topography and drainage. The type has an uneven topography and occurs on narrow ridges and rounded knolls along valleys and old stream courses. On account of the topography, the loose, open structure, and the coarse texture, the natural drainage is excessive, and this type is droughty.

Origin. The Coloma gravelly sand is of glacial origin and was deposited during the melting of the ice sheet. The sand grains consist chiefly of rounded quartz, from the Potsdam sandstone.

Native vegetation. The original timber growth consisted chiefly of scrub oak trees and hazel bushes. Much of the type is still in timber, but this has little value.

Agricultural development. Because of its droughty condition and low fertility only a small part of the Coloma gravelly sand is cultivated. Rye is grown more extensively than any other crop, but the yields are very low and unsatisfactory.

The results of mechanical analysis of a fine-earth sample of the soil are given in the following table:

Mechanical analysis of Coloma gravelly 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.....	10.9	47.3	20.5	12.4	5.0	2.4	1.5

COLOMA STONY SAND.

Description. The surface soil of this type to an average depth of 8 inches consists of a brown, medium textured sand, underlain by a light-yellowish sand of the same texture and extending to a depth of 36 inches and over. Both the surface and subsoil contain varying quantities of gravel and stones, which interfere to some extent with cultivation. The surface contains only a very small amount of organic matter, and the type has a low agricultural value.

Extent and distribution. The type comprises an area of about 3,000 acres. It occupies a strip from ¼ to 1 mile in width extending across Rose Township from northeast to southeast.

Topography and drainage. The type occupies a roughly rolling position and is morainic in character. Many deep pothole depressions lie between the high ridges and the type as a whole is the roughest in the county. On account of the loose, open structure, coarse texture, and uneven topography, the natural drainage is excessive and the type is droughty.

Origin. The Coloma stony sand is of glacial origin and represents an extension of the rough morainic belt found in Portage County. The material forming the soil came from the grinding of the local sandstone by the ice and the mixing of the fine particles with other rock debris brought from the north.

Native vegetation. The original timber growth consisted of scrub oak with considerable hazel brush. Most of the type is still in timber, but this has little value.

Agricultural development. Where the soil of this type is cultivated, crop yields are low, but compare favorably with those from the Coloma sand. The type has been neglected because of the presence of more easily tilled soils in the same re-

gion. It produces some grass and is used more for pasture than for anything else.

PLAINFIELD SAND.

Description. The surface soil of Plainfield sand to a depth of from 8 to 10 inches consists of a brownish, loose sand of medium texture. The amount of organic matter present in the surface soil is very low. The subsoil to a depth exceeding 36 inches consists of a loose, yellow, porous sand of medium texture. Where the type occurs in the Wisconsin River Valley there is frequently considerable gravel in the subsoil which makes boring difficult in places. In the eastern part of the area little gravel is found in the subsoil.

Extent and distribution. Plainfield sand is the third type in extent of occurrence in the county, occupying 14.1 per cent of the area or about 58,048 acres. The major portion of this soil lies in the western part of the county, immediately west of a line drawn through Plainfield and Hancock. Other areas of considerable size are found in Springwater, Bloomfield, and Mount Morris Townships. Smaller patches occur throughout the easteren part of the county.

Topography and drainage. The type has a level to gently undulating surface in the Wisconsin River valley and is level where found in the valleys of the eastern part of the county. On account of the loose, open character of the soil of this type and its texture, the natural drainage is excessive, and the type is droughty, except where the water table comes nearer the surface than typical, or during years when the rainfall is heavier than usual.

Origin. Soil of this type in the western part of the county occurs in the old Wisconsin River valley and was worked over and deposited at a time when the waters of that stream were flowing at a much higher level than at present. In the eastern part of the county the type probably represents overwash plains, and the material was deposited by streams issuing from beneath the ice sheet. The predominant material is quartz grains from the Potsdam sandstone, though material representing granitic rocks is also present, especially in the subsoil.

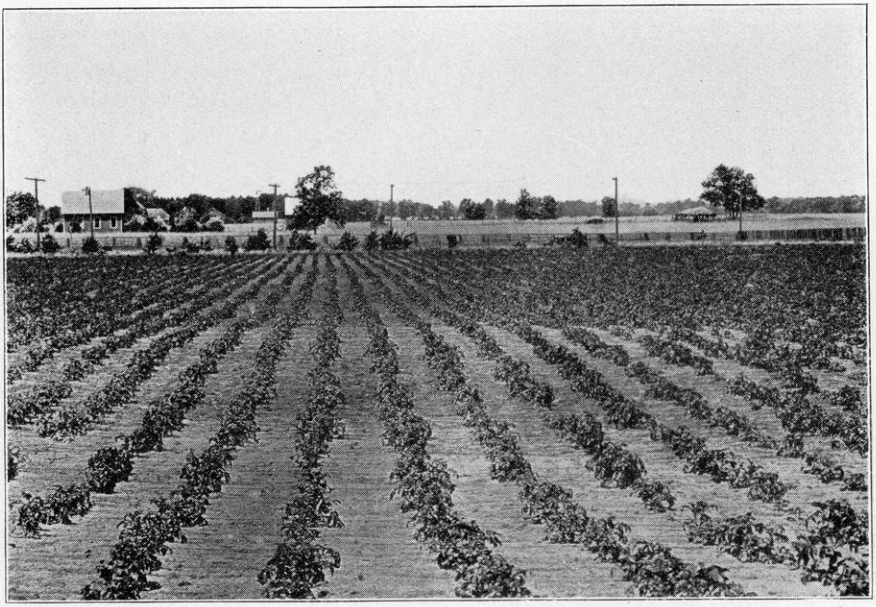


FIG. 1. VIEW OF PLAINFIELD SAND IN WESTERN WAUSHARA COUNTY, SHOWING CHARACTERISTIC TOPOGRAPHY.

Potatoes are the leading cash crop on this soil.

FIG. 2. VIEW OF PLAINFIELD SAND, SHOWING CHARACTERISTIC TOPOGRAPHY AND FARM BUILDINGS.

Rye is an important crop on this soil.

Litmus tests and the presence of sorrel indicate that the soil is in an acid condition.

Native vegetation. The original timber growth consisted of a scrubby stand of oak on the higher portions; and poplar, birch, and willow, with a few elms, on the lower levels.

Agricultural development. The major portion of the type is under cultivation, and where properly managed fair returns are secured, except during years when the rainfall is not well distributed and long dry spells do considerable damage to growing crops. The chief crops grown and the yields obtained are potatoes from 75 to 125 bushels, corn from 20 to 35 bushels, and hay from ½ to 1 ton per acre. Potatoes are more extensively grown than any other crop and form the cash crop upon which most dependence is placed. The rotation most often followed consists of potatoes or corn, rye, oats, or buckwheat followed by hay. It is difficult to get a stand of clover, and the hay crop is always limited. Dairying is carried on to a limited extent. The type is well suited to truck crops, of which the yield and quality are practically the same as for Coloma sand.

The following table gives average results of mechanical analyses of samples of the soil and subsoil of the Plainfield sand:

Mechanical analysis of Plainfield 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.....	0.4	11.7	19.6	42.3	12.4	8.4	5.4
Subsoil.....	.7	10.4	21.5	46.0	14.9	3.3	2.9

WAUKESHA SAND

Description. Waukesha sand to a depth of 8 to 10 inches consists of a dark brown to black medium sand containing a small amount of silt and clay and a medium amount of organic matter. Beneath this is found a loose, yellowish-brown sand of medium texture, becoming lighter in color and texture with depth to 36 inches. Below 3 feet the material is a yellowish

gravelly sand. Varying quantities of fine to medium gravel are found at different depths in the subsoil.

Extent and distribution. The type lies west of the morainic belt and is confined to the northwestern portion of Coloma and the southwestern portion of Hancock Townships. It covers an area of about 5,500 acres.

Topography and drainage. The surface of the type is level to gently undulating. Owing to the loose, open characater of the subsoil the water-holding capacity is not high and during seasons when the rainfall is not well distributed the soil suffers from drought.

Native vegetation. The region covered by the Waukesha sand is commonly spoken of a prairie, though over a portion of it there was originally a scrubby growth of oak.

Origin. The type lies within what is frequently spoken of as the Old Wisconsin River Valley and the material composing the soil has been more or less influenced by the action of water. The parent material is largely Potsdam sandstone. The dark color is due to the accumulation of organic matter, the growth of which was favored by moist conditions which prevailed at an earlier time. The soil shows considerable acidity to the litmus test and the type supports quite a growth of sorrel.

Agricultural development. The crops grown upon this type in order of their importance are potatoes, corn, oats, rye, and hay. Potatoes yield from 60 to 125 bushels per acre, corn from 15 to 35 bushels, oats from 15 to 30 bushels, rye from 8 to 10 bushels and hay from one-half to 1 ton per acre. This soil is not suited to hay but early truck crops thrive. The greater proportion of the type is under cultivation. The Waukesha sand has a lower value than the Waukesha sandy loam, but it is a better soil than the Plainfield sand.

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

Mechanical analyses of Waukesha 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..... ...	0.7	31.7	29.5	21.9	3.4	5.6	6.9
Subsoil.....	1.0	23.3	29.3	28.5	3.0	7.9	7.1

CHAPTER III

METHODS OF IMPROVEMENT FOR SANDY SOILS*

There are a number of soils in Waushara County which are so closely related in texture and structure that from the standpoint of improvement and management they may be considered in groups rather than as individual types. All of the sandy types and one sandy loam soil may be grouped together, and this group will include Coloma sand, Coloma stony sand, Coloma gravelly sand, Coloma sandy loam, Plainfield sand, and Waukesha sand.

In chemical composition these markedly sandy soils show less of practically all the important elements than do upland silt loam or clay loam soils. The total phosphorus in the surface 8 inches of this group of sandy soils averages about 800 pounds per acre, while in the silt loam and clay loam soils of the southern part of the state there are approximately 1,050 pounds of this element. The total amount of potassium in the surface 8 inches of the sand soils of Waushara County is, in round numbers, approximately 21,000 pounds per acre, while that in the heavier soils is approximately 45,000. The total amount of organic matter in sandy soils is about one half of that in the light colored silt and clay loam soils of the southern part of the state, and less than one third of that in the upland prairie soils of the southeastern and southwestern parts of the state.

Since Potsdam sandstone is the source of essentially all of these soils, they are very low in lime carbonate, having less than one half of the amount contained in the surface soils of the limestone section of the state; and the subsoils of this group have less than one-tenth of the amount usually found in the subsoils of the southeastern part of the state. It is evident, therefore, that these soils have less of all the essential elements required by plants than is contained in heavier and more fertile soils.

* See Bulletin No. 204, University of Wis., Agr. Exp. Sta., on "Improvement of Sandy Soils".

They have, of course, certain advantages for special crops, and it is possible to profitably supplement their natural supply of plant food material by the use of fertilizers. But all systems of farming on such land should be planned in such a way as either to conserve their natural fertility, or replace it by the use of commercial fertilizers.

The most important differences between these sandy types of soils and heavier classes, such as silt loams and clay loams, however, are not of a chemical nature, but of a physical nature, having to do with their water holding capacity, drainage, tillage, etc.

Suggestions for the improvement of these types are based upon field experiments, chemical and mechanical analyses, and upon studies and observations covering a variety of sandy soils.

In the management of these sandy soils it should be kept in mind that they are naturally low in organic matter and in the mineral elements required, the water holding capacity is poor and the soil is acid. As all of the types in this group, and a large proportion of the soils in the state are in an acid condition and would be greatly benefited by the application of lime, every farmer should know how to test his soil for acidity.* "A very simple and reliable method to detect soil acidity is by the use of blue litmus paper which can be secured of any good druggist. Take a handful of moist soil and form it into a ball. Break the ball into halves and place a piece of blue litmus paper in the center of one of the halves, and cover it with the other half. After 5 minutes break the ball, and if the paper is pink in spots or over the whole end, the soil is acid." "Soil acidity is also usually indicated by the growth of certain weeds, such as sheep sorrel, horse-tail rush, corn spurry and wood horse-tail."

When the amount of organic matter or humus forming material in the soil is increased, the water holding capacity is also increased. The humus forming material can best be increased by applying stable manure and by plowing under legumes as green manure. Of the legumes red and mammoth clover are perhaps better adapted to sandy soils than any of the others, but neither of these nor alfalfa will make the most satisfactory growth until the acid condition is corrected. The mineral elements required may be supplied by the use of commercial fertilizers.

* See Bulletin No. 230, Wis. Agr. Exp. Sta. on Soil Acidity and Liming.

When a soil can be made to produce a fair crop of clover, without an excessive expenditure, that soil can be successfully and profitably improved. It is therefore important that the first efforts in building up a soil should be directed toward the establishing of conditions which will be favorable for the growth of clover.

From experiments conducted it seems advisable to sow clover without a nurse crop, where the fertility of the soil is very low, since it will then have all of the moisture in the soil for its own growth. There is also some dangers of the young plants being damaged by the hot sun when the nurse crop is removed. The field intended for clover should be plowed in the fall, or as early as possible in the spring, and a top dressing of ground limestone applied at the rate of 2,000 pounds per acre. The field should be harrowed at short intervals to kill all weeds, and this harrowing should be kept up until about the middle of May. Fifteen pounds of seed per acre should be sown and covered to a depth of 1½ to 2 inches. The seeding should be followed by a roller to compact the soil around the seed, and the roller should be followed by a light harrow to roughen and loosen the immediate surface to check evaporation and blowing of sand by the wind. Where it can be secured a top dressing of well rotted manure should be applied before the last harrowing. If manure is not available about 300 pounds of acid phosphate or ground steamed bone-meal and 100 pounds of muriate of potash should be applied at the time of seeding to clover. If only a small amount of manure is available it may be supplemented by ground rock phosphate, and this can be sprinkled over the manure in the spreader and applied at the same time.

Peat may often be used to advantage as a fertilizer if peat marshes are close at hand. It contains a high percentage of nitrogen, but should be supplemented by potash and phosphate fertilizers, as it is deficient in these elements.

Late in summer it may be necessary to clip the weeds which are sure to come. The cutting bar should be run high and the clipping left on the field as a mulch. The second year the first crop should be cut for hay and the second crop plowed under as green manure to prepare the land for a cultivated crop. After the first application, ground limestone should be applied at the rate of about 1,000 pounds per acre once during every rotation.

The amount of commercial fertilizers containing phosphorus and potash which should be subsequently applied will depend on the crops to be grown and especially on the amount of manure produced on the farm.

Alfalfa may be successfully grown on portions of these types of soil, when properly managed. The preparation of the soil and manner and time of seeding is practically the same as for clover, except that the soil should be inoculated with earth from an old alfalfa field or from a patch of sweet clover. About 20 pounds of seed per acre should be sown, and the first year the crop should be treated the same as clover. The second year it may be cut at least three times.

If the clover or alfalfa should fail for any reason, a crop of spring vetch or tare, soybeans, cowpeas, yellow lupine, or serradella may be grown as a green manuring crop and plowed under.

In selecting a rotation of crops to follow on the sandy soils it should be kept in mind that the soil is low in organic matter, and that this must be supplied either by applying manure or by plowing under green manuring crops. When the soil has been built up to a fair stage of fertility, a nurse crop may be used in seeding clover and alfalfa to better advantage than when the soil is very poor; and it is frequently desirable to seed with rye or oats. This system is considered by many to be more desirable, since an extra crop can be secured.

A three, four, or five year rotation may be followed. If but little stock is kept, a three year rotation may be practiced, consisting of one year of a cultivated crop as potatoes or corn, one year rye or oats seeded to clover, and one year clover—the first crop to be cut for hay and the second to be plowed under for green manure. When the fertility of the type is well established, the second crop may be allowed to seed. Good yields have been secured where the soil is well managed. If manure is scarce, acid phosphate and potash may be applied at this time. If more stock is kept the rotation may be extended one year, using the clover field for pasture one season before plowing down the sod. The manure may then be applied to the sod in the winter or early spring of the year, the field is pastured. This will increase the growth of clover and benefit the succeeding crop. In a five year rotation alfalfa may be introduced, but this requires that considerable stock be kept, since none of the alfalfa should be sold.

FIG. 3. LIMING ACID SOILS FOR GROWING ALFALFA AND CLOVER IS VERY PROFITABLE.

Both plots from which this hay was cut were inoculated, but only one plot received lime.

FIG. 4. PEAT MAY BE USED TO ADVANTAGE AS A FERTILIZER ON SANDY SOILS.

Shock of corn on right shows effect of stable manure on sand. Shock in center was from plot which received no treatment. Shock on left shows result of peat when used in conjunction with potash and phosphate fertilizers.

The field should be left in alfalfa for three years with two years given to cultivated crops and grain. Manure should be applied to the cultivated crop and also to the first year of alfalfa. This system is very desirable except that it does not provide any pasture. To overcome this the farm may be divided and both the four and the five year rotation practised. Afalfa may also be grown by itself and kept on the same field year after year, in which case its place in the rotation should be filled by clover. When the alfalfa begins to run out, the field should be reseeded.

In the cultivation of the sandy soils fall plowing for rye, and spring plowing for all other crops, is the usual practice. The seed bed should be prepared to a depth of at least 8 inches and organic matter should be worked in deeply as well as near the surface to increase the water-holding capacity and to induce a deeper development of the roots. When the land is plowed in the spring it is often advisable to pack the soil with a roller, but this should be followed by a light harrow to secure a mulch on the surface. Where the fields are exposed, and the soil is blown by the wind, an effort should be made to prevent damage from this source. The most effective plan is to lay out the land in long narrow fields so as to have crops that cover the ground in the early spring, such as clover and rye, alternate with the cultivated ground.

With the successful growing of clover and possibly alfalfa, the dairy industry may be developed to a much greater extent than at present. By plowing under a crop of clover every few years and by following a definite rotation and approved methods, the yields of potatoes will be greatly increased; and this crop may well be depended upon as one of the chief sources of income for the sandy soils of the area. Beans, peas, sweet corn, etc., could be profitably grown to a much greater extent, and the trucking industry could be extended if proper arrangements were made for marketing. The soil warms up early and is well suited to cucumbers, strawberries, and all quick maturing vegetables.

In the management of this group of soils it will probably be found that Coloma sandy loam and the heavy phase of Coloma sand will respond more quickly to careful treatment than the other types, chiefly on account of their containing a higher percentage of clay in the subsoil.

CHAPTER IV

GROUP OF LOAM AND SANDY LOAM SOILS*

COLOMA LOAM

Description. The surface soil of Coloma loam to an average depth of 10 inches consists of a dark brown friable loam. Beneath this occurs a yellowish-brown loam which becomes somewhat heavier with depth to 18 inches, where the material is a yellowish sticky sandy clay containing some gravel. At 28 inches there is another change, the material at this depth being a yellowish gravelly sand containing some stones and a little clay. The type as a whole contains more organic matter and mineral plant food than either the sand or sandy loam types though about the same degree of acidity exists.

Extent and distribution. The Coloma loam is of very small extent, occupying only about 4½ square miles or 0.7 per cent of the area surveyed. The largest body of Coloma loam extends south from the north central part of Rose Township a short distance into Wautoma Township. A small area is also found in the northwestern part of Springwater Township, occupying an elevated, gently undulating plateau.

Topography and drainage. The topography of the largest area of this soil is slightly, to moderately rolling. While the position of this type gives it good natural drainage, the texture is such that it is capable of retaining sufficient moisture to mature good crops.

Origin. This soil is of glacial origin and is composed of a heterogeneous mass of sand, silt, gravel, and clay brought from

* As the types in this group are not as closely related in texture, origin, color, and crop adaptation as the group of sandy soils previously described, the methods of improvement are discussed for each soil separately, rather than for the group as a whole.

the north and mixed with material derived from the local disintegration of Potsdam sandstone.

Native vegetation. The original timber growth consisted chiefly of oak and a small amount of hickory. Nearly all of the timber has been removed, and the type is practically all under cultivation at the present time.

Agricultural development. This is the best soil of the Coloma series in the county, and is well suited to general farming and dairying. Potatoes yield from 100 to 150 bushels per acre, corn 35 to 60 bushels, rye 15 to 20 bushels, oats 40 to 60 bushels, and hay from 1½ to 2 tons per acre. Dairying is highly developed, and the quantity of manure available is therefore larger for each farm than is the case on the lighter soils. Red clover usually does well though the soil shows some acidity.

Methods of improvement. In chemical composition Coloma loam is markedly different from the more sandy soils described on page 25. The total phosphorus indicated by the analyses of this type so far made is about the same as that given for the sandy soils as described, but the potash content is distinctly larger, as is usually the case in soils of finer texture. The total amount of nitrogen is also distinctly higher, though it must be recognized that where land of this character has been farmed for several years without proper attention to keeping up the supply of fresh and actively decomposing organic matter, improvement in these respects will be required. These soils are for the most part acid. A rotation which gives good results on this type consists of corn or potatoes, oats, barley or rye, followed by clover and timothy. Hay may be cut two years or pastured the second year, before being plowed again for corn. The soil should be given an application of ground limestone at the rate of about 1,500 pounds per acre every four or five years. The stable manure should be carefully saved and applied, and this may well be supplemented occasionally by plowing under a crop of clover or some other legume. Alfalfa should be grown on this type and it will succeed if properly managed. The soil should be limed, fertilized, and inoculated, and the seed may be sown with or without a nurse crop. Dairying should continue to be the leading type of farming on this soil.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of the Coloma loam:

Mechanical analyses of Coloma 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	0.8	7.8	14.9	19.5	12.1	30.8	14.3
Subsoil	.5	6.6	17.3	24.9	19.2	19.7	11.7

WAUKESHA SANDY LOAM

Description. The surface soil of Waukesha sandy loam to a depth of from 8 to 15 inches consists of a dark brown to black sandy loam of medium texture and is comparatively rich in organic matter. It is underlain to a depth of 24 inches by a brownish-yellow, gravelly, sandy loam, becoming lighter in color to 36 inches. From 36 to 48 inches the subsoil is a yellowish, heavy, gravelly sandy loam. In places the subsoil to 24 inches is a yellowish sandy clay, and this is underlain by a yellowish, sandy, gravelly loam. Along the margin of the area of this soil the surface frequently becomes somewhat lighter in color, owing to the admixture of lighter colored material from surrounding soils. Where the type occurs in the vicinity of Plainfield and west of Coloma the subsoil is frequently lighter than the typical. In these localities the soil is underlain by a yellowish-brown medium sand to 20 inches and then by a sticky sandy clay extending in places to 36 inches or over. In some places the subsoil below 15 inches is a yellowish gravelly sand, containing a considerable quantity of stone fragments from 1 inch to several inches in diameter.

Extent and distribution. Waukesha sandy loam comprises a total area of 17,600 acres or approximately 4.3 per cent of the county. The largest occurrence is in Oasis Township where it is known as the "Great Prairie". Smaller areas are found in Plainfield and Coloma Townships.

Topography and drainage. On the "Great Prairie" the surface is level with occasional slight depressions and a few slightly

elevated terraces. In places where there is a little change in elevation small gravelly, sandy ridges or knolls occur. Over the remainder of the type the surface is level to gently undulating. The natural drainage is good, and where properly cultivated this soil retains moisture very well, except where the subsoil is more sandy than usual.

Origin. The portion of this type in Plainfield and Coloma Townships lies within the old Wisconsin River Valley and has been largely influenced by the action of water. The type as found on the "Great Prairie" has the appearance of being an old glacial lake basin, though it is probable that this region was at one time connected with, and formed a part of, the Wisconsin River Valley, and was cut off from it during glacial time by the dumping of glacial debris in the form of a moraine just east of Plainfield. The material forming the soil is in an acid condition as is indicated by the litmus test and the growth of considerable sorrel.

Native vegetation. The portion of Waukesha sandy loam in Oasis Township never supported a growth of timber. The type near Plainfield supported a scattering growth of oaks, while the small area west of Coloma was a prairie.

Agricultural development. A very large proportion of this type is under cultivation; it is considered a good soil, and most of the farmers living upon it are in a fairly prosperous condition. The type of farming most largely followed consists of dairying in connection with general farming. The chief crops grown and the yields secured are: potatoes 100 to 150 bushels per acre, corn from 40 to 60 bushels, oats from 25 to 40 bushels, rye about 15 bushels, and hay from 1½ to 2 tons per acre. The soil is comparatively easy to cultivate and no difficulty is experienced in securing a good tilth. The soil is adapted to a number of truck crops. Small plots of onions are now grown, and heavy yields of high quality are obtained. Small fruits also do well if given proper care.

Methods of improvement. In chemical composition the Waukesha sandy loam does not vary greatly from that of the sand types discussed on page 25. The chemical analyses, so far made, indicate that the total phosphorus is distinctly lower on the average, which is probably due to the fact that their higher

amount of organic matter, and consequently greater original fertility, has permitted the growth of heavier crops which have removed a larger amount of phosphorus than in the case of more sandy soils. The total quantity of potassium is moderate as is also the total amount of nitrogen. In this connection it must be recognized that a large portion of the nitrogen now found in soils of this class which have been farmed for a number of years is of a resistant character and does not become available to crops readily, so that the use of barn yard manure or green manure treatment is important.

While agriculture is well developed on this type, there are several points which should be kept in mind in the higher improvement of the soil, and one of the most important is that the soil is in an acid condition.* Before the best results can be obtained this should be corrected. About 2,000 pounds of ground limestone should be applied at the first application, and lighter dressings may be given every four or five years thereafter. As a rule clover still does fairly well, as the type is high in organic matter, but this crop will decline as the acidity increases. Potatoes or corn, rye or oats, clover, and timothy make up the rotation most extensively followed. While the soil is high in organic matter, the applications of stable manure may well be supplemented at times by the plowing under of a green crop. The type is deficient in phosphorus, and this may be supplied through ground steamed bone meal. When used to supplement the manure in an ordinary four year rotation, the bone meal should be used at the rate of 200 to 250 pounds per acre once in the rotation.

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

Mechanical Analyses of Wauhesha sandy 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.....	0.3	10.0	22.7	35.4	7.1	12.6	11.9
Subsoil.....	.7	6.8	15.5	39.8	13.1	11.9	12.2

* See Bulletin No. 230 of Wis. Exp. Sta. on "Soil Acidity and Liming".

SUPERIOR SANDY LOAM

Description. The surface soil of this type to an average depth of 12 inches consists of a grayish to medium brown loamy sand, of medium texture, and containing considerable organic matter. The subsoil consists of a yellowish-red sandy clay, sometimes becoming quite heavy, and grading into a reddish clayey sand. Occasionally a few small rocks and bowlders are scattered upon the surface.

Extent and distribution. Superior sandy loam is a soil of limited extent, occupying only 1.9 per cent of the county, or about 7,936 acres. It is confined to the eastern part of the county, where it is associated with other members of the Superior series and also with the Poygan soils. Most of the type occurs in Bloomfield and Aurora Townships.

Topography and drainage. The surface varies from nearly level to gently rolling, and the natural drainage conditions are good.

Origin. The red clay subsoil, while not as heavy as that of the other Superior types, is also of lacustrine origin. The surface covering of sandy soil, which is in places quite deep, was washed down from the lighter sandy areas near by.

Native vegetation. The original timber growth consisted chiefly of oaks with some hickory. All of the merchantable timber has been removed, and most of the type has been put under cultivation.

Agricultural development. The Superior sandy loam is nearly all under cultivation and where properly tilled holds moisture very well and produces profitable crops. Corn, potatoes, oats, rye, beans, and grasses are grown successfully, and some small fruit is raised. Dairying in connection with general farming is the chief type of agriculture followed. No commercial fertilizers are used, but all of the stable manure obtained is applied to the type.

Method of improvement. In chemical composition the Superior sandy loam is quite different from other sandy loam types. The total amount of phosphorus in the surface soil appears to be rather low, but the other elements occur in larger amounts. Especially is this true of nitrogen and organic matter, which are

found in larger quantity than in the other sandy loam types. This is probably because of the heavier growth of vegetation which this soil has supported as a result of its heavier subsoil. This subsoil is of a glacial nature and usually contains a considerable amount of lime, so that the soil as a whole is only slightly acid; and it is altogether probable that many fields will be found which are not acid at all, and on which clover and alfalfa will do well without the use of lime. It is important, however, that each owner of land of this character make the determination for acidity on his own land because of this variability.

A rotation fairly well adapted to this type consists of corn or potatoes, followed by oats, rye or barley seeded to clover. Hay may be cut two years, and the last cutting of each season saved for seed, though if the field is not very productive, the second crop of the second season should be plowed under. The growing of small fruits including strawberries, and the production of such other crops as peas and beans might well be extended. Where an acid condition exists ground limestone should be applied at the rate of 1,200 to 1,500 pounds per acre.

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

Mechanical analyses of Superior sandy 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	8.5	17.0	36.0	10.7	12.2	15.7
Subsoil.....	.0	7.2	12.7	44.3	13.9	9.4	12.1
Lower subsoil.....	.0	1.8	2.3	13.8	7.5	53.8	20.7

CHAPTER V

GROUP OF CLAY LOAM AND CLAY SOILS*

SUPERIOR LOAM

Description. Superior loam consists of 6 to 8 inches of medium brown heavy sandy loam to loam, underlain by a heavy, tenacious red clay extending to 36 inches or more. On the higher elevations and ridges the heavy red clay comes near the surface and is 20 feet or more in depth. A thin layer of a grayish yellow soil, about 1½ to 2 inches thick, is usually found between the surface soil and subsoil. This layer is similar to the subsoil, but has been acted upon and changed by the organic matter in the soil above. There are scattered over this type occasional small areas, a few square rods in extent, covered with several inches of sand which appears to have drifted from near-by sandy areas or from local deep sandy knolls. A little fine gravel is sometimes found between the surface soil and subsoil. The small quantity of sand in the surface soil prevents it from cracking when dry, except where the soil is very shallow.

Tillage of this type is more difficult than on the Coloma soils because of its heavier texture. The usual depth of plowing is from 4 to 7 inches. Plowing is generally done in the spring, though fall plowing would seem to be best, as it would give the heavy soil an opportunity to weather during winter, would enable it to catch more of the rainfall, and would give the sod a good chance to decay before spring planting. Plowing should be done when the soil is not too wet or puddling will result.

Extent and distribution. This type is of comparatively small extent occupying but a little over 3,000 acres. It is confined to

* As the Superior loam is more closely related to the clay loam and clay soils of this group than to the loam and sandy loams previously described, it is included with this group.

the eastern third of the county and occurs in irregeular bodies. Most of the Superior loam lies in the townships of Poy Sippi, Leon, and Aurora.

Topography and drainage. This soil occupies gently undulating to moderately rolling areas and is high enough so that most of the type has fairly good drainage. The region of this type lies from 10 to 40 feet above the level of Lake Poygan, occupies low rolling ridges in the Fox River Valley, and forms a belt between the Coloma soils and the Lake Poygan Basin.

Origin. This Superior loam is lacustrine in origin, having been deposited in Green Bay by the inflowing glacial streams when its waters were at a much higher level than at present. It has probably also been influenced, to a limited extent, by ice action. The soil was exposed, later, by the decline of the bay waters. The red color of the subsoil is due to the presence of ferric oxide.

Native vegetation. The original timber growth consisted chiefly of oak, elm, and considerable hickory. The trees are more prolific and longer-lived than those on the sandy types. Practically all of the first class timber has been removed.

Agricultural development. Superior loam is one of the best agricultural soils in the county and is well suited to dairying and hog raising, the main industries of the farmers in this region. Corn, oats, and hay are the chief crops. Corn yields from 50 to 80 bushels, oats from 40 to 60 bushels, and hay about 2 tons per acre. Potatoes are not as well adapted to this as to some of the lighter soils, but clover and timothy do very well. The rotation most commonly followed consists of corn followed by oats, with which timothy and clover are seeded. The land is left in sod from 2 to 5 years, and usually pastured for a couple of years after hay has been cut for two seasons.

Methods of improvement. The chemical composition of Superior loam shows it to have good amounts of most of the essential elements of soil fertility. It is only moderately well supplied with phosphorus, however, and where heavy crops are produced, and especially where grain or hay is sold from the farm and comparatively little concentrated feed stuff purchased, it will be found profitable to use commercial fertilizers containing this element. The total amount of pottasium is large, as is the case with

all members of the Superior series of soils. The total amounts of organic matter and nitrogen are good, on the average. The surface soil is often more or less acid, but the subsoil is well supplied with lime, so that while moderate applications of some form of lime will be necessary on much of this type of soil to permit clover and alfalfa to make their best growth, it is very probable that when alfalfa is well established and drawing on the subsoil, much less lime will be needed than on the more acid sandy soils.

Best results are usually obtained when this type is plowed in the fall, though where drainage is well established, no difficulty is experienced in securing a good seed bed following spring plowing. Where the type is low and inclined to be wet and cold in the spring, tile drains should be installed. Over portions of the type a crop of clover or some other legume should be plowed under occasionally to supplement the stable manure and to assist in keeping up the organic matter and nitrogen content of the soil. About once during each rotation a moderate application of ground rock phosphate could be made to advantage. A rotation quite commonly practiced consists of corn, followed by a small grain crop, usually oats or barley, with which clover and timothy are seeded. Hay is cut for two years before the field is again plowed for corn.

Mechanical analyses of Superior 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.....	1.2	10.3	23.2	24.7	4.4	17.6	18.6
Subsoil.....	.4	3.0	5.3	9.5	8.4	38.9	34.4

SUPERIOR CLAY LOAM

Description. Superior clay loam, to a depth of 6 inches, consists of a light chocolate-brown to red heavy clay loam of close texture and containing a moderate quantity of organic matter. This is underlain by a pinkish-red, compact, heavy, tenacious clay, containing very little grit, which extends to 24 inches, or

perhaps to 30 inches, below the surface, where it rests upon a reddish incoherent sand sometimes containing pockets of white sand. The red coloring of the sand is apparently due to iron salts leached in from the surface soil.

Extent and distribution. Soil of this type is of smallest extent in the county, occupying only about .3 per cent. of the area, or approximately 1152 acres. This soil is found chiefly in the southeastern part of Poy Sippi Township where it occurs in two small tracts.

Topography and drainage. The type is found in the low flat valley surrounding Lake Poygan, where it occupies slightly higher elevations than the Poygan clay which surrounds it. It is somewhat better drained than the Poygan clay, but needs ditching for the best results.

Origin. The Superior clay loam is of lacustrine origin and was deposited in the same manner as the Superior loam type. There are a number of artesian wells of excellent water on this type. The wells vary in depth from 35 to 150 feet.

Native vegetation. The original timber growth consisted of elm, hickory, and oaks; but all of the best timber has been removed, and most of the type is under cultivation.

Agricultural development. Agriculture is well developed on the Superior clay loam, and dairying and hog raising in connection with general farming is the chief system followed at present. In dry years very good crops are secured, but during wet seasons considerable damage may be done to crops by an excess of moisture. The crops grown and the yields secured are practically the same as for the loam type, and the same system of farming is followed.

Method of improvement. Chemical analysis of Superior clay loam shows it to have good amounts of most of the essential elements of soil fertility. It is, however, only moderately well supplied with phosphorus; and where heavy crops are produced, and especially where grain or hay is sold from the farm and comparatively little concentrated feed stuff purchased, it will be found profitable to use commercial fertilizers containing this element. The total amount of potassium is large, as is the case with all members of the Superior series of soils. The total amounts of organic matter and nitrogen are good on the average. The

surface soil is often more or less acid, but the subsoil is well supplied with lime, so that while moderate applications of some form of lime may be necessary on much of this type of soil to permit clover and alfalfa to make their best growth, it is very probable that when alfalfa is well established and drawing on the subsoil, much less lime will be needed than on the more acid sandy soils.

Because of its heavy texture and close structure, this soil requires careful management and should be cultivated only when the moisture conditions are the most favorable. It is advisable to plow the land in the fall. Practically all of the Superior clay loam would be greatly improved by tile drains and these should be installed. The plowing under of a crop of clover occasionally, to supplement the stable manure, would increase the organic matter and supply of nitrogen, and it would also loosen the soil and make it more loamy. A moderate amount of ground rock phosphate might well be applied once during each rotation. A rotation commonly followed on this soil is one year of small grain consisting of oats, wheat or barley, seeded to clover and timothy. Hay may be cut two years and the field pastured a year before being plowed for corn.

Mechanical analyses of Superior clay 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	2.5	8.6	25.4	1.9	36.8	24.4
Subsoil.....	.0	1.1	5.3	16.1	2.6	25.7	49.2
Lower subsoil.....	.0	1.2	16.2	68.6	2.3	.7	11.2

POYGAN CLAY LOAM

Description. The surface soil of the Poygan clay loam to an average depth of 10 inches consists of a dark brown to black medium textured clay loam containing a high percentage of organic matter. The subsoil consists of a heavy, tenacious, compact, pinkish-red clay which is similar to the subsoil of the Superior clay loam.

Extent and distribution. Poygan clay loam occupies about 5.6 per cent of the county and comprises a total area of approximately 23,232 acres. It is confined to the eastern half of the county, and with one exception to the two eastern tiers of townships. The largest tract is found in Bloomfield and Saxeville Townships and smaller patches occur in Poy Sippi and Aurora Townships. The type is associated with the Poygan clay and with the soils of the Superior series.

Topography and drainage. This type bears the same physiographic relation to the Superior loam as the Poygan clay bears to the Superior clay loam. The Poygan clay loam surrounds the Superior loam and usually extends down to areas of Muck. It occupies low, gently undulating or gently rolling areas and depressions. Over the more rolling portions the natural drainage is good, but in the low-lying places artificial drainage is often necessary.

Origin. The Material composing this type is largely of lacustrine origin. The dark color is due to a large accumulation of organic matter, the growth of which was favored by moist conditions which prevailed over the type.

Native vegetation. The original timber growth consisted chiefly of elm, hickory some oak and poplar, though most of the timber of value has been cut off.

Agricultural development. The greater proportion of Poygan clay loam is cultivated, and the type has a high agricultural value. Corn, oats, grass, and sometimes potatoes, form the rotation most commonly practiced. Corn yields from 40 to 80 bushels, oats 40 to 50 bushels, potatoes 75 to 150 bushels and hay 1½ to 2 tons per acre. General farming in conjunction with dairying and the raising of hogs is the leading type of farming followed, and the soil is well adapted to such a system of agriculture. Red clover and timothy thrive, and where the soil is well drained and not in an acid condition, alfalfa would doubtless grow successfully.

Mechanical analyses of Poygan clay 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	0.7	3.9	5.7	11.3	8.3	45.5	24.2
Subsoil	.5	1.4	2.3	9.2	12.4	44.7	29.6

POYGAN CLAY

Description. Poygan clay consists of 8 to 10 inches of dark-brown to black heavy clay, underlain, to a depth of 30 inches, by mottled drab, red, and white clay. From 30 to 36 inches the subsoil is a drab incoherent sand, usually saturated with water. When wet, the surface soil is plastic and very sticky, and when dry, it checks and cracks quite badly. The presence of a great deal or organic matter considerably improves the texture for cultivation, but great care should be exercised in choosing the time for plowing as its physical condition is easily impaired if the soil is worked while wet.

Extent and distribution. This type is of small extent occupying only about 2.5 per cent of the area or approximately 9,600 acres. It is confined to the eastern part of the county in Lake Poygan Valley. The largest area extends west from Tustin. Smaller tracts occur scattered through the eastern end of the survey. The type is associated with Poygan clay loam and the soils of the Superior series.

Topography and drainage. The soil of the Poygan clay type is low-lying, and the surface is level to undulating. The water-table is only 3 to 4 feet below the surface, and this, together with the low-lying position and the heavy texture, causes crops to suffer considerably from excess of moisture in years of normal to high rainfall. Crops consequently do best during dry years. All of the type is in need of tile drains.

Origin. The type is of lacustrine origin and owes its dark color to the decaying of vegetable matter, the growth of which was favored by the moist conditions prevailing over the type.

Native vegetation. The original timber growth consisted chiefly of elm, oak, poplar, and birch. Practically all of the good timber has been removed. When not tilled for several years, the soil becomes covered with a heavy growth of native grasses.

Agricultural development. Most of this type is under cultivation, and it is a strong soil. Dairying is the most important industry, and corn, oats, and hay are the leading crops grown. Corn yields from 40 to 60 bushels, oats from 40 to 60 bushels, and hay about 2 tons per acre. No systematic order of cropping is followed, and the land when used for hay is often left in grass for several years.

Mechanical analyses of Poygan clay.

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.....	0.3	2.2	5.5	9.2	3.1	33.4	46.2
Subsoil....	.0	.9	2.0	11.2	10.5	30.5	44.7

METHODS OF IMPROVEMENT FOR POYGAN CLAY LOAM AND POYGAN CLAY

The Poygan soils are essentially the same as the Superior soils, with the difference of a considerable amount of organic matter accumulated through the growth of vegetation, the decomposition and loss of which has been, to a considerable extent, prevented by the wetness of the soil. The total amount of phosphorus is comparatively low, but the other elements, potassium, nitrogen, and organic matter occur in large amounts. In fact, so far as fertility is concerned, phosphorus is probably the only element which will require much serious attention. The surface soils are frequently quite acid, but this will not reduce their fertility on account of the fact that there is a good supply of organic matter; and except where clover or alfalfa are to be grown, the use of lime will not be necessary, as a rule. Much of this land is not at present sufficiently drained, and it is too heavy in texture to permit the most satisfactory growth of alfalfa.

Where an effort is to be made, however, to grow this crop, determinations of acidity should be made and lime applied if an acid condition is found. The subsoil of both of these types is well supplied with lime carbonate, and except for a moderate application in starting alfalfa, liming will not be necessary. The Poygan soils have a high organic content and are not in need of green manuring crops to supply nitrogen. Such crops, however, if turned under would loosen the soil and thus assist in establishing better tilth.

It is important that these types should be carefully handled and the mechanical condition so maintained as to permit the circulation of air through the surface material. Cultivation should take place only when the moisture conditions are favorable, for, if plowed when too wet, the soil may become puddled, and the field remain in poor condition for several years. The soil should be plowed in the fall whenever this is possible. All of the stable manure made should be applied to the fields, and in addition, from 500 to 600 pounds of rock phosphate per acre might well be applied. Subsequent applications of half this amount, once during each rotation will give good results.

All poorly drained places should be drained, and the major portion of these types would be greatly benefited by tiling*.

A rotation of crops well suited to these soils is one year of small grain consisting of oats, barley, or wheat seeded to clover with a little timothy mixed in. The second year the clover from the first crop may be saved for hay, and the second allowed to go to seed. The third year clover and timothy hay may be cut; and the fourth, the field may be pastured. Following this the sod should be plowed for corn. Pasturing may be omitted if there is other grazing land on the farm. This makes a four or five year rotation. Stable manure should be applied to the sod before plowing for corn, or it may be scattered upon the plowed surface during the winter. Lime may be applied by putting some straw in the manure spreader and placing the ground limestone upon this. Rock phosphate may be mixed with the manure, or it may be scattered on top of the loaded manure spreader and applied with the manure.

* See Bulletin 229 of the Wis. Agr. Exp. Sta. on "The Right Drain for the Right Place."

CHAPTER VI.

MUCK

Description and origin. Occupying numerous low-lying irregular areas and narrow belts along stream courses throughout the county are accumulations of organic matter in various stages of decomposition locally called "Marsh land". The material of such areas varies in depth from 10 inches to 10 feet or more, being shallower near the margins of the areas, and shades in color from a brown in the peaty areas, to a black in the areas of Muck. The underlying material varies from sand to a sticky clay. The proportion of mineral matter is higher along the contact of the Muck areas with the higher lying soils. Decaying organic material with considerable mineral matter incorporated is called Muck. Where there is no mineral matter present, or only a small amount, such areas are in reality Peat, and the areas where water constantly stands at or above the surface, and where grass and other water-loving plants are found, but the ground is too soft to bear the weight of animals, are Swamp. It was not thought advisable, however, to attempt separation of the several variations in the conditions in which these organic soils exist. The Swamp area is small and is distinguished on the map by symbols. These areas were once lakes or channels for the water of melting glaciers. When the water receded, shallow lakes were formed in the depressions; and fibrous plants and water-loving grasses soon filled the depressions with their roots and their decaying tissues. The first stage in this process gives Swamp, the second Peat, and the third Muck.

Extent and distribution. Muck is the second type in extent in the county, occupying 16.6 per cent of the survey, or approximately 68,480 acres.

Most of these areas occur in the western, southern, and eastern parts of the county, the most extensive bodies being found in the eastern fourth of the county where the greater portion of the marshes are true Peat. In the western part these areas occur as narrow fingerlike belts, extending from one-half mile to several miles into Waushara County from Adams County. In the western and southern parts, the material is largely Muck and is underlain with a drab-colored, incoherent sand, usually saturated with water, while in the eastern part it is underlain by a heavy drab to bluish gray sticky clay. The only swampy areas are found in a narrow belt along Lake Poygan.

Topography and drainage. The Muck occupies low lying areas, and the surface is flat, except in a few places around the border of the marshes, where there is sometimes a gentle slope. This, however, is slight in grade, but is of consequence when the marsh is to be drained. The water table over the low lands is from 1 to 3 feet from the surface, and the natural drainage is very poor. None of the marshes are of value for cultivated crops until drainage systems have been installed. In dry periods, when the water table is lower than usual and the surface becomes dry, fires frequently burn over large areas, leaving the underlying sand and rough projections exposed. This usually leaves the land unfit for anything but grazing, though sometimes small areas of the underlying soil are cleared and tilled with good results.

Native vegetation. The native vegetation consists mainly of tamarack, poplar, birch, willow, and a heavy growth of coarse wild grasses.

Agricultural development. The cranberry industry has been followed with success for many years on the Muck areas in the southeastern part of the county, but there is only a small portion of this land devoted to the industry as yet. With good care a bog will continue to bear profitable crops for many years. At present this land is used almost exclusively for the growing of wild grasses for hay and pasture. The yield of hay is from 1 to 1½ tons per acre, and is usually of poor to medium quality. The land sells at from $10 to $40 per acre, depending on the drainage conditions.

*Method of improvement**. The drainage of marshes is the first step toward their improvement. On large marshes the organization of drainage districts and the cooperation of a number of adjoining land owners is necessary, but many farms include areas of this class of land which can be readily drained without legal difficulties. Proper cultivation of Muck when drained is of the utmost importance. The use of a heavy roller to pack the surface is often advisable since it produces a firmer seed bed which is better adapted to cultivated crops, especially the small grains.

The fertilization of the Muck as found in this area is important on account of the unbalanced condition of the elements contained. The content of nitrogen is high, but the amounts of potash and available phosphorus are low. Stable manure should be kept for the upland soils of the farm, and potash and phosphorus supplied by commercial fertilizers. The first application of rock phosphate should be from 800 to 1000 pounds per acre followed every 3 to 4 years by application of from 400 to 600 pounds per acre. Potash may be applied as the sulphate at the rate of 100 to 150 pounds per acre for such crops as corn, potatoes, cereals, and hay. This fertilizer is quite soluble, and frequent applications are necessary.

When properly drained and fertilized this Muck will produce good crops of corn, potatoes, cabbage, buckwheat, timothy, and alsike clover. When firmed by rolling, small grains can be grown successfully. With proper care good tame grass pastures can be developed on the Muck.

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* See Bulletin No. 205—The University of Wisconsin, Agr. Exp. Sta. on "The Development of Marsh Soils", and Bulletin No. 229 on "The Right Drain For the Right Place."

CHAPTER VII

GENERAL AGRICULTURE OF WAUSHARA COUNTY.

A few settlers entered the county as early as 1848, but little or no attempt was made to cultivate the land until 1850. There were no mineral resources in the county and only a few small areas of timber, so the early settlers were forced to depend on agriculture for their living. Wheat, corn, potatoes, and buckwheat were the first crops grown, and excellent yields were obtained for several years, but wheat soon began to decline in yields, and its production was abandoned. It was found that the sandy soils were well suited to corn, rye, and potatoes, and the growing of these and red clover was extended.

Little attention was given to crop rotation in early times, and it became evident, with the decline in yields, that some changes in the general practice were necessary if the productiveness of the soils was to be maintained. As early as 1875 the settlers began to experiment with a number of new crops to see which were best adapted to the soils and climate. It was soon found that potato culture was well suited to this area and that industry, with dairying, began to receive considerable attention. These two industries, with the production of red clover seed, hog raising, and the growing of beans, corn, rye, oats, and hay constitute the lines of farming now followed in this area. Potato raising and dairying are the two most prominent specialties at the present time, and they have done much to place the county in its present prosperous condition. The cranberry is the chief fruit exported.

In 1910 there were 2,622 farms in Waushara county, the average size of which was 140 acres. Of all of the land in the county 88.6 per cent is in farms, and of such land 61.8

per cent is improved. On the average there are 86 acres of improved land on each farm in the area surveyed. The census of 1910 indicates that 85.2 per cent of the farms are operated by the owners. During the period from 1900 to 1910 the value of farm property in Waushara county increased 82.1 per cent. During the decade of 1890 to 1900 the production of beans and red clover seed was doubled, the production of hay increased 33⅓ per cent and potatoes nearly 300 per cent, though in comparing these figures the possible effect of differences in the seasons must be given consideration. During the past decade the increase in production has not been nearly as great as that indicated above.

Whatever the type of farming, the system of cropping should be arranged so that a good supply of organic matter may be maintained in the soil, because, without this, crop yields are sure to diminish. The rotation generally followed at the present time is potatoes or corn, rye or oats, and clover and timothy. The sandy types are seldom left in sod for more than one or two years, because of the difficulty of maintaining satisfactory stands of grass for longer periods. The loams and clay loams are frequently left in sod from two to five years, the land during the last year or two being used for pasture. In many of the sandy localities where dairying has not been developed, farmers are having difficulty in obtaining sufficient organic matter to maintain the productivity of their soils. Heretofore they have depended upon a clover and timothy sod to plow down, but in recent years they have had considerable difficulty in securing satisfactory growths of red clover, and as a result the fertilizing value of the sod is greatly decreased. One or more legumes in the rotation are vitally important for the maintenance of the fertility of the sands and sandy loams, and where clover fails some other legumes, such as soy beans, cowpeas, or vetch should be substituted until the soils are in condition to support the growth of red clover again. Alfalfa can be grown when the necessary conditions are supplied. Where manure is not available it may be advisable to plow down an occasional crop of legumes, in order to supply organic matter and nitrogen. Care should

be exercised, however, in the plowing down of green crops, and if the growth is very heavy it is a good plan to give the land an application of lime. Commercial fertilizers can also be used to advantage on many of the soils.

Crop yields are greatly influenced by the methods of tillage used, and this is an especially important matter in Waushara county. The general practice is to plow in the spring for all crops except rye, for which the land is prepared early in the fall. Some farmers break sod land early in the spring, while others wait until just before planting time, claiming this is best as the sod prevents the soil from washing. Some systematic tests in tillage for the various types of soil would undoubtedly prove very beneficial. Spring plowing may be the most advisable for the sands and sandy loams, as their open texture permits free circulation of air, which aids in the rapid decomposition of organic matter. However, spring plowing is usually more shallow than fall plowing and the organic matter is kept near the surface. This causes the greatest root development to occur near the surface and in times of drought the crop is more likely to suffer for moisture than if the organic matter were worked deeper into the soil. If deeper spring plowing is practiced on the sandy soils, it may be advisable to firm the soil by using a corrugated roller. On the loams and clay loams, where there is little danger from washing, it would seem best to plow the sod land in the fall, as this method will give the organic matter sufficient time to decay, will destroy many worms and other pests, will have a better effect upon the granulation of the soil, and enable it to catch and hold more of the water which falls. A seed bed at least 10 inches deep is advisable for the heavy types, while on the sandy soils more shallow plowing is usually advisable, except under certain conditions. At present most of the plowing is done with single-share plows. With the easily tilled soils of this region and the scarcity and high price of labor, it would seem better to use gang plows.

With an average annual rainfall of only 28.3 inches and the usual occurrence of a period of dry weather during the growing season, it is very necessary to conserve all the moisture

possible for the growing crops, especially in the case of the loose sandy types of soils. The field may be properly plowed and the seed bed well prepared, and yet crops may fail, unless frequent and careful cultivation be practised during the growing season. In the sandy soils the aim should be to maintain the largest supply of moisture in the zone of greatest root development, which is from 3 to 24 inches below the surface, with the most effective region between 3 and 12 inches below the surface. Deep cultivation should be avoided when the plants have made considerable growth, as it cuts the surface roots and forces the root development below the richest part of the soil; but an effective mulch should be maintained during the growth of all intertilled crops by cultivating frequently cultivated the soil, to a depth of 4 feet, contained weeds and the loss of moisture otherwise drawn off by them. It will also reduce to a minimum evaporation of moisture from the soil itself, and this is by far the most important result of cultivation as affecting moisture conditions. From an examination of various types of soil in this county it was found that in every instance where fields had been well tilled and frequently cultivatedq the soil, to a depth of 4 feet, contained a moderate supply of moisture even during the driest part of the summer, while adjoining fields of the same types of soils, planted to the same crops, which had not received good cultivation, were in a droughty condition and the crops were suffering badly.

Most of the farms are operated by the owners and most of the labor is performed by members of the family. There is a general scarcity of help during potato-digging time, and from $2 to $2.50 a day, with board in addition is paid for good men. Much hand labor is being eliminated by the use of machinery. Many of the potatoes, however, are still dug by hand with forks, though this method is rapidly being displaced by machinery which elevates the potatoes into boxes, one man sorting the potatoes and changing the boxes as the work progresses.

In parts of the county where the soil is very light the tendency is to increase the size of farms, but on the older and better farms, especially those of the heavier types of soil, the

land is being divided into smaller tracts, usually among the members of the family.

SPECIAL INDUSTRIES.

The importance of a number of specialized crops for the soils of Waushara county can not be emphasized too strongly. With one special industry developed to the practical exclusion of other crops there is always the risk of overproduction or failure, whereas by giving attention to several specialized crops the loss of one may not seriously handicap the farmer. Every agricultural community should direct its attention to a few specialized crops suited to the soils and climate and by organization provide a way to dispose of the products in the most direct and profitable manner. The crops discussed in this chapter are very well suited to the soils and climate of the region, some of which are now being more or less extensively grown in this county.

Potatoes. As early as 1875 it was found that the sands and sandy loams of this area were well adapted to the growing of potatoes, and this industry has greatly increased since that time. In 1900 the yield from 23,685 acres was 1,905,737 bushels or an average of about 80½ bushels per acre. This was 17 bushels per acre less than the crop reported in 1890. In 1910 the yield from 21,599 acres was 2,255,887 bushels or about 104 bushels per acre. The increase over the yield reported for 1900 was probably due to more favorable weather condition rather than to any increased fertility of the soil. In fact the observations made in the field indicate that the yields per acre are gradually decreasing, due to a failure to maintain the productivity of the soil, either through lack of care in cultivation, or to the difficulty of securing good stands of clover, with a consequent depletion of humus and nitrogen.

The Rural New Yorker, Burbank, Early Ohio, Triumph, Hebron, and Early Rose are the main varieties of potatoes grown.

In growing this crop on land supporting a heavy sod it is a good plan to plow either in the fall or early in the spring, as this gives the sod a chance to rot well and destroy insect pests. The seed bed should be at least 7 inches deep, so that

the roots can develop downward into the moist soil. Disking and harrowing should begin in early spring and continue until time of planting, in order to conserve all the moisture possible. This practice should also be followed in the case of land plowed in the spring. No definite time for planting can be set, as this process is controlled by weather conditions. Potatoes should be harrowed at least once a week after they are planted until they are large enough to be cultivated. This will keep the weeds down and also keep a good mulch on the surface and prevent loss of moisture. Frequent cultivation should be given this crop—once a week is not too often. Level cultivation, which is generally practiced, is advisable, as it exposes the least surface to evaporation. The first cultivation may be deep, but subsequent cultivations should be shallow, not more than 2 inches of the soil being stirred.

Many potatoes are hauled directly to the station and sold, many are stored in warehouses, and some are pitted in the field to be hauled to market later. A charge of 2 cents per bushel is made for storage in warehouses, and 1 per cent is deducted for shrinkage in weight for each month.

Fruit. While Waushara county is not one of the chief fruit sections of the state, fruit of several kinds can be grown at least for home consumption. Strawberries and native plums do well on most of the light soils of the county, and fair success with the more hardy apples, such as the Duchess, Wealthy, McMahon, Fameuse, and Northwestern Greening, and some varieties of crabs can be expected with reasonable care. The bush fruits can also be grown on most of the soil types in the county and do exceptionally well on the heavier types. Cranberries have been grown on some of the marshes in the vicinity of Berlin for a great many years, and conditions in that section are well adapted to this crop.

Trucking crops. It has been demonstrated that profitable yields of sweet corn, garden peas, and asparagus can be obtained on the sands, sandy loams, and loams. The development of a trucking industry must depend to a considerable degree upon the establishing of local canning factories, but there is apparently nothing to prevent the profitable use of wide areas for the production of these crops whenever enough

interest can be aroused to cause concerted action of a number of farmers in their cultivation.

Sorghum. Considerable sorghum is grown on the lighter soils, the product being used by the local mills to make syrup. The lightest phase of newly broken Coloma sand produces the best quality of syrup. As the soil becomes heavier and the humus content increases, the color of the syrup becomes darker and the quality less desirable. As there are extensive areas of this type of soil in the county this industry might be extended sufficiently at least to supply local demands.

Beans. The Coloma sand, Plainfield sand, Coloma sandy loam, and Superior sandy loam are very well adapted to the production of navy and other kinds of beans. More than 40 varieties have been tested with varying degrees of success. The land should be well prepared and manured preparatory to planting and the crop should be frequently cultivated during its growth to keep the weeds down and conserve soil moisture. It is a splendid crop to use in rotation, matures quickly, and yields good profits.

Dairying. Dairying has developed into a very profitable industry on the sandy loams, loams, and clay loams of the county. It is followed to a limited extent on the sands, where it gives moderately good results, especially if there are Muck areas adjoining the sands to furnish hay and pasturage. The milk is sold to local creameries for buttermaking, and the skim milk is usually returned to the farmer for hog feed. Some attention has been given to special breeds of dairy cows, but many herds are composed mainly of grade animals. Jerseys, Holsteins, and some Guernseys are the leading dairy breeds. Silos are used quite extensively and much of the corn grown is used for ensilage. The raising of hogs and sheep has developed considerably in the eastern part of the area where the soils are heavier and grass crops are grown more easily.

Dairying and hog raising have been very important factors in the present prosperous conditions in the county and their further development, together with the improvement of the breeds of cattle, will have much to do with the future prosperity of Waushara County farms.

CHAPTER VIII.

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 agriculture which can be practiced to best advantage.

"The distribution of the rainfall over Wisconsin is remarkably uniform, the average yearly percipitation 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 rainfall one year, and other sections more in other years. The variation is caused 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 un-

* This chapter has been based largely upon Wisconsin Bulletin 223 on "The Climate of Wisconsin and Its Relation to Agriculture." This bulletin should be consulted for more information on the subject.

usually 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 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, but 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 Waushara County where sandy soils greatly predominate this condition would be even more marked than in regions having a heavy soil.

The eastern portion of Waushara County lies within "The Fox and Wolf River Basins" which are recognized as forming one of eight climatic provinces in Wisconsin. This region has an intermediate climate, partaking some of the influence of the lake but exhibiting more of the features of a land cli-

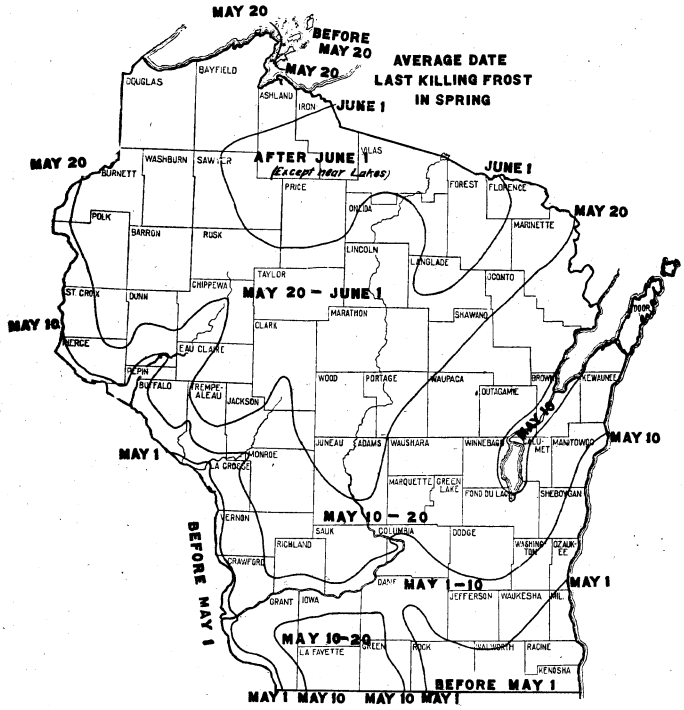

FIGURE 6. LAST KILLING FROST IN SPRING

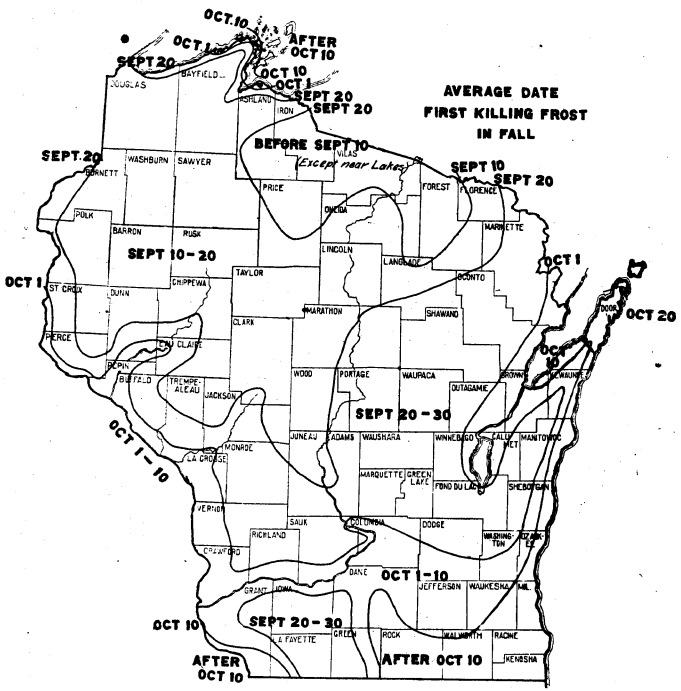

FIGURE 5. FIRST KILLING FROST IN FALL

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

mate. The winters at Green Bay, Appleton, Pine River,* Oshkosh, and Fond du Lac, with a mean temperature averaging 18.7°, are as warm as those at Dodgeville or at Lancaster, while the springs (43°) and the summers (68°) are as cool as the average of Eau Claire and Osceola. The growing season of 130 to 150 days, however, shows the land influence, being of about the same length as Richland, Buffalo, and St. Croix counties, Wisconsin; or Cattaraugus, Chenango, and Deleware counties, New York; Center and Lycoming counties, Pennsylvania; northern Iowa; or central Utah. The rainfall (29.6 inches) in this region is possibly a little less than elsewhere in the state."

By reference to figures 5 and 6, it will be observed that the average date of the last killing frost in the spring in the region including Waushara County is between May 10 and 20. The average date of the first killing frost in the fall in this same region is between September 20 and 30, thus giving a growing season of from 133 to 143 days. From the data given on these two maps, the length of growing season for any portion of the state may be readily determined.

The following table, compiled from the records of the Weather Bureau station at Hancock, shows the mean monthly, seasonal, and annual temperature and precipitation. The data here given are computed from records covering a period of ten years, and while the figures apply in general to the county as a whole, there are doubtless some local variations in rainfall and temperature which the table does not bring out.

* Located in Leon Township, Waushara County.

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

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	20	50	—25	1.2	1.8	1.1	7.5
January	16	53	—30	1.1	1.4	1.6	10.1
February	16	53	—35	1.2	1.2	1.6	7.9
Winter	17			3.5	4.4	4.3	25.5
March	30	73	— 8	1.7	0.5	1.2	6.5
April	46	85	11	2.4	1.0	2.9	2.8
May	58	93	25	3.7	1.8	5.6	.5
Spring	45			7.8	3.3	9.7	9.8
June	67	99	31	4.2	1.4	7.3	.0
July	72	100	44	4.0	1.8	4.0	.0
August	69	100	40	2.9	3.4	4.0	.0
Summer	69			11.1	6.6	15.3	.0
September	61	94	20	2.6	1.4	2.7	.0
October	50	84	15	2.1	0.4	1.0	.5
November	32	68	10	1.2	1.7	1.1	3.9
Fall	48			5.9	3.5	4.8	4.4
Year	45	100	—35	28.3	17.8	34.1	39;7

The climate of this area is invigorating and healthful. Though the winters are long and severe, the temperatures sometimes falling as low as —35° F., the air is usually dry and the cold is not so penetrating as in more humid climates. The soil generally freezes to a depth of 1 to 3 feet and is covered with snow from December 1 until about the 15th of March.

The summers are usually short and very pleasant, the temperature seldom reaching 100° F. The high percentage of sunshiny days causes crops to develop very rapidly, and they

mature in a relatively short time. In average years the growing season at Hancock extends from the middle of May to the latter part of September; from the recorded data of killing frost its length is one hundred and thirty-one days. The average date of the last killing frost in spring at Hancock is May 16 and of the first killing frost in fall September 24.

SUMMARY.

Waushara County is located in the south central part of Wisconsin. It has an area of 643 square miles, or 411,520 acres. It comprises three physiographic divisions, namely, the Wisconsin River Valley, the morainic belt, and the Lake Poygan and Fox River valleys. The valleys have a level to gently rolling topography; the morainic belt is quite broken and hilly.

Wautoma, the county seat, is centrally located. The rural population is well distributed throughout the county.

Fourteen soil types are shown in the map. These soils range from Muck to heavy clay. The heavy soils are used mostly for dairying, hog raising, and the growing of general farm crops. The sandy soils are devoted to potatoes and bean culture and are well suited to sweet corn, garden peas, and other truck crops. The great diversity of soils in the county offers excellent opportunities for the growing of many profitable crops.

The Coloma sand is by far the most extensive type. It is well suited to potatoes, beans, corn, rye, small fruits, and quickly maturing truck crops. This type is usually low in organic matter and responds well to manure.

Coloma sandy loam is found entirely within the morainic belt and is well adapted to general farm crops, alfalfa, fruit, potatoes, and the crops recommended for the Coloma sand.

Coloma loam has a very small extent. It is well suited to general farm crops, dairying, hog raising, and fruit.

Only a small area of the Coloma stony sand is found. Because of its stony nature it is not well suited to farm crops. It is used for pasture. When well tilled it produces moderate yields of corn, rye, potatoes, and beans.

The Coloma gravelly sand occurs as small irregular ridges along stream courses and has a low agricultural value.

Waukesha sandy loam is rich in organic matter and a productive type. Dairying and hog raising are the main industries. Potatoes, corn, rye, oats, and hay are the chief crops. This type is also well suited to the growing of onions and truck crops.

Waukesha sand has about the same producing power as the Coloma sand. If well tilled and manured it will yield moderately good crops. It is a good early truck soil, but needs organic matter and lime.

Plainfield sand occupies the level areas in the western, southern, and eastern parts of the county. It is a light to medium brown sand, low in humus, and inclined to be droughty. When well manured and cultivated, it produces moderately good crops of potatoes, beans, corn, oats, buckwheat, and hay. This type needs lime and organic matter to grow red clover successfully. It is well adapted to small fruits, quickly maturing truck crops, Canada peas, and beans.

Superior loam occupies small areas on ridges and uplands in the eastern part of the area. Dairying and hog raising are highly developed industries. The area of this type of soil is well drained, has good roads, and produces good crops of clover and timothy, corn, and oats, but is usually too heavy for potatoes and truck crops. It is well adapted to apples and small fruits.

Poygan clay loam is a dark-colored soil, rich in organic matter and very productive. Dairying and hog raising and the growing of general farm crops are the main industries on this type.

Poygan clay occupies low-lying level areas in Lake Poygan Valley. Good crops of corn, oats, and hay are produced and dairying is a thriving industry. It is generally in need of drainage.

Superior clay loam is closely associated with Poygan clay, being usually surrounded by the latter type. It lies a little higher than the Poygan clay and produces the same general farm crops. Many good artesian wells are found on this type, as on the preceding type.

Superior sandy loam is a well-drained type and produces good crops of potatoes, corn, oats, rye, and hay. It differs from Coloma sandy loam in having a heavy red clay subsoil.

Muck occurs to a large extent in the county, being usually found in irregular shaped, low-lying bodies and in narrow belts along stream courses. Cranberry growing has developed quite extensively in Aurora township on this type. Very few areas have been drained.

Agriculture is in a prosperous condition. Potatoes, corn, oats, rye, cranberries, and hay are the chief crops, and dairying and hog raising are the two leading industries. The milk is made into butter in local creameries.

Most of the labor is done by the owners of the farms and their families, but some hired help is used during the digging of potatoes and harvesting of other crops.

The summers are short and pleasant and the winters long and cold. The average yearly rainfall for a period of ten years is 28.3 inches. The drainage is to the south and east into Lake Poygan and Fox River.

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.

U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF.

SOIL SURVEY OF WISCONSIN, WAUSHARA COUNTY SHEET

STATE OF WISCONSIN
GEOLOGICAL AND NATURAL HISTORY SURVEY.
E. A. BIRGE, DIRECTOR.
COLLEGE OF AGRICULTURE, UNIVERSITY OF WISCONSIN.
H. L. RUSSELL, DEAN.
A. R. WHITSON, IN CHARGE SOIL SURVEY.

SOIL PROFILE
(3 feet deep)

- Coloma stony sand — S / S
- Coloma gravelly sand — S
- Coloma sand — S / S
- Coloma sandy loam — Sl / Sl / Grs
- Coloma loam — L / Sc / Grs
- Superior sandy loam — Sl / Sc
- Superior loam — L / C
- Superior clay loam — Cl / C / S
- Poygan clay loam — L / Sic
- Poygan clay — Cl / C / S
- Waukesha sand — S / S
- Waukesha sandy loam — Sl / S / Sc
- Plainfield sand — S / S

LEGEND

S	Sand
Sl	Sandy loam
Grs	Gravelly sand
L	Loam
Sc	Sandy clay
C	Clay
Cl	Clay loam
Sic	Silty clay

LEGEND

- Coloma stony sand — Css
- Coloma gravelly sand — Cg
- Coloma sand — Cs
- Coloma sandy loam — Csl
- Coloma loam — Cl
- Superior sandy loam — S
- Superior loam — Sl
- Superior clay loam — Sc
- Poygan clay loam — Pcl
- Poygan clay — Pc
- Waukesha sand — Ws
- Waukesha sandy loam — Wl
- Plainfield sand — Ps
- Muck — M
- Swampy areas
- Stony areas
- Rock outcrop areas

Soils surveyed by
J.W. Nelson, of the U.S. Department of Agriculture
and Guy Conrey and A.H. Kuhlman of the Wisconsin
Geological and Natural History Survey.
1909

Scale 1 inch = 1 mile

A. Hixon & Co. Lith. Rockford, Ill.