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WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

E. A. BIRGE, Director. W. O. HOTCHKISS, State Geologist
A. R. WHITSON, In Charge, Division of Soils.

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

BULLETIN NO. XXXVIII SOIL SERIES NO. 8

SOIL SURVEY

OF

JUNEAU COUNTY

WISCONSIN

BY
A. R. WHITSON, W. J. GEIB, L. R. SCHOENMANN, C. A. LECLAIR,
AND O. E. BAKER
OF THE
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AND
E. B. WATSON
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INTRODUCTION

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

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

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

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

Water holding capacity, and other physical properties of soil all depend chiefly upon *texture,* which refers to the size of the individual soil grains, or particles. A course 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 dumes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

Soils Containing Less Than 20% Silt and Clay

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

Soils Containing Between 20–50% of Silt and Clay

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

Soils Containing over 50% of Silt and Clay

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

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the 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 example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the material was originally derived chiefly from sandstone rock, and now 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 name of the *soil class,* which refers to texture, with the name of the *soil series,* which refers chiefly to origin, we get the *soil type,* which is the basis or unit of classifying and mapping soils. A *soil type,* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF JUNEAU COUNTY, WISCONSIN.

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

Juneau County is located a little south of the center of Wisconsin and is bounded on the north by Wood County, on the east by the Wisconsin River, which separates it from Adams County, on the south by Sauk County, and on the west by Vernon, Monroe, and Jackson Counties. It has a length north and south of 42 miles and a width east and west varying from about 17 to 27 miles. The county comprises an area of about 796 square miles, or approximately 509,440 acres.

The surface of the area surveyed falls naturally into two topographic divisions and the line separating them follows, in a general way, the main line of the Chicago, Milwaukee & St. Paul Railroad, which passes through Lyndon, Mauston, New Lisbon, and Camp Douglas. The region to the north, comprising about two-thirds of the county, is a nearly level plain with a gradual rise to the north and west. Projecting through the floor of this plain and rising to elevations from 20 to 200 feet or more are a few sandstone and quartzite hills, which form the most conspicuous features of the landscape. The country in general consists of extensive sand flats, on which some low dunes have been formed and which give way in the northwestern portion of the area to large stretches of marsh, dotted with innumerable small sand islands only 1 or 2 feet above the level of the lowlands. The fertility of the sands is low and agricultural development lim-

ited. On the marshes hay is the chief crop, though some cranberries are grown.

The region to the south, comprising about one-third of the area surveyed, consists of a very rugged country, much dissected by valleys and ravines, the slopes of which are often steep and frequently rocky. The surface is hilly to broken and there is an abrupt rise from the level land on the north to the hill country on the south. The difference in elevation ranges from 200 to more than 400 feet. Two and one-half miles northeast of Lyndon, on what is about the lowest portion of the plain, the elevation above sea level is 857 feet. The hilly country to the southwest of Lyndon ranges from 1,000 to 1,250 feet above sea level. Farther west the elevation is still greater. Although rough, this region includes the best farming land in the area.

The drainage of the entire county is into the Wisconsin River. The Yellow River enters the county at about the center of the northern boundary line and joins the Wisconsin River at Germantown, which is several miles below the center of the county. The Little Yellow River drains the northwestern portion of the county and flows into the Yellow River about 4 miles northwest of Germantown. The Lemonweir River traverses the county from northwest to southeast, passing through New Lisbon and Mauston and flowing into the Wisconsin River about 9 miles north of the southern boundary. This stream receives drainage water from the level sand areas to the north and also from the hill region to the south. The Baraboo River crosses the southwestern corner of the county and joins the Wisconsin River after traversing Sauk County. These rivers receive the drainage waters from numerous smaller streams and drainage ditches.

The first settlers came into the county in 1832 and located in the Lemonweir Valley. In 1837 a trading post was established where Mauston is now located. New Lisbon was settled in 1846, Necedah in 1849, and Elroy in 1860. The land south of the Lemonweir and west of the Wisconsin River was ceded in 1836 to the General Government by the Indians, and settlement in this region began after that date. The region north of the Lemonweir, however, was not settled until some years later. Adams County, which originally included Juneau, was established in

1848, but in 1857 Juneau was made a separate county. Lumbering was the chief industry about 1850, but this lasted for only a comparatively short time, after which permanent settlement was more rapid. In 1857 Mauston had a population of 800. What is now the Chicago, Milwaukee & St. Paul Railroad was completed through the county in 1837.

Among the early settlers were a considerable number of English and Irish and some French. Many settlers came from Michigan, Illinois, Ohio, New York, and some from other Eastern States. There are a number of Poles and Bohemians in the northeastern part of the county and in general the foreign population is greater on the sandy soils. At present all parts of the county are settled, although some sections are more thickly populated than others. The region most thinly settled is in the northwestern part of the county, while all of the level, sandy country contains a much smaller population per square mile than the hilly region throughout the southern and southwestern sections.

Mauston, with a population of 2,400, is the county seat and largest town in the area. It contains a large feed mill operated by water power from the Lemonweir River, an electric-light plant, water works, sewage system, fire department, machine shops, woolen mill, pickle factory, brewery, creamery, cooperage works, cigar factory, knitting works, glove factory, two banks, two newspapers, and in all over 50 places of business. Elroy, with a population of 1,450, is located in the southwestern part of the county, on the Baraboo River and the Chicago & North Western and Chicago, St. Paul, Minneapolis & Omaha Railways. It is an up-to-date city, having an electric-light plant, waterworks, two banks, two newspapers, and a number of other business interests. Division headquarters of the Chicago, St Paul, Minneapolis & Omaha Railway are located here, and the shops and switching yards give employment to a number of men. The city is surrounded by a good agricultural country, and live stock, grain, and other products are shipped in large quantities. Necedah, with a population of 1,116, is located a little north of the east-central portion of the county, on the new line of the Chicago & North Western Railway and a branch of the Chicago, Milwaukee & St. Paul Railroad. It is an enterprising town and the cen-

tral market and shipping point for a large area of sandy country in Juneau and Adams Counties. New Lisbon is a city of 1,300 inhabitants, 7 miles northwest of Mauston, on the Chicago, Milwaukee & St. Paul Railroad and the Lemonweir River. It contains over 25 business places, receives and ships farm produce quite extensively and is the third largest town in the county. Wonewoc, Camp Douglas, Mather, Lyndon, Meadow Valley, Union Center, and Hustler are smaller villages in various parts of the area.

The county is well supplied with railroads, and the transportation and shipping facilities are adequate to the needs of a much more highly developed region. No portion of the area, except a few square miles in the extreme northeastern corner, is over 9 miles from a railroad.

The numerous towns within the county furnish a market for considerable farm produce, but the greater portion is shipped to outside points. Practically all of the fat stock sold is shipped to Chicago. The output of the creameries goes principally to Chicago and the cities of the East. From Mauston to Chicago is 214 miles and to Milwaukee 128 miles over the Chicago, Milwaukee & St. Paul Railroad. From Mauston to Minneapolis the distance is 209 miles.

The roads throughout the northern two-thirds of the county are sandy. In places there are deposits of clay which could be utilized in making sand-clay roads, and this has been done to a limited extent. In the southern and southwestern parts of the county the roads are generally good, but the country is rough and the steep grades make the hauling of large loads very difficult and often impossible. The soil in this region is silty and roads through such material are comparatively easy to keep in good condition. Washing on the steep grades sometimes damages the roadbed.

SOILS.

Juneau County lies within the unglaciated portion of Wisconsin and comprises two distinct physiographic divisions, the sandy plains and marshy lowland, which occupies the northern two-thirds of the county, and the rougher highland, which occu-

pies the southern third. The underlying rock consists chiefly of Potsdam sandstone, with a very small amount of Lower Magnesian limestone in the southern part of the county and a few outcrops of quartzite near Necedah. The material comprising the various soil types has been formed through the weathering and disintegrating of the limestone, sandstone, and possibly some shale associated with the sandstone, and by the action of wind and water, which have transported the material and redeposited it in various forms. Material foreign to this immediate section has been brought in by these agencies, and this has assisted in, or is responsible entirely for, the formation of some of the types. The accumulation of decaying vegetable matter has modified the original deposits in places and formed types dependent on the high organic-matter content.

In the soil survey of Juneau County 16 soil types*, including Meadow, Rough stony land, Peat and Muck (undifferentiated), and Sands and Peat (undifferentiated), have been recognized and mapped. All of these types have characteristics by which they can be recognized.

The Knox series is found in the southern part of the county, occupying the hill country, and consists of silty material which overlies the Potsdam sandstone. There seems to be some question as to its origin, and it may have been derived in part from the limestones originally overlying the Potsdam sandstone, from shale associated with the sandstone, or from loess. This series comprises the best and most extensive areas of highly improved agricultural land in the county. One type, Knox silt loam with a steep phase, was mapped in this area.

The Boone series consists of residual material from the Potsdam sandstone, in one type of which there is frequently mixed a small amount of silt from the soils of the Knox series. These soils are confined principally to the southern half of the county and have a low agricultural value. Two types, Boone fine sandy loam and fine sand, the latter type containing two phases, were recognized and mapped as belonging to this series.

*Knox silt loam, steep phase, as described in this report includes what was originally mapped by the Bureau of Soils as Knox silt loam, shallow phase.

The La Crosse* series comprises dark-brown to black alluvial material found as terraces or valley fill along the streams which flow through or border the hilly portion of the county. This material has been derived largely from the silty covering of the hills by being washed down the slopes and carried away and again deposited by stream action. It is above the present flood plain. One type only, La Crosse silty clay loam, was mapped.

The Lintonia series includes the colluvial material which has been washed from the silty hills and accumulated on the lower slopes, frequently bordering the La Crosse soils. The color of the Lintonia soil is usually light brown or grayish, though it grades into dark brown in places. One type, Lintonia silt loam, was mapped in the present survey.

The Baxter series includes the material derived from the weathering of the Lower Magnesian limestone, only a few remnants of which still remain in this region. This series is characterized by gray surface soils over red clay subsoil. A large amount of chert is present upon the surface and mixed with the soil. Baxter silt loam is the only type of this series mapped.

The Superior series represents soils of lacustrine origin, but the true Superior material is exposed at the surface only over comparatively small areas in the present survey. The lacustrine deposit is characterized by a heavy red clay, over which, in many cases, there has been laid down varying amounts of sand. Most of these soils are found in the region adjacent to the Lemonweir River. The thickness of the deposit of red clay immediately along the river is frequently 10 feet and this is underlain by a fine sand. Back from the stream a mile or two the deposit is seldom over a foot in thickness, and many times it can not be found at all. Traces of lacustrine deposits are found at Necedah, but these consist of silt instead of clay. At Shenington, which is just outside of the county to the west, on the new line of the Chicago & North Western Railway, the lacustrine silt has a thickness of 26 feet, as found in two wells. Less than a mile east the deposit is only from 4 to 12 inches thick. It would seem, therefore, that the lacustrine material was laid down in basins and not over the entire low-lying country occupied by the sand plains region.

*In the future soils of the La Crosse series will be included with the Waukesha series.

Three types of the Superior series were mapped—Superior clay loam, fine sandy loam, and sand.

The Plainfield series consists of the material occupying a large proportion of the sand plains region. It seems that all of this has been influenced more or less by the action of water. All of the types found are very sandy and of low agricultural value. They are light in color and contain but little organic matter. The types mapped as belonging to the Plainfield series are Plainfield sand and fine sand.

The Dunning series consists of dark-colored soils of similar origin to the Plainfield, but with which there is sufficient organic matter to impart a dark color. It occupies a low position bordering the marshes and is poorly drained. Dunning sand is the only type of the series mapped in the survey.

Peat and Muck (undifferentiated) include extensive areas of marsh composed of vegetable matter in varying stages of decomposition, with which there is incorporated only a small amount of mineral matter. Such areas are quite extensive in Juneau County.

Sands and Peat (undifferentiated) include large areas of low marshy land in which there are numerous small islands of sand. The total area of the islands is about equal to that of the marsh, but on the scale used in mapping it was impossible to separate such small areas. The marsh includes black sand and shallow Peat, but no separations were possible, on account of the small areas and the wide variations found. This type of land has little agricultural value.

Meadow includes the low-lying, poorly drained areas along the rivers and smaller streams, in which the soils were so variable as to make classification impossible.

Rough stony land includes the steep rocky slopes, outcrops, and broken regions throughout the county, which are too rough and rocky to be cultivated and have a very low agricultural value.

The following table gives the name and extent of each soil mapped in the county:

Areas of different soils.

Soil.	Acres.	Per cent.
Boone fine sand	55,808	
Loamy phase	20,096	24.3
Low phase	47,744	
Sands and Peat (undifferentiated)	101,696	20.0
Knox silt loam	54,656	
Steep phase	24,064	15.4
Plainfield sand	52,096	10.2
Peat and Muck (undifferentiated)	39,616	7.8
Meadow	35,008	6.9
Rough stony land	28,800	5.6
Superior sand	14,848	2.9
Boone fine sandy loam	10,560	2.1
Lintonia silt loam	6,528	1.3
Dunning sand	5,952	1.2
Plainfield fine sand	3,648	.7
Superior clay loam	3,264	.6
Baxter silt loam	2,560	.5
La Crosse silty clay loam	1,472	.3
Superior fine sandy loam	1,024	.2
Total	509,440	.....

CHAPTER II.

GROUP OF HEAVY, LIGHT-COLORED SOILS.

KNOX SILT LOAM.

Description.—The surface soil of Knox silt loam consists of 12 inches of a grayish-brown or buff-colored silt loam, having a friable structure and a smooth feel. While there is present a small percentage of fine and very fine sand, but few coarser grains are found. The lower portion of the soil usually is of a yellowish color, and on drying the surface becomes ashen in appearance. As a whole the texture of the material is very uniform, but varies somewhat in depth with the degree of slope. The subsoil consists of a heavy yellow silt loam, grading into a silty clay loam at 18 to 20 inches, and usually becoming a light chocolate brown color at 30 to 36 inches. It is compact, contains only a very small percentage of material coarser than silt, and is uniform throughout its entire extent, except as indicated in the phase described below. The underlying rock lies from 4 to 10 or more feet below the surface.

The most important variation in the Knox silt loam is one based upon topography and consists of land which is so steep and broken that it is not advisable to grow intertilled crops because of the serious damage resulting from erosion. The portions of the type thus situated have a value somewhat lower than the typical soil, and because of this fact such areas have been separated on the soil map and are referred to in this report as the steep phase of Knox silt loam. The texture of the soil does not differ materially from the typical, except that the depth is usually a little less, and where erosion has been extensive the surface soil may be lacking over areas of limited extent. The underlying rock comes closer to the surface than typical, and in come instances is within reach of the soil auger. Outcrops are not uncommon. A more

detailed description of the deep phase is given following the description of the typical Knox silt loam.

Extent and distribution.—Knox silt loam is confined to the southern and southwestern portions of the county, in the hilly region, and is the most extensive type in that part of the survey. Practically all of this soil lies south of the main line of the Chicago, Milwaukee & St. Paul Railroad. Its continuity is broken by areas of Lintonia silt loam and Boone fine sand, Baxter silt loam, and a few other types of minor importance.

Topography and drainage.—Knox silt loam occupies a section of country which consists of a series of hills and ridges, throughout which erosion has been extensive. The typical Knox silt loam is found occupying the tops of these hills and ridges, where the surface is nearly level to gently rolling, and also on the more gentle slopes, and where all ordinary farm operations can be carried on without difficulty. Practically all of the type is subject to erosion but danger from this source is much greater on the steep phase than on the typical soil. On account of the uneven character of the surface the natural drainage is good. The type is quite retentive of moisture, and seldom suffers from drought except during long dry spells.

Origin.—The geology of this type has not been carefully worked out, but from its silty texture, its laminated structure, which is seen in places, and its uniform character, it would seem to be of loessial origin, having been deposited by wind action. Some of the highest points, however, have no silty covering, which fact would tend to eliminate the loessial theory. On some of the lower slopes a shaley material is found associated with the Potsdam sandstone, and this may have weathered into the material forming the silt loam. This formation of shale is frequently found with the Potsdam sandstone in other places, and may have covered most of this region at one time. The type may be partially residual and partly loessial in origin. A slight acid condition exists over part of the type.

Native vegetation.—The original timber growth consisted chiefly of several varieties of oak, hickory, ash, and birch, with some maple, elm, and butternut. On some of the steep slopes there is still considerable timber standing, but all of the best trees have been cut.

*Present agricultural development.**—By far the greater proportion of Knox silt loam is under cultivation, and it is the most extensive and important highly improved soil in the county. The type of farming followed consists of general farming in conjunction with dairying. The crops most extensively grown are corn, oats, barley, wheat, and hay. The yields of the different crops vary considerably, depending largely upon the methods of farming followed. Corn is an important crop and yields on an average about 40 to 50 bushels per acre. Oats give an average yield of 40 bushels and barley about 35 bushels per acre. Wheat is not grown extensively at the present time, though it was an important crop in the early history of the county. At the present time it yields 20 to 25 bushels per acre. Hay, consisting of timothy and clover, yields from 1 ton to 1½ tons per acre.

Nearly every farmer produces enough potatoes for home use and many have some to sell each year. The yield is usually about 150 bushels per acre. The soil is not as well adapted to this crop as some of the other types, especially the sandy loams, though the quality of the potatoes grown is fair.

Tobacco was at one time more extensively cultivated than at present. It is generally grown on the same field for four years in succession, but during the first 2 or 3 years the yields are best. Fields must be heavily manured, and this is done at the expense of the remainder of the farm. Tobacco usually follows potatoes or corn and is itself followed by wheat. The yields secured range from 1,000 to 1,600 pounds per acre. Since the crop requires careful attention and considerable labor, the acreage devoted to it on any farm is comparatively small.

Alfalfa is being tried by a few farmers, and some have secured a good stand without inoculating the soil. In order to secure the best results, however, the soil should be inoculated and liming may also be necessary, since the type is slightly acid in places.

Trucking and small-fruit growing are not carried on to any extent, though the ordinary garden vegetables and berries are grown for home use, and limited quantities are marketed in the

*For chemical composition and improvement of Knox silt loam see page 30.

near-by towns. There are a few small apple orchards, though the fruit industry has not received special attention on this soil.

Considerable fall plowing is done, and this is the best system to follow whenever possible. This also increases the water-holding capacity of the soil and destroys more weeds than when spring plowing is followed. On account of the silty nature of the soil the type is not difficult to handle, and a fine, mellow seedbed can be secured with but little difficulty. Erosion must be carefully guarded against in the cultivation of this type. The natural drainage is nearly always good, and the type can be worked under quite a wide range of moisture conditions. Too wet cultivation, however, may result in the soil becoming slightly puddled, and this should be avoided. No commercial fertilizers are used on this soil, but stable manure is applied whenever available. The plowing under of green crops is not practiced to any extent.

There is considerable variation in the crop rotations followed, and some pay but little attention to the selection of a system best adapted to conditions. The best farmers, however, have developed a definite system of crop rotation, and while this must be altered to meet the needs of various sections, it most commonly consists of corn one year followed by barley and oats one year each, with clover or clover and timothy seeded with the last grain crop. When wheat is grown it may take the place of the second grain crop. Hay may be cut for two years or the field may be pastured one year after being cut for hay the first year. On the steep slopes corn is sometimes omitted from the rotation because the land is more apt to erode when in an intertilled crop than when in a grain crop or in grass. The steepest slopes which are used are often kept in grass for the greater part of time, though some attempt to cultivate crops on land of this character. Stable manure is usually applied to the sod to be plowed for corn.

Farms on Knox silt loam sell from $40 to $80 an acre, depending on location, topography, improvements, and the productiveness of the soil. A few of the best farms have a still higher value, where the improvements are above the average, and where the soil is in a good state of fertility.

VIEW FROM NEAR ELROY IN SOUTHWESTERN PART OF JUNEAU COUNTY, SHOWING CHARACTERISTIC TOPOGRAPHY OF KNOX SILT LOAM.

This type is more highly developed and more important than any other soil in Juneau County. It is devoted to general farming and dairying and is well adapted to this type of agriculture. The steep slopes, including the timbered areas, represent the steep phase of Knox silt loam.

KNOX SILT LOAM, DEEP PHASE.

Description.—The soil of the Knox silt loam, steep phase, to an average depth of 10 inches, consists of a grayish-yellow or buff-colored silt loam, having a very smooth feel and containing only a comparatively small amount of organic matter. A few sandstone rock fragments occur in places upon the surface and outcrops are frequently seen on the steep slopes. The subsoil consists of a yellow silt loam or silty clay loam, extending to a depth of 18 to 30 inches, where fine sand occurs. The underlying bedrock may be encountered at 20 to 36 inches, though it is often below the reach of the auger. The fine sand is frequently mixed with the silty clay subsoil, and in places the material consists of a sandy silt loam. The first 18 inches is the same as the typical Knox silt loam in texture and color.

Extent and distribution.—The steep phase is confined to the hilly region in the southern portion of the county, where it is closely associated with the typical Knox silt loam. The most extensive development occurs 8 to 11 miles south of Mauston, though it is fairly well distributed throughout the rough part of the survey.

Topography and drainage.—The surface of the steep phase is rough, broken, and often badly dissected by ravines and gullies. It occupies the tops of narrow ridges and the more sloping sides of the valleys. On the gentler slopes and broader ridges the typical Knox silt loam is found. In general it may be said that the steep phase of the Knox silt loam occupies a topographic position several degrees rougher and more dissected than the typical soil. The steep slopes are subject to erosion, and this is the most important problem to be considered in the management of the type. On account of the topography and the underlying sand the natural drainage is good—sometimes excessive—and crops are apt to suffer from drought during part of the growing season.

Origin.—The silty portion of the soil has the same origin as the typical Knox silt loam, which is probably loessial. The sandy material is residual, and is the result of the weathering and disintegrating of the Potsdam sandstone.

Native vegetation.—The original timber growth consisted chiefly of white, black, and red oak, and hickory, with some maple and birch. The best timber has been removed, but on many of the slopes there is still some standing. From some slopes the trees have been cut and the ground is now covered with a thick growth of berry bushes and shrubs of various kinds.

*Present agricultural development.**—While the Knox silt loam, steep phase, is not sufficiently steep and broken to be classed as non-agricultural land, the surface is rough enough to be the limiting factor in the selection of crops to be grown. Crops requiring intertillage, such as corn and potatoes, are not adapted to this type on account of the danger from erosion on the cultivated fields, and these crops are almost entirely excluded from the rotations followed on this soil. The crops most frequently grown consist of oats, wheat, hay, buckwheat, and sometimes barley. Oats yield on the average 35 bushels, wheat 18 to 20 bushels, buckwheat 8 to 10 bushels, and timothy and clover from 1½ to 2 tons per acre. The most common rotation practiced consists of oats one year, oats or wheat one year, followed by clover and timothy one or two years, and pasture one year.

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

Mechanical analyses of Knox silt loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.6	2.6	3.4	10.1	5.8	69.5	8.0
Subsoil	.0	1.9	4.0	13.1	8.9	59.5	12.7
Steep phase.							
Soil	.1	.3	.7	12.7	3.4	67.1	15.6
Subsoil	.0	.1	1.6	75.5	2.0	14.6	6.3

*For chemical composition and improvement of this soil see page 30.

BAXTER SILT LOAM.

Description.—The surface soil of Baxter silt loam consists of 10 inches of gray silt loam, which contains only a small amount of organic matter. There is present upon the surface and mixed with the soil from 10 to 25 per cent of angular chert fragments. The subsoil consists of a heavy red clay, which also contains from 10 to 15 per cent of angular chert fragments. One well record showed that the red clay extended to a depth of 30 feet and rested upon sandstone. This is much deeper than the average, however, for in a number of places the sandstone can be reached with the auger. In places the subsoil is a yellow silty clay, and in a few instances a sandy clay was found at from 18 to 24 inches, which then graded into the stiff, heavy red clay. Wherever the red clay is found the chert is abundant, but the chert may occur without any red clay being present. The chert is frequently so plentiful as to form an almost complete covering over the surface. This makes cultivation very difficult. One exposure of limestone (Lower Magnesian) was seen where a limekiln had once been operated.

Extent and distribution.—The type is of small extent and occurs in long, narrow areas, chiefly on the tops of high, narrow, flat-topped ridges. The largest area is about 5 miles east of Wonewoc. A smaller tract is found 4 miles east and another 5 miles northeast of Elroy. The total area covered by this soil is only 2560 acres.

Topography and drainage.—The surface of the type varies from nearly level to undulating. There is always sufficient slope to insure good surface drainage, though seldom steep enough to be damaged by erosion.

Origin.—Baxter silt loam is derived from the weathering of the Lower Magnesian limestone, a few remnants of which still remain. The chert present represents a more extensive and much thicker bed of limestone than exists at the present time. The chert, being extremely hard, has withstood weathering, while the limestone has been largely removed. There is no loessial material occurring over the residual limestone soil. While the surface

soil is sometimes slightly acid, the subsoil usually contains a considerable amount of carbonate of lime.

Native vegetation.—The original timber growth consisted chiefly of oak, hickory, and maple, with some walnut. All of the merchantable timber has been removed, but in uncultivated places there is quite a thick undergrowth.

*Present agricultural development.**—A considerable proportion of the type has been under cultivation at one time, but on account of the numerous chert fragments, which interfere with cultivation, some of the fields have been left uncultivated. Where the chert is not too plentiful the type is considered a fairly good general farming soil, and the ordinary farm crops are grown successfully. Corn yields 40 to 60 bushels, oats 45 bushels, and wheat about 25 bushels per acre. Hay consists of timothy and clover mixed and yields of 1½ to 2 tons per acre are secured. Where free from numerous rocks not much difficulty is experienced in putting the fields in good tilth, if plowing is carried on when the moisture conditions are the most favorable. The rotation of crops most extensively followed consists of corn, oats, wheat seeded to clover, and timothy, which is cut for hay one or two years and pastured one year. The wheat may be omitted and the oats used as a nurse crop for the clover. Manure is usually applied to the sod to be plowed under for corn.

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

Mechanical analyses of Baxter silt loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.9	3.2	2.8	6.1	7.9	63.4	15.6
Subsoil	.6	2.0	3.4	9.4	3.8	38.7	42.1

*For chemical composition and improvement of Baxter silt loam see page 30.

LINTONIA SILT LOAM.

Description.—The surface soil of Lintonia silt loam consists of a heavy grayish-brown to nearly black silt loam, from 12 to 18 inches deep, having a very smooth feel and containing in places a considerable amount of organic matter. The subsoil consists of a drab or yellow silt loam to silty clay loam, which frequently contains a considerable amount of fine and very fine sand. The subsoil sometimes has a reddish color, due to iron stains, and usually the material has a mottled appearance, due to poor drainage conditions.

The type is a gradation from Knox silt loam on the one hand to La Crosse silty clay loam on the other, containing areas of the latter too small to map separately on the scale used. The higher portion of the soil is light colored, while the lower portion is dark.

Extent and distribution.—Lintonia silt loam is confined to the southern and southwestern parts of the county and is associated with Knox silt loam. One of the largest areas lies directly southwest of Mauston. More of the type is found in the vicinity of Union Center. Other areas are scattered throughout this portion of the survey. This may be classed as one of the types of minor importance, since it occupies a total area of only 6,528 acres, or 1.3 percent of the area of the county.

Topography and drainage.—The surface of this type is level to undulating, the highest portion extending up the slope and grading into Knox silt loam of the upland, and the lower portion extending frequently into the valley of streams and bordering La Crosse silty clay loam. The natural drainage of most of the type is deficient and before the best results can be obtained tile drains will be necessary.

Origin.—Lintonia silt loam consists of silty material, a large proportion of which has doubtless been washed from the higher lying soils and is therefore colluvial. The highest part of the type is sometimes in the form of a terrace, which may be several feet above the flood plain of the stream along which it occurs. The lowest portions of the type along the streams are partially alluvial. Had these latter areas been large enough they would have been shown on the maps as La Crosse silty clay loam. Tests with litmus paper indicate that this soil is somewhat acid.

Native vegetation.—The original timber growth on Lintonia silt loam consisted of oak, hickory, and some birch on the higher portion, and ash, elm, and some oak on the lower areas. Only a small amount of good timber is still standing.

*Present agricultural development.**—The type is limited in extent, and because of its poor drainage it is not highly improved. Hay is the most extensive crop grown and yields of 2 tons per acre are secured. Some oats, corn, buckwheat, and barley are sometimes grown, but the soil is usually too moist, especially in the spring and early summer and the fields are low. On the highest portion of the type the drainage is better and yields on such areas, which are limited in extent, are nearly equal to those obtained upon Knox silt loam.

SUPERIOR CLAY LOAM.

Description.—The surface soil of Superior clay loam consists of 8 inches of a grayish-brown compact silty clay loam. On drying the surface becomes quite hard and frequently cracks. The organic matter content is comparatively low. The subsoil to a depth of 36 inches or more consists of a heavy, red, tenacious clay, which shows fine laminations and a joint structure where exposed in cuts. A silty phase consists of 9 to 10 inches of gray silt loam, underlain to a depth of about 16 inches by a yellow silt loam, which is in turn underlain by heavy red clay or silty clay. In depressions there has been an accumulation of organic matter and the color is darker than typical. In areas of limited extent a small amount of fine sand may be mixed with the soil and upper subsoil.

Extent and distribution.—Superior clay loam is of comparatively small extent, though it is a distinct type and readily recognized. All of this soil is found to the north of the rough portion of the county and lies within or bordering the valley of the Lemonweir River and the small creeks flowing into it. The most northerly area is found 3 miles west of Cranberry Center. A number of small, irregular patches occur north of Mauston and

*For chemical composition and improvement of this soil see page 30.

also to the southeast of this place. A number of smaller areas are found in the intervening region.

Topography and drainage.—The surface of this type is level to gently undulating, with occasionally a few shallow depressions where the soil is darker than typical. On account of the level topography and the heavy character of the subsoil, the natural drainage is defective and tile drains could be installed to advantage over a considerable portion of the type.

Origin.—Superior clay loam is doubtless of lacustrine origin and was laid down at a time when this region was covered by standing water, probably during an interglacial period. Where there is a silty covering over the heavy red clay and this lies adjacent to the high silty country to the south it is probable that some of the silt has been washed down from the higher-lying soils. The material composing this type is naturally somewhat calcareous, but most of the lime carbonate has been leached from the surface soil and frequently a slightly acid condition is found. The subsoil, however, shows the presence of considerable lime.

Native vegetation.—The original timber growth consisted chiefly of oak, maple, elm, and a little hickory, with some white and Norway pine. Practically all of the timber has been removed and most of the type is now cultivated.

*Present agricultural development.**—Superior clay loam is a strong soil. The crops grown consist of corn, oats, barley, hay, a little wheat, a few potatoes, and some tobacco. The type is considered better for small grains than for corn. Corn yields from 30 to 45 bushels, oats average about 40 bushels, barley about 30 bushels, and wheat 20 to 25 bushels per acre. Where the drainage is deficient, planting is often delayed and the yields reduced. Hay does well on this soil and yields from 1½ to 2 tons per acre. The type is considered too heavy for potatoes, though yields of 75 to 150 bushels are obtained. Tobacco does not do as well as on some of the lighter soils.

The heavy phase of Superior clay loam is the most difficult soil to cultivate in the county. Unless worked when moisture conditions are the most favorable, lumps form, which can be pul-

*For chemical composition and improvement of this soil see page 30.

verized only with considerable effort. As the type is limited in extent and the surrounding soils are of a sandy nature, the methods followed are as a rule better suited to sandy soils than to heavy soils. Fall plowing is advisable, since the fields will then work up better in the spring and the crops can usually be planted earlier. The rotation most commonly followed consists of corn, oats, wheat or barley, and hay. The type is well adapted to grasses, and general farming and dairying are the chief lines of agriculture practiced.

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

Mechanical analyses of Superior clay loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	1.2	4.0	4.6	18.8	5.9	44.9	20.6
Subsoil	.0	.8	1.1	3.4	3.6	40.3	50.9

CHEMICAL COMPOSITION AND IMPROVEMENT OF KNOX SILT LOAM, BAXTER SILT LOAM, LINTONIA SILT LOAM, AND SUPERIOR CLAY LOAM.

While the soils of this group differ in topographic position, origin, and slightly in texture, there is a close relation in their chemical composition, and they may therefore be discussed as a group, rather than separately. The results of chemical analyses indicate that the soil of the surface 8 inches of this group contains on the average approximately 1,000 pounds of phosphorus, 32,000 pounds of potassium, and 2,700 pounds of nitrogen per acre. The phosphorus content of Lintonia silt loam and Superior clay loam is somewhat higher than in Knox silt loam and Superior clay loam is somewhat higher than in Knox silt loam and Baxter silt loam. The potassium content of the steep phase of Knox silt loam appears to be slightly higher than the average for the group, while the nitrogen content of this phase is lower than the average. These variations are doubtless due to the fact

that erosion has removed some of the surface soil, which contains most of the nitrogen, and allowed the subsoil, which contains more potassium, to be exposed in places. The nitrogen content is quite uniform throughout the group, but the total amount present is lower than is desirable. All of the soils show a slight degree of acidity.* This is most marked on the ridges, while on some of the slopes, the soil is not acid.

The analyses made were of soils taken from fields which have had the average history of farms on the heavy soils of Juneau County. The virgin soil contains considerable more phosphorus, but the years of cropping to small grains which occurred previous to the present decade have removed important quantities of this element. From this time on it will be necessary for farmers on these types of soil to consider carefully means of retaining and increasing the phosphorus content of their soils. Ground rock phosphate is probably the best source of phosphorus for use on this group of soils. The total potassium is sufficient to meet any demands, but its availability will depend upon the supply of actively decomposing organic matter; and the improvement of these soils as a whole calls chiefly for the addition of green manuring crops in the system of rotation followed, unless unusually large amounts of barnyard manure are available through intensive stock farming.

Where an acid condition is found to exist this may be corrected

*As a number of the soils in this County are in an acid condition and would be greatly benefited by the application of some form of lime, every farmer should know how to test his soil for acidity. Bulletin 230 of the Wisconsin Experiment Station on "Soil Acidity and Liming" gives the following method which can be readily applied. "A very simple and reliable method to detect soil acidity is by the use of the blue litmus paper, which can be secured of any good druggist. Take a handful of moist soil and form it into a ball. Break the ball into halves and place a piece of blue litmus paper in the center on one of the halves, and cover over with the other half. After 5 minutes break the ball, and if the paper is pink in spots or over the whole end, the soil is acid." "Soil acidity is also usually indicated by the growth of certain weeds, such as sheep sorrel, horse-tail rush, corn spurry, and wood horse-tail.

Another means of determining soil acidity known as "The Truog Method" has recently been perfected. This is more accurate than the litmus paper test, and as determinations can be made in the field in a few minutes time it is practicable for every day use. For detailed information concerning "The Truog Method" write the Soils Department, University of Wisconsin, Madison, Wisconsin.

by applyng ground limestone at the rate of from 1200 to 2000 pounds per acre.

The question of preventing erosion is one which should be carefully considered by all farmers on Knox silt loam and Baxter silt loam. It is a difficult matter to check erosion and repair the damage when once it has made considerable headway, but there are a number of ways by which washing may be prevented, or at least reduced to the minimum. On the tops of ridges and on gentle slopes, cultivated crops may be grown in rotation with other crops in the usual way; but when the slope becomes so steep that the bare ground would wash to any extent, fields should be used for hay and pasture as much of the time as practicable. Where the slope is so steep that modern farm machinery cannot be used, no cultivated crops should be grown, but the fields should be kept as permanent pasture. If such slopes are in timber they should be allowed to remain so. In some instances it would doubtless be advisable to reforest the steep slopes which have been cleared.

Where it is found necessary to cultivate steep land, the plow should follow the contour of the hill, and narrow strips of sod may be left to alternate with the cultivated strips. In some places strips of sod forming shallow sod ditches may be left running with the slope at points where most of the run off water flows. Erosion at such places will thus be held in check while the remainder of the field is being put into a grain crop and reseeded. It might be practicable to construct various forms of terraces on the slopes to prevent erosion, as is done in the southeastern portion of the United States, and thus permit a larger proportion of the land to be devoted to intertilled crops. The construction of terraces in Wisconsin, however, has not been practiced to any extent.

On account of the topographic position of Lintonia silt loam and Superior clay loam there is no danger from erosion on these soils. The question of drainage, however, is an important one, and tile drains could be profitably installed in a number of places. Thorough drainage will allow the soil to warm up earlier in the spring, permit earlier cultivation and planting, assist in making more plant food available by a thorough aeration of the soil, and thus materially increase the producing power of the soil.

Care should be exercised in selecting crop rotations best suited to this group of heavy soils. Where there is no serious danger of erosion the following rotation will be found to give good results: Small grain may be grown for one or two years and seeded to clover. The first crop should be cut for hay and the second plowed under as a green manuring crop. When sufficient organic matter has been incorporated with the soil, the seeding should be mixed clover and timothy and the field cut for hay for two years. Stable manure should then be applied to the field before being plowed for corn. The manure may be supplemented by 600 to 800 pounds of ground rock phosphate, and the two may be applied at the same time. Subsequent applications of half this amount of rock phosphate, once during each rotation, will doubtless be sufficient. Where the slopes are steep, intertilled crops should not be grown, corn should be eliminated from the rotation, and grains should not be grown any longer than is necessary to get the fields reseeded. As long as there is a good stand of grass on the steep slopes they should not be plowed. When ground limestone is to be used it may be applied at any convenient season, since in this form it is very slowly soluble and will not be carried away by the drainage waters.

This group of soils is probably better adapted to dairy than to any other branch of farming, and this industry which is now an important one could well be developed to still greater proportions. More silos should be constructed and more attention given to the growing of alfalfa. When the soil is limed, inoculated, and in a fair state of fertility large and profitable yields of alfalfa can be secured. The raising of hogs in conjunction with dairying could also be enlarged upon profitably. The addition of more organic matter, the following of thorough methods of cultivation, and the use of such crop rotations as are best suited to prevailing conditions, will tend to materially increase the productivity of this group of soils.

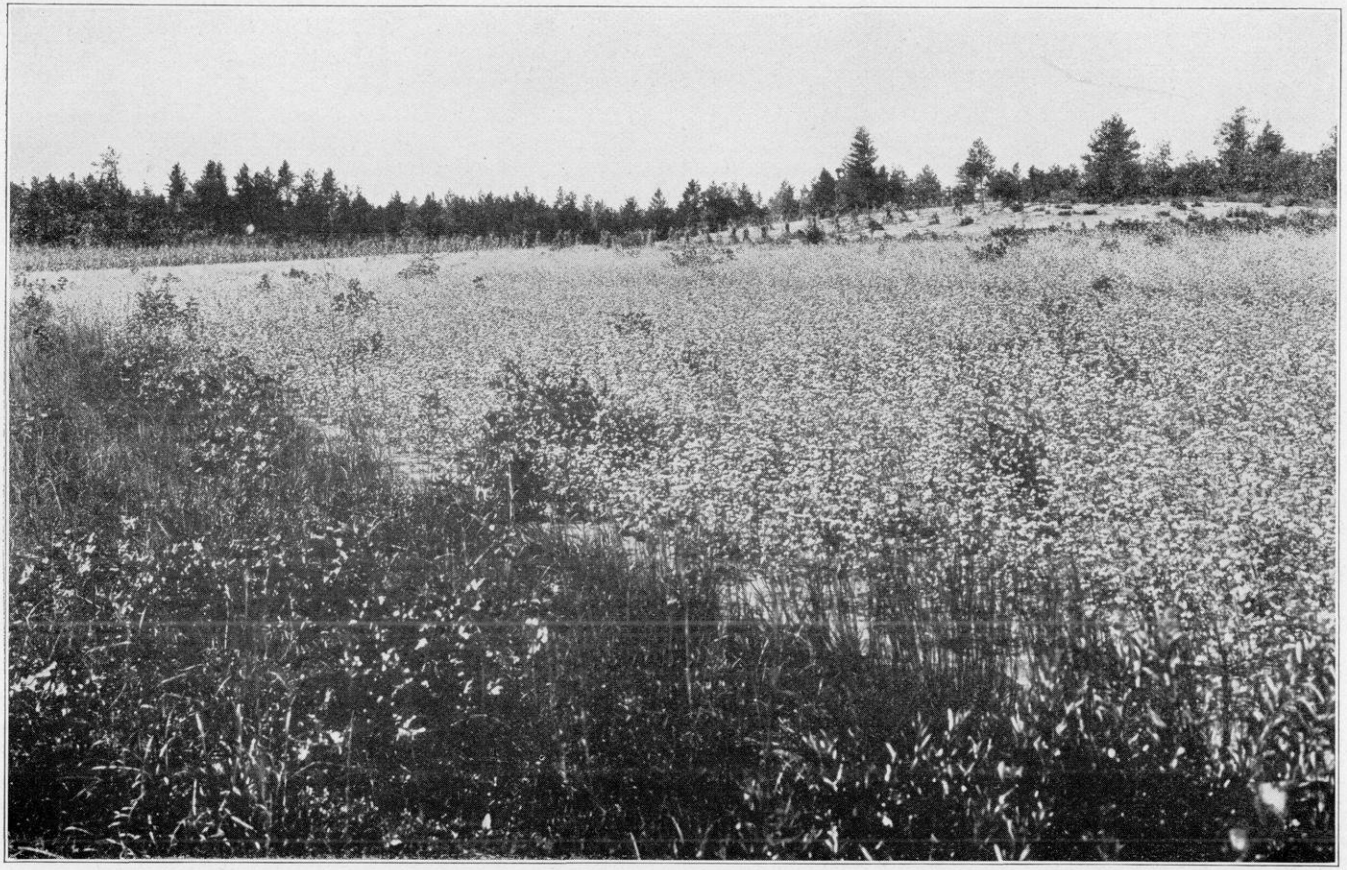
CHAPTER III.

GROUP OF SAND SOILS.

BOONE FINE SAND.

Description.—The soil of Boone fine sand, to an average depth of 6 inches, consists of a gray or yellowish fine sand, in the surface inch or two of which there is a very small amount of organic matter. The soil is loose and open and is frequently blown into small dunes by the wind. Sandstone fragments and some chert may occur upon the surface and mixed with the soil. The subsoil consists of a fine yellow sand, which contains fragments of sandstone and chert, and usually grades into disintegrated sandstone or into the solid rock at less than 3 feet. The texture may become coarser as the rock is approached. The underlying rock frequently outcrops. The depth to rock is variable and ranges from 1 foot to 5 or 6 feet. Where the depth is greatest rock fragments are seldom found; where the soil is shallow they may be very plentiful. As a rule the soil is thinner in the hill country than in the flat region. The subsoil in some places in the hilly section has a small amount of silt mixed with it from the silty types with which it is there associated. The subsoil may have a reddish-brown color, but the type as a whole is quite uniform, and what variations occur are of minor importance.

Extent and distribution.—The type is confined chiefly to the southern half of the county, and the largest areas are found in the southeastern part of the survey directly north and south of Lyndon. South of Germantown is an area of considerable size, and smaller patches are scattered throughout the southwestern portion of the county, where it is associated with the silt loam soils. In the extreme northwestern corner of the survey there are also a few areas.



VIEW OF BOONE FINE SAND IN VICINITY OF NECEDAH, SHOWING UNDULATING TOPOGRAPHY, FIELDS OF CORN AND BUCKWHEAT, AND AREAS OF UNCLEARED LAND.

This is a soil of low agricultural value. It contains but very little organic matter and is deficient in all mineral plant food elements. It requires very careful management before profitable yields can be secured. Under the usual methods of cultivation followed the yields are low. The native vegetation as shown in the background consists chiefly of scrub oak and Jack pine.

Topography and drainage.—Where the type is associated with the silt loam soils it occupies slopes and the tops of narrow ridges from which the silty covering has been removed. Frequently such areas are quite rough. Where the type occurs in the sand plains country the topography is less broken and may be gently rolling or have a gradual slope away from low residual hills or ridges. The surface soil has in places been blown into low dunes. On account of the loose, open character of the soil and subsoil the natural drainage is excessive, and crops usually suffer from drought during a portion of every season.

Origin.—Boone fine sand is of residual origin and has been derived from the disintegration of the Potsdam sandstone. Where it occupies undulating or sloping topography surrounding an extensive outcrop the material seems to have been influenced by water and perhaps deposited in shallow lakes on being washed away by wave action from the rock. The soil shows acid reaction to the litmus test.

Native vegetation.—The original timber growth consisted of Jack pine, scrub oaks, birch, poplar, and a few other varieties. The growth was stunted and scattering. The greater part of the type is still in timber and underbrush, though much of the merchantable timber has been removed.

*Present agricultural development.**—Only a small proportion of the type is under cultivation. In the rougher part of the county it is mostly in timber or in pasture and is of no agricultural importance. Some farming is carried on in the more level sections, especially where the underlying rock is deepest. The crops grown consist of corn, oats, rye, buckwheat, and potatoes. It is very difficult to obtain a stand of clover and but little is grown.

The yields of these crops are low and frequently they are a failure. The type is very low in organic matter, and unless the rainfall is well distributed crops suffer from drought.

BOONE FINE SAND, LOAMY PHASE.

Description.—The surface soil of Boone fine sand, loamy phase, to an average depth of 8 inches, consists of a gray or light-brown

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

fine sand, which contains sufficient finer material and organic matter to make it slightly loamy. It is loose and open in structure and is blown by the wind, though to a somewhat less extent than the low phase of the type. The subsoil to a depth of over 3 feet consists of a loose and incoherent yellow find sand. There is no gravel in the subsoil and the amount of material finer than fine and very fine sand is extremely small. Where the sand is blown into ridges the soil is almost entirely lacking in organic matter and the type is very similar to the fine sand. Along the Lemonweir River there are level areas, slightly above the flood plain, in need of drainage and having a higher organic content than usual. The subsoil in such places is sometimes a white fine sand.

Extent and distribution.—Boone fine sand, loamy phase, occurs in areas varying from a few acres to a couple of square miles in extent, and is scattered throughout the county on both sides of the main line of the Chicago, Milwaukee & St. Paul Railroad. It is chiefly confined to a strip of country from 4 to 6 miles wide directly north of the hill country. Some of the largest areas are found in the vicinity of Mauston.

Topography and drainage.—The surface of the loamy phase of the Boone fine sand varies from level to undulating and in a few places very gently rolling. It is found on the lower slopes of hills and ridges occupied by the Boone fine sand and occurs as level sandy plains bordering the Lemonweir River and as undulating stretches where the surface material has been influenced by the action of the wind. The natural drainage is excessive and most of the type is droughty.

Origin.—The parent material from which this soil was derived consists chiefly of the Potsdam sandstone, but has been influenced to some extent and perhaps transported short distances by the action of water. In a few places the type is undoubtedly residual. It occurs within a comparatively short distance of and considerably lower than the silt loam types of the upland country to the south and it is thought that its loamy character may be due in part to the presence of a small amount of silt from this source. The soil is acid, as indicated by the litmus test.

Native vegetation.—The timber growth consisted chiefly of Jack pine, some Norway pine, and black and red oak, somewhat scrubby. As a rule the timber was better than on the low phase of the Boone fine sand. Some prairie grasses, mostly blue stem, are found on the type.

*Present agricultural development.**—The loamy phase is a better soil than either the typical Boone fine sand or the low phase, though much more limited in extent. The chief crops grown and the yields obtained during average seasons are as follows: Corn 20 to 40 bushels, oats 25 to 30 bushels, rye 15 to 22 bushels, buckwheat 15 to 18 bushels, and potatoes 100 to 150 bushels per acre. It is difficult to obtain a stand of clover and the yields are very low. A small amount of sorghum is grown, from which a good quality of sirup is made. During seasons when the rainfall is below normal or when it is not fairly well distributed crops suffer from drought and the yields fall considerably below those indicated above.

BOONE FINE SAND, LOW PHASE.

Description.—The surface soil of Boone fine sand, low phase, consists of a yellowish-brown or gray, loose, incoherent fine sand, with an average depth of 6 inches, and containing a small amount of organic matter in the first inch of virgin soil. In cultivated fields the organic matter has usually disappeared. Being fine and loose, the surface soil is frequently blown into low dunes by the wind. The subsoil consists of a yellow, loose, incoherent fine sand, extending to a depth of over 3 feet and seldom containing any trace of silt or clay. In the vicinity of Necedah, where this type is associated with the Plainfield sand along the Yellow River, there is present in the soil a considerable amount of iron. In this respect it resembles the Plainfield sand, but is of finer texture. The position it occupies here is a second bottom which is subject to overflow at times.

Extent and distribution.—The most extensive development of Boone fine sand, low phase, is found within 10 miles of Necedah, to the southeast, south, southwest, and extending up the

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

west side of the Yellow River for about 7 miles north of Necedah. A great number of small areas are scattered throughout the country south and west of this region but north of the hill country.

Topography and drainage.—The surface of the low phase is level to billowy or undulating, with low sand-dune ridges occurring at irregular intervals. These vary in height from a couple of feet to about 20 feet. In some places there is a series of parallel ridges of varying lengths, while in other sections there seems to be no regularity. Often one dune is found surrounded by an extensive tract of level country. On account of the loose, open structure of the soil, the natural drainage is excessive and the type is very droughty, except on the phase subject to overflow, where the water table is closer to the surface than usual. Where the water table is over 3 feet from the surface, as is usually the case, the soil is droughty.

Origin.—The low phase of Boone fine sand lies entirely within the sand plains region and forms a portion of what is usually considered a former extensive flood plain of the Wisconsin River. Whether the waters from the Wisconsin River ever extended over the whole sand plain country is still a question. However, the type in question contains no material foreign to the immediate region, except bordering the Wisconsin and Yellow Rivers, and in this respect differs materially from the Plainfield sand. The Potsdam sandstone is the parent rock. This has disintegrated and been acted upon to a greater or less extent by water, and at a later date influenced somewhat by wind action. It is thought that some of the billowy topography may be due to erosion and that instead of the elevations being dunes the depressions are really shallow erosion channels formed when flood waters were receding. The larger ridges are unquestionably dunes and are being added to every year.

Native vegetation.—The timber growth consists of Jack pine, scrub oak, and poplar, with several varieties of shrubs. There is a sparse growth of prairie grasses scattered over the type, mostly blue stem, where cultivated, foxtail and sand burs spring up quickly. The timber is poorer on this soil than on any of the other types.

*Present agricultural development.**—About 10 per cent of this phase is cleared and has been cultivated. Some attempts are now being made to farm it, but many of these are meeting with failure and a number of places have been abandoned.

Boone fine sand, low phase, has a very low agricultural value; in fact, it is considered the poorest type in the county. Having a loose, open structure and fine texture, it is blown by the wind, and since it is almost entirely lacking in organic matter, the water-holding capacity is very poor. In these respects it is inferior to the Plainfield sand.

The chief crops grown and the average yields obtained during the most favorable seasons are as follows: Corn 15 to 20 bushels, oats 15 to 20 bushels, rye 12 to 15 bushels, buckwheat 10 to 12 bushels, and potatoes 50 to 100 bushels per acre. It is very difficult to obtain a stand of clover. Any of these crops may be a complete failure on account of drought, and some may be damaged a great deal by blowing sand. The methods of farming followed are inferior in every way to those practiced on the heavier soils of the area.

The following table gives the results of mechanical analyses of samples of the typical soil and subsoil of the Boone fine sand:

Mechanical analyses of Boone fine sand.

Description.	Fine gravel.	Coarse sand	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.4	8.0	16.9	54.5	9.3	6.2	5.5
Subsoil	.0	6.9	17.4	57.3	9.1	4.9	4.2

PLAINFIELD SAND.

Description.—The typical soil of Plainfield sand consists of a rusty or a dark-brown sand of medium texture extending to an average depth of 8 inches. The structure of the soil is loose

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

and open, and there is present a considerable amount of iron, which gives the rusty color and a slight loaminess. It also carries a small amount of organic matter, but the color indicates a higher content than actually exists. A little gravel is seen upon the surface, and a small amount of fine gravel is mixed with the soil. The subsoil consists of a yellow medium sand, which becomes coarser in texture with increased depth until below 30 inches there is considerable coarse sand and fine gravel. The subsoil always contains more gravel than the surface soil. Where the subsoil contains considerable iron, as is frequently the case, the material has a brownish or sometimes a reddish color, but this usually fades as the depth increases. A number of variations occur, some of which may be mentioned. The amount of gravel decreases as the distance from the streams increases. On the lower benches along the Yellow and Wisconsin Rivers the brown color extends to a greater depth, and there is more iron present than where the type lies a little higher. The amount of iron varies considerably. In some places it forms concretions or bog ore and in a number of others a hardpan. In some localities lenses or pockets of silt or silty clay, highly impregnated with iron, were found. Along the Yellow River some of this type has a darker surface soil than typical and grades into Dunning sand without any evidence of a distinct change, thus making the boundary line an arbitrary one.

Extent and distribution.—Plainfield sand is quite an extensive type, occupying slightly over 52,000 acres or approximately 10 percent of the county. The largest area lies in the northeastern part of the county, where it is found occupying the greater portion of the territory between the Yellow and Wisconsin Rivers. Practically all of this soil is confined to the northeastern quarter of the area.

Topography and drainage.—The surface of Plainfield sand is level for the most part, becoming gently undulating over a portion of the largest area in the northeastern part of the county. The benches are from 4 to 12 feet lower than the main body of the type and are subject to overflow about once in every five years. On account of the loose, open structure of the material, the natural drainage as a whole is excessive and the soil

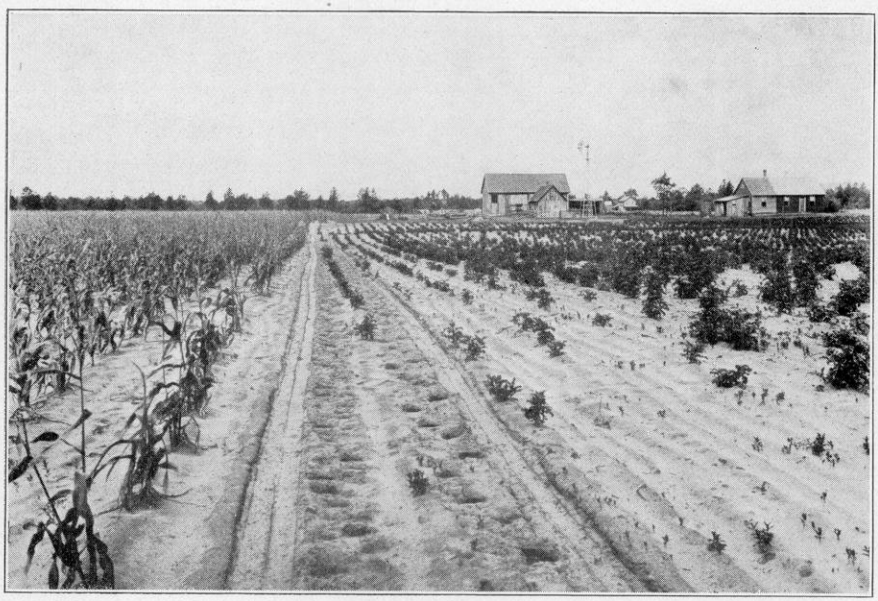


Fig. 1. VIEW SHOWING SURFACE FEATURES, AND POOR CROPS ON LIGHT, SANDY SOIL IN VICINITY OF NECEDAH.

This view illustrates the conditions which usually prevail where poor methods of farming are followed on a soil of low agricultural value. The potatoes and corn on this farm will scarcely pay for the cost of seed and cultivation.

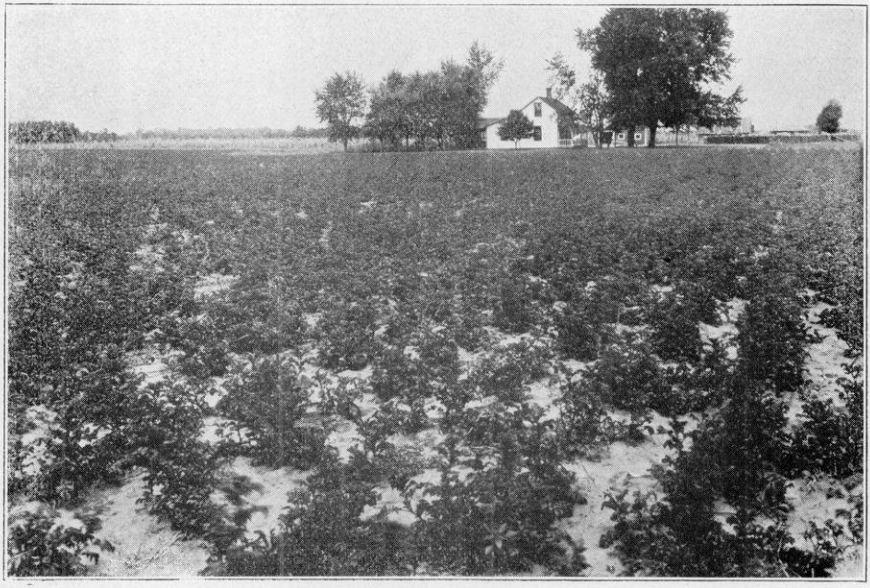


Fig. 2. VIEW SHOWING SURFACE FEATURES, AND GOOD CROPS ON LIGHT, SANDY SOIL IN VICINITY OF NECEDAH.

This view illustrates some results which can be obtained where intelligent methods of farming are practiced on the sandy soils of low agricultural value. Estimated yield of potatoes—175 bushels per acre. In the background to the left of house there is a field of corn which will yield at least 45 bushels per acre.

droughty. The presence of the iron and a small amount of organic matter tends to increase somewhat the water-holding capacity, and the type is better in his respect than the low phase of Boone fine sand. Where the type borders Dunning sand the water table is closer to the surface than usual.

Origin.—The type occurs within the Old Flood Plain of the Wisconsin River, in the form of definite terraces, and may therefore be considered an alluvial soil. The soil grains are considerably rounded, showing the action of water. While the major portion of the material consists of quartz, which came chiefly from the Potsdam sandstone of the immediate region, the presence of gravel representing rocks foreign to the region, granites, feldspars, etc., indicates that some of the material must have been transported from the country to the north, where granitic rocks abound. The coarser grains are as a rule more angular than the medium and fine grains. Litmus tests indicate that the type is acid.

Native vegetation.—The original timber growth consisted chiefly of red and black oak, Jack pine, and some Norway pine. There were fewer Norway pines than on the low phase of the Boone fine sand. As a whole, the timber growth is more thrifty than on the Boone fine sand, low phase, and the trees are larger. The best timber has been cut, but there still remains a considerable amount of small Jack pine and some oak, the largest of which is from 8 to 12 inches in diameter.

*Present agricultural development.**—From 25 to 40 per cent of the type has been cleared and cultivated, but a considerable number of farms have been abandoned and no crops are being grown upon them at the present time. The chief crop grown at the present time and the yields secured during the most favorable years are as follows: Corn 15 to 25 bushels, oats 20 to 25 bushels, wheat (rarely grown) 10 to 15 bushels, rye 12 to 20 bushels, buckwheat 12 to 16 bushels, and potatoes 100 to 150 bushels per acre. Potatoes form the chief cash crop and do better than any of the other crops grown. A little hay, consisting of clover and timothy, is produced, but the stand is thin and the yield seldom equals 1 ton per acre. Some sorghum is pro-

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

duced and yields about 24 gallons per acre. The type as a whole has a slightly higher agricultural value than the low phase of Boone fine sand, but is not quite equal to the loamy phase of Boone fine sand or Plainfield fine sand.

Plainfield sand is easily cleared and cultivated and for these reasons some persons are led to believe that it is to be preferred to the heavier, higher-priced land. The methods of cultivation, crop rotation, and fertilization followed are often not those best suited to a soil of this character. As stated above, the soil is acid and it is difficult to obtain a good stand of clover. But little stock is kept, therefore very little manure is available, and since the plowing under of green crops is not a common practice the soil is not improved. When a piece of new land is first cultivated fair crops are secured for a few years, but as each crop is removed and nothing returned the soil gradually becomes poorer. The best farmers on this type make a good living from their farms, but many merely exist. The larger portion of the population on Plainfield sand consists of foreigners, mostly Poles and Bohemians, many of whom know little about farming and their chances for making a success are therefore rather remote, unless their efforts are properly directed.

PLAINFIELD FINE SAND.

Description.—The surface soil of Plainfield fine sand consists of 10 inches of a gray loamy fine sand or light fine sandy loam, which contains sufficient silt, clay, and organic matter to impart the loamy characteristic. The surface of the type is heavier than any of the other sandy soils of the sand plains region. The subsoil consists of a loose, incoherent yellow fine sand, which extends to a depth greater than 3 feet.

Extent and distribution.—The largest area, covering nearly 2 square miles, is found about 8 miles northeast of Necedah, on the Wisconsin River. Other smaller tracts occur scattered through the country bordering the Wisconsin river. The total area covered by this type amounts to 3648 acres, and it is therefore of little importance from an agricultural standpoint.

Topography and drainage.—Where the type occurs as a terrace along streams the topography is level. Back from the

streams it is undulating or gently rolling. A few dunes have been formed, but the silt and clay content in the surface tends to check blowing and there are fewer dunes than on the loamy and low phases of the Boone fine sand. Except in a few low places along streams the natural drainage is somewhat excessive and crops suffer from drought at times.

Origin.—The parent rock from which most of this material was originally derived consisted of Potsdam sandstone. This has been transported varying distances, influenced more or less by water action, and deposited in the form of terraces. The influence of the wind has altered the surface features in some instances so that the level, plain-like appearance has been replaced by an undulating topography. The material forming this soil is non-calcareous and litmus paper tests indicate that the soil is acid.

Native vegetation.—The original timber growth consisted of black and red oak, with some Norway and a little Jack pine. The timber showed a more thrifty growth than on the loamy or low phases of the Boone fine sand.

Present agricultural development.—A considerable proportion of this soil is under cultivation and fair crops are secured during seasons of normal rainfall. The yields are slightly above those obtained on the loamy phase of the Boone fine sand and the methods followed are about the same.

CHEMICAL COMPOSITION AND IMPROVEMENT OF BOONE FINE SAND, PLAINFIELD SAND, AND PLAINFIELD FINE SAND.*

In chemical composition these sandy soils contain considerable less of practically all the important elements than do the upland silt loam, or clay loam soils. The total phosphorus in the surface 8 inches will average from 700 to 800 pounds per acre, while the heavy upland soils contain 1000 pounds or more per acre. Boone fine sand as found in the southern part of Juneau County where limestone is present, seems to contain a larger amount of phosphorus than in the central portion of the county

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

where there are no traces of limestone, or limestone material. The total amount of potassium in these light soils will average about 16,000 pounds to the surface 8 inches per acre, while the heavy soils of this area contain approximately 32,000 pounds.

The total amount of organic matter in this sandy group of soils is a little more than half the amount found in the light colored heavy textured soils of the county, and about one-third the amount in the upland prairie soils of the southern and southwestern parts of the State. The amount of organic matter in the Juneau County sands, however, appears to average slightly higher than some of the sands of the State which occur at higher elevations above ground water level. Most of the extensive sand tracts in Juneau County are only from 2 to 10 feet above the level of marshes in which the water table is close to the surface, while over many other sand tracts the depth to ground water is much greater. The slightly greater amount of moisture which may thus be available to plants has favored the accumulation of a somewhat larger amount of organic matter. This difference, however, is not sufficient in itself to give these sands an advantage over other soils which are frequently more favored by containing larger amounts of potassium or phosphorus.

Since Potsdam sandstone is the source of essentially all of these soils, they are very low in lime carbonate, and are usually acid. It is evident, therefore, that these soils have less of all the essential elements required by plants than is contained in heavier and more fertile soils. Their low water-holding power which permits them to become dry and warm early in the spring gives them certain advantages for special crops, and it is possible to profitably supplement their natural supply of plant food material by the use of fertilizers. But all systems of farming on such land should be planned in such a way as either to conserve their natural fertility, or replace it by the use of commercial fertilizers.

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

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

In the management of these sandy soils it should be kept in mind that they are naturally low in organic matter and in the mineral elements required, the water holding capacity is poor and the soil is acid.

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

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

From experiments conducted it seems advisable to sow clover without a nurse crop, where the fertility of the soil is very low, since it will then have all of the moisture in the soil for its own growth. There is also some danger of the young plants being damaged by the hot sun when the nurse crop is removed. The field intended for clover should be plowed in the fall, or as early as possible in the spring, and a top dressing of ground limestone applied at the rate of 2,000 pounds per acre. Such an application should be given once every 4 to 6 years. The field should be harrowed at short intervals to kill all weeds, and this harrowing should be kept up until about the middle of May. Fifteen pounds of seed per acre should be sown and covered to a depth of 1½ to 2 inches. The seeding should be followed by a roller to compact the soil around the seed, and the roller should be followed by a light harrow to roughen and loosen the immediate

surface to check evaporation and blowing of sand by the wind. Where it can be secured a top dressing of well rotted manure should be applied before the last harrowing. If manure is not available about 300 pounds of acid phosphate or ground steamed bone-meal and 100 pounds of muriate of potash should be applied at the time of seeding to clover. If only a small amount of manure is available it may be supplemented by ground rock phosphate, and this can be sprinkled over the manure in the spreader and applied at the same time.

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

Late in summer it may be necessary to clip the weeds which are sure to come. The cutting bar should be run high and the clipping left on the field as a mulch. The second year the first crop should be cut for hay and the second crop plowed under as green manure to prepare the land for a cultivated crop. The amount of commercial fertilizers containing phosphorus and potash which should be subsequently applied will depend on the crops to be grown and especially on the amount of manure produced on the farm.

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

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

In selecting a rotation of crops to follow on the sandy soils it should be kept in mind that the soil is low in organic matter, and that this must be supplied either by applying manure or by plowing under green manuring crops. When the soil has been

built up to a fair stage of fertility, a nurse crop may be used in seeding clover and alfalfa to better advantage than when the soil is very poor; and it is frequently desirable to seed with rye or oats. This system is considered by many to be more desirable, since an extra crop can be secured.

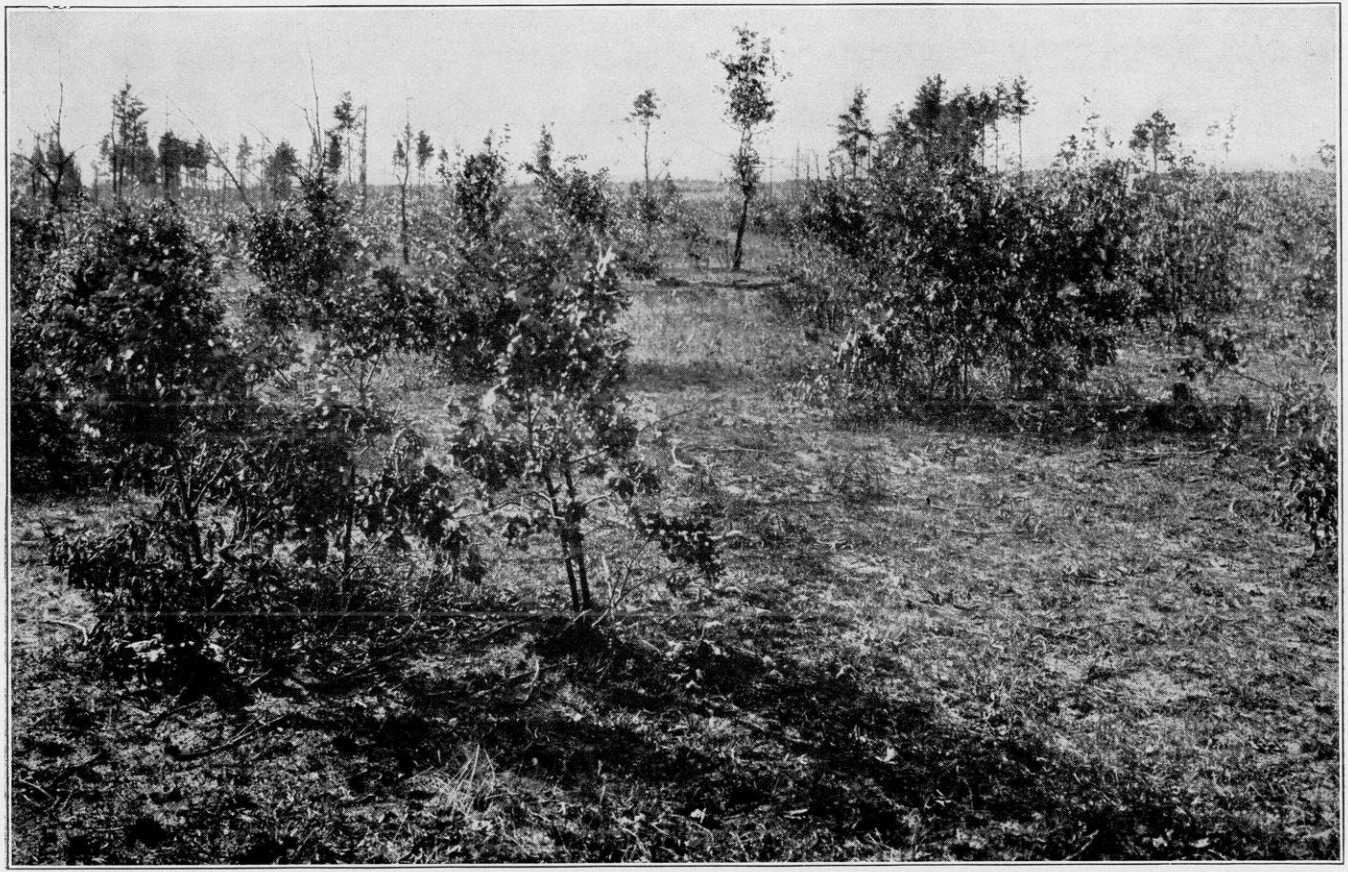
A three, four, or five year rotation may be followed. If but little stock is kept, a three year rotation may be practiced, consisting of one year of a cultivated crop such as potatoes or corn, one year rye or oats seeded to clover, and one year clover—the first crop to be cut for hay and the second to be plowed under for green manure. When the fertility of the type is well established, the second crop may be allowed to seed. Good yields have been secured where the soil is well managed. If manure is scarce, acid phosphate and potash may be applied at this time. If more stock is kept the rotation may be extended one year, using the clover field for pasture one season before plowing down the sod. The manure may then be applied to the sod in the winter or early spring of the year the field is pastured. This will increase the growth of clover and benefit the succeeding crop. In a five year rotation alfalfa may be introduced, but this requires that considerable stock be kept, since none of the alfalfa should be sold. The field should be left in alfalfa for three years with two years given to cultivated crops and grain. Manure should be applied to the cultivated crop and also to the first year of alfalfa. This system is very desirable except that it does not provide any pasture. To overcome this the farm may be divided and both the four and the five year rotation practiced, or where marsh land suitable for pasture is included in the farm no other pasture will be needed. Alfalfa may also be grown by itself and kept on the same field year after year, in which case its place in the rotation should be filled by clover. When the alfalfa begins to run out, the field should be reseeded.

In the cultivation of the sandy soils fall plowing for rye, and spring plowing for all other crops, is the usual practice. The seed bed should be prepared to a depth of at least 8 inches and organic matter should be worked in deeply as well as near the surface to increase the water-holding capacity and to induce a deeper development of the roots. When the land is plowed in

the spring it is often advisable to pack the soil with a roller, but this should be followed by a light harrow to secure a mulch on the surface. Where the fields are exposed, and the soil is blown by the wind, an effort should be made to prevent damage from this source. The most effective plan is to lay out the land in long narrow fields so as to have crops that cover the ground in the early spring, such as clover and rye, alternate with the cultivated ground.

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

In the cultivation of these extremely sandy soils it must be borne in mind that the fertility is low and that before profitable crops can be secured from year to year, it will be necessary to add a considerable amount of plant food. Those, therefore, who are interested in farming this class of land should be prepared to expend a considerable amount in addition to the original cost of the land before profitable crops can be expected. Soils of this character require very careful management and in order that expensive failures may be prevented the inexperienced should not hesitate to call upon the State Experiment Station for the direction and supervision of their efforts. It would be well also for those who contemplate taking up land in this region to inquire of the Soils Department of the University of Wisconsin concerning the quality of the land, the purchase of which they are considering.



VIEW SHOWING GROWTH WHICH IS CHARACTERISTIC OF THE SANDY SOILS OF JUNEAU COUNTY.

Jack pine and scrub oak are very common. Poplar and some hazel brush frequently form part of the vegetation. Where the growth is sparse there is sufficient grass to furnish fair pasture during spring and early summer.

CHAPTER IV.

GROUP OF FINE SANDY LOAM SOILS.

BOONE FINE SANDY LOAM.

Description.—The surface soil of Boone fine sandy loam consists of a dark-gray fine sandy loam, 12 inches deep, which contains varying amounts of silt. The subsoil consists of a yellow silt loam carrying considerable fine and very fine sand and extending to a depth of about 24 inches. Below this depth the amount of fine sand usually increases and at 30 to 36 inches a pure fine sand is sometimes encountered. While the above covers the description of a large proportion of the type, the soil is extremely variable. In places the surface is a silt loam having a fine sand subsoil. Where the type borders the Superior clay loam the subsoil is frequently red in the lower depths. The silt loam areas throughout the Boone fine sandy loam are rarely large enough to be separated, yet in themselves they constitute a soil type quite similar to the Lintonia silt loam. Between the silt loam and the fine sandy loam there are a great number of variations, which it would be impossible to show on a map of the scale used.

Extent and distribution.—The type is of comparatively small extent and is confined, with but one or two exceptions, to the southern and southwestern parts of the area, where it is closely associated with Knox silt loam and the Knox silt loam steep phase. The largest area extends for about 4 miles to the northwest and about 2 miles to the southeast of New Lisbon. There are several areas in the vicinity of Mauston and Hustler and also in various sections throughout the hill country. A few small areas are found along the Wisconsin River south of Germantown. These consist of a fine sandy loam to loam, brown to quite dark in color, and underlain at from 12 to 20 inches by a

yellow, coarse silt, which in turn grades into fine, medium, or coarse sand.

Topography and drainage.—The surface varies from level to undulating, and in a few cases very gently rolling. The type occurs on the lower slopes of hills and ridges, covered with Knox silt loam and Knox silt loam, steep phase, and extends into the lowland bordering the streams. It may occupy very low ridges, the summits of which are always sandy. Sometimes it occupies all of the valley bottoms. Shallow, saucer-shaped depressions are frequently seen over the flat areas. The natural drainage in such places is poor, and tile drains will be necessary over certain portions of the type. This condition has retarded the development of this soil for agriculture.

Origin.—In origin Boone fine sandy loam is partly residual and partly colluvial. It is a mixture of the silty material washed down from the hills and the fine sand formed from the disintegrating of the Potsdam sandstone. That portion of the type found along the Wisconsin River is somewhat different and consists of a river deposit. Litmus tests indicate that the soil is slightly acid.

Native vegetation.—The original timber growth consisted chiefly of oak, elm, soft maple and hickory. Most of the timber of any value has been removed.

*Present agricultural development.**—The larger proportion of the type is under cultivation, and fair yields are secured. Planting is sometimes delayed in the spring on account of the soil being too wet. The crops commonly grown are corn, oats, and hay, with some tobacco and a little barley. The soil is variable, as are also the methods followed, so that there is quite a range in the crop yields. The methods of cultivation followed are similar to those practiced on Knox silt loam, and about the same rotations are in use.

SUPERIOR FINE SANDY LOAM.

Description.—The soil of Superior fine sandy loam, to a depth of 10 to 16 inches, consists of a grayish fine sandy loam, grading

*For chemical composition and improvement see page 55.

into a yellowish fine sandy loam. The supply of organic matter is low, which accounts in part for the light color. The subsoil to a depth of 36 inches consists of a heavy red clay, similar to the subsoil of the Superior clay loam. The depth to the clay is somewhat variable, ranging from 6 to 30 inches. Where the type occurs adjacent to the slopes from the high land to the south there is sometimes enough silt mixed with the sand to make it approach a silt loam. Such areas, however, are of limited extent.

Extent and distribution.—The type is closely associated with Superior clay loam and is usually found lying between this type and other soils mapped as sand. There are no areas over one-half square mile in extent. A number of small patches are found from 2 to 4 miles northeast and about the same distance southeast of Mauston.

Topography and drainage.—The surface of Superior fine sandy loam varies from gently rolling to level. On the higher elevations the sand is usually deeper than on the flat areas. It frequently occupies gentle slopes adjoining areas of Superior clay loam. Where the surface is undulating or a little rolling the natural drainage is good, but where it is level the type is in need of tile drains.

Origin.—The subsoil is a lacustrine deposit, the same as the Superior clay loam. The surface soil is largely sand which has been blown or washed over the clay, and with which some fine material has become incorporated. The parent rock from which the sand came is the Potsdam sandstone. The sandy material is slightly acid, while the underlying clay loam contains a considerable amount of the carbonate of lime.

Native vegetation.—The original timber growth consisted of oak, maple, and some pine, with a little elm and ash on the poorly drained portions. Practically all of the timber has been removed.

*Present agricultural development.**—A large proportion of the type is under cultivation, but it is of very limited extent, and no system of cultivation or cropping has been developed.

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*For chemical composition and improvement of this soil see page 55.

Where found on the gentle slopes the soil is very productive, but on the level areas it is in need of drainage and crop yields are lower. Corn, oats, barley, wheat, hay, and some tobacco are grown. It is considered a good tobacco soil, and during normal seasons gives satisfactory yields of the ordinary farm crops. In the management of the Superior fine sandy loam an effort should be made to increase the content of organic matter, and the wet places should be tile drained.

The following table shows the result of mechanical analyses of samples of the soil and subsoil of Superior fine sandy loam:

Mechanical analyses of Superior fine sandy loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Soil	0.3	14.4	19.9	28.6	5.9	23.6	6.9
Subsoil	.0	3.2	4.1	6.1	1.3	46.3	38.4

SUPERIOR SAND.

Description.—The surface soil of Superior sand consists of 8 inches of a grayish-brown fine sand to loamy sand. The poorer-drained areas contain a larger amount of organic matter than typical and in such places the color of the soil is darker. The subsoil consists of a yellow fine sand, which becomes lighter in color with depth, in places almost white. At about 24 inches the material often takes on a pinkish hue and at an average depth of 30 inches a compact, red silty clay is encountered. Where the drainage is the most defective the sand of the subsoil may be bluish in color in its lower depths and the silty or sandy clay may also be blue, drab, or slightly mottled. The most characteristic feature of the type is the light-colored sandy subsoil, which grades into the Superior silt or silty clay loam. The type is subject to considerable variation and the depth at which the silt or clay is found ranges from 18 inches to 5 feet. The areas underlain by the clay at 18 inches were of small extent. Land of this character, when in large enough patches to warrant sepa-

ration, was classed with the Superior fine sandy loam. When the clay was over 5 feet below the surface its effect upon the agricultural value of the soil was so small that such material was excluded from this type. The texture of the subsoil frequently becomes coarser with depth and at 24 to 30 inches it may be a medium sand. The sand of the sandy clay may also be of medium texture.

Extent and distribution.—This is the most extensive type of the Superior series. The largest area lies directly north of Camp Douglas, where it occurs along both sides of the Lemonweir River for over 6 miles. An area several miles in extent is found directly northwest and another directly northeast of New Lisbon. Other smaller patches occur along the Lemonweir River. But little of the type is found north of the new line of the Chicago & North Western Railway and only a few small areas are found to the south and east of New Lisbon. Superior sand is closely associated with Superior clay loam and Superior fine sandy loam.

Topography and drainage.—The surface of the type is flat to very gently undulating. No very pronounced ridges or depressions occur, though there are a few narrow ridges on which the sand is of sufficient depth to exclude it from this type, but for the fact that they are too small to be indicated. The differences in elevation over the type as a whole are not more than several feet at most. On account of the flat topography and the underlying, impervious clay loam or silty clay loam, the natural drainage of a great deal of the Superior sand is poor. The type seldom suffers from drought, as the heavy subsoil keeps the water within reach of the roots of growing crops. During the spring and fall there is usually an excess of moisture. A few tile drains have been installed and the results obtained more than justified the expenditure.

Origin.—The clay subsoil of Superior sand is of lacustrine origin. The surface sandy material has doubtless been deposited by water also, but at a later date and under different conditions. The Potsdam sandstone is the parent rock from which most of the sandy material was originally derived. Litmus tests indicate that the surface soil in places is in an acid condition, though

the heavy subsoil contains a considerable amount of the carbonate of lime.

Native vegetation.—The original timber growth consisted of elm, bur oak, black oak, maple, and willow, with some white and Norway pine. The timber was considerably better than on any of the other sand types not underlain by the clay. Practically all of the merchantable timber has been removed.

Present agricultural development.—A large proportion of the type is under cultivation and better returns are secured than from any of the other sand types in the area. It is considered a fairly good soil. The chief crops are corn, oats, timothy, and clover, with potatoes as a cash crop and buckwheat a frequent crop on new land. Where the drainage conditions are the most favorable or where artificial drains have been installed corn yields 35 to 50 bushels per acre, with a very good yield of silage, which is much in excess of the yields on the other sands. Oats yield 40 bushels, hay 1½ to 2 tons per acre, buckwheat from 10 to 30 bushels, and potatoes from 150 to 250 bushels per acre. The type produces excellent pasture of bluegrass and clovers. On account of the sandy nature of the soil it is easy to cultivate, and when wet weather does not interfere there is no difficulty in getting a good seed bed with a minimum expenditure of labor. The rotation of crops most often followed consists of corn or potatoes one year, followed by oats seeded to clover and timothy. The hay is cut for two years, and the field is pastured for a year before being again plowed for corn. The manure is usually applied to the pasture land. The growing of potatoes in conjunction with dairy farming appears to be about the best combination that has been tried on this soil. When dairying is followed the poorly drained areas can always be utilized for pasture. Potatoes supply a cash crop better suited to the land than any of the grains which can be grown. By installing tile drains a much larger proportion of the type could be improved and made to yield profitable returns. Cucumbers have been successfully grown to a limited extent, and it would seem that the trucking industry might be profitably extended. Peat has been successfully used as a fertilizer by a few farmers. One report indicates that the effect of one application could be noticed for 11 years.

CHEMICAL COMPOSITION AND IMPROVEMENT OF BOONE FINE SANDY LOAM, SUPERIOR FINE SANDY LOAM, AND SUPERIOR SAND.

The chemical composition of this group of soils indicates that their fertility is intermediate between the extremely sandy soils on the one hand, and the silt and clay loam soils on the other. The total amount of phosphorus in the surface 8 inches averages from 700 to 800 pounds per acre, which is practically the same as for the sand soils. The total amount of potassium, however, will average considerably higher, though it is extremely variable, usually ranging from 10,000 to 20,000 pounds per acre, for the surface 8 inches. In the case of the Boone fine sandy loam it frequently runs even higher. The total amount of potassium in these soils appears to vary with the fineness of the texture, so that the larger the proportion of fine material there is present, the greater will be the amount of potassium. In the Superior fine sandy loam and fine sand types the total amount of potassium and phosphorus varies with the depth to the underlying clay. The total amount of organic matter in the Boone fine sandy loam is somewhat higher than in the group of sand soils, but in the case of the Superior fine sandy loam and fine sand, the amount is practically the same.

In the improvement of this group of soils it is necessary that the organic matter content should be increased, and that a considerable amount of mineral plant food should be added to the soil. Before clover and alfalfa can be grown successfully it will be necessary to apply some form of lime to correct the soil acidity. The building up of these soils may be carried forward along the same lines as suggested for the group of sand soils, and the reader is referred to pages 43 to 48 for additional information along this line. The water holding capacity of the sandy loam soils is somewhat greater, and the natural fertility higher, than is the case of the sand soils, and, therefore, they may be expected to respond more quickly to careful management.

CHAPTER V.

MARSH SOILS.

PEAT AND MUCK (UNDIFFERENTIATED).

Description.—The material included in Peat and Muck (undifferentiated) consists of decaying vegetable matter in varying stages of decomposition, with which there has been incorporated in places a small amount of mineral matter. It is of a black or brown color and extends to a depth varying from a few inches to over 15 feet. The material underlying the greater portion of such areas consists of fine sand. In the sections where the Superior soils are found the underlying material is usually a silt or clay. Throughout a considerable portion of the marshes there are a number of sand islands varying in area from a few square rods to a couple of acres. Where less than 25 per cent of the land is occupied by these islands they have been included with the Peat and Muck (undifferentiated). Where the islands occupy more than 25 per cent of the area and are not large enough in themselves to be mapped, such regions have been classed under a separate type.

Nearly all of the peat beds have been burned over. Where this is the case and where the fire has been rather recent a layer of yellowish ash from one-half inch to 3 inches deep is found upon the surface. Beneath this for a variable depth of 8 to 20 inches the material is usually quite thoroughly decomposed, while below this, where the peat is deep, it is only slightly decomposed and is still in a fibrous condition. Where the Peat is shallow there is a larger amount of mineral matter present than where the material is deep.

Extent and distribution.—Areas of Peat and Muck (undifferentiated) are distributed throughout the sand plains section of the county. Extensive areas are found north of Camp Douglas,

north of Cranberry Center, along Little Yellow River, and in various other localities, chiefly along the Lemonweir River.

Topography and drainage.—The surface of the Peat and Muck (undifferentiated) is nearly level, but the sand islands which occur throughout a portion of the type vary from 1 to 2 feet higher than the level of the marshes and give the region where they are the most plentiful a gently undulating appearance. Being flat, occupying a low position, and having the water table near the surface, the natural drainage is very poor. A number of large open ditches have been constructed and portions of the marshes drained.

Origin.—The material making up the Peat and Muck (undifferentiated) consists of vegetable matter in varying stages of decomposition. The underlying sand and that forming the sand islands is undoubtedly from the Potsdam sandstone and has been influenced more or less by the action of water. The clay and silt underlying some of the Peat and Muck (undifferentiated) is probably of lacustrine origin, the same as the Superior clay loam. These Peat marshes are practically all in an acid condition.

Native vegetation.—The native vegetation consisted of sedges, cattails, wire grass, marsh grasses, sphagnum moss, cranberries, willows, etc.

Present agricultural development.—Peat and Muck (undifferentiated) is devoted chiefly to the production of marsh hay, wire grass, moss, and cranberries. The marsh hay consists of wild grasses and yields on the average about 1 ton per acre. The price received varies with the supply, quality, and whether baled or not, the range being from $3 to $9 per ton. The yield of wire grass is about the same, and the price received is usually about $14 per ton f. o. b. in bales. This wire grass is used in the manufacture of rugs.

Where drainage systems have been installed the greater portion of the marshes is still devoted to marsh hay and pasture, but some areas in close proximity to the ditches have been cultivated with varying degrees of success. Timothy and alsike clover are grown to a limited extent, and the yields average about 1 ton per acre, though 1¾ tons are sometimes secured, while the crop is

often a complete failure. Oats are grown in a few places, and yields of 20 bushels per acre are reported as the average, though much larger yields are sometimes obtained. Some corn has been grown. The cultivated crops, however, are all uncertain.

The growing of cranberries was at one time an extensive industry, but many of the marshes have been destroyed by fire and the acreage greatly reduced. Practically all of the marshes remaining have been set out. A successful cranberry marsh must be so situated that the water supply can be controlled. The crop is subject to damage from frosts, and during the dry summer months there is great danger from fires. The industry is, therefore, a speculative one. The cost of establishing cranberries is considerable. Scalping a peat bed costs from $30 to $75 per acre, sanding about $90, and setting about $32. Vines are usually secured from trimmings, but if bought they cost about $100 per acre. The weeding for the first year on sanded marsh costs $10 and on Peat $50 per acre. Weeding the second and third year on sanded marsh costs $10 and on peat $20 per acre. Full crops are seldom received until four years after setting. It costs about $1 per bushel to pick and prepare the berries for market. One bog this year (1911) yielded 555 bushels per acre. When $2 per bushel is secured such a yield is very profitable. Yields of this size are seldom secured oftener than once in five years, and many marshes never produce such large crops.

From 20 to 30 cars of sphagnum moss are shipped from Mather each year. The moss is collected by long-toothed rakes operated by hand, cured, and packed in bales weighing about 30 pounds each. The price per bale is 50 cents in Chicago. The moss is used by nurserymen and florists. It takes from three to four years for a marsh to renew itself after moss has been collected. Since the drainage of the marshes much of the moss has been destroyed by fires. The owner of the marsh usually receives 50 cents per ton for the moss, and the work is done by men who make a business of gathering moss.

*Chemical composition and improvement.**—The chemical com-

*See Bulletin No. 205—The University of Wisconsin, Agr. Exp. Sta. on "The Development of Marsh Soils", Bulletin No. 229 on "The Right Drain For the Right Place," and Bulletin No. 213 on "Cranberry Bog Construction for Wisconsin".

position of the material mapped as Peat and Muck (undifferentiated) is quite variable, and this variation is due chiefly to the variation in the amount of mineral matter which is incorporated with the Peat. The result of analyses of this material from Juneau County indicates that the supply of the mineral elements is small. The total amount of phosphorus will average approximately 500 pounds per acre in the surface 8 inches, while the amount of potassium will average about 900 pounds per acre. On comparing this with the potassium and phosphorus content of the heavy upland soils of this county it will be seen that it is extremely small especially in the case of potassium. Where this type consists of a mixture of decaying vegetable matter and a considerable amount of mineral matter so as to be a true muck the total amount of potassium and phosphorous is always considerably higher than where the material is a true peat and contains but little mineral matter. Because of an acid condition which is found to exist throughout the areas of Peat and Muck in Juneau County, the phosphorus is not as readily available as in marshes which are not acid. In view of the enormous quantity of nitrogen contained in the Peat and Muck, the average amount of which is approximately 11,000 pounds per acre 8 inches, it is unnecessary to use fertilizers which contain nitrogen in building up this class of land.

The fertilization of the Peat as found in this area is important on account of the unbalanced condition of the elements contained. Stable manure should be kept for the upland soils of the farm, and potash and phosphorus supplied to the marsh soils by commercial fertilizers. Rock phosphate, acid phosphate, and bone meal are the chief sources of phosphorus for fertilizers, and of these the rock phosphate will doubtless give best results on this class of land. The first application of rock phosphate should be from 800 to 1000 pounds per acre followed every 3 to 4 years by an application of from 400 to 600 pounds per acre. Potash may be applied as the muriate at the rate of 100 to 150 pounds per acre for such crops as corn, potatoes, cereals, and hay. This fertilizer is quite soluble, and frequent applications are necessary.

While the Peat and Muck in this area is in an acid condition the acidity is not so detrimental in the case of marsh lands as in

the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on the higher lands to secure nitrogen, and to the growth of which the marsh soils are not so well adapted physically.

In the improvement of this class of land the question of drainage is the first step to be considered. In Juneau County there are now a large number of drainage districts, and many miles of large open ditches have been constructed. In some cases these are sufficient to drain the land fairly well so that some of the Peat and Muck can be improved, but in a number of cases the drainage is not sufficiently thorough. By deepening some of these ditches through the Peat marshes, and by the construction of more laterals it is probable that the greater proportion of the Peat and Muck can be reclaimed, and made to produce profitable crops.

When properly drained and fertilized this class of land will produce profitable yields of corn, potatoes, cabbage, buckwheat, timothy, alsike clover, and a number of other crops. When firmed by rolling, small grain can be grown successfully, though the growth of straw is often too rank. With proper care good tame grass pastures can be developed on the Peat and Muck. The growing of cranberries is an industry well adapted to this class of land, and while it is now engaged in to a certain extent, it is thought it could be profitably extended by following the most up-to-date and scientific methods.

SANDS AND PEAT (UNDIFFERENTIATED).

Description.—The soils mapped as Sands and Peat (undifferentiated) is subject to a wide variation and consists of shallow peat and black sand in a low, marshy condition, with numerous small islands of light-colored sand occurring throughout its entire extent. None of these variations are of sufficient extent in themselves to be mapped as a separate type. Peat consists of vegetable matter in various stages of decomposition, with which there is incorporated varying amounts of earthy matter. It extends to a depth of 1 to 20 inches and in a few instances to 30 inches. The underlying material consists of fine or medium

sand, usually white, though it is frequently stained with iron or slightly mottled. The black sand corresponds to that mapped as Dunning sand, though the depth of the surface soil may vary from 1 to 18 inches. The sand on the islands is usually identical with the low phase of the Boone fine sand, though in some sections it is coarser and corresponds more closely to the Plainfield sand. The islands range in size from a fraction of an acre to 5 acres or over and in elevation from 1 to 2 feet above the level of the marsh. In a few places, where ridges occur, an elevation of 20 feet is attained. The black sand is found surrounding the islands, usually as a narrow belt, while the Peat occupies the larger spaces between the islands. Where the islands are close together there may be no Peat between them. The islands occupy from 25 to 75 per cent of the total area, but taken as a whole the type will average about 50 per cent sand islands and 50 per cent marsh.

Extent and distribution.—The most extensive areas of this type are in the northwestern part of the county, where it occurs along the Lemonweir, Little Yellow, and Yellow Rivers, and occupies most of the intervening country as well. The main body extends south for about 4 miles below the new line of the Chicago & North Western Railway, in the vicinity of Cranberry Center, and a belt extends to the southeast nearly to the Wisconsin River. Other areas are found throughout the sand-plains country.

Topography and drainage.—The surface of the Sands and Peat (undifferentiated) is level, with slight undulations due to the low islands, which rise only a few feet above the level of the marsh. In places an elevation of 20 feet is attained, but this is exceptional. The islands in themselves are usually sufficiently drained and become droughty each summer. The intervening areas of black sand and shallow peat, however, are poorly drained. The water table is close to the surface and cultivated crops can not be grown until drainage systems have been installed. Even where such systems have been established they are not always sufficient to properly drain the extensive areas of lowland and comparatively little of the type has been improved so as to make the growing of cultivated crops successful. Other

conditions aside from drainage, however, must be met before success will be assured.

Origin.—The material forming the sand islands and the subsoil of the marshes has been derived from the Potsdam sandstone, but has been influenced more or less by the action of water. The sand on the islands has also been acted upon by the winds, and low dunes are quite common. In fact, the islands themselves may be largely of dune origin. Some of the depressions between the islands are considered by some to be erosion channels formed when the water from shallow floods was receding or when this entire region was occupied continuously by an expansion of the Wisconsin River. The Peat consists of vegetable matter in varying stages of decomposition with which there is mixed different amounts of sand. The black sand contains a considerable amount of vegetable matter, but not enough to form a Peat. The surface material of this type is in an acid condition.

Native vegetation.—The growth on the islands consisted chiefly of Jack pine, Norway pine, scrub oak, poplar, and birch, with a considerable stand of underbrush comprising several varieties of shrubs and a scattering growth of prairie grasses, sweet fern, etc. On the Peat and black-sand areas the growth consists of marsh grasses, wire grass, moss, etc.

Present agricultural development.—With a few exceptions, the production of marsh hay, wire grass, and the furnishing of pasture is the only use made of this type. Large drainage systems have been established throughout the region, with the idea of improving the land by drainage and making possible the growing of cultivated crops. For various reasons the ditches have frequently not fulfilled the expectations of those interested. In some sections the assessments on the land to cover the cost of the ditches have been as high as $10 per acre, yet the drainage afforded is seldom sufficient, and as a result but few efforts are made to cultivate the land. Marsh hay cut from the Peat and black sand will frequently yield 1 ton per acre. The harvesting of wire grass is quite an important industry. The usual price received is $14 per ton, in bales, delivered at the shipping point. The shipment from Cranberry Center has been as high as 154 carloads in one season. In 1911 sixty cars were shipped. Wire

grass is used in the manufacture of rugs and mattings. The islands do not support a growth of grass sufficient to cut for hay, but in conjunction with the lowland they furnish some pasture.

*Chemical composition and improvement.**—On account of the extreme variations which occur in this type a chemical analysis of any one phase would not be representative of all conditions, and an average of analyses from the different phases would have little meaning because of the wide range covered. It is therefore considered advisable to compare the various phases of the Sand and Peat type with other types which have been mapped in Juneau County, rather than to attempt giving specific chemical data for this condition as a unit.

As indicated above, this type is composed of about 50 per cent of marsh, consisting of shallow Peat and dark colored sand, and about 50 per cent of light colored sand which occurs in small islands scattered through the marsh. On account of the shallow condition of the Peat and the fact that it contains considerable mineral matter, its chemical composition differs somewhat from that of typical Peat. It contains slightly more phosphorus and potassium, but less nitrogen than typical Peat. The dark colored sand is comparable with the Dunning sand, which is described in the following chapter, and wherever areas of sufficient extent were found they were mapped separately as Dunning sand. In chemical composition this dark sand contains more phosphorus and potassium, but considerable less nitrogen that the Peat. Because of the acid condition which prevails throughout this type a smaller proportion of the phosphorus is available than where an acid condition does not exist. The total amount of both the phosphorus and potassium in the Peat and dark sand is small and before profitable crops can be expected over a series of years these mineral elements will have to be supplied.

The chemical composition of the sand islands is practically the same as that of the group of sand soils previously described.

*See Wisconsin Experiment Station, Bulletin 205, Management of Marsh Soils.

For special information concerning drainage, write the Soils Department of the Wisconsin Experiment Station.

The soil is low in the mineral plant food elements and also in the supply of organic matter. It is deficient in its water holding capacity, and the soil is acid. Since most of the islands have an elevation of only a few feet above the level of the marsh, the water table is closer to the surface than in the upland soils, even under these conditions the moisture supply is deficient for a large portion of the growing season.

Before cultivated crops can be grown successfully on the dark sand and shallow Peat thorough drainage is necessary. As in the case of the Peat and Muck, a number of large drainage ditches have also been constructed through this type, and some crops have been grown close to the ditches. The drainage of the large tracts, however, does not appear to be sufficient, and often the methods of cultivation followed are not those best suited to the improvement of this class of land.

In cases where the covering of Peat has been burnt off there is frequently sufficient potassium available for several crops, but this element must be supplied ultimately and the supply in the soil should not be allowed to be depleted before more is added. If corn or potatoes are to be grown 150 pounds of high grade muriate of potash should be applied per acre, but if cereals or hay grasses are to be grown 100 pounds per acre will be sufficient. When these crops are grown in rotation it may be unnecessary to use the potash fertilizer in seeding down with a cereal following a crop on which a heavy application was used the previous year. Phosphorus can best be supplied as ground rock phosphate and this should be applied at the rate of about 1000 pounds per acre, followed by applications of half this amount every 3 or 4 years. Ground steam bone meal and acid phosphate are also excellent phosphate fertilizers for such land, though much more expensive than the rock phosphate. From 300 to 500 pounds per acre may be used at the beginning and every 3 to 5 years thereafter.

While the shallow Peat and dark sand is quite strongly acid the acidity is not as detrimental in the case of marsh lands as in upland soils, since the chief objection to the acidity is that it interferes with the growth of legumes, such as clover and alfalfa, which are needed on the higher lands to secure nitrogen, and

VIEW FROM NEAR SPRAGUE SHOWING CHARACTER OF THE MARSH AND SAND ISLANDS. THIS TYPE IS REFERRED TO IN THE REPORT AS SANDS AND PEAT (UNDIFFERENTIATED).

The marsh consists of black sand or shallow Peat underlain by light colored fine sand. The usual growth is coarse marsh grass which may be cut for hay, wire grass which is used for matting, or moss which may be used by nurserymen.

The sand islands range in size from a few square rods to something over ten acres. They are but a few feet above the marsh, consist of loose, fine sand and support a scattering growth of Jack pine, poplar, and scrub oak, with only a small amount of grass. There are over 100,000 acres of this class of land in Juneau County. It affords fair grazing.

to the growth of which the marsh soils are not so well adapted physically. It would probably require at least 4000 pounds of ground limestone to correct the acidity of these marsh soils. When properly handled some of the crops which may be grown on this land are corn, potatoes, buckwheat, cabbage, and timothy and alsike clover, though yields equal to those obtained on good upland soil should not be expected except under the most careful management.

The improvement of the sand islands, where of sufficient size to justify separate treatment, may be carried on along the same lines as suggested for the improvement of the group of sand soils on page 43. A point which should be considered in this connection is that the water table on the sand islands will be lowered when the marsh is drained, and the sand will thus become more subject to drought.

It will thus be seen from the foregoing that where farms are located on this class of land they will require very careful management, and it will be necessary to expend a considerable amount in addition to the original cost of the land before profitable crops can be expected. The drainage of the land, while necessary, will not solve the questions of soil fertility, and before profitable crops can be secured from year to year liberal applications of fertilizers, as indicated above, will be necessary. Those expecting to develop farms on this land should therefore be prepared to meet these conditions.

The agricultural value of this class of land as a whole is low, and its development along the lines suggested will not in all cases be practicable. It is suggested, therefore, that a more extensive system be considered by those holding large tracts. From information at hand it would appear that such land could be handled profitably in the raising of livestock. The idea would be to pasture as many cattle as the land would carry, and cut some marsh hay for part of the rough, winter feed. The steers could be sold as feeders and the cows kept for milk production. The stock should be yarded at night and the manure saved and applied to the islands, and the best drained portions of the marsh, where sufficient small grain, and corn for silage could be grown for winter feed.

As compared with other classes of land this Sand and Peat type has a lower value than typical Peat. It also has a lower value than marsh soils which are underlain by a heavy subsoil. These facts should be given consideration by those who may be interested in the development of marsh soils. It would be well for those who contemplate the purchase of land in this region to write the Soils Department, University of Wisconsin for any additional information which may be desired concerning the character of the soils and their improvement.

CHAPTER VI.

GROUP OF MISCELLANEOUS SOILS.

LA CROSSE SILTY CLAY LOAM.*

Description.—The soil of La Crosse silty clay loam, to an average depth of 12 inches, consists of a black silt loam, which contains a high percentage of organic matter, in places approaching a mucky soil. The subsoil, to a depth of 20 inches, consists of a gray or drab silt loam to silty clay loam, below which the material is frequently mottled with yellow. In places the lower subsoil is a sandy silt or sandy clay loam.

Extent and distribution.—La Crosse silty clay loam is of limited extent, but occurs in a number of small areas. Several of these are found from 2 to 5 miles southeast of Mauston and from 2 to 3 miles south of New Lisbon. A number of other patches occur throughout the hill section and in the country immediately at the foot of the bluffs. It is confined to stream valleys, terraces, and low depressions where there has been an accumulation of organic matter.

Topography and drainage.—The surface of the areas of La Crosse silty clay loam is level and the soil often occurs in basin-shaped depression. In such places the natural drainage is poor. Practically all of the type would be greatly benefited by tile drainage. Areas bordering the streams may be flooded in part during periods of heavy rainfall.

Origin.—The soil is believed to be in the main of alluvial and colluvial origin, though it includes some lacustrine material having the general characteristics of Clyde soils of the glaciated areas, though occupying slightly higher elevations. The dark color is due to the accumulation of a considerable amount of organic matter which has undergone decomposition under moist conditions.

Native vegetation.—The original timber growth consisted of elm, ash, some maple, and willows. All of the best timber has been removed.

*In the future La Crosse silty clay loam will be included with Waukesha silt loam.

Present agricultural development.—Because of its poorly drained condition, a considerable proportion of the type is unimproved. Around the margins of the areas where the drainage is best, and in a few cases over the entire area, the type is cultivated and good crops are secured. The soil is well adapted to corn, but grains are apt to develop too much straw and lodge.

Chemical composition and improvement.—The chemical composition of this soil indicates that all of the essential plant food elements are present in sufficient amounts to produce excellent crops over a long period of years. The total amount of phosphorus in the surface 8 inches is approximately 2000 pounds per acre, which is more than is contained in any of the other soils of Juneau County. The total amount of potassium is approximately 25,000 pounds per acre in the surface 8 inches, and while this is lower than the amount in Knox silt loam, it is nevertheless sufficient. Its availability will depend upon the actively decomposing organic matter, but as much of this soil has not been brought under cultivation, and as none of it has been depleted, there will be a sufficient supply of available potassium so long as good methods of farming are followed. There is an abundant supply of nitrogen present in this soil, the amount being approximately 10,000 pounds to the surface 8 inches. The surface soil of this type is slightly acid, but this condition may be readily corrected by the application of about 1,500 pounds of ground limestone per acre.

The most important question in the improvement of this soil is one of drainage. Practically all of the land has sufficient fall so that tile drains could be installed successfully. When this type is properly drained it will be the best corn land in Juneau County. Small grains may also be grown but they are apt to lodge, and the quality of the grain is not so good as when grown on the light colored upland soils. Clover and alfalfa may be successfully grown on this type, and as a whole it may be considered as good general farming land.

DUNNING SAND.

Description.—The surface soil of Dunning sand consists of black, medium, or fine sand, 12 inches deep, containing a high

percentage of organic matter which imparts to the soil its dark color. The subsoil consists of a grayish or whitish fine to medium sand, which has a leached or washed appearance, and extends to a depth considerably beyond 3 feet. In places the subsoil is stained yellow by iron oxide and a bluish mottling is not uncommon. The depth of the surface soil varies considerably, but in other particulars the type is uniform.

Extent and distribution.—Dunning sand is confined to the sand plains portion of the county and in mapping it was frequently made to include some of the land lying between the marshes and the low phase of the Boone fine sand. One of the most extensive areas is found along the Iron Creek Ditch, which it borders for several miles. There is an area 2 miles west of Necedah and another about 7 miles north of Mauston. Other smaller patches occur scattered throughout the sandy region adjoining the marshes or bordering stream courses. The total area is not extensive, but it is quite widely distributed.

Topography and drainage.—The surface of the soil is low and always level. It is very little higher than the level of the marshes and slightly lower than the bordering sands of light color. On account of its low position and the nearness of the water table to the surface, the natural drainage is poor, and as a result the type is too wet for ordinary farm crops, except during the dry portion of the summer. Where the big, open ditches traverse this soil it is drained sufficiently to produce cultivated crops.

Origin.—The Potsdam sandstone is the parent rock from which Dunning sand was derived. It has been reworked, transported, and deposited by the action of water, but to what extent it is impossible to say. The soil was doubtless formed in the same way as the low and loamy phases of the Boone fine sand, but since it occupies a lower position and has been under moist conditions it has acquired a black color through the growth and decay of vegetation. The whitish color of the subsoil may be due to the leaching of organic acids. All of the soil is in a very acid condition at the present time.

Native vegetation.—The native vegetation consists of Jack pine, poplar, sweet fern, common ferns, mosses, blue stem, and several species of marsh grass. There is no timber of any value on the type at the present time.

Present agricultural development.—As the type is low, poorly drained, and very acid, it is not cultivated except in a few places. It is devoted chiefly to the production of wild marsh hay and to pasture. Where cultivated corn and buckwheat are the crops most grown. One farmer reported a yield of 40 bushels of corn and 150 bushels of potatoes per acre.

Chemical composition and improvement.—In chemical composition the Dunning sand is found to be deficient in the mineral plant food elements. It contains a fair amount of phosphorus, which in some instances is nearly equal to the amount in the heavy upland soils of Juneau County. The potassium supply, however, is only about ⅓ of that in the heavy upland soils, while the supply of nitrogen is somewhat greater than in the light colored, heavy types. Dunning sand is very acid and about 4000 pounds of ground limestone per acre would be required to correct this condition.

Thorough drainage is the first step to be considered in the improvement of this class of land. When this has been accomplished, the system of farming followed should provide for supplying the mineral plant food elements, phosphorus and potash, in the form of commercial fertilizers. The improvement of this type may be carried forward in the same manner as suggested for the shallow Peat and dark colored sand on page 63, and the same crops may be grown.

MEADOW.

The material mapped as Meadow consists of the low-lying areas along streams and drainage channels, where the texture of the soil is so variable as to make classification into different types impossible. Meadow is poorly drained and subject to frequent overflows, making the growing of cultivated crops very uncertain. The texture of the soil varies from a medium sand to silt loam, depending upon the character of the soil within the drainage basin of the water course along which it occurs. Frequently mucky or peaty areas are found along with sandy spots.

Meadow is most extensively found along the Wisconsin, Lemonweir, and Yellow Rivers, where it varies in width from one-

eighth to over 1 mile. The surface is level, except where there are a number of old stream channels, which give it an undulating topography.

The type is of alluvial origin, having been carried down and deposited by the streams along which it occurs during times of high water. Most of the material comes from the Potsdam sandstone, though the silt present owes its origin to the same source as the silt of the upland soils.

The timber growth consisted of oak, maple, river birch, ash, willows, elm, aspen, a few pines, hazel, alder, and blackberry bushes. Much of the type is still in timber, but all of the best trees have been removed.

As Meadow is very low, it would be difficult to drain it sufficiently to make the cultivation of crops safe at all times. A portion of the soil is naturally quite productive, and if it could be drained would yield good crops. Some marsh hay is cut, and a portion of the type is used for pasture.

ROUGH STONY LAND.

The areas mapped as Rough stony land include regions which are too steep and rocky to be of agricultural value. The rock consists for the most part of Potsdam sandstone and may be in the form of extensive out crops or as rock fragments of various sizes thickly strewn over the surface and mixed with the soil on steep slopes. At Necedah and in a few other places the rock consists of quartzite.

Rough stony land occurs most extensively in the southern part of the county, in the hilly country, where it occupies the steep slopes and narrow ridges. It is also found in a number of places as precipitous bluffs, which are the most conspicuous features of the landscape in the sand plains country.

The timber growth consisted of scrub oak, birch, and some Jack pine in a few places. Land of this character is never cultivated, but much of it is used as pasture, though the grazing afforded is very limited. Most of the type is still in timber.

CHAPTER VII.

GENERAL AGRICULTURE OF JUNEAU COUNTY.

Prior to 1850 lumbering was the chief industry in Juneau County and farming received but little attention. About this time, however, farms began to be opened up and settlement became quite rapid. The country along the Lemonweir River and to the south was opened up sooner than the country to the north and farming was also begun there earlier. Wheat was the important cash crop for a considerable period, while corn and oats were grown on a less extensive scale. The methods of farming followed were crude and but little, if any, attention was given to the selecting of crops or methods best suited to particular soils.

During the period from 1860 to 1880 the hop industry was developed to considerable proportions. The crop was at first so profitable that nearly every farmer went into the business. Frequently one crop would pay for the land and entire equipment. The industry grew to considerable proportions in other sections of the State and overproduction finally resulted. In connection with low prices, the hop louse invaded this region, which aided in bringing failure upon many farmers. By 1880 the hop industry was almost entirely abandoned.

The growing of tobacco has been and is still an important industry, but the acreage is being gradually decreased.

For over 30 years cranberries have been grown on the areas of Peat in the northwestern part of the county. At first only the berries which grew wild in the bogs were gathered. About 15 years ago nearly all of the marshes were destroyed by fire, and since that time cranberry vines have been transplanted and a larger proportion of the cranberry marshes cultivated. A few marshes have been sanded, but the industry as a whole is not nearly as extensive as it was formerly.

The type of agriculture most extensively followed in Juneau County at the present time consists of general farming, with dairying and stock raising as the most important branch. In the southern and southwestern portions of the county the soil is better, land values are higher, and agriculture is more highly developed than in the northern part, where the soil is either sandy or in a marshy condition and the drainage conditions have not been sufficiently improved to insure the growing of cultivated crops. All of the general farm crops common to the region, including corn, oats, barley, wheat, hay, and rye, are grown. Some special crops, including tobacco, potatoes, and cranberries, are produced and trucking is carried on to a limited extent in different parts of the county. The cutting of wire grass and the gathering of moss are special industries confined to the marshy portions of the county.

The figures given in connection with the various crops are taken from the census reports of 1910 and cover the farm products for the year 1909. While these reports cover but one year, they give an idea of the size of the various crops grown.

The acreage devoted to hay is greater than that of any other crop. From 37,024 acres in 1909 a crop of 55,927 tons was harvested, which is an average yield of about 1.2 tons per acre. This includes the marsh hay, of which there was over 10,000 acres, as well as the hay from tame grasses and clover. Most of the tame hay consists of a mixture of clover and timothy, which is seeded with barley, oats, rye, or wheat. There is a small amount of timothy grown alone and a smaller amount of clover. Only a few patches of alfalfa are grown, but where reported the yield averaged a little over 2 tons per acre. The average yields of hay on the silt loam soils of the southern part of the county are considerably higher than the average for the county, while the yields on the sandy types are much lower.

The oat crop is second to that of hay and it is the most extensive of the cultivated crops. From 27,618 acres a yield of 809,963 bushels, or 29.3 bushels per acre, was secured in 1909. Oats are more extensively grown in the hilly portion of the area, where the soils are heavier and the yields larger than in the flat

country, where the soils are sandy. Most of the crop is fed, though a number of farmers sell some each year.

Corn is the cultivated crop of second importance from the standpoint of acreage, and from 18,768 acres in 1909 a yield of 370,899 bushels, or 19.7 bushels per acre, was secured. This average yield is very low, owing to the fact that considerable corn is planted in the sandy section where the yields are light. In fact, the crop is often a complete failure on the sand, while on the heavier soils very good yields are secured. Practically all of the corn is fed on the farms where it is grown.

Rye is an important crop, especially on the sandy soils. The crop yield of 1909 from 7,123 acres was 52,977 bushels, or an average of 7.4 bushels per acre. Rye is seeded in the fall and the land may be used for pasture both in the fall and early spring. On the sandy loam types fair crops are secured, but on the Boone fine sand, low phase, and the Plainfield sand the yields are low and the crop is frequently a failure.

At present barley is not as extensively grown as in former years, yet it is a profitable crop. But little is produced on the sandy soils. From 4,748 acres 121,008 bushels, or an average of 25.4 bushels per acre, was secured in 1909. Clover is frequently seeded with the barley in the spring.

Buckwheat is confined largely to the sandy portion of the county and is not extensively grown. The acreage in 1909 was 2,349, yielding 23,680 bushels, or an average of 10 bushels per acre.

Wheat was extensively grown earlier in the history of the county, but the acreage at present is small. In 1909 there were 449 acres of winter wheat, which averaged 16.8 bushels per acre, and 901 acres of spring wheat, which averaged 18.1 bushels per acre. Wheat is confined chiefly to the heavier soils of the area and as a rule does fairly well. It is not probable that the acreage will be increased, since dairying is becoming the chief factor in the agriculture of the area, especially in the region where most of the wheat was formerly grown.

Potatoes are grown more extensively than any other of the other special crops and the acreage exceeds that of several of the general farm crops. In 1909 there were 11,992 acres, which

yielded 748,530 bushels, or an average of 62.4 bushels per acre. Most of the potatoes intended for market are grown on the sandy soils, though on the silt soils they are grown for home use and the surplus sold. The growing of potatoes could doubtless be profitably extended.

The growing of tobacco[1] began about the time the hop industry declined, and while it is not cultivated as extensively at present as it has been, there is still considerable grown in various parts of the county, especially in the southern part. The fine sandy loam soils are probably the most desirable, as they produce an early crop of thin, light-colored, elastic leaves. These soils usually contain only a small amount of humus and require an annual dressing of barnyard manure to maintain their fertility. The slit loam types, on account of a tendency to become heavy and compact in texture through the loss of humus, do not always produce as fine a leaf after several years of cultivation as the sandy soils. The "new breaking" on this type of soil, however, has the reputation of producing the finest quality of heavy-yielding crops. Where tobacco is grown, nearly all of the manure produced on the farm is applied to the tobacco field at the expense of the rest of the farm. Crop rotations are necessary to maintain the fertility of the soil. A successful method provides for growing tobacco three years in succession, followed by corn, barley, and clover each one year. Oats may be substituted for barley on the poorer soils. Since tobacco occupies the land but a part of the year, the use of a cover crop is desirable. Grains and legumes such as rye and hairy vetch are used to advantage.

The cranberry[2] industry of Wisconsin is confined chiefly to the the counties of Wood, Jackson, Juneau, Monroe, Winnebago, and Waushara. The average crop of Wisconsin is about 75,000 barrels per year. The industry in Juneau County is not as extensive as formerly, many of the bogs having been run over by fires and never replanted. The cranberries are grown on

[1] For further information on tobacco culture see Bulletin 206, University of Wisconsin Agricultural Experiment Station.

[2] Buls. 119, 213, and 219, Wis. Agr. Expt. Sta., and Bul. "T," Weather Bureau, U. S. Dept. of Agr.

areas of Peat, and under the head Peat and Muck (undifferentiated) the industry is discussed at greater length.

The cutting of wire grass and the gathering of sphagnum moss are special industries which have reached considerable magnitude in this county. The growth of these plants is confined to the low, marshy areas mapped as Peat and Muck (undifferentiated) and Sands and Peat (undifferentiated). Fires have reduced the amount of moss available, and shipments are decreasing yearly. From 20 to 30 carloads are shipped from Mather each year. As high as 154 carloads of baled wire grass have been shipped from Cranberry Center in one season.

A small amount of clover seed is produced in connection with general farming in various parts of the county. In Lyndon Township more alsike clover seed is grown than in any other part of the area. Some red clover seed is also secured in certain sections of the hilly country.

Cucumbers for pickling are grown at various points in the county, especially on the sand or fine sandy loam types. The crop is usually a profitable one and very satisfactory returns are frequently secured. Pickle factories are located at Lyndon and Mauston.

Trucking has not been extensively developed on a commercial scale in any part of the county. However, such crops as strawberries, bush berries, cabbage, tomatoes, melons, etc., are grown to supply the home markets, and it would seem that the industry could be extended, especially along the railroad lines, which provide excellent transportation facilities.

The fruit industry has not been developed on a commercial scale, though there are small apple orchards on a number of the farms. There are many good orchard sites throughout the rougher portions of the county and locations could be selected which would be suitable for the growing of apples. Each farm, where the soils and other conditions are favorable, should at least support a small apple orchard sufficient to supply the home and perhaps provide some for the market. Other fruits, such as bush berries and strawberries, are as well adapted to conditions here as the apple and are being successfully grown in the Sparta district, the soils of which are similar to those in Juneau County.

While the dairy industry is not as highly or as extensively developed in Juneau County as in many other sections of Wisconsin, it is, nevertheless, the most important branch of farming in the region surveyed. There are ten creameries and 3 cheese factories in the county. One creamery is located at Necedah, and the remainder are in the west-central and southern sections of the county. Dairying has been developed mostly on the silt loam soils and on the sandy types which are underlain by clay. In the northern part of the region surveyed, where the soils are very sandy or where marshy conditions prevail, there are no creameries or cheese factories. For every 100 head of cattle in Juneau County there are 54.8 milch cows. The total number of dairy cows is 1,5345. Wherever the Knox silt loam and the other heavier soils of the county are found the number of cows is considerably greater than where the soils are very sandy. Aside from the milk and cream disposed of through the cheese factories and creameries, considerable butter is made on some of the farms, and all of the towns within the area are supplied with milk and cream from near-by dairy farms. There are a number of good dairy farms in the county, and on some of these pure-bred, registered stock of the various breeds is raised.

A gradual decrease is taking place in the production of grain and tobacco and an increase in dairying and hog raising. This change seems to be more apparent among the American farmers than among those who are foreign born. Dairying is not only more profitable from a financial standpoint, but it tends to build up the fertility of the soil and is a more certain proposition from year to year than the growing of tobacco. The slopes of the rough country furnish sufficient pasture for a larger number of dairy stock than is now kept, and the industry should be extended.

The raising of beef cattle is not nearly as extensive as the dairy industry, though there are some purebred Aberdeen Angus, Shorthorns, and a few Herefords in the area. Most of the stock sold for beef is of mixed breed and usually consists of a few head from a number of farms rather than a large number from a few beef-producing farms.

Some hogs are raised in connection with dairying, but the number of hogs in the county is less than the number of dairy

cows. The number of both classes of stock is comparatively small and could well be increased. Hog raising in conjunction with dairying can be made a very profitable line of farming.

The number of sheep in the county is about equal to the number of hogs. Sheep raising is confined largely to the rougher portion of the county, where there is considerable steep land which can not be used for cultivated crops. The number of sheep in the area surveyed, as given in the census for 1910, is 15,716. It would seem that even though more pasture is required for cows, owing to the extension of dairying, a greater number of sheep could readily be kept, since there is a considerable area on the average farm in the hill country which can be used for nothing but pasture.

It is generally recognized within the county that certain soils are better adapted to certain crops than other soils. For example, the finest grade of tobacco is grown on the sandy soils which are underlain by clay. Barley, oats, and corn give better results on the heavy soils than on the sands. Rye and buckwheat do better on the sands than any of the other crops commonly produced in the county. Potatoes give the best results on the sands or sandy loams underlain by clay. But little success has been attained in raising clover on the sand, while on the heavier soils good yields are usually secured. The question of adaptation of soils to crops, however, has not been thoroughly worked out, and considerably more study and experimental work are necessary before final recommendations can be made.

A number of different rotations are practiced, but in many cases it was found that no definite system was followed. On the heavier soil types, which are confined to the southern part of the county, the most common rotation consists of corn, barley, and oats, with the oats seeded to clover and timothy mixed. Hay may be cut for one or two years or the field may be pastured a year before plowing again for corn. On the sandy soils in the central, eastern, and northeastern parts of the county rye and buckwheat are quite commonly grown, and more potatoes are produced than on the heavier soils. A rotation consisting of clover, potatoes, and rye is a good one for the sandy soils, but as a rule no definite system has been followed on the majority of

sand farms. In the rotation suggested the first crop of clover should be cut for hay and the second crop plowed under as a green manuring crop. It is important that every farmer should give the matter of selecting a crop rotation very careful attention. It has been found that commercial fertilizers can often be used to advantage on the sandy soils in getting legumes started.

The methods of cultivation which are followed on the heavier soils of the southern and southwestern parts of the county are better adapted to conditions existing there than are the methods followed in the central and northern parts adapted to sandy soils. On the heavier types considerable fall plowing is done. As a rule the fields are well cultivated and in a fair condition of tilth at the time of seeding. More frequent after cultivation of intertilled crops would tend to conserve the soil moisture by forming a mulch upon the surface. The question of erosion is an important one, and many of the slopes which are now badly washed could have been preserved had proper methods been followed to prevent erosion. The steepest slopes now timbered should be kept in timber. When steep slopes are cleared they should be kept in grass and pastured as much as possible. Where cultivated, strips of sod may be alternated with cultivated crops, the strips running at right angles to the slope. On the more gentle slopes contour cultivation may be followed over the entire field. In some places strips of sod form shallow ditches down the slope, through which the surface water runs off. This system, however, is less desirable than where the sod strips run at right angles to the slope.

Throughout that portion of the county occupied by the deep sand types the farm buildings, fences, etc., are of inferior grade, often in a poor state of repair, and the equipment is limited. On the sandy types underlain by clay conditions are better, while on the heavier soils the farm buildings, cultivated fields, and farm stock indicate a more thrifty and prosperous condition than is found elsewhere in the area surveyed.

The question of securing farm labor is not as serious here as in some other parts of the State, since there are no large cities or manufacturing plants very near to draw away the labor.

Some difficulty, however, is experienced in getting the quality of help desired. The wages paid range from $25 to $35 per month, with board, or $1.50 to $1.75 per day during the haying and harvest time.

The losses resulting from weeds are not as great in Juneau County as in some other portions of the State, but concerted effort should be made to exterminate all noxious weeds without delay. Quack grass, Canada Thistle and Wild Mustard are among the most troublesome weed pests in this region. "Fallowing or cultivation without a crop is the most certain method of eradication on large areas, and may be used to good advantage except on the most sandy soils, and those continuously wet or very porous. Success depends upon the depth of plowing and frequent cultivation. The prevention of leaf growth in weeds means certain death. Certain cropping systems will usually be successful with Quack Grass."*

Of the total land area of the county 67.1 per cent is in farms, and on the average 66 acres of each farm is improved land. There are 2,470 farms in the county, the average size being 140 acres. Of all farms 87.6 per cent are operated by the owner, and of the remainder something over half are operated on the share system of renting.

The value of land in Juneau County is extremely variable, and prospective buyers should examine carefully into the character of the soil, drainage conditions, and the crops to which the various soils are adapted before locating on a farm in a region with which they are not acquainted. Large tracts of land classed as Sands and Peat (undifferentiated) recently sold for $6 per acre. Land of the same nature, in small tracts and on long time payments, frequently sells at a price considerably higher than this figure. Land in the sandy portion of the county is frequently exchanged in small tracts for city property, and the value placed upon the land in such an exchange is always higher than the cash value. The types of soil which consist of deep sand have a low agricultural value, and require very careful manage-

*Extract from Circular 48 of the Agricultural Experiment Station of the University of Wisconsin. This publication should be consulted for more information on "How to Rid Our Farms of Weeds."

ment to make farming successful. The sandy types underlain by clay have a higher agricultural value than the deep sand and sell at prices ranging from $20 to $50 per acre, and sometimes more. The silt loam soils have the highest agricultural value of any soils in the county, and the selling price ranges from $25 to over $75 per acre, depending upon the location, topography, improvements, and the amount of waste land included in the farms. Some of the best farms in the county have a value of over $100 per acre.

Most of the soils of the county, and especially the sandy types, are deficient in organic matter, and the system of farming followed on any farm should be so arranged as to gradually increase the humus content of the soil. This may be accomplished by applying stable manure, supplemented by the plowing under of legumes. Where Peat beds are convenient to the farm Peat may be spread upon the surface and plowed under. This will supply nitrogen, but should be supplemented by commercial fertilizers to provide the mineral requirements of the soil. On the sand types very careful methods of farm management must be practiced if the fertility of the soils is to be increased and farming operations made profitable. Careful rotations should be worked out to suit the varying conditions. Many of the soils of the county are in an acid condition, and this must be corrected before the best results with clover or alfalfa can be expected. Ground limestone is the best form in which to apply lime, and its effect will be seen in the soil for a long time. There are certain legumes including cow peas, lupines, and serradella which usually do well on acid soils, and where it is very expensive to secure some form of lime for correcting the acidity some of these acid-resisting legumes should be grown to supply the nitrogen for the soil.

Erosion in the hilly country and the conserving of moisture in all parts of the county are very important questions and should be given careful study by all farmers. More specific suggestions will be found in connection with the discussion of the various soil types.

The dairy industry could be profitably extended and more

creameries and cheese factories established. Hog raising in connection with dairying could also be developed on a larger scale. The trucking industry should be carried on to a greater extent, especially along the railroad lines, where excellent transportation facilities are afforded. Various crops for canning, such as peas, tomatoes, etc., could be successfully grown on a commercial scale.

CHAPTER VIII.

CLIMATE.*

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

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

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

"Of equal importance, in agriculture, to the total rainfall is its seasonal distribution, and in this respect Wisconsin is un-

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

usually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand is slight; December, January and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the State during the winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches, and during autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin received during the growing season, April to September, inclusive, an average of 21 inches, which is as much rain as is received during the same months by eastern Texas, Illinois, Ohio, or eastern New York. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil, or erosion.''

Another form of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for from one to four weeks, and occasionally longer. Observations taken at Madison over a period of 30 years, from 1882 to 1911, inclusive, show that there are, on the average, three ten-day periods during each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil (Miami silt loam) actually suffer from lack of moisture. In southern and southwestern Juneau County about the same conditions would prevail. In the sandy portions of the county, however, the periods of drought will average longer, and may be more frequent on account of the light character of the soil.

The low sandy and marshy portions of Juneau County are located within ''The Wisconsin River Basin'', which is one of eight climatic provinces in Wisconsin. ''This region appears to be cooler than the Mississippi Valley to the west, or the Michigan shore to the east, being cooler (68°) than the former (70°) in summer, and cooler (16°) than the latter (21°) in winter. This region averages about thirteen days in winter when the tempera-

ture drops lower than 10° below zero, and 13 days in summer when the thermometer rises above 90°. The growing season is also considerably shorter, owing probably to the altitude, the sandy soil, and the marshy condition of much of the land, Mauston having an average season of 130 days from frost to frost, as compared with 163 days at La Crosse to the west, and 149 at Oshkosh, or 167 at Sheboygan to the east. Likewise, Stevens Point, which is on the Wisconsin River in the county north of Juneau, has an average growing season of 126 days, which is 33 days less than Green Bay and 35 days less than Wabasha or Red Wing in the Mississippi Valley."

"This short growing season, as well as the sandy soil, aids in explaining the small amount of corn raised in this region, and the more extensive development of the potato industry. The rainfall is practically the same as the average for the State, and it has a seasonal distribution similar to that for the whole State."

The hilly section which is confined to the southern and southwestern portions of the county, lies within "The Southern Highlands" climatic province. This region has an elevation generally over 1,000 feet above sea level and includes the greater part of the hilly, driftless area of the State. This higher land within the area surveyed has a slightly longer growing season free from frost than the low sandy and marshy tracts, but data showing the exact differences within the county could not be obtained. The small valleys within the elevated portion of the county are in greater danger from frosts than the higher land.

By reference to figures—and—, it will be observed that the average date of the last killing frost in the spring in the region including Juneau County is from May 10 to 20 in the southern part, and from May 20 to June 1 in the low sandy and marshy portions of the county. The average date of the first killing frost in the fall in the same region is from September 20 to 30 in the southern part, and from September 10 to 20 in the low sandy and marshy portions of the survey. From the data on these two maps the approximate length of the growing season for any part of the State can be readily determined.

The climatic conditions prevailing in Juneau County are somewhat variable, owing to the differences in topography. The

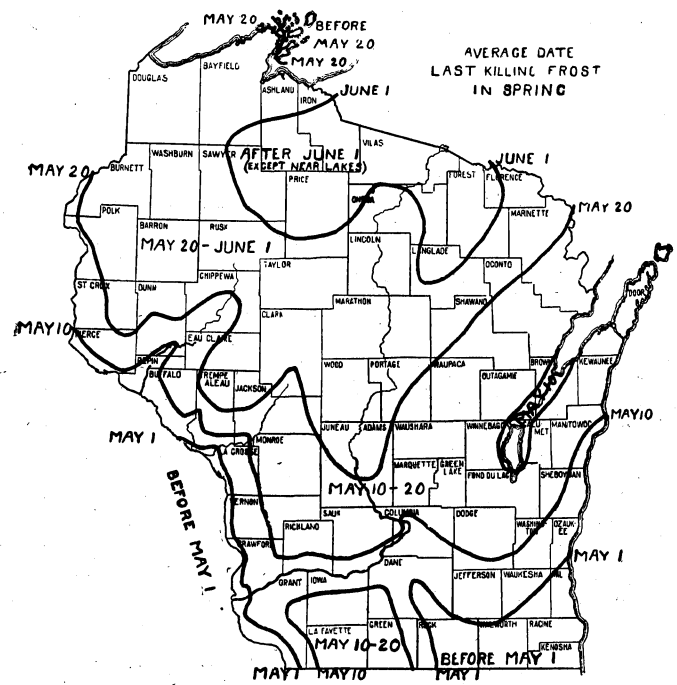

FIG. 3. LAST KILLING SPRING FROST.

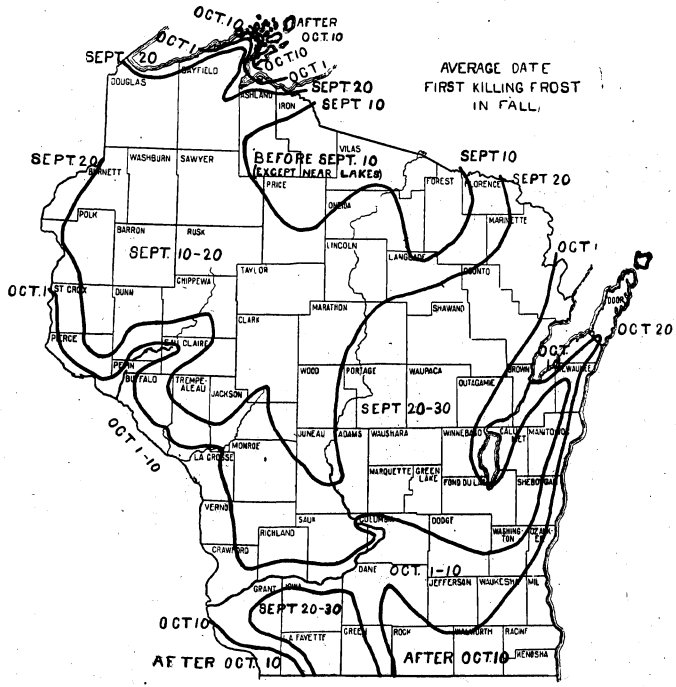

FIG. 4. FIRST KILLING FALL FROST.

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

northern two-thirds of the area consists of extensive marshes and sand flats, while the southern third is a rough, broken country, with an average elevation of over 200 feet above the level of the lowlands. The most pronounced variations resulting from differences in topography are in connection with the occurrence of frosts. The only Weather Bureau station in the county is located at Mauston, which is close to the border of the extensive sand plains area and considerably lower than the upland region in the southern part of the county. It is about 8 miles from the border of the main marshy tract, and the records taken there, particularly those applying to frost occurrence, do not apply to the extensive low, wet areas in the northwestern portion of the county or to the higher lands to the south, but must be confined to a comparatively small tract of country similar to that in the immediate vicinity of the station. The following tables give data collected at the Mauston station and at Hancock, which is about 20 miles east of the eastern county boundary and on the eastern border of the sand plains region, together with frost data for Mauston, Hancock, and La Crosse. The records from the two latter places are given for the purpose of making comparisons.

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

Month.	Mauston.				Hancock.						
	Temperature.			Precipitation.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total am't. for the driest year.	Total am't. for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	*Inches*	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	19.4	60	—25	1.12	20	50	—25	1.2	1.8	1.1	7.5
January..	15.8	55	—40	1.06	16	53	—30	1.1	1.4	1.6	10.1
February.	15.2	55	—50	1.07	16	53	—35	1.2	1.2	1.6	7.9
Winter..	16.8	.....	.....	1.08	17	.....	.....	3.5	4.4	4.3	25.5
March....	30.2	77	—15	2.03	30	73	—8	1.7	0.5	1.2	6.5
April.....	45.0	87	5	2.40	46	85	11	2.4	1.0	2.9	2.8
May	56.1	90	20	4.36	58	93	25	3.7	1.8	5.6	0.5
Spring..	43.7	.....	.....	2.93	45	.....	.....	7.8	3.3	9.7	9.8
June.....	65.4	100	26	4.58	67	99	31	4.2	1.4	7.3	0.0
July.....	70.2	106	39	4.29	72	100	44	4.0	1.8	4.0	0.0
August...	67.8	96	29	3.34	69	100	40	2.9	3.4	4.0	0.0
Summer.	67.8	.....	.....	4.07	69	.....	.....	11.1	6.6	15.3	0.0
Sept.....	60.8	94	14	3.16	61	94	20	2.6	1.4	2.7	0.0
October..	48.9	84	10	2.49	50	84	15	2.1	0.4	1.0	0.5
Nov.....	34.7	77	—13	1.64	32	68	10	1.2	1.7	1.1	3.9
Fall	48.1	.....	.....	2.43	48	.....	.....	5.9	3.5	4.8	4.4
Year....	44.1	106	—50	31.54	45	100	—35	28.3	17.8	34.1	3.7

Dates of first and last killing frosts.

Station.	Length of record	Average date of—		Average length of growing season.
		First killing frost in autumn.	Last killing frost in spring.	
	Years.			*Days.*
Mauston	14	Sept. 24	May 17	130
Hancock	18	Sept. 28	May 18	133
La Crosse	37	Oct. 10	Apr. 30	163

From the Mauston records it will be observed that the mean annual temperature is 44.1° F. and the mean annual precipitation 31.54 inches. The average date of the first killing frost in the fall is September 24 and that of the last killing frost in the spring, May 17. This gives an average growing season of about 130 days. In the marshy region to the north and west from Mauston the period free from frost is shorter than this, while over the hilly country to the south it is somewhat longer.

The records show that the rainfall is normally well distributed throughout the growing season, and that during the months of May, June, July, and August there is on the average over 3¼ inches of rain each month, yet during any of these months, especially July and August, there may be dry spells, during which crops will suffer considerably from drought. The winters are long and severe, but the summers are pleasant.

It is regretted that there are no data available showing the differences in the occurrence of frosts in the hilly sections and in the low marshy areas within the county. Nevertheless in the improvement of the agriculture of the low marshy areas in the county the probability of the occurrence of frosts during summer months should be kept in mind, for it may be a determining factor in selecting a type of farming best suited to prevailing conditions.[1]

[1] Buls. Nos. 119, 213, and 219 of the Wisconsin Agricultural Experiment Station, Madison, give valuable information concerning the climatic conditions in the cranberry marshes and also in the construction and management of cranberry bogs. For a further discussion of climatic conditions in the lowlands see Bul. T of the U. S. Weather Bureau. See also Bul. 223, Wis. Expt. Sta. This gives information on the climate of Wisconsin and its relation to agriculture.

SUMMARY

Juneau County is located a little south of the center of Wisconsin, and comprises an area of 796 square miles. About one-third of the area is rolling to hilly and rough, while the remainder consists of nearly level sand areas and low marshy tracts.

The county is well supplied with railroads, which provide excellent transportation facilities.

Mauston, a city of 2,400, is the county seat and the largest city in the area. It is 214 miles from Chicago, 128 miles from Milwaukee, and 209 miles from Minneapolis, over the Chicago, Milwaukee & St. Paul Railroad.

Juneau County lies within the unglaciated portion of Wisconsin, and comprises two distinct physiographic divisions, consisting of a sand plains and marsh region covering the northern two-thirds and a rough, hilly section covering the southern one-third of the area. The northern section is usually referred to as a part of the old Wisconsin River Valley, in which the soils are largely of alluvial origin and very sandy. In the southern portion the soils are heavier and probably of loessial origin. In the survey of Juneau County 8 soil series and 16 soil types, including Meadow, Rough stony land, Peat and Muck (undifferentiated), and Sands and Peat (undifferentiated), have been mapped.

The Knox series includes the most highly improved farming land in the county and is characterized by a rolling to hilly topography and light-colored silty soils subject to erosion. The Knox silt loam and Knox silt loam, steep phase, were mapped.

The Baxter series includes residual soils from the Lower Magnesian limestone and is represented here by only one type, the

silt loam. This has a light-colored silty soil and a red clay subsoil, with large quantities of chert present. It is of limited extent.

Lintonia silt loam, the only member of this series mapped, represents colluvial material washed down the slopes from higher areas of Knox soils, and varies in color from light to dark brown. The natural drainage is sometimes deficient. It is of limited extent.

One member of the La Crosse series, La Crosse silty clay loam, was mapped. It consists of dark-brown to black alluvial material along the streams in the rough portion of the county. It is deficient in drainage, but is naturally a strong soil.

The Boone series includes residual soils from the Potsdam sandstone. This rock is exposed on many of the steep slopes, and comes near to the surface over a part of the sandy region. Two types were mapped. Boone fine sandy loam is a fair sandy soil of limited extent. Boone fine sand is quite extensive, but a poor agricultural soil. A loamy and a low phase of this type were also mapped.

The Superior series includes lacustrine material, over a part of which varying amounts of sand have been deposited. Superior clay loam is a strong soil and a good general farming type, though somewhat difficult to cultivate. Superior fine sandy loam is easy to cultivate, having a sandy soil and a heavy subsoil. It is therefore more retentive of moisture than the deep sand types. Superior sand has from 2 to 3 feet of sand over red clay. It is the most extensive of the Superior soils, and is fairly productive.

The Plainfield soils as found here have a relatively low agricultural value. They are low in organic matter and are acid and droughty. The types mapped are Plainfield sand and fine sand.

Dunning sand is the only member of this series encountered. It is similar to the sands of the Plainfield series in origin, but is slightly lower lying, and has a quantity of organic matter in the surface which gives it a black color. It is poorly drained and but slightly improved.

Peat and Muck (undifferentiated) consists of vegetable matter in varying stages of decomposition. There are several ex-

tensive tracts in the county. Cranberries are grown on the peat bogs.

Sands and Peat (undifferentiated) represents a vast number of very small sand islands scattered through extensive tracks of low, wet land. These islands are too small to be mapped separately, yet they form approximately half of the land surface in such areas. The value of such tracts is chiefly in the marsh hay which can be cut. Extensive drainage districts have been organized and ditches dug, but the drainage has not been sufficient, and but few cultivated crops are being tried. All such tracts are underlain by sand, and at best the land has a very low value.

Meadow includes the low-lying land along the rivers where the surface is flooded several times each year, and the soil is so mixed that a separation into types would be impossible.

Rough stony land includes the steep rocky slopes, rock outcrops, and rough sections, which are of no agricultural value and afford only a limited amount of pasture. Many of these steep areas are still in timber.

The type of agriculture most extensively followed in the southern and southwestern parts of the county, where the soils are heavier than elsewhere, consists of dairying in conjunction with general farming. The chief crops grown are hay, oats, corn, barley, and potatoes, with some rye, buckwheat, and tobacco. In the low, wet areas marsh hay and wire grass are cut and the sphagnum moss is gathered and sold. The deep sand soils of the central and northeastern parts of the area have a low agricultural value and are only slightly improved. But little trucking is carried on, and the fruit industry is not developed on a commercial scale in any part of the county.

The mean annual temperature at Mauston is 44.1° and the mean annual precipitation 31.54 inches. The average date of the last killing frost in the spring is May 17 and of the first in the fall September 24, giving an average growing season of about 130 days at Mauston.

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.


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SOIL MAP
WISCONSIN
JUNEAU COUNTY SHEET

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

SOIL PROFILE
(3 feet deep)

Knox silt loam — Sil / Sil / Sicl
Steep phase — Sil / Sil / Fs
Boone fine sand — Fs / Fs
Loamy phase — Lfs / Fs
Low phase — S / S
Boone fine sandy loam — Fsl / Fs & Vfs
Superior sand — Ls to Fs / Fs / C
Superior fine sandy loam — Fsl / C
Superior clay loam — Sicl / C
Plainfield sand — S / Ms / Cs
Plainfield fine sand — Fsl / Fs
Buxter silt loam — Sil / C
Lintonia silt loam — Sil / Si & Fs
La Crosse silty clay loam — Sil / Sicl
Dunning sand — Ms / Fs to Ms

LEGEND

Sil Silt loam
Sicl Silty clay loam
Fs Fine sand
Lfs Loamy fine sand
S Sand
Fsl Fine sandy loam
Vfs Very fine sand
Ls Loamy sand
C Clay
Ms Medium sand
Cs Coarse sand
Si Silt

LEGEND

Knox silt loam — Kl
Steep phase — Kl
Boone fine sand — Bs
Loamy phase — Bs
Low phase — Bs
Boone fine sandy loam — B
Superior sand — Ss
Superior fine sandy loam — Sf
Superior clay loam — Scl
Plainfield sand — Ps
Plainfield fine sand — Pfs
Buxter silt loam — Bl
Lintonia silt loam — Ls
La Crosse silty clay loam — Ll
Dunning sand — Ds
Peat and Muck (Undifferentiated) — P
Sands and Peat (Undifferentiated) — S
Meadow — M
Rough stony land — R

Soils surveyed by W.J. Geib, L. R. Schoenmann
C.A. Le Clair and O.E. Baker of the Wisconsin
Geological and Natural History Survey, and
E.B. Watson of the U.S. Department of Agriculture.

BASE MAP IN PART FROM
U.S. GEOLOGICAL SURVEY SHEETS

Scale 1 inch = 1 mile