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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. XLVII Soil Series No. 12

RECONNOISSANCE SOIL SURVEY

OF

NORTH EASTERN WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, CARL THOMPSON, CLINTON B. POST, AND A. L. BUSER

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

L. R. SCHOENMANN AND ARTHUR E. TAYLOR

OF THE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE,

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MILTON WHITNEY, CHIEF.

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MAP.

SOIL MAP OF NORTHEASTERN WISCONSIN—Attached to back cover.

NOTE

The soil survey of Wisconsin is being made along two lines; first, a general survey of the northern and less developed portions of the state, and second a detailed survey by counties of the southern and older portions. The northern part of the State has been divided into five areas of each of which a general map of the soils is being prepared.

The first area surveyed included Portage, Wood, Clark, Taylor, Lincoln, Marathon, and portions of Price and Langlade Counties. The first survey of the soils of this area was made a number of years ago by Doctor Samuel Weidman in connection with the geological survey, and the classification followed in this work differed somewhat from that at present in use, and the maps do not show as much detail. The reports on this survey are no longer available. However, the field work of an entirely new survey of the soils of Portage, Wood, Clark, Taylor, Marathon, and Lincoln Counties has been completed and it is hoped that the report and new map of the soils of these counties will be ready for distribution early in the year 1917.

The second area, called the South Part of North Western Wisconsin, included Polk, Barron, most of Rusk, and all of Chippewa, Dunn, St. Croix, Pierce, Pepin, and Eau Claire Counties. The edition of this report has been exhausted.

The third area, called the North Part of North Western Wisconsin, included Burnett, Washburn, Sawyer, Douglas, and Bayfield counties, and most of Ashland County. The report on this area is now available.

A special report has been prepared on the northeastern portion of Bayfield County along the bay and including the islands, in which considerable development of the fruit industry is taking place. This is now available for distribution.

The fourth area, covered by the present report, includes Florence, Forest, Langlade, Oconto, Marinette, and Shawano Counties. The survey of Marinette County was made during the summer of 1909 by Doctor Samuel Weidman of the Wisconsin Geological & Natural History Survey and Percy O. Wood of the United States Department of Agriculture, and a special report was issued on this county, but is no longer available for distribution; however, the map and all essential parts of the report are included in the present report.

The field work of the fifth area, called the North Part of North Central Wisconsin, including Iron, Vilas, Price, and Oneida Counties and the eastern portions of Ashland and Rusk Counties, has been completed and it is hoped that the report will be ready for distribution in the fall of 1916. A special report on the soils of Vilas County and portions of adjoining counties was prepared during the season of 1914 at the request of the Legislature when that body was considering the extent to which the development of forest reserve should be carried. Mr. T. J. Dunnewald was in charge of the field work of this survey. The map accompanying this report is included in the report on the soils of the North Part of North Central Wisconsin as well as the more important portions of the report itself, but copies of the special report and map are still available.

RECONNOISSANCE SOIL SURVEY OF NORTH EASTERN WISCONSIN

CHAPTER I

GENERAL DESCRIPTION AND HISTORY OF THE AREA

Location and Boundaries.—The area covered by the Reconnoissance Soil Survey of North Eastern Wisconsin includes Forest, Florence, Marinette, Oconto, Langlade, and Shawano Counties, and comprises a total area of approximately 6,098 square miles, or 3,902,720 acres.

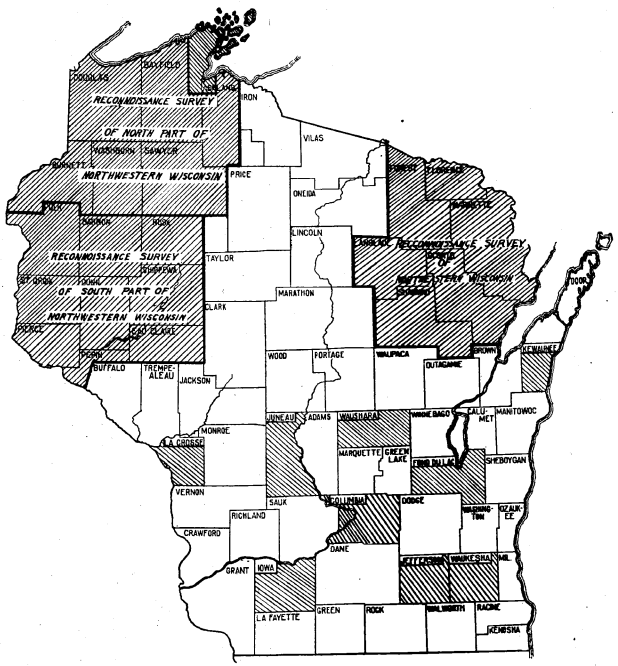


Fig. I. Showing areas which have been surveyed in Wisconsin.

Topographic Features.—The surface features are characteristic of a glaciated region and the topography varies from level to rolling and hilly. Ridges in the form of terminal and recessional moraines frequently alternate with less broken tracts of ground moraine, with basins, extensive outwash plains, and numerous swamps and lakes,

all having a general northeast and southwest direction. In some places the glacial drift covering has completely obliterated the topographic features of the underlying rock formation, while in other places it only modifies the older topography. While there is some broken land in the area, and numerous hills with steep slopes, the proportion of land which is too rough to be developed agriculturally is comparatively small.

The northwestern portion of this area forms a part of the high plateau-like region of northern Wisconsin, and is dotted with lakes and swamps which are the source of a large number of rivers. The swamps and lakes of this plateau have an average elevation of about 1600 feet. The lowest land has an elevation of about 585 to 590 feet. Thus it will be seen that there is a difference between the highest and the lowest points within the area of something over 1000 feet.

*Water power.**—The rivers of the area have wonderful possibilities for the development of water power, and a number of projects have been installed, but only a very small proportion of the available power has been developed. From the north line of Langlade County where the Wolf River crosses to Shawano, a distance of about 80 miles, there is a fall of 774 feet. The Oconto River through its course of 87 miles, all of which is within the area, has a total fall of 945 feet. All of the numerous streams which have their source in the high plateau-like crystalline rock region of northern Wisconsin, and reach their outlet within a comparatively short distance, must necessarily have a very rapid descent.

Settlement.—The first permanent settlers were attracted to this region by the lumber industry. The first saw mill was located at Marinette in 1832. A settlement was started at Pensaukee in Oconto County in 1829 and a saw mill was erected in Oconto in 1835 and 1836. A mill was put in operation at Oconto Falls in 1846. Antigo was founded in 1877 and platted in 1879. As early as 1871 there was a settlement established on the Military Road in eastern Langlade County and in 1876 and 77 a settlement was also established at Phlox.

In 1882, a railroad line reached Antigo and in 1881 what is now the Chicago, Milwaukee, and St. Paul Railroad was completed across the area from north to south. Since that time a number of other lines have been completed, all of which have greatly assisted in the development and settlement of the region.

The first farming operations in the area were begun about 1870, but agriculture was an unimportant industry until in the eighties.

* See Wis. Geological Survey Bul. XXXV.

The southeastern parts of Marinette, Oconto, and Shawano Counties, and the country about Antigo, in Langlade County, were first settled and are now the most extensive and highly developed portions of the region surveyed.

Probably half of the early settlers were native born Americans from the southern part of the state and from other states. A large proportion of the foreign born element was from Canada, of English and French extraction. The most important sources of immigration from Europe before 1885 were Germany, Sweden, Norway, Great Britain, and Ireland. Later the Polish became an important element. Bohemia, Austria, France, Denmark, and Holland, are also represented. The greater proportion of the present population consists of native born Americans. Native born Germans are probably second in numbers, with Scandinavians third. The population of the entire area for 1910 was 118,578, or at the rate of about 19 per square mile. The southern portion, and southeastern portions of the area are well settled and many communities have as large a population per square mile as the highly developed farming communities of southern Wisconsin. Forest and Florence Counties have on the average about 6 people per square mile. Between these two extremes, all degrees of settlement and improvement are found within the present survey.

Transportation Facilities.—Excellent transportation facilities are afforded nearly every portion of the survey that is developed, and railroad lines lead into many of the undeveloped regions where lumbering is being carried on. In addition to these lines there are a number of logging roads, which also carry freight and passengers, which are not permanent. From the southern boundary of the area to Green Bay it is but 12 miles, to Milwaukee 126 miles, and 311 miles to Chicago over the Northwestern Railway.

Markets.—The cities, towns, and lumbering camps within the area surveyed afford a market for a large amount of farm produce. Green Bay, Milwaukee, and Chicago also provide a ready market for all classes of produce. The extensive lumbering interests in this portion of Wisconsin and in northern Michigan, together with the iron and copper mining districts consume large amounts of food stuffs and in addition to freight charges, Chicago prices are usually paid.

Public Roads and Schools.—Throughout the southern and southeastern portions of the area there are public roads on most of the section lines. Many of these are graded and some are crowned with gravel and are well improved. In the northern part of the survey, which is thinly settled, there are not many public roads. The

wagon roads between the chief towns are usually in fair condition, but the side roads are often in poor repair. A number of roads are now being improved under the new State Highway Law, through which the state co-operates with the county and township.

Rural free delivery mail routes have been established in nearly all portions of the region and by far the greater proportion of the families in this region have their mail delivered daily. The rural telephone is also in common use.

The rural school buildings throughout this region are in many cases superior to those in the southern part of the state. In a number of instances where the attendance was small several districts have been consolidated, and the children are carried to and from school in public conveyances.

Underlying Rocks.—The soils of this region were formed by the action of the ice during glacial periods on the residual soils originally existing, and which had previously been formed by weathering from the underlying rocks. The underlying rocks of this part of the State are granite and other crystalline varieties in the larger portion of the area covering Florence, Forest, Langlade, and the northwestern portions of Marinette, Oconto, and Shawano Counties.

Along the southeastern side of this area there is a broad belt of sedimentary rocks the lower member of which is the Potsdam sandstone resting on the granitic formation and having a dip to the southeastward. Lapping on the Potsdam come successively the Lower Magnesian limestone, St. Peters sandstone, and Trenton limestone, the outcrops of which extend northeastward and southwestward and have a width depending on the thickness of the strata. The bulk of the subsoil now existing was derived by weathering from these rocks, but has been reworked and carried from one section to another somewhat by the glacial ice of the Labrador Glacier.

In the northern parts of Florence and Forest Counties considerable sandy material is now found which was brought from sandstone rock across the border in northern Michigan. Associated with the till soils are considerable areas of overwash plains and valley trains, varying in texture from that of fine silt loam to coarse sands.

Ten soil series and twenty-five types, excluding Peat and Muck, have been mapped.

The following table gives the names and the actual and relative extent of each of the soils mapped in this survey:

AREAS OF DIFFERENT SOILS

Soil	Acres	Per cent	Soil	Acres	Per cent
Kennan silt loam	738,432	22.9	Coloma fine sandy loam	46,656	1.2
Rolling phase	156.672				
Kennan fine sandy loam	428,544	10.9	Superior fine sandy loam	27,072	.7
Peat	380,736	9.8			
Vilas sandy loam	316,224	8.1	Plainfield sandy loam	14,976	.4
Vilas fine sand	294,336	7.5	Vilas sand	10,368	.3
Miami fine sandy loam	275,904	7.4	Poygan fine sandy loam	9,856	.3
Poorly drained phase	13,824				
Muck	273,600	7.0	Coloma sand	9,792	.3
Plainfield sand	183,290	4.7	Superior fine sand	8,704	.2
Coloma fine sand	131,328	3.4	Superior clay loam Rolling phase	8,128	.2
Miami loam	118,656	3.0			
			Superior loam, Rolling phase	7,552	.2
Superior fine sandy loam, rolling phase	108,288	2.8	Fox fine sandy loam	6,976	.2
Plainfield fine sand,	78,780	2.5			
Poorly drained phase	17,856		Clyde loam	6,016	.2
Merrimac silt loam	91,584	2.3			
			Merrimac fine sandy loam	4,352	.1
Colby silt loam	14,400	1.9			
Rolling phase	60,480				
Vilas stony sand	59,328	1.5			

CHAPTER II.

GROUP OF HEAVY SOILS

COLBY SILT LOAM

Extent and distribution.—The Colby silt loam is one of the most important and extensive soil types in north central Wisconsin, but within the area covered by the present survey it occupies only about 117 square miles, and is confined to the western part of Langlade County where it occupies one continuous tract in Summit, Vilas, Ackley, and the western part of Peck and Upham Townships.

Description.—The surface soil of this type to an average depth of 10 inches consists of a light brown or grayish silt loam which contains a moderate amount of organic matter. Over the lowest portions there is sometimes a few inches of peaty or mucky material. The percentage of silt is high and the soil has a smooth feel which is characteristic of silt loams. The type is somewhat heavier and more compact, however, than the other silt loam soils of the area because of the higher clay content, and in a few places the type approaches a silty clay loam in texture. The lower portion of the surface soil is frequently mottled.

The subsoil consists of a yellowish brown, buff, or grayish compact silt loam which gradually becomes heavier with depth and grades into a silty clay loam or clay loam at from 16 to 20 inches. Below and sometimes above this depth the material is mottled with yellow, brown, and bluish and reddish brown, indicating poor under drainage. The lower subsoil below 24 to 30 inches has a pronounced reddish brown color which holds throughout the entire area, though its depth may be somewhat variable. Incorporated with the lower subsoil there are usually small irregular rock fragments, fine gravel, or particles of fine and medium sand which give the material a somewhat gritty feel. Where the drainage conditions are the most deficient this reddish brown color gives place to bluish gritty clay which is mottled.

While there are a few stones found upon the surface, they are not nearly as plentiful as on the Kennan silt loam and do not interfere with cultivation to any extent. While the amount of organic matter in the soil varies somewhat, being greater in the depressions where

there has been a slight accumulation, the texture, structure, and color of the type as a whole are remarkably uniform. Over the entire type an acid condition has developed in the soil and in most places this is very marked. Only a very few rock outcrops were observed and from records obtained it appears that the depth to bed rock over the type as a whole ranges from 4 to 50 feet.

Because of its heavy character this soil cannot be worked under as wide a range of moisture conditions as other types of the area. It is somewhat more difficult to handle than the Kennan silt loam.

Topography and drainage.—The surface of this type of soil varies from nearly level to undulating and gently rolling. The differences in elevation between the highest and lowest points will probably not exceed 40 feet, and all slopes are long and gentle. The typical portion of this type is nearly level or undulating and water runs off slowly, so that the natural drainage is deficient. Where the surface is more uneven and the natural drainage is better, it has been shown separately on the soil map and referred to as the rolling phase. On account of the heavy compact character of the subsoil, all of the main portion of the type could be tile drained to advantage.

Origin.—The material forming the Colby silt loam is the weathered product of the mass of ground-up rock left upon the surface of this portion of the State during the early periods of the Great Ice Age. It has been derived almost entirely from the old crystalline rocks. The soil has some of the characteristics of a residual soil and it is probable that in places the deep subsoil is residual. The surface soil may have been deposited in part by wind action.

Native vegetation.—The Colby silt loam was originally covered with a dense forest growth of hardwood and hemlock with a scattering of large white pine. Practically all of the pine has been cut, but there is still some virgin hardwood and hemlock. The hardwood consists of maple, birch, basswood, and elm, with some ash and oak. Where all of the merchantable timber has been removed a second growth of poplar and birch has sprung up.

*Present agricultural development.**—Practically all improvement on Colby silt loam in this area is confined to the rolling phase, where drainage conditions are better than on the portion of the type just described. When properly drained all portions of the Colby silt loam can be developed into good agricultural land well adapted to dairying and all general farm crops suited to the climatic conditions of this portion of Wisconsin.

*For chemical composition of Colby silt loam see page 25.

COLBY SILT LOAM—ROLLING PHASE

The chief difference between this phase and the portion of the type above described is in topography, the phase being gently rolling and always having sufficient slope so that surface water will run off readily.

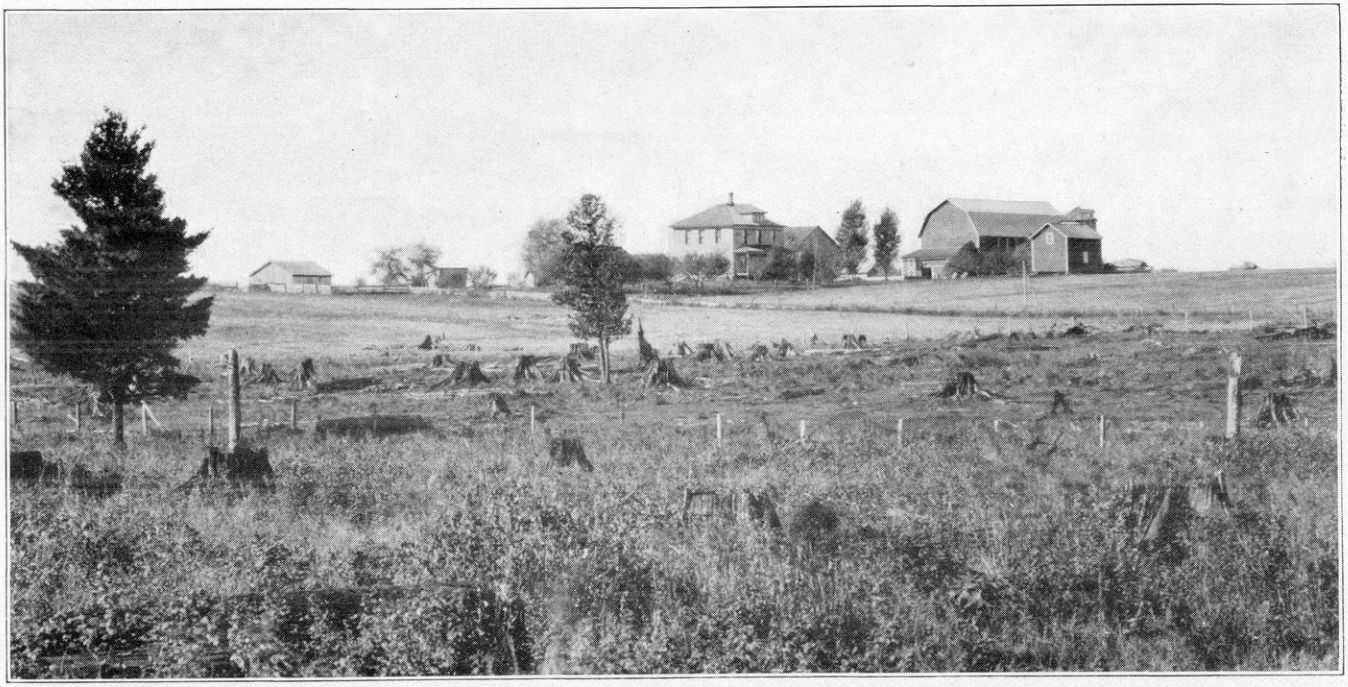
Somewhat more than half of the Colby silt loam in this area is included in the rolling phase. The phase has not quite as large a supply of organic matter as the remainder of the type, but as far as texture, structure, origin and native vegetation are concerned it is very similar. About 15 to 20 per cent of the Colby silt loam—rolling phase is cleared and under cultivation, and agriculture is well advanced. All crops common to this section are successfully grown. Grasses and clover do especially well and the yields of hay range from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Oats are grown as the leading small grain crop and yield from 35 to 50 bushels per acre. Wheat yields about 25 bushels per acre on the average, but the acreage is comparatively small. Some barley and rye are also raised and satisfactory yields are obtained. Corn is grown especially for fodder and ensilage and some years the crop will mature, though it cannot be depended upon every year.

Where the timber has been removed and the brush cut the type affords excellent grazing and this region as a whole is well adapted to the dairy industry in conjunction with general farming which is the chief type of agriculture being followed at present. The tendency seems to be toward the more extensive development of dairying.

The crop rotation most commonly followed consists of corn followed by oats, with which clover or clover and timothy may be seeded; or the oats may be followed by a year of wheat, barley, or rye before the field is seeded to clover and timothy. Hay is usually cut for two years and the field may be pastured for a year before being again plowed for corn. Where there is much uncleared and brush land, however, such tracts usually provide sufficient grazing and so the cultivated fields on many farms are not used for grazing at any time during the rotation. Stable manure is the only fertilizer used and this is most often applied to sod.

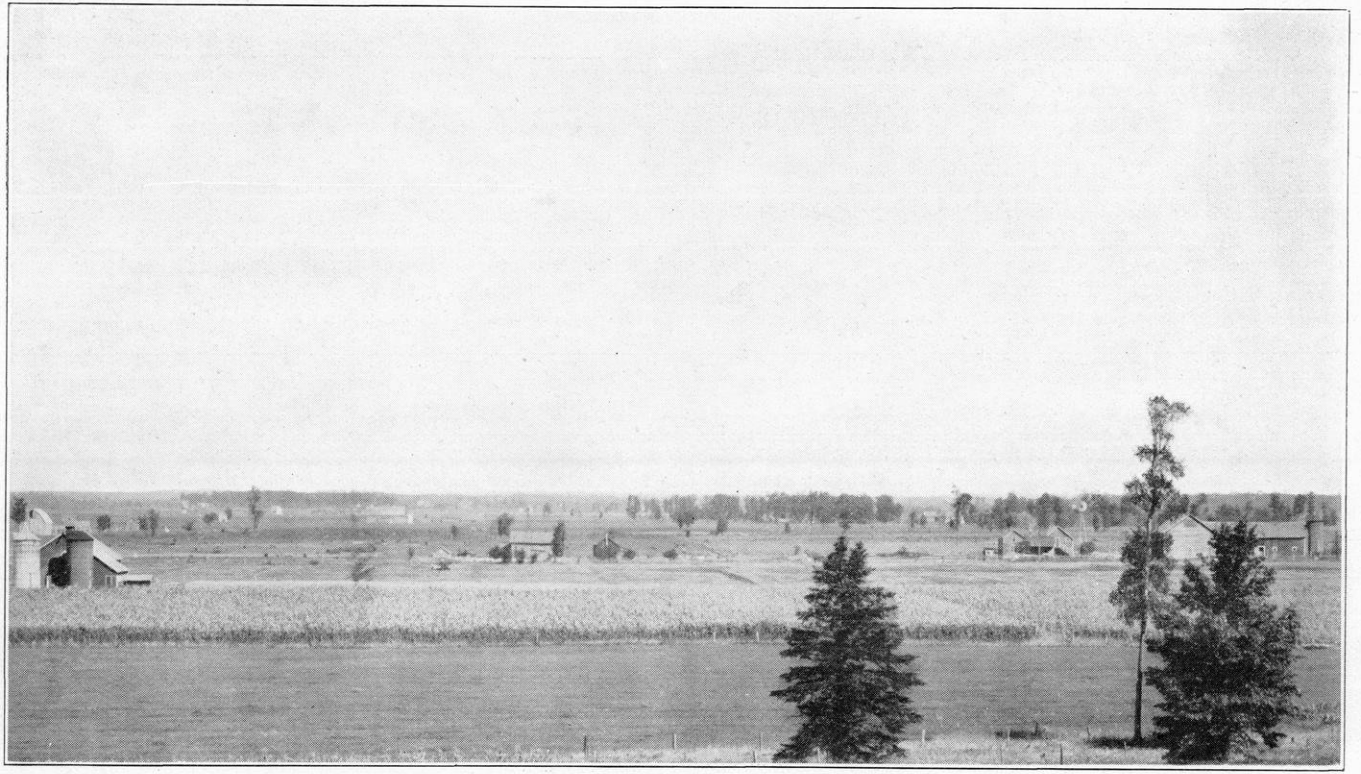
ANTIGO SILT LOAM

Extent and distribution.—The Antigo silt loam is the most extensive type of the Antigo series in the region surveyed and it may be classed with the more important soil types of the area. The most extensive tract is found in the southwestern part of Lang-



COLBY SILT LOAM, ROLLING PHASE.

View showing typical surface features and well improved farmstead. In the present survey this type of soil is confined to the southwestern part of Langlade County.



VIEW OF ANTIGO SILT LOAM NEAR ANTIGO, LANGLADE COUNTY.

Note level topography, highly improved farms, and heavy crop of corn. In the vicinity of Antigo there are about 175 square miles of this class of land.

lade County where there is an unbroken area covering approximately 150 square miles. Antigo, Deerbrook, Bryant, Malcolm, and Ormsby are located upon this tract. Numerous other tracts of this soil, though of much smaller extent, are scattered throughout the northwestern half of the area surveyed.

Description.—The surface soil consists of a light brown or grayish brown friable silt loam which extends to an average depth of 12 inches. The content of silt is usually high, giving the material a smooth feel. The amount of organic matter present is comparatively small and the soil as a whole is acid. The subsoil consists of a yellowish or yellowish brown silt loam which gradually becomes heavier and grades into a silty clay loam. At an average depth ranging from 22 to 30 inches the material grades abruptly into beds of stratified sand and gravel. The depth to the the sand and gravel is variable, however, and differences of from 1 to 4 feet may occur within a distance of a few rods. In general, it may be said that the type to the east of Antigo is somewhat lighter in texture than it is to the west. There is frequently a sprinkling of gravel upon the surface and a few stones ranging in diameter from 4 to 8 inches may also occur, though over areas where the silt loam is the best developed but little gravel and few stones are found.

While the major portion of the material mapped conforms to the above description, this soil is not uniform, but consists rather of a combination of several types so closely associated that in a general survey of this character the individual types of small extent could not be indicated separately on the soil map. The surface material varies from a silt loam to a fine sandy loam.

Topography and drainage.—The surface of this soil varies from level to very gently undulating, usually having a very gentle slope toward the water course along which it occurs. The extensive tract about Antigo in Langlade County is a prairie-like plain in which the differences in elevation do not appear to exceed from 6 to 10 feet in a distance of several miles. There is a very gentle slope towards the southwest.

While the surface of the major portion of the type is level, the underlying gravel and sand comes close enough to the surface in most cases to afford good drainage. Where these beds are three feet or more below the surface, however, the natural drainage is somewhat defective. Tile drains could be installed to advantage over these poorly drained areas. The soil retains moisture very well and crops seldom suffer from drought to as great an extent as soils of the same texture where the topography is more broken.

Origin.—The material composing the Antigo silt loam is alluvial and occurs as outwash plains and stream terraces, and was deposited by streams issuing from the ice sheet during glacial times. The beds of stratified sand and gravel found below the surface extend to a considerable depth and at Antigo are known to be 58 feet in thickness. The underlying rock is granite. The gravel found throughout the section quite generally consists of granite and other crystalline rocks.

Native Vegetation.—The original timber growth on this soil consisted of hardwood and hemlock with a very generous scattering of magnificient white pine, a little Norway pine, and hemlock. Of the hardwoods, maple predominated, with birch, basswood, elm, ash, and oak found in smaller amounts. In the vicinity of Ormsby in Langlade County there is still a considerable tract of standing timber.

*Present agricultural development.**—By far the greater proportion of the Antigo silt loam is cleared, under cultivation, and highly improved. It includes some of the finest agricultural land in northern Wisconsin and the area about Antigo is the largest solid body of this type of soil in the State. The leading type of agriculture followed at present consists of dairying in conjunction with general farming, with a strong tendency toward the more extensive development of the dairy industry, to which the region is well adapted. The chief crops grown are oats, hay, potatoes, corn—chiefly for silage, with some barley, rye, and wheat. Peas are a special crop of importance and sugar beets are also grown, though to a less extent. Poppy seed is grown for home consumption in many gardens and ginseng growing is a special industry of importance. Rape is grown as a pasture for hogs.

Probably the most common crop rotation which is followed at present consists of corn 1 year, oats for 1, 2, or sometimes 3 years, or oats followed by barley for 1 year. Timothy and clover are seeded with the grain and hay is cut for 1 or 2 years and the field may be pastured for a year before being again plowed for corn.

But little if any fertilizer other than stable manure is used and this is usually applied to the sod land. This type of soil is not difficult to plow, as it has a friable structure and works readily into a mellow seed bed. Fall plowing is desirable and quite generally practiced, though not as important as where the texture is a clay.

*For chemical composition and improvement of Antigo silt loam see page 25.

KENNAN SILT LOAM

Extent and distribution.—The Kennan silt loam is an important and extensive soil in the present survey. It covers a total area of 244.8 square miles and comprises some of the best undeveloped agricultural land in northern Wisconsin. Tracts of considerable size are found along Pine River in western Florence County, to the southwest of Crandon, to the east of Blackwell, and in various other parts of Forest County. In Langlade County there are important areas in northern Elton and Langlade Townships and smaller patches in the southern part of the county. In Shawano County it is confined to a large number of rather small tracts scattered throughout the western half of the county. It is not extensive in Oconto County, where it is confined to the northwestern section. The rolling phase of the Kennan silt loam, is much more extensive than the typical soil. A description of this phase follows the discussion of the typical soil.

Description.—The surface soil of the Kennan silt loam consists of a brown or light-brown, friable, loesslike silt loam, extending to an average depth of 12 to 14 inches. The subsoil consists of a light-yellow or yellowish-brown silt loam to silty clay loam which usually becomes somewhat heavier with depth, and silty clay loam or heavy clay loam is reached at from 18 to 20 inches. This heavy layer usually extends to an average depth of about 30 inches. The lower part of this section frequently contains some sand and the material sometimes becomes a gritty clay loam. Below 30 inches the subsoil grades into a bed of unassorted glacial till consisting of fine and medium sand and gravel with only a small percentage of silt and clay. Stones and bowlders are present upon the surface, though they are not so large or so plentiful as on the rolling phase. There are tracts of considerable extent where they are almost lacking. It is seldom that large bowlders are found on this type. The areas which occur in western Shawano County, however, are more stony and have a greater number of large stones than other portions of the type.

There are a number of variations in this type which are worthy of note. The depth of the silty material over sand and gravel is nearly as variable as in the rolling phase, though on the whole it averages deeper. It very frequently occurs that the unassorted till is 3 or 4 feet or even more below the surface, while there are a few tracts over which it is within 1 foot of the surface and where there is some gravel scattered over the surface of the soil. The shallow silt areas are usually confined to small tracts of the type, and most of the extensive

tracts have a silt covering of at least the average depth. In southwestern Shawano County a number of the shallow silt areas are found and there is also a variation in which there is a considerable proportion of fine sand incorporated with the silt. Such tracts, if of sufficient size, would be mapped as a heavy fine sandy loam or a loam. In such places the subsoil is often a sandy clay loam instead of a silty clay loam or silt loam. Another phase is found in southwestern Shawano County where the subsoil is rather heavy and red in color.

Topography and drainage.—The surface of the typical Kennan silt loam varies from nearly level to gently rolling. In most cases the natural drainage is thorough, but where the surface is level or gently undulating and the silty covering is 3 feet or more deep the internal drainage is somewhat deficient and tile drains are very advantageous in improving the land. This soil retains moisture very well, and because of the smooth topography there is no destructive erosion.

Origin.—This type is of glacial origin and consists of material ground from the underlying crystalline rocks. A large proportion of it is ground moraine. The areas which are gently undulating or nearly level may be in part till plains. It is known that in some places the sandy gravelly material in the deep subsoil is stratified, and such areas are doubtless outwash plains. It is probable that some of the outwash plains have been worked over by an ice sheet after being deposited, and where the surface is not level such tracts more closely resemble the Kennan than the Antigo soils.

Native vegetation.—The forest growth consists chiefly of maple, birch, and hemlock. Basswood, elm, and white pine are found to a less extent. Most of the pine has been cut, but the greater part of the hardwood and hemlock is still standing.

*Present agricultural development.**—Only a comparatively small percentage of this type is cleared and under cultivation, but it gives promise of becoming one of the most highly improved and important soils in the area. Much of this land is still owned in large tracts by lumbering companies, railroads, and individuals, and its development along the line of agriculture is retarded. As rapidly as the timber is removed and the land placed upon the market it is being taken up in small tracts and farms started. The districts where this soil is now being farmed are found chiefly in western Shawano County, southern Langlade County, and in Forest County in the vicinity of North Crandon, and also to the southwest of Crandon.

*For chemical composition and improvement see page 25.

The crops grown, the methods of farming followed, and the crop rotations practiced are practically the same as on the rolling phase. The main type is considered a more desirable soil than the phase. There are stone-free areas of considerable size on which such implements as potato diggers can be operated without difficulty, and for this reason it seems probable that the potato-growing industry will develop to a greater extent than on the rolling phase. Alfalfa can be grown successfully, provided the soil is limed and inoculated. Live-stock raising, dairying, potato culture, and small-grain growing seem well adapted to conditions found upon this soil, and most of the development now taking place is along these lines.

KENNAN SILT LOAM, ROLLING PHASE

Extent and distribution.—The Kennan silt loam, rolling phase, is closely associated with the typical soil, and is mapped in the same parts of the area. It is the most extensive soil mapped in the survey, and covers 1,153.8 square miles. While not extensively farmed at present, because of the numerous tracts of standing timber, which is still in large holdings, it gives promise of being one of the most important agricultural types of soil in this section of the State when fully developed. It occupies an extensive belt of country in the western half of the survey and reaches from the Michigan-Wisconsin line on the north border of Florence and Forest Counties to the southern boundary of Shawano County, a distance of nearly 100 miles. In Forest County and the western third of Florence County this soil occupies over 50 per cent of the total area, while in eastern and central Langlade and western Shawano Counties it is the predominating soil. It is also found as a narrow belt along the western margin of Marinette County and in the northwestern corner of Oconto County. Associated with this phase is the typical soil and numerous areas of Kennan fine sandy loam and Vilas stony sand, fine sand and sandy loam.

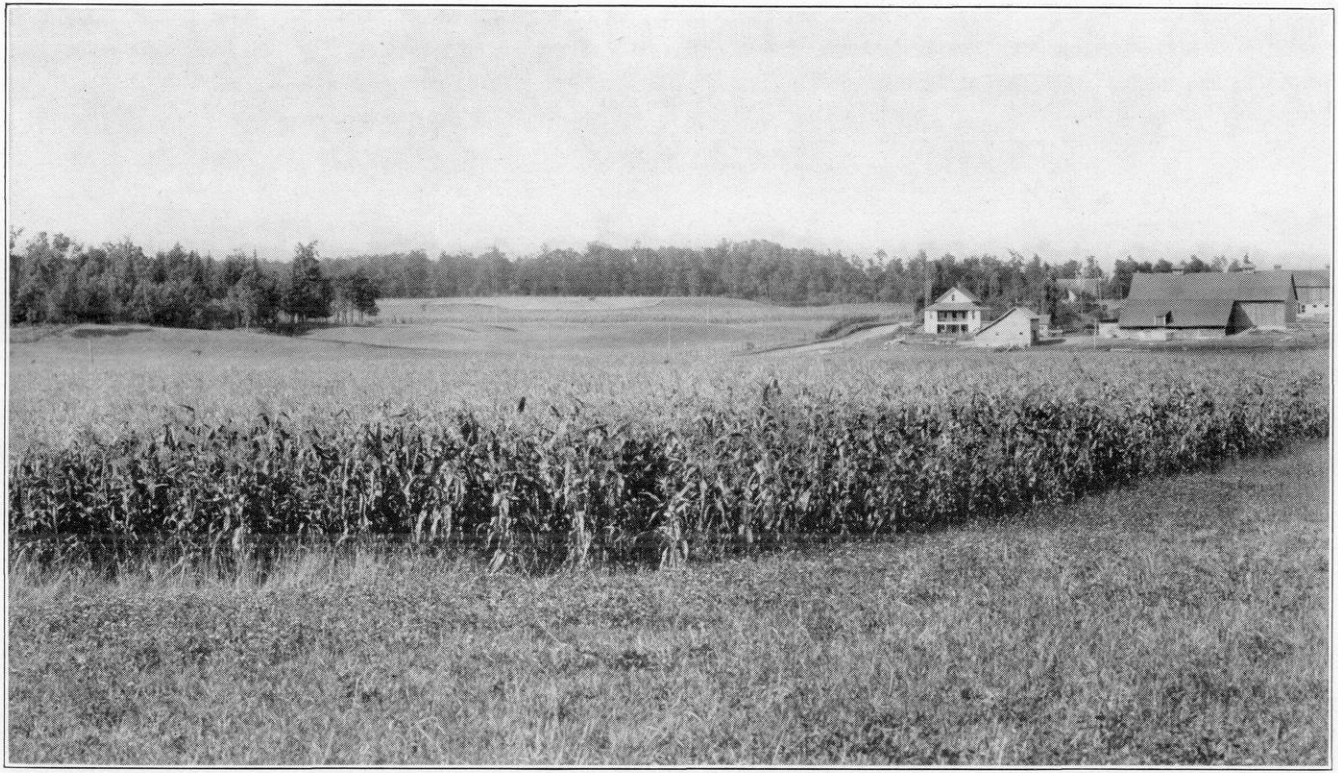
Description.—The soil of the Kennan silt loam, rolling phase, to an average depth of 10 to 12 inches consists of a brown or grayish-brown friable silt loam which has a smooth feel and contains a moderate amount of organic matter. The surface 6 inches is usually somewhat darker than the material immediately beneath because of the larger content of organic matter. When dry, the soil frequently has a gray, ashen appearance. It is usually free from coarse grains of sand and fine gravel, and the smooth, velvety feel is a remarkably uniform characteristic over most of this phase. The soil has somewhat the appearance of loess.

The subsoil consists of a yellow, yellowish-brown, or slightly grayish yellow silt loam which usually becomes heavier in texture with depth, grading into a silty clay loam at 16 to 20 inches. This heavier material extends to a depth of 20 to 26 inches, where fine gravel or sand is often incorporated with it. Below this depth the percentage of sand and gravel increases, and the lower subsoil usually consists of an unstratified mixture of light-yellowish or brownish fine and medium sand, with considerable quantities of gravel, but only a small proportion of silt and clay. The gravel is sometimes so plentiful as to prevent penetration with the soil auger.

A large number of stones and bowlders occur scattered over the surface of this soil. These range in size from a few inches to several feet in diameter. In places of small extent the rocks are so numerous as to be an obstacle in the clearing of the land, while in other localities the surface is practically free from stones. Because of the irregularity of their occurrence it is impracticable to indicate the stone-free areas. Where stones are the most plentiful and fields are cleared, stone fences are common.

There are a number of variations in the phase which are worthy of note, although not of sufficient extent or importance to indicate separately on the soil map. On the tops of practically all the hills and ridges the silty covering over the sandy gravelly subsoil is thinner than typical, and on some of the sharpest ridges gravelly material outcrops and gravel is found upon the surface. Toward the foot of the slopes the silt covering gradually becomes deeper, and frequently along the lower slopes and across the valley to the next rise it is so deep that no gravel can be reached with the 3-foot soil auger. Where the slopes are gentle and the hilltops broad and nearly flat, the silt covering frequently continues of uniform depth. In the southeastern part of Forest County in the vicinity of Wabeno the surface soil contains a higher percentage of silt than typical and the subsoil is heavier and deeper, even on the hilltops, than is usually the case. In western Marinette County the phase is a little lighter than typical. In many localities there is a considerable amount of fine sand incorporated in both soil and subsoil, so that the soil approaches a fine sandy loam.

Topography and drainage.—The surface of the Kennan silt loam, rolling phase, varies from gently rolling to rolling and hilly, and in a few places, to rough and broken, though most of it may be classed as rolling. The surface is often in the form of a series of parallel ridges extending in a northeast and southwest direction. The highest portion of the ridges ranges from 50 to 150 feet above the intervening valley bottoms, but the slopes are seldom too steep to prevent the



KENNAN SILT LOAM, LANGLADE COUNTY.

Note the gently rolling topography. This type of soil with its rolling phase covers 22.9 per cent of the area surveyed. Corn is grown successfully in this region.

KENNAN SILT LOAM, ROLLING PHASE, NEAR WABENO, FOREST COUNTY.

This phase includes over 700,000 acres within the present survey. It is an excellent soil and capable of being highly improved. Most of it is still timbered.

use of modern farm machinery when the land is cleared. In many localities the slopes are long and gentle and it is frequently one-half mile or a mile, or more, from one hilltop to the next. In the vicinity of Crandon, around Stone Lake, and to the south in Forest County the hills are quite high and some of the slopes steep. To the southwest of Lakewood in Oconto County there is a considerable area which is extremely rough and broken and much of which is too steep for cultivation. This area comprises parts of secs. 35 and 36 in T. 33, R. 15, parts of secs. 31, 32, 33, and 34 in T. 33, R. 16, and parts of secs. 4, 5, 6, and 7 in T. 32, R. 16, Oconto County.

In the depressions between the hills and ridges there are a large number of swamps and lakes. The swamps consist chiefly of areas of Peat, and are most numerous in the northern part of Forest County, though marshy tracts occur to a greater or less extent throughout the entire region covered by this soil.

Because of the uneven surface and the loose, open structure of the deep subsoil, the natural surface drainage is excellent and the internal drainage is very good, except in a few places where the silty covering is deeper than usual and the surface is in the form of a valley or small depression, in which case tile drains could doubtless be installed to advantage. On many of the steeper slopes erosion will be a problem requiring attention when the land is cleared and put under cultivation. Where fields have been cleared and cultivated on the steeper slopes, small ravines soon form if the surface of the ground is not covered by a growing crop most of the time. These gullies enlarge quite rapidly and in time cut up the fields badly unless checked. Fortunately, as the country is new, means of preventing damage from erosion can be adopted as the land is cleared.

Origin.—The material composing this soil has been derived from the weathering of the glacial drift which covers this entire region, ranging in depth from a few feet to over 100 feet. It appears that the surface was considerably eroded before the decomposition of the drift and that the preglacial topography in general was quite similar to the present surface arrangement. The drift forms a veneering over the underlying rocks and was deposited chiefly as ground moraine, though many of the ridges have the appearance of being terminal or recessional moraines, and the hills frequently appear to be elongated drumlins.

Native vegetation.—The timber growth consisted chiefly of hardwoods and hemlock, with a scattering of white and Norway pine. A large proportion of the pine has been cut, but the phase still supports some of the most extensive hardwood forests remaining in Wisconsin. Over the northern part of Forest, the eastern part of

Langlade, the northwestern part of Oconto, and in scattered areas in Shawano County there are large tracts of virgin forest. The hardwood consists chiefly of maple and birch with a small amount of basswood and elm and a very little oak.

Present agricultural development.—Only a small part of the rolling phase has been put under cultivation, though large areas have been cleared of their timber and are now awaiting the settler. The most extensive developments are in Rolling, Norwood, Polar, and Evergreen Townships in Langlade County and in the western part of Shawano County. Enough has been done along the line of agricultural development, however, to demonstrate that the soil is well adapted to all the general farm crops suitable to the climate and that it is a naturally strong, productive soil and one of the best and most important soils, as well as the most extensive, in the area surveyed. General farming is the chief type of agriculture followed. The tendency seems to be toward the development of dairying and potato culture as the two most important lines of farming.

The chief crops grown are potatoes, hay, and oats, with some corn. Potatoes thrive and seem to be especially suited to the soil and climate. Yields range from 150 to 200 bushels per acre, often being considerably higher. Oats yield about 50 bushels and hay from 2 to 3 tons per acre. Clover and all kinds of grasses suited to the climate do remarkably well on this soil. Peas are grown to some extent and give very satisfactory yields. Barley, wheat, and sugar beets all grow well but are not produced to any extent in this new country. In the southern part of the area corn is a practically sure crop, being depended upon to mature nearly every year, while in the northern part of the area where this phase occurs the season is somewhat shorter and there is more danger from early fall frosts. Corn for silage, however, can be grown very well over the entire area of this soil, and early maturing varieties are being introduced.

As most of the region covered by the rolling phase is still new, no definite systems of crop rotation or methods of cultivation have been put into general practice. The virgin soil is strong and productive and the question of maintaining soil fertility has not received serious consideration.

Kennan silt loam, with its rolling phase, offers more opportunities for agricultural development than any other soil in the area surveyed, and where it predominates the prosperity of the community depends chiefly upon its development and improvement.

Cut-over land of this phase ranges in price from about $12 to $25 an acre, depending chiefly upon the location. Forested land ranges from $18 to about $50 an acre, according to the location and stand of

timber. Partly improved farms are valued at $35 to $50 or $60 an acre, depending upon the location, buildings, and the amount of land cleared and under cultivation.

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

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

Phosphorus.—The total amount of phosphorus in an acre to a depth of 8 inches varies from 1100 to 1400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorus has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorus content of this layer of soil is retained at from 1500 to 2000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorus—in fact they contain on the average approximately 30,000 pounds of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium, therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorus which goes to the grain and is, therefore, more likely to be sold.

Organic matter and nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctly low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. However, the vegetable matter

which they do contain when first cleared and broken is of an active character, but provision should be made for maintaining and increasing this material. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively few farms is there sufficient manure produced to maintain the organic matter in soils of this character and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in the organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are, therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soy beans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element. When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm, but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and liming. Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1000 to that which would require 5000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops, but does interfere with the growth of the best legumes. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land.

Crops.—The Antigo and Kennan soils are adapted to a wide range of crops including corn, potatoes, and root crops as well as grasses and small grains. The Colby soils are not particularly well adapted to root crops on account of their rather inadequate subsoil drainage

and their stickiness. They are, however, exceptionally well adapted to grains and grasses. Fields on the Colby soils having good slope and surface drainage can be made to produce good crops of corn by careful management. The soils of these types are well adapted to the development of dairy farming on account of their unusual fitness for the growing of hay and pasture.

SUPERIOR LOAM—ROLLING PHASE

Extent and distribution.—This type of soil has a total area of approximately 11 square miles. The largest tract is located in eastern Florence County about 9 miles south of Florence in Homestead Townsnip. The remainder of the type occurs in several small patches about 6 miles southwest of Suring in Oconto County.

Description.—The surface soil to an average depth of from 10 to 12 inches varies from a very fine sandy loam to a loam of a gray to yellowish-gray color. The subsoil to a depth of 36 inches and over consists of a heavy stiff compact pinkish-red clay, which well records indicate frequently extends to a depth of 80 feet. The depth of the surface soil is quite variable and may frequently extend to 18 inches, while in other localities the underlying clay outcrops over areas which are too small to be shown in a general survey.

Topography and drainage.—The surface varies from undulating to very gently rolling with a few small tracts that are nearly level. As a type the natural surface drainage is fairly good, but the subsoil is so heavy and compact that the internal drainage is defective. The rougher portions of the type occur adjacent to the stream courses where erosion has been most pronounced.

Origin.—The heavy red clay subsoil is doubtless of lacustrine origin but since its first deposition it has been influenced more or less by glacial action, weathering, and erosion. The sandy or loamy covering was probably more recently deposited than the clay. While the red clay is somewhat calcareous, there is no limestone present, except a very small amount in the area in Oconto County.

Native vegetation.—The original timber growth consisted chiefly of maple, birch, and elm, with some white and a little Norway pine. Practically all of the merchantable timber has been cut and where not cleared and improved a dense second growth has sprung up.

*Present agricultural development.**—Probably over 40 per cent of the Suprior loam is cleared and under cultivation. The area in Florence County is a little far north for corn to mature with certainty, although on all of the type corn for silage can readily be

*For chemical composition and improvement see page 29.

grown and most seasons it can be matured. Oats, barley, wheat, and hay are crops well suited to this soil and all give good yields. It is well adapted to general farming and dairying. The farming communities on this soil are comparatively new, and definite systems of cultivation and crop rotation have not been carefully worked out. On the portions of the type where the drainage is most defective hay is grown more largely than any other crop and some of the land is used for pasture.

SUPERIOR CLAY LOAM—ROLLING PHASE

Extent and distribution.—This type of soil is of small extent and does not occupy over 12 square miles. It is confined to southeastern Shawano County in Maple Grove Township, and to Maple Valley and Spruce Townships in Oconto County. The tracts are seldom over 1 square mile in extent and are quite widely scattered.

Description.—The surface soil to an average depth of 8 inches consists of a dark gray or dark reddish-brown silty clay loam containing a comparatively small amount of organic matter. The subsoil consists of a heavy compact pinkish-red clay or silty clay loam which extends to a depth of over 3 feet. It contains considerable lime carbonate and the soil is seldom acid. The texture varies somewhat, though chiefly in the surface soil. In some of the lower lying places there is more organic matter present and the surface is dark gray or almost black. Such variations, however, are of too limited extent to be indicated in a general survey. The type as a whole resembles the Superior loam—rolling phase, but differs in having a heavier surface soil, and in containing a smaller amount of gravel.

Topography and drainage.—The surface varies from gently undulating to gently rolling and there is sufficient slope over the type as a whole to afford fairly good surface drainage. The subsoil is so heavy and compact, however, that the internal drainage is poor and water moves through the soil very slowly. The lower portions of the soil are in need of tile drains and even gentle slopes would be benefited by tiling.

Native vegetation.—The original timber growth consisted chiefly of large white pine with some maple, hickory, elm, and basswood. All of the timber has been removed and practically all of the type is now under cultivation.

Present agricultural development.—This type is considered to be a good general farming soil and in this area is devoted to the raising of timothy and clover, and small grains including oats, barley, and wheat. Some corn is also raised and sugar beets and peas are two

special crops grown to a limited extent. The heavy character of the soil makes it somewhat late, but it produces good yields under proper conditions of moisture and cultivation. The type is more difficult to cultivate than most other soils in the area, and there is danger of puddling and baking if plowed too wet. But when worked at the proper time a fairly good seed bed can be secured with comparatively little difficulty.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR LOAM AND CLAY LOAM—ROLLING PHASES

The chemical analyses of the Superior loam and clay loam soils show that their phosphorus content is somewhat lower than the average of other silt loams and clay loams in the State, while the potassium content is considerably larger. Their content of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections being acid, while in others they contain as high as 25 or 30 per cent of lime carbonate.

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

Crop	10 tons manure only	10 tons manure and 1000 lbs. rock phosphate	Per cent of increase
Potatoes	87 bu. per A	128 bu.	47
Rutabagas	108 bu. per A	137 bu.	27
Corn	30.4 bu. per A	36.8 bu.	21
Clover hay	2223 pounds	3177 pounds	43
Clover seed	217.5 pounds	336.7 pounds	47

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

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

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

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

CHAPTER III.

GROUP OF FINE SANDY LOAM SOILS

KENNAN FINE SANDY LOAM

Extent and distribution.—The Kennan fine sandy loam is one of the most extensive soil types in the area surveyed and covers approximately 670 square miles. It is found in all of the six counties where crystalline rocks make up the underlying geological formation, but it is most extensive in Marinette and Shawano Counties. The type is closely associated with the Vilas fine sand on the one hand and the Kennan silt loam on the other. Along the southern border of its occurrence in Marinette, Oconto, and Shawano Counties it grades into soils of the Coloma series with such a gradual change that the line between the two series is an arbitrary one.

Description.—The surface soil of the Kennan fine sandy loam to an average depth of 12 inches consists of a light brown or yellowish-brown, mellow, friable fine sandy loam. The surface of cultivated fields when thoroughly dried has a grayish appearance but becomes somewhat darker as the content of moisture increases. The subsoil consists of a light yellowish-brown to yellow fine sandy loam which usually becomes coarser in texture and somewhat lighter in color with increased depth, so that the last 6 to 10 inches in the 3 foot section are mainly yellow sand and gravel. The greatest amount of gravel occurs below the depth of 18 or 20 inches. Stones and bowlders are plentiful on the surface and through the soil section, but rarely as numerous as on the silt loam, and they seldom retard agricultural development. Their occurrence is irregular and there are areas of considerable size which are practically stone-free. A variation from the typical soil was noticed in a number of places where both the soil and subsoil were heavier than typical. The change from the Kennan to the Superior fine sandy loam—rolling phase, is a very gradual one, and in this general survey some small areas of one type have been included with the other.

Topography and drainage.—The surface of this type varies from gently rolling to rolling and hilly. As a type it is not quite as rough as the average Kennan silt loam. There are a few places of rather limited extent where the surface is only undulating. Such

an area occurs due east from Boot and Pickerel Lakes in Florence County. A similar tract was found in Sections 33 and 34, Town 34, Range 10 East, in Langlade County. A few other small tracts were also noted, but mostly of such limited extent as to make their separation impracticable. On account of the uneven surface features of this type and the loose open structure of the subsoil, the natural surface drainage is excellent.

Origin.—This type owes its origin to the weathering of glacial till which was deposited over the crystalline rocks and it consists of material which was derived largely from this geological formation through the grinding action of the ice and subsequent weathering. A portion of the type may consist of lateral or recessional moraines.

Native vegetation.—The timber growth over this soil consisted of a mixture of white pine, hemlock, and hardwoods. On the lighter and coarser textured phases some Norway pine was also found. Hemlock and maple are the most plentiful, though there is also a considerable amount of birch, basswood, some oak, and a little elm. Over the eastern portions of the type there is also some beech. In Marinette County the white and Norway pine seemed to be the predominating growth.

Present agricultural development.—Probably not over 10 per cent of this soil is in improved farms, but it is a good productive soil, it has a most desirable texture for this portion of the State, and is adapted to a wide range of crops. Farming on the Kennan fine sandy loam in this region is new but promising. The chief crops are oats, rye, potatoes, timothy and clover hay, and corn. Buckwheat, peas, sugar beets, and cucumbers are other crops grown to a limited extent. Potatoes, oats, and clover are the most common crops and they are often grown in rotation as given. When the soil is new clover does well; on older fields, however, some difficulty may be experienced in getting a good stand, probably on account of the acid condition which is more harmful as the fertility of the soil is reduced. Alfalfa was seen growing in a few places.

There is a thriving apple orchard of over 750 trees in bearing just south of Mountain, Oconto County, where Red Astrakhan, Early Harvester, Duchess, Wealthy, Snow, and Longfield are among the varieties of apples being successfully grown. Several varieties of crab apples are also being grown successfully. Bush fruits such as raspberries and blackberries do very well and they are found growing wild through all of the slashings. Strawberries also do especially well on this type.

Dairying is being built up as the country settles and is yearly becoming more important.

VIEW SHOWING TOPOGRAPHY AND TIMBER GROWTH OF KENNAN FINE SANDY LOAM.

Portions of this type are somewhat more rolling than the illustration indicates, but it is a good soil, easy to work, is capable of being highly developed, and it has a promising future. There are over 400,000 acres of this class of land in the area surveyed.

VIEW OF MIAMI FINE SANDY LOAM NEAR GILLETT, OCONTO COUNTY.

Undulating to gently rolling topography, and well improved farms are characteristic of this type of soil as found in Marinette, Oconto and Shawano Counties. Second crop of clover in foreground.

CHEMICAL COMPOSITION AND FERTILITY OF KENNAN FINE SANDY LOAM

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

The total amount of the plant food elements phosphorus and potassium is nearly if not quite as large in the Kennan fine sandy loam as in the Kennan silt loams. However, it has rather less organic matter and this together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

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

This soil was derived from rocks devoid of lime carbonates and therefore has a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in

the virgin condition this soil acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

This type of soil is well adapted to general farming and some special crops such as potatoes can also be grown to good advantage.

SUPERIOR FINE SANDY LOAM

Extent and distribution.—The Superior fine sandy loam occupies a total area of approximately 42 square miles. The largest occurrence is in southeastern Shawano County in Navarino, Angelica, and Maple Grove Townships. In Oconto County tnere is another quite extensive irregular tract, chiefly in Chase Township. In Marinette County there are several small patches about 2 miles south of Dunbar.

Description.—The surface soil to an average depth of 10 inches consists of a light brown to dark brown fine sandy loam, which frequently contains a large percentage of very fine sand. The supply of organic matter is usually limited. The subsoil consists of a fine or very fine sandy loam, or fine sand of a yellowish color which may become gray in some of the poorly drained places. This material extends to a depth ranging from 20 to 30 inches where a heavy stiff red clay is encountered. Lenses of fine sand are sometimes found in the heavy clay. The depth of this bed of red clay is quite variable. It may not be encountered until a depth of 36 inches is reached or it may occur within 10 inches of the surface and outcrop frequently. In some places the texture of the surface soil is a loam or clay loam, while in other places the surface is so shallow that the underlying clay will be turned up by the plow when put under cultivation. Such variations, however, are all of too limited extent to be indicated on a general soil map. The surface is free from stones and bowlders. The red clay is of a calcareous nature.

Topography and drainage.—The surface of this type of soil is level or only very gently undulating and on account of this and the heavy character of the subsoil the natural drainage is frequently defective.

Origin.—The heavy material composing the subsoil is undoubtedly of lacustrine origin. The surface soil was probably deposited over the clay at a date somewhat later than the deposition of the clay and probably during the last period of glaciation.

Native vegetation.—The original timber growth consisted chiefly of maple and birch with some hemlock and elm and a scattering of white and Norway pine. Most of the merchantable timber has been cut and a second growth of birch and poplar is common.

*Present agricultural development.**—Probably about 50 per cent of this type of soil is cleared and under cultivation at present. Dairying in conjunction with general farming is the chief type of agriculture followed. In Navarino Township, Shawano County, there is a very thrifty prosperous farming community developed on this soil. The chief crops grown consist of corn, oats, and clover and timothy hay. Some barley, potatoes, and a little wheat are also raised and the average yields of all of these crops where fields are sufficiently drained are about equal to the yields on the Miami fine sandy loam. The soil is not difficult to cultivate except in a few places where the clay subsoil comes near the surface or outcrops.

FOX FINE SANDY LOAM

Extent and distribution.—The Fox fine sandy loam is one of the soil types of minor importance, occupying a total area of not more than 11 square miles. The largest continuous area is found from 1½ to 5 miles northeast from Gillett in Oconto County. The remainder of this soil is found in the southern part of Shawano County where it is confined to small scattered areas in Waukechon, Hartland, Navarino, and Lessor Townships.

Description.—The surface soil of the Fox fine sandy loam to an average depth of 12 inches consists of a light brown or grayish brown friable fine sandy loam, which contains a rather low percentage of organic matter. The upper portion of the subsoil consists of a fine sandy loam somewhat heavier than the surface soil or a brown sandy clay loam. At from 20 to 24 inches this material grades quite abruptly into a light brown fine sandy loam containing a high percentage of fine sand and in places medium sand. The subsoil is stratified and beds of lighter textured material alternate with thin layers of fine sandy loam and sometimes clay loam.

While a small amount of gravel occurs with the soil material, no gravel deposits or beds of any size were found underlying the type. The most extensive deposit occurs in the area 2 miles south of

*For chemical composition and improvement see page 37.

Bonduel in Shawano County. About 40 per cent of the gravel in the soil and the stones and bowlders upon the surface consist of limestone.

As found in Shawano County the Fox fine sandy loam is somewhat lighter in texture than the description above would imply. The subsoil seldom contains material heavier than a fine sandy loam, except in the small area due south of Bonduel, where the tract as a whole approaches a loam.

Topography and drainage.—The surface of the Fox fine sandy loam varies from level to very gently undulating. The slight undulations which frequently occur appear at intervals of from 10 to 15 rods and the difference in elevation within such distance will range from 2 to 3 feet.

On account of the level character of the surface and the fact that the subsoil of the Oconto County tract is quite heavy in places, the natural drainage is somewhat deficient and tile drains could be installed to advantage over a portion of this type. In Shawano County the most of this soil would not require drainage. The lighter portions of the type, especially where slightly elevated, are subject to drought and when improved and cultivated, crops will doubtless suffer somewhat from lack of moisture during portions of each growing season.

Origin.—The material composing this type of soil occurs as outwash plains or stream terraces and was doubtless deposited by waters issuing from the ice sheet. Most of the soil came from the underlying limestone and the presence of limestone material keeps the subsoil from being acid. The surface soil has been leached to a considerable extent and is frequently found to be slightly acid.

Native vegetation.—White and Norway pine, maple, beech, oak, and some elm were all to be found upon this soil. On the heavier portions the hardwoods seemed to predominate, while on the lighter tracts the pine was the most plentiful. Practically all of the merchantable timber has been removed and where not under cultivation there is now a growth of small poplar, birch, and white pine.

*Present agricultural development.**—The greater proportion of the type in Oconto County is cleared and under cultivation. In Shawano County probably $\frac{1}{3}$ or $\frac{1}{2}$ of this soil is cleared. General farming is the type of agriculture followed and dairying is the most important branch. The crops most commonly grown are clover, corn, rye, oats, and winter wheat. The rotations followed and average yields obtained from the tract in Oconto County are about the same as for the Miami fine sandy loam. In Shawano County the yields

*For chemical composition and improvement see page 37.

will not average quite as high owing to the fact that the soil is somewhat lighter in texture.

ANTIGO FINE SANDY LOAM

Extent and distribution.—The Antigo fine sandy loam is of very limited extent and of minor importance. The largest tract of several square miles is found along the Brule River about 8 miles northwest from Florence in Florence County. Other small tracts occur in Germania and Almon Townships in Shawano County.

Description.—The surface soil of this type to an average depth of 8 to 10 inches consists of a light brown fine sandy loam. In structure the material is rather loose and open, but it is noticeably heavier than the Plainfield fine sand. The subsoil consists of a yellow fine sand which usually becomes somewhat coarser with depth and grades into a medium sand at from 2 to 3 feet. In a few places the subsoil was found to be slightly sticky, owing to the presence of a small amount of clay, but as a rule the only difference between this type and the Plainfield fine sand is the greater amount of silt and clay in the surface soil of the fine sandy loam.

Topography and drainage.—The surface is level to very gently undulating, and on account of the loose open character of the subsoil the natural drainage is good and usually somewhat excessive.

Origin.—The soil consists of alluvial material which has been deposited chiefly as stream terraces. The parent material was chiefly from crystalline rocks which were ground up by glacial ice. There is no limestone material present in any of the soil and an acid condition exists in both soil and subsoil.

Native vegetation.—The original timber growth consisted chiefly of white and Norway pine. The type is better than land which usually supports a growth of Jack pine. All of the timber has been removed and it is now all stump land.

Present agricultural development.—While this type of soil is somewhat better land than the Plainfield sand or fine sand, none of it has been cleared and put under cultivation. The distance from settlements probably is the chief reason for this, another being the fact that pine stumps are numerous and their removal would be difficult and expensive.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR, FOX, AND ANTIGO FINE SANDY LOAMS

These types of soil occur over comparatively small areas usually adjoining areas of the silt loam types of the same name. In chemical

composition these soils do not differ much from the Kennan fine sandy loam, with the exception of the Superior fine sandy loam which has more lime in the subsoil. So far as methods for maintaining and increasing the fertility are concerned, they should be the same as those outlined on page 000 for the management of the Kennan fine sandy loam. The Superior, Fox, and Antigo soils, however, are nearly level in topography and as a result often have relatively poor under drainage, making tiling or the use of open surface drains necessary. Proper care in this respect together with the use of methods for increasing the organic matter and available plant food in the soil will build up and maintain these soils in a high degree of fertility.

SUPERIOR FINE SANDY LOAM—ROLLING PHASE

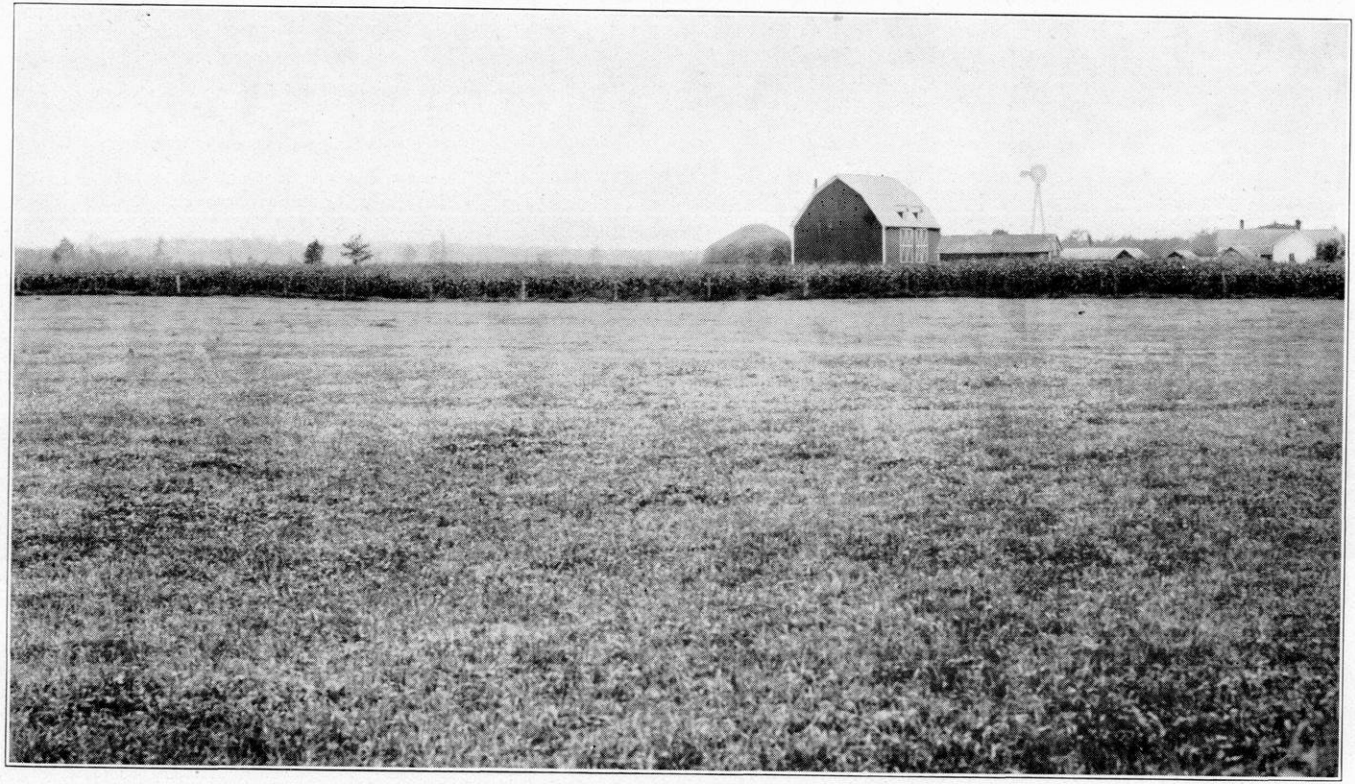
Extent and distribution.—The Superior fine sandy loam—rolling phase is one of the important soil types in the area surveyed from the standpoint of acreage and also from the standpoint of agricultural development. It is confined to Shawano, Florence, and Oconto Counties and comprises a total area of about 170 square miles. Two distinct tracts are found in Shawano County—the first is directly southwest and west from Shawano, chiefly in Richmond and Belle Plaine Townships; and the second is in the southeastern corner of the county in Hartland, Angelica, Lessor, and Maple Grove Townships. This last named tract is the largest unbroken area mapped and from an agricultural standpoint it is one of the best developed regions in the whole area surveyed. In Oconto County the type is confined chiefly to the vicinity of Suring, in Howe, Maple Valley, and Spruce Townships.

Description.—Under normal moisture conditions the surface soil to an average depth of 10 inches consists of a grayish brown to brown fine sandy loam. The amount of organic matter is rather low, but the soil is mellow and friable and all cultural operations can be conducted without difficulty.

The surface soil rests upon a yellowish brown fine sandy loam somewhat lighter in texture than the surface material as well as lighter in color. This light stratum usually extends to a depth of from 16 to 20 inches where the subsoil changes abruptly into a heavy compact pinkish red gritty clay loam or clay. There are present upon the surface and mixed with the soil varying amounts of gravel and frequently a few bowlders are found associated with the soil. Taking the type as a whole the stones are not sufficient to detract at all from the agricultural value of the type. Over the portions of the type in Florence County and central Shawano County

SUPERIOR FINE SANDY LOAM, ROLLING PHASE, NEAR BONDUEL, SHAWANO COUNTY.

Note the gently rolling topography, which insures good natural drainage. This is an excellent general farming soil and is highly improved.



VIEW OF FOX FINE SANDY LOAM EAST OF GILLETT, OCONTO COUNTY.

Showing characteristic level topography and highly improved farm. The surface features are typical of all Fox and Antigo types of soil.

the gravel and stones mixed with the soil are chiefly granitic. In Oconto County there is considerable limestone gravel and some limestone bowlders. In southeastern Shawano County fully 95 per cent of the gravel mixed with the soil is limestone and the underlying rock is also limestone.

There are a number of variations in the type which may be noted. There are places where the depth to the underlying clay is greater than the average depth and in some of these localities the clay is below the reach of the 3-foot auger. This phase is confined to the areas found in Oconto County. Then there are also small tracts where the clay comes closer to the surface than typical and in some localities the surface covering has been entirely removed. Such spots are most noticeable on the knolls in freshly cultivated fields. While some such tracts are found in Oconto County, probably the larger proportion occurs in Shawano County. Both of these variations, however, occur in such small tracts that in a general survey they could not be indicated on the soil map.

The extensive area of the Superior fine sandy loam—rolling phase in southeastern Shawano County differs somewhat from the typical soil. The lighter colored material immediately below the surface soil is often lacking or much thinner than usual, and the heavy underlying clay thus comes closer to the surface than over the remainder of the type. The surface soil is frequently heavier than typical also and may be described as a heavy fine sandy loam which in places grades into a loam. This whole tract may, therefore, be considered as a heavy phase. In a detailed survey it is probable that in addition to the fine sandy loam, a loam and a clay loam could be recognized.

This type is largely associated with the Miami fine sandy loam in Oconto and southeastern Shawano Counties. The line between these two types is not always sharply drawn because the change from one to the other is a gradual one. In the large tract to the southwest of Shawano this type is associated with the Coloma fine sandy loam.

Topography and drainage.—The surface varies from undulating to gently rolling and rolling, though the amount of land that is undulating is comparatively small. A portion of this soil in Oconto County possesses long gentle slopes from relatively broad ridge tops, and upon these slopes there is frequently superimposed a series of low mounds which give a somewhat hummocky appearance. In Shawano County there is more variation in the surface and in a few places it is hilly. The differences in elevation from the highest hilltops to the bottom of the intervening valleys will probably

exceed 200 feet. The slopes, however, are nowhere too steep to be cultivated and practically all of the type is highly improved. A few pot holes occur on this soil but even in such places there is but very little waste land.

On account of the uneven topography the natural surface drainage is good over the greater proportion of the type. The subsoil is frequently quite heavy and compact, however, and the internal drainage is often somewhat defective.

Origin.—The material composing the subsoil was originally laid down as a lacustrine deposit. After its first deposition it appears to have been greatly influenced by glacial action. The advance and retreat of the ice sheet not only reworked the lacustrine material but it also ground up the underlying rock and mixed it with the material from which the soil has been derived. Thus we now find a large amount of limestone mixed with this red clay in the limestone region, and a considerable amount of granite where the glacier traversed the regions underlain by this class of rock.

The heavy red subsoil of this type is of a calcareous nature and contains large amounts of lime carbonate, especially throughout the region underlain by limestone rock.

Native vegetation.—The original timber growth consisted of maple, elm, beech, basswood, hickory, birch, with some hemlock, white and Norway pine.

*Present agricultural development.**—This soil is highly improved and probably over 75 per cent of it is under cultivation. Considering the extent of the type and its present development, it is the best and most highly improved soil in the area surveyed. The type of agriculture most extensively practiced consists of general farming, with dairying as the most important branch. The tendency at present is toward engaging more extensively in the dairy industry. The silo is in quite common use and more are being constructed each year.

The usual crops grown and yields secured are as follows: oats from 30 to 50 bushels per acre, timothy and clover hay from 1 to $2\frac{1}{2}$ tons, and corn from 40 to 60 bushels per acre. While corn can be matured nearly every year except in the most northern occurrence of the type in Florence County, and while even here it matures during a large proportion of the seasons, a large part of the crop is grown for silage, of which a very excellent quality is produced. Potatoes are grown on a commercial scale in a few localities on this soil and yields from 200 to 250 bushels per acre are not at all uncommon. The light phase of the type is better adapted to potato growing

*For chemical composition and improvement see page 46.

than the heavy. Peas are grown for both seed and canning purposes, though on this soil mostly for seed. Sugar beets are grown to a limited extent and yields of from 12 to 15 tons per acre are secured. Alfalfa is being grown in a small way and yields of about 3 tons per acre are the average. Wheat is still grown by a number of farmers and as a rule the yields secured are satisfactory, ranging from 20 to 30 bushels per acre. A small amount of barley and some rye are also raised though not extensively in any section.

The rotation of crops most usually followed consists of corn, followed by oats, which may be followed by oats a second time, wheat, barley, or rye. If a grain crop does not follow the oats the field is seeded and hay is cut for the two following years, with possibly one year additional of pasturing before the field is again plowed for corn. The stable manure is usually applied to sod to be plowed for corn.

MIAMI LOAM*

Extent and distribution.—The Miami loam is confined chiefly to Little River, Lena, Oconto, and northern Stiles Townships in Oconto County, where it is the predominating soil. This same general tract extends north in southern Marinette County.

Description.—The surface soil of the Miami loam to an average depth of 10 to 12 inches consists of a brown or grayish brown loam. The surface soil rests upon a layer of lighter colored fine sand or fine sandy loam, which extends to a depth of 16 to 18 inches where a brown or reddish brown compact silty loam to clay loam carrying limestone gravel and rock fragments is encountered. This heavy material may extend to over 36 inches, though usually at 30 to 34 inches a yellowish fine sandy material containing a large amount of gravel and rock fragments is reached. In localities where the lighter material immediately below the soil is lacking the type frequently approaches a silty loam in texture. Below 30 inches a red clay is encountered in a few instances and here the soil approaches the Superior fine sandy loam—rolling phase. There is usually a sprinkling of gravel over the surface of this soil and stones and bowlders are sometimes plentiful upon the surface. A large proportion of the gravel, stones, and bowlders are of limestone. While stones are common, there are numerous areas that are practically stonefree.

Topography and drainage.—The surface of this type varies from undulating to very gently rolling. The slope is usually sufficient

*This type has been included with the fine sandy loam group of soils because it is quite similar to the Miami fine sandy loam, and will respond readily to the same methods of improvement.

to provide ample surface drainage, though the subsoil is sometimes sufficiently heavy to retard under drainage, so that over the lower portions of the type and on a number of the gentle slopes tile drains could be installed to advantage. The soil retains moisture very well and crops seldom suffer from drought except during the most severe dry periods.

Origin.—The material forming the Miami loam is derived from the calcareous glacial drift which covers the southeastern portion of the present survey.

Native vegetation.—The original timber growth was a mixture of pine, hardwood, and hemlock, the greater proportion being hardwood.

*Present agricultural development.**—A large proportion of this type is under cultivation. Very little timber is still standing. The type ranks as one of the best and most productive soils in the area surveyed. The crops grown are the same as on the Miami fine sandy loam, but the average yields frequently run a little higher. The acreage of potatoes is somewhat lower than on the fine sandy loam. The same methods of farming are followed and the same rotations practiced as on the Miami fine sandy loam, though the dairy industry appears to be somewhat more highly developed.

MIAMI FINE SANDY LOAM

Extent and distribution. The Miami fine sandy loam is one of the best, most important, and most highly developed soil types in the area. It appears as an extensive belt of country including a large part of southern Marinette, southern and southeastern Oconto, and southeastern Shawano Counties. Included with the typical Miami fine sandy loam are a number of phases, the most important of which has been indicated separately on the soil map as the poorly drained phase. The entire type covers an area of 452.7 square miles.

Description.—The surface soil of the Miami fine sandy loam consists of a brown or light brown friable sandy loam extending to an average depth of 10 to 12 inches. On drying the surface has a grayish appearance, which gradually becomes darker as the moisture content increases. Usually the amount of organic matter present is small, but in depressions where it has accumulated or where moisture conditions have been favorable for growth the surface soil frequently has a dark brown color. Immediately below the surface soil there is usually a yellow or yellowish brown loamy fine sand which extends to a depth of 18 to 20 inches, where it grades into a rather compact

*For chemical composition and improvement see page 46.

sticky sandy loam or gritty clay loam. This heavy material extends to a depth of from 26 to 30 inches, where unassorted glacial till is reached consisting of a yellow or yellowish brown sand or sandy loam with which is mixed varying amounts of gravel and stones. Stones and bowlders are irregularly distributed over this type, though seldom in sufficient numbers to interfere with cultivation. Most of the stones have been removed from the improved land and used for building purposes, or as fences, or have been disposed of in piles about the farms. A considerable proportion of the gravel and bowlders are limestone.

At a number of places, especially in Shawano County where the Miami fine sandy loam borders the Superior fine sandy loam—rolling phase, the surface soil is heavier than typical and frequently contains enough silt to be classed as a loam. The color of the subsoil is frequently a reddish brown and in places it is heavier than typical and extends to a greater depth. The line between the two types in Shawano County is usually an abritrary one and small tracts of one soil have sometimes been mapped with the other. At Cecil and at various places in Washington and Waukechon Townships in Shawano County, the red subsoil can be found. In a few places it was found that the lighter colored and lighter textured layer immediately below the soil was not present. There are a few places throughout the type where gravel beds occur at or near the surface, but never over any extensive area.

The Miami fine sandy loam resembles the Superior fine sandy loam —rolling phase, and also the Kennan fine sandy loam in many respects. It differs from the Superior in the color and texture of the subsoil, the latter having a reddish or pinkish red subsoil, which is usually somewhat heavier than that of the Miami fine sandy loam. The Miami differs from the Kennan chiefly in containing a large amount of limestone material, while the latter contains none.

Topography and drainage.—The surface of the Miami fine sandy loam varies from gently rolling to rolling, with a few undulating tracts of rather limited extent. The slopes are usually quite long and gentle and upon some of these long slopes there are sometimes minor irregularities which tend to give the region a bumpy appearance, but such tracts are of small extent. No steep abrupt slopes are found, and modern farm machinery can be used over the entire soil type. Because of the lay of the surface and the gravelly nature of the subsoil, the natural drainage is excellent. While the subsoil is sufficiently heavy to retain moisture for growing crops, it is porous enough to permit the excess water from rains to percolate through and drain away.

Origin.—The material composing the Miami fine sandy loam has been derived from the weathering of glacial drift which is found here chiefly in the form of an extensive ground moraine. The greater proportion of the type is found overlying Lower Magnesian, Trenton, and Galena limestone, and the ground-up material from these formations has entered largely into the composition of the soil. The granitic bowlders indicate that a portion of the drift must have been transported some distance from the north. The glacial ice carried the calcareous drift beyond the margin of the underlying limestone in places, so that soils of the Miami series are sometimes found over other formations than limestone.

Native vegetation.—Of the original timber maple, birch, beech, and hemlock were the most plentiful, though there was a generous supply of oak, elm, basswood, ash, and some hickory. Over most of the type there was only a scattering of white and some Norway pine, though in a few places of rather small extent pine was the predominating growth.

*Present agricultural development.**—A large proportion of the type is in improved farms and probably as much as 60 per cent is under cultivation. Dairying in conjunction with general farming is the leading type of agriculture followed. Quite a number of hogs are raised, especially on the farms engaged in dairying. Some beef cattle are raised, though feeding stock for the market has not been developed to prominence.

The crops grown and the yields obtained on this type of soil are: oats 30 to 45 bushels, barley 20 to 30 bushels, corn 35 to 50 bushels, peas 25 to 30 bushels, potatoes 125 to 200 bushels, and hay 1½ to 2½ tons per acre. Some sugar beets are grown and the yields range from 10 to 12 tons per acre. The quality of the grain grown on this type is very good. Wheat was grown to some extent a number of years ago, but has been largely abandoned. Peas are grown for canning as well as for seed. Potatoes are the most important cash crop and tubers of high quality are produced. Early varieties of corn will mature on practically all portions of the type, though early frosts frequently do some damage. Quite a large proportion of corn is cut for silage. Alfalfa can be successfully grown on this soil and some farmers have thrifty fields, though the total acreage is small.

More apples are grown on this soil than on any of the other types in the area and the fruit is of high quality. The soil is rich in lime, the subsoil is sufficiently open and porous to permit good root development, and the climate is such as to stimulate a vigorous sturdy growth of wood. The rolling character of the surface affords a large

*For chemical composition and improvement see page 46.

number of good orchard sites, and while the industry is not extensively developed at present, there are a number of commercial orchards, the success of which indicates that apple culture could profitably be extended to considerable proportions on this type of soil. The varieties most commonly grown here are Northwestern Greening, Wealthy, Grimes Golden, Snow, Red Astrakhan, and Duchess. Some small fruits such as strawberries and raspberries are grown, but none of these are produced on an extensive scale.

The question of rotation of crops best suited to this soil is being considered by the leading farmers and, while comparative tests have not been made on individual farms, various rotations have been tried in the different communities. The rotation most commonly followed consists of corn or potatoes, followed by a grain crop consisting of oats, barley, or rye, usually oats. Clover or a mixture of clover and timothy is seeded with the grain and hay is cut for 2 years, after which the field may be pastured a year before being again plowed for corn. The stable manure is most often applied to the sod to be plowed under for corn.

MIAMI FINE SANDY LOAM—POORLY DRAINED PHASE

The poorly drained phase of the Maimi fine sandy loam is of comparatively small extent and is confined chiefly to Green Valley Township in Shawano County and to scattered areas in Oconto County chiefly in Morgan, Oconto Falls, Gillett, and Stiles Townships.

This phase represents those portions of the Miami fine sandy loam which are deficient in drainage throughout the greater proportion of their extent. The surface soil to a depth of 10 to 12 inches consists of a yellowish to grayish brown rather heavy fine sandy loam. This material rests upon a brown compact sandy clay which shows frequent mottling of gray and yellow. This heavy material may extend to a depth of over 36 inches, becoming more mottled with depth, or it may change gradually below 20 to 26 inches to a grayish yellow or gray sticky sand containing considerable gravel. Over the lowest portions of the type there is sometimes a shallow covering of Muck and Peat, but such areas are of very small extent. Where there is no Muck or Peat the surface soil is heavier than typical. Some stones and bowlders are found on the surface.

The surface of the poorly drained phase varies from flat to undulating, with low ridges and marshy tracts so closely associated and occurring in such small areas that a separation could not be made between the low wet land and the higher lying soil in a general

survey of this kind. Most of the tracts are so situated that open ditches and tile drains could be readily installed and the land thoroughly drained.

Only a very small proportion of this phase is improved, and where farms are in operation it is used chiefly for pasture or as hay land. Most of it is utilized in connection with better drained land, and in this way can be made of considerable value.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR FINE SANDY LOAM—ROLLING PHASE, MIAMI LOAM, AND MIAMI FINE SANDY LOAM

The texture and chemical composition of these types of soil are similar to those of the Kennan fine sandy loam described on page 32. The chief difference between the Miami and Superior soils on the one hand and the Kennan on the other is that the former have heavier subsoil which occasionally makes the under drainage less satisfactory, and they also have a considerable amount of lime carbonate in the subsoil as a result of their origin by glaciation either directly from limestone rock or, in the case of the Superior soils, from clays laid down in water containing calcareous material.

The same management and treatment so far as the use of fertilizers containing the mineral elements phosphorus and potassium and the importance of increasing the organic matter suggested in the discussion of the Kennan and Coloma fine sandy loams should be followed in the management of the Miami and Superior soils. The need of lime is much less general but acidity will be found to occur in patches.

CHAPTER IV

GROUP OF FINE SAND AND SANDY LOAM SOILS

PLAINFIELD FINE SAND

Extent and distribution.—The Plainfield fine sand is quite widely distributed and is found in four of the counties surveyed. With its poorly drained phase it has a total area of 144 square miles. In Shawano County this type is confined to the Wolf River Valley where it occurs bordering Shawano Lake. Another small tract lies along Embarrass River in Belle Plaine Township in Shawano County. In the Central part of Oconto County there are a number of tracts, the largest of which occurs along the Oconto River, both north and south of Suring. Large areas of the type occur in the southeastern corner of Marinette County and along the front of Green Bay in Oconto County, with small tracts in various other portions of the survey.

Description.—The surface soil to an average depth of 8 inches consists of a yellowish brown or grayish brown fine sand. The material is loose and open in structure, the organic matter content is low, and the soil is acid. The subsoil consists of a yellow fine sand to a depth of 18 to 24 inches, where it grades into a medium sand which in the lower depths of the 3-foot profile frequently contains a small amount of fine gravel.

Topography and drainage.—The surface of this type is level to very gently undulating, except in places where the wind has blown the fine sand into low dunes. In such places, which are of small extent, the surface is very gently rolling. On account of the loose open structure of the soil and subsoil, the natural drainage is thorough and usually excessive.

Origin.—Plainfield fine sand is an alluvial soil which was deposited as stream terraces, as outwash plains, or deltas built into the glacial lakes. The material was originally derived principally from sandstone rocks with smaller quantities of crystalline rock material. The southernmost tracts may have come in part from limestone till, but from this practically all lime carbonate has been removed by leaching. Since its first deposition, the surface has been modified slightly by the action of the wind.

Native vegetation.—The original timber growth consisted chiefly of white and Norway pine. Jack pine is scarce. The timber was all removed from this type years ago and at present there is an irregular growth of poplar, sand cherry, and white birch, with an under growth of sweet fern in a number of places.

*Present agricultural development.**—Large areas of Plainfield fine sand are not under cultivation, but near Oconto, Marinette, Crivitz, and Peshtigo it is utilized quite extensively. The crops chiefly grown are potatoes, rye, corn, buckwheat, beans, and hay. The yields average higher than those from Plainfield sand, and it may be considered a soil of fair agricultural value. By careful management profitable yields can be readily secured.

PLAINFIELD FINE SAND—POORLY DRAINED PHASE†

The poorly drained phase of the Plainfield fine sand is confined entirely to Oconto County in Morgan, Chase, Pensaukee, and Little Suamico Townships. The greater portion of this phase occurs as one continuous though somewhat irregular area. Most of it lies between the Pensaukee and Oconto Rivers, but a portion lies south of the Pensaukee.

The surface soil to an average depth of about 6 inches consists of a fine gray sand. In places the surface 1 or 2 inches has a brown or sometimes nearly black color, due to the presence of organic matter. The subsoil consists of a yellowish brown or rusty colored fine sand which is sometimes mottled with gray in the lower depths. The texture frequently becomes coarser with depth and at 30 to 36 inches a medium or even coarse sand may be found.

The surface is low and flat and, while a swampy condition does not prevail over the phase, it is all poorly drained and in its present condition has a low agricultural value. Scattered throughout the large area of this soil are small patches which have a shallow covering of peat, but all these were too small to be indicated. The original timber was chiefly white and Norway pine. At present the growth consists of poplar, birch, hazel, and willow.

SUPERIOR FINE SAND

Extent and distribution.—The Superior fine sand is of limited extent and occupies a total area of only about 12 square miles. The greater proportion is found in the southern part of Navarino and the

*At Crivitz in Marinette County the Wisconsin Experiment Station has secured very gratifying results with experiments on Plainfield fine sand. Reports covering this line of work can be secured by writing the College of Agriculture, Madison, Wisconsin.

†For chemical composition and improvement of Plainfield fine sand see page 57.

southwestern part of Lessor Townships in Shawano County. The type is associated chiefly with the Superior fine sandy loam.

Description.—The surface soil to an average depth of 10 inches consists of a light brown to slightly yellowish brown fine sand which contains only a small amount of organic matter in the surface 1 or 2 inches. The subsoil is a yellow or yellowish brown fine sand which extends to a depth of 24 to 30 inches where the sand is usually of a pinkish tinge. At a depth of from 36 to 48 inches heavy red clay may be encountered, though the depth to clay is variable.

In a number of places there are small sand dunes on this type, but wherever these were of sufficient size they were indicated on the map as Coloma fine sand. These usually occur where the depth of clay is greatest and the surface dries out thoroughly.

Topography and drainage.—The surface of the Superior fine sand is level. The heavy clay underlying the type has a tendency to hold up the water and there are times in the spring when the soil is too wet. Later in the season, however, the bed of clay is beneficial, as it acts as a reservoir and keeps a supply of moisture on hand for growing crops. There are a few places where open ditches or tile drains could be installed to advantage, though over much of the type fairly good crops could be grown without any drainage work being done.

Origin.—The heavy red clay underlying this soil is doubtless of lacustrine origin, having been deposited in quiet water, probably during an inter-glacial period. Most of it is confined to the Wolf River Valley and is lower than the surrounding country. The sandy covering was probably deposited during the invasion of the last ice sheet, or it may have been washed down from the higher land adjoining after the retreat of the last ice sheet. The heavy red clay is quite calcareous but over the sandy covering an acid condition has developed.

Native vegetation.—The original timber growth consisted chiefly of white and Norway pine, all of which has been cut. There is now a second growth consisting of poplar, birch, and hazel bushes and in the wettest places some willow.

*Present agricultural development.**—Only a very small proportion of this soil is under cultivation, the major portion of it having been left to itself after the timber was removed. Where farms have been started fair results are being obtained and corn, grass, and small grains are being raised successfully.

*For chemical composition and improvement see page 57.

PLAINFIELD SANDY LOAM

Extent and distribution.—The Plainfield sandy loam is of minor importance in the present survey, since it occupies a total area of only about 23 square miles. One of the largest tracts is found along the Embarrass River and Mill Creek in Belle Plaine and Herman Townships, Shawano County. Directly northeast of Antigo in Langlade County there is another area. Other small patches occur scattered over these two counties and also in Oconto and Florence Counties.

Description.—The surface of this type of soil to an average depth of 12 inches consists of a brown or light brown sandy loam of medium texture. In places the texture approaches that of a sand and could be classed as a loamy sand, but such variations are not extensive. The subsoil consists of a loose yellow sand which becomes somewhat coarser with depth and below 26 to 30 inches there is frequently some small water-worn gravel. In the lower layers this material is stratified.

Topography and drainage.—The surface of the Plainfield sandy loam is level to very gently undulating and because of the loose open character of the subsoil the natural drainage is good and somewhat excessive. Where the soil is under cultivation crops very frequently suffer from lack of moisture during some portion of practically every growing season. Where the type occupies a low terrace, as is sometimes the case, the water table is nearer the surface than typical and the soil is not so droughty.

Origin.—The Plainfield sandy loam consists of alluvial material which has been deposited as outwash plains or stream terraces. The parent material from which the type was derived consists partly of crystalline rocks, though there may also be varying amounts of material from sandstone. No traces of limestone are to be found and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber growth consisted of white and Norway pine with varying amounts of birch, hemlock, and some maple. Jack pine is not found on this type. Over some portions of the type the hemlock predominated, while in other places the pine was the chief growth.

*Present agricultural development.**—Less than half of this land has been cleared and put under cultivation. Potatoes, small grain, and some corn silage are being grown. Yields are only moderate unless the soil is especially well handled.

*For chemical composition and improvement see page 57.

COLOMA SANDY LOAM

Extent and distribution.—The Coloma sandy loam is confined to Marinette and Oconto Counties where it occupies an area of approximately 72 square miles. It occurs as a somewhat irregular belt about 4 miles wide and extending to the southwest from the vicinity of Wausaukee in Marinette County to White Potato Lake in Brazeau Township in Oconto County. About 90 per cent of the type is in Marinette County.

Description.—The surface soil to an average depth of 10 inches consists of a light brown or grayish brown loose fine sandy loam, which in places gives way to a medium textured sandy loam. There is present only a comparatively small amount of organic matter, but there is sufficient fine material, consisting chiefly of silt, to impart a somewhat loamy character to the soil. The subsoil to a depth of about 24 inches consists of a light textured fine to medium sandy loam, which has a lighter color than the surface soil. At from 24 to 36 inches this grades into a light yellow medium sand. By far the greater proportion of the type is free from stones, and gravel is not found except in a very few spots.

This type very closely resembles the Vilas sandy loam but differs from that soil in having only a very few stones upon the surface, in having a somewhat less broken topography, and in having been derived largely from sandstone instead of in part from crystalline rocks.

Topography and drainage.—The surface of this type varies from gently rolling to rolling. The natural drainage of this soil is excellent. The internal drainage is somewhat excessive and the type is apt to suffer from drought during the latter portion of each growing season.

Origin.—The material composing the Coloma sandy loam consists of glacial debris which has been derived largely from the underlying Potsdam sandstone. It is probable that there is a small amount of material from the granitic rocks mixed with weathered sandstone material.

Native vegetation.—The timber growth on this type consisted of mixed pine and hardwood, but was made up most largely of white and Norway pine, with white birch, some beech, and red oak. Practically all of the merchantable timber has been removed.

Present agricultural development.—Only a very small proportion of this type has been redeemed from the cut-over stage and placed under cultivation. It is a fair soil and will produce reasonably good yields of all the general farm crops commonly grown in this region.

Observations in the field indicate that the average yields will probably range a little lower than for the Kennan fine sandy loam. It is not as productive a soil as the Miami fine sandy loam, but it is a type which can be successfully and profitably farmed.

COLOMA FINE SAND

Extent and distribution.—The Coloma fine sand comprises a total area of approximately 200 square miles. The largest tract occurs immediately north of Shawano Lake and east of the Wolf River in Shawano County, and in the southwestern part of Oconto County. The Coloma fine sand is also quite extensive in Marinette County and in the southern part of Oconto County where it is associated with the Miami fine sandy loam.

Description.—The surface soil of this type consists of a yellowish brown or grayish brown fine sand extending to an average depth of 8 inches. There is a very small amount of organic matter in the surface 2 or 3 inches of virgin soil but after a few years cultivation most of this is lost. The subsoil consists of a yellow loose fine sand. This becomes slightly lighter in color and somewhat coarser in texture with depth, until in the lower portion of the subsoil the material is a pale yellow medium sand. The type is practically stone free.

A variation from the typical soil which was included with the type is represented by long narrow winding ridges or eskers, which are locally known as "hog backs." On these ridges both soil and subsoil are often quite gravelly, and some of the gravel is limestone.

The Coloma fine sand corresponds very closely to the Kennan fine sand which occurs over crystalline rocks, and has practically the same texture, structure, and topography, but differs in that the Coloma has been derived largely from sandstone glacial till. The type as a whole is in an acid condition and contains very little lime carbonate, although the southern areas of this soil are closely associated with types of the Miami series which are not acid.

Topography and drainage.—The surface of the Coloma fine sand varies from undulating to gently rolling. In a number of places sand dunes have been formed, and where the cultivated fields are not kept covered with a growing crop the surface soil dries out quickly and is readily shifted by the wind. Growing crops are frequently damaged to a considerable extent by blowing sand. Owing to the topography of the type and the loose open character of both soil and subsoil the natural drainage is excessive.

Origin.—The material composing this soil consists of glacial debris which has been ground from the Potsdam sandstone by the

action of glacial ice. In some places, and especially along the northern border, there is a small amount of gravel present which indicates that some of the soil material may have been transported to this region from crystalline rock formations to the north and mixed with the sandstone material. About three-fourths of this type is underlain by Potsdam sandstone and one-fourth by limestone. It is probable that much of the material over the limestone has come from the sandstone region to the north. Where the parent material contained glacial limestone debris the soil has been leached to such an extent that practically all lime carbonate has been removed. Both phases have the same agricultural value and are therefore included in the same type.

Native vegetation.—The original timber growth consisted of scattered white and Norway pine with some localities which were covered entirely with Jack pine. In a few places there was found a growth of oak, but this was usually stunted and of little value. Fires have run over most of the type, and considerable tracts are so nearly cleared that it looks as though there had never been a forest growth. Sweet fern, blueberry bushes, scrub oak, white birch, and a little popple, with now and then a white, Norway, or Jack pine tree, make up the present growth.

*Present agricultural development.**—Probably about 8 per cent of the Coloma fine sand is under cultivation at present. The improved tracts are mostly on the portion of the type over limestone, where associated types are highly improved. The soil is of low agricultural value and returns from farms of this type are small. General farming is the kind of agriculture followed by most farmers on this soil, and the crops most commonly grown consist of potatoes, corn, rye, beans, hay, and some oats.

VILAS FINE SAND

Extent and distribution.—The Vilas fine sand is one of the extensive soil types in the area and covers approximately 475 square miles of which about one-half is found in Marinette County. Oconto, Florence, and Shawano Counties also contain from 50 to 100 square miles each. As is the case with other types of the area, this soil occurs in extensive irregular belts having a northeast and southwesterly direction. The type is closely associated with the Kennan fine sandy loam and the sandy soils of the Plainfield series.

Description.—The surface soil of the Vilas fine sand to an average depth of 9 to 10 inches consists of a loose yellowish brown fine sand.

*For chemical composition and improvement see page 57.

The surface inch on virgin areas is often a little darker due to a small accumulation of organic matter, but when the land has been burnt over, as is very often the case, the surface has a grayish appearance. The subsoil consists of a yellow fine sand which usually becomes some what coarser in texture and a little lighter in color with depth. The lower portion of the 3-foot section at times shows varying amounts of fine gravel and some stone. A moderate number of stones and bowlders may be present upon the surface and mixed with the soil, though there are extensive areas which are stone free. There are fewer stones and bowlders on this type than on the sandy loam of this series, but rock outcrops are more numerous than on any of the other types of the area. Extending through Oconto, Marinette, and into Florence County where this type occurs there is a series of extensive outcrops of granitic rocks. The outcrops are so large and so numerous that frequently areas as large as a square mile are of little or no agricultural value. The proportion of the entire type which is taken up in this way, however, is comparatively small.

A heavy phase of this type, consisting of a loamy fine sand, is found in Section 3, Town 33, Range 17, and in portions of Town 33 Range 16 in Oconto County. Similar areas also occur in Menomonee Indian Reservation in Shawano County, though none of them were found to be extensive.

Topography and drainage.—The surface of the Vilas fine sand varies from undulating to gently rolling with some areas that consist of low hills, giving a bumpy or hummocky appearance. The surface is not as rough and broken as the sandy loam of the same series. The slopes are usually long and gentle, so that from the standpoint of topography alone none of the type would be difficult to cultivate. Owing to the character of the surface and the loose open structure of the soil, the natural drainage is good and the under drainage is excessive.

Origin.—This type owes its origin to the weathering of glacial drift, some of which was derived drom the grinding action of the ice sheet over the crystalline rocks of this region. A portion of the material probably came from the sandstone formation of northern Michigan. The type differs in this respect from the Coloma fine sand, which has been derived almost entirely from sandstone. There are no traces of limestone or limestone material in this type of soil and both soil and subsoil are found to be in an acid condition.

Native vegetation.—The original timber growth consisted of white and Norway pine with some Jack pine and scrub oak in a number of places. All of the valuable white and Norway pine has been removed and the present growth consists of small Norway pine, Jack pine,

scrub oak, and white birch. A few white pine trees are frequently seen but seldom any of the present merchantable value. Fires have run over large areas of this soil so frequently that in numerous places there is no tree growth.

*Present agricultural development.**—Probably not over 2 or 3 per cent of this type is under cultivation at present. In the vicinity of Florence, in Florence County, at Mountain and Breed in Oconto County, and at a few points in Marinette County there is more of this soil being farmed than elsewhere. The crops grown are corn, oats, peas, potatoes, and buckwheat. Yields are usually low. The cost of clearing this land is very small as compared with the cost of clearing any of the hardwood types.

VILAS SANDY LOAM

Extent and distribution.—The Vilas sandy loam is quite widely distributed over portions of five of the six counties included in the area, and comprises a total area of approximately 400 square miles. The largest tracts are found in Langlade and Forest Counties. Smaller irregular tracts are scattered through Oconto, western Florence, and central Shawano Counties.

Description.—The surface soil of this type to an average depth of 12 inches consists of a medium textured brown or slightly yellowish brown sandy loam which has a rather loose structure. When thoroughly dry it frequently has a grayish appearance, expecially in cultivated fields where the amount of organic matter is smaller than in the virgin soil. The subsoil gradually becomes lighter in color and frequently coarser in texture, and below 22 inches it consists of an unstratified mixture of medium to coarse sand and fine gravel. Gravel frequently occurs scattered over the surface, though it is seldom very plentiful. Stones and bowlders occur scattered over the surface and mixed with the soil material, but they are not as plentiful as on the Kennan silt loam. There are areas of varying sizes which are stone free.

A number of variations occur in the type and some of these are worthy of note. In Rolling Township in the southern part of Langlade County the soil is somewhat heavier than typical, is less rolling, has fewer stones, and taken as a whole is somewhat better for all agricultural purposes than the typical soil. Farming is better developed on this tract than elsewhere in the area. In the western part of Upham Township the type is more gravelly than usual and the texture is variable within short distances.

*For chemical composition and improvement see page 57.

Topography and drainage.—The surface of the Vilas sandy loam varies from gently rolling to rough and hilly. Over the major portion of the type the surface is not too steep for the growing of cultivated crops. In the extreme northern part of Forest County, in the northwestern part of Langlade County in Town 34, Range 9 (except in Sections 17 and 18 where the surface for one square mile is only gently undulating) and in the vicinity of Rose and Edith Lakes in Town 34, Range 14, the surface is very rough and the land has a low agricultural value. The surface frequently appears as a series of parallel ridges varying in elevation from 15 to 40 feet above the intervening valley bottoms and placed from 20 rods to $\frac{1}{4}$ mile apart.

On account of the uneven surface features of this type and the loose open structure of most of the material, the natural surface drainage is good, the under drainage is excessive, and the soil suffers from drought during a portion of nearly every growing season.

Origin.—The material composing the Vilas sandy loam consists of glacial debris which has been deposited by the ice sheet over the region of crystalline rocks, and which has been largely derived from the grinding up of this formation. A few eskers occur but these are of only limited extent, and the type as a whole consists of assorted and unassorted glacial till. It is not probable that any large portion of the material forming the soil has been transported a long distance, though sandstone formations to the north have contributed in part to its formation. There is no limestone in the region where this type occurs and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber consisted of a mixed growth of pine, hemlock, maple, birch, and a little elm and basswood. In places, especially where the soil is lighter than typical, the pine was the predominating growth, while in the region where the soil is a sandy loam or heavier the maple and hemlock form the chief growth. Practically all of the pine has been cut as have also large tracts of hemlock and hardwood. There are, however extensive areas of this type which still support the virgin forest.

Present agricultural development.—Only a small proportion of this type is cleared and under cultivation at the present time, probably not more than 8 or 10 per cent. The proportion which is the most highly developed is that which occurs in Rolling Township in Langlade County. Rye, potatoes, corn, oats, and hay are the chief crops grown and fair yields are usually secured where improved methods are followed. Potatoes are the most important cash crop. The stony character of the soil, however, usually prevents the use of the potato digger and other improved machinery. The rotation most often followed consists of corn, or potatoes, rye or oats, followed by clover

and timothy. Dairying is being carried on to a limited extent and seems to be growing in favor. In other portions of the area surveyed, but little of this type is under cultivation except in small patches.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDS AND SANDY LOAMS

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

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in all types except the Vilas sandy loam which contains on an average about 1150 pounds in the surface 8 inches per acre, or from 25 to 40 per cent more than the other types. The total potassium of the surface 8 inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 per cent in the second 8 inches. They have a correspondingly low nitrogen content averaging from a thousand to 1500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches. This organic matter is largely in the form of leaf-mold and fine roots and is hence of an active character so that it decomposes quickly when the surface is first broken, furnishing a sufficient supply of nitrogen for a good growth of crops for a few years. It however, is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

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

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

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

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

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not to be considered that this is an indication that they have less value, than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these fine sands and sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204 and 230 of the Experiment Station.

CHAPTER V.

GROUP OF SAND SOILS

COLOMA SAND

Extent and distribution.—The Coloma sand is a type of small extent and of minor importance in this area. It occupies a total area of approximately 10 square miles and is confined entirely to Shawano County. The greater proportion of this soil is found to the northwest of Shawano in Richmond Township.

Description.—The surface soil to an average depth of 8 inches consists of a light brown, loose sand of medium texture which contains only a very small amount of organic matter. The subsoil consists of a yellow medium sand which usually becomes coarser with depth and often lighter in color until at 30 to 36 inches the material is a coarse to medium sand of a pale yellow color. There may be some fine gravel present in the deep subsoil, but no gravel beds were found associated with this soil. There are a few granitic bowlders upon the surface and in places a small amount of gravel.

Topography and drainage.—The surface of the Coloma sand varies from gently rolling to rolling, and a few areas have been included where the surface is undulating. On account of the surface features and the loose open structure of the material, the drainage is excessive and the type is droughty.

Origin.—The material composing this type consists of glacial debris which has been derived chiefly from the grinding off of the underlying Potsdam sandstone by the glacial ice sheet. The presence of a few granitic bowlders and gravel indicates that there is probably a small amount of material from the region over the granitic rocks that has been carried from the north and mixed with the broken down sandstone. There is no trace of limestone in this type and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of white and some Norway pine. In places there was a little oak but the growth was stunted. All of the merchantable timber has been removed and the greater portion of the type is now in stumps. In places there is a second growth of white birch and poplar. Sweet fern is also common over most of the type.

*Present agricultural development.**—Not over 15 per cent of this type is under cultivation. The soil has a low agricultural value. The crops most commonly grown are potatoes, corn, rye, oats, and a little hay.

VILAS SAND

Extent and distribution.—The Vilas sand is of limited extent, of minor importance, and occupies only about 16 square miles in the area surveyed. A few small tracts are found in Elcho Township in Langlade County, in the northwestern corner of Oconto County around Boot Lake, and in Pella, Herman, Fairbanks, and Germania Townships in Shawano County.

Description.—The surface soil consists of a light brown medium sand which extends to an average depth of 8 inches. The material is loose and open in structure, contains only a small amount of organic matter and is in an acid condition. The subsoil consists of a yellow medium sand which becomes slightly coarser with depth and often somewhat lighter in color. Some fine gravel may occur in the deep subsoil and occasionally there is a small amount scattered over the surface. A few stones may also be present upon the surface, but never in such numbers as to interfere with cultivation.

Topography and drainage.—The surface of the type is gently rolling for the most part with some portions which are hilly. Owing to the rough topography and the loose open character of the soil and subsoil the natural surface drainage is excessive as is also the underdrainage, and the type suffers from lack of moisture during practically every season.

Origin.—The material composing this type consists of glacial debris which has been ground in part from the underlying crystalline rock, but not transported for any great distance. Sandstone formations to the north have also doubtless contributed to the formation of this soil. There is no limestone material present and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber consisted chiefly of white and Norway pine with Jack pine in places and an occasional scattering of hardwood, though the hardwood was never plentiful.

Present agricultural development.†—Only a very small proportion of this soil is cleared and under cultivation at present and because of its low agricultural value it is not at all probable that it will be improved rapidly, except portions of the type which are the most favorably located. The portion of this soil in the vicinity of Tigerton

*For chemical composition and improvement of Coloma sand see page 64.

†Chemical composition and improvement of Vilas sand will be found on page 64.

in Shawano County is somewhat better than the average and some very satisfactory crops are being grown there. Corn, rye, potatoes, clover, beans, and oats are the chief crops.

VILAS STONY SAND

Extent and distribution.—Vilas stony sand occupies a total area of about 70 square miles and is a type of minor importance. It has a lower agricultural value than any of the other upland soils of the area surveyed. The largest tract is found in northern and northwestern Forest County and in the western half of Florence County, chiefly along the Popple River to the northwest of Fence. There is also some of this type in northern Oconto County and small patches occur in the northern part of Langlade County along the Wolf River and in southwestern Shawano County chiefly in Germania and Fairbanks Townships.

Description.—The surface soil of this type to an average depth of 8 to 10 inches consists of a yellowish brown or yellow loose medium sand. The surface 1 or 2 inches frequently has a grayish color. The amount of organic matter present is very small. The subsoil consists of a loose yellow sand which becomes coarser with depth and usually somewhat lighter in color. Gravel also occurs in the subsoil and the amount of it usually increases until at from 2 to 3 feet the material frequently consists of a coarse gravelly sand. Stones are very plentiful upon the surface and some large bowlders are also found. On many of the ridges and hill tops gravel occurs at the surface. The stones and bowlders are sometimes so plentiful as to justify calling this "rough stony land."

Topography and drainage.—The surface of this type varies from rolling to bumpy and choppy. Kames and eskers make up a considerable proportion of the type and the surface is everywhere very irregular and broken. Long narrow gravelly ridges frequently alternate with a series of rounded steep hills and leave the surface in such a condition that even though the soil were heavy the topography is such as to give it a very low agricultural value. The surface is so irregular and the soil so open and porous that the natural drainage is excessive and the type very droughty.

Origin.—The material composing the stony sand consists of glacial debris which has been deposited as kames, eskers, and probably as lateral and recessional moraines. The glacial drift was doubtless derived in part from the underlying crystalline rocks through the grinding action of the glacial ice sheet and also from sandstone forma-

tions to the north. The gravel, stones, and bowlders are largely of crystalline rocks.

Native vegetation.—The original timber growth consisted chiefly of white, Norway, and Jack pine. There are a few tracts of limited extent where some hemlock and a little maple grew, but in these localities the topograpy was so rough and the surface so stony that the agricultural value was considered no greater than the average of the type.

*Present agricultural development.**—On account of the loose droughty nature of this soil, its stony bowldery surface, and its uneven broken topography, the type has very little value for agricultural purposes and much of it may well be considered a non-agricultural soil.

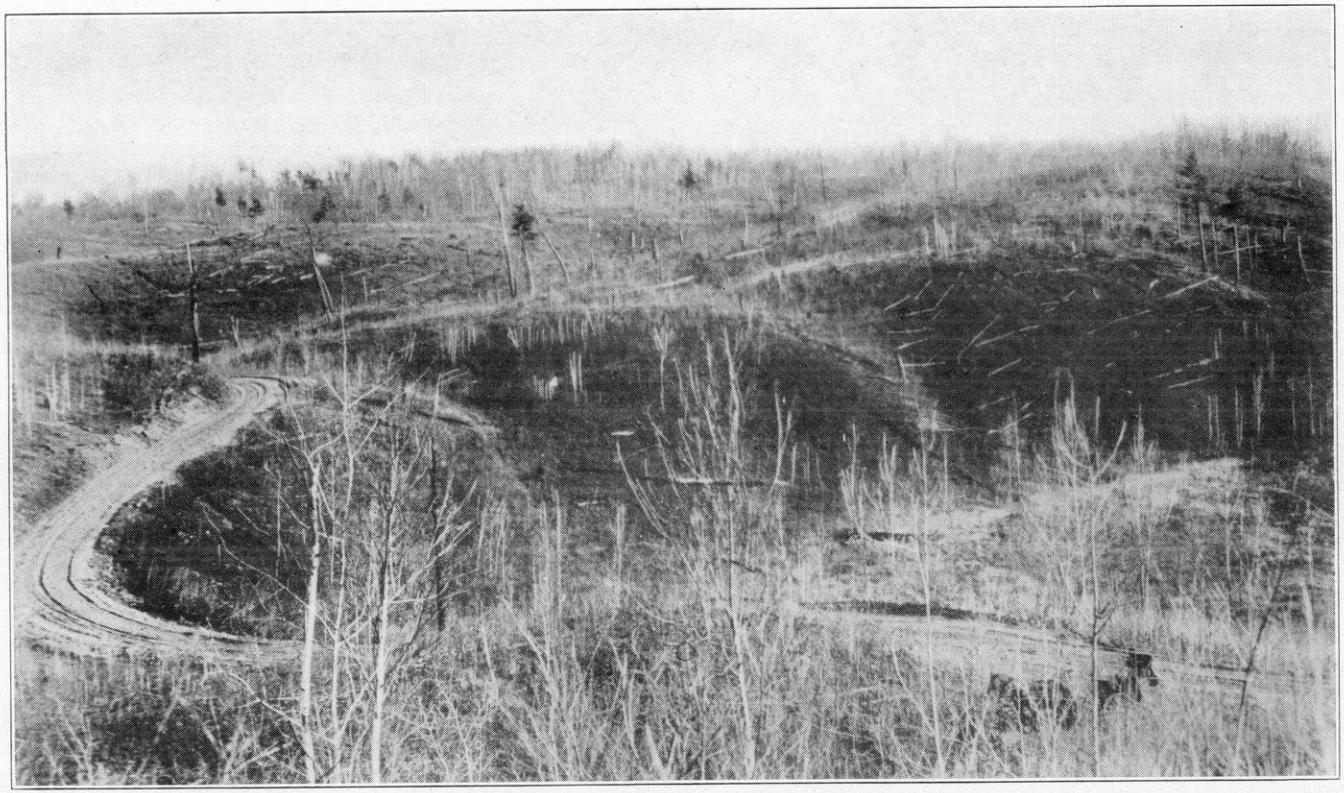
PLAINFIELD SAND

Extent and distribution.—The Plainfield sand occurs in five of the six counties included in this area and covers a total area of about 285 square miles, of which about 225 square miles are found in Marinette County. In Florence County none of this type was mapped.

Description.—The surface soil of the Plainfield sand to an average depth of 8 inches consists of a light colored, yellowish brown, or grayish brown loose sand of medium texture. In the virgin soil there is frequently a slight accumulation of organic matter in the upper few inches, but after a few years of cultivation under the usual methods this largely disappears. The subsoil consists of a yellow, yellowish brown, or grayish brown loose sand of medium texture which usually becomes somewhat lighter in color and coarser in texture with depth. Below 24 to 30 inches there is often a considerable proportion of coarse sand and some fine well rounded gravel. Litmus paper tests and the nature of the vegetation indicate an acid condition of both the soil and subsoil.

A quite common variation in this type occurs where the surface soil is a coarse sand. There are a number of such tracts in Marinette County, and the area south of Mountain, in Oconto County, is of this character. A texture slightly finer than that of the typical soil is another phase of the Plainfield sand. This is found in various parts of Marinette County. It is largely confined to regions where the surface is uneven and the material probably of wind-blown origin. Eskers containing large quantities of gravel are also found in Marinette County, but their total area is very small. Throughout northern Marinette County and in other localities where the underlying formation consists of crystalline rocks there are a number of rock

*For chemical composition and improvement see page 64.



VIEW SHOWING ROUGH, MORAINIC CHARACTER OF VILAS SAND AND VILAS STONY SAND.

These types of soil have a low agricultural value, and present conditions seldom favor their improvement.

VIEW SHOWING SURFACE FEATURES CHARACTERISTIC OF PLAINFIELD SAND.

The level surface is also typical of Plainfield fine sand, but as the sand type has a coarser texture it is not equal to the fine sand in producing power. Plainfield sand requires careful management.

outcrops and a few bowlders scattered through many of the areas of Plainfield sand, though the type as a whole is free from stones and bowlders. Where the underlying rock is sandstone there are no outcrops and very few bowlders.

The Plainfield sand is locally known by such terms as "sandy land," "Jack-pine land," or "sand plains."

Topography and drainage.—The surface of the Plainfield sand where typically developed is level to very gently undulating. In Marinette County there is more variation in the surface than elsewhere, and to the southeast of High Falls wind-formed dunes occur in such numbers as to impart a somewhat rolling surface. This same condition exists in other parts of the county, though to a smaller extent. Eskers and kames have been included with the type in a few instances, as none of these areas are more than a few acres in extent. On account of the loose open structure of the Plainfield sand the natural drainage is ample and very often excessive, so that field crops frequently suffer from lack of moisture.

Origin.—The Plainfield sand, where typically developed, consists of alluvial material which has been deposited as stream terraces, valley fill, or outwash plains. The greater portion of the material was doubtless deposited during the advance and retreat of the last ice sheet which covered this region. The few kames and eskers which occur were deposited beneath the ice sheet, while most of the other irregularities in the surface, such as the dunes, are due to the action of the wind. The gravel present in the subsoil and the bowlders which occur over small areas are largely composed of crystalline rocks. These with the Potsdam sandstone make up the underlying formation and the parent material came largely from these sources. In a few instances limestone is the underlying formation, but it has no appreciable influence on the soil.

Native vegetation.—The original timber consisted chiefly of Jack pine, which is the characteristic growth on this type, with some scrub oak and occasionally a little Norway and white pine. As an undergrowth the land is usually covered with sweet fern, blueberry bushes, and wild oat-grass.

Present agricultural development.—Only a small proportion of the Plainfield sand is under cultivation at present, but land is being cleared each year and new farms started. The type of agriculture most common consists of general farming, with potato growing and dairying as important branches. The chief crops grown are oats, rye, buckwheat, hay, potatoes, peas, beans, and corn. Average yields are low. Only a small quantity of corn is grown and most of it is cut for silage. The type is well adapted to truck crops. The rotation most

commonly followed consists of corn, potatoes, and oats or rye, followed by a hay crop, usually timothy and clover mixed. What manure is produced on the farm is most frequently applied to sod land to be plowed for potatoes or corn.

CHEMICAL COMPOSITION AND FERTILITY OF COLOMA, VILAS, AND PLAINFIELD SANDS

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and they therefore suffer from drought. Moreover, some sandy soils are lower in their supply of the chemical elements demanded by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams have fairly good water-holding capacity and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands, such as the Coloma, Vilas, and Plainfield sands are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain and that on small portions of soils mapped as sands a more detailed mapping would have shown fine sands. This is particularly true in the case of sands mapped as Plainfield sand in Marinette County which was surveyed several years before the remainder of this area was mapped. The discussion of the composition and agricultural value of fine sands will be found on page 57. With very unimportant exceptions, the soils mapped as Coloma, Vilas, and Plainfield sands in this area are of a very sandy character and profitable farming will be possible on them only when they are managed with unusual care and the crops to which they are best adapted are grown. The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparative-

ly slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorus in the surface 8 inches per acre averages between 1000 and 1100 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium in the surface 8 inches per acre is approximately 35,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1200 and 1400 pounds in the surface 8 inches per acre. When a sufficient supply of active organic matter is developed in these soils a considerable portion of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. The growth of a good crop of mammoth clover or soybeans through the use of mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. This crop should be plowed under as a green manuring crop. Ordinarily on these soils clover should be sown without a nurse crop. It should also be put in a little deeper than on heavier soils and the drill should be followed by a roller and finally the drag or corrugated roller should be used.

By the adoption of a rotation of crops including one year in four in which a legume crop is grown and the entire crop plowed under and the use of moderate amounts of commercial fertilizers containing phosphorus and potassium together with proper attention to cultivation to conserve moisture, fair crops can be grown during the remaining three years. When dairying or other line of stock farming is followed so that most of the crops grown aside from the green manuring crop are fed, the fertility of this land can be maintained. This will permit the growth of potatoes or other truck crops for direct sale on approximately one-eighth of the land on the farm.*

*Extensive experiments have been carried on on Plainfield sand near Sparta, information on which may be secured by writing to the Soils Department, of the Wisconsin Experiment Station.

CHAPTER VI

GROUP OF POORLY DRAINED SOILS

CLYDE LOAM

Extent and distribution.—The Clyde loam is one of the least important types in the area from the standpoint of acreage. It occupies 9.4 square miles and is confined to a portion of the area underlain by limestone. The type usually occurs in long narrow strips along stream courses, or in depressions where a marshy condition is approached.

Description.—The surface soil of the Clyde loam to an average depth of 12 inches consists of a very dark or black loam which contains a high percentage of organic matter. Frequently small areas occur which have a shallow covering of peat. The subsoil consists of a gray or bluish material of variable texture. The upper subsoil may be clay loam or a loam which becomes lighter in texture with depth, grading into a gritty and somewhat sandy loam at 18 to 24 inches. The deep subsoil is often mottled with yellow or reddish iron stains.

Topography and drainage.—The position of the Clyde loam is always low and it is naturally poorly drained. It is level to very gently sloping.

Origin.—The Clyde loam is partly alluvial and probably partly lacustrine in origin. On account of the calcareous nature of the subsoils of most of the upland types in this portion of the area and the leaching which has taken place, large quantities of lime carbonate have been carried into these low-lying places.

Native vegetation.—The original timber growth consisted chiefly of elm, ash, and soft maple, with some willow. All of the best timber has been removed, but there is still much willow and a number of larger trees of second quality.

*Present agricultural development.**—Only a very small proportion of the Clyde loam has been cleared and put under cultivation. In its present condition this type has a low value, but when drained and properly farmed its productivity will doubtless be equal to that of any other soil in the area.

*For chemical composition and improvement see page 68.

POYGAN FINE SANDY LOAM

Extent and distribution.—The Poygan fine sandy loam as mapped in the present survey is confined to one area of about 15 square miles in the extreme southeastern corner of Oconto County. It occurs in a belt about 2 miles wide bordering Green Bay and extends from the southeastern corner of the county northward for a distance of 8 miles.

Description.—The surface soil to an average depth of 8 inches consists of a dark gray or almost black fine sandy loam. The dark color is due to the content of organic matter, which is quite variable.

The subsoil consists of a light gray fine sand which extends to a depth of from 24 to 30 inches where a pinkish red clay is usually encountered. In some localities where drainage is the most defective the clay has a bluish color but the texture is the same. The depth to the clay is quite variable and sometimes is below the reach of the soil auger. In a few places the clay comes to within 12 to 16 inches of the surface.

Topography and drainage.—The surface of the Poygan fine sandy loam is low and very nearly level. There is only a very gentle slope toward Green Bay but this is usually sufficient to afford the necessary fall for open drainage ditches or tile drains. Owing to the level surface and its low position the natural drainage is deficient.

Origin.—The clay subsoil underlying the Poygan fine sandy loam is doubtless of lacustrine origin. The fine sand and fine sandy loam covering over the clay has probably been washed down from the higher lands adjoining and deposited over the clay. There is a very sandy low ridge running parallel with the shore about 1 mile inland and this appears to be an old beach line. The clay subsoil is highly calcareous, but the dark surface soil shows slight indication of acidity in places.

Native vegetation.—The original timber growth consisted chiefly of elm and ash, with a considerable growth of willow.

Present agricultural development.—Probably 50 per cent of this soil has been cleared and a number of farms are now in operation upon it. Fully half of the cleared portion is used for cutting wild hay. A number of open ditches have been constructed but a much more extensive drainage system must be installed before the type as a whole can be utilized for cultivated crops. Corn, oats, and hay are the chief cultivated crops grown. A small amount of buckwheat, some potatoes, and garden truck are also raised.

CHEMICAL COMPOSITION AND FERTILITY OF CLYDE LOAM AND POYGAN FINE SANDY LOAM

These two types of soil are well balanced in chemical composition. Both have a good supply of organic matter and as a rule both contain considerable lime carbonate at least in the subsoil. Their total content of the elements phosphorus and potassium is also nearly if not quite as large as that found in most upland soils of a good degree of fertility. As a result these soils are usually quite fertile and productive. They are relatively flat, however, and the presence of rather heavy subsoil for the most part renders drainage often unsatisfactory making the use of tile or open ditches necessary.

The organic matter found in these soils while usually of sufficient quantity, is not all of an active character and it is frequently found in the continued cropping of soils of this kind that while it still retains sufficient organic matter to give it a strong dark color, this material is rather inert and does not decompose readily. Furthermore, it is quite possible that it protects the rock grains of the soil from the decomposing action of the soil moisture so that the mineral elements phosphorus and potassium do not become available as readily as they otherwise would. When these soils begin to lose fertility as indicated by lessening yields and good drainage has already been provided the owner should determine whether they do not need a larger supply of active phosphorus and potassium as well as of active organic matter. The use especially of potash fertilizers on these soils is frequently very helpful. Frequently patches of from a few square rods to several acres are met on which some crops, especially corn, make very unsatisfactory growth and the use of potash fertilizers is often found to increase the yield on these patches to a very satisfactory point. Wood ashes can be used as a potash fertilizer as well as the standard forms.

PEAT

Peat is found in every county in the area and in tracts ranging in size from a few acres to over 25 square miles. The most extensive tract occurs along Peshtigo Brook, in northeastern Oconto County. Other large areas occur in the southeastern part of Marinette County and in Navarino Township, in Shawano County. In northern Forest County there is also considerable Peat.

The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw, fibrous condition, showing plainly the remains of vegetable

growth from which derived. This raw, fibrous material is of a brown color, but the more thoroughly decomposed it becomes the darker is the color. Small quantities of mineral matter may be incorporated with the organic matter, but when this becomes sufficient to change the texture appreciably, the material is classed as Muck. In the extensive areas of Peat little or no mineral matter is found, except about the margins, where there is frequently sufficient inorganic matter present to form Muck. In such places where the area of Muck was small it was included with the Peat. A number of the large areas mapped as Muck in an earlier survey of Marinette County would under the present classification be mapped as Peat.

The depth of Peat is variable and ranges from 10 inches to over 20 feet. In practically all of the swamps where the area is a square mile or more in extent the Peat is over 3 feet deep. In many of the smaller patches there is a margin of several rods where the underlying material can be reached at 12 to 20 inches, while in the center of the marsh it will be over 3 feet below the surface. In some of these places, however, the entire tract is shallow, but when the average depth is 18 inches or over it has been mapped as Peat.

The material underlying the Peat is variable, and ranges from sand to silt loam or clay loam. In general it may be stated that the texture of the underlying material is determined largely by the texture of the upland soil in the vicinity of the Peat areas. Throughout the areas of silt loam the underlying material is unusually heavy and of a light gray or bluish color. Throughout the sandy portions of the area Peat is underlain by a grayish or nearly white fine to medium sand, and in some instances there is considerable gravel mixed with the sand. One marshy area in northern Forest County was found to be underlain by a bed of marl. The surface of practically all of the Peat areas is level. Most of the Peat areas are wet for the greater part of the year and there is often a few inches of water over the surface in the spring, when most of the heavy rains occur. There are a large number of the Peat marshes which lie on a sufficient slope to enable them to be successfully drained. In fact, it seems very probable that far the greater proportion of the Peat in the area is so situated as to permit of drainage. Up to the present time, however, only a very small proportion of it has been reclaimed. About 2 miles west of Marinette a number of farmers have formed a drainage district, and have drained a large area of Peat with a deep canal. Aside from the above mentioned tract, only a few small tracts on individual farms have been drained and placed under cultivation.

The vegetation on the areas of Peat consists chiefly of tamarack, cedar, and spruce. On the shallow areas there is some ash and a little

soft maple. There are a number of marshes which at present either do not support any timber or have only a scattering growth of spruce or tamarack. In most of these places the original timber has been completely destroyed by fire, though there are a few marshes which it seems were always treeless. On some of the open marshes there is now a growth of coarse grass which is cut for hay or matting, though in the majority of cases the vegetation consists of sphagnum moss, cranberry bushes, and other moisture-loving plants.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT

Throughout the southeastern portion of the area, where limestone is the underlying rock formation and where the subsoils of the upland types are calcareous, Peat is seldom in an acid condition, or is only slightly acid, but in the region where the underlying formation consists of sandstone or crystalline rocks and the soils are made up entirely of noncalcareous material it is practically all very acid.

The chief difference between peat soils and upland soils, consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium; and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats of this region so far analyzed is .135 per cent. This means that in an acre of the soil to a depth of a foot there is approximately only 675 pounds or in 2 feet 1350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soils.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average .3 per cent of this element, while good upland clay loam soils average 2 per cent or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about .12 per cent and this only in the surface 8 inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and po-

tassium. Of course, these elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on the peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers, phosphorus, and potassium used on the peat land.

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

When thoroughly drained and properly managed with reference to fertilizers as above outlined, peat lands can be made to produce good crops of the kinds to which they are adapted. In the southeastern portion of this area where the temperature conditions are favorable these lands may be used for such crops as corn, potatoes, and sugar beets, as well as others not affected by light frost such as grasses for hay and small grains. In the northern portion where the altitude is greater and the liability to summer frost is greater, it will probably not be found practicable to use this land to any considerable extent except for the growing of grass for hay and crops not affected by frosts such as some of the root crops and small grains.

MUCK

The material mapped as Muck occurs in four of the six counties of the present survey, and while its extent is greater than that of several minor upland types, it is much less than that of the Peat. The greater proportion of the Muck is found in Marinette County, where it occupies over 175 square miles. The most extensive occurrence in this county is immediately to the south of the Wausaukee River and to the east of Lake Nocque Bay. In the southwestern corner of the county there is a tract of considerable size along Peshtigo Brook and in the southeastern portion a larger tract extends to the northeastern corner of Oconto County. Other tracts occur throughout Marinette, Oconto, Shawano, and Langlade Counties, chiefly as narrow belts of low land along streams rather than as extensive marshy areas.

Where most typically developed the Muck consists of black well decomposed organic matter with which there is incorporated an

appreciable amount of mineral matter. In Marinette County this material extends to a depth of from 3 to over 5 feet in a number of the larger tracts, but in the majority of areas, which are long and narrow, the depth is usually less than 3 feet. The material included as Muck is variable, and it includes a number of small tracts which in a detailed survey would be classed as Meadow and doubtless also a number of small tracts of Peat. The meadow consists of low wet land along streams where the texture of the soil is so variable as to make a textural classification impossible.

Throughout the southeastern portion of the survey, where the underlying rock is limestone, the soil is not sour. In the portion of the survey underlain by sandstone and crystalline rocks, where the soils are all non-calcareous, the Muck is very sour.

Where the Muck is deepest the timber growth consists of cedar and tamarack, with soft maple, ash, alder, elm, and some willow where it is shallow. Some of the low wet lands included with Muck are treeless and are called "hay marshes."

Only a few patches of Muck are under cultivation, but when drained thoroughly and properly managed it will produce profitable crops of corn, potatoes, cabbage, buckwheat, and timothy and alsike clover for hay. Small grains may also be successfully grown. Tame grass pastures can be developed on these Muck areas with proper care. Muck is rich in organic matter and nitrogen, but requires applications of potash and phosphorous in the form of commercial fertilizers to keep up the productiveness. Its need for potassium is not so great as that of the Peat. In other respects it is similar to Peat, for the discussion of which the reader is referred to page 68.

ROCK OUTCROP

There are a few local areas in the present survey where ledges of the underlying rock outcrop in sufficient numbers to make such areas practically worthless for agricultural purposes. Wherever outcrops of any important extent occur they have been indicated on the soil map by means of appropriate symbols.

The most extensive and numerous outcrops occur in a belt running from the northeast portion of Marinette County to the vicinity of Mountain in Oconto County, and these are associated with the Vilas fine sand and fine sandy loam types of soil more extensively than with any of the other soils of the area. Other ledges occur quite frequently in southwestern Shawano County and along the Wolf River in northern Shawano and eastern Langlade County. Practically all of the rock exposures are confined to the region where granitic rocks make up the underlying formation.

CHAPTER VII

GENERAL AGRICULTURE

Agricultural Development.—Agricultural operations were not well under way in this region until in the 70's, and farming could not be considered of very much importance until in the early 80's. By this time considerable timber had been removed from southern Marinette, Oconto, and southeastern Shawano Counties and substantial farming communities were established. The first homestead in Langlade County was taken up in 1875, and a settlement was made at Phlox in 1876 and 77. Lumbering operations were extensively carried on in the immediate vicinity of Antigo during the 80's and 90's, and farming followed rapidly upon the trail of the lumbermen.

Extensive and highly improved farming communities are now to be found in western and southern Langlade, southern and southeastern Shawano, southern and southeastern Oconto, and southern Marinette Counties. Between this condition and the extensive tracts of virgin forest and undeveloped cut-over lands throughout the northern portion of the area surveyed, all stages of agricultural development may be found.

At the present time the type of agriculture which is the most extensively practiced consists of general farming in conjunction with dairying, with hay and oats as important cash crops. In the newly developing communities potatoes are an important cash crop. A larger proportion of Shawano County is cleared and under cultivation than is the case with any of the other counties in the survey.

Chief Crops Grown.—The crops most extensively grown in this region in order of their respective acreage are hay, oats, corn, barley, potatoes, rye, wheat, and peas. Yields of from 2 to 2½ tons of timothy and clover are very common on the best soils of the area. Alfalfa can be successfully grown and the acreage is gradually increasing. Where the soils are in an acid condition liming is necessary and the soil should be inoculated.

Oats is grown more extensively than any other grain crop. The average yield per acre for 1909 for all kinds of soils was about 31 bushels. The yields on the light sandy soils, which are poorly adapted to oats, were very low, but on the soils as heavy as fine sandy loams or heavier, the yields were very satisfactory. Yields of 50 bushels per acre are very common.

Statistics show that corn is the third crop in importance from the standpoint of acreage. As dairying increases the number of silos also increases. This calls for an increased acreage of corn. Golden Glow, Wisconsin No. 12, and Wisconsin No. 8 are early dent varieties which are being grown successfully in addition to the native yellow dent corn of mixed breeding. Flint corn is also quite commonly grown. Throughout the southern portion of the area the dent varieties mentioned above will mature four years out of five.

Barley is the second small grain crop of importance. It is raised most extensively in Shawano, Oconto, and Langlade Counties, and during 1909 the total acreage in these three counties was over 15,000 acres, which produced an average yield of slightly over 25 bushels per acre. The yields on the light soils are low, but on the Antigo silt loam, rolling phase of the Superior fine sandy loam, and Miami fine sandy loam types yields of 35 bushels per acre are quite common.

Rye is grown to a limited extent. The average yield on all kinds of soils was about 15 bushels per acre.

Wheat is grown to a very limited extent and is confined chiefly to Shawano, Oconto, and Marinette Counties. In 1909 these three counties had a total acreage in wheat of about 7,000 acres, which gave an average yield of about 15 bushels per acre.

Potatoes are an important cash crop and one upon which many of the new settlers largely depend. The crop is grown on practically all of the soil types mapped. In the southern portion of the area where dairying is well developed, potatoes are grown more often on the lighter soils than on the heavy types, but in the northern and newer agricultural sections potatoes are grown on all types of soil. Yields of 200 and 250 bushels per acre are not uncommon for fields of 10 or 12 acres in extent.

Peas are grown both for seed and for canning purposes. In 1909 there were nearly 11,000 acres of peas grown to maturity in addition to a large acreage for canning purposes. Canning factories are located at Oconto, Oconto Falls, and Antigo.

Buckwheat is grown to a limited extent, but is confined chiefly to the light textured soils. Yields usually average from 15 to 18 bushels per acre.

While beans can be grown successfully and profitably on many of the soils within the region, the acreage devoted to this crop is limited. They are confined chiefly to the sandy types of soils.

The following table shows the total acreage and yields of the various general farm crops which are grown in each of the six counties included in this soil survey report.

Table Showing Approximate Acreage and Yields of Crops most Extensively Grown in Each of the Counties Surveyed. From U. S. Census, 1910.

		Florence	Forest	Langlade	Marinette	Oconto	Shawano
Approximate area in sq. mi.		498	1045	855	1413	1080	1135
Per cent of land under cultivation		2.6	.65	8.5	8.6	18.8	23.0
Hay & Forage	Acres	3468	2239	18891	23690	42034	41478
	Yield, tons	3089	2830	27807	31899	60019	63206
Corn	Acres	64	55	602	3597	7441	12575
	Yield, bushels	1824	968	24367	94913	23913	500719
Oats	Acres	1612	617	9554	13029	24975	35010
	Yield, bushels	45053	22010	325550	405503	752296	1049130
Barley	Acres	195	66	2597	1499	4016	9139
	Yield, bushels	4241	1702	70481	32019	83543	227886
Potatoes	Acres	379	483	1329	3689	3099	4061
	Yield, bushels	57898	62998	180970	439857	30400	506125
Wheat	Acres	54	10	193	893	2028	4171
	Yield, bushels	872	182	3382	15669	30907	73554
Rye	Acres	51	15	630	2487	4566	6667
	Yield, bushels	980	242	12699	43989	68274	99927
Peas (Dry)	Acres	20	23	1549	48	5640	3452
	Yield, bushels	369	340	27331	698	82231	48711

Special Crops.—There are a few special crops grown within the area, though intensive agriculture has not become highly developed. Sugar beets are grown successfully, though on a small scale. Ginseng is quite extensively grown in Langlade County.

In the vicinity of the larger towns there are small tracts devoted to the raising of special crops. Strawberries are probably grown more extensively than any of the other trucking crops, and very satisfactory results are obtained.

Cucumbers are grown in several localities, especially on the sandy soils. A number of salting stations are located within the area. Cabbage, lettuce, tomatoes, celery, and a number of other garden crops are grown in a limited way, chiefly for home use.

Fruit.—The apple is the most important fruit. Most of the orchards are confined to the southern portion of the area, and have been planted chiefly on the rolling Superior and Miami fine sandy loams. Throughout the region covered by these types nearly every farmer has a small apple orchard. Among the varieties most extensively grown are Wealthy, Duchess, Northwestern Greening, Red Astrakhan, Grimes Golden, Wolf River, Northern Spy, Early Harvester, Snow, and a number of varieties of crabs. Cherries, plums, pears, and grapes are grown to a very limited extent, but sufficient has been done with these fruits to indicate that they can at least be grown for home use.

Dairying.—Dairying is the most important branch of agriculture followed at the present time within the area, and the one which gives the greatest promise of extensive growth as the country develops. Pure bred sires are being used in building up the herds. In 1910 the value of the dairy products from this area amounted to $1,624,000, and at present the output doubtless amounts to over $2,000,000 annually. The greater proportion of the dairy output is sold in the form of cheese and butter. In 1913 there were 41 creameries and 116 cheese factories within the area.

Table Showing Importance of Dairy Industry in Each County in the Area Surveyed. From U. S. Census, 1910, and Wisconsin Dairy and Food Report, 1910.

	Florence	Forest	Langlade	Marinette	Oconto	Shawano
No. Dairy Cows	709	565	7215	8335	15709	24093
Milk produced—Gallons	189069	146716	1339382	1806906	4016478	8728344
Creameries 1910	0	0	6	2	12	18
Creameries 1913	0	1	7	5	12	16
Cheese Factories 1910	0	0	9	7	23	62
Cheese Factories 1913	0	0	10	5	33	68
Value of Dairy Products, excluding Home Use of Milk and Cream	$20,480	$19,331	$199,361	$235,987	$410,650	$738,188

The raising of beef cattle has not reached any extensive proportions in this portion of Wisconsin. Some of the lumbering interests, and also private individuals, owning large tracts of cut-over land buy up young cattle in the spring, allow them to graze until fall, and then sell them again either as feeders or frequently as grass finished cattle. Excellent pasture is afforded all through the cut-over regions on the heavier types of soil, and in addition to the profits derived from the increased weights of the cattle, this grazing also assists in the clearing of the land, which is a very important item.

In the older portions of the survey hogs are raised chiefly in conjunction with dairying. Sheep are raised, though not as extensively as hogs.

Relation of Soils and Crops.—The question of the adaptation of soils to crops has not been given as much consideration in this region as in many sections of the country which have been under cultivation for a longer time. There are a number of specific instances, however, which indicate an appreciation of the fact that certain crops and certain types of farming are better adapted to one type of soil than to another. It is generally recognized that rye will do better on sandy soils than will any of the other small grain crops. Greater success is obtained on the fine sandy loam and silt loam soils with the dairy industry than on the light sandy soils. Potato growing can be made more successful on lighter soils than can the growing of a number of other crops. Beans and buckwheat are crops which also give very fair results on the sandy types of soil.

Crop Rotations.—Various crop rotations are practiced within the area, but little careful study has been given to the selection of rotations which are best adapted to the varying conditions of the soil. In the southern part of the area on the silt loam and fine sandy loam soils, where considerable corn is raised, a rotation quite commonly followed consists of corn for one year, followed by oats or barley seeded to timothy and clover. Hay may be cut for one or two years, and the field then pastured for one or two years, after which it is again plowed for corn. On the sandy soils a rotation which is quite common consists of rye for one year followed by clover and then by potatoes, corn, or beans. Buckwheat may then be grown for one year.

It is desirable that fall plowing should be practiced on the heavier types of the area whenever this is possible. On the steepest slopes, where there is some danger of erosion, it would be advisable to plow in the spring. The light sandy soils may be plowed in the spring, since the moisture conditions will permit working such soils very early.

Barnyard manure is the only fertilizer extensively used in the area. Green manuring is not practiced to any extent, though there are a few farmers who frequently plow under a crop of clover or rye.

Weeds.—The most important weed pests within the survey are Canada thistle and quack grass. Wild mustard is also found growing extensively in a number of places. Immediate steps should be taken to eradicate such pests.

Land Clearing.—In developing new farms in this region the clearing of the land is the first operation with which the settler has to concern himself. In some parts of the area stones are plentiful, but the most stony portions of the farms are left for pasture. In clearing the usual method is to select a site which seems best suited for the location of the farm buildings, and start clearing from this point. All brush, logs, and stumps may be removed from a rather small tract so that cultivated crops can be readily grown, and then a larger area cleared of the brush and logs. The tract not stumped may be seeded and pastured, and the stumps gradually removed, or cultivated crops may be grown between the stumps. After a few years the hardwood stumps will decay and can be easily pulled or burned out. Stump pulling machines, dynamite, and fire are all used in clearing the land of stumps. In many places fires have run through the cut-over country and cleared away most of the underbrush and old logs, so that the cost of preparing the land for the plow is greatly reduced.

The following table shows the area of the different counties, the number and size of farms, and the percentage of improved land in each of the counties, together with the average value of farm property.

Table Showing Amount of Improved Land, Size of Farms, Increase in Value of Farm Property, etc. From U. S. Census, 1910.

	Florence	Forest	Langlade	Marinette	Oconto	Shawano
Approximate land area—acres	318080	896000	560000	905600	715520	741120
Per cent of land area in farms	9.2	3.1	23.0	24.0	39.8	51.4
Number of all farms	2741	237	1434	1919	2868	3549
Average size of farms—acres	106	119	90	114	99	107
Per cent of farm land improved	29.1	21.7	37.1	36.2	47.0	44.7
Average improved land per farm—acres	31	26	33	41	47	48
Improved land in farms 1910—acres	8491	6129	47788	79474	133961	170318
Improved land in farms 1900—acres	4312	1573	$31168	47126	91273	135322
Average value per acre of farm property 1910	$16.00	$21.08	$31.69	$23.67	$31.40	$35.05
Average value per acre of farm property 1900	$8.45	$10.72	$13.55	$13.33	$16.55	$17.27
Per cent of farms operated by owners	93.4	92.8	92.0	93.9	94.6	95.4

Land Values.—The value of land is variable, depending upon the character of the soils, the topography, location, amount of improvements, and the amount of timber. Some of the lightest sandy soils can be bought for as low as $4.00 per acre. The best grade of cut-over land frequently sells as high as $20 to $25 per acre, and most of the wild land without timber will have a value between these limits. Good hardwood timber land has a selling value of from $20 to $50 per acre, depending upon its location, the condition of the timber, and the ease with which it can be gotten out. In the regions where farming is well developed, land values are quite high—often $75 per acre and in some cases $100 or more per acre.

While the agriculture of the southern part of the area is well developed and the farmers, as a class, are in a prosperous condition, there are a number of ways by which the methods of farming might be improved and the returns from the farms increased. Suggestions along this line are given under the specific groups of soil to which they refer.

CHAPTER VIII

CLIMATE*

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

The distribution of 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.

The local distribution of rainfall varies, however, from year to year in different sections. 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.

The distribution of the rainfall during the year is just as important as its total amount. In this respect Wisconsin is unusually 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. 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. The small winter precipitation in Wisconsin, mostly in the form of snow, causes virtually no leaching of fertility from the soil or erosion.

The following table gives the mean precipitation at five points in the area and also at Menominee, Michigan, which is just across the Menominee River from Marinette, Wisconsin.

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*For further information see Wisconsin Expt. Sta. Bul. 223.

Mean Precipitation at Menominee (Michigan), Florence (Wisconsin), Crandon, Oconto, Shawano, and Koepenick

	Florence	Crandon	Menominee	Oconto	Shawano	Koepenick
Length of record	19 years	19 years	19 years	19 years	19 years	19 years
December	1.54	1.12	0.52	1.80	1.52	1.26
January	1.16	1.46	0.76	1.64	1.32	1.35
February	1.10	1.08	1.05	1.56	1.15	1.28
Winter	3.80	3.66	2.33	5.00	3.99	3.89
March	2.00	1.48	1.48	2.15	1.69	1.86
April	2.44	1.48	1.73	2.95	2.77	2.71
May	3.98	2.38	3.39	3.60	2.97	3.62
Spring	8.42	5.34	6.60	8.70	7.43	8.19
June	4.15	2.62	3.63	3.40	3.16	3.96
July	3.86	3.15	4.36	3.32	3.46	3.84
August	3.35	2.70	2.68	2.50	2.26	3.41
Summer	11.36	8.47	10.67	9.22	8.88	11.21
September	3.61	3.76	3.27	3.00	2.88	4.21
October	2.86	2.65	1.63	2.24	2.41	3.17
November	2.05	2.26	1.18	2.07	1.61	1.98
Fall	8.52	8.67	6.08	7.31	6.90	9.36
Annual	32.10	26.14	25.68	30.23	27.20	32.65

It will be seen from the above table that the mean annual precipitation of the area surveyed is 29 inches. The precipitation seems to be more effective in this region than the same rainfall would be a few hundred miles south. One reason for this is that the season is shorter, average temperatures are somewhat lower, and there is less moisture lost by evaporation.

A large proportion of the area surveyed lies within "The Northern Highland," which is recognized as one of the eight climatic provinces of Wisconsin. The portion of this region within the area has an elevation ranging from a few feet above the level of Lake Michigan to over 1000 feet above the level of the Great Lakes. It includes the head waters of the Wolf and Eau Claire Rivers, smaller tributaries of the Wisconsin River, and the courses of the Peshtigo, Oconto, Pine, and a number of other good sized streams. The northern portion of the area is characterized by a short growing season, cold winters, warm summer days, and cool summer nights. In the extreme north the growing season for corn and potatoes is about 100 days, but this gradually lengthens with the distance south and east, until in

the southern and southeastern portions of the area bordering Green Bay, there is an average growing season of about 150 days. As far inland as Shawano there is a growing season of over 130 days.

The following table gives the average dates of the last killing frost in the spring and the first in the fall, at various stations within the area and at Menomonee, Michigan.

Table Showing Frost Dates for North Eastern Wisconsin

Station	Length of record	Average date of		Elevation of station above sea level
		Last killing frost in spring	First killing frost in fall	
	Years			Feet
Florence	18	June 2	Sept. 13	1293
Crandon	12	June 3	Sept. 14	1060
Menomonee, Michigan	9	May 14	Oct. 6	.....
Oconto	19	May 10	Oct. 2	590
Shawano	13	May 14	Sept. 26	796
Koepenick	18	June 3	Sept. 17	1683

From this table it will be observed that the average date for the first killing frost in the fall at the different stations ranges from September 13 to October 6, and the average date for the last killing frost in the spring at the different stations ranges from May 10 to June 3. In the extreme northwestern part of the area summer frosts may occur, but these are seldom of sufficient severity to seriously injure growing crops. As the timber is cleared away, the land more thoroughly drained, and more of the land put under cultivation, the growing season will gradually lengthen.

While the growing season for corn, potatoes, and other crops affected by light frosts is relatively short in the extreme northern portion of this area, the growing season for the small grains, grass and root crops is more nearly equal to that in the southern part of the State. The spring is a little later, but grass and hardy vegetables grow nearly if not quite as late in the fall as they do in the southern part of the State. Fig. 2 shows the length of the growing season between frosts which would kill corn. Fig. 3 shows the average temperture for the six growing months, and forms a more accurate basis for comparing periods of growth throughout the State than Fig. 2 since many crops withstand considerable frost.

The climatic influence of Green Bay is confined to a belt of from 5 to 10 miles in width, immediately bordering the bay. The southeastern half of the area has a growing season which is practically the same as that in the southwestern portion of Wisconsin, including St. Croix, Pierce, Buffalo, Monroe, Richland, Iowa, and intervening

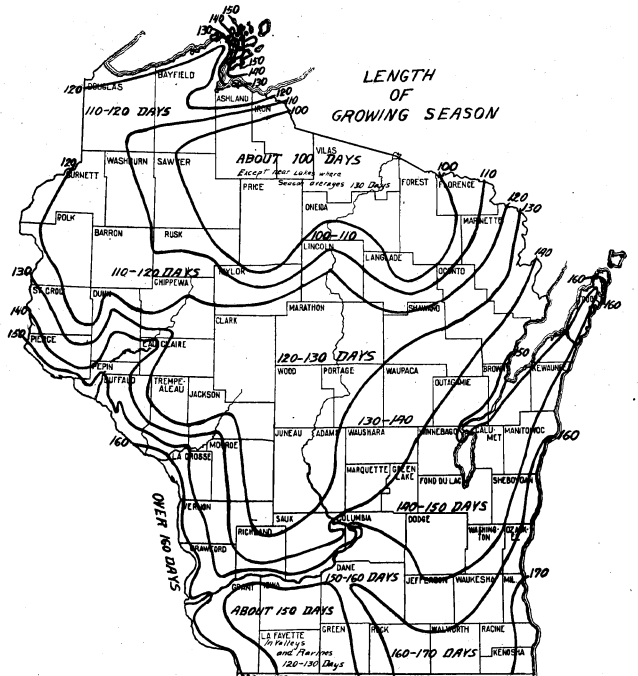

Fig. 2. Map showing length of growing season for corn.

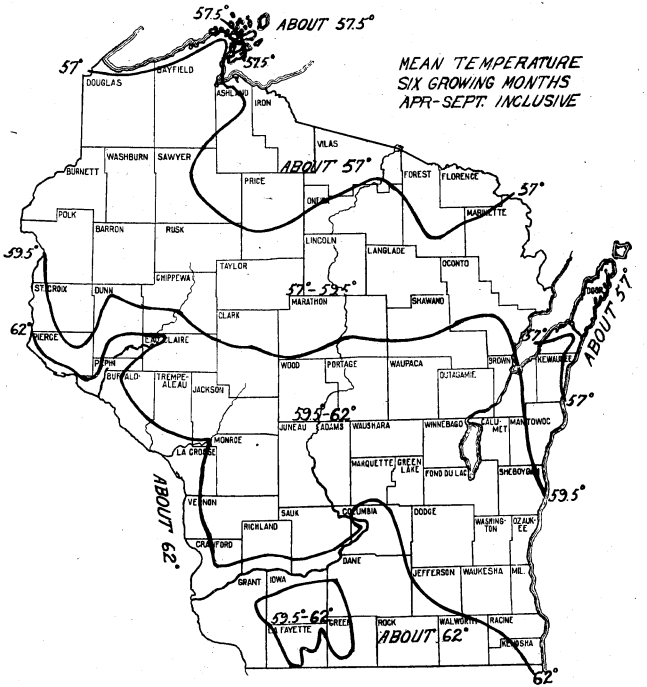

Fig. 3. Map showing average temperature for the six growing months April to September, inclusive. Note that the difference between the average temperature for the areas surveyed, and the southern portion of the State is only slight, varying from 2.5 to 5 degrees.

counties. The portion of the area immediately bordering Green Bay has about the same length of growing season as Fond du Lac, Winnebago, Dodge, and Calumet Counties.

The mean summer temperature ranges from 63.6° to 66.9° and the mean annual temperature for all the stations is 41.5°. There are about five days during the summer when the temperature rises above 90°, and it seldom gets as high as 100°, and there are also about five days during the winter when it falls lower than 20° below zero.

While the winters are long and severe, the summers are delightful, and all crops make a wonderfully rapid growth when spring opens. The delightful summer climate of this region, the excellent fishing in streams and lakes, the good water which can be readily secured in all parts of the area, the summer resorts on the lakes, and the hunting attract a considerable number of people to this region each year. These factors, together with the large areas of excellent unimproved agricultural land, are also instrumental in attracting large numbers of new settlers to this region.

SUMMARY

The area covered by the reconnoissance soil survey of northeastern Wisconsin includes six counties, Forest, Florence, Marinette, Oconto, Shawano, and Langlade, and embraces a total area of 6,098 square miles, or 3,902,720 acres, located in the extreme northeastern portion of the State. The surface features are characteristic of a glaciated region, and the topography varies from level to rough and broken. Elevations range from practically the Great Lakes level to over 1,000 feet above. The highest portion is the Northern Highlands, where many important rivers of the State rise. Some of these through their rapid descent within the area afford much potential water power. The earliest settlement of the area dates back to 1786, but industrial activities did not begin until about 1832, when the first lumber mill was started in Marinette. Lumbering was the most important industry for almost 50 years. Agricultural operations were not well under way until the seventies and farming could not be considered of much importance before the eighties, when the southeastern portion of the region surveyed was rapidly being settled and put under cultivation. Throughout the northern part of the area lumbering is still the most important industry, but agriculture is rapidly developing wherever the timber has been removed.

Three important railway systems traverse this region, providing excellent transportation facilities and connecting this section with some of the largest and most important markets of the Middle West.

The region covered by the present survey, in common with all of northern and eastern Wisconsin, owes the general character of its surface to glacial action. The glacial drift which covers this region has been derived largely from the underlying geologic formations, of which there are six, and all of these have contributed to a greater or less extent in the formation of the various soils. Ten soil series and 25 soil types, excluding Peat, Muck, and Rock outcrop, have been recognized and mapped in this survey. The material composing these soils has all been derived from glacial till, though some of it has been reworked and deposited by water and modified by the action of the wind or by the incorporation of organic matter since its first deposition.

The Miami series includes the light colored upland timbered soils in the glaciated limestone region, and two types were mapped. The

fine sandy loam and loam include some of the most highly improved farming land in the area.

The Fox series includes light colored timbered soils of alluvial origin which have been formed in the glaciated limestone region as glacial outwash plains, filled-in valleys, or stream terraces. Only the fine sandy loam type was mapped in this survey. It is inextensive, but usually found under cultivation.

The Coloma series includes light colored timbered noncalcareous upland soils in the glaciated region derived largely from Potsdam sandstone material. The soils are coarse in texture, and the three types recognized in this survey are not extensively utilized as yet, but are all capable of development. The amount of organic matter is small.

The Kennan series consists of light colored noncalcareous upland timbered glaciated soils where the material has been derived largely from crystalline rocks. The silt loam and fine sandy loam are the only types mapped as belonging to this series, but both of these cover extensive areas.

The Vilas series is similar to the Kennan, but is derived only in part from glacial crystalline rock material and in part from glaciated sandstone debris. No soils heavier than a sandy loam are included in this series. The types mapped are Vilas sandy loam, sand, stony sand, and fine sand.

The soils of the Antigo series consist of material derived from crystalline-rock formations, which were deposited late in the glacial period as terraces. Two types were recognized—the silt loam and fine sandy loam. The silt loam is one of the best soils in northern Wisconsin and mostly under cultivation. The fine sandy loam is not as yet utilized for farming.

The Plainfield series consists of light colored timbered noncalcareous soils of alluvial origin which have been formed as glacial outwash plains or stream terraces. The fine sand, sand, and sandy loam are mapped in this area. The soils are low in organic matter.

The Superior soils in this Survey consist chiefly of lacustrine material possibly modified by glacial action. The original heavy material having been overlain in places by light-textured deposits. The typical soils have a level surface and drainage is not thorough. The types mapped are Superior fine sandy loam and fine sand, and rolling phases of fine sandy loam, loam and clay loam.

The Colby series includes light colored timbered upland soils from the older drift material, derived largely from crystalline rocks. Only one type, the silt loam, was mapped.

The Poygan series is of lacustrine origin and resembles the Superior but the surface soil is dark colored. It is of limited extent, and only one type, of no great agricultural importance, the fine sandy loam, was mapped in this survey.

The Clyde soil mapped is the loam. This is high in organic matter, occupying old lake beds, drainage channels, and ponded valleys. It is partly alluvial and partly lacustrine in origin and is calcareous. It is inextensive and only a small proportion of it has been cleared and tilled.

Peat and Muck include areas of organic deposits in varying stages of decomposition. Much of the area covered by these soils can be drained and used to great advantage for farming. Peat and Muck cover one-sixth of the entire area surveyed.

Rock outcrop includes exposures of the underlying bedrock of such extent or so numerous as to preclude tillage. It covers large areas.

Within the region surveyed all stages of agricultural development are represented. The southeastern and southern portions are well settled and highly improved, with land values ranging from $50 to $100 an acre for the best improved farms, while the northern portion is largely in virgin forests of hardwoods. Cut-over land can be bought for $4 an acre and upward, depending upon the character of the soil and the location. The lightest sandy soil, originally covered with pine, has a low agricultural value, but the cut-over hardwood regions include much excellent land which offers exceptional opportunities for agricultural development. The chief crops grown at present are oats, hay, corn, potatoes, barley, rye, wheat, peas, sugar beets, buckwheat, and a number of trucking crops, the last being grown only to a limited extent. As reported in the census of 1910, Shawano County has 51.4 per cent of its entire area in farms, of which 44.7 per cent is in improved land. In Forest County only 3.1 per cent of the land is in farms, and of this only 21.7 per cent is improved. The other counties range between these two extremes in the extent of improvement. During the decade 1900 to 1910 the average value of farm property practically doubled. The type of farming chiefly followed at present consists of general farming in conjunction with dairying. There are 43 creameries and 116 cheese factories within the area, and the dairy industry is being gradually extended.

The winters of this region are long and cold, but the summers are delightful, and all crops make rapid growth. Excellent water is available in all parts of the area, and the region is a healthful one.

KEEP THE MAP

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

U. S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY
W. E. McLENDON, INSPECTOR NORTHERN DIVISION

SOIL MAP

WISCONSIN

RECONNOISSANCE SURVEY—NORTHEASTERN WISCONSIN 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)

Vilas stony sand — S / S
Coloma fine sand — Fs / Fs
Vilas sand — S / S
Coloma sandy loam — Fsl / Fsl / S
Vilas fine sand — Fs / Fs
Plainfield sandy loam — Sl / S
Vilas sandy loam — Sl / Sl / S & Gr
Plainfield sand — S / S
Kennan fine sandy loam — Fsl / Fsl / S & Gr
Plainfield fine sand — Fs / Fs / S
Kennan silt loam — Sil / Sicl
Poorly drained phase — Fs / Fs / Cs
Miami loam — L / Fsl / Sicl
Rolling phase — Sil / Sicl / Gr
Antigo fine sandy loam — Fsl / Fs / S
Miami fine sandy loam — Fsl / Fs / Sl
Antigo silt loam — Sil / Sicl / S & Gr
Poorly drained phase — Fsl / Sc
Superior fine sand — Fs / Fs
Colby silt loam — Sil / Sil / Sicl
Rolling phase
Superior fine sandy loam — Fsl / Fsl / C
Colby silt loam — Sil / Hail / Sicl
Fox fine sandy loam — L / C
Poorly drained phase — Fsl / Fsl / Fs
Rolling phase
Superior loam — Fsl / Fsl / Cl / C
Poygan fine sandy loam — Fsl / Fs / C
Rolling phase
Superior clay loam — Cl / C
Clyde loam — L / Cl
Rolling phase
Coloma sand — S / S

LEGEND

Fs —Fine sand
Cs —Coarse sand
S & Gr—Sand and gravel
Gr —Gravel
L —Loam
Sl —Sandy loam
Fsl —Fine sandy loam
Cl —Clay loam
Sil —Silt loam
Sicl —Silty clay loam
C —Clay
Sc —Sandy clay
Hsil —Heavy silt loam

LEGEND

Vilas stony sand — Vc
Coloma fine sand — Cf
Vilas sand — Vs
Coloma sandy loam — Cl
Vilas fine sand — Vf
Plainfield sandy loam — Psl
Vilas sandy loam — Vo
Plainfield sand — Ps
Kennan fine sandy loam — K
Plainfield fine sand — Pf
Kennan silt loam — Kl
Poorly drained phase — Pf
Rolling phase — Kl
Miami loam — Ma
Antigo fine sandy loam — Af
Miami fine sandy loam — Ms
Antigo silt loam — Al
Poorly drained phase — Ms
Superior fine sand — Sf
Colby silt loam — Cs
Rolling phase
Superior fine sandy loam — Ss
Colby silt loam — Cs
Rolling phase — Ss
Fox fine sandy loam — Fs
Superior loam — Sl
Poygan fine sandy loam — Pl
Rolling phase
Superior clay loam — Sc
Clyde loam — Cy
Rolling phase
Coloma sand — Cs
Muck — M
Peat — P

CONVENTIONAL SIGNS

CULTURE
(printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
Secondary roads and Trails
Railroads Steam and Electric
Bridges, Ferry
R. R. crossings, Tunnel
Ford, Dam
School or Church Cemeteries
Mine or Quarry Mine Dumps Made land
Bluff, Escarpment, Rock outcrop and Triangulation station
Stony and gravelly areas
Soil boundaries
Boundary lines
Boundary lines
Boundary lines
U. S. township and section lines

RELIEF
(printed in brown or black)

Contours Depression contours
Prominent Hills Mountain Peaks
Sand, Wash, and Sand dunes
Shore and Low-water line, Sandbar

DRAINAGE
(printed in blue)

Streams
Lakes, Ponds, Intermittent lakes
Intermittent streams
Springs, Canals and Ditches, Flumes
Swamp Salt marshes
Submerged Marsh Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Soils surveyed by W. J. Geib, A. L. Buser, Carl C. Thompson and Clinton B. Post of the Wisconsin Geological and Natural History Survey and L. R. Schoenmann and Arthur E. Taylor of the U. S. Department of Agriculture.

Scale 1 inch = 3 miles

J. Bien & Co. Lith. Rubbercoat. N.Y.