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SOIL SURVEY
OF
WAUPACA COUNTY
WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, AND MARTIN O. TOSTERUD

OF THE

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AND

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* MAP

Soil map of Waupaca county, Wisconsin..... Attached to back cover



INTRODUCTION

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

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

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering

suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

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

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

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

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater

proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOILS CONTAINING LESS THAN 20% SILT AND CLAY

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.

Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.

Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Very fine sand.—Over 50% very fine sand.

SOILS CONTAINING BETWEEN 20-50% OF SILT AND CLAY

Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay.—Less than 20% silt.

SOILS CONTAINING OVER 50% OF SILT AND CLAY.

Loam.—Less than 20% clay, and less than 50% silt.

Silt loam.—Less than 20% clay, and over 50% silt.

Clay loam.—Between 20 and 30% clay, and less than 50% silt.

Silty clay loam.—Between 20 and 30% clay, and over 50% silt.

Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for examples, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the soil class with the soil series we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF WAUPACA COUNTY, WISCONSIN

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA

Waupaca County is situated a little to the east of the center of the State of Wisconsin. It comprises an area of about 759, square miles, or 485,760 acres. Waupaca, the county seat, is 221 miles from Chicago and 146 miles from Milwaukee by rail.

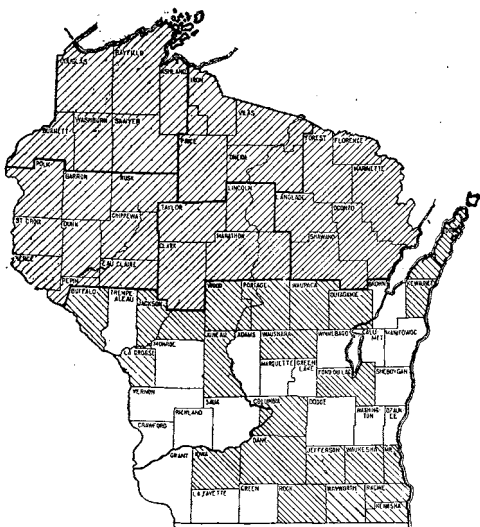


Figure I. Sketch map showing the areas surveyed.

The surface features of the region may be considered as falling into three divisions. In the northwestern quarter of the county, which is the highest portion of the area, the surface varies from gently rolling to hilly, and in many places stones and boulders are very plentiful. This portion of the county is underlain by granitic rocks which outcrop frequently.

The southwestern quarter of the county is characterized by extensive sandy plains. The surface is, for the most part, level and is almost entirely stone free. In this region there are a number of beautiful lakes chiefly in Farmington and Dayton townships.

The region which may be considered as forming the third class occupies the greater portion of the east half of the county. The surface varies from level to gently rolling, and the most characteristic feature is the heavy red clay subsoil. This is the lowest portion of the county. While the underlying material is of a clayey nature, and while the surface soil is also frequently heavy in character, there are a number of places throughout this region where there are areas of fine sand which appear to have been dumped down upon the red clay. It is frequent to find therefore very sharp soil boundary lines where the range in texture changes from a fine sand to a loam or clay within a very short distance.

The region of highest elevation is found in the northwestern part of the county, and the general slope is from this section to the south and also to the east. Elevations above sea level at various places are as follows: Iola 930 feet; Waupaca 870 feet; Manawa 828 feet; Northport 779 feet; New London 767 feet; and Weyauwega 779 feet.

All of the county lies within the drainage basin of the Wolf River, which flows in a southwesterly direction across the southeastern portion of the county. The Embarrass River, which is one of its largest tributaries, enters the Wolf near New London a short distance outside of Waupaca County. The Little Wolf, Pigeon and Waupaca Rivers are smaller streams within the county. All of these drainage waters flow through the Wolf into the Fox River and thence into Green Bay and Lake Michigan.

Scattered throughout the county are numerous marsh areas and some lakes. The most extensive tracts of marsh are found in the southeastern quarter of the county along the Wolf River. For the most part the marsh areas of this county are still undeveloped.

The Wolf River as it passes through this county is very sluggish. The entire fall between Shawano and where the Wolf joins the Fox River is less than one-half foot per mile. The Embarrass River where it crosses the county is also sluggish. The streams flowing into these two rivers, however, from the

west and coming out of the higher portions of the county, have considerable fall. Water power is being used in a limited way on these streams at Big Falls, Waupaca, Manawa, and Weyauwega. There is considerable water power on these small streams which is still undeveloped. The water supply for stock and farming purposes throughout the county is excellent. In the eastern half of the county there are many flowing wells and in the western half excellent water can be secured without difficulty.

The first settler is reported to have arrived in Waupaca County in 1843, settling at the present site of Fremont. By 1849 a number of settlers had taken up lands in the southern part of the county. The county was organized practically as now existing, in 1851—claims to the territory being finally surrendered by the Menomonic Indians in 1852.

In 1910 the population *of Waupaca County was 32,782. Of the total population 83.7% is classed in the census report as rural. The density of the rural population is given as 36.1% persons per square mile.

Waupaca, the county seat, had a population in 1910 of 2,789. New London, with a population of nearly 4,000, is located on the east county line, partly in Waupaca and partly in Outagamie County. Among other towns and villages within the area are Clintonville, Marion, Manawa, Ogdensburg, Scandinavia, Iola, Weyauwega, Fremont, Royalton and Northport.

Three railway systems have lines extending into this county. These railroads offer good transportation facilities to nearly all portions of the county. In the southwestern portion and in other regions where the soils are sandy, the wagon roads are usually of a sandy nature. Throughout the remainder of the county where the soils are heavier, the roads are naturally better. In many places they have been macadamized, and new and improved highways are constantly being built. Rural mail delivery routes reach all parts of the county, and the telephone is in common use through the country districts.

The towns within the county provide markets for considerable farm produce, but most of the surplus from the farms is shipped to outside markets. Live stock goes mostly to Chicago

* In the edition of this report published by the U. S. Bureau of Soils the population of Waupaca County was erroneously given as 23,782 for 1910.

and Milwaukee, as does also the potato crop. Dairy products find a market throughout the middle west.

SOILS

Waupaca County, in common with several other counties in the central portion of Wisconsin, owes the general character of its surface material to several distinct methods of accumulation. These materials may be glacial, lacustrine or alluvial. To these important agencies may be added the accumulation of organic matter in low places which has resulted in the formation of peat.

In the geological classification based upon the character of the underlying rocks, the county falls into three divisions. The surface rock in the northwestern portion of the county consists of crystalline rock, chiefly of granite and gneiss. Throughout this granitic rock region, rock outcrops are frequently seen. Stone and boulders are plentiful.

In the extreme southeastern corner of the county in the southeastern portion of Caledonia township, there is a remnant of Lower Magnesian limestone which outcrops or comes very near the surface in Sections 11, 12, 13 and 14.

All of the remainder of the county, which makes up a total of over half of the area surveyed, has Potsdam sandstone as the surface rock formation. As this rock is rather soft there are but few outcrops, and in most cases it is buried at a considerable depth by glacial, lacustrine and alluvial materials. The accompanying sketch shows the extent of the three rock formations within Waupaca County.

All of the county has been traversed by an ice sheet of the Late Wisconsin glaciation. The section of the county having the most pronounced glacial features is the west half of the county, and especially the northwest quarter. Stream terraces and outwash plains are numerous in the southwestern part of the county, and rather extensive terraces are also found along Pigeon River in the north-central part of the county. Extensive alluvial deposits occur along the Embarrass and Wolf Rivers. Pot-holes, recessional moraines and drumlins are other evidences of glaciation which are found in various parts of the county. Marshes are quite plentiful, and from a geological standpoint the topography of the whole area is young. The

large number of boulders which occur have probably not been transported for any great distance.

The rock formations in the county have contributed to a greater or less extent in the formation of the soils. By far the greater proportion of the material has come from crystalline rocks and from sandstone. Since these materials were first deposited by the ice sheet they have been modified by running water, by the action of wind, by weathering and by accumulation

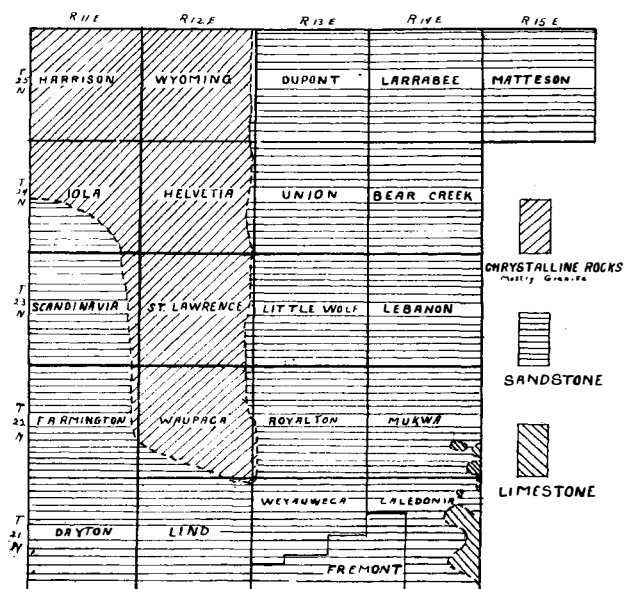


Fig. 2. Sketch map showing the surface rock formations in Waupaca County. All of these formations have contributed to the making of the soils.

and decay of vegetable matter. In the soil survey of Waupaca County the soils have been classified into eight series and thirty-two types, not including peat. In several instances, phases of some of the types have been recognized.

The soil series (which correspond to the family groups) are not shown on the soil map which accompanies this report, and are described here only very briefly. The individual soil types, however, are shown on the map, each being indicated by a distinct color. It is the soil type in which we are especially interested, since the type is the unit in mapping and classification of soils. Following is a complete list of the soil types mapped in the county and the series or family groups to which each type

belongs. Following this general discussion of the soils will be found a full and detailed description of all of the types, together with statements covering the present uses of the soils and the methods through which each type can best be improved.

The Kennan series includes light colored upland soils in the timbered regions where the soils have been derived through glacial action from granitic rocks. These soils are always acid, and are frequently quite stony. The types mapped in Waupaca County are the Kennan fine sandy loam, loam and silt loam.

The Antigo series also includes light colored upland soils in the timbered region where the material has been derived from glacial granitic debris which has been deposited by water in the form of level plains taking the form of outwash plains or stream terraces. The lower subsoil of the types in this series is usually sandy or gravelly. The types mapped are the fine sandy loam, loam and silt loam.

The most characteristic feature of the Superior series is the heavy red clay subsoil which was deposited in quiet waters and later modified to varying degrees by glacial action. Typically the surface is level or nearly so, and the natural drainage somewhat deficient. Where the surface is sufficiently rolling to insure fair to good drainage the term "rolling phase" is attached to the various types. The types mapped here are the Superior sandy loam, fine sandy loam, loam, silt loam and clay loam. All of these types except the clay loam have a rolling phase which is shown on the map.

The Coloma series includes light colored upland soils where the material has been derived chiefly from sandstone rocks through glacial action. Varying amounts of granitic material are mixed in with the sandstone particles. The types mapped are Coloma sand and fine sand.

The Plainfield series is made up of the same material as the Coloma except that it has been deposited by water in the form of level plains, known as stream terraces or outwash plains. The types mapped are the Plainfield fine sand, sand and sandy loam.

The Whitman series includes dark brown to black soils which occur in depressions or along stream channels where the material has been derived largely from granitic glacial drift. On account of the low position and poor drainage there has been an accumulation of organic matter which accounts for the dark color. The only type mapped in this area is Whitman silt loam.

The Poygan series includes the dark brown to black soils which occupy depressions in the region of Superior soils. The subsoil is the same heavy red clay found under the Superior types. The natural drainage is poor and there has developed a considerable amount of organic matter in the surface soil. The types mapped are Poygan fine sandy loam, silt loam and clay loam.

The Dunning series includes dark colored, light textured soils occupying low poorly drained areas, chiefly in the region where the soils are largely of sandstone origin. The only type mapped in the series in Waupaca County is Dunning fine sandy loam.

The Genesee series includes the brownish soils which occur as first bottom land along the streams of the area. This land is subject to annual overflow and so can seldom be utilized for cultivated crops. The types mapped are the fine sandy loam and silt loam.

In addition to the soils included in the nine series described above, a large amount of peat has been mapped. This peat consists of accumulations of vegetable matter in varying stages of decomposition and with which there has been incorporated a small proportion of mineral matter.

In subsequent pages of this report the various soil types mapped in Waupaca County are discussed in detail. The distribution of the various soils is shown on the map accompanying this report.

CHAPTER II.

GROUP OF HEAVY SOILS

KENNAN SILT LOAM

Extent and Distribution.—This type is not extensive, it covering a total area of less than 16 square miles. It is confined almost entirely to the northwest quarter of the county. Tracts seldom exceed two square miles in extent. Most of this soil is found north of Waupaca, between Waupaca and Scandinavia, to the west of Scandinavia, and also to the west and south of Iola.

Description.—The surface soil of this type to a depth of about 10 inches consists of a brown or grayish-brown, or in the upper few inches of virgin areas dark brown, friable silt loam. The subsoil consists of yellow or light yellowish brown silt loam, which usually becomes somewhat heavier with depth to 16 to 24 inches, where the texture is lighter,—a fine sandy loam, sandy loam, or sandy clay loam, usually containing varying amounts of fine gravel. The line between the silty covering and the coarser material is often quite sharp. The surface material is usually free from gravel, while the deep subsoil may contain a considerable amount of it. Boulders occur on the surface in rather irregular distribution. In places they are sufficiently numerous to interfere with cultivation. Some have been removed, but others are so large that moving them is difficult. Some areas are practically stone free.

Topography and drainage.—The surface varies from gently rolling to hilly, and because of the surface features the natural drainage is good. There is not much danger from erosion, although this should be kept in mind, and the steeper slopes kept covered with a growing crop as much of the time as possible.

Origin.—The material forming this soil has been derived largely from crystalline rocks through glacial action. Nearly all of the boulders present are of crystalline rocks also. There is no calcareous material present and both soil and subsoil are acid.



SHOWING GENTLY ROLLING SURFACE FEATURES CHARACTERISTIC OF A LARGE PROPORTION OF THE SOIL IN THE KENNAN SERIES.

Many areas of this soil are stone free, or nearly so. The silt loam, loam and fine sandy loam as found in this county are for the most part, very good agricultural land.



SHOWING UTILIZATION OF STONY LAND.

Soils of the Kennan series are stony in some places and stone free in other places. Where the stones interfere seriously with cultivation, the land, such as shown here, supplies excellent grazing.

Native vegetation.—The original timber growth on this soil consisted of maple, birch, hemlock, with some basswood, oak and elm. Some white and Norway pine were also mixed in with the hardwood. All of the pine has been removed, and the best of the hardwood has also been cut, but there are still limited tracts where some merchantable timber remains.

*Present agricultural development.**—A considerable proportion of this type is cleared, under cultivation, and in highly improved farms. It is good soil for general farming and dairying—the chief lines to which it is devoted. The chief crops grown are small grain, corn, and hay. Potatoes are also grown on a commercial scale on some farms, and sugar beets do well, though not grown to any extent at present. Peas are grown to a limited extent. Corn for ensilage is a certain crop, but corn will not always mature in this latitude on account of frosts. By growing early varieties and by selecting the fields which warm up readily and permit early planting, the danger from frosts can be materially reduced. Commercial fertilizers will hasten growth and frequently reduce the time required for maturing the crop by one or two weeks.

ANTIGO SILT LOAM

Extent and distribution.—This type is of limited extent and is found chiefly in the west central part of the county in the vicinity of Sheridan, about 2 miles north of Waupaca, south of Scandinavia and between Scandinavia and Iola.

Description.—The surface soil of the silt loam to an average depth of 8–10 inches consists of a grayish brown silt loam which frequently approaches a loam in texture. The material is usually rather compact in its natural condition but when placed under cultivation, its structure permits the securing of good tilth very readily. The upper subsoil consists of a light brown, compact loam or silt loam which at about 14–16 inches grades into a buff colored or slightly yellowish brown silty clay loam. Below 24 inches, the subsoil changes abruptly into a mixture of sand and gravel containing very little clay. The depth to this gravelly material is variable and in several instances was found to vary from less than one foot to about three feet.

* For chemical composition and fertility see page 20.

In most cases this soil is free from large stones and boulders; although about the margins of areas some may be found, and stones from 4-8 inches in diameter may also occur in small numbers.

Topography and drainage.—The surface varies from level to very slightly undulating and because of the underlying coarse material, the natural drainage is good. There are only a few small sags or potholes where the drainage is deficient.

Origin.—The type is of alluvial origin and consists largely of crystalline glacial debris deposited as outwash material or valley fill. None of the soil-forming particles are of a calcareous nature, and the type shows varying degrees of acidity.

Native vegetation.—The original timber growth consisted of maple, birch, and hemlock with a small amount of pine.

Present agricultural development.—Antigo silt loam is an excellent soil and most of it is cleared, placed under cultivation, and in prosperous farms. Its freedom from stones makes it more desirable than some of the upland types. The type is well adapted to small grains, grasses, potatoes, root crops, etc. Corn makes excellent silage and often matures, but cannot be counted on to mature every season.

CHEMICAL COMPOSITION AND FERTILITY OF ANTIGO SILT LOAM, AND KENNAN SILT LOAM

The soils of the Antigo, and Kennan series have a good supply of the mineral elements phosphorus and potassium.

Phosphorus.—The total amount of phosphorus in an acre to a depth of 8 inches varies from 1,100 to 1,400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorous has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorous content of this layer of soil is retained at from 1,500 to 2,000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorus—in fact they contain on the average approximately 30,000 pounds

of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorous which goes to the grain and is, therefore, more likely to be sold.

Organic matter and nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctly low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. However, the vegetable matter which they do contain when first cleared and broken is of an active character, but provision should be made for maintaining and increasing this material. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively few farms is there sufficient manure produced to maintain the organic matter in soils of this character and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in the organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soy beans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element.

When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm, but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and liming.—Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1,000 to that which would require 5,000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops but is an indication that there is not enough lime present for crops which need a good deal of that element. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land. Other crops also are benefited by lime.

Crops.—The Antigo and Kennan soils are adapted to a wide range of crops including corn, potatoes, and root crops as well as grasses and small grains. The soils of these types are well adapted to the development of dairy farming on account of their unusual fitness for the growing of hay and pasture.

SUPERIOR CLAY LOAM

Extent and distribution.—The Superior clay loam is confined to the eastern half of the county chiefly to the south eastern quarter within the valley of the Wolf River. The most important areas are found in the vicinity of Fremont and Weyauwega. A few small tracts are found near Clintonville and Northport also, and others are scattered about through the eastern part of the area.

Description.—The surface soil of this type to an average depth of 6 to 8 inches consists of a grayish-brown to light chocolate brown clay loam or frequently a silty clay loam. The subsoil is a heavy, compact pinkish-red clay which extends to a depth greater than three feet, though below 30 inches the ma-

terial frequently becomes somewhat lighter, both in color and texture. Throughout the subsoil thin streaks of ashy gray frequently appear, and it is probable that these mark the location of former cracks into which surface silty material has been washed. Upon drying large cracks are formed in the surface and these extend to a considerable depth into the subsoil. These are of course most noticeable in uncultivated fields. Occasionally water worn gravel and a few small stones are found upon the surface and mixed with the soil but these are always of very limited number. In some places in the deep subsoil there is found a substratum of medium to fine sand. This is seldom more than a few inches thick when the red clay is again encountered. This condition is found chiefly east of Fremont.

Topography and drainage.—The surface of the Superior clay loam is level or nearly so, and because of the heavy character of the subsoil the natural drainage is deficient. Many farmers have laid out open ditches or have laid out the fields in narrow lands so that the dead furrows would serve as surface drains. Some of the most progressive farmers have installed tile drains with very marked success and it is only a question of time until practically all of this type will be fully tile drained.

Origin.—The material forming this soil is largely of lacustrine origin, but since its first deposition by quiet waters it has been more or less influenced by the action of glacial ice. Typically the Superior soils contain considerable carbonate of lime, and varying amounts are found in this type, especially in the subsoil. The surface is usually not acid, though in some cases a slight acidity has developed.

Native Vegetation.—The original timber growth consisted of hickory, oak, elm, birch, some maple, and poplar. By far the greater part of the timber has been removed.

*Present agricultural development.**—A considerable proportion of the Superior clay loam is being utilized for farming purposes. The best drained portions are devoted to cultivated crops, and the less well drained tracts are used for hay and pasture. When thoroughly drained this is an excellent soil, though somewhat difficult to handle because of its heavy texture. It is devoted to general farm crops consisting of hay, small grains, corn and potatoes, and where drained good yields are secured.

* For chemical composition and improvement of this soil see page 25.

Considerable fall plowing is done and in general up-to-date methods of cultivation are being practiced.

SUPERIOR SILT LOAM

Extent and distribution.—This type is of limited extent and is confined to a few areas in the eastern half of the county. The more important tracts are found east of Clintonville, and north and northwest from Manawa.

Description.—The surface soil of this type to a depth of from 6 to 8 inches consists of light brown friable silt loam which contains only a moderate amount of organic matter. In some of the lower locations the surface contains more organic matter than the average and here the color is somewhat darker than usual. The subsoil consists of a light reddish to pinkish red heavy compact clay loam which extend to a depth of over 3 feet. On drying large cracks are formed in both soil and subsoil, especially in uncultivated places, and a section of the soil shows light colored streaks which were crevices into which some of the surface silt was washed. This soil is quite uniform, and closely resembles the clay loam type. The chief difference being the surface soil is somewhat more silty in character.

Topography and drainage.—The surface is level to very gently undulating, and because of the heavy nature of the subsoil the natural drainage is deficient. Where the type borders the rolling phase of Superior soils into which it grades very gradually it is frequently difficult to establish a boundary line, since the only difference between is in topography.

Origin.—In origin this type is identical with the Superior clay loam, having been deposited in quiet waters, probably during interglacial time and then having been modified to a limited extent by glacial action.

Native vegetation.—The original timber consisted of hickory, elm, oak with some ash and willow in the wettest places.

*Present agricultural development.**—Most of this soil is cleared and being used for some agricultural purpose. Where drained it is mostly cultivated and excellent crops are usually secured. Where not drained it is used chiefly for hay or pasture for which it is very well suited. When properly drained this is an excellent soil and well adapted to general farming

* For chemical composition and improvement of this soil see page 25.

and dairying. The chief crops grown are small grains, corn and hay.

SUPERIOR SILT LOAM, ROLLING PHASE

This type is of limited extent and therefore of minor importance. The largest tracts occur southeast and southwest from Marion and north of Manawa.

The surface soil of this soil to a depth of about 8 inches consists of a brown or light brown silt loam which contains only a moderate amount of organic matter. This is underlain by a grayish silt loam or silty clay loam which at 14 to 16 inches is underlain by the typical pinkish-red heavy clay which is characteristic of the Superior soils. This extends to a depth usually much greater than 3 feet, though frequently in the lower portion of the 3 foot section there may be thin layers of fine sand. A lighter color may also mark the heavy clay at this depth. The soil as a whole is quite uniform. The amount of stoniness is variable however. Some areas being entirely stone free, while some have quite a number of bowlders upon the surface.

The surface of this soil is gently rolling to rolling and the surface drainage is usually good. Along some of the lower slopes where the type adjoins lower lands there are small areas deficient in drainage.

The original timber was the same as on the loam and fine sandy loam types of this series. Most of the merchantable timber has been removed and the land placed under cultivation. Most of the land is well improved, and it is an excellent soil. It is easier to work than a clay loam but sufficiently heavy to retain moisture well and also the fertilizing material which may be applied to it. The same crops are grown as on the loam soil, the same methods are followed, and the same line of improvement will apply.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR CLAY LOAM, SUPERIOR SILT LOAM AND SUPERIOR SILT LOAM, ROLLING PHASE

The chemical analyses of the Superior silt loam and clay loam soils show that their phosphorous content is somewhat lower than the average of other silt loams and clay loams in the State, while the potassium content is considerably larger. Their con-

tent of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections being acid, while in others they contain as high as 10 to 12 per cent of lime carbonate.

Phosphorus.—The comparatively small total amount of phosphorus contained in these soils together with the relatively large amount of iron oxide renders this element somewhat unavailable to growing crops and makes it important that farmers operating on this type of soil see to it that the available supplies of this element are maintained or increased either through the use of feeding stuffs high in this element or the purchase of sufficient phosphate fertilizers. Experiments on this soil at Ashland showed a large increase through the use of phosphate fertilizers in addition to manure. The following table gives the results of some of these experiments.

Crop	10 tons manure only	10 tons manure and 1000 lbs rock phosphate	Per cent of increase
Potatoes	87 bu. per A	128 bu.	47
Rutabagas	108 bu. per A	137 bu.	27
Corn	30.4 bu. per A	36.8 bu.	21
Clover hay	2223 pounds	3177 pounds	43
Clover seed	217 5 pounds	336.7 pounds.	47

The importance of having sufficient supplies of this element is made still greater by the relatively poor drainage which the Superior clay loam has and its consequent tendency to be cold so that crops are slow in maturing. The element phosphorus is particularly helpful in hastening the maturity of crops and the formation of seed.

Potassium.—These soils average over 50,000 pounds of this element per acre to a depth of 8 inches. This potassium, however, in the form in which it exists in the soil is not available to crops and becomes so only as a result of chemical changes which are chiefly brought about through the action of organic matter. When a good supply of active organic matter is maintained the quantity of potassium is sufficient to supply growing crops almost indefinitely and it is only in the case of fields low in organic matter or where crops using unusually large amounts of



AN IMPLEMENT FOR LIFTING AND REMOVING LARGE BOULDERS.

While these stones are undesirable, and interfere with the cultivation of the land, it is usually true that where they occur the soil itself is of good quality.



SHOWING SURFACE FEATURES TYPICAL OF THE SUPERIOR SERIES OF SOILS.

This Superior soil has a high agricultural value.

available potassium are grown that fertilizers containing this element need be used.

Nitrogen and organic matter.—Nitrogen exists in the soil almost entirely in combination with organic or vegetable matter. In this soil the vegetable matter is relatively low and should be increased. The accumulation of organic matter high in nitrogen is most readily brought about through the growth of legumes such as clover, alfalfa, or soy beans. These may either be turned under as green manuring crops in which case all of the nitrogen collected from the atmosphere is returned to the soil and made available to succeeding crops, or they may be fed to animals and the manure returned to the soil so that a portion at least of the nitrogen gathered from the atmosphere is returned to the land to add to the supply already there. Whatever system of farming is followed on this type of soil should involve a rotation one member of which is a legume.

Lime and soil acidity.—This soil was originally laid down in an extension of Lake Superior as a sediment and in this a considerable amount of lime carbonate was deposited. This water-deposited soil was then worked over by the ice during the glacial period. Since this time the lime has been dissolved out of portions of the soil to a considerable extent, but other parts, less pervious to the water or containing large amounts of lime, still retain considerable quantities of this material. As a result these soils have become acid in patches, but as a whole are not acid and the subsoil still generally contains considerable lime. This is particularly favorable to the growth of clover and alfalfa, but where sorrel or other plants show the development of acidity lime should be used especially for alfalfa.

Drainage.—Where the surface of these soils is level, as is very frequently the case the question of drainage is one of importance. Over practically all level areas tile drains could be installed to advantage. Thorough drainage will make these soils warm up earlier in the spring, insure better tilth and increased yields.

CHAPTER III.

GROUP OF LOAMS AND FINE SANDY LOAMS

KENNAN LOAM

Extent and distribution.—The Kennan loam is one of the extensive and important soils in the area. It is confined chiefly to the west half of the county, and the most extensive areas occur in the northwestern quarter of the area. Throughout the region north of Iola, Northland and Big Falls, and north to the county line, the loam is the predominating soil.

Description.—The surface soil of this type to a depth of from 10 to 12 inches consists of a brown, or grayish-brown, or buff colored loam or somewhat gritty silt loam. This is underlain by a brown compact gravelly sandy loam or sandy clay which gradually changes at from 24 to 30 inches or below into material of a much more sandy and gravelly nature. The gravelly material is frequently so plentiful in the subsoil that boring is impossible in the lower depths. Typically there are a moderate number of stones and bowlders on the surface and through the soil, but these are not so numerous as to interfere seriously with cultivation. There are marked exceptions to this rule, however, and in some cases the number of stones and bowlders is so great as to interfere seriously with cultural operations. In such cases their presence has been indicated on the map by appropriate symbols. From many fields the stones have been removed and some stone fences are seen in various parts of the area. In places there is a small amount of gravel on the surface and in the upper subsoil, but such material is most abundant in the lower subsoil. The texture of the Kennan loam is somewhat variable and frequently approaches a fine sandy loam. In fact some areas of fine sandy loam have been included where they were of limited extent and where the change of one type to another was very gradual.

Topography and drainage.—The surface of the Kennan loam varies from undulating to rolling and somewhat hilly. Al-

though this type occurs on some of the largest and highest elevations there are comparatively few steep or abrupt slopes, and by far the greater proportion of the type has such a topography as to permit the use of modern farm machinery. Where extremely steep slopes have been found, or where the surface was of a very rough or broken character, a rough phase has been indicated on the soil map. These areas are frequently very stony as well as rough. The soil within the rough phase is also subject to greater variation than typical, ranging from a fine sandy loam to a silt loam. Over the roughest areas some portions have been quite badly eroded. Because of the uneven surface features of the type as a whole, and the character of the subsoil, the natural drainage is excellent. The type contains a sufficient amount of fine material so that it retains moisture well and does not suffer from drought except during extended dry periods.

Origin.—The material forming the Kennan loam has been derived through glacial action largely from crystalline rock formations. This material in a number of cases has been carried by an ice sheet over regions where Potsdam sandstone is the underlying rock, so that the resulting soil consists of a mixture of materials from these two sources. However, the granitic rock material predominates in this soil in practically all cases. There is no limestone material present in the portion of the area where this type occurs and both soil and subsoil show varying degrees of acidity.

Native vegetation.—The original timber growth on this soil consisted of maple, birch and oak, with varying amounts of hemlock, white and Norway pine. A considerable part of the type as found in the extreme northwestern part of the county is still in timber. Where the original timber has been removed there is usually a second growth in which poplar, white birch and hazel brush are plentiful.

*Present agricultural development.**—Probably from one-third to one-half of this type has been cleared and placed under the plow. Where not extremely stony, it is one of the most desirable soils in the west part of the county, and one which has very good agricultural value. It is devoted chiefly to dairying and general farming, with potatoes as an important cash crop. The

* For chemical composition and improvement of this soil see page 33.

type affords excellent grazing, and where the stones are most plentiful the land can be used to best advantage for this purpose. Sheep are raised to some extent, although it would seem that this industry could be materially extended. Corn is raised principally for silage, but when it matures the yield usually ranges from 40 to 60 bushels per acre. Oats yields range from 35 to 60 bushels per acre with some yields reported much higher than this. Barley usually yields from 25 to 35 bushels, and rye from 15 to 20 bushels. The hay, which consists chiefly of clover and timothy, yields from 1½ to 3 tons per acre. Alfalfa is grown to a limited extent, although special treatment of the soil is usually necessary in getting this crop started. Potatoes yield from 100 to 200 bushels per acre and are the most important cash crop grown on the type. Wheat is grown only to a limited extent but gives very satisfactory yields on this soil. Probably the most common rotation followed by farmers on this soil consists of small grain, seeded to clover and timothy,—hay being cut for two years, after which the land is plowed for corn or potatoes and then again followed by small grain. Stable manure is the only fertilizer used to any extent though a small amount of green manuring is practiced.

KENNAN FINE SANDY LOAM

Extent and distribution.—The Kennan fine sandy loam is an important type though not fully improved. It is confined almost entirely to the western half of the county, and chiefly to the northwestern quarter of the area where it occurs in tracts of from 10 or 20 acres to several square miles.

Description.—The surface soil of this type to an average depth of 8 inches is brown or slightly grayish-brown, mellow, fine sandy loam. This material becomes somewhat lighter in color with depth and becomes a yellowish-brown at a depth of from 10 to 18 inches. In texture the subsoil is usually a fine sandy loam containing considerable clay which in places becomes a sandy clay loam. The heaviest portion of the subsoil usually occurs at a depth of from 18 to 24 inches. This may sometimes extend to a depth of 30 inches, but in the lower depths the material usually becomes somewhat more sandy. In some areas the subsoil through its entire section was found to be somewhat sandy, but was not sufficiently light to be classed under another type name.

A lighter phase of this soil was found to occur 4 or 5 miles south of Big Falls where the material approaches a loamy fine sand in texture. The extent here, however, was too limited to justify a separation. The type as a whole is somewhat stony, though as typically developed these stones are not sufficiently plentiful to interfere materially with agricultural development. Where the stones are most plentiful, and where they do interfere with the cultural operations to any marked degree, their presence has been indicated on the soil map by appropriate symbols.

Topography and drainage.—The surface of this soil is undulating to rolling with a few locations which could be classed as hilly. Modern farm machinery can be used on practically all of the type, and because of the surface features and the sandy nature of the soil the natural drainage is good. There is a sufficient amount of clay in the subsoil so that moisture is retained in a very satisfactory manner, and the type does not suffer from drought except during periods of extended dry weather.

Origin.—The material forming the Kennan fine sandy loam has been derived through glacial action chiefly from crystalline rocks though the underlying rock over a portion of the area where this type occurs is Potsdam sandstone. Material from both of these formations is found in this soil, but the crystalline material appears to predominate. There is no limestone material in this region and both soil and subsoil are found to be in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of hardwoods, including maple, oak, birch and some elm. Varying amounts of hemlock, white and Norway pine were found with the original timber growth. Where the land has been cut-over and not put in farms the present growth consists largely of poplar, white birch and hazel brush.

*Present agricultural development.**—This is one of the most desirable soils of the area, although because of its irregular occurrence but few farms are made up entirely of it. A considerable proportion of this soil is under cultivation and in improved farms. The yields which are secured and the methods of farming followed are very similar to those of the Kennan loam. In fact, the type as a whole is very closely related to

* See page 33 for chemical composition and improvement.

this soil, and the boundary line separating them is frequently an arbitrary one.

ANTIGO LOAM

This soil is of limited extent. It is found chiefly in the northwest quarter of the county northeast and west of Scandinavia, north and northwest of Iola, and north of Northland.

The surface soil of this type to an average depth of 10-12 inches consists of a brown or grayish brown loam, or light silt loam of a friable structure. This is underlain by a lighter colored compact loam or silt loam which below 14-16 inches becomes quite gritty, and at about 24 inches grades abruptly into gravel or sand, or a mixture of these materials. As in the silt loam, the depth to the underlying coarse material is variable. Frequently some gravel may occur upon the surface and through the soil section. A few granitic boulders, probably deposited by floating ice, are also found in places, though they are not numerous.

The surface of this type is level or very nearly so, and the natural drainage is good. There are only a few small sags or potholes where the drainage is deficient.

This soil has the same origin as the silt loam and consists largely of alluvial materials deposited by glacial waters as outwash plains or as stream terraces. The parent material was chiefly crystalline rocks. No calcareous material has entered into the formation of the soil, and varying degrees of acidity prevail.

The original timber growth consisted chiefly of maple, birch, hemlock with some white and Norway pine.

Although of limited extent, this is very valuable farming land, and is highly improved. It is used for general farming purposes, and is well adapted to all general farm crops common to the region.*

ANTIGO FINE SANDY LOAM

This soil is of limited extent. One tract of about one square mile occurs 2-3 miles north of Waupaca. Another is found northeast of Big Falls along the Shawano county line. A number of other smaller patches are widely scattered throughout the county.

* For chemical composition and improvement of this soil see page 33.

The surface of this soil to an average depth of 8 inches consists of a grayish brown fine sandy loam which becomes lighter in color with depth. At 14–16 inches a yellowish-brown color may obtain and a small percentage of clay is present. In places there is a gravel deposit at about 30 inches and a moderate amount of gravel may be distributed through the soil section. The areas found in the eastern half of the county are usually free from gravel but are underlain by fine sand instead.

The surface of this type is level, or only very slightly undulating and the natural drainage is good.

This soil consists of alluvial material deposited as outwash or valley fill. The parent material was largely crystalline rocks, but in the central and eastern parts of the county, the glacial debris contains considerable sandstone material and some of this has also entered into the formation of the Antigo fine sandy loam. No. calcareous rocks have contributed to this soil, however, and both soil and subsoil are in an acid condition.

The original timber consisted of maple, birch, hemlock, and some pine.

Most of the soil is cleared and is under cultivation, but because of its being found only in small tracts, but few farms are made up entirely of this class of land. It is mostly well improved and gives good yields of all the general farm crops common to the region. It is excellent potato land and would also make fine soil for truck crops, but its location regarding markets is not such as to encourage the extensive development of this line of farming.

CHEMICAL COMPOSITION AND FERTILITY OF LOAMS AND FINE SANDY LOAMS

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorus and potassium, is nearly if not quite as large in the Kennan and

Antigo fine sandy loams as in the silt loam.* However, they have rather less organic matter and this, together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of securing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

The Kennan and Antigo soils were derived from rocks devoid of lime carbonates and therefore have a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is in a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of

* See page 20.

lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage. These soils of intermediate texture are better adapted to potato culture than are the heavier types on the one hand or the light sandy soils on the other.

SUPERIOR LOAM

This soil is of limited extent and is confined to the eastern half of the county. Some of the type is found in the vicinity of Nicholson and other small tracts near Symco and New London.

The surface soil of this type to an average depth of 8 or 9 inches consists of a grayish-brown mellow loam which contains an appreciable amount of fine and very fine sand. This is underlain by a compact pinkish-red clay or clay loam which continues to a depth greater than 3 feet. Usually the color becomes deeper red, and the structure somewhat more plastic with depth. In places there is a small amount of gravel on the surface and mixed with the soil, but as a whole the type is quite uniform. The surface is level to undulating and the natural drainage is in most cases fair to good. Only in the lowest places is it deficient. It is better than on the clay loam and silt loam types.

The loam has the same origin as the clay loam and silt loam types, having been deposited in quiet waters and later modified to a limited extent by glacial action.

The original timber growth consisted chiefly of oaks, hickory, and some elm.

Most of this type is cleared, under cultivation, and in a high stage of development. It is an excellent soil, well suited to the general farm crops commonly grown in the region. Small grains, corn and hay are the chief crops. Potatoes are also grown, but usually only for home use. It is easier to cultivate than the clay loam, and altogether is a somewhat more desirable soil. Stable manure is practically the only fertilizer used at present, though commercial fertilizers are being considered, and experience has shown that properly used they are profi-

table. The soil responds especially well to a phosphate fertilizer.*

SUPERIOR LOAM, ROLLING PHASE

Extent and distribution.—The Superior loam rolling phase is generally associated with other soils of this series. It is confined to the eastern half of the county where it is an important soil. It is most extensive in the southeastern quarter of the county and there are also numerous areas southwest of Marion and east of Symco.

Description.—The surface of this phase to an average depth of 8 to 10 inches consists of a dark brown or grayish brown loam which is usually somewhat gritty. This material usually becomes somewhat lighter in color and more compact in the lower surface section and remains quite loamy to a depth of 14 to 16 inches. While these depths represent the average, there is some variation in this respect and the loamy material in places extends to nearly two feet. The change to the subsoil is usually quite abrupt and the heavy pinkish-red clay is generally found at 14 to 16 inches below the surface. This heavy, compact red clay extends to a depth of more than 3 feet, often times many feet—though in the lower portion of the 3 foot section it sometimes becomes lighter in color, and may contain a few thin layers of sandy material. In numerous places granitic stones and bowlders were originally found upon the surface, but in many fields these have been entirely removed. Places were seen, however, where the bowlders were still present and where they were sufficiently numerous to interfere with cultivation. Gravel and some small rock fragments are frequently present in the soil and subsoil. The gravel and stones are most plentiful along the most westerly occurrences of the type, where it borders the soils of the Kennan series. In many places extensive areas are almost entirely stone free. As a whole the material forming this soil is quite uniform, the chief variation being in the stoniness. There is an exception to this, however, in Sec. 13 and 14 Town of Caledonia where the subsoil is not red, but of a yellowish-brown color. Here the material also rests upon limestone rock which occurs within the three foot section in places. This phase is really Miami loam, but because of its limited extent it was included with the Superior.

* For chemical composition and improvement of this soil see page 43.

Topography and drainage.—The surface of the loam soil ranges from gently rolling to rolling, with a few areas which could be classed only as undulating. Because of the usual surface features the natural surface drainage is generally well established. In some of the lower places it sags, and the draws between hills the drainage is sometimes deficient, but such areas are usually of small extent. Where the type borders the level phase of Superior soils or those of the Poygan or Whitman series there is frequently a narrow strip which would be improved by tile drains. There is seldom danger of serious erosion but on unprotected fields the surface soil washes to some extent during heavy rains.

Origin.—The subsoil of the Superior loam has the same origin as the Superior clay, having been laid down as a lacustrine deposit and later influenced by glacial action. The surface soil may be in part of the same origin, but a considerable proportion of the surface soil doubtless came from crystalline rock material. Some of it, and especially the more sandy phases, probably came from sandstone rock. In a few places the surface soil shows slight acidity, but the subsoil is not acid and usually contains a considerable amount of lime carbonate.

Native vegetation.—The native timber growth on this soil consisted chiefly of maple, oak, ash, hickory, walnut, and some pine. While by far the greater proportion of the merchantable timber has been removed there are still many farm wood lots containing the original timber.

*Present agricultural development.**—A large proportion of the type is cleared and under cultivation and it is one of the best soils for general agriculture within the county. All of the crops common to the region are grown successfully upon it but the chief type of farming is general farming with dairying as the chief branch. Small grains, corn and hay are grown most extensively. While most of the hay is clover and timothy, alfalfa is coming to be an important crop and is being grown with success on many farms. Potatoes are grown for home use on all farms and on a number commercially. The most common crop rotation consists of small grain, hay, corn, to which may be added a year of pasture after one or two years of hay, making a four or five year rotation. Stable manure is the chief

* For chemical composition and improvement of this soil see page 43.

fertilizer used though commercial fertilizers are now being tried by some farmers with marked success.

SUPERIOR FINE SANDY LOAM

Extent and distribution.—This soil is found in scattered areas in the eastern half of the county associated with other types of the Superior series. Of the larger developments may be mentioned the one north from Bear Creek, and those between Clintonville and Embarrass. The total extent of the type is comparatively small.

Description.—The surface soil of this type to a depth of 10 inches consists of a grayish brown fine to very fine sandy loam, containing a moderate amount of organic matter. In low places the surface is darker than typical owing to a greater accumulation of vegetable matter. The subsoil consists of a pinkish-red clay loam which may extend without change to over 3 feet, though frequently fine sand is encountered at about 30 inches. In the lower depths the color is also lighter. The depth of the surface soil over the clay is variable and may range from 6 inches to 16 or 18 inches.

Topography and drainage.—The surface of the Superior fine sandy loam is level to undulating and except in the lowest places the natural drainage is fair to good. In the depressions or level tracts it is sometimes deficient.

Origin.—The subsoil of this type has the same origin as the remainder of the Superior types, but the surface has doubtless been influenced to a greater extent by glacial action than has the heavy clay subsoil.

Native vegetation.—The original timber consisted chiefly of maple, elm, oaks, birch and some poplar, with now and then a white pine.

*Present agricultural development.**—The greater part of this type has been brought under cultivation. The lowest and more poorly drained portions are devoted chiefly to hay and pasture, but on the remainder of the type good yields of the general farm crops are secured. The soil is not difficult to cultivate and a good mellow seed bed can be readily secured. Corn, small grain, hay and potatoes are the most important crops. This type is much better adapted to potato growing than the

heavier soils of this series. Alfalfa is grown in some localities with good success.

SUPERIOR FINE SANDY LOAM, ROLLING PHASE

Extent and distribution.—This soil is confined almost entirely to the eastern half of the county where it occurs in numerous tracts of from less than one mile to 3 to 5 square miles in extent. Its continuity is broken by other soils of this series and also by tracts of peat and soils of the Antigo series.

Description.—The surface soil of this phase to a depth of about 10 inches consists of a grayish-brown fine sandy loam. In a few places the material approaches a fine sand in texture. The lower portion of the soil section becomes somewhat lighter in color, due to the smaller amount of organic matter present. The subsoil usually begins quite abruptly and consists of a pinkish-red compact clay or clay loam. This usually extends to a depth much greater than 3 feet, though in the lower portion of the 3 foot section it is quite common to find thin layers of fine sand. The color of the clay is often lighter at this depth. A small amount of gravel sometimes occurs upon the surface and small rock fragments may be found through the soil section. Granitic boulders are also quite plentiful upon the surface, and in places are sufficiently numerous to interfere with cultural operations. In many fields these have been removed and placed in piles along the fence rows. Much of the type is practically stone free. The depth to clay is variable but seldom exceeds two feet.

Topography and drainage.—The surface of this soil ranges from gently sloping to gently rolling and in some cases rolling. Because of the uneven surface features the natural drainage is well established. In no place is the type too broken to permit the growth of cultivated crops. Erosion is not a serious problem, though on the more rolling areas there is some danger of washing when the fields are bare, especially during the heavy rains of spring, when the ground is saturated with water.

Origin.—In origin the subsoil has the same source as other Superior soils, having been first laid down as a lacustrine deposit probably during interglacial times and later influenced to a greater or less extent by glacial action. The surface sandy

* For chemical composition and improvement of this soil see page 43.

material probably comes largely from crystalline and sandstone glacial debris. Most of the gravel, stones and boulders associated with this soil are largely of crystalline rock origin. The surface soil is frequently slightly acid, but the red clay subsoil is not acid and usually contains considerable carbonate of lime.

Native vegetation.—The original timber growth on the soil consisted of maple, oak, elm, hickory, some walnut and varying amounts of pine. Most of the merchantable timber has been removed, though there are numerous farm wood lots in which there is still valuable timber. No extensive tracts of native forest, however, are found on this soil at present.

*Present agricultural development.**—By far the greater proportion of this soil is cleared, under cultivation, and highly improved. It is devoted chiefly to general farming and dairying, and practically all of the crops common to the region are grown upon it. It is an excellent general farming soil, and some of the most highly improved farms of the region are found upon it. The surface soil is sufficiently sandy to make cultivation easy, while the subsoil is heavy so that moisture, and fertility is retained. The surface is uneven enough to insure good drainage, but never too steep to permit the use of modern farm machinery. It occurs in good sized tracts so that many farms are located entirely upon this one soil type. The crops grown are corn, oats, barley, rye, wheat, clover, timothy, alfalfa, potatoes, and other root crops. In addition some truck crops are also grown, but the trucking industry has not been developed on a commercial scale in any part of the county, although this soil is well suited to the growing of trucking crops.

The general methods of farming followed are usually such as tend to gradually improve the soil, but there is still considerable room for improvement along these lines. The rotation most commonly followed consists of corn, small grain, and hay. The field usually being left in hay for two years, and possibly pastured for a year in addition, making a four or five year rotation. Stable manure is the chief fertilizer used, though a number of farmers have started the use of commercial fertilizers with very good results. The supply of stable manure is seldom sufficient to meet the needs of the soil, and the use of commercial fertilizers to supplement this supply is advisable.

* See page 43 for chemical composition and improvement.

SUPERIOR SANDY LOAM

This soil is of rather limited extent, covering a total area of about 4 square miles. It is confined chiefly to the southeastern portion of the area south and southeast from Fremont. Some of this soil is also found north of Weyauwega, and a few scattered areas occur farther north in the interior of the county. The type is usually associated with areas of Superior clay loam.

The surface soil of this type to a depth of 10 to 12 inches consists of a brown or grayish brown loamy sand to light sandy loam. Below this there is usually a few inches of light brown or yellowish loamy sand which is underlain at about 18 inches by a dense, compact pinkish red clay, which extends to 36 inches or more. In some places there is a substratum of yellowish sand, usually water saturated, at about 30 inches. The depth of the sandy material over the clay subsoil is quite variable but the heavy subsoil is always found at 2 feet or less.

The surface is level or gently undulating, and except for a few sags the drainage is fair to good.

The original timber consisted of oaks, maple, birch, some elm and in the wettest places a few willows. Some pine also grew on this soil.

This is a valuable soil for general farming, and most of the crops common to the region are successfully grown upon it. Where drainage is thorough it is a first class potato soil. It is easy to cultivate, and retains moisture well. Where shipping facilities are convenient this soil could well be utilized for more intensive farming operations, since its light surface texture places it in the class of trucking soils.

SUPERIOR SANDY LOAM, ROLLING PHASE

Extent and distribution.—This soil is of limited extent and is confined chiefly to the southern and southeastern portions of the county where it is associated with other types of the Superior series. It is frequently found adjacent to Antigo soils. Of the more important tracts may be mentioned that just south of Weyauwega and that in the vicinity of Readfield. A few smaller tracts are found in the interior of the county.

Description.—The surface soil of this phase to an average depth of 10 inches consists of a rather loose, brown sandy loam, which in places becomes as light as a loamy sand. This is usually underlain by a lighter colored sand or loamy sand for several inches and this in turn grades quite abruptly into the heavy red or pinkish red clay characteristic of the Superior series. A small amount of gravel may be found on the surface and in some localities granitic bowlders occur, though seldom in sufficient numbers to interfere with farming operations. The depth of sandy material over the clay is somewhat variable, but is seldom over 2 feet deep. The amount of organic matter in the surface soil is rather low, except in some of the lower places where a more moist condition has favored the development of more natural vegetation.

Topography and drainage.—The surface soil varies from gently rolling to rolling, and in a few places it is rather hilly. Because of the uneven surface the natural drainage is good.

Origin.—The subsoil of this type is lacustrine in origin and since its finest deposition has been influenced by glacial action. The surface material is doubtless largely of glacial origin in part from sandstone rocks and in part from crystalline rocks. The surface soil is usually slightly acid, but the subsoil is not acid and usually contains considerable lime carbonate.

Native vegetation.—The original timber consisted chiefly of oaks, maple, hickory with some pine in places.

*Present agricultural development.**—Approximately half of the type is being cultivated at present, the remainder being in second growth timber or in pasture. This is a good soil and while devoted chiefly to general farming it is doubtless better adapted to trucking crops and a more intensive system of farming. All crops common to the region are grown, and corn, for example usually does better than on the heavier types because it gets an earlier start in the spring. The soil is easy to cultivate and responds readily to soil improvements. While stable manure is about the only fertilizer now used, commercial fertilizers can be used with profit, and farmers should look into the merits of such fertilizers.

* See page 43 for chemical composition and improvement.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SUPERIOR LOAM,
FINE SANDY LOAM, AND SANDY LOAM

These soils are more open in texture than the group of heavy soils. They have a water holding capacity which is sufficient to insure good pasture, where the land is in grasses. Because of the more rolling surface, and the higher content of fine sand in the surface soil, the natural drainage is better than on the heavy level lands and the soil thus warms up earlier in the spring and does not have the tendency to bake and crack which is characteristic of some of the heavier soils. These qualities make these types better adapted to such crops as corn and potatoes, and also to the growing of fruit.

The total amount of the plant food elements phosphorus and potassium is nearly but not quite as large in the loams and fine sandy loams, as in the group of heavy soils previously described. The amount of organic matter is somewhat smaller, as is also the supply of nitrogen. Because of this and the coarser texture the rate of chemical change may not always be as rapid as in the heavier soils. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or commercial fertilizer becomes more important, especially when crops are grown which are sold from the farm.

An increase of the supply of organic matter in these soils is of great importance. It is desirable to have nearly twice as much organic matter in the soil as these types now contain. The plowing under of legumes, such as the second crop of clover, or a crop of soy beans is a good way of securing this result. The supply of stable manure is usually too limited to meet the needs of the entire farm.

As in the group of heavy soils in this county, and as is quite common in most of the state the phosphorus content of these soils is below normal, and should be increased. Even the use of stable manure will not itself supply the amount of phosphorus needed, and it is a good plan to supplement the use of stable manure with a phosphate fertilizer. Acid phosphate is the most quickly available and under present conditions is doubtless the most profitable form to use. This may be applied with small grain which is seeded to clover and about 250 to 300 pounds per acre should be used. When used with corn it may be drilled in

the row with a fertilizer attachment to a corn planter or drilled in with a regular lime and fertilizer sower just before the corn is planted.

Where general farming is followed and it is desired to build up the organic matter supply the following rotation is a good one to use:—Corn or a cultivated crop one year, followed by a small grain with which clover is seeded, the first crop the following year cut for hay, and the second plowed down as a green manuring crop to be again used for a cultivated crop. When commercial fertilizer is used it may be applied with the small grain or to the corn crop. Where a second crop of clover is not turned down it should be fed and the manure returned to the field in as liberal amounts as can be secured.

The growing of alfalfa should be greatly extended on these soils and every farmer should consider the question of starting a small acreage.

CHAPTER IV.

GROUP OF SANDY LOAMS AND FINE SANDS

PLAINFIELD FINE SAND

The type is of limited extent and is confined chiefly to the eastern half of the county where it is often associated with Coloma fine sand.

The surface soil of this type to a depth of 6 to 8 inches consists of a brown or yellowish brown fine sand underlain by a yellow fine sand to a depth of over 3 feet. Quite a few gravel stones are sometimes found. The type is usually free from gravel as well as stones. Some deep well borings show red clay and it is possible that most of the type may be underlain by such material.

The surface is level or very gently undulating and where the watertable is not close to the surface, the natural drainage is excessive.

The Plainfield fine sand is of alluvial origin and has been deposited as outwash plains or valley fill. A large proportion of it came from glaciated sandstone material though there is some crystalline material also mixed in.

The native timber growth consisted chiefly of oak and white pine with some poplar.

A large proportion of this type is being cultivated, but because of its limited extent and low agricultural value, it can be classed with the soils of minor importance.

General farm crops are grown and cucumbers and buckwheat are also raised to some extent. Dairying is the leading industry.

As with the other Plainfield sandy types, the soil is deficient in organic matter and mineral plant foods. These must be supplied if marked increased yields are to be secured.*

* See page 50 for chemical composition.

PLAINFIELD SANDY LOAM

The largest continuous area of this type of several square miles is found west of Waupaca. Other smaller tracts occur in various parts of the county, though chiefly in the western half associated with the soils of the Kennan series. The small patches which occur in the eastern part of the county contain less gravel than the western areas.

The surface of this type to an average depth of 8 to 10 inches consists of a brown or slightly dark brown sandy loam of medium texture. This is underlain by a yellowish brown sandy loam or a yellowish loamy sand which at from 18 to 24 inches contains a sufficient amount of clay to make the material somewhat sticky when wet. Gravel stones are often sufficiently numerous in the subsoil to make boring difficult. Gravel is also found in places on the surface, and bordering some of the areas boulders are quite plentiful.

The surface of this type is level or nearly so, and because of the coarse material present, the natural drainage is frequently excessive; though the type is not as subject to drought as is the plainfield sand. The small amount of clay in the subsoil greatly assists in retaining moisture.

The Plainfield sandy loam has the same origin as the other soils of the Plainfield series, consisting of alluvial material deposited as outwash plains and valley fill by glacial waters. The parent material was both crystalline rock and sandstone drift and the soil is a mixture from these two sources. No calcareous material is present and both soil and subsoil are acid.

The original timber was chiefly oaks and white pine. All merchantable timber has been cut.

Probably about 75% of this soil has been improved. All the general farm crops common to the region are grown in connection with dairying farming. Rye does well on this soil, but other small grains do not yield as well as on the heavier types. Corn and potatoes yield better than on the sand, and clover can be raised with less difficulty. Some alfalfa is being grown, but liming is necessary to secure and maintain a good stand.*

* See page 50 for chemical composition and improvement.

COLOMA FINE SAND

Extent and distribution.—While by far the greater portion of the material included in this type is fine in texture, there is a marked variation to this in some of the areas to the east of Clintonville. In these areas, the soil and subsoil both consist of very fine sand. Because of its extreme fineness and the presence of organic matter, these areas approach in value the fine sandy loam. The chief areas of very fine sand are found in T. 25 N. R. 15 E. in Section Nos. 14, 15, 21, 22, 23, 24, 25, 26, 27, 34, 35, and 36.

The Coloma fine sand is confined to the eastern part of the county. The areas east of White Lake, south of New London, and those about 5 miles east of Clintonville are the most extensive.

Description.—The surface soil of this type to an average depth of 6 inches consists of a brownish-yellow, loose, fine sand which contains only a limited amount of organic matter. The surface two or three inches has a somewhat darker color than the material immediately below this depth. This is due to the larger amount of organic matter near the surface.

The subsoil consists of a loose yellow fine sand which extends to a depth of at least 36 inches, and usually to a much greater depth. In a few instances, traces of red clay were found a little below three feet. This is the same material which makes up the subsoil of the Superior soils.

Topography and drainage.—The soil has a gently rolling surface which in a few places becomes nearly hilly. It usually occupies the most elevated positions and is thus exposed to prevailing winds. Where the surface is not protected the material is sometimes blown by the wind into dunes. In a few places wind action has rendered this soil unfit for cultivation. Such places, however, are of limited area.

Because of the loose open character of this soil and the surface features, the natural drainage is very thorough and in places somewhat excessive.

Origin.—This soil has been derived largely from glaciated sandstone material. No limestone has entered into its formation, and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of scrubby white and black oak, poplar, and pine.

*Present agricultural development.**—Approximately 75% of this soil is cleared and used for some agricultural purpose. The range of crops grown is more limited than in the heavier soils. Corn and potatoes are grown most extensively, but average yields are low. Clover and grasses do not do well. Small grains are grown, but yields are low. Rye is the most important grain. Buckwheat is a crop of minor importance. Cucumbers are grown in places and frequently produce very satisfactory yields.

VILAS SANDY LOAM

Extent and distribution.—The Vilas sandy loam is confined chiefly to the northwestern quarter of the county. It occurs mostly in irregular areas seldom greater than one or two square miles in extent. Some of the more important tracts are found in the vicinity of North Lake and in the stretch of country between Ogdensburg and Big Falls.

Description.—The surface soil of the Vilas sandy loam to an average depth of about 12 inches consists of a brown or grayish-brown sandy loam or a loamy sand of a rather loose and open structure. This grades into a light brown or yellowish loamy sand which at about 24 inches grades into a gritty sandy clay or sometimes into a light clay loam. Quite frequently this heavy material is in the form of a layer of from 6 to 10 inches in thickness, below which sandy material is again found. In a few instances this heavier layer was entirely absent or only a few inches in thickness. A small amount of gravel is sometimes found upon the surface and mixed with both soil and subsoil. As is the case with the Vilas sand, the sandy loam frequently has upon the surface a number of stones and boulders. Wherever these are found in sufficient numbers so as to interfere with farming operations to any marked extent they have been indicated on the map by means of appropriate symbols. Over most of the type they are not sufficiently numerous to detract from the value of the land.

There is some variation in the type and in a few cases it approaches a fine sandy loam in texture.

Topography and drainage.—The surface of the Vilas sandy loam ranges from gently rolling to rolling and hilly. The type

* For chemical composition and improvement see page 50.

quite frequently occurs as ridges, some of which are quite pronounced. In some instances the slopes are extremely steep, quite frequently eroded and often stony. These extremely rough areas have been indicated on the map separately and referred to as a rough phase. The soil within the rough areas is usually subject to more variation than the typical soil. The topography of the typical soil is such that modern farm machinery can be used on practically all of the areas. On the rough phase this is difficult and it is often impossible to use modern farm machinery.

On account of the irregular surface features and the rather open character of the subsoil the natural drainage is well established and often excessive.

Origin.—This type of soil has practically the same origin as the Vilas sand having been derived through glacial action from crystalline rock material mixed with debris from sandstone rocks. It is probable that the sandy loam however, contains a somewhat larger proportion of material derived from the granitic rocks than is the case with the sand type. No limestone material has entered into the formation of this type, and both soil and subsoil show varying degrees of acidity.

Native vegetation.—The original timber growth consisted largely of oak with some white pine, poplar, birch and a small amount of maple and elm in places. At the present time the cut-over sections which are not cultivated have a second growth of poplar, scrubby oak, hazel brush, and some sweet fern.

Present agricultural development.—Probably somewhat over half of this soil is under cultivation at present, and where improved and where fair methods are followed, usually quite satisfactory returns are secured. Dairying and potato raising are the chief lines of farming. Somewhat better yields are secured than on the sand type. Potatoes are better adapted to this soil than to the Vilas sand, and the type is more readily improved. The most common rotation followed consists of a small grain, followed by clover, and then by corn or potatoes. Some difficulty is experienced in getting stands of clover—one reason being that the soil is acid and needs lime. In a few cases this has been supplied with good results, but on most of the farms no lime has ever been used.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDS AND SANDY LOAMS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in all types except the Vilas sandy loam which contains on an average about 1,150 pounds in the surface 8 inches per acre, or from 25 to 40 per cent more than the other types. The total potassium of the surface 8 inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 per cent in the second 8 inches. They have a correspondingly low nitrogen content averaging from a thousand to 1,500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches. This organic matter is largely in the form of leaf-mold and fine roots and is hence of an active character so that it decomposes quickly when the surface is first broken, furnishing a sufficient supply of nitrogen for a good growth of crops for a few years. It however, is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the

farm is fed. When dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover, occasionally, all of which is to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil fertility. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not be considered that this is an indication that they have less value, than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these fine sands and sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops.

From the above it will be seen that by the use of lime, by increasing the organic matter in the soil, and by the careful use

of commercial fertilizers containing phosphorus, these sandy soils may be improved and made to produce profitable crops.

For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletin 204 and 230 of the Experiment Station.

CHAPTER V.

GROUP OF SAND SOILS

PLAINFIELD SAND

Extent and distribution.—The Plainfield sand is quite an extensive soil. The principal development of the type is found in the southwestern part of the county in the Town of Dayton. It is found in other smaller areas in various other parts of the county, but mostly in the western half. In the northeastern portion this soil is found in the vicinity of Embarrass and along the Pigeon River between Clintonville and Marion.

Description.—The surface of Plainfield sand to an average depth of 8 to 12 inches consists of a loose, rather open sand of medium texture. It has a grayish-brown or yellowish-brown color at the surface, indicating a low content of organic matter. The upper subsoil is often a rusty brown grading into a yellow or light yellow sand which frequently contain a small amount of fine gravel. Gravel and a few small stones are sometimes found in and on the surface soil.

The chief variation in this soil is found in the areas in the eastern and northeastern parts of the county where the material contains less gravel and is frequently entirely free from both gravel and stones.

Topography and drainage.—The surface of Plainfield sand is level to very slightly undulating. In a few places there are pot holes or sags, but these are always of limited area. The slight surface relief is due chiefly to wind action. A few hummocks occur which are quite pronounced sand dunes.

Because of the loose open character of the material the natural drainage is excessive except where the water table comes close to the surface.

Origin.—The soil is of alluvial origin and has been deposited as outwash plains and stream terraces. The material has been derived both from crystalline and from sandstone glacial drift. In the western and north central portions of the county the dark colored crystalline grains are quite numerous; while in the

eastern part there is a larger proportion of quartz grains. There is no calcareous material present and both soil and sub-soil show varying degrees of acidity.

Native vegetation.—The original timber growth consisted of scrub oak, jack pine, and white pine with hazel brush and sweet fern quite abundant. Most of the type has been cleared and placed under cultivation, but because of its low productiveness and droughty condition, some farms have been abandoned. It is not uncommon for fields to remain idle for several years at a time.

*Present agricultural development.**—Probably 75% of this type is under cultivation more or less regularly and while there are some highly improved prosperous farms located upon it, there are more farms that are in a depleted state. The chief crops grown are potatoes, rye, corn and hay. Clover does not do well unless special attention is given to it. Rye does better than other small grains but average yields are low.

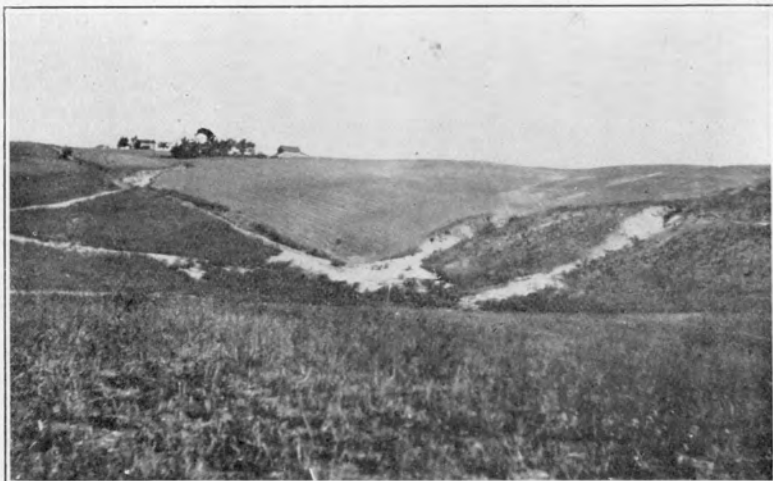
Potatoes are the chief cash crop, and a considerable acreage is grown on nearly every farm each year. Some dairying is carried on, and this is a good system for building up the soil, but the difficulty of securing good yields of forage crops gives this soil a handicap in the dairy industry.

VILAS SAND

Extent and distribution.—The Vilas sand is found most extensively in the southwest quarter of Waupaca County. The most extensive areas are found in Dayton Township and in the southern part of Farrington Township. Smaller areas occur in the northwestern portion of the county, chiefly in the vicinity south of Big Falls. Smaller and less important areas are found throughout the western half of the county.

Description.—The surface soil of the Vilas sand to an average depth of about 8 inches consists of a brown or grayish-brown sand or slightly loamy sand of medium texture. In structure the material is usually loose and open. In some small areas the texture approaches a fine sand, while in others the soil is somewhat loamy, but these variations are not of sufficient extent to be mapped separately. In places the virgin soil is slightly darker than usual in the surface 1 or 2 inches because of the ac-

* See page 56 for chemical composition and improvement.



SHOWING ROLLING SURFACE OF VILAS SAND.

While erosion is usually not a serious problem on sandy soils, these fields, being somewhat steeper than the average, have washed badly. This is due chiefly to furrows which ran up and down the slope along the edge of the fields. The surface water, during heavy rains collected in these furrows and soon cut deep channels. With a little care this could have been prevented. Furrows should be run with the contour of the hills.



SHOWING TYPICAL LEVEL SURFACE OF PLAINFIELD SAND.

This soil is loose and open in structure, somewhat droughty and deficient in both nitrogen and the mineral plant foods. With proper methods of fertilization and cultivation, however, it can be made to produce fair crops as indicated in this view.

cumulation of a small amount of organic matter. After a few years of cultivation, however, this usually disappears. The subsoil consists of a yellow or yellowish-brown sand of about medium texture. This very frequently becomes lighter in color and coarser in texture with increase in depth. In some instances gravel may occur sparingly on the surface, but it is usually more abundant in the subsoil below a depth of 24 inches.

Stones and bowlders of glacial origin are quite commonly found scattered over the surface of this soil, but typically these are not sufficiently numerous to interfere materially with cultivation. In some localities, however, they do interfere with agricultural operations to a marked extent. Such areas are indicated on the soil map by means of appropriate symbols. Where the soil is stony there is frequently more variation in texture than over typical areas of this soil.

Topography and drainage.—The surface of the Vilas sand varies from gently rolling to somewhat hilly. Most of the slopes are rather gentle and the hills fairly well rounded. Many areas have but a gently rolling topography. In the southwestern part of the county many of the areas of Vilas sand stand out in rather sharp contrast to the surrounding level country where the soils belong to the Plainfield series. Because of the surface features and the loose, open character of the soil and subsoil, the natural drainage is very good and often somewhat excessive.

Origin.—Vilas sand has been derived from glacial action largely from crystalline rock formations, although the underlying rock where much of the type occurs now consists of sandstone. The ice sheet in its movement carried the material from the region of the granitic rocks out over the standstone area so that the resulting soil consists of a mixture of the materials from these two sources. Crystalline rock material, however, appears to predominate. No limestone material has entered into the formation of this soil and it is all in an acid condition.

Native vegetation.—The original timber growth on this land consisted of scrubby oak, and some white pine. In the areas toward the northern part of the county some Norway pine was found, and in a few instances hickory has been found growing on this soil. The chief growth at present consists of scrubby oak, hazel and sweet fern.

*Present agricultural development.**—Probably less than half

* For chemical composition and improvement of this soil see page 56.

of the Vilas sand is under cultivation at the present time. Where cleared and under cultivation general farming, dairying and potato raising are the usual lines followed. Potatoes are the most important cash crop and yield from 75 to about 125 bushels to the acre with occasional yields which are somewhat higher where special and improved methods have been followed. Corn yields from 15 to 35 bushels, oats from 15 to 30 bushels, rye from 10 to 15 bushels, and hay from $\frac{1}{2}$ to $\frac{3}{4}$ tons per acre. It is somewhat difficult to get a good stand of clover on this soil and timothy does not succeed very well. The yields on this soil depend to a considerable extent upon the amount and distribution of rainfall and the manure or organic matter applied to the soil. The type is quite easily exhausted by continuous or improper cropping, and the methods followed are usually not those best suited to building up the productiveness of the land.

CHEMICAL COMPOSITION AND FERTILITY OF SAND SOILS

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and they therefore suffer from drought. Moreover, sandy soils are lower in their supply of the chemical elements demanded by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams have fairly good water-holding capacity, and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands, such as the Coloma and Plainfield sands, are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain.

The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or

fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorus in the surface 8 inches per acre averages between 750 and 900 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium in the surface 8 inches per acre is about 25,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1,200 and 1,400 pounds in the surface 8 inches per acre.

When a sufficient supply of active organic matter is developed in these soils a considerable portion of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. But before legumes can be grown with the greatest success the liming of the soil is necessary. The growth of a good crop of mammoth clover or soybeans through the use of lime and mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. In most cases this legume should be plowed under as a green manuring crop.

Probably the best way to get clover started is to seed with a small grain. By using a light seeding of rye, disked or harrowed in and seeded to clover in the spring, a good stand can usually be secured. The seed should be put in a little deeper than on heavy soils, and the drill should be followed by a corrugated roller, or if this implement is not at hand, an ordinary roller, followed by a light harrow should be used. When clover is seeded with a small grain in this way the growing grain helps to hold the soil in place and prevent blowing of the loose soil by the wind.

As the result of careful experiments on extremely sandy soils it appears that the best crop rotation for this class of land con-

sists of rye, clover, and corn. If the fertility is extremely low. it will be advisable to plow under the entire clover crop. If the fertility is fair the first crop may be cut for hay and the second plowed under. While potatoes are quite extensively grown on these extremely sandy soils this crop is not as well adapted to the sand soils as to sandy loam types. It has been shown by actual field tests that the yields of corn, for example, can be more readily increased on the sand soil than can the yield of potatoes. The potato when grown on sand soil does not respond to methods of soil improvement as readily as when grown on soils which contain somewhat more silt and clay. The sandy loams and fine sands and fine sandy loams are much better adapted to potato culture than are the sand soils. It is therefore advisable to reduce, where possible, the acreage of potatoes on sand soils.

With an increased acreage of corn it will be possible to put up enough silage so silage may be used for summer feeding. With this practice less pasture will be required, and this again will be desirable since the sand soils do not supply good grazing, and are not well adapted to any of the grasses. This system would make possible keeping more stock, and with the increased supply of manure the fertility of the land could be more readily maintained.

CHAPTER VI.

GROUP OF POORLY DRAINED SOILS

GENESEE FINE SANDY LOAM

Most of this soil is limited to the valley of the Wolf River where it is found at and below New London. A few other patches occur along the Little Wolf river near Manawa.

The surface soil of this type consists of a brown or dark brown fine sandy loam about 8 to 10 inches deep. Some of the surface soil is more nearly a very fine sandy loam. The subsoil is a lighter brown fine sand, somewhat loamy with frequent thin layers of red clay. In the lower depths there is usually found fine sand. The type is somewhat variable in texture, ranging from a fine sand to a loam, but these separations could not be made because of the limited extend of the phases.

The surface of the type is level, and it is all within the present flood plain of the streams along which it occurs. The natural drainage is therefore very deficient.

The material forming the soil is all of alluvial origin and has come in part from sandstone and in part from crystalline rock material,

The native timber growth consists of elm, ash, willows, coarse marsh grasses and other water loving vegetation.

Since the type is all subject to overflow only a very small part of it has been brought under cultivation. Near New London this soil is being farmed to some extent to truck crops, and good returns are secured when floods do not interfere. Most of the soil is used for pasture and for hay, to which in its present condition it is doubtless best adapted.

The danger from flooding makes farming on this land uncertain, so that the development of this type of soil is not encouraging. To prevent flooding dikes would in most cases be necessary, and such great expense would not be justified under present conditions.

GENESEE SILT LOAM

Most of this soil is associated with the fine sandy loam along the Wolf River. Often a strip of fine sandy loam lies between the silt loam and the river. The sandy soil being slightly higher than the silt loam.

The surface soil of this type to a depth of 10 inches consists of a brown or frequently dark brown rather compact silt loam. The underlying material is of a lighter brown color, in places it has a suggestion of red in it. The subsoil is usually a silt loam or silty clay loam in which lenses of fine sand sometimes occur. The deep subsoil is frequently found to be a fine sandy loam or very fine sand. The type as a whole is subject to considerable variation:

The surface of this soil is level, and as it is low and within the flood plain of streams the natural drainage is very poor. It is subject to annual flooding and in places new material is being added to it each high water.

The timber growth consists of ash, elm, willow, soft maple, coarse grasses and other water loving vegetation. In a few places attempts have been made to cultivate it but the danger of flooding prevent any extensive developments. The soil itself is very fertile and productive, and if the drainage could be perfected it would be a valuable soil. Under present conditions it would not be practicable to attempt to drain it. The use of dikes, and possibly pumping plants would be necessary which would not be justifiable under prevailing conditions.

WHITMAN SILT LOAM

Extent and distribution.—This type occurs in two distinct forms. One is as depressions, or sags in the upland, and the other is as low land bordering streams. The latter is by far the most extensive, and the largest tract of this type is found along the Wolf River just north of Fremont, in the southeastern part of the county. Smaller tracts occur along the same stream in the northeastern part of the county and also along the Embarrass River. A few scattered areas of the other phase occur throughout the remainder of the county, but these are of limited extent.

Description.—The surface soil of this type to a depth of 10 to 18 inches consists of a dark brown or black loam to silt loam

which contains a large amount of organic matter. In numerous places there is a thin layer of peat or muck over the surface of the earthy matter. This organic matter layer, however, is not sufficient to justify classing the type as peat or Muck. The subsoil consists of a black or dark brown heavy loam or silty clay loam which at from 18 to 24 inches usually becomes gray or bluish in color, with numerous yellow and rusty mottlings. In the lower portion of the 3 foot section the texture frequently becomes lighter and is often a fine or very fine sandy loam. The type is subject to considerable variation in texture, depth of the black soil over the bluish subsoil, and also in the sand layer in the deep subsoil. It is uniform however in being all rather heavy, dark colored, high in organic matter and all poorly drained, giving it all a uniformity in its present agricultural value.

Topography and drainage.—The surface of this type is level, or having only a very gentle slope toward the stream along which it occurs. The small depressed tracts frequently have a saucer shape. Because of its low position, and its situation adjacent to streams its natural drainage is very deficient. Practically all of that along streams is subject to overflow, and much of it is under water for some portion of each year.

Origin.—The portion of the type adjacent to streams is largely of alluvial origin with a large accumulation of organic matter in surface. The parent material came largely from the crystalline rock region, although within the area much of the soil lies directly over sandstone formations. The part of the type which is not adjacent to streams is largely of glacial origin and occurs chiefly in shallow potholes or slight depressions where drainage is deficient, and where there has been an accumulation of organic matter. In most cases there is no lime carbonate in the material forming this soil and the material shows varying degrees of acidity.

Native vegetation.—The native vegetation on this soil consists of willows, elm, ash, soft maple, and some poplar. There are quite extensive tracts which are treeless, and where there is now only a dense growth of coarse marsh grass.

Present agricultural development.—The chief use made of this soil is for pasture and hay, but a considerable part of it is too wet even for such use.

Chemical composition and fertility.—The Whitman silt loam is quite similar to the Clyde silt loam of southeastern Wisconsin,

differing chiefly by being acid, while the Clyde soils are not acid. From the standpoint of plant food elements which they contain these two types represent the best balanced soils in Wisconsin.

Whitman silt loam contains from 3-5 times as much nitrogen and organic matter as does the average light colored heavy soil of the same region. It contains from 1,500 to 2,000 pounds per acre of phosphorus in the surface 8 inches, and from 40,000 to 50,000 pounds of potassium.

In the improvement of this type the first step is to supply adequate drainage. Open ditches will not be sufficient by themselves, and should be supplemented by the use of tile drains. When well drained this will be one of the strongest and naturally most productive soils of the county. Because of the extremely low position the reclaiming of some of this land would require diking, which under present conditions would not be justified.

DUNNING FINE SANDY LOAM

Extent and distribution.—This soil is found rather widely distributed throughout the county, usually in small bodies and narrow strips along water courses. In but few instances does a single area exceed one square mile in extent. The soil is found most extensively in the eastern half of the county—mostly in the southeastern quarter, where it is associated with other low-lying soils along the valley of the Wolf River. Smaller tracts occur along the Embarrass River and also along smaller streams of the county.

Description.—The surface soil of this type consists of a dark brown to black fine sandy loam extending to a depth of from 8 to 12 inches. In places the texture approaches a sandy loam, while in other places it is nearly a very fine sandy loam. In all cases it contains a large amount of organic matter and there is frequently a thin covering of peaty or mucky material over the surface of the type. This is not deep enough, however, to be classed as shallow peat. The subsoil consists of a grayish, or grayish brown fine sandy loam or gritty sandy clay loam containing considerable silt in places. The deep subsoil is often mottled, especially where there is the most clay present. The texture of the type is quite variable but is always somewhat sandy, high in organic matter and low-lying.

Topography and drainage.—The surface of this type is level, it is all low lying and the natural drainage is very deficient. Much of the type is subject to overflow and portions of it are under water for a time each year.

Origin.—That portion of the type adjacent to streams is largely alluvial in origin, while that more distant from streams is largely glacial, occurring in old lake or pond beds. The parent material came in part from crystalline rock regions, and in part from sandstone formations. In most cases the material is acid.

Native vegetation.—The native vegetation consisted of elm, willows, ash, soft maple, some poplar, and coarse marsh grasses. Many areas are treeless and support only coarse grasses.

Present agricultural development.—The chief use made of this soil is for hay and pasture but much of it is too wet most of the year even for such use. In a few instances better drained parts of the type have been placed under cultivation, and during seasons of limited rainfall good crops are produced.

Chemical composition and fertility.—This soil is well supplied with nitrogen and organic matter, but is usually deficient in the mineral plant foods phosphorus and potassium. The greatest deficiency, however, is in drainage, and before cultivated crops can be grown successfully a thorough system of drains must be provided. Open ditches as now installed are not sufficient in themselves, and must be supplemented either by open laterals, or tile drains, or both. When drainage has been provided it will be found that the most economical and profitable crop production can be secured by the use of mineral fertilizers containing phosphorus and potassium. Such crops as alsike clover and timothy, buckwheat, and corn may be expected to give best results on this kind of land under good management.

POYGAN CLAY LOAM

The surface soil to a depth of 8 to 10 inches consists of a dark brown to black silty clay loam to silty clay. This is underlain by a light brown, drab, or bluish silty clay often mottled with brown and yellow. At from 14 to 20 inches the material changes to a plastic clay streaked or spotted with pinkish-red and bluish-gray. With increasing depth the reddish color becomes more pronounced until at from 20–24 inches the material becomes a dense, pinkish red clay similar to the subsoil of the Superior soils.

This type is of limited extent and occurs in many small widely scattered areas throughout the eastern half of the county. It is found mostly in small pockets or sage of less than 100 acres in extent. The largest area mapped lies north of Bear Creek.

The surface is flat or saucer shaped, and the natural drainage is poor. Water frequently stands on the surface in the spring and after heavy rains. Before it can be used for cultivated crops drainage is necessary. The material forming this soil is largely of lacustrine origin though it has doubtless been modified to some extent by glacial action. There has been accumulated at the surface a large amount of organic matter which accounts for its dark color. This soil is seldom acid, and the subsoil frequently contains considerable lime carbonate.

The native timber growth consisted of elm, ash, willow with considerable coarse grass and other water loving vegetation.

This is naturally a strong productive soil when drained, but only a very small proportion of it has been placed under cultivation. Where cleared, it is being utilized chiefly for grazing and for hay.*

POYGAN SILT LOAM

The Poygan silt loam is not an extensive type but it is found in numercus small tracts throughout the northeastern portion of the county. There is also some in the southeastern part of the area. It frequently borders marshes, and is also associated with soils of the Superior series.

The surface soil of this type to an average depth of about 12 inches consists of a dark brown or black silt loam which contains a very high proportion of organic matter. While much of the surface is a silt loam the type is somewhat variable, and many of the areas approach a loam in texture and there is also some fine sandy loam included with the type.

The subsoil consists of a gray or bluish silt loam which continues to from 24 to 30 inches where the typical red color of the Superior clay loam is found. At or near three feet, beds of sand or fine sand are frequently found. The upper portion of the subsoil is subject to some variation. It may be no heavier than a loam with which there is mixed more or less gritty material. Entire absence of the red clay was noted in places.

* For chemical composition and improvement of this soil see page 66.

The surface of this type is low, level and naturally very poorly drained. Most of it is so situated, however, so that it can be drained by the use of tile.

The material forming this type is largely lacustrine but since its deposition there has been added to it large accumulations of organic matter through the growth and decay of a rank vegetation. Before this organic matter accumulated the material had doubtless been influenced to some extent by glacial action. The material, especially in the subsoil, is of a calcareous nature, and the type is very seldom found to be in an acid condition.

The original timber on this land consisted chiefly of elm, soft maple, ash, willows, alder, coarse grasses and other water loving vegetation.

Because of the naturally poor drainage, only a small part of this type has been placed under cultivation. It is a rich productive soil, and when thoroughly drained makes excellent farming land. Most of it is now utilized chiefly for hay and pasture.*

POYGAN FINE SANDY LOAM

The surface soil of this type consists of a black, or very dark brown fine sandy loam or loam which contains a large amount of organic matter. This usually extends to a depth of about 12 inches where the material becomes lighter in color, and usually heavier in texture. At about 18 inches a drab, gray or bluish silt loam or loam somewhat gritty is found and this continues to from 2 to 3 feet where the red clay typical of the Superior series is usually but not always found. The lower subsoil is quite variable and may be a sticky sandy loam or loam of a bluish color. In a few places it was a fine sand. It is probable however that the heavy red clay occurs beneath all of this soil, although not always within reach of the soil auger used.

This soil is of limited extent. It is found chiefly in the north-eastern quarter of the county. Several small tracts occur east and west of Embarrass, three miles north of Bear Creek, and about three miles northwest of Clintonville.

The surface is level, low lying and the natural drainage very poor. It is found associated with other Poygan soils, and with types of the Superior series. It frequently occurs bordering marshes.

* See page 66 for chemical composition and improvement of this soil.

The red subsoil has the same origin as the Superior soils, but it is probable that the sandy portion of the material may have been washed in from the higher lying lands adjoining. The dark color is of course due to the growth and decay under moist conditions of a rank vegetation.

The native timber vegetation consisted of elm, ash, willows, alder, coarse grasses and other moisture loving vegetation. But little of this soil is cleared and cultivated because of the poor drainage condition. Most of it is devoted to pasture or to hay, although some is still in timber and is not utilized at all. When thoroughly drained this will be an excellent soil for farming crops and also for numerous trucking crops, where other conditions are favorable for the development of intensive farming operations.

CHEMICAL COMPOSITION AND FERTILITY OF POYGAN CLAY LOAM,
SILT LOAM, AND FINE SANDY LOAM

These types of soil are characterized by having relatively large amounts of organic matter, accumulated as a result of poor drainage. The supply of phosphorus in these soils is usually fairly high, but in many cases it is not readily available. Its availability will depend largely upon the rate of decomposition of the organic matter. The total amount of potassium in these soils is fair in all and large in some, but the chief question here also is in regard to its availability.

While soils well supplied with vegetable matter as these usually are, do not need special treatment with reference to potassium and phosphorus immediately after reclamation, they very generally do show a need of care in this regard within a few years, and patches of these types frequently fail to produce satisfactory crops even immediately after drainage and breaking unless barnyard manure or special mineral fertilizer is used.

In the improvement of these types the first step of course is drainage. Both open ditches and tile drains can be installed to advantage in the reclamation of these lands. Plowing fields in narrow strips with dead furrows from 2 to 4 rods apart, and having these lead into shallow open ditches along the side of the field will greatly assist in carrying off the surface water. In order to make the internal drainage of the soil complete, however, tile drains should be used to supplement the surface ditches.

With thorough drainage these soils will be adapted to a wide range of general farm crops. Special crops such as cabbage and sugar beets are well suited to these lands when drained.

PEAT

The material mapped as Peat consists of decaying vegetable matter in varying stages of decomposition with which there has been incorporated a small amount of mineral matter. Where raw and fibrous, and only slightly decomposed, the Peat has a brown color, but where more completely decayed it becomes darker and is sometimes black. It is light in weight as compared with other soils, and is loose and rather spongy. The surface material is often of a lighter brown color than that found at a depth of 2 feet or more. This is usually true of the timbered marshes. In some instances the more thoroughly decomposed material occurs at the surface and the raw fibrous peat is found at lower depths. This appears to be the case most frequently where marshes were originally treeless.

The material mapped as Peat ranges in depth from 18 inches to over 3 feet. Where less than 18 inches it has been classed as shallow peat and mapped separately. In some instances the peat is known to be over 10 feet deep. The material found beneath the peat is variable. Where the marshes are surrounded by sandy soils the peat is usually underlain by sand, and where the upland bordering the marsh is heavy the material under the marsh is usually also heavy.

Peat is an extensive soil in Waupaca county and is found in practically all parts of the county. The tracts vary in size from a few acres to several square miles. Of the most extensive areas may be mentioned one found 5 to 6 miles southwest from Clintonville, one 7 to 8 miles east of Manawa and another immediately northeast from White Lake. East of Embarrass there are also several smaller tracts. Many less important areas are scattered throughout the county. The line between the Kenan and Superior soils is frequently marked by areas of Peat.

The surface of all peat areas is low, level, water soaked, and naturally very poorly drained. Before farming operations can be carried on the Peat must be reclaimed by some system of drainage. A small proportion of the marsh land in Waupaca County has been drained more or less thoroughly by open ditches, which in some cases have been supplemented by tile drains.

Probably the most important factor in determining the value of marsh land will be the crops which can be grown upon it. This depends upon two factors, first the degree of drainage, and second the danger from frosts. When only the main outlet and lateral ditches have been installed, in the great majority of cases, hay crops are the only ones which can be safely grown, and the character of the hay will also depend a good deal on the character of the drainage. In the case of peat land underlain by sand, the drainage by well constructed and sufficiently deep ditches 40 to 80 rods apart will, in some cases give adequate drainage for hay. When the peat is underlain by silt or clay, however, ditches not more than 20 rods apart will be necessary, and these must lower the water in the ditch to a point 4 or 5 feet below the surface during part of the growing season. When tilled crops are grown, such as corn, cabbage, or potatoes, or small grains are to be grown the drainage must be more certain, and over the larger proportion of the marsh land this will mean the installation of drainage systems in the form of either open lateral ditches or of tile not more than 10 and often not more than 5 rods apart on the average. Tile drainage is the more satisfactory. The cost of tile drainage will vary from \$40—\$80 per acre after the main outlets have been put in.

It is well known that frosts frequently occur on marsh land when there is no frost at all on the higher land adjoining. This is partly because the cold air which forms on the surface of all the ground at night tends to flow down and collect in low places, but it is also the result of the fact that the loose, spongy soil of peat marshes does not conduct the heat received from the sun during the day downward to so great an extent as do upland earthy soils. In consequence of this, the lower layers of soil do not become warmed in peat marshes as they do in other earthy soils and the little heat left in the surface inch or two is rapidly lost at night by radiation, so that the freezing point is frequently reached on such soil when it would not be on more earthy soils such as sandy loam or clay loams which would conduct the heat downward better during the day, and so keep warm farther into the night.

This difficulty with peat marshes can be overcome to a certain extent by heavy rolling which, by compacting the soil, permits the heat to be conducted downward more readily. It will also to a certain extent become less in time as the peat decom-

poses and takes on more of the character of muck. Nevertheless, it must always be expected that marsh land will be more subject to the late spring frosts and the early fall frosts than high land. It may be stated as a general guide that the occurrence of killing frosts is as liable on marsh land at any given point as it is on upland soil having good air drainage about 150 miles farther north. In other words the marshes of Dane County are as liable to have a frost which will kill corn as early as are the upland regions of Shawano, Marathon and Clark Counties. The marsh land regions of Waupaca County are as liable to have frost two weeks or more earlier than the hilltops of the same latitude. This means that corn and potatoes, while safe crops for the upland region, are not safe for the marsh land, and should not be depended on as the chief marsh land crops.

The native vegetation on the Peat marshes consisted chiefly of coarse marsh grasses, sedges, and sphagnum moss on the open marshes, with willow, alder, some poplar, and tamrack on the timbered tracts.

By far the greater portion of the Peat is still in its wild state. Some tracts have been cleared and are being utilized for hay and pasture. The hay is made from the coarse marsh grasses which have a considerable lower feeding value than the tame grasses. Wire grass from some marches is marketed for making rugs and matting. In a few instances small tracts have been reclaimed and are being used for cultivated crops. Part of the tract north from Waupaca is used for growing potatoes, cabbage, celery, onions and other garden truck. It is well suited to these crops. There is no reason why a larger proportion of the Peat lands of this county should not be reclaimed and utilized for these and other cultivated crops, as well as for hay and pasture.

Peat. Shallow Phase.—The shallow peat is not nearly so extensive as the deep peat, although it is fairly well distributed throughout the area. It often forms the border between the highland and areas of deep peat, but some tracts are made up entirely of the shallow peat.

The only difference between the two phases is that the shallow peat has a depth of 18 inches or less, while the deep peat has a greater depth—usually over three feet. Both are made up of the same material and have the same origin. As with the deep peat the subsoil is variable, and conforms quite closely

with the character of the adjoining upland. Where heavy soils border the marsh the underlying material is usually heavy, but where the upland is sandy the subsoil of the marsh is usually sandy also. There is probably somewhat more mineral matter mixed with the shallow peat, than with the deep peat, but none of the material could be classed as muck. But very little of the shallow peat is under cultivation. It is utilized to some extent for hay and pasture, but only a few small areas have been reclaimed for cultivation.

Chemical composition and fertility.—In the improvement of peat lands in Waupaca County the first step, of course, is drainage. With the exception of some of the marshes immediately along the Wolf River it is thought that much of the peat could be readily drained and successfully cultivated. Along the Wolf River the surface of the peat is so low that much of it would require diking, or a lowering of the bed of the river, which would be very expensive, and hardly justifiable under present conditions.

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds, or in two feet 1,350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average 0.3 per cent of this element, while good upland clay loam soils average two per cent, or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3,000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface eight inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potassium. These elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will probably be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

Crops and system of farming on marsh lands.—Since the growth of corn and potatoes to which these marsh lands would otherwise be adapted, is limited in this section on account of the danger from frost, the best staple crops for this land are grasses for hay and pasture, hardy root crops, and rye, and to a less extent oats. When properly fertilized and limed, clover, alfalfa, and other legumes can also be grown. On fairly well drained marsh land not too raw good pasture can also be developed. The compacting of the soil resulting from the use of this land as pasture is also a great benefit to it. When peat land is placed under cultivation a heavy roller should be classed along with implements necessary to its successful management.

On account of the crops to which this land is adapted and its use as a pasture, marsh lands can be used for dairying or stock raising to good advantage.

Certain special crops, such as cabbage, onions, buckwheat, and rape, are well adapted to such lands when well drained and fertilized.*

* For more complete discussion of the management of marsh soils see bulletin on this subject by the Agricultural Experiment Station.

CHAPTER VII.

GENERAL AGRICULTURE OF WAUPACA COUNTY

The development of agriculture in this region was preceded by the growth of the logging and lumbering industries. The earliest settlements were made chiefly in the sandy portions of the county as the forest growth here was largely pine, which was the only timber handled by the early lumberman.

The first farming operations were started in Waupaca County in 1849 on a bit of sandy prairie in the town of Lind. The first farms, opened after the advance of the lumbermen, were small. While farming ventures were first started largely on the sandy soils following the cutting of the pine, the highest agricultural development has been reached in those sections where the soils are heavier. The earlier and more primitive types of farming have gradually developed into the present conditions of agriculture. Farming has extended into practically all parts of the county with the exception of some areas in the northwestern part which are still in a cut-over stage. Even through this section a number of farms are already in operation. By far the greater proportion of the county is well improved agriculturally.

While practically all the general farm crops now grown were produced in the early history of the county, the relative importance of a number of the crops has changed to a considerable degree. In 1879, wheat occupied 21,731 acres, which was more than twice the area devoted to oats, and nearly twice as much as was devoted to corn. In 1909 the total area devoted to wheat was only 1150 acres, while there were 38,860 acres devoted to oats and 19,948 to corn. The acreage devoted to hay, corn and potatoes has steadily increased since the early history of the county. The acreage devoted to rye and barley has changed less than that devoted to the other general farm crops. The development of the potato growing industry has been marked. In 1879, there was a total production of 250,307 bushels, while in 1909 the yield amounted to 2,392,213 bushels. In 1919 the yield was 1,907,046 bu. an average of 106 bu. per acre.

* Figures given for 1919 are from reports of assessors.

The type of farming which is followed most extensively in Waupaca County is based upon the dairy industry. In the southwestern and western parts of the county, potato raising is the leading industry in connection with dairying. In the eastern part, in the region of Superior soils, much less attention is paid to potato growing, and dairying is the leading industry. In the region of these heavier soils there are a number of farms upon which not enough potatoes are grown to supply the home table. On these heavier soils grain raising receives more attention than elsewhere.

Practically all of the crops grown at present may be considered in part as cash crops, for hay, corn, oats, rye and barley are sold to some extent directly from the farm. Potatoes are grown mainly for sale, although they are one of the most important subsistence crops. The greater part of the hay, corn, oats and barley is used in feeding life-stock, and a large proportion of it finally reaches the market in the form of dairy products, beef and pork.

Hay is grown more extensively than any other crop. In 1909 the census reports 58,286 acres in all hay crops with a production of slightly over 98,000 tons. Of the hay crops grown, by far the greater proportion consists of timothy and clover mixed. A small amount of timothy is grown alone and also a small amount of clover. There are approximately 9,500 acres from which marsh hay is cut, and the balance of the hay crop is made up of alfalfa, millet, grain which is cut for hay, and coarse forage crops. The best hay crops are produced on the heavier type of the Superior, Kennan and Antigo series. As many of the soils in the western part of the county are somewhat acid, alsike clover is sometimes grown in place of red clover. Red clover does well on land whose productiveness has been kept up, and succeeds on new land in spite of the acidity; but on run down fields which are acid, it is frequently difficult to get a good stand of clover. In 1919 there were 1248 acres of alfalfa in the county.

In 1909, the acreage devoted to oats was 38,860 acres which produced a total yield of 1,153,059 bushels. This crop does best on the fine sandy loams, loams and silt loam soils. Where it is raised on the extremely sandy soils in the southwestern part of the county, results are usually unsatisfactory. In 1919 the average was 40,781.

In 1909, corn was grown on 19,948 acres, and the total yield was 602,144 bushels. This crop is not grown as extensively as in counties to the south as the climate does not always permit the crop to mature. In 1919 there were 32,413 acres in corn, about 67 percent was used for silage and the remainder was harvested for grain.

The potato crop is one of the most important, especially in the southwestern quarter of the county where sandy soils predominate. In 1909, the acreage amounted to 19,810 acres and the total yield 2,392,213 bushels. While the greater proportion of the crop is grown in the extremely sandy sections, the best yields are obtained where there is a sufficient amount of clay in the soil to make it somewhat loamy. In 1919 the acreage was 1,907,046.

A large part of the potatoes if not immediately sold from the field are stored in dealer's warehouses or in cooperative warehouses until finally put on the market. Dealers usually charge 3c a bushel for storage, including insurance, between October 1 and January 1, and 1c a month or fraction per bushel for each succeeding month. Many farmers have storage cellars for potatoes, but do not always use them on account of the difficulty in handling the potatoes during extremely cold weather. The variety most extensively grown is the Rural New Yorker. Among other varieties grown are Cobbler, Triumph and Hebron. There is a gradually increasing number of potato growers who are co-operating with the State Experiment Station in the production of standard varieties. Many of these farmers are treating their seed according to instructions given by the College, are having their fields inspected by representatives of the Experiment Station, and are producing high grade, certified seed. The question of co-operating in storing and marketing the potato is also receiving considerable attention.

Rye was grown on 8,204 acres in 1909, and the total yield for that year amounted to 109,381 bushels. This crop is grown most extensively on sandy soils, and gives better results on the extremely sandy types than any of the other small grain crops. In 1919 there were 13,462 acres in rye and the average yield was 15 bu.

During 1909, barley was raised on 5,734 acres, and produced a total yield of 145,890 bushels. In 1919 there were 4,597 acres in barley. Its production is fairly well distributed over the county.

There was a gradual reduction in the growing of wheat from 1880 until 1910 when only 1,150 acres were devoted to this crop. Average yields during this year amount to about 20 bushels per acre. Owing to the great demand for wheat at the present time, there has been an increased acreage devoted to wheat production, though it is still very small as compared with the acreage of 30 years ago. In 1919 there were 1225 acres of winter wheat and 2315 acres of spring wheat in the county. The heavy types of Superior, Kennan, and Antigo series are well adapted to the growing of this crop.

The following table shows the acreage and production of the principal crops in the last four census years:

Crop	1879		1889		1899		1909	
	Acres	Bushels	Acres	Bushels	Acres	Bushels	Acres	Bushels
Hay.....	26,995	26,898T	37,867	44,368 T	43,212	66,299T	58,286	98,771T
Oats.....	9,897	272,947	22,963	846,531	34,634	1,186,360	38,860	1,153,059
Corn.....	11,055	300,122	12,709	435,031	16,075	491,559	19,948	602,144
Patatoes.....		250,307	11,127	1,261,920	17,498	1,572,554	19,810	2,392,213
Rye.....	5,904	69,933	7,330	112,069	11,343	167,280	8,204	109,381
Barley..	1,724	32,128	1,056	30,731	2,414	62,330	5,734	145,890
Wheat...	21,731	252,925	12,564	212,889	12,160	240,400	1,150	21,955

It will be noted from the foregoing that the most recent statistical data quoted is from the U. S. Census taken in 1909. In order that the progress since that time may be studied there is given below more recent figures collected by the Cooperative Crop Reporting Service for Wisconsin.

The following table has been compiled by the Cooperative Crop Reporting Service For Wisconsin, and appears in Bulletin No. 28 of the State Department of Agriculture:

ANNUAL REPORT ON CROP AND LIVESTOCK PRODUCTION FOR WAUPACA COUNTY, WISCONSIN

	1919	1918	1909
No. of farms	3,613	.....	3,417
Acreage in 22 cultivated crops including tame hay.	158,700	156,593	139,078
Value 16 principal crops.....	\$7,407,488	\$6,077,189	.....
Corn, all acreage.....	32,740	31,812	19,948
Production—bushels.....	1,440,560	1,145,232	.....
Corn for grain, acreage.....	10,477	10,498	.....
Production—bushels.....	481,942	388,426	.....
Corn for silage, acreage.....	21,936	20,996	.....
Production—tons.....	216,586	188,964	.....
Silos, number.....	2,398	2,059	.....
Oats—acreage.....	39,781	40,108	38,860
Production—bushels.....	1,074,087	1,604,320	.....
Winter wheat, acreage.....	1,225	686	844
Production—bushels.....	20,825	14,406	.....
Spring wheat, acreage.....	2,315	2,487	306
Production—bushels.....	23,150	54,714	.....
Barley—acreage.....	4,497	5,066	5,734
Production—bushels.....	94,437	172,210	.....
Buckwheat, acreage.....	481	620	373
Production—bushels.....	7,215	8,680	.....
Rye, acreage.....	13,462	11,586	8,204
Production—bushels.....	201,930	208,548	.....
Dry beans, acreage.....	97	249	115
Production—bushels.....	970	3,237	.....
Dry peas, acreage.....	119	136	191
Production.....	1,547	1,768	.....
Clover and timothy, acreage.....	47,777	44,549	44,017
Production—tons.....	71,643	44,549	.....
Alfalfa, acreage.....	520	201	78
Production—tons.....	1,248	482	.....
Other tame hay, acreage.....	357	482	387
Production—tons.....	536	578	.....
Wild hay, acreage.....	8,360	9,085	9,566
Production—tons.....	9,196	10,902	.....
Potatoes, acreage.....	17,991	18,145	.....
Production—bushels.....	1,907,046	2,104,820	.....
Cabbage, acreage.....	94	45	30
Production—tons.....	705	360	.....
Sugar beets, acreage.....	88	187	102
Peas for canning, acreage.....	.....	23	.....
Other root crops, acreage.....	45	97	.....
Flax, acreage.....	11	10	6

	January, 1920	January, 1919	April, 1910
Horses and mules, number.....	12,379	12,301	11,482
Milk cows, number.....	33,578	32,995	31,152
Other cattle, number.....	26,762	26,005	20,384
Sheep, number.....	5,656	5,160	7,246
Swine, number.....	27,045	28,658	23,672
Milk produced, cwt.....	1,665,462	.....	.....

Of the special crops cucumbers are grown to some extent mostly on the sandy soils. Salting stations are located at several of the towns within the county. In a few localities in the eastern part of the area sugar beets are grown. Most of these are shipped to the beet sugar factory at Menomonie. Cabbage is another crop of some importance, though it is not raised as extensively in this county as in Outagamie County to the east. Minor crops used in supplementary feeding are mangels, rape, peas, turnips and so forth. To supply the home needs there is grown the usual line of garden produce. Strawberries are raised to a limited extent, as are also raspberries, currants and other bush berries. The trucking industry, however, is not developed on a commercial scale in this region. Fruit growing receives but little attention in Waupaca County. Apples are grown more extensively than any other fruit, and most of the farms have a small home orchard, but apples are not raised on a commercial basis. The census of 1910 indicates that there are something over 60,000 apple trees in the county. Apples do best in those sections of the county where the surface is more or less rolling. The heavy level areas of soil, for example, are not well adapted to fruit, owing to the poor drainage conditions prevailing.

The raising of live stock is an important industry. In 1909 there were 51,536 cattle in the county, of which 31,152 were milch cows. During the same year the census reports indicate there were 23,672 hogs and 10,457 sheep. During that year there were 18,107 calves sold or slaughtered, and over 26,000 head of hogs were sold from the farms in the area. Hogs are raised chiefly in conjunction with dairying and general farming, though hog raising is not as well developed in this county as in sections where corn is more certain to mature.

Sheep are raised on a few farms and are confined most largely to the rougher portions of the area, though some are found in nearly all parts of the county.

The dairying industry is one of the most important in the county. The dairy products sold during 1909 amounted to \$1,202,611, exclusive of home use. Of the dairy stock, cattle of Holstein breeding are most numerous with Guernseys second in importance. There are a few herds of Jerseys and also a few Short Horns. There are quite a number of pure bred herds of registered stock in the county, though the greater proportion of the herds are being built up from grade stock. There are several cow testing associations within the area, and as a result of the work being done along this line the cows of poor production are being gradually weeded out. The milk is manufactured into butter and cheese and a considerable amount is taken to the condenseries located at Manawa and New London. The total amount of milk is fairly evenly distributed through these three channels. Creameries are located in most of the principal towns, and at some neighborhood centers. One of the most modern and up-to-date creameries is located at Iola. Cheese factories are most common in the southeastern and northwestern parts of the county. Most of the milk in the eastern and east-central part is disposed of to the condenseries. A large proportion of the cheese factories and creameries are run on the co-operative basis. On Jan. 1, 1920 there were 33,578 cows on the farms in Waupaca County. During 1919 the amount of milk produced was 1,665,462 cwt. and this has a value of \$4,879,804. In 1918 there were 53 cheese factories and 31 creameries in the county.

Farmers generally recognize the importance of the adaptation of crops to certain soils. It is generally recognized, for example, that rye will do better on the sandier type of soil than will any of the other small grain crops. It is generally considered also that potatoes can be grown more profitably upon soils of a sandy nature than on heavy types. In this region, where the season is somewhat short, corn is more certain to mature on the light sandy soils than on the heavy clay areas, because the sandy soils warm up more quickly in the spring. The sandy types, however, are not so well adapted to hay crops, and to oats and barley, as are the heavier soils. The general methods of farming followed are about the same as those practiced throughout the general farming and dairying districts of

Wisconsin. The silo is in quite common use on dairy farms and a considerable part of the corn crop is handled as ensilage. Usually sufficient means are taken to prepare the land for all crops. Plowing is usually to a depth of 6 or 8 inches, and on the heavier soils much of the plowing is done in the Fall. Disk harrows are frequently used for pulverizing the soil. On some of the sandier types rye is often sown without the land being plowed. In such cases the seed is harrowed or drilled in following the removal of the previous crop, and in the case of corn it is frequently sown before the shocks are removed. Where potatoes are grown, modern machinery is in common use, and where the acreage justifies their purchase most farms are supplied with horse-drawn planters, diggers and spraying outfits. In all lines of farming modern machinery is in common use on most of the farms.

Throughout most of the area the farms are equipped with substantial, well-built and attractive buildings. This is especially noticeable in the eastern half of the county. Practically every dairy farm has a silo. Many of these are made of wooden staves, but recently a large number have been constructed by the use of concrete. A number of the dairy farms are now equipped with power milking machines. Improved implements, such as manure spreaders, seeding and harvesting machinery, are in common use. Farm tractors are being introduced in a few places in an experimental way.

A rotation quite commonly followed on the sandy soils consists of small grain, followed by clover, and this by potatoes. The second crop of clover in some instances is plowed under as a green manuring crop, though this practice is not general. On the extremely sandy types it is desirable to arrange a system so that the ground may be covered as much of the time as possible to prevent drifting, which sometimes causes damage to growing crops. On the heavier soils the usual rotation is somewhat different from those on the sandy types. Here corn more frequently takes the place of potatoes, and the land is usually left in grass for hay for two years, and frequently is pastured for one year before again being plowed. On neither the sandy or heavy types has the question of crop rotation been given the careful consideration which it deserves.

Stable manure is the most common fertilizer used, a second crop of clover is frequently plowed under as a green manuring crop, and sometimes rye is plowed under. The practice of green

manuring, however, is not at all common. Commercial fertilizers are being used in a few cases, chiefly in an experimental way and mostly on the potato crop. It is certain that the use of commercial fertilizers will gradually increase since the results obtained on the potato crop in this and other counties are very gratifying. In the vicinity of Weyauwega on a sandy loam soil, unfertilized, the yield of potatoes was 85 bushels to the acre. On the same soil where 14 spreader loads of manure were used, supplemented with 500 pounds of a complete commercial fertilizer, the yield amounted to 350 bushels to the acre. Experiments which have thus far been conducted indicate that the best results with the commercial fertilizers are secured on soils which are in a fairly good state of fertility.

The question of securing competent farm labor is often somewhat difficult. In many cases, however, especially where the farms are small, the members of the family are able to do practically all of the farm work—extra labor being needed only at the time of haying and harvesting.

Farms usually range in size from 40 to 160 acres, although there are a number of holdings of 200 acres or more. On many of the larger farms there is a considerable amount of unimproved land. The average size of all farms in the county, according to the 1910 census, was 110 acres. In 1910 there were 3,794 farms in the county and in 1920 there were 3,770 farms.

The last census reports that 90.1% of all farms in the county were operated by the owner. Most of the rented land is in the poorer sandy sections. Rent is usually on the share basis, the tenant furnishing equipment and half of the stock and seed and receiving one-half of the farm produce. While the share system is most common, there are a number of variations in this system.

The value of lands has been steadily increasing in this county. The better improved farms sell from \$100 to \$150 per acre where well located. Cut-over lands, mostly in the northwestern part of the county, have a selling value from \$15 to \$35 per acre. The farms in the sandy region where the fertility of the soil is sometimes low and the improvements rather inferior have a value of around \$40 per acre, though this of course is extremely variable depending upon a number of factors.

CLIMATE

The climatic conditions in Waupaca County are fairly representative of a considerable area in the central part of Wisconsin. While the topographic features of the county are not uniform for all sections, there is probably not a great variation in liability to frost in various parts of the county except over the marsh areas. As none of the large marshy tracts have been reclaimed, the question of liability of frosts on these marshes at times when the frost would not affect the upland is not of great importance at the present time. As the marsh areas are reclaimed here, it will doubtless be found to be true in this region, as in other sections of the state, that frost in the marsh land will occur about the same time as frost in the upland will occur at a point one hundred miles farther north.

The table given below contains climatic data gathered by the Weather Bureau Station located at Waupaca. This station has an elevation of about 870 feet above sea level.

The following table shows the normal monthly and annual temperature and precipitation at Waupaca:

NORMAL MONTHLY AND ANNUAL TEMPERATURE AND PRECIPITATION

	Mean temperature	Highest temperature	Lowest temperature	Mean precipitation
January.....	16.2	51	-32	1.01
February.....	15.5	53	-38	0.93
March.....	29.0	72	-16	2.08
April.....	44.1	86	7	2.66
May.....	56.4	91	20	4.14
June.....	65.3	102	30	4.42
July.....	70.7	100	42	3.48
August.....	68.1	96	36	3.41
September.....	60.9	95	18	3.25
October.....	48.2	85	11	2.29
November.....	33.6	68	-13	1.71
December.....	19.5	50	-24	1.28
Annual.....	44.0°	102	-38	30.66

From the above table it will be noted that the average rainfall for the year amounts to nearly 31 inches. A large proportion of this occurs during the growing months when most needed, but occasionally, especially in July and August, crops may suffer somewhat from the lack of moisture. Storms of a destructive nature are very rare. The climate of the region is healthful and well suited to a high development of agriculture. While the winters are long and rather severe, the temperatures are much more uniform than farther south. The average snowfall amounts to about 40 inches. The summers are very pleasant and farm crops make rapid growth.

The average date of the last killing frost in the spring, as recorded at Waupaca, is May 22, and the average date of the first killing frost in the fall is September 28. This gives an average growing season of 137 days free from killing frosts. The average season is therefore sufficiently long to permit the maturing of corn. However, early fall frosts frequently occur which damage the crop, as was the case in 1917, when but little corn matured in Wisconsin. Corn will always mature sufficiently, however, for silage, and a large proportion of the crop is disposed of in this way.

Excellent water for household purposes and for stock can be readily secured in all parts of the county. There are many flowing wells in the eastern half of the county. In the southwestern part of the area there are a number of lakes known as the Waupaca chain of lakes which attract many tourists during the summer season.

SUMMARY

Portage County is situated a little to the east of the center of the state. It comprises an area of 759 square miles or 485,760 acres. The surface features vary from level to rolling to hilly, with the major part of the county gently rolling. Elevations along railroads range from 767 to 930 feet above sea level. All of the county lies within the drainage basin of the Wolf River. The Embarrass, Waupaca, and Little Wolf are tributaries of the Wolf River which traverse portions of the area surveyed.

The first settler came to Waupaca County in 1843, and settled at the present site of Fremont. The county was organized in 1851. In 1910 the population of the county was 32,782 of which 83.7% was classed as rural. This is a well established region, and population is fairly well distributed throughout the county. The largest tracts of unimproved land are in the northwestern part of the county.

This country is traversed by the main line of the Green Bay & Western Railroad, the Soo Line, and the eastern side of the area is skirted by the Chicago & Northwestern Railway.

The mean annual rainfall is approximately 31 inches, and the mean annual temperature 43.9 degrees. The winters are long severe with a snow fall of about 40 inches, but the summers are warm and all crops make rapid growth. There is an average growing season of 127 free from killing frosts.

The agriculture of the county shows all stages of development. The southwestern portion of the area has considerable sandy soil some of which has a low value for farming purposes. There are also some sandy spots in other parts of the county but not of such great extent. There are many highly improved farms within the area, and this is one of the leading potato growing districts of the state.

The principal crops grown are hay, oats, potatoes, corn, rye, barley, some wheat and buckwheat. General farming is the prevailing type of agriculture, with dairying and potato growing as the most important interests. The average size of farms is 110 acres and approximately 90% of the farms are operated by their owner.

The soils of this county are variable and range in texture from sand to clay. There are numerous areas of marshland but little of which has been reclaimed to date. The material forming the soils has been derived largely through glacial action from crystalline and sandstone rocks. The underlying rock in the western half of the county is largely crystalline, while the eastern half is chiefly sandstone. There is also considerable lacustrine material in the county, but since its deposition by water it has been influenced by glacial action. In the low, undrained places there are large accumulations of organic matter making up the peat marshes.

In the classification of the soils of this county these various materials have been separated into 10 soil series and 24 types, not including peat. In several instances phases of types have also been recognized. Each soil has peculiar characteristics by which it can be recognized, and the full understanding of these characteristics are necessary in the selection of crops and systems of farming best suited to each soil.

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.