WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE
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SOIL SURVEY

OF

NORTHERN WISCONSIN

BY

A. R. WHITSON, T. J. DUNNEWALD AND CARL THOMPSON

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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Additional copies of this report may be secured free by asking for Bulletin 306 of the Agricultural Experiment Station of the University of Wisconsin. With each report a soil map of any one of the northern counties will be included upon request.

Those wishing to secure a general soil map of the entire northern half of Wisconsin may do so by writing to the Superintendent of Public Property, State Capitol, Madison, Wisconsin, enclosing twenty-five cents.

The Soils of Upper Wisconsin

One hundred thousand farms of 80 acres each are waiting the farmer in upper Wisconsin. This land has a good soil, has an abundant rainfall, is close to the railroads, and has access to large markets.

Nearly one half of the 18,500,000 acres in upper Wisconsin is already occupied in farms in all stages of development—there is left more than 8,500,000 acres of good farm land, as well as 2,000,000 acres suitable only for pasture and forestry purposes.

Upper Wisconsin appeals to the business farmer. The value of the crops produced per acre of improved land in upper Wisconsin is higher than in the southern Wisconsin counties or the average Illinois, Iowa, or Ohio country. Here is the proof taken from the government figures:

In Marathon county according to the U. S. census, the average value per acre of improved land of all crops produced in 1909 was $15.00. In Dodge and Fond du Lac counties, which are two of the richest counties in the southern part of the state, the average value was $14.00 per acre, and in Dane county $15.00 per acre. In the state of Illinois for the same year the average production per acre was $13.00, in Iowa $11.00, in Ohio $12.00 and in Wisconsin $12.00.

Just to see what is being done in developing upper Wisconsin notice the figures taken from the census figures for three periods, 1890, 1900, and 1910. Three of the typical counties in the northern section of the state are shown. These counties have been settled during the past 30 years and are similar in their general character to the lands yet to be developed. Here are the figures:

Development of Typical Counties in Wisconsin

County	Year	Number of all farms	Acres of farm land improved	Value of all farm crops	Value of all dairy products
Clark	1890	2,086	71,700	.....	.....
	1900	3,456	120,964	$1,304,210	$305,484
	1910	4,196	151,891	2,151,733	1,171,341
Marathon	1890	2,789	83,863	.....	.....
	1900	4,276	145,060	1,713,544	282,272
	1910	5,080	184,153	2,758,318	883,816
Barron	1890	1,859	64,618	.....	.....
	1900	3,004	117,407	1,056,385	196,012
	1910	3,852	170,208	2,156,442	792,647

It will be seen that the land in farms in these counties has about doubled in the twenty year period, that the value of all farm crops has increased about four times in Clark and Marathon counties and more than five times in Barron county in twenty years. The increase in dairy products is even more remarkable. In all of these

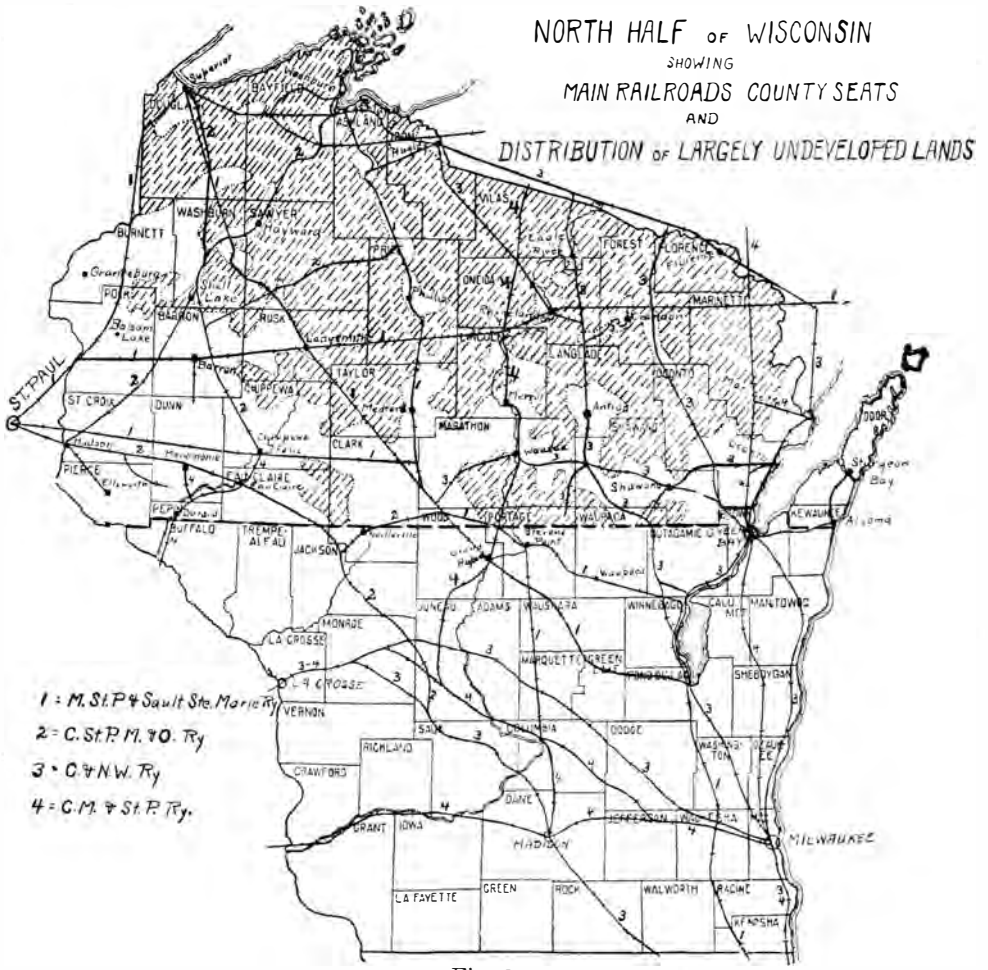

Fig. 1

counties the value of dairy products was more than trebled in the ten year period 1900–1910.

There are many different kinds of soils in this part of the state. They vary from heavy clays to light sands. There are considerable areas of level lands although for the most part the country is rolling and in some sections it is very rough and broken. Most of the soils

have good natural drainage but some have poor underdrainage and there are considerable areas of marshes. The soils also vary in the amount of vegetable matter or humus they contain.

It is the purpose of this report to describe all of these different kinds of soils and the purpose of the map is to show where the soils are located.

CHAPTER I.

CLIMATE OF UPPER WISCONSIN

The climate of the country, together with its soil, determine the crops which can be grown. By climate we mean the amount and distribution of the rainfall and the temperature.

RAINFALL

In regard to rainfall, both the total amount and the way it is distributed through the growing season must be considered. As an average of the past nineteen years, the total rainfall for the year in northern Wisconsin is just a little under 30 inches. Of this about 21 inches comes during the six months from April 1st to October 1st and the average by months is as follows:

April	2¼ inches
May	3½ inches
June and July	4¼ inches, each
August	3¼ inches
September	3½ inches

It will be seen that the heaviest rainfall comes during midsummer when crops are making their most rapid growth and require the most moisture.

There is of course considerable variation in the distribution of rainfall during the season from year to year and also in the total amount from year to year. Dry spells of two to four weeks in length occur occasionally and at any time of the year, but northern Wisconsin suffers less from such dry periods than most other portions of the country. These dry periods of course affect crops growing on the very lightest soils more than on heavier soils and yet it must be borne in mind that a moderate rainfall of ¼ to ½ inch, coming during a dry period, is more helpful on light soils than on heavier soils because it reaches to a greater depth, and a larger portion of it is available to crops. As a rule, therefore, it is only on the very lightest sandy soil that crops suffer much from drought.

The relative freedom of this section of the country from the hot

dry southwest winds which occur in the country farther south also means less loss from drought and the more effective use of the rainfall. The amount and distribution of the moisture is adapted not only to the growth of grain and cultivated crops, but is such as to secure exceptional pasturage and in the great majority of years a good second growth of clover.

There is no other section in the country in which the distribution of rainfall is better adapted to agriculture than in northern Wisconsin. There is less rain in the spring when the ground is to be seeded for crops than in the eastern states and there is more rain when needed by the growing crops in the summer than in the western states.

TEMPERATURE

The temperature of a country more completely controls the crops which can be grown than anything else. Each crop has its particular needs in regard to temperature. The temperature of northern Wisconsin is characterized by cold winters with clear dry atmosphere, and summers of moderately cool but quite uniform temperature. This climate is particularly adapted to the growing of small grains and of grass for pasture and hay. The cool temperatures of the spring months are extremely favorable to the germination and stooling of the small grains and the cool moderately moist atmosphere of the remainder of the season causes them to fill well and yield headily when the soil is properly tilled and its fertility maintained.

The temperature conditions are also very favorable to root crops. Sugar beets yield a very high percentage of sugar and rutabagas make exceptional growth during the fall period. The quality of potatoes is the very best. The climate is also well adapted to cabbage and celery.

CORN IN UPPER WISCONSIN

The temperature conditions of northern Wisconsin are not so favorable for corn as for small grains. Early varieties of corn require about 100 days to ripen. The line having an average of 130 days without killing frost, running thru Polk, southern Chippewa and Lincoln and central Marinette counties, marks the northern limit of the section in which early corn will be uninjured by frost, four out of five years. North of this line the risk of injury by frost becomes greater, but during fully half the seasons corn will reach a good silage state. Local conditions such as the character of the soil and the lay of the land have an important influence on possibility of maturing this crop. In the same location and situation corn will mature in from ten days to two

weeks less time on sandy soils than on heavy silt loam soils, which amounts to the same thing as lengthening the season free from frost by that number of days.

The hilltops and upper slopes, because of the smaller liability of frosts occurring in these situations, act similarly to lengthen the growing season locally.

FROSTS

The influence of local conditions on the occurrence of light summer frosts must be considered. Low land soil which is wet and cold is more liable to frost than dry land. Peat soils which are loose and do not let the heat penetrate the body of the soils, lose their temperature more rapidly at night and are therefore in danger of frost more than earthy soils. The tops and upper slopes of hills are much less liable to the occurrence of these frosts because there is opportunity for the cold air to drain down the slope and away from the crop. Corn and other tender crops can, therefore, be grown on upper hillsides and hilltops with much less danger than on lower ground. The influence of the large lakes on temperature is also considerable. The cool air from Lake Superior in particular makes that section less well adapted to corn than the country fifteen to twenty-five miles away from the lake. The temperature effect of the lake is intensified by the heavy clay soils of that section, while on the other hand, these very conditions make that section especially adapted to the small grains, grasses and many of the hardier vegetables.

THE GROWING SEASON

The average length of time between killing frost in the spring and in the fall is shown on the accompanying map. This map shows the number of days on the average year during which corn or other tender crops will grow. It should be remembered, however, that there would be too much risk taken if one were to grow varieties of corn which would require the number of days indicated on the map to ripen, since that would mean that these varieties would be killed on an average every other year. If we assume that we can take the risk of a frost killing corn one year out of five, then the length of growing season would be about thirty days less than indicated on the map.

Long Season For Pasture and Most Crops. The light frosts in the spring and fall which are sufficient to kill corn or other tender crops do not interfere seriously with the growth of grass for pasturage or hay or of small grains or hardier root crops and vegetables. For the

growth of these crops the season is of course much longer than for corn.

Good pasturage begins in northern Wisconsin about the middle of May. This is nearly two weeks later than the beginning of pasturage

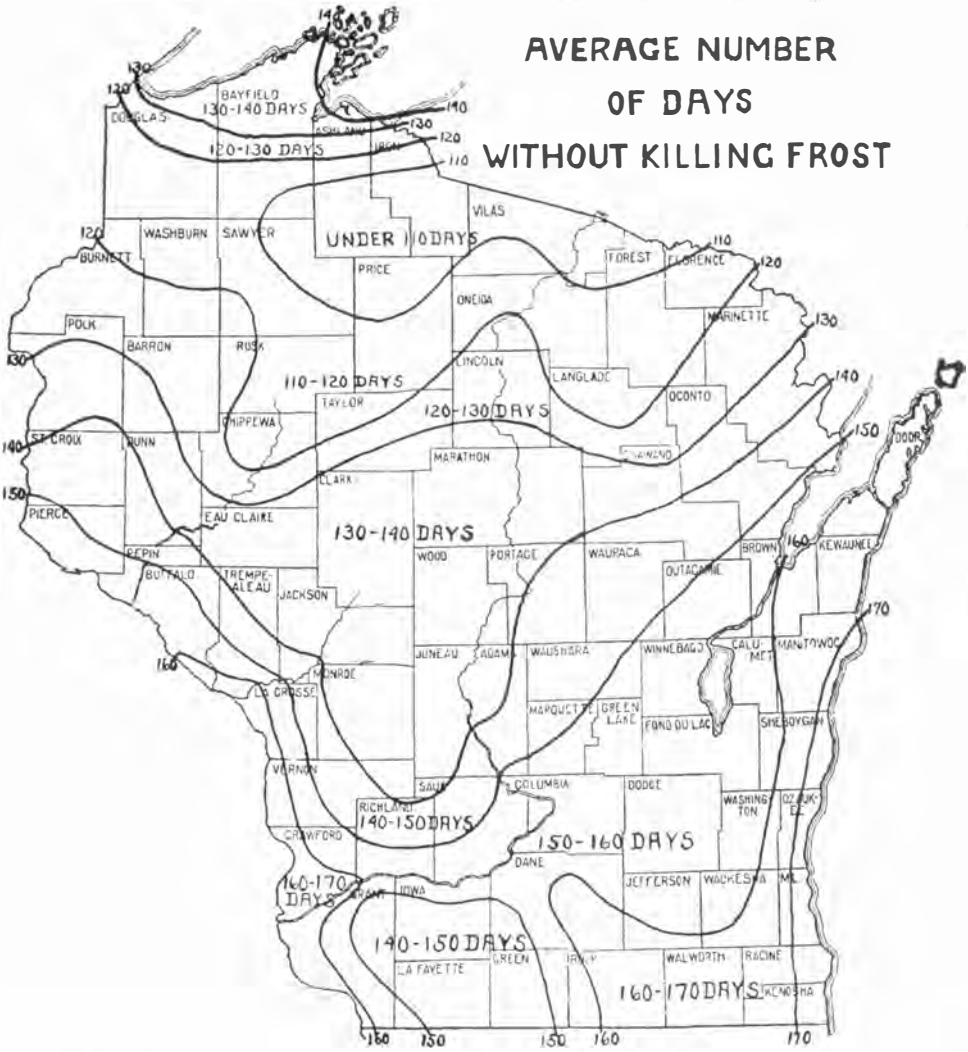

Fig. 2.

in southern Wisconsin, southern Minnesota, or northern Iowa. But the shortage of pasture due to drought in northern Wisconsin is so much less on the average than in the southern part of the state, during the early fall especially, that the total pasture season is probably nearly or quite equal to that in the southern section and certainly

much longer than that in the prairie sections to the southwest. The amount of feed necessary to carry the stock through the winter and dry periods is therefore not greater in northern Wisconsin than in other sections of the state and adjoining states, which have already become the chief dairy sections of America. Corn for silage must to some extent be replaced by hardy root crops.

CHAPTER II.

KEEPING UP FERTILITY

Farmers starting on new land should make an effort to keep up and increase the fertility of the soil from the beginning rather than to let it run down for several years until the crop yields are small and more expensive methods are necessary to build up the fertility again. In order to maintain the fertility of the soil it is necessary to keep a supply of organic or vegetable matter in it which by its decomposition will furnish growing crops with nitrogen and cause chemical changes in the soil by which other elements become available to growing plants. This organic or vegetable matter may be either stable manure or green manure such as clover, or other crops, or straw and stubble left from the growing of grains. Legumes such as clover, soybeans, etc., are the best for green manuring purposes and also most helpful in keeping up the nitrogen supply of the soil, when fed to stock, because of the fact that they are higher in nitrogen than other crops and secure this element from the air so that growing them adds to the quantity of nitrogen in the soil on the farm, whereas the growing of other crops tends to reduce the quantity of nitrogen. The growing of legumes therefore is important in any system of farming unless a large amount of expensive fertilizers containing nitrogen are bought, which under northern Wisconsin conditions is unprofitable.

Other important elements of plant food are phosphorus potassium and calcium or lime. Phosphorus exists in very small amounts in all soils and is used by every growing plant. It accumulates largely in the seeds of plants as they ripen and so after grain is sold there is considerable loss of phosphorus and even if the grain is fed and milk or the entire animal sold the phosphorus is taken away in the milk or bones of the animals. While there is enough phosphorus in most soils to last a good many years, without purchasing a new supply in fertilizers, still yields will not be so large and will gradually decrease unless new supplies of phosphorus are secured. There are, however, enormous stores of phosphates which are being mined and these together with bones of animals from the slaughter houses are available for keeping up and increasing the phosphorus content of

the soil. The best yields of the best grades of grain and other crops can only be secured by keeping up the supply of this element.

Potassium exists in large amounts in all earthy soils but occurs in small amounts in such soils as peat and muck which are largely made up of vegetable matter. The potassium in clay and silt or earthy soils becomes available through the action of decomposing organic or vegetable matter and this action is one of the most important reasons for keeping up the organic matter of the soil. Some crops need much more potassium than others. Potatoes, cabbage and root crops use large amounts and it is frequently desirable to use potassium fertilizer to increase the yields of these crops. Marsh soils are low in potassium and potash fertilizers should be used on them.

Calcium, the chief element in lime, is needed by all crops though some use more of it than others. Alfalfa, clover, peas and beets are among those using the largest amounts. Lime containing calcium is lost by leaching, as well as by removal by crops and hence best yields especially of crops using considerable amounts of lime are only possible over a long period of years when lime is returned to the soil. Limestone rocks which need only to be crushed and ground occur in southern and western Wisconsin and the application of a ton of lime to the acre every four to six years will greatly improve the fertility of the farm at a small expense.

Live Stock Raising Compared with Crop Selling. It is quite often stated that the keeping of live stock is necessary in order to keep up the fertility of the soil of a farm. This is not true. It is just as easy to keep up the fertility by using green manuring crops and commercial fertilizers as by using stable manure. There is, however a large opportunity to use the time during the winter in the care of stock and secure some profit by feeding the crops grown and farmers who have means to purchase stock and who can feed profitably should certainly do so. A large amount of excellent pasturage can also be secured on new land in the process of clearing which would otherwise be wasted.

It is in fact chiefly because land can be used in pasture in this condition that land in the cut-over sections is cheap in comparison with fully developed land elsewhere.

FIG. 3.—A FARM IN THE EARLY STAGES OF DEVELOPMENT

Note the small cultivated acreage, the stump land pasture and the timber in the background.

CHAPTER III.

KINDS OF SOIL

There are a great many different kinds of soil, probably a hundred different kinds could be distinguished in the State of Wisconsin.

On this map, however, we have grouped these into ten classes, but most of these classes are subdivided into two or three phases, to take account of differences in the lay of the land, or topography, and other characteristics. The grouping into the ten classes is chiefly made on the basis of the fineness of grain of the soil. This is generally called its texture. This quality of the soil is most important because it is the chief thing which determines the kinds of crops to which the soil is adapted. Sandy soils, for instance, will grow fair crops of a few kinds, such as rye, mammoth clover, and corn, if their fertility is kept up, but they will not grow good pasture grasses because they do not hold enough moisture. On the other hand, silt loam soils or heavy clay soils will carry excellent pasture grasses and are well adapted to small grains, but are not adapted to potatoes, soy beans, and some other crops; while heavy sandy loam soils will hold enough moisture to grow good grass and small grains, but are also light enough to be well adapted to potatoes, corn, clover, and other crops which do not grow well on the heaviest soils.

On account of the importance of the fineness of grain, or texture of the soil, this is made the chief basis of classification. The particles or grains which go to make up any soil can be separated into three grades or sizes,—first, sand; second, silt; and third, clay. Sandy soils have large amounts of sand with very small amounts of silt and clay. Light sandy loam soils have somewhat less sand and more silt and clay than the sands. The heavy sandy loams have less sand than the light sandy loams and more silt and clay. Silt loam soils have very large amounts of silt with a relatively small amount of sand and some clay; while in clay soils there is a large amount of clay, some silt, and relatively little sand. To which of these classes a soil belongs is determined by a mechanical analysis in the laboratory.

In addition to the texture of the surface soil, it is necessary to take into consideration the character of the subsoil because this influences

the drainage of the soil. Whether there is lime in the soil or not makes a difference which is also shown on the map.

Taking these matters into consideration with the texture we have the soils subdivided into the sands, fine sandy loams, heavy sandy loams, silt loams with well drained subsoil, silt loams with heavy subsoil, silt loams on limestone, and heavy red clay. Each of these classes is subdivided into two or three phases depending on the lay of the land, or topography, there being a level phase of sandy soil, and an undulating to rolling phase, and so on with the other classes.

In addition to these classes, the map shows poorly drained soils subdivided into (1), those which are rather sandy; (2), those which are heavier, as sandy loams and silt loams; and (3), peat and muck. The rough, or very stony land has two groups; (1), those which are too sandy to support grass for pasture; and (2), the heavier soils which would be well adapted to pasture.

HOW THE MAP WAS MADE

The men who made the soil map went over all of the roads, and where the roads are a good way apart they went over every other section line. In this way they saw a part of every section, but they did not see every quarter section. There are, therefore, a great many pieces of land, some as large as half a section in extent which may not be exactly as represented on the map. This must be borne in mind in using the map. But the map does show the location of all large areas of the different kinds of soil; so that it is comparatively easy for anyone with a map in hand to decide where he should go to look for soils of the kind he wants.

In mapping the soils the men used augers welded to steel rods so that they could bore into the soil and subsoil and determine its nature.

It is impossible to show the degree of stoniness on the map as that varies within very short distances. On some patches the stones are too thick to make clearing practicable. Some of these patches are as large as 40 acres in extent.

It is therefore very important for anyone in examining the piece of land he is thinking of buying to go over it carefully to see just what the lay of the land is, the amount of stoniness, and the thickness of the stumps.

The following pages describe these different classes of soils, and give general information in regard to the other matters above mentioned.

RELATION OF SOIL TO LINE OF FARMING

Each different kind of soil is adapted to some crops and some lines of farming better than to others and as far as possible the crops best adapted should be grown. It is only when working with Nature that we can expect the best results.

One looking for land should first decide the kind of farming he wants to engage in. If he decides to make stock raising the chief line, whether as dairying or for beef or mutton, he should select land which will best grow the crops he wishes to feed. He should also as a rule, at least in the northern part of Wisconsin, select land which will give good pasture. This means that the land should be not lighter than heavy sandy loam. If he wishes to grow wheat, barley or oats to a considerable extent for sale, he will find silt loam, clay loams, and clay the best soils for his purpose. If potatoes is to be the chief cash crop then he should select a light sandy loam or a heavy sandy loam. The heavy sandy loam soil is adapted to the largest variety of crops and lines of farming. With the large variety of soils in Wisconsin, good locations for any important line of farming to which the climate is adapted can be found. These relations between the soil and crops and lines of farming are fully pointed out in the description of each class of soil in the following pages.

CHAPTER IV.

SANDS

The sand soils of upper Wisconsin have been put into two classes: i. e., those which are level or nearly so, and those which range from just a little rolling, or undulating, to rolling. The roughest sand soils which are better suited to forestry than farming are classed with ROUGH AND VERY STONY LAND on the map.

A large part of the sand soils shown in Burnett and Douglas counties are finer than the average of the Sands, and have therefore, somewhat higher value than the average of sands in other portions of the northern part of the state.

The original timber on the sands was largely Jack and Norway pine with a small amount of White pine. The growth of timber, however, was comparatively light and since practically all the timber of value has been removed, there remains only a scattering growth of smaller Jack and Norway pine, with which is mixed some Black oak, poplar, birch and cherry.

THE VALUE OF SAND SOILS

Sand soils have less producing power than heavier soils, first, because of the fact that they do not hold moisture as well and so are somewhat more subject to drought, and second, because they contain less plant food as shown by chemical analysis.

The fact that sandy soils hold less water from rains makes it possible to work them immediately after it stops raining; so that much time can be used in cultivation and other field work on sandy land which cannot be so used on clay soils. Moreover, light rainfalls which are not sufficient to wet heavy soils down far enough to reach the roots of crops do penetrate the sandy soils far enough to be of great help to growing crops. This is a decided advantage possessed by sandy soils. Moreover, this same tendency to dry out more readily than heavy soils permits them to warm up much more quickly in the spring; so that crops can often be planted a good many days earlier on sandy soils than on heavy soil. This is especially true in regard to corn in the northern part of the state and it often happens that

corn is planted enough earlier on sandy soils to mature before frosts; when on heavy this would be impossible.

While these soils will probably never have the selling value of heavier land, they still have considerable possibilities for agricultural use. When properly managed, fair crops of clover, rye, soy beans and corn can be grown on these sandy soils. With good management the yields of these crops on sand soils can readily be made to average two-thirds the yields of the same crops on heavy soil, and considering the small capital invested and the lower cost in operation, fair profits are possible on these soils. But it must be remembered that clover, soy beans, or other legume crops which have the power of fixing nitrogen from the air must be grown right from the start. If rye, corn, potatoes, and other crops are grown for several years after breaking without legumes, the land quickly becomes run down so that much more expense is involved in building it up.

These soils do not support good pasture grasses; so that corn or other fodder must be used in the summer during dry periods. Again, this land does not as a rule maintain a sufficient degree of fertility to warrant the growing of potatoes for sale. A system of farming including a rotation of rye, clover and corn, and the keeping of as many dairy cows or other stock as can readily be fed, is the best general plan for farming on these soils.

Handling and Fertilizing Sand Soils. Somewhat different practice in regard to plowing and seeding than that usually used on heavy soils is called for. Seed should be placed more deeply on sandy soils, and the use of a roller, especially one of the corrugated type, is very beneficial in giving a greater degree of firmness to the seed bed. The use of some ground limestone to neutralize acidity and of small amounts of commercial fertilizer, especially those containing phosphorus, will help greatly to build up the producing power of these soils.

Two Kinds of Sand Soils. While the level sands have been separated on the map from those which are undulating to rolling, the difference between these, as far as their value and use in farming is concerned is not great. The **level sand soils** are more easily farmed than the rolling lands, and when they have the same degree of fineness, will retain water somewhat better. Occasionally, two or three feet below the surface the sand becomes much coarser or is even a fine gravel, and this, of course, greatly reduces its value. One should examine the subsoil of these lands to determine whether this coarse material is found in the subsoil or not. On the other hand, even a thin layer of silty or clayey material in the subsoil helps to hold the water. These areas of sandy soils occur especially in the valleys where they were deposited by running water.

The **undulating** to **rolling sand soils** vary greatly in roughness. Some have gentle slopes so that farm machinery can be used about as easily as on the level sands, but some areas are quite rough. Where these occur in large tracts they are shown on the map as the **rough lands,** but when they are in small areas of forty to eighty acres along with more gently rolling or level sands, they have not been separated. These rolling sandy soils vary in degree of fineness more than do the level sands, and seldom become much coarser in the subsoil. But they are sometimes rather stony while the level sands are practically free from stone.

FIG. 4.—THE SECOND STAGE IN THE DEVELOPMENT OF A FARM IN NORTHERN WISCONSIN

Part "brushed" stump land pasture, part cultivated, a profitable combination.

CHAPTER V.

LIGHT SANDY LOAMS

These soils, while still quite sandy, are finer and hold moisture better than those classified as sands. They also have somewhat more fertility. One must note the texture or degree of fineness carefully to appreciate the difference in these soils, because relatively small differences in degree of fineness are important.

LEVEL AND UNDULATING LIGHT SANDY LOAMS

While the map shows the level and undulating portions of the light sandy loams separately the difference between these, so far as their value and use in farming is concerned, is not great. The level phase is usually quite free from stones and is apt to get a little coarser in the subsoil than is the case with the undulating phase. The latter, in some sections, is more or less stony. On account of the relatively little difference between the level and undulating phase they will be discussed together.

Considerable variations in the texture of these light sandy loams occur within short distances. Often the quality of the soil on one forty-acre tract is distinctly better than that on the adjoining forty acres. Some variations occur in the general character of these soils in different parts of upper Wisconsin. In the Chippewa River valley in Rusk county, the soil is quite variable, being more sandy near the small tributary streams and heavier farther back. In the southern half of Oconto county there is considerable limestone gravel which improves the character of these soils. In parts of Langlade, Forest, Pierce, and Barron counties, these soils are apt to be more stony on the more hilly portions.

The light sandy loams originally supported somewhat heavier timber than the sands described on the preceding pages and a larger portion of it consisted of Norway and White pine. There is also a small amount of basswood, hemlock, oak and birch. The second growth which now covers most of this land consists of oak, poplar, white birch, and pine from ten to thirty feet in height. The supply of firewood is, therefore, generally sufficient on this

class of lands to meet the needs of settlers for some time. The labor involved in clearing is moderate, on account of the comparatively light growth of timber in general, but is of course somewhat larger than on the sands.

VALUE AND USE OF LIGHT SANDY LOAMS

These soils have a distinctly higher value than sands. The staple crops should be rye, clover, corn and soybeans. These soils, however, will grow good crops of potatoes when the fertility is maintained and many other special crops can be grown. This soil is not sufficiently heavy to support good pasture grass and other forage should be grown to supplement pasturage in the summer.

While these soils are not especially adapted to stock raising or dairying, a moderate amount of stock can be kept on new farms where some pasturage is available in land not well enough cleared to be broken or cultivated.

KEEPING UP FERTILITY

Manure is of great assistance in keeping up the fertility of the soil, but it must be remembered that when heavy crops, such as potatoes and root crops, are sold from the farm, the use of some fertilizer in addition to stable manure is desirable.

Most of these soils, in common with soils of the northern half of the state generally, are somewhat acid and crops needing large amounts of lime, such as alfalfa, soybeans, and mammoth clover will require its use in order to secure good yields. Clover usually does well on these lands for several years without liming, but will in all probability be benefited by the use of moderate amounts of lime after a few years of croping. Plowing under a second crop of clover, or still better, the growing of a crop of soybeans or other legumes to be plowed under entirely as a green manuring crop in addition to the growing of clover for hay, is very helpful in building up the organic matter of the soil. This practice has been found to pay for itself in the increased yields of potatoes and other crops. Moderate amounts of phosphate fertilizers will prove profitable, although they are not necessary to secure fair yields for the first few years.

CHAPTER VI.

HEAVY SANDY LOAMS

The most common class of soils through upper Wisconsin is the heavy sandy loams. These soils are among the most valuable farm lands in this part of the state. They are intermediate in texture being sufficiently heavy to carry good pasture grass, and yet have a sufficient amount of sand and gravel in their composition to give them good under drainage; so that they warm up more readily in the spring than do heavier soils. Crops growing on them have a distinctly longer growing season than on heavier soils which is of great importance in the latitude having a relatively short growing season. Their adaptation to a wide range of crops still further increases their value. Their texture also gives them a good mellow tilth and makes them easy to work; so that they are adapted to special crops such as potatoes, and root crops generally, as well as to the staple crops including clover, timothy and small grains.

The original timber on these soils consisted of a good growth of mixed pine and hardwood. The pine was chiefly White with some Norway and a small amount of Jack pine. In some sections there was a heavy growth of hemlock on these soils. The hardwood included a mixture of birch, maple, basswood, and a little oak. Since most of the pine on this soil was merchantable timber, it has been cut, except in limited localities, and only a little second growth pine and the hardwood remains. The hardwood, however, is sufficient to supply an abundance of firewood in practically all sections and there is often considerable cordwood available.

The fairly heavy growth of timber on this land means, of course, that the clearing is moderately heavy compared with lighter soils, although small tracts are frequently found which have been burned over to such an extent that the labor of clearing is considerably reduced.

Two groups of heavy sandy loams are shown on the map. The level, or nearly level phase occurs only in limited areas, but the undulating group, which is by all means most common, is found in large widely distributed bodies.

UNDULATING HEAVY SANDY LOAMS

Soils of this class are, for the most part, undulating to rolling in topography. In some sections especially in the northern part of the state, the land may even be called rough and hilly, but for the most part it is not so rough that it would prevent good agriculture development. Hilly land, too rough for cultivation, should be used as pasture and farmed with other land. The hilly land should be cheaper.

Stoniness varies greatly over the areas occupied by these soils. In some sections large cobbles and bowlders are so numerous as to make clearing very expensive, but this is true only on a small fraction of the land and in most cases extreme stoniness occurs only over patches of a comparatively few acres; so that by using these portions for pasture, the land as a whole may be developed.

There is quite a little variation in the subsoil of this class of soil. Near Superior in Iron county, there is a tract of about 12 sq. miles, the soil of which is underlaid by clay at from 24 inches to 26 inches. This gives the soil of this tract a considerably heavier character in general and less thorough underdrainage than the rest of the undulating sandy loams.

In central Ashland County there are about 50 sq. miles of this soil which is very stony. In the so-called iron ranges, hard granite rock underlies the rougher and more hilly tracts. In Ashland county the Penokee iron and copper ranges are accompanied by a belt of hilly and stony land, which is about one mile wide. Other tracts of stony land occur in certain parts of Burnett, Washburn, Marinette, Shawano, and Sawyer counties and the stoniness varies within very short distances so that it cannot be shown on the map. Many of the most stony of these tracts can be used only for pasture and wood lots but when the farm includes a sufficient amount of good land to raise crops for feed, good results can be secured.

A tract of about 50 sq. miles in Price and Oneida counties and one of about 25 sq. miles in Burnett county have a heavier subsoil, which is reached at a depth of from 18 inches to 36 inches. A large tract of about 100 sq. miles between Webster and Grantsburg has a heavier subsoil which generally comes to within 8 inches to 24 inches of the surface and gives the soil rather poor drainage in those tracts which are level. After some attention has been given to the drainage of these tracts, this soil will be greatly improved in character and will be better adapted to pasture and to small grains than the soils of this type generally are, while the fairly light character of the surface soil makes them still well adapted to potatoes and other special crops which do best on soils of a medium texture. In Chippewa, Eau Claire, and Dunn counties, this class of soil is relatively free from stones and of

excellent character, but somewhat more hilly than in other regions. Here practically all of it has already been developed into farms.

The rolling surface of these soils gives them better air drainage than more level land has, and corn, potatoes, and other crops easily injured by frost can be grown on the side hills successfully in even the northern part of the state, although on flat land in the same section, their growth may be attempted with much greater risk. The loamy texture of the soils further tends to make them warm and so adapted to tender crops.

LEVEL HEAVY SANDY LOAMS

As shown on the map, the level heavy sandy loams occur over small areas in different counties. Most of the land of this type was formed by the filling in of shallow lakes and streams. These soils are usually quite free from stone, have a level or gently undulating surface, and the subsoil is usually lighter or sandier than the surface soil.

Their level surface and comparative freeness from stones gives these soils a higher value for general farming. Their lighter subsoils, for the most part, give them good underdrainage, though there are some local areas which need some attention to secure good surface drainage. These soils are well adapted to grass, hay, or pasturage, and to the small grains and are especially well adapted to potatoes, except as an occasional severe summer frost interferes.

CALCAREOUS HEAVY SANDY LOAMS

A belt of soils having the texture of heavy sandy loam occurs in a strip west of Green Bay in Marinette, Oconto and Shawano counties. This soil is similar to the heavy sandy loams described above, except that it contains a good deal of ground limestone and limestone pebbles, especially in the subsoil, having been formed by glacial ice passing over a country of limestone rocks. The presence of this limestone in the subsoil lessens the tendency of the soil to become acid and gives it an added value. This soil is one of the best types in the state. It is adapted to practically all the crops which grow in this climate—corn, root crops, small grains, grasses and legumes—and has the advantages of heavy sandy loams pointed out in the description on page 21. The presence of the limestone makes it especially adapted to the growing of alfalfa, peas, and other crops needing large amounts of lime. Orchard crops, particularly apples, also do unusually well.

Most of the surface is undulating to rolling with long gentle slopes

so that farm machinery can be used on practically all of it, though there are a few small areas where the surface is somewhat choppy. The underdrainage is good except on a few tracts which are chiefly confined to Green Valley Township in Shawano county and to small scattered areas in Oconto county, chiefly in Morgan, Oconto Falls, Gillett, and Stiles Townships. These tracts will need dranage for their improvement.

In the western part of Polk and St. Croix counties is a similar belt of this soil with limestone gravelly subsoil. The majority of this area has a rolling to hilly surface but includes many nearly level areas. The surface soil is more sandy in portions than in others. Large areas of the hilly sandy loam occur in the Town of Somerset, St. Croix county, and around Dresser Junction in Polk county. Stones and boulders are usually plentiful on the surface and stone piles and stone fences are common. Areas of considerable size are practically stone free.

CHAPTER VII.

SILT LOAMS WITH WELL-DRAINED SUBSOILS

The silt loam soils with well-drained subsoil are next in abundance to the heavy sandy loam soils in upper Wisconsin. These silt loam soils are quite generally called clay loam but it is important to distinguish them from clay loam soils which are considerably heavier. A soil of silt loam texture has high water holding capacity and is therefore, well adapted to grass and pasturage, and to small grains, but it is not too heavy to work well when sufficiently well drained; so that it is also suited to crops needing cultivation.

ROLLING SILT LOAM

The larger portion of these silt loam soils in upper Wisconsin are undulating to rolling in topography. They occur in large tracts in Florence, Forest, Langlade, and Marathon counties in the eastern part of upper Wisconsin, and in Sawyer, Rusk and Polk counties in the western part. These soils were formed by glaciation chiefly from granitic rocks and so bowlders and cobbles are quite generally distributed through them. Stoniness varies greatly so that tracts of moderate size are occasionally found which are too stony to be readily cleared, but for the most part, stones do not form a serious obstacle. The rolling surface gives good surface drainage on practically all of this land, but some small tracts where the subsoil is too heavy to permit of good underdrainage would be benefited by tile drainage.

The original timber growth on this class of soil consisted for the most part of hardwood, especially maple and birch with some basswood and oak and of soft wood, especially large White pine and hemlock. In Chippewa, Barron, Eau Claire and Dunn counties the timber is largely oak with some maple and poplar. In some areas White pine greatly predominated over the hardwood and the removal of the pine stumps, of course, adds considerably to the cost of clearing the land. On practically all new land there is a sufficient amount of small timber left to furnish stovewood and frequently considerable amounts of cordwood, and bolts of paper wood can be cut which in part meets

the expense of clearing. Rough lumber for building purposes can also usually be secured.

VALUE AND USE OF ROLLING SILT LOAM

These soils are especially adapted to grass, both for pasture and hay and to clover, small grains, and root crops. Dairying and stock raising are, therefore, the chief lines of farming to which this soil is adapted with the raising of small grain as a side line. While good yields of potatoes can be grown, the heaviness of the soil makes it somewhat difficult to harvest them properly especially during wet falls. Corn can be grown readily, especially on the higher slopes where the air and water drainage are good, while on the lower slopes or more level portions the heaviness of the soil interferes somewhat with the growth of this crop, which requires a quick and warm soil in this section.

The tracts of this class of land in different sections of the northern part of the state differ somewhat one from another. In the southeastern and northern portions of Ashland county the rolling phase of this soil is more hilly and rough than the average and there is more stoniness and the subsoil is more gravelly. But with the exception of small tracts where bowlders are too numerous all the land can be farmed.

The map shows considerable areas of this silt loam soil with well drained subsoil in northeastern Chippewa, western Rusk, northwestern Barron, and over a large part of Polk county. This soil is, for the most part, of excellent texture and high agricultural value. The survey of this section was made a few years before the remainder of the state and in somewhat less detail so that some tracts are included with this type of soil which really belong to others, but they are of relatively small extent. Most of this section is already fairly well developed.

In the northeastern portion of the state, especially Forest, northern Shawano and Oconto counties, the land of this class is more rolling and numerous long high hills underlaid by granite rock occur. The soils of most of these hillsides is excellent, though occasionally patches are found which are so stony as to make clearing expensive, but these long slopes give good air and water drainage and there is less danger from frost than on the lower land. Some tracts are more stony than others, among which might be mentioned an area of about ten square miles in the northeastern corner of Oconto county and one of about the same extent southeast of Marathon in Marathon county.

LEVEL SILT LOAMS

Tracts of level or very gently undulating silt loam soils occur in a few sections as shown on the map. The largest areas of this kind are in the vicinity of Antigo in Langlade county and Milltown in Polk county. These tracts have a level surface and are of alluvial origin, having been formed from the settling of sediment in shallow lakes at the edge of the ice during the glacial period, and very commonly have some sand and even gravel in the deeper subsoil. They are practically free from stone of any size on the surface. The level character of these tracts and freedom from stones gives them considerable advantage in the readiness with which farm machinery can be used and so they have somewhat higher value, except where the unusual number of large pine stumps make clearing expensive. For the most part, the under drainage of these soils is good on account of the sand or gravel in the subsoil, but it is often necessary to provide some small surface ditches to remove surface water quickly in the spring.

These soils are especially adapted to grass and hay and to small grains. Corn is less successful because of their tendency to be a little colder and more backward in the spring than higher land. Root crops do exceptionally well.

LEVEL PRAIRIE SILT LOAMS

Some tracts of level silt loams which occur in the western portion of the state, are quite dark or nearly black from the large amount of humus. These tracts were originally prairie soils. They are very fertile and adapted to the growing of most staple crops. Soils of this description are already very extensively developed and improved and so do not call for a further description here.

CHAPTER VIII.

SILT LOAMS WITH HEAVY SUBSOIL

One of the most important and uniform types of soil in northern Wisconsin is the silt loam with heavy subsoil. This covers an extensive area in Wood, Clark, Marathon, Taylor, Lincoln, Rusk and Price counties. This soil is often spoken of as a clay loam, but should really be called a silt loam, since it usually contains from fifty to sixty-five per cent of silt. The soil is relatively free from stoniness. Two phases or kinds of this soil are shown on the map, the rolling, and the level. Both phases are generally fertile and are being developed into excellent agricultural land. The fine texture of the soil makes it especially adapted to small grains and to grass, both for pasture and hay. The soil is not high in its content of vegetable matter and means of increasing the vegetable matter should be used. This soil is also acid or sour and crops requiring considerable lime such as alfalfa, clover, sugar beets, etc., will be greatly benefited by the application of lime. While clover succeeds very well on comparatively new ground, it is probable that the need of lime, will become more apparent as time goes on.

The original timber on this land was mixed hard and soft wood. In some sections the hardwood which included maple, basswood, birch and some oak predominated, while on others White pine stood very thick and constituted the chief timber. On such tracts clearing of the large White pine stumps makes the expense of improving the land rather high. On more level portions in addition to White pine, there is considerable hemlock, balsam, ash and elm.

ROLLING SILT LOAM

The portion of this silt loam mapped as the rolling phase consists largely of rolling hills of moderate height having smooth uniform slopes practically all of which can be readily farmed. In fact, the slopes are just sufficient to give good surface drainage, and to give good air drainage from the higher portions. The rolling silt loam is therefore less subject to frost and has good drainage; so that the earliest varieties of corn usually mature and practically always reach a good silage stage before fall frosts.

FIG. 5.—A HIGHLY DEVELOPED FARM IN NORTHERN WISCONSIN

At this stage a large part of the farm is covered by the rotated crops of hay, pasture, corn or potatoes and grain.

LEVEL SILT LOAM WITH TIGHT SUBSOIL

This silt loam occurs extensively in eastern Rusk and southern Price counties. This is a fertile soil, especially adapted to the small grains and grass for hay and pasture. The level character of the soil itself causes it to be rather poorly drained during wet seasons. Surface drains in the form of shallow ditches connected with dead furrows should be used to remove surface water as much as possible. Tile drainage may be profitable if cultivated crops are to be grown, but tile are not usually necessary when land is largely used for grass and hay or even small grain. The somewhat unsatisfactory drainage of this land makes it less well adapted to corn, potatoes and other crops sensitive to frost or requiring cultivation.

Over a portion of this type of soil the underlying rock is sandstone rather than granite. This applies especially to something over twenty square miles in the southeastern corner of Clark county and an area about five miles southeast of Greenwood. The presence of this sandstone which gives rise to some sandiness in the sub-soil also improves drainage conditions considerably.

Where the level phase of this silt loam soil with tight sub-soil occurs in large tracts, the lack of drainage is more serious and those purchasing it should include in the estimates of cost of developement the digging of such ditches as may be necessary to remove surface water and probably for its fullest agricultural development, the expense of tiling will be involved. Some tracts of this land are of a marshy character, forming small grass meadows along streams, but in most cases the muck or peat of this soil is not deep and the vegetable matter it contains will improve the fertility of the soil after drainage.

By the use of systems of farming to which it is adapted a large part of this type of land will undoubtedly develop into valuable farms. When only portions of farms consist of this level phase and the remainder is higher or rolling, the lower portions can be used as pasture and hay land, while the upper portions are used for corn and other cultivated crops in such a way that the farm as a whole will be highly developed.

CHAPTER IX.

SILT LOAMS ON LIMESTONE

In the southwestern part of upper Wisconsin, including St. Croix, Pierce, Dunn, Eau Claire, and Chippewa counties, there are considerably areas of silt loam soil underlaid by limestone rocks from which the soils were largely derived or formed. Part of this section was covered by the ice of glacial times and this had the effect of grinding up some of the limestone rock and mixing it with the surface soil originally there and also of filling up the valleys and rounding off the hills; so that the surface is now gently undulating to rolling. Of this area which was covered by the ice, a portion has since been largely prairie with only sparse forest growth while another portion was quite heavily timbered. The prairie portion has somewhat darker soils coming from the vegetable matter of the fine roots of grasses while in the timbered portions the soils are lighter in color. This difference in organic matter, however, is not large. The other part of this limestone region was not covered by the ice of glacial times. This part makes up the unglacial silt loam soils on limestone. It has the deep valleys and steep slopes produced by long periods of stream erosion, and the surface soil has been constantly leached of its lime; so that it now contains much less lime than the soil over which the ice passed. There are, therefore, three sub-divisions of this area of soils underlaid by limestone rocks: (1), Prairie glaciated group; (2), Timbered glaciated group; and (3), Unglaciated group.

ROLLING PRAIRIE SILT LOAM ON LIMESTONE

This soil covers about 200 sq. miles in western St. Croix county. This region is partly quite level, but portions of it are gently undulating with long gentle slopes. Some groves of trees chiefly of oak, maple, basswood and other hardwoods, with a few pine, were scattered over this section, but for the most part, it was a prairie region when first settled.

Value and Uses. This region is one of a very high degree of fertility, adapted to grain and stock raising and is already fully developed. Prices of land are correspondingly high. The amount

of organic matter in these soils is not so large as in the typical prairie sections of Illinois and Iowa, but it is enough to give the soil a distinct character. The soil is a good silt loam heavy enough to grow the best pasture grass, and to be well adapted to small grains; while its location in the state, and its good supply of organic matter makes it well adapted to corn.

Improving and Fertilizing. Some tracts of this land can be improved by drainage. The subsoil of some portions is rather retentive of moisture, and for the fullest development, a limited amount of tiling would be helpful. While the soil of this section was at first very fertile, some of it has been cropped a good many years to small grain and hay, much of which has been sold. This has had the effect of reducing the available phosphorus so that the use of phosphate fertilizers in connection with stable manure will greatly increase yields of crops. The cultivation of the land for many years has also resulted in the leaching out of a good deal of the lime in patches over this section and an application of ground limestone or other forms of lime will also be helpful, especially for crops such as alfalfa, peas, beets, etc., which draw heavily on the lime of the soil.

GLACIATED SILT LOAMS ON LIMESTONE

These soils occupy a large tract of land in eastern St. Croix and northern Pierce county. This section was passed over by the ice during glacial times, after which it was quite heavily timbered. It has a gently undulating surface, and rather brownish gray colored soils of a fairly heavy silt loam texture.

Value and Uses. These lands are very fertile and adapted to a wide range of corps including small grains, grasses for hay and pasture and corn. It is already fully developed and rapidly becoming one of the richest sections of the state. The soil of this section has a good supply of lime, except in patches here and there where leaching during a number of years of cultivation has reduced it. On these tracts, lime would be beneficial for crops requiring a good deal of this substance and the use of phosphate fertilizers with stable manure will also be helpful.

Need for Tiling and Liming. While there is almost no marsh land in this region, there are a good many sections where the land is nearly level and the subsoil rather heavy so that underdrainage is not rapid enough during wet seasons. For these sections tiling would be a very great improvement. With the improvements that could be affected by the use of lime, phosphate, and tile drainage, the soil of this region, although already very productive, can be made still more productive.

UNGLACIATED SILT LOAMS ON LIMESTONE

There are several areas of soils derived from limestone in Pierce, Dunn, Eau Claire and Chippewa counties. These regions have deep valleys with rather steep slopes, giving them a rather rough surface, although many tracts of upland between the streams are moderately level or undulating.

Value and Uses. The soil of this regeion while of fairly heavy texture and originally of good degree of fertility, is less well supplied with lime and the hillsides are more subject to washing and leaching by which their fertility is lessened. These factors should be taken into account in choosing lines of farming and in selecting means for improvement. The texture of the soil is well adapted to grass both for pasture and hay, and keeping the steeper slopes under pasture or meadow greatly reduces the surface wash. These regions are, therefore, especially suited, to stock raising in which pasturage is extensively used, while small grain and corn for winter feed are grown on the more level portions of the land.

Fertilizing and Improving. Since the soil of these sections was formed by the weathering of the limestone rocks during very long periods of time, the lime has been largely removed by leaching and a good deal of the soil is more or less sour or acid. The highest fertility can therefore only be reached on these lands through the application of ground limestone, or other forms of lime, especially for crops requiring a good deal of these substances, such as alfalfa, clover, peas, beets, etc., but other crops will also be benefited by its use. An increase in the organic matter through the use of stable manure, green manuring crops, and the plowing under of stubble, straw, or other roughage is also important and the use of some form of phosphate fertilizer will still further increase their fertility.

These lands are already entirely occupied by farms, but a very considerable increase in their productivity can be produced by the application of methods above suggested.

CHAPTER X.

HEAVY RED CLAY

A broad belt of heavy red clay occupying about 1,000,000 acres extends along the south shore of Lake Superior. Small areas of the same soil occur in Burnett county, also in southeastern Shawano county. The country on the south shore of Lake Superior occupied by this soil is a plain gradually rising from the lake, sloping at the rate of thirty to thirty-five feet to the mile. Rather deep ravines and stream valleys have cut their way back into the plain from the lake making areas of steep or hilly topography in places. The sides of these ravines and valleys have good drainage while some portions of the land between these channels are somewhat poorly drained. Shallow depressions or pot holes are occasionally found, but for the most part, there is sufficient slope to permit good surface drainage on this type of soil.

Most of this soil originally bore a heavy growth of White and Norway pine, together with birch and some hemlock. After the pine timber had been cut a thick growth of poplar, White birch, balsam and willow brush took its place. Large areas of this soil have been so frequently burned over that only very small brush or poplar and birch trees remain so that on these areas the clearing is not especially difficult. On some tracts the later growth of birch and poplar are quite thick, making clearing more expensive.

Value and Uses. The fine texture of this soil makes it especially adapted to small grains and grass as hay or pasture. Wheat, barley and oats on well managed farms of this soil produce very high yields of exceptionally good quality of grain. Field peas, clover, timothy, and other grasses grow unusually well. On account of the heavy character of the soil which makes tillage and the development of good tilth difficult during wet seasons this land is not so well adapted to corn or other cultivated crops as are somewhat lighter soils. Hardy root crops should be substituted largely for corn or stock feed. The nearness to the lake keeps the temperature somewhat lower during the growing season which is also a disadvantage for

corn. If, after two or three crops of clover have been grown, care is taken not to plow and cultivate this land when it is too wet, the mechanical condition of the soil becomes very much better, and corn and other cultivated crops can be grown more successfully, especially on tracts which have good slope.

Tiling and Fertilizing. Tile drainage is very successful on this class of soil and will prove one of the chief improvements which can be made in it. This soil is usually not acid, though occasionally patches of acid soil are found. The amount of organic matter, or humus varies a good deal. The slight depressions scattered over the surface usually contain a shallow muck, giving the soil considerable organic matter, though in general, the soil is not high in humus and an effort should be made to increase this through the use of stable manure and green manuring crops. Besides organic matter and nitrogen, the only element at all lacking as plant food is phosphorus. The amount of this element in this soil is somewhat less than in other classes of clay soils and the use of some form of phosphate fertilizer in addition to stable manure will in the long run be found beneficial, though its use is not necessary in order to secure good yields for several years after breaking.

FIG. 6.—WHEAT ON HEAVY RED CLAY AT ASHLAND SUB-STATION FARM

There are 1,000,000 acres of this soil along the south shores of Lake Superior. This soil produces heavy yields of wheat, barley and oats. Field peas, clover, timothy and other grasses do unusually well.

CHAPTER XI.

POORLY DRAINED SOILS

This group of soils includes bottom land along streams and along the borders of marshes where the lack of good underdrainage frequently extends for some distance beyond the marsh proper. The meadow lands along streams are mostly subject to overflow during high water, but even where not overflowed the drainage is not sufficient for good cultivation. A few small additional tracts are included with these soils and shown on the map as poorly drained lands, which are so situated that they receive spring or seepage water from above, making the subsoil too wet for cultivation.

Most of these soils would be available for farming if they were underdrained. Part of them are so situated that they cannot be readily and economically drained as in the case of those lying along streams and subject to overflow at high water which would require very considerable expense for diking to prevent the overflow.

It has not been found practicable to subdivide these poorly drained soils into as many classes with reference to texture or fineness of grain as in the case of upland soils and they have been simply divided into (1) poorly drained sandy soil and (2) poorly drained heavier soils.

POORLY DRAINED SANDY SOILS

Poorly drained sandy soils include strips of land along the borders of the marshes in sandy sections. They are mostly covered with a growth of hemlock, cedar, birch, etc., but there are frequent patches of open meadow bearing blue-joint and other marsh grasses. The soil is usually quite dark or black in color from the organic or vegetable matter they contain although this vegetable matter does not constitute more than ten to fifteen per cent of the weight of the soil, and they cannot, therefore, be called muck or peat.

Improving and Fertilizing. Drainage should be the first step in the improvement of these soils; though much of it can be used for crops which will stand considerable water, such as red top, and blue joint, or even timothy and alsike clover for hay and pasture. Any further use for farming purposes would require drainage. Most of

these soils are also somewhat acid and will be benefited by liming, and by the use of some fertilizers containing phosphorus, unless stable manure is available. After clearing, this treatment will add greatly to the value even of the pasture.

POORLY DRAINED HEAVY SOILS

This group includes wet lands lying along the borders of marshes and along streams, such as loams and silt loams with generally heavy subsoils. Most of this land was covered by a growth of trees including soft maple, elm, cedar, black ash and birch.

Value and Use. The agricultural use of this land in its present condition is quite variable. Most of it can be developed into very good pasturage after clearing and seeding in of the right grasses. Land of this kind should be divided up with higher land so that it can be used as pasture while the higher land is used for other crops.

Drainage Needed for Full Use. Where this land is so situated that it can be drained either by good ditches or by tiling, practically all of it is capable of development into very good farm land. This is particularly true of portions of this land in Marathon, Clark, Taylor and Lincoln counties.

CHAPTER XII.

PEAT AND MUCK

Marshes of considerable extent occur scattered over a large part of the northern portion of the state. These have been largely formed by the gradual filling up of shallow lakes left at the close of the ice epoch. Sphagnum moss and other water plants growing in these lakes and settling to the bottom gradually filled them up, leaving the deposit of peat. Where sediment from upland washed in it formed muck. The vegetable matter of these peat and muck soils varies in depth from a few inches to as much as 10 ft. or 12 ft. The most common depth is between 2 and 5 ft.

Drainage Needed for Development. Two factors influence the cost of reclaiming these marsh lands for agricultural use: (1), the readiness with which good drainage can be secured, and (2), the expense of clearing and breaking. When the land exists in large tracts, the organization of drainage districts will usually be necessary in order to secure sufficient outlet. The distance and amount of ditching necessary to secure this outlet ditch, and the co-operation of all land owners concerned must be considered. Then again when the marsh land is covered with a heavy growth of tamarack, spruce or other trees, the labor of clearing is of course very much larger than in the case of open grass marshes.

Thorough drainage of these lands, which will make possible the growth of other crops than simply pasture or hay grasses, usually requires that ditches or still better tile be put in from six to ten rods apart and costing under ordinary conditions from $15 to $25 per acre.

Handling and Fertilizing. In addition to good drainage, these muck and peat lands are found to require fertilizers containing phosphorus and potash to maintain their fertility. They are very high in nitrogen, a plant food which occurs in the organic matter. Fertilizers containing phosphorus and potash will ordinarily give as good results as will heavy applications of stable manure so that on farms including upland as well as marsh land, the stable manure should be used on the upland and phosphate and potash fertilizers purchased for the marsh land. In addition to proper fertilization these lands are usually open and loose in character and are greatly

benefited by the use of a heavy roller to compact the soil. Pasturing for two or three years where this is practicable effects the same improvement.

The use of lime in some form is very frequently necessary in addition to the other fertilizers mentioned. This is particularly true in the case of very raw peat marshes, especially in the northern part of this section, and it is probable that the use of lime, or ground limestone, or marl, at the rate of 1 to 2 tons per acre for the first application followed by about ½ ton every 3 to 5 years will be found profitable very generally.

Crops for Marsh Land. When well drained, properly fertilized and managed, these marsh lands can be made to produce heavy yields of the crops to which they are adapted. Among these crops are certain special crops such as cabbage, celery and onions, but of course the larger portions must be used for staple crops including buckwheat, grasses for hay and pasture, especially timothy and alsike clover, hardy root crops and some small grains, especially rye. These lands are more subject to frost than upland and so are less adapted to tender crops, such as corn or potatoes.

CHAPTER XIII.

ROUGH OR VERY STONY LAND

There is considerable land in northern Wisconsin which is so rough and hilly as to make the use of agricultural machinery impracticable and it is, therefore, unsuited to agricultural use. Most of the land of this character occurs in tracts of considerable size. There is, however, quite a little rough land scattered through the other types of soil in small areas which it was impracticable to indicate separately on the map. Moreover, when this rough land occurs in small tracts it can be divided up with good land adjacent in such a way that it can be used as pasture or wood-lot to good advantage. But when rough land occupies tracts three or four square miles or more in extent, it is impossible to divide it up into farms on which there will be a sufficient amount of good tillable land. Two phases of this rough and hilly land are shown on the map.

Sandy Soil. This phase is not only very rolling, or rough and stony, but the soil is so sandy as not to be able to support even a fair pasture grass. Rock outcrop and rough stony land is included where bed rock or ledge rocks outcrop so frequently that the shallow soil cover cannot well be cultivated.

Value and Uses. This class of land could be used for woodlots or forestry purposes, and this is the only extensive use to which they are adapted. This land occurs extensively in Bayfield, Sawyer, Vilas, Oneida, and Forest counties and to less extent in several other counties. It is of course true that there are some small tracts as large as forty acres in extent that are sufficiently smooth to permit cultivation, associated with this rough land, but it has been impracticable to separate these in the work of the Survey in this part of the state and even if the small tracts were separate, it would be undesirable for settlers to locate on these tracts scattered infrequently through larger areas which would not be suitable for agricultural use since they would be very much isolated and have poor schools, and other disadvantages. It is to be hoped that these large tracts of rough sandy land will be developed for forestry purposes by either the state or by private interests.

Heavy Soil. The other class of rough lands has a sufficiently heavy soil to carry at least a fair pasture grass through ordinary seasons

and so is suitable for grazing. Land of this character occurs in considerable tracts in Taylor, Lincoln, Oneida, Vilas, Price, Rusk and some other counties. Much of this land is not only too rough for cultivation, but is very stony.

Value and Uses. It would be suitable for grazing on a large scale. It is of course true that there are some small tracts of comparatively good land which could be cultivated scattered through this rough land, but there is too small an amount of it to raise the feed necessary for winter feeding of stock which would pasture on the rough land. It would be necessary, therefore, either to take stock to other sections for winter feeding or to haul feed to these sections which could be used for grazing.

Clearing for Pasture. The proper clearing of this land for pasture purposes is a matter which would require considerable care. The pasturage on the uncleared brush land is of course very poor and it would be necessary to "brush" the land and seed in grasses in order to secure good pasturage. Such land would have a very considerable value for this purpose. The gross returns are of course small in comparison with those from cultivated land, but the expense of management is also very small so that the net profit is very considerable. Northern Wisconsin is especially adapted to grazing because it has comparatively cool summers and an excellent rainfall. The rainfall during the six months from the first of May till the first of November is about 18 inches and is ordinarily very well distributed through this period. Moreover, the heavy snows which usually occur in the northern part of the state act as a protection to the grasses through the winter and are absorbed gradually in the spring giving the soil a sufficient amount of moisture to penetrate several feet into the subsoil. While pasturage is usually not good until about the middle of May, it ordinarily continues good late in the fall so that the pasture period is seldom less than six months.

HOW TO USE THE MAP

The location or description of a tract of land is usually given by Section, Township, Range, thus: Sec. 10, T. 35 N, R 5 E. This map is so drawn that one inch on the map means six (6) miles on the ground, and it is divided by dotted lines into squares one inch on each side. These squares are Civil Townships. The townships are numbered from the bottom of the map UP, beginning with Township 25 North. The number of the Range (R 5 E, or R 5 W) shows how many squares the township is east or west of the Fourth Principal Meridian. The Fourth Principal Meridian runs north and south just west of Phillips in Price County. To make locating easy, the Ranges are numbered across the bottom of the map and along an east and west line just north of Park Falls in Price County. The township numbers are put along the sides of the map, and on the Fourth Principal Meridian.

A Correction Line running across the map from Marinette to New Richmond causes an offset in the Range Lines between Townships 30 and 31 N. For locations north of this correction line use the Range numbers (II, V, X, etc.) found along the east and west line just north of Park Falls.

Each township is divided into 36 sections. They are numbered beginning at the upper right hand corner and running west to No. 6. Section 7 is immediately south of section 6, and 12 immediately south of 1, 13 south of 12, and so on.

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APPENDIX I.

The foregoing pages are based on the reconnoissance survey of the northern half of the state on which five reports have been published as follows:

1. South Part of Northwest Wisconsin.
2. North Part of Northwest Wisconsin.
3. Northeastern Wisconsin.
4. North Part of North Central Wisconsin.
5. South Part of North Central Wisconsin.

It also includes the detailed survey of Door County and the northern tier of towns in Kewaunee, Brown, Waupaca, Portage, Wood and Clark counties.

The types described in these reports have been grouped in the present report as shown in the following list:

Sands

Level Sands

Plainfield Sand
Beach Sand
Sterling Sand
Plainfield Gravelly Sand

Undulating Sands

Vilas Sand
Coloma Sand
Gloucester Sand

Light Sandy Loams

Level Light Sandy Loams

Plainfield Fine Sand
Plainfield Sandy Loam
Superior Fine Sand
Meridian Sandy Loam
Thornapple Sandy Loam
Chetek Sandy Loam

Undulating Light Sandy Loams

Vilas Fine Sand
Vilas Sandy Loam and Rolling Phase
Coloma Fine Sandy (Auburn Sandy Loam part)
Coloma Sandy Loam
Marathon Loam
Boone Fine Sand

HEAVY SANDY LOAMS

Level Heavy Sandy Loams

Antigo Fine Sandy Loam
Superior Fine Sandy Loam, Level Phase
Rice Lake Loam (part)
Fox Fine Sandy Loam
Superior Loam (Iron and Burnett Counties)

Rolling Heavy Sandy Loams

Kennan Fine Sandy Loam
Kennan Loam, Rolling Phase
Mellen Fine Sandy Loam and Rolling Phase
Mellen Loam and Rolling Phase
Boone Fine Sandy Loam
Auburn Loams
Marathon Fine Sandy Loam
Superior Loam (Burnett County)
Superior Fine Sandy Loam
Superior Sandy Loam
Chelsea Loam

Calcareous Heavy Sandy Loams

Miami Fine Sandy Loam and Poorly Drained Phase
Miami Loams
Cushing Loams

SILT LOAMS WITH WELL-DRAINED SUBSOILS

Level Silt Loams With Well-Drained Subsoil

Antigo Silt Loam
Milltown Silt Loam
Rice Lake Loams, Silt Loam Phase

Level Prairie Silt Loams With Well-Drained Subsoil

Rice Lake Loam (part)

Rolling Silt Loams with Well-Drained Subsoil
Kennan Silt Loam and Rolling Phase
Mellen Silt Loam and Rolling Phase
Marathon Silt Loam
Marathon Gravelly Silt Loam

SILT LOAM WITH HEAVY SUBSOILS

Level Silt Loams with Light Subsoil
Colby Silt Loam, Level Phase
Colby Loam
Vesper Silt Loam
Webster Loam, Clay Loam Phase

Rolling Silt Loams with Heavy Subsoil
Colby Silt Loam, Rolling Phase
Superior Loam
Superior Loam, Rolling Phase

SILT LOAMS ON LIMESTONE

Rolling Prairie Silt Loams on Limestone
Part of Baldwin Silt Loam

Unglaciated Silt Loams on Limestone
Knox Silt Loam

Glaciated Silt Loams on Limestone
Miami Silt Loam
Baldwin Silt Loam

HEAVY RED CLAY

Clays and Clay Loams
Superior Clay Loam and Rolling Phase
Superior Clay

POORLY DRAINED SOILS

Sandy
Dunning Fine Sand
Plainfield Fine Sand, Poorly Drained Phase
Genesee Sand
Genesee Sandy Loam

Heavy

Whitman Silt Loam
Meadow
Genesee Loam
Genesee Silt Loam
Poygan Fine Sandy Loam
Clyde Loam
Vesper Fine Sandy Loam
Colby Fine Sandy Loam

PEAT AND MUCK

Swamp and Marsh

ROUGH OR VERY STONY LAND

Sandy Soil

Vilas Sand
Vilas Stony Sand
Vilas Gravelly Sandy Loam
Rock Outcrop
Rough Stony Land

Heavier Soil

Kennan Fine Sandy Loam, Rough Phase
Vilas Sandy Loam, Rolling Phase
Iron range, Copper range, Rib Hill, rough areas in Kennan Silt Loam and Chelsea Loam, etc.

SUMMARY

The temperature and rainfall in northern Wisconsin are favorable for many other crops. The rain comes when the plants are making their most rapid growth. While the winters are cold these sections have a clear dry atmosphere. The summers are moderately cool with a uniform temperature. The growing season ranges from 110 to 140 days. Pages 6 to 10.

The fertility of new soils is easily maintained with the right kind of treatment from the start. Livestock plays an important part. Pages 11 to 12.

There are ten principal soil types in upper Wisconsin. These include sands, light sandy loams, heavy sandy loams, silt loam with a well-drained subsoil, silt loam with a heavy subsoil, silt loam on limestone, heavy red clay, poorly drained soils, peat and muck, and rough or very stony lands. Pages 13 to 15.

Sand soils have advantages as well as disadvantages. They do not hold moisture as well, and are more affected by dry weather, and are lower in plant foods than the heavier soils. However, they can make better use of light rains than heavy soils and they warm up more quickly in the spring. While they are not the equal of the heavier soils, when properly managed they produce fair crops of clover, rye, soy-beans, and corn. Pages 16 to 18.

Light sandy loams are finer and hold moisture better than the sands. They have more plant food. The best crops are rye, clover, corn, and soy-beans. Potatoes can best be grown if the fertility is maintained. Pages 19 to 20.

Heavy sandy loam is the most common soil and one of the most valuable in upper Wisconsin. It is well adapted to a wide range of crops. Dairying and potato raising are the two most important lines of farming. Pages 21 to 24.

Silt loam soil with a well-drained sub-soil follow the heavy sandy loams in acreage. They are especially adapted to grass and pasture, small grains, root crops and clover. Dairying and stock raising are profitable on this type of soil. Pages 25 to 27.

The silt loam with a heavy subsoil is one of the most uniform soils in the region. It is fertile and develops into excellent farm land. It is particularly adapted to small grain and grasses. This soil type is often wrongly called a clay loam. Pages 28 to 29.

Silt loam soils on limestone are very fertile. This section is rapidly becoming one of the richest parts of the state. Pages 30 to 32.

A million acres of red clay lies in the Lake Superior district. It is especially adapted to small grain and hay production. Pages 33 to 34.

The poorly drained soils are grouped in two classes: poorly drained sandy soil, and poorly drained heavy soils. Wet lands need drainage before they are of agricultural value. Pages 35 to 36.

Peat and muck lands need drainage and fertilizers. If uncleared they require more effort to stump and brush. They are subject to earlier frosts. Certain crops produce heavily with the proper management. Pages 37 to 38.

Rough or very stony land is best adapted to pasture or forestry purposes. Its value is limited. Pages 39 to 40.