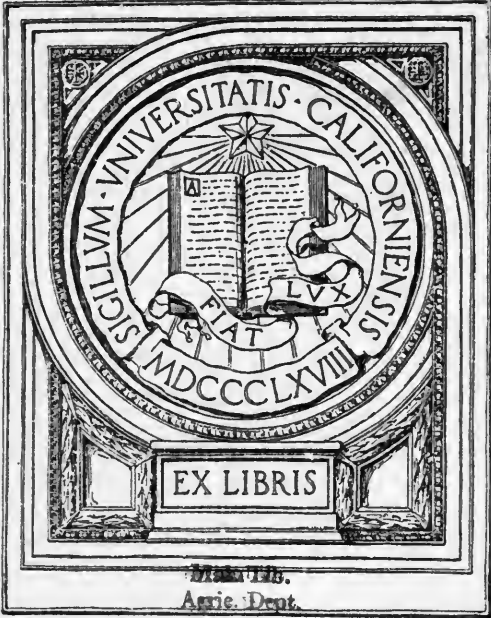


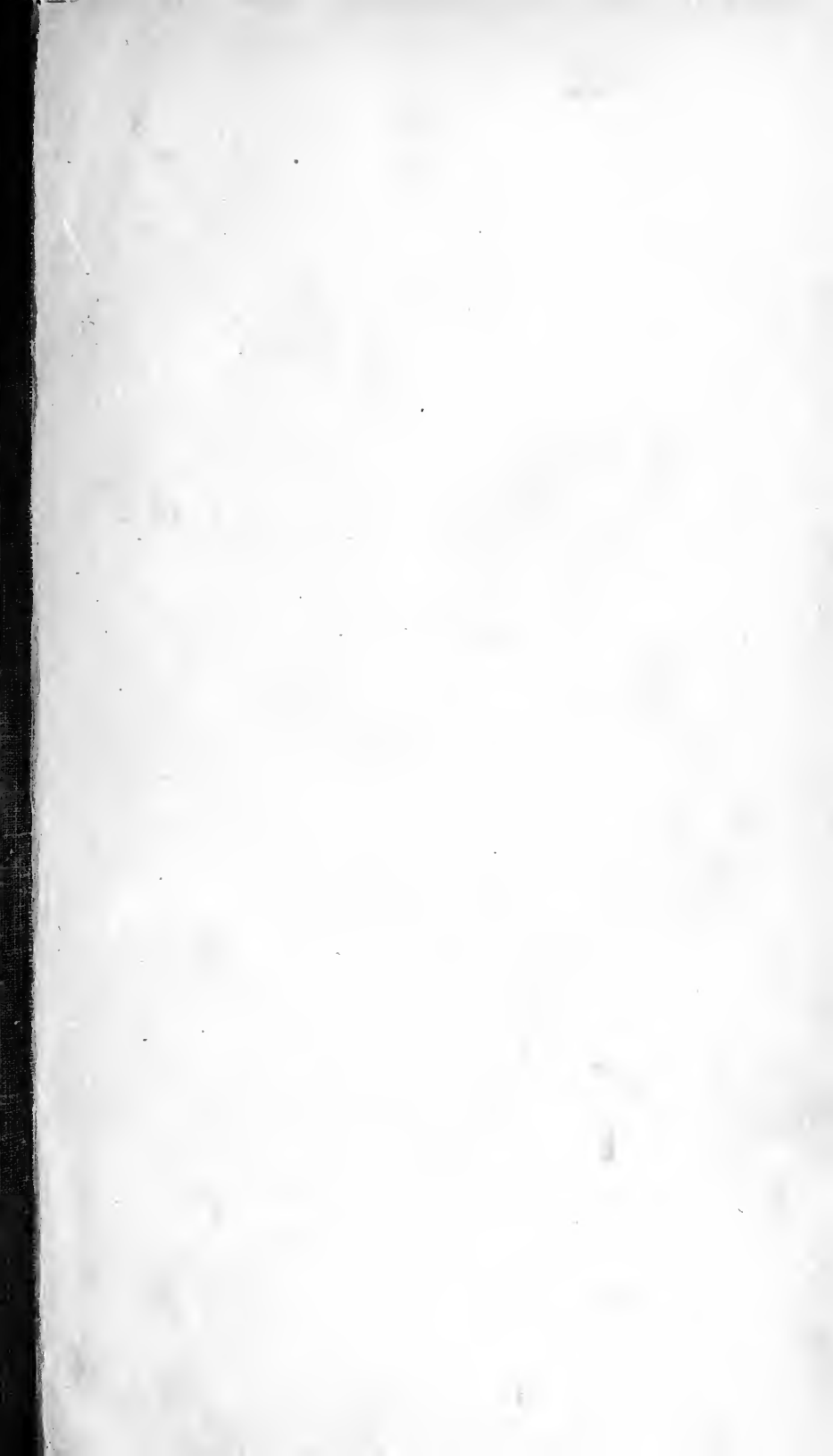
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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XII.

THE CARRINGTON LOAM.

BY

JAY A. BONSTEEL,
Scientist in Soil Survey.



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BUREAU OF SOILS.

MILTON WHITNEY, *Chief of Bureau.*

ALBERT G. RICE, *Chief Clerk.*

SCIENTIFIC STAFF.

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CURTIS F. MARBUT, in charge of Soil Survey.

OSWALD SCHREINER, in charge of Fertility Investigations.

W J MCGEE, in charge of Soil Water Investigations.

SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XII.

THE CARRINGTON LOAM.

GEOGRAPHICAL DISTRIBUTION.

The Carrington loam is a widely developed type of soil in the more northern portion of the central prairie States. It has been mapped in 14 different areas in 6 States, covering an aggregate extent of 1,601,088 acres. With the exception of 3 areas located around the southern extremity of Lake Michigan, practically all of the type thus far encountered has been found in regions west of the Mississippi and principally lying between the Mississippi and Missouri Rivers north of the northern boundary of Missouri. It is probable that as the number of soil surveys within this general region is increased, other extensive areas will be found throughout the section.

CHARACTERISTICS OF SOIL AND SUBSOIL.

The surface soil of the Carrington loam, to a depth of 10 to 14 inches, is a very dark brown to black, mellow loam, which in the more western areas not infrequently contains an appreciable quantity of medium or fine sand. The subsoil to a depth of nearly 3 feet is ordinarily a brown or yellowish-brown, compact loam which grades downward into a heterogeneous mass of clay, sand, gravel, and bowlders. This latter material constitutes the unweathered glacial till from which the type is directly derived. The thickness of this glacial till is usually considerable, ranging from 5 or 10 feet in the shallowest portions to 80, or even 150, feet over the greater portion of the region where the Carrington loam is developed.

Owing to the prevalent dark-brown or black color of the surface soil of the Carrington loam, and of other types associated with it in the Carrington series, it is usually easily distinguished from practically all other glacial soils. It is readily distinguished from the black soils of the Marshall series, through the fact that it contains gravel, and in many instances bowlders, in both the surface soil and subsoil, while these are lacking in the case of the Marshall soil types. Like the soils of the Marshall series, the Carrington loam is principally developed in prairie regions, although in southern Michigan and

northern Indiana there are portions of the type which were heavily wooded before they were cleared for agricultural occupation. In all of the more western areas, however, it constituted a prairie type whose surface was dotted only along the margins of shallow lakes and along the stream courses by clumps and narrow lines of trees.

SURFACE FEATURES AND DRAINAGE.

The surface of the Carrington loam in all of the regions where it occurs is remarkably uniform. The greater part of the type is only gently undulating or slightly rolling, although low ridges and lines of hills, consisting of glacial moraines, not infrequently cross the area of the type, giving it locally a somewhat rolling to slightly hilly surface configuration. There are no marked differences in altitude between the lower and the more elevated portions of the type in the majority of the areas where it occurs, and generally the extreme range of altitude within the limits of this type in a single county is not over a hundred feet. Owing to the undulating or slightly rolling character of its surface there are not infrequently to be found small depressed areas, occupied by swamps or ponds, or low swales without natural outlet. In the majority of instances these depressions are composed of soils other than the Carrington loam, but in some cases this type is also developed at these lower altitudes.

When the entire area occupied by the Carrington loam in the North Central States is considered it is found that there are considerable variations in the altitude of the type. Thus around the lower end of Lake Michigan the elevations range from 650 feet to about 800 feet above tide. In north-central Iowa and southern Wisconsin the altitudes range from 1,000 feet to about 1,250 feet, while in North Dakota the Carrington loam is found at altitudes ranging from about 1,100 feet above sea level in the southeastern part of the State to an altitude of 1,600 feet in its northern portion. This difference in altitude, coupled with an accompanying difference in climatic conditions, varies to some extent the characteristic crops which may be grown to the best advantage upon the type in the different locations where it is found.

In general the natural drainage of the Carrington loam when it was first occupied for agricultural purposes was somewhat deficient, particularly in the more level and lower lying portions of the type. In many instances the first necessity for the occupation of the type consisted in the construction of open ditches and the improvement of these drainage conditions. In the more western regions of its occurrence, however, the drainage was fair to good, and the prairie condition of the Carrington loam required only the breaking of the

heavy prairie sod to enable the farmers to produce crops upon the type immediately. There still remain in all locations where the Carrington loam has been encountered during the course of soil surveys, local depressions, which may be greatly improved by the construction of outlets and the laying of some tile drains to supplement the natural drainage. In general, however, the drainage requirements are not nearly so great as in the case of the Carrington black clay loam and of associated types of other series.

Nowhere throughout the total extent of its development is the Carrington loam subject to erosion sufficient to interfere in any degree with the production of any of the farm crops.

LIMITATIONS IN USE.

The loamy and usually friable surface soil, well supplied with organic matter, constitutes a seed bed favorable to the production of a considerable range of general farm crops. The rather heavy and compact subsoil forms a storage reservoir sufficient to supply moisture during the crop-growing season in all cases, except those of extreme drought. The natural drainage of the Carrington loam is usually adequate, and the type thus constitutes one of the best general farming soils of the more northern portion of the central States, possessing at the same time a somewhat wider range of crop adaptation than in the case of the more silty or the more sandy soils.

The organic matter content of the Carrington loam in its original prairie condition was excellent and over the majority of the type it is still maintained, although the continual production of one grain crop, whether corn or wheat, has in some instances impaired this favorable condition and given the type a markedly gray appearance, especially when the surface soil is dry. This contrasts rather sharply with the dark-brown or black color which is more representative of the natural condition of the Carrington loam. Only in more eastern areas has any serious attempt been made to maintain or restore the organic matter content of the soil. In the sections where the growing of grain for sale is the prevalent system of agriculture upon the type, the difficulty with the organic matter content of the soil is most pronounced.

The limitations upon crop uses incident to variations in natural drainage have largely been eliminated by the construction of open ditches and the laying of tile in the older settled communities. Something still remains to be done along these lines in the more northern prairie States, and when this has been accomplished practically all portions of the type may be occupied for the production of the general farm crops.

Erosion is not a problem in connection with the tillage of this type.

Locally and particularly upon the morainal ridges to be found within the area of the Carrington loam there are accumulations of bowlders and of smaller stone, which it is necessary to remove before the total area of the type may be subjected to cultivation. In such instances the bowlders are usually removed and used for the construction of the foundations of buildings and the erection of stone fences or, in extreme cases, where the presence of bowlders occurs in connection with the knobs and ridges of the higher moraine, such portions of the type are occupied for grazing purposes only, while the more level and the more nearly stone-free portions of the type are used for tillage.

In the more southern and eastern regions where the Carrington loam is developed, particularly in the vicinity of Lake Michigan and in north-central Iowa, there is abundant rainfall for the production of all of the usual general farming crops. The temperatures during the growing season are also such that corn may be grown to maturity, while in Indiana and Michigan the climatic conditions induce the production of winter wheat as contrasted with the spring wheat which is grown chiefly upon this type from Iowa westward. In its extreme western development in Nebraska and North Dakota the rainfall is sometimes insufficient to produce fair average yields of ordinary varieties of wheat, and recourse is had to the production of the durum wheat and of emmer in place of winter or spring wheat. Usually, however, through any long period of years the rainfall is adequate for wheat production, and fair yields are obtained where any attempt is made at crop rotation and the proper care of the soil.

IMPROVEMENT IN SOIL EFFICIENCY.

The Carrington loam has been occupied in Indiana and in Michigan for agricultural purposes for 60 years or more; in Iowa, for a period of 40 to 50 years; in Minnesota, for about 40 years; and in North Dakota, for only about 30 years. In the older settled regions the early stages of pioneer farming have passed, and the agriculture has settled down to the usual practices of established farming. In such regions crop rotations for the type have been worked out and have usually become prevalent. Some care is taken with regard to the feeding of the produce of this soil to live stock upon the farms where it occurs, and the stable manures are usually saved and applied to the land. In these instances the early crop yields of the pioneer days, which were slightly decreased under the continued production of corn and wheat for a considerable number of years, have been restored by the adoption of crop rotation in conjunction with some form of animal husbandry and with the restoration of organic manures to the soil. In the more northern and western sections, where the

Carrington loam is developed, agriculture is just passing through its pioneer stages, crop rotation is not generally practiced, the feeding of live stock is subordinate to grain production, and practically no stable manure is saved or applied to the land. As a result there has been some decrease in the crop yields of the type during the past 15 or 20 years, and the farmers in these regions are becoming convinced of the necessity for crop rotation, the introduction of animal husbandry, and the application of manures in order that the original efficiency of the type may be restored, maintained, or even increased.

In Minnesota and North Dakota, where the Carrington loam is extensively developed, the principal improvements in soil efficiency can be effected by the adoption of a regular crop rotation, utilizing the considerable variety of general farm crops well suited to production upon this type and capable of production under the climatic conditions which exist. In numerous instances where the practice of crop rotation has already been adopted material increases in yield, both of corn and of spring wheat, have been attained, even when the changed farm practice only included the alternation of corn with wheat rather than the continued growing of the one crop or the other. When in addition seeding to clover and other tame grasses has been introduced into the rotation marked increases in the yields of the grain crops have been secured. In Michigan, Indiana, and Iowa, where the feeding of beef cattle and the keeping of dairy stock has been prevalent upon this soil type for periods of 20 to 30 years, no difficulty is experienced in maintaining the crop-producing power of the soil at an average efficiency considerably higher than the general average for these States.

In consequence it is apparent that in order to maintain the efficiency of the Carrington loam it is only essential to adopt the proper methods of crop rotation, to combine animal husbandry with crop production, and to use moderate care in preserving and applying stable manures. Practically throughout the extent of the Carrington loam, as far as shown by the surveys, the use of commercial fertilizers is unknown and the need for them has not been felt.

LIMITATIONS UPON SPECIAL CROPS.

The Carrington loam is so well suited to the production of a considerable range of general farm crops that little attention has been paid to the introduction of special crops upon it. In addition to the grain and grass crops commonly grown, Irish potatoes have been successfully produced for home use and for sale in all of the more eastern regions. It has also been found that the small fruits give satisfactory results upon this type where they have been grown for home consumption, and in the vicinity of larger cities or of facilities for rapid transportation it is probable that these may be grown to

advantage. Upon the lower lying and less well-drained portions of the Carrington loam cabbages and onions might be introduced as supplementary crops.

In general only limited portions of the Carrington loam should be considered for orcharding, although the home orchard may be located upon the more elevated and rolling portions of the type. Throughout the general region there usually exist other soil types, like the Knox silt loam, which are better suited for orcharding upon a commercial scale, both by reason of their inherent characteristics and from their location with regard to air and water drainage. It is thus probable that the Carrington loam will remain for a considerable period of time one of the leading soils for general farming purposes in the regions where it occurs without being developed to any extent for the production of special crops, except the vegetables and fruits required for home use.

EXTENT OF OCCUPATION.

Throughout the region of its occurrence the Carrington loam is practically all occupied for agricultural purposes. It ranks high as a general farming soil and its crop efficiency, coupled with fair natural drainage and a somewhat elevated position, led to its early occupation by the pioneer farmers. In the more eastern regions, where the type was originally timbered, the forest growth was cleared at an early date, and the land was plowed and cultivated in preference to the local prairie soils. This preference arose chiefly from the fact that the Carrington loam was more easily plowed than the matted prairie-grass sod. Also it was usually better drained and the timber upon it was available for the construction of buildings. Throughout the more western region, where the Carrington loam constituted a prairie type of soil, the heavy prairie sod was broken by the pioneer farmers to a shallow depth and corn, wheat, and oats sown upon this sod. Only small portions of the type were cultivated in the early days and the prairie grasses which made luxuriant growth upon the remainder furnished excellent pasturage for the grazing of beef cattle. With increasing density of population the entire extent of the type was placed under cultivation, and the grazing of cattle was discontinued, to be replaced by the production of grain crops. At a later period, in nearly all instances, grain growing was supplemented by the feeding of beef cattle and of dairy cows maintained in inclosures and supported by the pasturing of native grasses grown in regular rotation with other crops. Under this system of occupation increasing areas of the Carrington loam have been occupied during the past 50 years until practically none of it either remains in timber in the more eastern States or in prairie sod in the more western region. The land is considered highly desirable for general farming purposes

and has established an excellent reputation for itself for the production of corn, wheat, oats, and the tame grasses in all areas where it occurs. Increased occupation of the Carrington loam must, therefore, take the form of more intensive farming rather than of an extension of tilled area upon the type.

CROP ADAPTATIONS.

Since the Carrington loam is distributed over a considerable extent of territory and occurs under varying conditions of altitude, latitude, and of mean annual rainfall, there is quite a variation in the adaptation of the type to crops. Thus in the region of southern Michigan and northern Indiana, where it has been extensively mapped, and also in central and northern Iowa corn constitutes the dominant crop upon the Carrington loam, while in Minnesota and in North Dakota spring wheat dominates all other crops. Winter wheat is also grown extensively in Indiana, in conjunction with the production of oats.

The Carrington loam under proper conditions of rainfall and with a growing season sufficiently long may be considered an excellent soil for the production of corn. The yields secured in Michigan, Indiana, and Iowa average from 35 to 45 bushels per acre over extensive areas, with frequent yields in excess of 50 bushels per acre. Even in southern Minnesota, where the production of spring wheat has long dominated the agriculture of the section, the acreage of corn is being gradually increased, and the yields secured are very satisfactory. They average from 30 to 35 bushels per acre, and with the best methods of farming, including the use of stable manures and the adoption of a definite rotation, these yields may be increased. In North Dakota the production of corn is entirely subordinate to that of the growing of spring wheat, although certain early maturing varieties may be grown to advantage, and even the longer growing varieties may be produced as a silage crop for feeding to dairy cows. Although the Carrington loam is not a great, dominant corn soil like the Marshall silt loam, it ranks high both in the acreage planted each year and in the yields per acre. While it is thus secondary as a corn producing soil among those of the central prairie States, it still holds an important place in the production of this crop wherever the conditions of rainfall and of length of growing season are favorable. In fact, the Carrington loam is subordinate only to the Marshall silt loam and to the Carrington black clay loam as a corn soil.

The variation in climatic conditions attendant upon the broad extent of the Carrington loam shows its most striking influence, possibly, upon the crop adaptations of the type in the case of wheat production. Thus in southern Michigan, in Indiana, and to a degree

in Iowa winter wheat is one of the prominent small grain crops. In all instances the acreage devoted to this crop is being decreased annually, although the yields are fair, the average from year to year ranging from 10 to 15 bushels per acre. The reason for this decrease lies principally in the general adoption of a crop rotation, well suited to the type, which includes the growing of corn, oats, and grass to the exclusion of wheat. The superior value of this rotation in the maintenance of the crop-producing power of the soil has been well learned by the farmers in these locations, with the result that wheat growing has been subordinated to the other forms of general farming and to the crops produced in the regular rotation for the feeding of beef cattle and of dairy cows. In fact, the growing of wheat in these locations is practically a survival of the early pioneer conditions while the adoption of the regular rotation marks an advance in the agricultural methods of these States.

In southern Minnesota, particularly, and to a considerable degree in eastern North Dakota the Carrington loam is known as an excellent spring wheat soil. In fact, in the Marshall area, Minnesota, comprising a portion of Lyon County, the Carrington loam taken as a whole excels all other soil types of the area in the production of spring wheat, not only because of the excellent yields, averaging 14 bushels per acre through a long period of years, but also because of the superior quality of the wheat grown, making possible its sale for milling purposes at prices above those usually received for wheat grown upon other soil types. Similarly in North Dakota the Carrington loam produces an excellent quality of spring wheat and the yield per acre is dependent more upon the methods of tillage of the soil and upon attendant circumstances of rainfall than upon the inherent properties of the soil itself. This is markedly shown in the soil survey of the Jamestown area, North Dakota, where the yields of wheat on the Carrington loam in the eastern portion of the area are nearly double the yields secured upon the same type in the more western portion of the same survey. This is due primarily to the decreasing annual rainfall from the eastern to the western part of a single soil survey area located along the line of critical precipitation so far as wheat production is concerned.

Thus the Carrington loam may be ranked as an important wheat-growing soil, particularly in the more northern and northwestern regions of its development.

In the more southern and eastern sections, oats constitute the dominant small grain upon the Carrington loam, the acreage of this crop being second only to that devoted to corn. The yields of oats in Indiana, Iowa, and Minnesota are uniformly high, averaging from 35 to 45 bushels per acre through long periods and attaining the high mark of 50 to 60 bushels per acre in favorable seasons upon

lands which have been well cared for. There is something of a tendency in the production of oats toward an excessive growth of straw at the expense of grain, which involves danger through the lodging of the crop in the case of severe storms just before the time of harvesting. With this exception the Carrington loam may be ranked high as a soil for the growing of oats. In the more northern and northwestern regions only a small acreage is devoted to oat production, while barley enters as a small grain crop, both in Minnesota and in North Dakota. The yields of barley are excellent, ranging from 20 to 25 bushels per acre.

A considerable acreage of the Carrington loam is annually devoted to the growing of grass for hay in all of the older settled areas where it occurs. The grass is seeded in regular rotation with the grain crops and excellent yields are secured. In Indiana the hay cut ranges from 1 to $1\frac{1}{4}$ tons per acre. In Iowa the unusually high average of $1\frac{1}{2}$ tons is secured in counties whose area is dominated by the Carrington loam, while individual fields under favorable circumstances produce 2 tons or more per acre. In all of these areas a mixed seeding to timothy and clover prevails, but in addition a considerable acreage of pure clover seeding is grown each year. In this case the first crop is cut for hay, while the second crop is used for the production of seed.

In very few instances has alfalfa been tried upon this soil type, although in Iowa, Minnesota, and North Dakota varieties of alfalfa, competent to withstand the severe winter climate, have been shown to be suited to growth upon it. In these latter locations the type shows a considerable percentage of calcium carbonate in the subsoil. Wherever surface and subsoil drainage are complete, and where inoculation has been secured, alfalfa has given good yields upon the Carrington loam. It is particularly well suited as a hay crop to the more western locations, where the rainfall is sometimes not sufficient to give large yields of the mixed timothy and clover commonly seeded.

In addition to the tame grasses thus grown, a large acreage of wild prairie grass is cut annually in the North Dakota areas where the Carrington loam occurs. The average yields reported range from 1 ton to $1\frac{1}{2}$ tons per acre, with an average of $1\frac{1}{4}$ tons over considerable periods of time. Prairie grass is also grazed both for beef production and for dairy purposes.

Flax is grown in both Minnesota and North Dakota for the seed, and average yields of 10 to 12 bushels per acre are secured. The crop is a favorite one in pioneer sections where the prairie sod covering the Carrington loam is first broken. The first yields—for one, two, or even three years—are high, but then rapidly deteriorate until the crop is abandoned. It has been found, however, that with

the adoption of a proper crop rotation the yields of flax may be maintained at a profitable point for a considerable length of time.

Sugar beets are successfully grown upon the Carrington loam in some of the southern Minnesota locations, with yields of 8 to 10 tons per acre. The beets show a high percentage of sugar and a high index of purity.

Irish potatoes have been little grown upon the Carrington loam except for home use or in a few scattered locations for sale. The crop is deserving of far greater attention than has usually been given it in connection with the cultivation of this type. Especially in the more northern areas in Minnesota and North Dakota, where rainfall is sufficient, the potato would prove an excellent money crop to be grown in rotation with grain and grass. In these more northern localities the extensive production of corn is hardly desirable, but the adoption of a rational crop rotation will require the growing of an intertilled crop, and for this purpose Irish potatoes could scarcely be excelled. Upon the small areas already devoted to this crop the yields are excellent, ranging from 150 to 200 bushels per acre of smooth marketable tubers of high quality. With proper attention to the selection of varieties suited to more northern locations, potatoes should become a valuable commercial crop upon the Carrington loam, and one well suited to take its place in a standard rotation upon this type for Minnesota and North Dakota localities.

In the extreme western regions of its development the rainfall conditions attendant upon the Carrington loam are such that many of the ordinary farm crops may not be produced with security. In more northern locations recourse must be had to the production of durum wheat and the growing of emmer and millet for forage purposes. In more southern localities, as in Nebraska, Kafir corn may also be produced to advantage.

It is thus seen that the Carrington loam, owing to the wide extent of its distribution and the attendant variations in its climatic surroundings, is not only suited to the production of quite a variety of different crops, but also requires the selection of different groups of crops, in order to establish a necessary and rational crop rotation in the different localities where it occurs. For the more southern and eastern sections the growing of corn for one or two years, to be followed by a crop of oats, and this by the production of grass for two years will constitute an excellent standard crop rotation. In the more northern regions where the rainfall is adequate and the climate is not too severe the growing of corn followed by spring wheat for one or two years, to be followed by grass, will constitute a good rotation. In other cases a division of the acreage devoted to tilled crops between corn and potatoes will probably be more satisfactory

than the production of either of these crops to the exclusion of the other. In the most western region of its development the growing of durum wheat, emmer, millet, and alfalfa will probably constitute the best crop adaptation for this type of soil under conditions of scantier rainfall.

FARM EQUIPMENT.

The farm equipment upon the various areas where the Carrington loam has been encountered varies considerably. In the more eastern locations the regular equipment of the central prairie States dominates with heavy two or four horse teams and an adequate supply of power machinery. In many instances the farm buildings include the dairy barn and silo. In Iowa this form of equipment predominates, although stock raising for beef purposes is more prevalent than dairying as yet. In Minnesota and North Dakota the farm equipment is usually that of numerous teams and power machinery for the seeding and harvesting of large acreages of spring wheat. The barns for the housing of dairy cattle are not so numerous, although dairying is gaining a foothold, particularly in Minnesota.

The type is rather easily tilled and is not difficult to keep in good condition, provided proper crop rotations are adopted. Light-weight teams and equipment, however, are out of place in the cultivation of this soil; and in the areas where it is developed as a prairie soil, particularly, the four-horse hitch and power machinery are better suited to the Carrington loam than any lighter equipment.

SUMMARY.

The Carrington loam is an extensive and important general farming soil. It is developed as a timbered soil in the region around the southern end of Lake Michigan and as a prairie soil in Iowa, Minnesota, and North Dakota.

The Carrington loam is one of the most extensive soil types derived directly from glacial till to be found in the central prairie States.

Both in its physical characteristics and in its organic matter content it is a soil well suited to the production of a wide range of general farming crops. Chief among these are corn, oats, and grass, which dominate the acreage in the more southern locations. Spring wheat dominates the more northern areas where the Carrington loam is found, while flax and barley are here subordinate crops.

Irish potatoes are well suited to production upon this soil and should constitute a commercial crop throughout a considerable portion of the territory where it is found.

Aside from the general farming interests developed on the Carrington loam there is a considerable production of beef cattle in the

western and northern regions where it occurs, and an increasing occupation of this type for the purposes of dairying throughout its extent.

The most important suggestion which may be made for the improvement of the efficiency of the type is that of the adoption of crop rotations suited to the climate of the different areas in which the type is found. Some small portions of the type require supplemental tile drainage to complete the fair to excellent natural drainage of the soil and subsoil.

The Carrington loam ranks high as a corn-producing soil and is noted for the superior quality of the spring wheat grown upon it in Minnesota and North Dakota.

In regions of adequate rainfall, practically all of the Carrington loam has been occupied for general farming purposes. In its more western locations portions of the soil are still used for the cutting of wild hay and for the grazing of cattle.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *May 27, 1911.*

APPENDIX.

The following table shows the extent of the Carrington loam in the areas surveyed to this time.

In the first column is stated the particular soil survey in which the soil was encountered; in the second column, its extent of development in acres; and in the third column, the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of Carrington loam encountered in the soil survey.

Survey.	Area of soil.	Year of publication, Field Operations.	Survey.	Area of soil.	Year of publication, Field Operations.
Indiana:	<i>Acres.</i>		Nebraska:	<i>Acres.</i>	
Marshall County ¹	121, 216	1904	Lancaster County ¹ ...	96, 576	1906
Newton County ¹	81, 856	1905	North Dakota:		
Iowa:			Cando area ¹	79, 936	1904
Cerro Gordo County ¹ ..	242, 112	1903	Carrington area ¹	114, 560	1905
Story County ¹	303, 808	1903	Jamestown area ¹	206, 976	1903
Tama County ¹	1, 728	1904	Richland County ¹	91, 264	1908
Michigan:					
Cass County ¹	20, 554	1906			
Minnesota:					
Blue Earth County ¹ ..	8, 768	1906			
Marshall area ¹	108, 352	1903			
Rice County.....	123, 392	1909			

¹ Mapped as Marshall loam.

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