UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 40

WHITESIDE COUNTY SOILS

By R. S. SMITH, O. I. ELLIS, E. E. DeTURK, F. C. BAUER, and L. H. SMITH

URBANA, ILLINOIS, JUNE, 1928

The Soil Survey of Illinois was organized under the general supervision of Professor Cyril G. Hopkins, with Professor Jeremiah G. Mosier directly in charge of soil classification and mapping. After working in association on this undertaking for eighteen years, Professor Hopkins died and Professor Mosier followed two years later. The work of these two men enters so intimately into the whole project of the Illinois Soil Survey that it is impossible to disassociate their names from the individual county reports. Therefore recognition is hereby accorded Professors Hopkins and Mosier for their contribution to the work resulting in this publication.

[1] Deceased.
[2] Engaged in Soils Extension as well as in Soil Experiment Fields.
[3] On leave.

INTRODUCTORY NOTE

It is a matter of common observation that soils vary tremendously in their productive power, depending upon their physical condition, their chemical composition, and their biological activities. For any comprehensive plan of soil improvement looking toward the permanent maintenance of our agricultural lands, a definite knowledge of the various existing kinds or types of soil is a first essential. It is the purpose of a soil survey to classify the various kinds of soil of a given area in such a manner as to permit definite characterization for description and for mapping. With the information that such a survey affords, every farmer or landowner of the surveyed area has at hand the basis for a rational system of improvement of his land. At the same time the Experiment Station is furnished an inventory of the soils of the state, upon which intelligently to base plans for those fundamental investigations so necessary for solving the problems of practical soil improvement.

This county soil report is one of a series reporting the results of the soil survey which, when completed, will cover the state of Illinois. Each county report is intended to be as nearly complete in itself as it is practicable to make it, even at the expense of some repetition. There is presented in the form of an Appendix a general discussion of the important principles of soil fertility, in order to help the farmer and landowner to understand the significance of the data furnished by the soil survey and to make intelligent application of the same in the maintenance and improvement of the land. In many cases it will be of advantage to study the Appendix in advance of the soil report proper.

Data from experiment fields representing the more extensive types of soil, and furnishing valuable information regarding effective practices in soil management, are embodied in the form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

While the authors must assume the responsibility for the presentation of this report, it should be understood that the material for the report represents the contribution of a considerable number of the present and former members of the Agronomy Department working in their respective lines of soil mapping, soil analysis, and experiment field investigation. In this connection special recognition is due the late Professor J. G. Mosier, under whose direction the soil survey of Whiteside county was conducted.

CONTENTS OF SOIL REPORT NO. 40

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By R. S. Smith, O. I. Ellis, E. E. DeTurk, F. C. Bauer, and L. H. Smith[1]

Whiteside county is situated on the Mississippi river in the northwestern part of Illinois about 40 miles south of the Wisconsin state line. It has an area of about 700 square miles.

The climate of Whiteside county is characterized by a wide range in temperature between the extremes of winter and summer. Records from the weather station at Morrison, Illinois, show that the greatest range in temperature for any one year during the past twenty-three years was 130 degrees in 1914. The highest temperature recorded during this period was 107°; the lowest, 30° below zero. The average date of the last killing frost in the spring is May 4. The latest killing frost recorded was May 27 in 1907. The average date of the first killing frost in the fall is October 12, and September 11 is the earliest date on which such a frost has occurred. The average length of the growing season is 161 days.

The average annual rainfall during this period of twenty-three years was 33.92 inches, distributed as follows: January, 1.47 inches; February, 1.55; March, 2.58; April 3.10; May, 4.22; June, 4.03; July, 3.46; August, 3.75; September, 4.00; October, 2.36; November, 1.81; December, 1.54.

The topography of Whiteside county varies from flat to rough and broken. The southern and southwestern portions of the county are flat except where broken by sand dunes or dune-like topography, resulting from wind action. In the northern and northwestern parts of the county rough, broken land occurs. This broken topography is the result of stream erosion.

The drainage of the county all finds its way into Mississippi river, for the most part thru Rock river. The swamp and terrace areas south of Rock river and in the neighborhood of the village of Erie, north of Rock river, are underlain by sand and gravel. Because of the high water table, however, the drainage of these areas was not good until dredge ditches were constructed. Meredosia slough, which forms the boundary between Rock Island and Whiteside counties, is a sluggish stream. It serves as a cut-off between Mississippi and Rock rivers during periods of high water.

The altitudes at a few points in Whiteside county are as follows: Sterling, 649 feet; Morrison, 670; Fulton, 594; Albany, 586; Erie, 597; Prophetstown, 627; Tampico, 647.

AGRICULTURAL PRODUCTION

A diversity of interests is represented in the agriculture of Whiteside county, the more important of which are grain production, livestock, and dairying. On some farms one or another of these enterprises predominates, while on other

[1] R. S. Smith, in charge of soil survey mapping; O. I. Ellis, Assistant Chief in soil survey mapping; E. E. DeTurk, in charge of soil analysis; F. C. Bauer, in charge of experiment fields; L. H. Smith, in charge of publications.

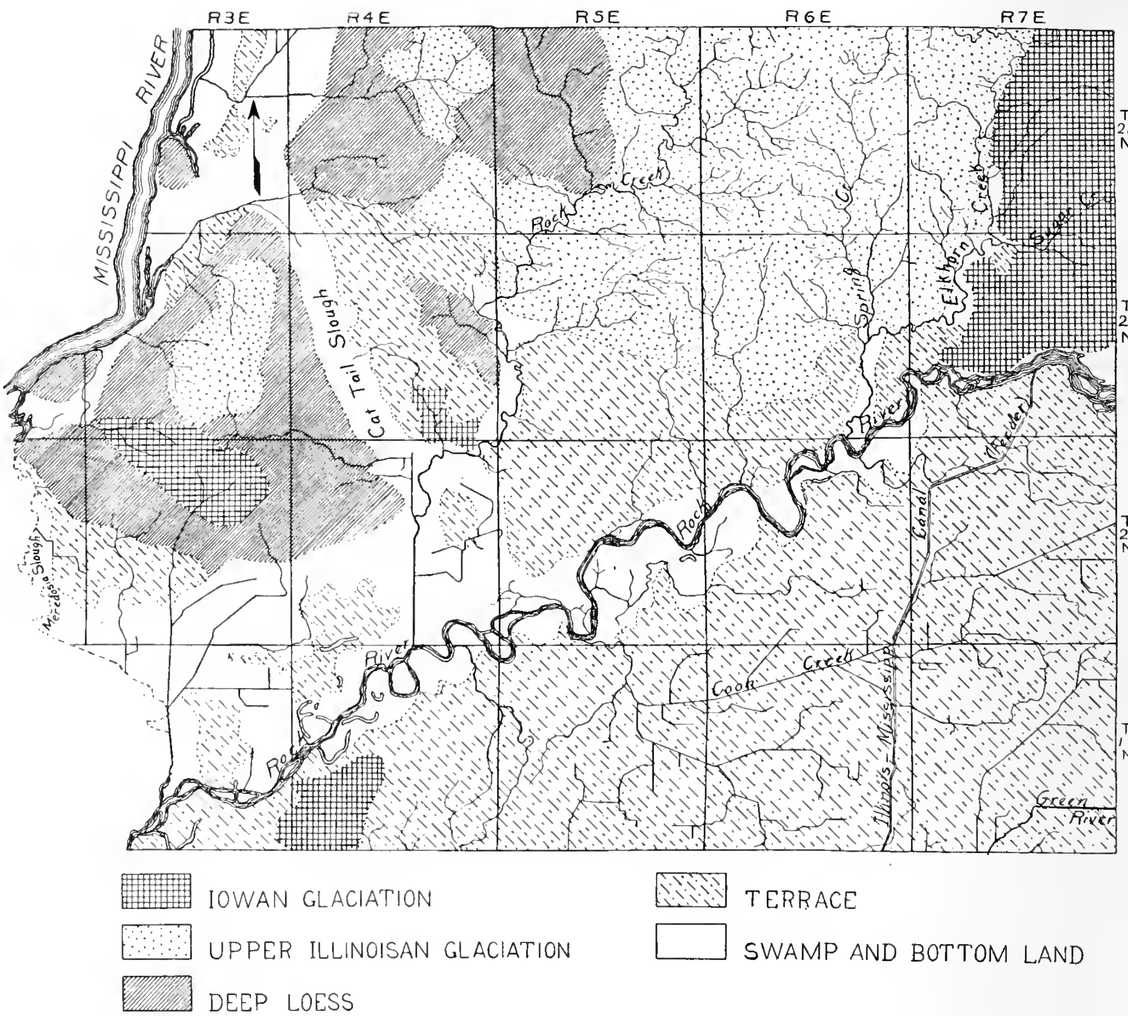


FIG. 1.—DRAINAGE MAP OF WHITESIDE COUNTY, SHOWING STREAM COURSES AND GEOLOGICAL AREAS

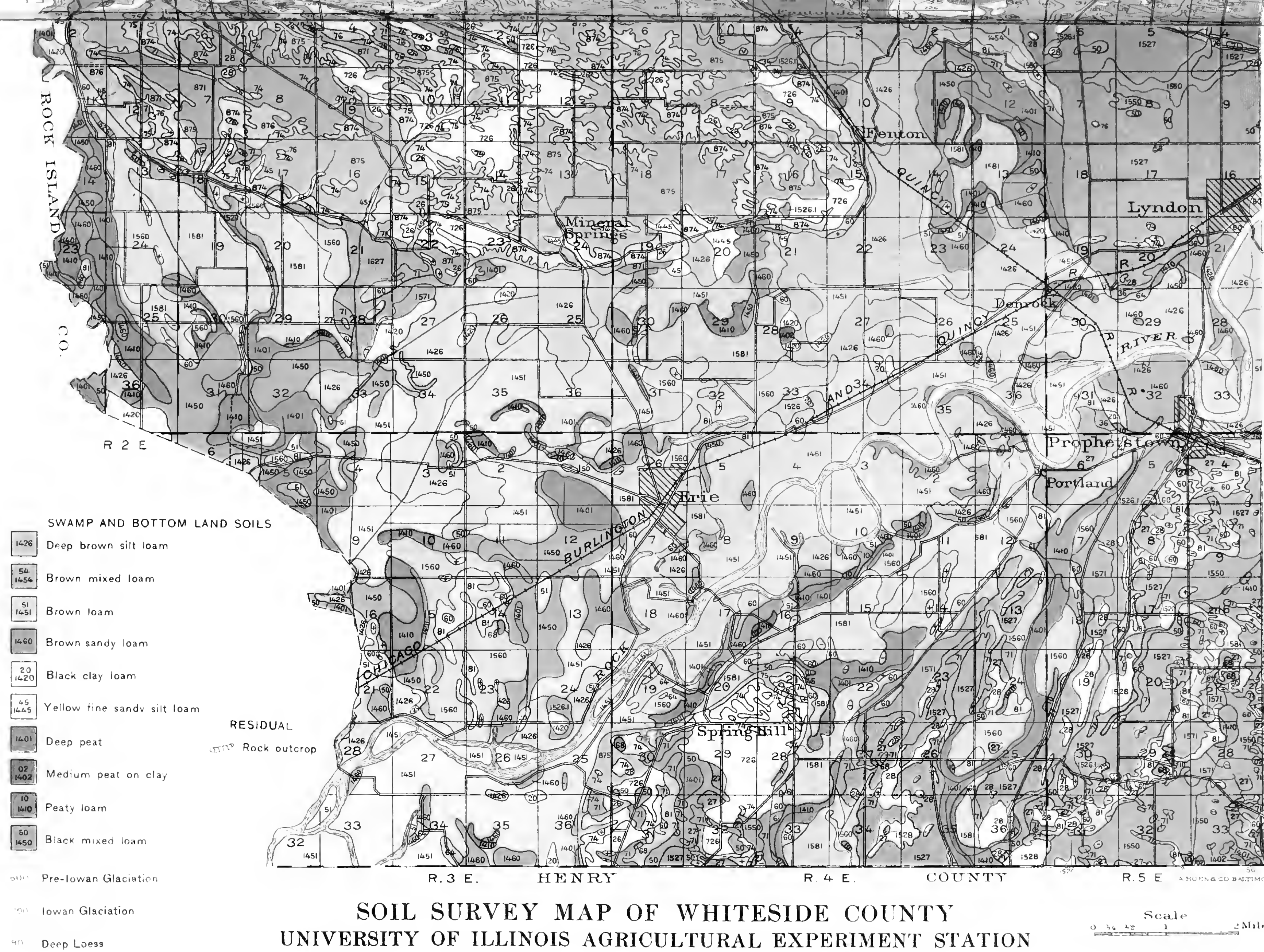
farms a combination of them is found. Taking the county as a whole, the most important sources of farm income are dairy products, beef cattle, and hogs, supplemented by the sale of grains and hay.

The livestock industry is well developed on the uplands in the western part of the county where the land is adapted to pasture because of its rough and broken topography. The dairy industry is centered around Morrison, Sterling, and Rock Falls. Most of the milk is hauled in by trucks to the condensories which are located in these towns.

The lowlands in the terrace and swamp area south of Rock river have, for many years, been in pasture because of the lack of proper drainage. Within recent years these lowlands for the most part have been sufficiently drained by dredges and tile to permit cultivation.

Sweet clover, alfalfa, and red clover grow very well on many of the soil types in the county without liming. A mixture of vetch and rye is grown on


LEGEND
UPLAND PRAIRIE SOILS
26 626 726 Brown silt loam
71 871 Brown fine sandy loam
76 876 Mixed sand and loess
660.5 Brown sandy loam on rock
UPLAND TIMBER SOILS
34 634 734 Yellow-gray silt loam
35 635 735 Yellow silt loam
74 874 Yellow-gray fine sandy loam
76 875 Yellow fine sandy loam
TERRACE SOILS
27 1527 Brown silt loam over gravel
36 1536 Yellow gray silt loam over gravel
1526.1 Brown silt loam on clay
28 1528 Brown-gray silt loam on tight clay
71 1571 Brown fine sandy loam
50 1550 Black mixed loam
61 1561 Black sandy loam
60 1560 Brown sandy loam
68 1568 Brown-gray sandy loam on tight clay
64 1564 Yellow-gray sandy loam
81 1581 Dune sand
1520 Black clay loam
R.3 E.
CARROLL
R.4 E.
COUNTY
R.5 E
T. 22 N.
T. 21 N
MISSISSIPPI RIVER
CHICAGO
BURLINGTON AND
C. B. & Q. R. R.
C. M. & ST. P. R. R.
C. & N. W. R. R.
Fulton
East Clinton
Garden Plain
Albany
Ustick
Union Grove
Unionville
MORRISON
Fenton Jc.



SOIL SURVEY MAP OF WHITESIDE COUNTY
UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

much of the sandy soil. A rough estimate places the area devoted to pasture at 55,000 to 60,000 acres. A very large proportion of this pasture land is too rough for cultivation.

As a rule, each farm includes a small truck garden and orchard. In the deep loess region in the western part of the county, some commercial orcharding is carried on.

According to the Fourteenth Census of the United States there were 2,789 farms in Whiteside county in 1920, a decrease of 109 farms in ten years.

The following table shows the acreage and yield of the more important crops for the year 1919, as given by the above-mentioned Census.

Crops	*Acreage*	*Production*	*Yield per acre*
Corn	110,537	4,796,574 bu.	43.4 bu.
Oats	57,632	1,869,165 bu.	32.4 bu.
Wheat	26,397	615,726 bu.	23.3 bu.
Rye	20,946	291,213 bu.	13.9 bu.
Barley	8,864	199,270 bu.	22.4 bu.
Timothy	8,946	12,460 tons	1.39 tons
Timothy and clover mixed	22,782	36,089 tons	1.58 tons
Clover	4,437	7,565 tons	1.70 tons
Alfalfa	588	1,610 tons	2.74 tons
Silage crops	7,700	70,044 tons	9.09 tons
Corn for forage	8,218	20,202 tons	2.45 tons

It should be borne in mind that these figures represent the yields for only a single season. Figures furnished by the U. S. Department of Agriculture give the following average acre-yields for the five-year period, 1921-1925: corn, 41.4 bushels; oats, 37.1 bushels; wheat, 20.1 bushels; tame hay, 1.46 tons.

The following figures taken from the 1920 Census show the character of the livestock interests in Whiteside county. The total value of livestock was $7,919,000 in 1919.

Animals and Animal Products	*Number*	*Value*
Horses	19,213	$1,582,149
Mules	590	64,989
Beef cattle	25,455	1,731,900
Dairy cattle	35,993	2,497,977
Swine	85,927	1,961,405
Sheep	6,107	80,005
Value of eggs and chickens	......	828,923
Value of dairy products	......	1,804,767

ORIGIN AND DEVELOPMENT OF SOILS

One of the most important periods in the geological history of the county, from the standpoint of soil formation, was the Glacial period, during and immediately following which there was being deposited the material that later formed the mineral portion of the soils. From the centers of accumulation in Labrador, in the Hudson Bay region, and in the northern Rocky mountains, at least six great ice sheets moved southward, each of which covered a part of northern United States, altho the same parts were not covered during each advance.

Whiteside county occupies a region which has been subjected to vigorous glacial and stream action. The exact glacial history of the region is not fully known, but for the purpose of the soil survey, it is sufficient to note that the glacial, stream, and wind action was such as to cover the entire county with loess to a depth varying from about 150 feet in the western portion to 15 or 20 feet in the eastern portion. A few restricted areas in the eastern portion of the county have a loess cover of only about 5 feet, but loess is the material from which nearly all the soils of the county. as we find them today, were formed. Sand dunes occur, chiefly along Mississippi river and Meredosia slough and south of Rock river. This sand material was segregated by the wind from the alluvial material deposited by the streams. It now forms undesirable soil because of its coarse texture and relative poverty in the elements of plant food. A number of peat deposits occur in Whiteside county. These deposits occur in depressions where excess water favored the growth of swamp vegetation and the accumulation of deep deposits of this organic material.

Limestone outcrops occur in the northwestern part of the county, but they are not extensive. The reader is referred to State Geological Survey Bulletin No. 46 for information regarding the quantity, quality, and availability of the limestone outcrops in Whiteside county.

Immediately following the deposit of the soil material, the forces of weathering began the development of the soils as they now occur. The upland became, for the most part, covered by a grass vegetation, thus very largely preventing erosion and making possible the slow but uninterrupted accumulation of organic matter and the formation of the dark-colored prairie soils. The upland adjacent to the streams is occupied by light-colored soil, due to the fact that trees invaded the land along the streams, thus bringing about conditions unfavorable for the accumulation of organic matter. During this time the movement of water thru the soil caused the formation of layers or horizons, commonly spoken of as surface or A_1 horizon, subsurface or A_2 horizon, and subsoil or B horizon. The less-weathered material below the B horizon is spoken of as the C horizon, and its character, particularly with reference to presence or absence of limestone particles, is important.

The bottom lands are occupied by alluvial, or water-borne, material which, because of its recent deposition and continued movement by the wind, has not formed distinct horizons.

SOIL GROUPS

The soils of Whiteside county are divided into the following groups:

Upland Prairie Soils, including the dark-colored upland soils.

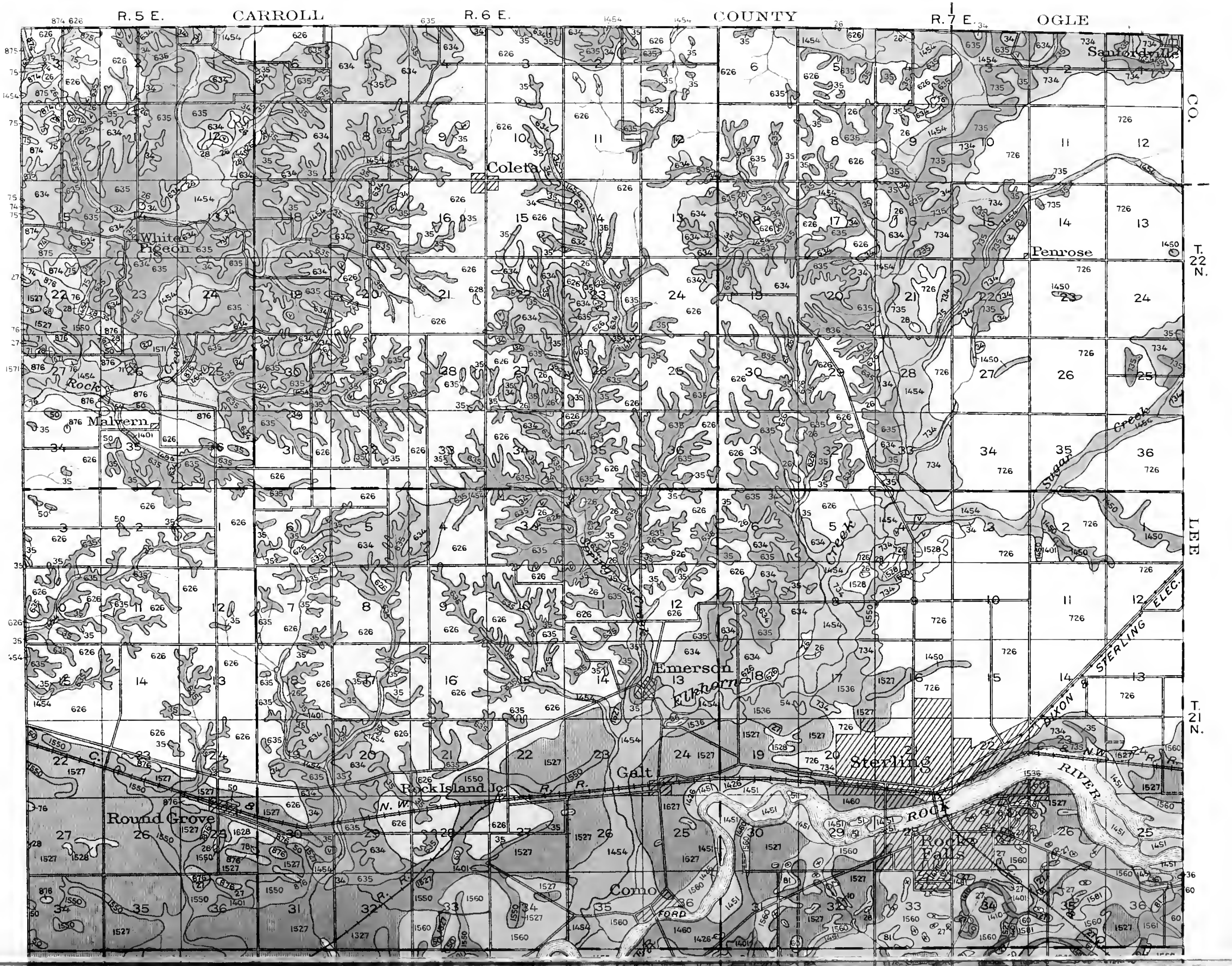
Upland Timber Soils, including the light-colored upland soils.

Terrace Soils, including alluvial soils now above overflow or rarely under water.

Swamp and Bottom-Land Soils, including the overflow lands or flood plains along streams, the swamps, and the poorly drained lowlands.

Residual Soils, including rock outcrop areas and soils formed in place thru weathering of rocks.

Table 1 gives the list of soil types found in Whiteside county, the area of each in square miles and in acres, and also its percentage of the total area. The



LEGEND

UPLAND PRAIRIE SOILS

- 26, 626, 726 — Brown silt loam
- 71, 871 — Brown fine sandy loam
- 76, 876 — Mixed sand and loess
- 660.5 — Brown sandy loam on rock

UPLAND TIMBER SOILS

- V 34, 634, 734 — Yellow-gray silt loam
- 35, 635, 735 — Yellow silt loam
- 74, 874 — Yellow-gray fine sandy loam
- 75, 875 — Yellow fine sandy loam

TERRACE SOILS

- 1520 — Black clay loam
- 27, 1527 — Brown silt loam over gravel
- 36, 1536 — Yellow gray silt loam over gravel
- 1526 — Brown silt loam on clay
- 28, 1628 — Brown-gray silt loam on tight clay
- 71, 1671 — Brown fine sandy loam
- 50, 1550 — Black mixed loam
- 61, 1561 — Black sandy loam

- 1568 Brown-gray sandy loam on tight clay
- 64 / 1664 Yellow-gray sandy loam
- + / 81 / 1581 Dune sand

SWAMP AND BOTTOM LAND SOILS

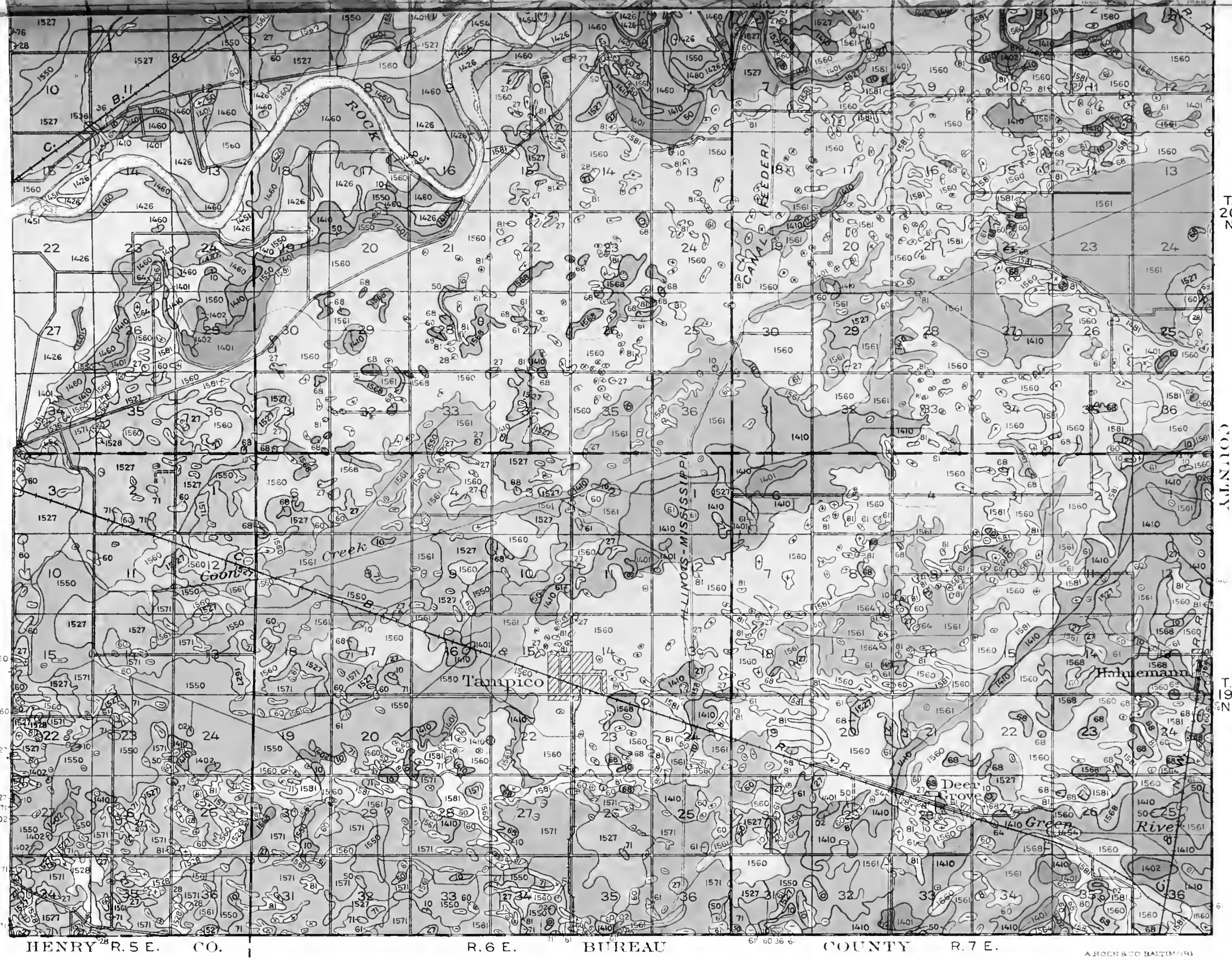
- 1426 Deep brown silt loam
- 54 / 1454 Brown mixed loam
- 51 / 1451 Brown loam
- 1460 Brown sandy loam
- 20 / 1420 Black clay loam
- 45 / 1445 Yellow fine sandy silt loam
- 1401 Deep peat
- 02 / 1402 Medium peat on clay
- 10 / 1410 Peaty loam
- 50 / 1450 Black mixed loam

RESIDUAL

- Rock outcrop
- Pre-Iowan Glaciation
- Iowan Glaciation
- Deep Loess

Scale

0 ¼ ½ 1 2 Miles



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accompanying map in two sheets shows the location and boundary of each type down to areas a few acres in extent. For explanations concerning the classification of soils and interpretation of the map, the reader is referred to the first part of the Appendix to this report.

TABLE 1.—SOIL TYPES OF WHITESIDE COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	Upland Prairie Soils (600, 700, 800)			
626 726	Brown Silt Loam	93.28	59,699	13.31
871	Brown Fine Sandy Loam	9.99	6,394	1.43
876	Mixed Sand and Loess	25.91	16,582	3.70
660.5	Brown Sandy Loam On Rock	.29	186	.04
		129.47	82,861	18.48
	Upland Timber Soils (600, 700, 800)			
634 734	Yellow-Gray Silt Loam	26.65	17,056	3.80
635 735	Yellow Silt Loam	38.48	24,627	5.49
874	Yellow-Gray Fine Sandy Loam	27.58	17,651	3.93
875	Yellow Fine Sandy Loam	35.76	22,886	5.10
		128.47	82,220	18.32
	Terrace Soils (1500)			
1527	Brown Silt Loam Over Gravel	73.97	47,341	10.55
1536	Yellow-Gray Silt Loam Over Gravel	3.70	2,368	.53
1526.1	Brown Silt Loam On Clay	1.55	992	.22
1528	Brown-Gray Silt Loam On Tight Clay	4.17	2,669	.59
1571	Brown Fine Sandy Loam	13.56	8,678	1.93
1550	Black Mixed Loam	27.87	17,837	3.98
1561	Black Sandy Loam	22.36	14,310	3.19
1560	Brown Sandy Loam	86.57	55,405	12.35
1568	Brown-Gray Sandy Loam On Tight Clay	4.22	2,701	.60
1564	Yellow-Gray Sandy Loam	.72	461	.10
1581	Dune Sand	33.25	21,280	4.75
1520	Black Clay Loam	.17	109	.03
		272.11	174,151	38.82
	Swamp and Bottom-Land Soils (1400)			
1426	Deep Brown Silt Loam	28.53	18,259	4.07
1454	Brown Mixed Loam	24.07	15,405	3.43
1451	Brown Loam	33.78	21,619	4.82
1460	Brown Sandy Loam	22.99	14,714	3.28
1420	Black Clay Loam	2.41	1,542	.34
1445	Yellow Fine Sandy Silt Loam	6.64	4,250	.95
1401	Deep Peat	14.60	9,344	2.08
1402	Medium Peat On Clay	.91	582	.13
1410	Peaty Loam	19.35	12,384	2.77
1450	Black Mixed Loam	8.28	5,299	1.18
		161.56	103,398	23.05
	Residual Soils (000)			
099	Rock Outcrop	.12	77	.02
	Miscellaneous			
	Water	9.17	5,869	1.31
	Total	700.90	448,576	100.00

INVOICE OF THE ELEMENTS OF PLANT FOOD IN WHITESIDE COUNTY SOILS

THREE DEPTHS REPRESENTED BY SOIL SAMPLES

In the Illinois soil survey each soil type is sampled in the manner described below and subjected to chemical analysis in order to obtain a knowledge of its important plant-food elements. Samples are taken, usually in sets of three, to represent different strata in the top 40 inches of soil, namely:

1. An upper stratum extending from the surface to a depth of 6⅔ inches. This stratum, over the surface of an acre of the common kinds of soil, includes approximately 2 million pounds of dry soil.
2. A middle stratum extending from 6⅔ to 20 inches, and including approximately 4 million pounds of dry soil to the acre.
3. A lower stratum extending from 20 to 40 inches, and including approximately 6 million pounds of dry soil to the acre.

By this system of sampling we have represented separately three zones for plant feeding. It is with the upper, or surface layer, that the following discussion is mostly concerned, for it includes the soil that is ordinarily turned with the plow and is the part with which the farm manure, limestone, phosphate, or other fertilizing material is incorporated. Furthermore, it is the only stratum which can be greatly changed in composition as a result of adding plant food.

For convenience in making application of the chemical analyses, the results presented in Tables 2, 3, and 4 are given in terms of pounds per acre. It is a simple matter to convert these figures to a percentage basis in case one desires to consider the information in that form. In comparing the composition of the different strata, it must be kept in mind that it is based on different quantities of soil, as indicated above. In order to show the comparative concentration of the various constituents in the different strata, the figures for the middle and lower strata must, therefore, be divided by two and three respectively.

Wide Range in Organic Matter and Nitrogen

It can readily be seen from Table 2 that there is a wide variation among the different soil types of Whiteside county with respect to their content of the different plant-food elements in the upper 6⅔ inches of soil. There appears to be but little relationship among these variations except with respect to organic carbon and nitrogen, the quantities of which run parallel from type to type tho the organic-carbon content is usually 10 to 12 times as great as the nitrogen. This relationship between organic carbon and nitrogen is explained by the well-established facts that all soil organic matter (of which organic carbon is the measure) contains nitrogen and that most of the soil nitrogen—usually 98 percent or more—is present in a state of organic combination, that is, as a part of the organic matter.

The upland prairie soils of Whiteside county are, for the most part, relatively high in organic matter and nitrogen; the upland timber soils in general fairly low, altho there is some overlapping in the two groups with respect to these constituents. For example, the lowest amount of organic carbon found among the upland prairie types, 20,800 pounds an acre in Brown Sandy Loam On Rock, is somewhat lower than the highest value in the upland timber group, 25,020 pounds in Yellow-Gray Silt Loam, even tho the upland prairie soils as a whole contain more than twice as much organic carbon as the timber soils. Their respective averages are 42,300 and 19,310 pounds for the surface 6⅔ inches.

The terrace and bottom-land soils contain, in general, more organic matter than the upland soils, altho wide variations are to be found also among the different types within each of these two groups.

The largest amount of organic carbon is found in Deep Peat. Since organic matter is approximately half carbon, the 352,360 pounds of organic carbon in a million pounds of this soil correspond to 704,720 pounds of organic matter, or to 70.5 percent of the soil. The lowest amount of this constituent, 11,800 pounds an acre, is found in Yellow-Gray Sandy Loam, Terrace; while Dune Sand, Terrace, with 14,670 pounds, and Yellow Fine Sandy Loam, Upland, with 12,620 pounds, are close seconds. Soils of this character present unusual difficulty when it comes to maintaining an adequate supply of organic matter, their porous, open texture permitting its rapid oxidation, so that it disappears much more rapidly than from the heavier types. For this reason especial care should be taken to provide frequent green-mānuring crops as well as any other available organic residues which may be used for maintaining a supply of organic matter. These soils are usually acid, and consequently the application of limestone is in most cases the first step in their improvement.

With the exception of Deep Peat, all the soil types diminish rather rapidly in organic matter and nitrogen with increasing depth, and this diminution is noticeable even in the middle stratum.

Phosphorus Content Increases From Light to Heavy Types

The sandy soils contain, on the whole, less total phosphorus than those of heavier texture. The smallest quantity, 620 pounds in the upper stratum, was found in Yellow-Gray Sandy Loam, Terrace. All the very sandy soils, as well as the light-colored timber soils, are somewhat low in total phosphorus. Such soils, while they generally respond to phosphate fertilization, do not produce the increases for such treatment that might be expected, in part because of the greater feeding range for crop roots afforded by the loose, penetrable character of these types. On the whole, soils which are very high in organic matter are usually somewhat high in total phosphorus. Thus Black Clay Loam, Deep Brown Silt Loam, Deep Peat, and other types carrying 80,000 pounds or more of organic carbon in the surface soil of an acre usually have about 2,000 pounds or more of phosphorus in that stratum.

Phosphorus, unlike some other elements, is not appreciably removed from the soil by leaching. It is converted by growing plants into organic form and tends to accumulate in the surface soil in plant residues at the expense of underlying strata. Investigations at the Illinois Station have shown that in Brown Silt Loam, for example, about 33 percent of the total phosphorus of the surface soil is organic, and in Black Clay Loam about 37 percent. It is the second stratum (6⅔ to 20 inches) which furnishes most of the phosphorus thus moved upward. Consequently in the majority of soil types the surface soil contains a larger proportion of phosphorus than the middle stratum and, in some cases, more than the lower stratum.

Sulfur Generally Well Supplied

While other elements are not so closely associated with each other as are organic matter and nitrogen, there is some degree of correlation between sulfur, another element used by growing plants, and organic carbon. This is because a considerable tho varying proportion of the sulfur in the soil exists in the organic form, that is, as a constituent of organic matter.

Most of the Whiteside county soils are fairly well supplied with sulfur altho some low values are found. It ranges in the surface soil from a minimum of 180 pounds an acre in Brown Sandy Loam On Rock up to 3,340 pounds in Deep Peat. Excluding the peat soils, the sulfur content of Whiteside county soils averages a little less than half that of phosphorus.

The sulfur content decreases with depth in nearly all cases as may be seen from a comparison of the figures in Tables 2, 3, and 4. This is to be expected since, as stated above, a portion of the sulfur exists in combination with the organic matter of the soil and not only is the organic matter more abundant in the upper stratum, but also the organic forms of sulfur are held more tenaciously against the leaching action of ground water than are the inorganic forms.

The sulfur available to crops, however, is affected not only by the soil supply but also by that brought down from the atmosphere by rain. Sulfur dioxid escapes into the air in the gaseous products from the burning of all kinds of fuel, particularly coal. The gaseous sulfur dioxid is soluble in water and consequently is dissolved out of the air by rain and brought to the earth. In regions of large coal consumption the amount of sulfur thus added to the soil is relatively large. At Urbana during the eight-year period from 1917 to 1924 there has been added to the soil by the rainfall an average of 3.5 pounds of sulfur an acre a month. Similar observations have been made in other localities for shorter periods. The precipitation at the various points in the state in a single month has varied from a minimum of ¾ of a pound to more than 10 pounds an acre.

These figures afford some idea of the amount of sulfur added by rain, and also of the wide variations under different conditions. On the whole, the facts would indicate that the sulfur added from the atmosphere supplements adequately that contained in the soil, so that apparently there is little need for sulfur fertilizers in Whiteside county. In order to determine definitely the response of crops to applications of sulfur fertilizers, experiments with gypsum have been started on a number of the Illinois experiment fields.

Potassium Deficient in Peat and Sand Types

Potassium is deficient both in Deep Peat and in Medium Peat On Clay, as is usually the case with these types; the total amounts in the upper 6⅔ inches are 4,590 and 9,030 pounds an acre respectively. A number of the sandy types in Whiteside county are comparatively low in their content of this element. Black Sandy Loam, Brown-Gray Sandy Loam On Tight Clay, and Dune Sand contain, for example only 19,000 to 21,000 pounds per acre of this element and Peaty Loam only 20,590 pounds. These amounts are about two-thirds as high as the 33,000-pound value around which most of the types vary. This condition, however, does not extend to all the sandy types.

Sandy soils, besides containing generally less total potassium than the heavier types, carry a large proportion of their potassium in the coarse sand grains. The relatively smaller total surface exposed in the case of these coarser soil particles reduces the rate at which potassium is dissolved, thus lowering its availability. This deficiency of available potassium in sandy soils may be offset, partly at least, by the greater facility with which crop roots can penetrate soils of that character as compared with heavier types.

The other soil types of Whiteside county are normal in their content of potassium. Potassium exhibits little difference in concentration in the three sampling layers.

Calcium and Magnesium Vary Widely Within the Type

The variations in the amounts of calcium and magnesium present in the soils of Whiteside county are very wide, tho none of the types are particularly low in either of these elements. In very acid soils it sometimes happens that the calcium present is in such highly insoluble forms that there is not enough of it available for good crop growth. The benefit realized from liming acid soils may, therefore, be due not wholly to the correction of acidity but in part to the fact that the limestone supplies calcium as a plant-food element in a form which rapidly becomes available to crops.

Variations in the amounts of these two elements in the different depths of those soils which do not contain native calcium carbonate furnish a clue as to the translocations of these elements during the long period in which the different types were developing. In the surface stratum calcium exceeds magnesium in most cases. This would indicate a larger percentage of calcium than of magnesium in the soil-forming materials. The idea is also in harmony with geological evidence. With increasing depth we find the calcium concentration about the same as in the surface, while an increase in magnesium occurs in the second stratum and becomes very pronounced in the lower.

This situation may be explained by the fact that as these two elements are dissolved from the surface soil, they are carried downward in solution. In the downward movement magnesium is more readily reabsorbed by the soil mass than calcium, tending to force calcium into the solution to be carried farther down. Consequently, while magnesium tends to accumulate in the middle and lower strata, the liberated calcium may accumulate at still greater depths or may be washed away entirely. These movements of calcium and magnesium, as indicated by the analyses of the different strata, constitute one factor in estimating the relative maturity of the various soil types. The higher proportion of magnesium to calcium in the lower levels as compared to the surface soil tends, in general, to increase with the more fully developed or mature profiles. Thus we see a correlation of this chemical characteristic of the soil with the processes of its development.

Some of the calcium figures, as given in the tables. appear to be very erratic. The very large amounts of calcium in some of the types are an indication of the presence of finely divided native calcium carbonate (limestone) in some or all of the samples of such types. Sometimes calcium carbonate is present in the surface stratum, as in the case of Black Sandy Loam, with its high calcium figure of

53,620 pounds an acre. Again, being fairly soluble in the soil water, the calcium carbonate has leached away from the upper stratum in some soils, but is still present in the middle or in the lower stratum. Brown Sandy Loam, Bottom, illustrates this condition. In this type the upper and middle strata are acid in all samples collected and the calcium content is, on the whole, no higher than in other types, namely, 10,970 pounds per acre in the upper and 34,460 pounds in the second stratum. The lower stratum, however, has 217,470 pounds of calcium in 6 million pounds of soil, which after being converted to the 2-million pound basis for comparison with the surface stratum is found to be nearly seven times as concentrated. The lower stratum in this case contains a large amount of calcium carbonate which has not yet been leached away, and this is responsible for the high figure for total calcium.

Some increase in total magnesium will be observed accompanying the high calcium of the carbonate-containing soils. These are not great, however, since the magnesium does not readily persist in the soil as the carbonate. The carbonate of carbonate-containing soils is chiefly that of calcium.

Local Tests for Soil Acidity Often Required

It is impracticable to attempt to obtain an average quantitative measure of the calcium carbonate present in a given type because, while some samples contain large amounts, others contain none, but on the other hand have a lime requirement due to the soil acidity. We thus have what may be considered positive and negative values ranging, perhaps widely, on the opposite sides of the zero or neutral point, the numerical average of which could have no significance whatever, since it would not necessarily even approach the condition actually existing in a given farm or field. It is for this reason that the tables contain no figures purporting to represent either the lime requirement or the limestone present in the different soil types.

The qualitative field tests made in the process of the soil survey are much more numerous than the chemical analyses made in the laboratory, and do give a general idea of the predominating condition in the various types as to acidity or alkalinity. These tests, therefore, furnish the basis for some general recommendations which are given in the descriptions of individual types on pages 14 to 29. To have a sound basis for the application of limestone the owner or operator of a farm must often determine individually the lime-requirements of his different fields. The section in the Appendix dealing with the application of limestone (page 37) is pertinent and should be read in this connection.

Supplies of Different Elements Not Proportional to Crop Removal

In the foregoing discussion we have considered mainly the amounts of the plant-food elements in the surface 6⅔ inches of soil, and rather briefly the relative amounts in the two lower strata. We have noted that some of the elements of plant food exhibit no consistent change in amount with increasing depth. Other elements show more or less marked variation at the different levels, the trend of these variations serving in some cases as clues to the relative maturity of different types and the processes involved in their development.

TABLE 2.—PLANT-FOOD ELEMENTS IN THE SOILS OF WHITESIDE COUNTY, ILLINOIS
UPPER SAMPLING STRATUM: ABOUT 0 TO 6⅔ INCHES

Average pounds per acre in 2 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils, (600, 700, 800)							
626, 726	Brown Silt Loam	61 150	4 850	1 200	670	34 120	8 270	11 710
871	Brown Fine Sandy Loam	44 940	3 930	1 220	740	32 570	7 700	11 640
876	Mixed Sand and Loess[1]	......	......	......	......	......	......	......
660.5	Brown Sandy Loam On Rock	20 800	1 740	740	180	24 980	3 820	8 820
	Upland Timber Soils (600, 700, 800)							
634, 734	Yellow-Gray Silt Loam	25 020	2 220	880	320	37 030	6 680	10 280
635, 735	Yellow Silt Loam	16 230	1 730	890	290	35 610	9 370	9 270
874	Yellow-Gray Fine Sandy Loam	23 360	2 350	790	330	35 350	7 460	10 840
875	Yellow Fine Sandy Loam	12 620	1 510	870	290	35 150	9 670	12 230
	Terrace Soils (1500)							
1520	Black Clay Loam	83 380	7 600	2 160	1 220	28 160	15 480	54 980
1527	Brown Silt Loam Over Gravel	47 940	4 110	1 160	560	31 080	6 900	9 850
1536	Yellow-Gray Silt Loam Over Gravel	33 990	3 040	940	330	35 900	5 870	11 350
1526.1	Brown Silt Loam On Clay	54 260	4 280	1 220	560	33 900	7 660	11 320
1528	Brown-Gray Silt Loam On Tight Clay	63 410	6 210	1 910	800	33 970	5 960	9 370
1571	Brown Fine Sandy Loam	60 590	4 840	1 480	670	29 380	7 350	14 950
1550	Black Mixed Loam[1]	......	......	......	......	......	......	......
1561	Black Sandy Loam	98 090	9 590	1 840	1 520	19 150	10 570	53 620
1560	Brown Sandy Loam	35 230	2 930	960	490	24 070	4 730	7 490
1568	Brown-Gray Sandy Loam On Tight Clay	38 560	3 320	1 000	380	21 380	4 240	5 680
1564	Yellow-Gray Sandy Loam	11 800	940	620	200	28 000	2 880	6 800
1581	Dune Sand	14 670	1 230	910	210	21 360	3 750	6 710
	Swamp and Bottom-Land Soils (1400)							
1426	Deep Brown Silt Loam	80 020	6 430	2 010	1 020	30 780	11 250	17 140
1454	Brown Mixed Loam[1]	......	......	......	......	......	......	......
1451	Brown Loam	90 330	7 390	2 660	1 150	28 580	9 360	12 850
1460	Brown Sandy Loam	43 080	3 660	1 330	450	25 860	6 280	10 970
1420	Black Clay Loam	86 340	6 720	2 240	960	30 680	15 780	23 220
1445	Yellow Fine Sandy Silt Loam	27 280	2 080	1 080	460	36 320	9 620	21 360
1401	Deep Peat[2]	352 360	30 860	3 060	3 340	4 590	4 800	21 070
1402	Medium Peat On Clay[2]	167 520	16 610	1 150	2 350	9 030	4 400	20 340
1410	Peaty Loam	228 720	20 290	2 050	2 950	20 590	11 350	66 500
1450	Black Mixed Loam[1]	......	......	......	......	......	......	......

LIMESTONE and SOIL ACIDITY.—In connection with these tabulated data, it should be explained that the figures for limestone content and soil acidity are omitted not because of any lack of importance of these factors, but rather because of the peculiar difficulty of presenting in the form of numerical averages reliable information concerning the limestone requirement for a given soil type. A general statement, however, will be found concerning the lime requirement of the respective soil types in connection with the discussions which follow.

[1]On account of the heterogeneous character of this soil type, chemical analyses are not reported.
[2]Amounts reported are for 1 million pounds of Deep Peat and Medium Peat On Clay.

By adding together the figures for all three strata we have an approximate invoice of the total plant-food elements within reach of most of our field crops, since practically their entire feeding range is included in the upper 40 inches. One of the most striking facts brought out of this consideration of the data is the great variation within a given soil type in the relative abundance of the

TABLE 3.—PLANT-FOOD ELEMENTS IN THE SOILS OF WHITESIDE COUNTY, ILLINOIS
MIDDLE SAMPLING STRATUM: ABOUT 6⅔ TO 20 INCHES

Average pounds per acre in 4 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (600, 700, 800)							
626, 726	Brown Silt Loam	59 310	5 290	2 000	490	69 530	20 050	20 720
871	Brown Fine Sandy Loam	51 580	4 420	1 960	540	67 260	19 120	23 360
876	Mixed Sand and Loess[1]	......	......	......	......	......	......	......
660.5	Brown Sandy Loam On Rock	46 440	4 120	1 640	840	48 560	16 880	33 440
	Upland Timber Soils (600, 700, 800)							
634, 734	Yellow-Gray Silt Loam	16 140	2 010	1 710	470	76 750	20 530	19 960
635, 735	Yellow Silt Loam	12 920	1 670	1 990	290	70 160	21 630	18 880
874	Yellow-Gray Fine Sandy Loam	17 760	1 700	1 640	460	72 440	19 940	20 700
875	Yellow Fine Sandy Loam	10 600	1 470	2 030	360	70 040	21 800	24 830
	Terrace Soils (1500)							
1520	Black Clay Loam	81 000	7 360	3 320	1 400	58 280	30 200	86 200
1527	Brown Silt Loam Over Gravel	47 910	4 300	1 790	800	64 970	17 010	19 370
1536	Yellow-Gray Silt Loam Over Gravel	15 360	1 860	1 540	260	75 000	16 180	18 400
1526.1	Brown Silt Loam On Clay	70 120	5 480	2 120	360	71 520	17 400	21 920
1528	Brown-Gray Silt Loam On Tight Clay	36 020	3 440	2 900	1 350	77 060	13 740	17 200
1571	Brown Fine Sandy Loam	61 880	4 780	2 560	940	59 940	15 440	26 360
1550	Black Mixed Loam[1]	......	......	......	......	......	......	......
1561	Black Sandy Loam	83 220	7 380	2 660	1 260	44 460	21 640	70 500
1550	Brown Sandy Loam	46 390	3 950	1 830	690	50 130	10 560	14 690
1568	Brown-Gray Sandy Loam On Tight Clay	21 240	2 160	1 040	440	52 320	11 720	11 760
1564	Yellow-Gray Sandy Loam	11 680	920	1 240	320	61 280	7 800	14 160
1581	Dune Sand	16 230	1 430	1 680	250	42 790	7 330	13 950
	Swamp and Bottom-Land Soils (1400)							
1426	Deep Brown Silt Loam	82 020	7 360	2 880	1 280	63 280	32 240	49 500
1454	Brown Mixed Loam[1]	......	......	......	......	......	......	......
1451	Brown Loam	77 380	6 450	2 630	1 190	60 770	19 390	24 230
1460	Brown Sandy Loam	57 360	5 320	2 420	660	55 400	17 700	34 460
1420	Black Clay Loam	98 320	7 360	3 760	760	63 200	34 240	46 760
1445	Yellow Fine Sandy Silt Loam	52 560	4 080	2 480	1 040	72 120	21 120	40 960
1401	Deep Peat[2]	586 460	39 080	13 470	4 010	14 360	10 660	30 700
1402	Medium Peat On Clay[2]	216 080	19 600	1 570	2 350	9 030	4 400	20 340
1410	Peaty Loam	160 680	13 790	2 670	1 850	49 850	22 710	104 280
1450	Black Mixed Loam[1]	......	......	......	......	......	......	......

LIMESTONE and SOIL ACIDITY.—See note in Table 2.

[1]On account of the heterogeneous character of this soil type, chemical analyses are not reported.
[2]Amounts reported are for 2 million pounds of Deep Peat and Medium Peat On Clay.

various elements present as compared to the amounts removed by crops. For example, in the most extensive type in the county, Brown Silt Loam, Upland, we find that the total quantity of nitrogen in all three strata is 13,380 pounds. This is about the amount of nitrogen contained in the same number of bushels of corn. The amount of phosphorus is only about half as much, or 6,100 pounds, but this amount is equivalent to the phosphorus in nearly three times as much corn, namely, 35,900 bushels.

Table 4.—Plant-Food Elements in the Soils of Whiteside County, Illinois
Lower Sampling Stratum: About 20 to 40 Inches

Average pounds per acre in 6 million pounds of soil

Soil type No.	Soil type	Total organic carbon	Total nitrogen	Total phosphorus	Total sulfur	Total potassium	Total magnesium	Total calcium
	Upland Prairie Soils (600, 700, 800)							
626, 726	Brown Silt Loam	28 300	3 240	2 900	510	103 040	38 810	38 870
871	Brown Fine Sandy Loam	26 550	2 880	2 850	240	102 180	33 570	40 950
876	Mixed Sand and Loess[1]	......	......	......	......	......	......	......
660.5	Brown Sandy Loam On Rock	37 740	3 420	2 400	1 020	70 680	33 240	61 680
	Upland Timber Soils (600, 700, 800)							
634, 734	Yellow-Gray Silt Loam	14 060	1 970	3 450	540	109 590	36 360	35 490
635, 735	Yellow Silt Loam	11 920	1 620	3 480	160	108 860	36 540	36 040
874	Yellow-Gray Fine Sandy Loam	11 640	1 980	3 450	420	105 750	35 100	36 540
875	Yellow Fine Sandy Loam	18 640	1 640	3 580	280	105 540	42 360	63 340
	Terrace Soils (1500)							
1520	Black Clay Loam	51 660	4 440	3 960	960	93 780	45 300	70 140
1527	Brown Silt Loam Over Gravel	26 980	2 780	2 840	710	95 310	30 460	33 110
1536	Yellow-Gray Silt Loam Over Gravel	13 230	1 860	3 330	90	104 370	34 200	33 900
1526.1	Brown Silt Loam On Clay	54 300	3 960	3 240	120	106 500	65 100	38 700
1528	Brown-Gray Silt Loam On Tight Clay	21 210	2 610	3 510	230	111 660	32 640	32 970
1571	Brown Fine Sandy Loam	29 890	2 880	3 000	330	94 320	28 140	43 110
1550	Black Mixed Loam[1]	......	......	......	......	......	......	......
1561	Black Sandy Loam	47 130	3 300	3 330	1 140	78 180	34 020	58 020
1560	Brown Sandy Loam	27 340	2 420	2 080	360	72 300	16 220	20 160
1568	Brown-Gray Sandy Loam On Tight Clay	18 960	2 220	1 800	420	82 380	26 940	23 220
1564	Yellow-Gray Sandy Loam	11 040	900	2 220	180	85 140	17 700	25 140
1581	Dune Sand	12 820	1 260	2 080	180	64 720	11 040	20 340
	Swamp and Bottom-Land Soils (1400)							
1426	Deep Brown Silt Loam	41 380	3 720	3 420	570	91 410	79 020	201 600
1454	Brown Mixed Loam[1]	......	......	......	......	......	......	......
1451	Brown Loam	34 360	2 960	3 040	620	91 260	43 480	86 640
1460	Brown Sandy Loam	59 970	4 320	3 120	1 170	85 350	61 020	217 470
1420	Black Clay Loam	77 520	4 560	7 980	720	71 280	50 280	58 500
1445	Yellow Fine Sandy Silt Loam	172 020	13 620	5 400	2 160	110 220	37 560	52 020
1401	Deep Peat[2]	879 690	58 620	20 210	6 010	21 540	15 990	46 050
1402	Medium Peat On Clay	187 440	16 440	3 530	3 780	94 800	62 160	112 440
1410	Peaty Loam	61 560	4 160	5 200	1 200	87 120	37 800	86 860
1450	Black Mixed Loam[1]	......	......	......	......	......	......	......

LIMESTONE and SOIL ACIDITY.—See note in Table 2.

[1]On account of the heterogeneous character of this soil type, chemical analyses are not reported.
[2]Amounts reported are for 3 million pounds of Deep Peat.

In the surface stratum, however, which is the zone of most intensive crop feeding, we find the relative amounts of nitrogen and phosphorus more nearly in accord with the rate of removal of these elements by crops. Here the nitrogen is equivalent to nearly 5000 bushels of corn, and the phosphorus to 7,000 bushels.

The total stock of potassium, amounting in this type to 206,690 pounds an acre, would furnish this element for more than one million bushels of corn.

Service of Chemical Analysis in Soil Improvement

The foregoing statements should not be taken to mean that it is possible to predict how long any certain soil could be cropped under a given system before it would become exhausted. Nor do the figures alone indicate the immediate procedure to be followed in the improvement of a soil. It must be kept in mind that the *amount* of plant food shown to be present is not the sole measure of the ability of a soil to produce crops. The *rate* at which some of these elements are liberated from insoluble forms and converted to forms that can be used by growing plants is a matter of at least equal importance, as explained on page 35, and is not necessarily proportional to the total stocks present. One must know, therefore, how to cope with the peculiarities of a given soil type if he is to secure the full benefit from its stores of plant-food elements and from applied fertilizing materials. In addition there are always economic factors that must be taken into consideration, since it is necessary for one to decide at how high a level of productive capacity he can best afford to maintain his soil.

The chemical soil analysis made in connection with the soil survey is seen to be of value chiefly in two ways. In the first place it reveals at once outstanding deficiencies or other chemical characteristics which alone would affect its productivity to a marked extent or point the way to corrective measures. It should be borne in mind, however, that fairly wide departures from the usual are necessary before the chemical analysis alone can be followed as a guide in practice without supplementary information from other sources. Examples of this use of soil analyses are the extremely low potassium content of peaty soils, soils containing only 300 to 400 pounds of phosphorus per acre, and chemical tests for lime need. It is quite probable that the results of the soil analysis are frequently misused by attempting to interpret small differences in amount of a certain plant-food element as indicative of similar differences in fertilizer need.

The second function of soil analysis is as an aid in the scientific study of soils from many angles, the ultimate aim of which is, of course, the more economical utilization of the soil for efficient crop production. Not only do chemical studies aid in determining the processes involved in soil development under natural conditions, but also in determining the effects of different soil management and fertilizing practices upon the soil and upon the utilization by crops of the plant-food elements involved.

DESCRIPTION OF SOIL TYPES

UPLAND PRAIRIE SOILS

The upland prairie soils of Whiteside county occupy 129.47 square miles, or 18.48 percent of the area of the county. They are found chiefly in the northeast quarter of the county. Relatively small areas are also found in a triangular-shaped body lying between Fulton and Erie.

These soils vary in color from black to light brown or grayish brown in the surface, and in texture from silts to sands. The subsoils of this group vary in compactness and other characters, as will be noted in the type descriptions to follow.

The dark color of the prairie soils is due to an accumulation of organic matter from the fibrous roots of the prairie grasses that grew on this land for centuries. A covering of fine soil and a mat of vegetative material by partially excluding the oxygen protected these roots from rapid and complete decay. From time to time the mat of old grass stems and leaves was partially destroyed by prairie fires and decay, but it was constantly being renewed, and while it added but little organic matter to the soil directly, it served to retard the decay of the roots of the grasses.

Brown Silt Loam (626, 726)

Brown Silt Loam as mapped occupies 93.28 square miles, or 13.31 percent of the area of Whiteside county. It is fairly uniformly distributed over the northern part of the county, with an isolated area occurring in the southwestern part adjacent to Henry county. At the time the soil map of this county was prepared, certain areas were classified as Brown Silt Loam which, in the light of more recent studies, would now be considered as not strictly a part of this type. These variations are noted in the following paragraphs.

The topography of the type varies from almost level to rolling, and associated with this variation is a variation in soil character. Erosion in relatively recent time has cut numerous deep gorges into the type between Rock and Elkhorn creeks, and these eroded areas are included in the type Yellow Silt Loam (635, 735). There are many long, gentle slopes, mapped as Brown Silt Loam, from which much soil material has been removed by erosion without forming gullies. Areas of this sort have not been differentiated on the map but they should be recognized in planning soil management and treatment, as they differ materially in their requirements from the more level-lying portions. Natural drainage is good thruout the type.

As previously stated, this soil was formed from wind-blown loessial material varying in depth from 5 to 15 feet or more. Near Mississippi river the loess deposit is deeper than in the eastern part of the county. In the region between East Clinton and Mineral Springs this type contains more fine sand than is commonly found in a silt loam. Some of the areas of Brown Silt Loam in this region probably should have been mapped as Brown Fine Sandy Loam, tho the separation is very difficult to make.

The A_1 horizon, which averages about 8 inches in depth, is a light brown to medium brown silt loam and contains an appreciable amount of fine sand. The A_2 horizon, extending to about 20 inches in depth, is a friable silt loam, varying in color from light brown to yellowish brown. The B horizon is about 12 inches thick and is a slightly compact, lightly mottled, yellow silt loam. Below 32 inches a friable, slightly mottled yellow silt loam occurs. It is spotted with occasional yellow or brown iron stains. On the lower, more nearly level areas the B horizon is more strongly mottled and more compact and its color is drabbish yellow or grayish yellow. In places where erosion has been active, sufficient loess material has been washed off from the surface so that the gravelly drift occurs within 40 inches of the surface and occasionally even on the surface.

Management.—In planning a system of management for this soil, the first consideration should be to provide for a regular supply of fresh leguminous organic matter. This is particularly necessary on the above mentioned areas where the slope is sufficient to permit erosion. It should be noted that even gentle slopes are subject to erosion, tho it is often not very noticeable unless gullies form. Sweet clover is an excellent legume to grow as a soil improver and it is also a good pasture crop. Before seeding sweet clover, the soil should be tested in detail to determine the amount of limestone needed. In general, this type requires about 2 tons an acre for either alfalfa or sweet clover; there are, however, many exceptions to this rule.

The Mt. Morris experiment field in Ogle county and the Dixon experiment field in Lee county are located on soil which, with the exception of a few areas, is similar to Brown Silt Loam as mapped in Whiteside county. These fields, which have been under full treatment since 1913 and 1912 respectively, are in agreement that manure gives very good increases in yield in a rotation of corn, oats, wheat, and clover. (The data from the Mt. Morris field will be found on page 48, and from the Dixon field on page 50.) The results show also that the plowing down of crop residues is a profitable practice and that limestone returns a large profit when used on this soil.

The evidence furnished by these fields regarding the value of rock phosphate is consistent in showing that when manure is used, rock phosphate does not cause as much increase in yield as when no manure is used and crop residues are depended on as a source of organic matter. If we average the two fields, we find that the application of rock phosphate in addition to manure has barely caused sufficient increase in yield to pay for the application of half a ton of rock phosphate once in the rotation, while in the residues system the increase has been sufficient to pay a small profit on this rate of application. The question arises as to whether a half-ton application would cause as much increase in yield as the one-ton application, which was the amount used in these experiments; but no data are available upon which to base an answer to this question. It is suggested that those who wish to increase their acre yield and thus make possible the cultivation of fewer acres try rock phosphate on a few acres, together with the minimum amount of limestone which it is thought can be used. Acid phosphate is a standard phosphatic fertilizer which it would also be well to try. This material should be applied chiefly, if not entirely, for the wheat crop. The application should be made after plowing, and before working down the seed bed, at the rate of about 300 pounds an acre. If the wheat drill is provided with a fertilizer attachment, the acid phosphate may be applied at the time of seeding the wheat.

It should be remembered that no phosphate can be expected to give satisfactory returns unless sufficient nitrogen is present and the soil is in good physical condition. In general farming, the acre returns are not sufficiently high to justify the purchase of commercial nitrogen at its present price. It is therefore necessary to depend on legumes for the nitrogen supply; and of the legumes, sweet clover ranks highest as a source of nitrogen and organic matter.

The use of potash is not advised on this soil since the evidence indicates that it would not cause sufficient increase in yield to pay for its cost.

Brown Fine Sandy Loam (871)

Brown Fine Sandy Loam, Upland, occupies practically 10 square miles, or 1.43 percent of the area of the county. Practically all of this type is found in the region extending from East Clinton to Mineral Springs, west of Cattail slough.

The topography of this type varies from undulating to rolling. The area becomes more rolling south of Albany where, with minor exceptions, the wind has reworked the soil material. Drainage is good thruout the type. The texture and compactness of the subsoil vary somewhat. On the flat areas it is much heavier and more compact than on the rolling areas.

The A_1 horizon, which is about 8 inches in depth, is a light brown to medium brown fine sandy loam. The A_2 horizon, extending to a depth of 18 or 19 inches, varies from a light brown to yellowish brown fine sandy loam. The B horizon is a slightly mottled, yellow fine sandy or silt loam. It varies in texture and compaction as above noted but is never excessively heavy or compact. At a depth of about 30 inches a friable, slightly mottled, yellow fine sandy loam or silt loam occurs. This material contains carbonates at a depth of 40 to 50 inches. The areas of this type which are adjacent to the type Mixed Sand and Loess have not developed any well-defined horizons, indicating that the deposition of this soil material by the wind has taken place within very recent times.

Management.—Brown Fine Sandy Loam shows a slight to medium acidity and in general should have an application of 1½ to 2 tons of limestone an acre before the growing of alfalfa or sweet clover is attempted. Before applying limestone, however, each field should be tested in detail, for there is considerable variation in the degree of acidity.

This soil is relatively low in organic matter and nitrogen. These deficiencies should be taken care of by growing legumes at regular intervals in the rotation and by the application of all manure available. Because of its physical properties, Brown Sandy Loam favors the deep penetration of roots, thus greatly increasing the feeding range of plants over that in a soil having a relatively impervious subsoil.

As a guide to the treatment of this type we may go to the records of the Union Grove experiment field, which was located on a soil sufficiently similar for the results to be of value. On this field a rotation of corn, corn, oats or barley, and clover was grown. The results, which will be found on page 52, show high returns from the use of crop residues and very high returns from the use of manure. Potassium applied in the form of sulfate of potash gave good results in the residues system, but on the manure plots the increases following its application were not sufficiently high to justify its use. Rock phosphate did not cause sufficient increase in the crops in this rotation to pay for its cost even if used at the rate of half a ton once in the rotation. A nine-year rotation of potatoes and alfalfa was established on another series of plots. The results of this work indicate that rock phosphate may be used profitably for alfalfa on this soil.

The following specific suggestions may be made for the treatment of Brown Fine Sandy Loam, based largely on results from the Union Grove experiment field. *First,* apply only sufficient limestone to grow the crops which it is desired to grow.

If alfalfa or sweet clover is to be grown, more limestone will have to be used than if red clover is the legume to be grown. The assistance of the farm adviser should be secured in making a detailed test of each field before applying limestone. *Second,* make full use of all available manure and plow down all crop residues with the possible exception of wheat, oat, and barley straw. *Third,* apply 100 to 150 pounds of a potash salt for corn. *Fourth,* if alfalfa is grown, apply one ton of rock phosphate or about 600 pounds of acid phosphate an acre and work it into the soil thoroly as the seed bed is being prepared.

Mixed Sand and Loess (876)

Mixed Sand and Loess, as the name indicates, is variable in character. It owes its mixed composition and variable character to the deposition by the wind, during remote times, of material of varying texture. The final deposit was fine in texture. Subsequent erosion, either by wind or water, removed this fine loess covering in some places and not in others, and as a result a mixed soil was formed. The areas of different texture are so small that they cannot be differentiated successfully on the soil map and are therefore all grouped together as one type.

Mixed Sand and Loess occurs in the northwestern part of Whiteside county, occupying a total of 25.91 square miles. The topography varies from billowy to rough and broken, the latter condition being found adjacent to the Mississippi bottom. Both surface drainage and underdrainage are good on this type.

The diverse character of this type makes it impossible to give more than a generalized profile description. The surface soil varies in depth, color, and texture, but in general is friable and easily worked. In places it is too coarse in texture to be a good general-purpose soil. The subsurface varies as greatly as does the surface and no true subsoil is present because the soil materials have not been exposed to the soil-forming forces sufficiently long for a compact zone to be developed.

Management.—Mixed Sand and Loess is not a unit with respect to management requirements. The reader is referred to Brown Fine Sandy Loam, page 17, for a discussion of the management of the finer-textured portions of this type and to Brown Sandy Loam, Terrace, page 24, or Dune Sand, Terrace, page 25, for management suggestions for the coarser portions of the type.

Brown Sandy Loam On Rock (660.5)

Brown Sandy Loam On Rock is a type of little importance. A small area of 186 acres is found just east of Albany.

The surface soil, which extends to about 7 inches in depth, is a brown sandy loam. The subsurface is a medium-grained brown sandy loam resting on limestone rock, which occurs at a depth of 12 to 24 inches below the surface.

This type is used chiefly for pasture and is suited for nothing else because of its shallowness.

UPLAND TIMBER SOILS

The upland timber soils are found in the northern and western parts of Whiteside county. They are characterized in color by a grayish yellow surface soil. The long-continued growth of forest trees on these soils has been chiefly responsible for their low organic-matter content. This group of soils occupies 128.47 square miles in Whiteside county.

Yellow-Gray Silt Loam (634, 734)

Yellow-Gray Silt Loam occurs as an outer light-colored soil belt bordering the stream courses. Its topography varies from undulating to rolling. Natural drainage is good, and with reasonable care and good farming methods, little difficulty should be encountered with washing and gullying. This type occupies 26.65 square miles, or 3.80 percent of the area of the county.

In the vicinity of Elkhorn and Rock creeks the light color of certain areas has resulted largely from removal of the surface soil by erosion rather than from timber growth. These areas are shown on the map as Yellow-Gray Silt Loam, tho they differ somewhat from the type.

The A_1 horizon, which is about 6 inches thick, varies from a brownish yellow to a grayish yellow silt loam. The A_2 horizon extends to about 18 inches and is a friable, mottled, yellow silt loam, floury in texture. The B horizon, extending to about 30 inches, is a friable, slightly compact, strongly mottled, yellow silt loam. The C horizon is a friable, somewhat mottled, yellow silt loam, spotted with brown and red iron concretion stains. Those areas of the type which are nearly level have a much grayer A_2 horizon and a more compact B horizon than described above.

Management.—Yellow-Gray Silt Loam is acid, tho not strongly so. In general, about 2 tons of limestone an acre are required for sweet clover or alfalfa.

This type is particularly in need of nitrogen and fresh organic matter. Sweet clover is the best source of these materials. It may be used to advantage as a pasture crop the fall of the first year and then as a green-manure crop for corn the spring of the second year. Some areas of this type are so rolling as to erode badly and should, if possible, be kept in permanent pasture.

Yellow Silt Loam (635, 735)

Yellow Silt Loam occurs mainly in the northeastern portion of the county, with a few isolated areas north of Morrison. If washing has not been active for a few years, the surface soil is brownish yellow in color. On some of the steep slopes glacial drift is exposed, but for the most part the material to a depth of 40 inches is loess. The type occupies a total area of 38.48 square miles.

Management.—This type should be utilized, for the most part, for permanent pasture, timber, or orchards. If it is cultivated, particular attention must be given to controlling run-off, if ruinous erosion is to be prevented. Terracing may be used to advantage in many cases as a means of lessening erosion, particularly when laying off a field for planting to orchards. For an account of experiments to prevent erosion on land of this character, the reader is referred to page 57, where the work conducted for nine years on the Vienna field in Johnson county is described.

Yellow-Gray Fine Sandy Loam (874)

Yellow-Gray Fine Sandy Loam occurs adjacent to the Mississippi river bluffs. It cover 27.58 square miles, or about 4 percent of the area of the county. It is undulating to rolling in topography. The surface drainage and underdrainage of the type are good.

The A_1 horizon, which is about 6 inches thick, varies from a brownish yellow to grayish yellow fine sandy loam. The A_2 horizon is a yellow fine sandy loam. The B horizon, occurring below 16 or 18 inches, is a yellow, fine sandy silt to sandy loam.

Management.—The type is acid, tho usually only slightly so. Carbonates occur at a depth of 50 to 60 inches. This type is similar to Yellow-Gray Silt Loam, but is much more permeable because of its coarser texture and more friable nature. The reader is referred to Yellow-Gray Silt Loam, page 19, for suggestions regarding the management of Yellow-Gray Fine Sandy Loam.

Yellow Fine Sandy Loam (875)

Yellow Fine Sandy Loam occurs in the western part of the county but not immediately adjacent to the Mississippi river bottoms. It covers an area of 35.76 square miles. In topography the type is rolling to hilly but the slopes are not so steep as in the case of the eroded silt loam types. On a part of the type deep gullies have been formed by long-continued erosion. Following the removal of the timber from these slopes, they were farmed intensively with no provision made for returning organic matter, with the result that much of this land has been seriously injured. There is, for the most part, no true surface or subsurface present because they have been eroded away. A thin surface soil, from 3 to 4 inches in depth, however, has been developed over small areas where the growth of grass has protected the soil from erosion.

Management.—The type, because of its topography, should be used for pasture, orchards, or timber. The depth to carbonates varies greatly. Alfalfa and sweet clover can often be grown successfully on the more gentle slopes without the addition of limestone. Where limestone is needed for the growing of legumes, the amount to be applied should be determined by careful examination. The assistance of the farm adviser or the Agricultural Experiment Station can be secured in making this determination. If it is necessary to farm a portion of this type, great care should be used to reduce erosion to the minimum, otherwise the removal of the surface will be so rapid as to keep the land in a state of low productivity. This soil is particularly deficient in nitrogen and organic matter and the first step in building it up should be to provide for a regular supply of fresh leguminous organic matter, preferably sweet clover.

TERRACE SOILS

About 39 percent of Whiteside county is a terrace formation. The immense alluvial fill which constitutes the terrace was deposited by flowing waters during glacial times. Finer-textured, wind-blown material was later deposited on the sandy, gravelly, terrace material. This finer material constitutes the mineral portion of the soils as they now exist.

Brown Silt Loam Over Gravel (1527)

Brown Silt Loam Over Gravel occupies 73.97 square miles, or 10.55 percent of the area of the county. It occurs principally north of Rock river. The topography is undulating except where sandy ridges occur, giving the surface a billowy appearance. Drainage is usually good, altho isolated areas occur which are poorly drained because of the presence of a thin layer of relatively impervious material in the subsoil. There is an appreciable amount of fine sand present thruout the type because of the deposition of this material by the wind upon the terrace.

The A_1 horizon, which is about 8 inches in thickness, varies from a light brown to dark brown silt loam. The A_2 horizon extends to a depth of 19 inches and is a yellowish brown silt loam. The B horizon is a yellow silt loam or fine sandy silt loam and contains some gray and drab splotches. The C horizon begins at about 32 inches and is ordinarily a slightly mottled, friable, yellow sandy loam. The depth to the sand and gravel substratum varies from 4½ to 8 feet.

Management.—A large proportion of this type is not acid and in only a few cases was it found to be more than slightly acid. It is a productive, easily worked soil and is adapted to any of the farm crops common to the region. Provision should be made for the systematic addition of leguminous organic matter to this soil. Sweet clover is unexcelled for this purpose and can be used to good advantage as a combination pasture and green-manure crop by pasturing it in the fall of the first year and plowing it down for corn in the spring of the second year. If it is shown by tests that the soil is acid, an application of limestone should be applied before attempting to grow sweet clover or alfalfa.

Yellow-Gray Silt Loam Over Gravel (1536)

Yellow-Gray Silt Loam Over Gravel occurs chiefly just north of Sterling, along Elkhorn creek, and just north of Morrison, along Rock creek. It covers a total area of 3.70 square miles. The type is flat to undulating in topography. Underdrainage is good because of the presence of a sandy, gravelly substratum.

The A_1 horizon to a depth of about 6 inches is a brownish yellow to grayish yellow silt loam. The A_2 horizon, about 12 inches in thickness, is a slightly grayish yellow silt loam. The B horizon, extending to a depth of about 30 inches, is a fairly compact, lightly mottled, yellow, silty clay loam. The C horizon is a friable, mottled, yellow silt loam, spotted with brownish yellow and red iron stains. It rests upon a sandy, gravelly subsoil which varies in depth from 45 to 60 inches below the surface.

Management.—The acidity tests made on this type indicate in general the need for an application of limestone at the rate of about 2 tons an acre for sweet clover. This soil is well adapted to alfalfa following the application of limestone. Experience indicates that the application of one-half to one ton of rock phosphate for alfalfa is a profitable practice; or acid phosphate may be used, applying it after plowing at the rate of 600 or 800 pounds an acre. Following the increase in the nitrogen and organic matter in this soil thru the use of legumes, any of the general farm crops common to the region may be grown successfully.

Brown Silt Loam On Clay (1526.1)

Brown Silt Loam On Clay occupies a total of only 1.55 square miles in Whiteside county. The largest area is located southwest of Prophetstown. The topography is flat, and effective underdrainage cannot be secured because of the presence of the impervious clay layer.

The A_1 horizon, which is about 9 inches in thickness, is a medium to dark brown silt loam with a grayish cast after the soil has become thoroly saturated and then dried. The A_2 horizon, extending to about 21 inches in depth, varies from a brown or yellowish brown silt loam to a grayish brown silt loam. The B horizon, extending to a depth of about 34 inches, is a very sticky and compact, mottled, reddish yellow to drabbish yellow clay. The C horizon, below 34 inches, is a less compact, slightly friable, mottled, yellow silt loam.

Management.—This type is medium acid and should have an application of at least 2 tons of limestone per acre. Surface drainage by means of open furrows and ditches is necessary. Sweet clover should be grown and plowed under the spring of the second year for corn.

Brown-Gray Silt Loam On Tight Clay (1528)

Brown-Gray Silt Loam On Tight Clay occupies 4.17 square miles in Whiteside county. Nearly all of the areas of this type are located south of Prophetstown. It occurs in depressions or pockets that are not well drained.

The A_1 horizon is about 7 inches in thickness and is a grayish brown silt loam. The A_2 horizon, extending to a depth of about 17 inches, is a brownish gray to gray silt loam. The B horizon is a sticky, plastic, compact, drab to gray clay. The C horizon occurs below 28 or 30 inches. It is a gray to drab silt loam or silty clay loam spotted with yellow iron stains.

Management.—This type is strongly acid and should receive about 4 tons of limestone per acre. Surface drainage must be depended on to remove excess water. Sweet clover should be grown regularly. If handled in this way, Brown-Gray Silt Loam On Tight Clay will produce reasonably good crops of corn or the small grains.

Brown Fine Sandy Loam (1571)

Brown Fine Sandy Loam, Terrace, occurs most extensively in the terrace south of Rock river. The type lacks uniformity because of the wind deposition of the soil material. It varies in topography from slightly undulating to billowy. The type occupies 13.56 square miles.

The A_1 horizon is a light brown to a medium brown fine sandy loam, varying in thickness from about 4 to 9 inches. The A_2 horizon, where distinguishable, varies from a light brown or yellowish brown fine sandy loam to a sandy silt loam. The B horizon, extending from about 20 to 32 inches is in general a slightly compact, bright yellow, fine sandy silt loam or sandy loam. The C horizon below 32 inches is a friable, grayish yellow to yellow fine sand.

Management.—This type varies in acidity but ordinarily the surface is only slightly acid, while the lower horizons usually show a stronger acidity than the surface. It is a productive, easily worked soil and the friability of the subsoil favors deep root penetration. The organic-matter and nitrogen contents should be increased thru the growth of legumes.

Black Mixed Loam (1550)

Black Mixed Loam, Terrace, occurs in the low-lying, poorly drained areas in the terrace and might properly be included in the swamp and bottom-land group instead of in the terrace group. The type covers 27.87 square miles, or 3.98 percent of the area of the county. Its topography is flat but drainage is fairly well provided for by means of tile and open dredges. The streams in some of these dredge ditches are sluggish, owing to lack of proper fall and to the filling of the channels with silt and fine sand.

The mixed nature of this type makes it impossible to write a description that will apply to the type as a whole. The surface varies from a brown or black silt loam to a black sandy clay loam or peaty loam. The subsurface varies in like manner but is usually somewhat heavier than the surface. The subsoil is generally a plastic, compact, mottled, yellowish drab or drab clay loam. The subsoil is underlain with sand or gravel.

Management.—This type is, for the most part, productive when properly drained. Alkali occurs on some of the areas in sufficient concentration to be harmful. When such is the case, an application of potash will usually correct the condition. This soil is, for the most part, well supplied with nitrogen and organic matter, but provision should be made for plowing down some leguminous material at regular intervals.

Black Sandy Loam (1561)

Black Sandy Loam occurs in the terrace near Tampico. It occupies a total area of 22.36 square miles in Whiteside county. It is a type which has been developed under poor drainage and now occupies low-lying, nearly level areas. Within recent years most of the areas have been provided with drainage by means of tile, dredge ditches, and shallow, open ditches. One difficulty encountered in draining this type is the filling of the ditches because of the loose character of the soil material and the small slope.

The A_1 horizon, which is about 10 inches in thickness, is a black sandy loam. With drainage and cultivation, the color of this horizon changes with relative rapidity to brown because of the oxidation of the organic matter. The A_2 horizon, extending to about 22 inches, varies from a yellowish brown sandy loam to black sandy loam. The B horizon is a fairly compact, mottled drab or yellowish drab clay loam with a mixture of silt, sand, and clay in varying proportions. This horizon is stained with yellow and red iron concretions. The C horizon, which occurs at a depth of about 34 inches, is a drab or gray sandy loam or sand.

Management.—The organic matter and nitrogen are both low in this type. The lower horizons usually show somewhat more acidity than the surface and it is therefore advisable to apply somewhat more limestone than the test of the surface indicates. In general, about 2 tons of limestone an acre is needed. Following the application of limestone, legumes should be given a regular place in the rotation. Sweet clover is an excellent legume for this soil, both as a pasture and soil-improving crop.

This type has a tendency to be drouthy. This fact makes it better adapted to small grain than to corn.

Brown-Gray Sandy Loam On Tight Clay (1568)

Brown-Gray Sandy Loam On Tight Clay occurs south of Rock river. Fortunately it is not extensively developed, occupying a total of about 4¼ square miles. It is found on areas slightly lower than those of adjacent soil types. It is flat in topography and is not well drained.

The A_1 horizon, which is about 8 inches in thickness, is a grayish brown sandy loam. The A_2 horizon, extending to a depth of about 22 inches, is a gray sandy loam. The B horizon, which is 8 or 9 inches in thickness, is a plastic, compact, gray sandy clay. The material below 30 or 32 inches is a medium-grained sand, drabbish gray to white in color, and spotted with yellow and red iron stains.

Management.—Additional drainage is necessary in many of the areas of this type. In placing tile, the joints must be carefully made in order to keep out silt and fine sand which are particularly troublesome in this type. Black Sandy Loam is commonly alkaline and in many areas the alkali is sufficiently concentrated to be harmful. This unfavorable condition can be remedied by using potash. The organic-matter content of this type is still high in most of the areas but it is resistant to decay and therefore the addition of fresh leguminous material is beneficial.

Brown Sandy Loam (1560)

Brown Sandy Loam, Terrace, is extensively developed and fairly well distributed over the terrace with extensive areas in the southeastern part of the county. It occupies 86.57 square miles, or practically ⅛ of the area of the county. Its topography varies from flat to slightly undulating, the irregularity being due to the formation of low sand dunes over which finer material has been deposited. Drainage of the type is, for the most part, good.

The A_1 horizon, which is about 8 inches in thickness, is a brown sandy loam. The A_2 horizon, extending to 19 or 20 inches in depth, is a yellowish brown sandy silt loam or sandy loam. The B horizon is a friable yellow sandy loam or sand, becoming an incoherent mass of yellow sand below 32 to 35 inches.

Management.—Furrows and open ditches must be depended on for the drainage of this type. Most of it requires 3 or 4 tons of limestone an acre. Sweet clover does well following the limestone application.

Yellow-Gray Sandy Loam (1564)

Yellow-Gray Sandy Loam, is undulating in topography and is found in small areas along Rock river. The type occupies a total of only 461 acres. It is similar to Yellow-Gray Silt Loam Over Gravel except that it is coarser in texture. The areas of this type are so small that ordinarily they should be managed in the same way as the adjoining types.

Dune Sand (1581)

Dune Sand is widely distributed thruout the terraces in Whiteside county. The dunes vary in altitude from 2 or 3 feet to 25 or 30 feet above the adjacent types and cover a total area of 33.25 square miles. Many "blowouts" have been formed where the wind has had an opportunity to drift the sand. The topography varies from undulating to billowy or rolling.

The surface in places shows a slight accumulation of organic matter and in general is a brownish yellow sand. This darker surface may extend to a depth of 3 or 4 inches. Below this thin surface horizon the material is an incoherent mass of yellow sand.

Management.—This type in its natural condition represents, for the most part, a barren waste. It varies somewhat, however, in its potential agricultural value according to the texture of the sand. There are portions of the type that

FIG. 2.—RECLAIMING A SAND DUNE THRU REFORESTATION

At one end of the dune seen in the distance the barren waste of shifting sand has been transformed into a fine grove of trees while the other portion of the dune remains in its natural desolation. This is the work of Mr. A. N. Abbott, of Morrison, Illinois.

are susceptible of considerable improvement thru soil treatment, as demonstrated on the Oquawka experiment field in Henderson county. On this field fair crops of corn, wheat, rye, soybeans, alfalfa, and sweet clover are being produced by the application of limestone and organic manures. The results of this work on the Oquawka field are discussed in greater detail on page 59.

Even the shifting dunes, which are ordinarily considered as absolutely waste land, have been shown to be susceptible of reclamation thru forestation. In Section 31, Township 22 North, Range 4 East, reforestation has been thoroly demonstrated as a success. Following the planting of locust trees, blue-grass starts and does well, increasing the pasture value of the land many times.

Black Clay Loam (1520)

Black Clay Loam, Terrace, is a minor type in Whiteside county. It occupies a total of only 109 acres and occurs in small, scattered areas. The topography is flat. Drainage is fair.

The A_1 horizon, which is about 7 inches thick, is a plastic, black clay loam. The A_2 horizon, 8 to 18 inches, is a plastic, drabbish black to drab clay loam. The

B horizon, to a depth of about 32 inches, is a plastic, fairly compact, drabbish black clay, spotted with red iron concretions. Below 32 inches, a fairly plastic, friable, grayish drab to drab sandy clay or clay loam occurs. It is strongly spotted with yellow and brown iron stains.

Management.—Black Clay Loam, Terrace, is frequently alkaline. The alkali may or may not be sufficiently concentrated to require the use of potash to overcome its harmful effects. It is essential to maintain a good supply of organic matter in this soil, otherwise it becomes very difficult to farm.

SWAMP AND BOTTOM-LAND SOILS

This group includes the bottom lands along Mississippi and Rock rivers and their tributaries, and the swamps and poorly drained lowlands. The soil material is of alluvial origin, and the land is largely subject to overflow. These swamps were once lakes or a part of the preglacial river channels. The total area of this group, consisting of ten soil types, is 161.56 square miles, or nearly one quarter of the area of the county.

Deep Brown Silt Loam (1426)

Deep Brown Silt Loam occupies a total area of 28.53 square miles in Whiteside county. Practically all of this type is located along Rock river and south of Cattail slough. The topography of this type is not so uniformly flat as is common for bottom-land soil because of the presence of long depressions which mark previous stream beds.

Deep Brown Silt Loam does not show distinct horizon development because of its youth. The surface varies considerably in color and texture but in general is a brown silt loam. At a depth of 8 or 10 inches the texture becomes finer and the color darker, and ordinarily a drab color appears at about 30 inches in depth. The drab-colored material is discolored with reddish yellow iron stains.

Management.—This type for the most part is subject to overflow. It needs no treatment other than good tillage. It is a productive soil and its productivity is maintained by the sediment deposited at each overflow.

Brown Mixed Loam (1454)

Brown Mixed Loam occupies 24.07 square miles, or 3.43 percent of the county and is found for the most part along the small streams. This type, as mapped, is made up of a number of distinct soils varying in texture from silts to sandy loams and in color from grayish yellow to brown or black. It is not practicable to separate these various soils because they occur in very small areas and also because much of the type is subject to overflow and is being constantly changed.

Management.—Brown Mixed Loam is a good soil but it is not so consistently good as Deep Brown Silt Loam because of the presence of patches of sandy soil. Since it is subject to overflow, no fertilizer treatment is advised.

Brown Loam (1451)

Brown Loam is the most extensive bottom-land type in Whiteside county. It occupies a total of 33.78 square miles and occurs for the most part along Rock river below Prophetstown. The topography of this type is flat to slightly undulating. The irregularities in topography are due to the work of streams during periods of overflow. The type, as mapped, is rather diverse and therefore only a very generalized description of it is possible. It is only within recent years that Brown Loam has been placed under cultivation.

The surface soil to a depth of 5 or 6 inches is commonly a brown loam, but varies from silt loam or clay loam to fine sandy loam. Below this surface 5 or 6 inches the material is usually somewhat lighter in color and varies greatly in texture. At a depth of about 18 or 20 inches a rather compact and plastic drab or black clay loam occurs. This heavy layer is ordinarily not over 6 or 8 inches thick. Below this heavy layer the material is sandier and at a depth of 28 to 32 inches gray, white, or yellow sand occurs.

Management.—The type drains fairly well if suitable outlets can be obtained. Many areas are left in permanent pasture; however, some portions of the type give good returns when cropped. The periodic overflows usually cover this with sediment; therefore no fertilizer treatment is advised.

Brown Sandy Loam (1460)

Brown Sandy Loam, Bottom, occurs along the Mississippi and Rock rivers and occupies a slightly higher elevation than the adjacent bottom-land types. The type covers a total area of practically 23 square miles. Its topography varies from flat to slightly undulating. The undulations are due to wind action which piles the sandy material in low ridges.

Horizons are not well developed over much of this type and it is rather diverse in character. The surface is commonly brown sandy loam and below the surface layer the material becomes sandier. Coarse sand or gravel is not uncommon at a depth of 35 to 45 inches.

Management.—This type varies in acidity. Some portions of it require no limestone and ordinarily not over 2 tons are required where it is acid. Overflow is common. Areas which are not subject to overflow may be managed as advised for Brown Sandy Loam, Terrace, page 24.

Black Clay Loam (1420)

Black Clay Loam, Bottom, occurs in the western part of the county and occupies a total of only 2.41 square miles. It is flat in topography and occurs in depressions in the bottom land. Its drainage is poor on account of the lack of proper outlets.

The surface, to a depth of about 7 inches, is a black silty clay loam or clay loam. Below this surface layer, a plastic, black clay loam usually occurs. At a depth of about 18 or 20 inches the color is drabbish black, and at about 30 inches it is gray or drab.

Management.—This type contains alkali, frequently in sufficient amounts to be harmful to crops. When this condition exists, potash may be used to correct it. Particular care should be used in maintaining a good supply of fresh organic matter, as this heavy soil is rather difficult to keep in good physical condition. Additional drainage is necessary on some of the areas.

Yellow Fine Sandy Silt Loam (1445)

Yellow Fine Sandy Silt Loam, commonly called "bluff wash," occurs as outwash from the upland loessial deposits. It is a recent formation and occurs as a fan-like deposit on the bottom land at the mouth of small streams. This type occupies a total area of 6.64 square miles. The topography is usually gently sloping and drainage is fair.

This deposit is so recent that little or no horizon development can be observed with the exception of a slight darkening of the surface to a depth of 6 or 8 inches. The color of the surface is light brown or yellowish brown. The texture of the deposit is variable but is usually a fine sandy silt loam.

Management.—This type is well supplied with carbonates and is an excellent alfalfa and sweet clover soil. It is not well supplied with nitrogen and organic matter but these constituents are easily built up because of the calcareous nature and productivity of the type. No fertilizer treatment is advised, at least until a good organic-matter supply has been built up thru the use of clovers.

Deep Peat (1401)

Deep Peat occupies 14.6 square miles, or about 2 percent of the area of the county. The largest area is found in Cattail slough extending from east of Fulton to Fenton Junction in what was originally an old channel of the Mississippi river. The type is flat in topography and originated in low-lying areas which were continuously wet, thus favoring the growth and accumulation of organic matter.

The surface to a depth of about 6 inches is black, well-decomposed peat containing charred remnants of sedges. The material below this surface layer to a depth of about 22 inches is usually a light brown, finely fibrous peat containing bands of shells. Below this depth the color is reddish brown and the plant material is well preserved.

Management.—The first consideration in bringing an area of Deep Peat under cultivation is that of providing good drainage. Potash is needed on this soil, and potassium sulfate at the rate of 100 to 150 pounds an acre may be applied for corn just before planting.

Deep Peat is a good trucking soil and is used extensively for that purpose. For results of field experiments on this type see the account of Manito field, page 61.

Medium Peat On Clay (1402)

Medium Peat On Clay is of minor importance in Whiteside county, the type occupying a total of less than one square mile.

The surface, to a depth of about 2 inches, is well-decomposed black peat. Below this depth the color is usually brown. The clay substratum occurs at a depth of 15 to 30 inches. The upper part of the clay is black in color and the lower part, usually starting at a depth of 25 to 35 inches, is gray.

Management.—Good drainage must be provided for this type. It is not so deficient in potash as is Deep Peat, but this material is frequently needed because of alkali. No special treatment other than improvement of the drainage and use of potash on the alkali spots is advised for the present.

Peaty Loam (1410)

Peaty Loam occupies nearly 20 square miles and, as mapped, is widely distributed thruout the terraces. The type was formerly swampy, poorly drained, and uncultivated. Within recent years tile and dredge-ditch drainage, together with cultivation, have promoted rapid decay of the peaty material. This, together with the deposition of sand from adjacent sandy areas, has resulted in changing many areas of the type to Black Sandy Loam or even to Brown Sandy Loam. However, some areas of true Peaty Loam still remain.

On the remaining areas of Peaty Loam the surface to a depth of about 6 inches is peaty loam. Below this surface stratum to a depth of about 20 inches the material varies from peaty loam to black sandy loam. Below 20 inches slightly compact, gray to yellow sand with some clay and silt occurs, while below 30 inches the material is usually grayish yellow or yellow sand.

Management.—Peaty Loam is usually alkaline, and potash is needed. Potassium chlorid or potassium sulfate should be applied for the corn crop at the rate of 100 to 150 pounds an acre. No treatment in addition to this is advised for the present. The field experiments at Tampico are of interest in this connection and an account of them is given on page 63.

Black Mixed Loam (1450)

Black Mixed Loam, Bottom, was formed in low, poorly drained areas. Within recent years most of the areas of this type have been drained so that crops can be grown on them. The type occupies a total area of 8.28 square miles.

The surface, extending to a depth of about 8 inches, varies from black clay loam to black sandy or peaty loam. Below this to a depth of about 24 inches the material varies from black silt loam to black clay loam and contains an appreciable amount of sand. Plastic, drab clay occurs below about 24 inches.

Management.—Black Mixed Loam is, for the most part, productive. It contains patches of alkali and some areas are not well drained. These poorly drained areas are left in permanent pasture.

RESIDUAL SOILS

Rock Outcrop (099)

Limestone Outcrop occupies a total area of 77 acres in Whiteside county. It occurs, for the most part, along the Mississippi river bluffs. For further information concerning limestone in Whiteside county, the reader is referred to Bulletin No. 46, Limestone Resources of Illinois, issued by the State Geological Survey, Urbana.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

In order to interpret the soil map intelligently, the reader must understand something of the method of soil classification upon which the survey is based. Without going far into details the following paragraphs are intended to furnish a brief explanation of the general plan of classification used.

The soil type is the unit of classification. Each type has definite characteristics upon which its separation from other types is based. These characteristics are inherent in the strata, or "horizons," which constitute the soil profile in all mature soils. Among them may be mentioned color, structure, texture, and chemical composition. Other items, such as native vegetation (whether timber or prairie), topography, and geological origin and formation, may assist in the differentiation of types, altho they are not fundamental to it.

Since some of the terms used in designating the factors which are taken into account in establishing soil types are technical in nature, the following definitions are introduced:

Horizon. A layer or stratum of soil which differs discernibly from those adjacent in color, texture, structure, chemical composition, or a combination of these characteristics, is called an horizon. In describing a mature soil, three horizons designated as A, B, and C are usually considered.

A designates the upper horizon and, as developed under the conditions of a humid, temperate climate, represents the layer of extraction or eluviation; that is to say, material in solution or in suspension has passed out of this zone thru the processes of weathering.

B represents the layer of concentration or illuviation; that is, the layer developed as a result of the accumulation of material thru the downward movement of water from the A horizon.

C designates the layer lying below the B horizon and in which the material has been less affected by the weathering processes.

Frequently differences within a stratum or zone are discernible, in which case it is subdivided and described under such designations as A_1 and A_2, B_1 and B_2, etc.

Soil Profile. The soil section as a whole is spoken of as the soil profile.

Depth and Thickness. The horizons or layers which make up the soil profile vary in depth and thickness. These variations are distinguishing features in the separation of soils into types.

Physical Composition. The physical composition, sometimes referred to as "texture," is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents: clay, silt, fine sand, sand, gravel, stones, and organic material.

Structure. The term "structure" has reference to the aggregation of particles within the soil mass and carries such qualifying terms as open, granular, compact, columnar, laminated.

Organic-Matter Content. The organic matter of soil is derived largely from plant tissue and it exists in a more or less advanced stage of decomposition. Organic matter forms the predominating constituent in certain soils of swampy formation.

Color. Color is determined to a large extent by the proportion of organic matter, but at the same time it is modified by the mineral constituents especially by iron compounds.

Reaction. The term "reaction" refers to the chemical state of the soil with respect to acid or alkaline condition. It also involves the idea of degree, as strongly acid or strongly alkaline.

Carbonate Content. The carbonate content has reference to the calcium carbonate (limestone) present, which in some cases may be associated with magnesium or other carbonates. The depth at which carbonates are found may become a very important factor in determining the soil type.

Topography. Topography has reference to the lay of the land, as level, rolling, hilly, etc.

Native Vegetation. The vegetation or plant growth before being disturbed by man, as prairie grasses and forest trees, is a feature frequently recognized in differentiating soil types.

Geological Origin. Geological origin involves the idea of character of rock materials composing the soil as well as the method of formation of the soil material.

Not infrequently areas are encountered in which type characters are not distinctly developed or in which they show considerable variation. When these variations are considered to have sufficient significance, type separations are made provided the areas involved are sufficiently large. Because of the almost infinite variability occurring in soils, one of the exacting tasks of the soil surveyor is to determine the degree of variation which is allowable for any given type.

Classifying Soil Types.—In the system of classification used, the types fall first into four general groups based upon their geological relationships; namely, upland, terrace, swamp and bottom land, and residual. These groups may be subdivided into prairie soils and timber soils, altho as a matter of fact this subdivision is applied in the main only to the upland group. These terms are all explained in the foregoing part of this report in connection with the description of the particular soil types.

Naming and Numbering Soil Types.—In the Illinois soil survey a system of nomenclature is used which is intended to make the type name convey some idea of the nature of the soil. Thus the name "Yellow-Gray Silt Loam" carries in itself a more or less definite description of the type. It should not be assumed, however, that this system of nomenclature makes it possible to devise type names which are adequately descriptive, because the profile of mature soils is usually made up of three or more horizons and it is impossible to describe each horizon in the type name. The color and texture of the surface soil are usually included in the type name and when material such as sand, gravel, or rock lies at a depth of less than 30 inches, the fact is indicated by the word "On," and when its depth exceeds 30 inches, by the word "Over," for example, Brown Silt Loam On Gravel, and Brown Silt Loam Over Gravel.

As a further step in systematizing the listing of the soils of Illinois, recognition is given to the location of the types with respect to the geological areas in which they occur. According to a geological survey made many years ago, the state has been divided into seventeen areas with respect to geological formation and, for the purposes of the soil survey, each of these areas has been assigned an index number. The names of the areas together with their general location and their corresponding index numbers are given in the following list.

000 *Residual,* soils formed in place thru disintegration of rocks, and also rock outcrop
100 *Unglaciated,* including three areas, the largest being in the south end of the state
200 *Illinoisan moraines,* including the moraines of the Illinois glaciations
300 *Lower Illinoisan glaciation,* formerly considered as covering nearly the south third of the state
400 *Middle Illinoisan glaciation,* covering about a dozen counties in the west-central part of the state
500 *Upper Illinoisan glaciation,* covering about fourteen counties northwest of the middle Illinoisan glaciation
600 *Pre-Iowan glaciation,* but now believed to be part of the upper Illinoisan
700 *Iowan glaciation,* lying in the central northern end of the state
800 *Deep loess areas,* including a zone a few miles wide along the Wabash, Illinois, and Mississippi rivers
900 *Early Wisconsin moraines,* including the moraines of the early Wisconsin glaciation
1000 *Late Wisconsin moraines,* including the moraines of the late Wisconsin glaciation

1100 *Early Wisconsin glaciation,* covering the greater part of the northeast quarter of the state
1200 *Late Wisconsin glaciation,* lying in the northeast corner of the state
1300 *Old river-bottom and swamp lands,* formed by material derived from the Illinoisan or older glaciations
1400 *Late river-bottom and swamp lands,* formed by material derived from the Wisconsin and Iowan glaciations
1500 *Terraces,* bench or second bottom lands, and gravel outwash plains
1600 *Lacustrine deposits,* formed by Lake Chicago, the enlarged glacial Lake Michigan

Further information regarding these geological areas is given in connection with the general map mentioned above and published in Bulletin 123 (1908).

Another set of index numbers is assigned to the classes of soils as based upon physical composition. The following list contains the names of these classes with their corresponding index numbers.

Index Number Limits	Class Names
0 to 9	Peats
10 to 12	Peaty loams
13 to 14	Mucks
15 to 19	Clays
20 to 24	Clay loams
25 to 49	Silt loams
50 to 59	Loams
60 to 79	Sandy loams
80 to 89	Sands
90 to 94	Gravelly loams
95 to 97	Gravels
98	Stony loams
99	Rock outcrop

As a convenient means of designating types and their location with respect to the geological areas of the state, each type is given a number made up of a combination of the index numbers explained above. This number indicates the type and the geological area in which it occurs. The geological area is always indicated by the digits of the order of hundreds while the remainder of the number designates the type. To illustrate: the number 1126 means Brown Silt Loam in the early Wisconsin glaciation, 434 means Yellow-Gray Silt Loam of the middle Illinoisan glaciation. These numbers are especially useful in designating very small areas on the map and as a check in reading the colors.

A complete list of the soil types occurring in each county, along with their corresponding type numbers and the area covered by each type, will be found in the respective county soil reports in connection with the maps.

SOIL SURVEY METHODS

Mapping of Soil Types.—In conducting the soil survey, the county constitutes the unit of working area. The field work is done by parties of two to four men each. The field season extends from early in April to the last of November. During the winter months the men are engaged in preparing a copy of the soil map to be sent to the lithographer, a copy for the use of the county farm adviser until the printed map is available, and a third copy for use in the office in order to preserve the original official map in good condition.

An accurate base map for field use is necessary for soil mapping. These maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as the basis in their construction.

Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil type boundaries, together with the streams, roads, railroads, canals, town sites, and rock and gravel quarries are placed in their proper location upon the map while the mapper is on the area. With the rapid development of road improvement during the past few years, it is almost inevitable that some recently established roads will not appear on the published soil map. Similarly, changes in other artificial features will occasionally occur in the interim between the preparation of the map and its publication. The detail or minimum size of areas which are shown on the map varies somewhat, but in general a soil type if less than five acres in extent is not shown.

Sampling for Analysis.—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. The samples for this purpose are usually taken in three depths; namely, 0 to 6⅔ inches, 6⅔ to 20 inches, and 20 to 40 inches, as explained in connection with the discussion of the analytical data on page 6.

PRINCIPLES OF SOIL FERTILITY

Probably no agricultural fact is more generally known by farmers and landowners than that soils differ in productive power. A fact of equal importance, not so generally recognized, is that they also differ in other characteristics such as response to fertilizer treatment and to management.

The soil is a dynamic, ever-changing, exceedingly complex substance made up of organic and inorganic materials and teeming with life in the form of microorganisms. Because of these characteristics, the soil cannot be considered as a reservoir into which a given quantity of an element or elements of plant food can be poured with the assurance that it will respond with a given increase in crop yield. In a similar manner it cannot be expected to respond with perfect uniformity to a given set of management standards. To be productive a soil must be in such condition physically with respect to structure and moisture as to encourage root development; and in such condition chemically that injurious substances are not present in harmful amounts, that a sufficient supply of the elements of plant food become available or usable during the growing season, and that lime materials are present in sufficient abundance favorable for the growth of the higher plants and of the beneficial microorganisms. Good soil management under humid conditions involves the adoption of those tillage, cropping, and fertilizer treatment methods which will result in profitable and permanent crop production on the soil type concerned.

The following paragraphs are intended to state in a brief way some of the principles of soil management and treatment which are fundamental to profitable and continued productivity.

CROP REQUIREMENTS WITH RESPECT TO PLANT-FOOD MATERIALS

Ten of the chemical elements are known to be essential for the growth of the higher plants. These are *carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, potassium, calcium, magnesium,* and *iron.* Other elements are absorbed from the soil by growing plants, including manganese, silicon, sodium, aluminum, chlorin, and boron. It is probable that these latter elements are present in plants for the most part, not because they are required, but because they are dissolved in the soil water and the plant has no means of preventing their entrance. There is some evidence, however, which indicates that certain of these elements, notably manganese, silicon, and boron, may be either essential but required in only minute quantities, or very beneficial to plant growth under certain conditions, even tho not essential. Thus, for example, manganese has produced marked increases in crop yields on heavily limed soils. Sodium also has been found capable of partially replacing potassium in case of a shortage of the latter element.

TABLE 5.—PLANT-FOOD ELEMENTS IN COMMON FARM CROPS[1]

Produce: Kind	Produce: Amount	Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain......	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat straw......	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain.......	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn stover.......	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs........	1 ton	4.00	....	....	4.00	....	....	....
Oats, grain.......	1 bu.	.66	.11	.06	.16	.04	.02	.01
Oat straw........	1 ton	12.40	2.00	4.14	20.80	2.80	6.00	1.12
Clover seed.......	1 bu.	1.75	.50	....	.75	.25	.13	....
Clover hay.......	1 ton	40.00	5.00	3.28	30.00	7.75	29.25	1.00
Soybean seed.....	1 bu.	3.22	.39	.27	1.26	.15	.14	....
Soybean hay......	1 ton	43.40	4.74	5.18	35.48	13.84	27.56	....
Alfalfa hay.......	1 ton	52.08	4.76	5.96	16.64	8.00	22.26	....

[1]These data are brought together from various sources. Some allowance must be made for the exactness of the figures because samples representing the same kind of crop or the same kind of material frequently exhibit considerable variation.

Table 5 shows the requirements of some of our most common field crops with respect to seven important plant-food elements furnished by the soil. The figures show the weight in pounds of the various elements contained in a bushel or in a ton, as the case may be. From these data the amount of an element removed from an acre of land by a crop of a given yield can easily be computed.

PLANT-FOOD SUPPLY

Of the elements of plant food, three (carbon, oxygen, and hydrogen) are secured from air and water, and the others from the soil. Nitrogen, one of the elements obtained from the soil by all plants, may also be secured from the air by the class of plants known as legumes, in case the amount liberated from the soil is insufficient; but even these plants, which include only the clovers, peas, beans, and vetches among our common agricultural plants, are dependent upon the soil for the other six elements (phosphorus, potassium, magnesium, calcium, iron, and sulfur), and they also utilize the soil nitrogen so far as it becomes soluble and available during their period of growth.

TABLE 6.—PLANT-FOOD ELEMENTS IN MANURE, ROUGH FEEDS, AND FERTILIZERS[1]

Material	Pounds of plant food per ton of material		
	Nitrogen	Phosphorus	Potassium
Fresh farm manure	10	2	8
Corn stover	16	2	17
Oat straw	12	2	21
Wheat straw	10	2	18
Clover hay	40	5	30
Cowpea hay	43	5	33
Alfalfa hay	50	4	24
Sweet clover (water-free basis)[2]	80	8	28
Dried blood	280	.....	.....
Sodium nitrate	310	.....	.....
Ammonium sulfate	400	.....	.....
Raw bone meal	80	180	.....
Steamed bone meal	20	250	.....
Raw rock phosphate	.....	250	.....
Acid phosphate	.....	125	.....
Potassium chlorid	.....	.....	850
Potassium sulfate	.....	.....	850
Kainit	.....	.....	200
Wood ashes[3] (unleached)	.....	10	100

[1]See footnote to Table 5.
[2]Young second-year growth ready to plow under as green manure.
[3]Wood ashes also contain about 1,000 pounds of lime (calcium carbonate) per ton.

The vast difference with respect to the supply of these essential plant-food elements in different soils is well brought out in the data of the Illinois soil survey. For example, it has been found that the nitrogen in the surface 6⅔ inches, which represents the plowed stratum, varies in amount from 180 pounds per acre to more than 35,000 pounds. In like manner the phosphorus content varies from about 320 to 4,900 pounds, and the potassium ranges from 1,530 to about 58,000 pounds. Similar variations are found in all of the other essential plant-food elements of the soil.

With these facts in mind it is easy to understand how a deficiency of one of these elements of plant food may become a limiting factor of crop production. When an element becomes so reduced in quantity as to become a limiting factor of production, then we must look for some outside source of supply. Table 6 is presented for the purpose of furnishing information regarding the quantity of some of the more important plant-food elements contained in materials most commonly used as sources of supply.

LIBERATION OF PLANT FOOD

The chemical analysis of the soil gives the invoice of plant-food elements actually present in the soil strata sampled and analyzed, but the rate of liberation is governed by many factors, some of which may be controlled by the farmer, while others are largely beyond his control. Chief among the important controllable factors which influence the liberation of plant food are the choice of crops to be grown, the use of limestone, and the incorporation of organic matter. Tillage, especially plowing, also has a considerable effect in this connection.

Feeding Power of Plants.—Different species of plants exhibit a very great diversity in their ability to obtain plant food directly from the insoluble minerals of the soil. As a class, the legumes—especially such biennial and perennial legumes as red clover, sweet clover, and alfalfa—are endowed with unusual power to assimilate from mineral sources such elements as calcium and phosphorus, converting them into available forms for the crops that follow. For this reason it is especially advantageous to employ such legumes in connection with the application of limestone and rock phosphate. Thru their growth and subsequent decay large quantities of the mineral elements are liberated for the benefit of the cereal crops which follow in the rotation. Moreover, as an effect of the deep-rooting habit of these legumes, mineral plant-food elements are brought up and rendered available from the vast reservoirs of the lower subsoil.

Effect of Limestone.—Limestone corrects the acidity of the soil and supplies calcium, thus encouraging the development not only of the nitrogen-gathering bacteria which live in the nodules on the roots of clover, cowpeas, and other legumes, but also the nitrifying bacteria, which have power to transform the unavailable organic nitrogen into available nitrate nitrogen. At the same time, the products of this decomposition have power to dissolve the minerals contained in the soil, such as potassium and magnesium compounds.

Organic Matter and Biological Action.—Organic matter may be supplied thru animal manures, consisting of the excreta of animals and usually accompanied by more or less stable litter; and by plant manures, including green-manure crops and cover crops plowed under, and also crop residues such as stalks, straw, and chaff. The rate of decay of organic matter depends largely upon its age, condition, and origin, and it may be hastened by tillage. The chemical analysis shows correctly the total organic carbon, which constitutes, as a rule, but little more than half the organic matter; so that 20,000 pounds of organic carbon in the plowed soil of an acre corresponds to nearly 20 tons of organic matter. But this organic matter consists largely of the old organic residues that have accumulated during the past centuries because they were resistant to decay, and 2 tons of clover or cowpeas plowed under may have greater power to liberate plant-food materials than 20 tons of old, inactive organic matter. The history of the individual farm or field must be depended upon for information concerning recent additions of active organic matter, whether in applications of farm manure, in legume crops, or in sods of old pastures.

The condition of the organic matter of the soil is indicated to some extent by the ratio of carbon to nitrogen. Fresh organic matter recently incorporated with the soil contains a very much higher proportion of carbon to nitrogen than do the old resistant organic residues of the soil. The proportion of carbon to nitrogen is higher in the surface soil than in the corresponding subsoil, and in general this ratio is wider in highly productive soils well charged with active organic matter than in very old, worn soils badly in need of active organic matter.

The organic matter furnishes food for bacteria, and as it decays certain decomposition products are formed, including much carbonic acid, some nitrous acid, and various organic acids, and these acting upon the soil have the power to dissolve the essential mineral plant foods, thus furnishing available phosphates, nitrates, and other salts of potassium, magnesium, calcium, etc., for the use of the growing crop.

Effect of Tillage.—Tillage, or cultivation, also hastens the liberation of plant-food elements by permitting the air to enter the soil. It should be remembered, however, that tillage is wholly destructive, in that it adds nothing whatever to the soil, but always leaves it poorer, so far as plant-food materials are concerned. Tillage should be practiced so far as is necessary to prepare a suitable seed bed for root development and also for the purpose of killing weeds, but more than this is unnecessary and unprofitable; and it is much better actually to enrich the soil by proper applications of limestone, organic matter, and other fertilizing materials, and thus promote soil conditions favorable for vigorous plant growth, than to depend upon excessive cultivation to accomplish the same object at the expense of the soil.

PERMANENT SOIL IMPROVEMENT

According to the kind of soil involved, any comprehensive plan contemplating a permanent system of agriculture will need to take into account some of the following considerations.

The Application of Limestone

The Function of Limestone.—In considering the application of limestone to land it should be understood that this material functions in several different ways, and that a beneficial result may therefore be attributable to quite diverse causes. Limestone provides calcium, of which certain crops are strong feeders. It corrects acidity of the soil, thus making for some crops a much more favorable environment as well as establishing conditions absolutely required for some of the beneficial legume bacteria. It accelerates nitrification and nitrogen fixation. It promotes sanitation of the soil by inhibiting the growth of certain fungous diseases, such as corn-root rot. Experience indicates that it modifies either directly or indirectly the physical structure of fine-textured soils, frequently to their great improvement. Thus, working in one or more of these different ways, limestone often becomes the key to the improvement of worn lands.

How to Ascertain the Need for Limestone.—One of the most reliable indications as to whether a soil needs limestone is the character of the growth of certain legumes, particularly sweet clover and alfalfa. These crops do not thrive in acid soils. Their successful growth, therefore, indicates the lack of sufficient acidity in the soil to be harmful. In case of their failure to grow the soil should be tested for acidity as described below. A very valuable test for ascertaining the need of a soil for limestone is found in the potassium thiocyanate test for soil acidity. It is desirable to make the test for carbonates along with the acidity test. Limestone is calcium carbonate, while dolomite is the combined carbonates of calcium and magnesium. The natural occurrence of these carbonates in the soil is sufficient assurance that no limestone is needed, and the acidity test will be negative. On lands which have been treated with limestone, however, the surface soil may give a positive test for carbonates, owing to the presence of undecomposed pieces of limestone, and at the same time a positive test for acidity may be secured. Such a result means either that insufficient limestone has been added to neutralize the acidity, or that it has not been in the soil long enough to entirely correct the acidity. In making these tests, it is desirable to examine samples of soil from different depths, since carbonates may be present, even in abundance, below a surface stratum that is acid. Following are the directions for making the tests:

The Potassium Thiocyanate Test for Acidity. This test is made with a 4-percent solution of potassium thiocyanate in alcohol—4 grams of potassium thiocyanate in 100 cubic centimeters of 95-percent alcohol.[1] When a small quantity of soil shaken up in a test tube with this solution gives a red color the soil is acid and limestone should be applied. If the solution remains colorless the soil is not acid. An excess of water interferes with the reaction. The sample when tested, therefore, should be at least as dry as when the soil is in good tillable condition. For a prompt reaction the temperature of the soil and solution should be not lower than that of comfortable working conditions (60° to 75° Fahrenheit).

The Hydrochloric Acid Test for Carbonates. Take a small representative sample of soil and pour upon it a few drops of hydrochloric (muriatic) acid, prepared by diluting the concentrated acid with an equal volume of water. The presence of limestone or some other carbonates will be shown by the appearance of gas bubbles within 2 or 3 minutes, producing foaming or effervescence. The absence of carbonates in a soil is not in itself evidence that the soil is acid or that limestone should be applied, but it indicates that the confirmatory potassium thiocyanate test should be carried out.

Amounts to Apply.—Acid soils should be treated with limestone whenever such application is at all practicable. The initial application varies with the degree of acidity and will usually range from 2 to 6 tons an acre. The larger amounts will be needed on strongly acid soils, particularly on land being prepared for alfalfa. When sufficient limestone has been used to establish conditions favorable to the growth of legumes, no further applications are necessary until the acidity again develops to such an extent as to interfere with the best growth of these crops. This will ordinarily be at intervals of several years. In the case of an inadequate supply of magnesium in the soil, the occasional use of magnesian (dolomitic) limestone would serve to correct this deficiency. Otherwise, so far as present knowledge indicates, either form of limestone—high-calcium or magnesian—will be equally effective, depending upon the purity and fineness of the respective stones.

Fineness of Material.—The fineness to which limestone is ground is an important consideration in its use for soil improvement. Experiments indicate that a considerable range in this regard is permissible. Very fine grinding insures ready solubility, and thus promptness in action; but the finer the grinding the greater is the expense involved. A grinding, therefore, that furnishes not too large a proportion of coarser particles along with the finer, similar to that of the by-product material on the market, is to be recommended. Altho the exact proportions of coarse and fine material cannot be prescribed, it may be said that a limestone crushed so that the coarsest fragments will pass thru a screen of 4 to 10 meshes to the inch is satisfactory if the total product is used.

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[1] Since undenatured alcohol is difficult to obtain, some of the denatured alcohols have been tested for making this solution. Completely denatured alcohol made over U. S. Formulas No. 1 and No. 4_1 have been found satisfactory. Some commercial firms are also offering other potassium thiocyanate solutions which are satisfactory.

The Nitrogen Problem

Nitrogen presents the greatest practical soil problem in American agriculture. Four important reasons for this are: its increasing deficiency in most soils; its cost when purchased on the open market; its removal in large amounts by crops; and its loss from soils thru leaching. Nitrogen usually costs from four to five times as much per pound as phosphorus. A 100-bushel crop of corn requires 150 pounds of nitrogen for its growth, but only 23 pounds of phosphorus. The loss of nitrogen from soils may vary from a few pounds to over one hundred pounds per acre, depending upon the treatment of the soil, the distribution of rainfall, and the protection afforded by growing crops.

An inexhaustible supply of nitrogen is present in the air. Above each acre of the earth's surface there are about sixty-nine million pounds of atmospheric nitrogen. The nitrogen above one square mile weighs twenty million tons, an amount sufficient to supply the entire world for four or five decades. This large supply of nitrogen in the air is the one to which the world must eventually turn.

There are two methods of collecting the inert nitrogen gas of the air and combining it into compounds that will furnish products for plant growth. These are the chemical and the biological fixation of the atmospheric nitrogen. Farmers have at their command one of these methods. By growing inoculated legumes, nitrogen may be obtained from the air, and by plowing under more than the roots of these legumes, nitrogen may be added to the soil.

Inasmuch as legumes are worth growing for purposes other than the fixation of atmospheric nitrogen, a considerable portion of the nitrogen thus gained may be considered a by-product. Because of that fact, it is questionable whether the chemical fixation of nitrogen will ever be able to replace the simple method of obtaining atmospheric nitrogen by growing inoculated legumes in the production of our great grain and forage crops.

It may well be kept in mind that the following amounts of nitrogen are required for the produce named:

1 bushel of oats (grain and straw) contains 1 pound of nitrogen.
1 bushel of corn (grain and stalks) contains 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) contains 2 pounds of nitrogen.
1 ton of timothy contains 24 pounds of nitrogen.
1 ton of clover contains 40 pounds of nitrogen.
1 ton of cowpea hay contains 43 pounds of nitrogen.
1 ton of alfalfa contains 50 pounds of nitrogen.
1 ton of average manure contains 10 pounds of nitrogen.
1 ton of young sweet clover, at about the stage of growth when it is plowed under as green manure, contains, on water-free basis, 80 pounds of nitrogen.

The roots of clover contain about half as much nitrogen as the tops, and the roots of cowpeas contain about one-tenth as much as the tops. Soils of moderate productive power will furnish as much nitrogen to clover (and two or three times as much to cowpeas) as will be left in the roots and stubble. In grain crops, such as wheat, corn, and oats, about two-thirds of the nitrogen is contained in the grain and one-third in the straw or stalks.

The Phosphorus Problem

The element phosphorus is an indispensable constituent of every living cell. It is intimately connected with the life processes of both plants and animals, the nuclear material of the cells being especially rich in this element.

The phosphorus content of the soil is dependent upon the origin of the soil. The removal of phosphorus by continuous cropping slowly reduces the amount of this element in the soil available for crop use, unless its addition is provided for by natural means, such as overflow, or by agricultural practices, such as the addition of phosphatic fertilizers and rotations in which deep-rooting, leguminous crops are frequently grown.

It should be borne in mind in connection with the application of phosphate, or of any other fertilizing material, to the soil, that no benefit can result until the need for it has become a limiting factor in plant growth. For example, if there is already present in the soil sufficient available phosphorus to produce a forty-bushel crop, and the nitrogen supply or the moisture supply is sufficient for only forty bushels, or less, then extra phosphorus added to the soil cannot increase the yield beyond this forty-bushel limit.

There are several different materials containing phosphorus which are applied to land as fertilizer. The more important of these are bone meal, acid phosphate, natural raw rock phosphate, and basic slag. Obviously that carrier of phosphorus which gives the most economical returns, as considered from all standpoints, is the most suitable one to use. Altho this matter has been the subject of much discussion and investigation the question still remains unsettled. Probably there is no single carrier of phosphorus that will prove to be the most economical one to use under all circumstances because so much depends upon soil conditions, crops grown, length of haul, and market conditions.

Bone meal, prepared from the bones of animals, appears on the market in two different forms, raw and steamed. Raw bone meal contains, besides the phosphorus, a considerable percentage of nitrogen which adds a useless expense if the material is purchased only for the sake of the phosphorus. As a source of phosphorus, steamed bone meal is preferable to raw bone meal. Steamed bone meal is prepared by extracting most of the nitrogeneous and fatty matter from the bones, thus producing a more nearly pure form of calcium phosphate containing about 10 to 12 percent of the element phosphorus.

Acid phosphate is produced by treating rock phosphate with sulfuric acid. The two are mixed in about equal amounts; the product therefore contains about one-half as much phosphorus as the rock phosphate itself. Besides phosphorus, acid phosphate also contains sulfur, which is likewise an element of plant food. The phosphorus in acid phosphate is more readily available for absorption by plants than that of raw rock phosphate. Acid phosphate of good quality should contain 6 percent or more of the element phosphorus.

Rock phosphate, sometimes called floats, is a mineral substance found in vast deposits in certain regions. The phosphorus in this mineral exists chemically as tri-calcium phosphate, and a good grade of the rock should contain 12½ percent, or more, of the element phosphorus. The rock should be ground to a powder, fine enough to pass thru a 100-mesh sieve, or even finer.

The relative cheapness of raw rock phosphate, as compared with the treated or acidulated material, makes it possible to apply for equal money expenditure considerably more phosphorus per acre in this form than in the form of acid phosphate, the ratio being, under the market conditions of the past several years, about 4 to 1. That is to say, under these market conditions, a dollar will purchase about four times as much of the element phosphorus in the form of rock phosphate as in the form of acid phosphate, which is an important consideration if one is interested in building up a phosphorus reserve in the soil. As explained above, more very carefully conducted comparisons on various soil types under various cropping systems are needed before definite statements can be given as to which form of phosphate is most economical to use under any given set of conditions.

Basic slag, known also as Thomas phosphate, is another carrier of phosphorus that might be mentioned because of its considerable usage in Europe and eastern United States. Basic slag phosphate is a by-product in the manufacture of steel. It contains a considerable proportion of basic material and therefore it tends to influence the soil reaction.

Rock phosphate may be applied at any time during a rotation, but it is applied to the best advantage either preceding a crop of clover, which plant seems to possess an unusual power for assimilating the phosphorus from raw phosphate, or else at a time when it can be plowed under with some form of organic matter such as animal manure or green manure, the decay of which serves to liberate the phosphorus from its insoluble condition in the rock. It is important that the finely ground rock phosphate be intimately mixed with the organic material as it is plowed under.

In using acid phosphate or bone meal in a cropping system which includes wheat, it is a common practice to apply the material in the preparation of the wheat ground. It may be advantageous, however, to divide the total amount to be used and apply a portion to the other crops of the rotation, particularly to corn and to clover.

The Potassium Problem

Our most common soils, which are silt loams and clay loams, are well stocked with potassium, altho it exists largely in a slowly soluble form. Such soils as sands and peats, however, are likely to be low in this element. On such soils this deficiency may be remedied by the application of some potassium salt, such as potassium sulfate, potassium chlorid, kainit, or other potassium compound, and in many instances this is done at great profit.

From all the facts at hand it seems, so far as our great areas of common soils are concerned, that, with a few exceptions, the potassium problem is not one of addition but of liberation. The Rothamsted records, which represent the oldest soil experiment fields in the world, show that for many years other soluble salts have had practically the same power as potassium salts to increase crop yields in the absence of sufficient decaying organic matter. Whether this action relates to supplying or liberating potassium for its own sake, or to the power of the soluble salt to increase the availability of phosphorus or other elements, is not known, but where much potassium is removed, as in the entire crops at Rothamsted, with no return of organic residues, probably the soluble salt functions in both ways.

Further evidence on this matter is furnished by the Illinois experiment field at Fairfield, where potassium sulfate has been compared with kainit both with and without the addition of organic matter in the form of stable manure. Both sulfate and kainit produced a substantial increase in the yield of corn, but the cheaper salt—kainit—was just as effective as the potassium sulfate, and returned some financial profit. Manure alone gave an increase similar to that produced by the potassium salts, but the salts added to the manure gave very little increase over that produced by the manure alone. This is explained in part, perhaps, by the fact that the potassium removed in the crops is mostly returned in manure properly cared for, and perhaps in larger part by the fact that decaying organic matter helps to liberate and hold in solution other plant-food elements, especially phosphorus.

In laboratory experiments at the Illinois Experiment Station, it has been shown that potassium salts and most other soluble salts increase the solubility of the phosphorus in soil and in rock phosphate; also that the addition of glucose with rock phosphate in pot-culture experiments increases the availability of the phosphorus, as measured by plant growth, altho the glucose consists only of carbon, hydrogen, and oxygen, and thus contains no limiting element of plant food.

In considering the conservation of potassium on the farm it should be remembered that in average livestock farming the animals destroy two-thirds of the organic matter and retain one-fourth of the nitrogen and phosphorus from the food they consume, but that they retain less than one-tenth of the potassium; so that the actual loss of potassium in the products sold from the farm, either in grain farming or in livestock farming, is negligible on land containing 25,000 pounds or more of potassium in the surface 6⅔ inches.

The Calcium and Magnesium Problem

When measured by crop removals of the plant-food elements, calcium is often more limited in Illinois soils than is potassium, while magnesium may be occasionally. In the case of calcium, however, the deficiency is likely to develop more rapidly and become much more marked because this element is leached out of the soil in drainage water to a far greater extent than is either magnesium or potassium.

The annual loss of limestone from the soil depends, of course, upon a number of factors aside from those which have to do with climatic conditions. Among these factors may be mentioned the character of the soil, the kind of limestone, its condition of fineness, the amount present, and the sort of farming practiced. Because of this variation in the loss of lime materials from the soil, it is impossible to prescribe a fixed practice in their renewal that will apply universally. The tests for acidity and carbonates described above, together with the behavior of such lime-loving legumes as alfalfa and sweet clover, will serve as general indicators for the frequency of applying limestone and the amount to use on a given field.

Limestone has a direct value on some soils for the plant food which it supplies, in addition to its value in correcting soil acidity and in improving the physical condition of the soil. Ordinary limestone (abundant in the southern and western parts of Illinois) contains nearly 800 pounds of calcium per ton; while a good grade of dolomitic limestone (the more common limestone of northern Illinois) contains about 400 pounds of calcium and 300 pounds of magnesium per ton. Both of these elements are furnished in readily available form in ground dolomitic limestone.

The Sulfur Question

In considering the relation of sulfur in a permanent system of soil fertility it is important to understand something of the cycle of transformations that this element undergoes in nature. Briefly stated this is as follows:

Sulfur exists in the soil in both organic and inorganic forms, the former being gradually converted to the latter form thru bacterial action. In this inorganic form sulfur is taken up by plants which in their physiological processes change it once more into an organic form as a constituent of protein. When these plant proteins are consumed by animals, the sulfur becomes a part of the animal protein. When these plant and animal proteins are decomposed, either thru bacterial action, or thru combustion, as in the burning of coal, the sulfur passes into the atmosphere or into the soil solution in the form of sulfur dioxid gas. This gas unites with oxygen and water to form sulfuric acid, which is readily washed back into the soil by the rain, thus completing the cycle, from soil—to plants and animals—to air—to soil.

In this way sulfur becomes largely a self-renewing element of the soil, altho there is a considerable loss from the soil by leaching. Observations taken at the Illinois Agricultural Experiment Station show that 40 pounds of sulfur per acre are brought into the soil thru the annual rainfall. With a fair stock of sulfur, such as exists in our common types of soil, and with an annual return, which of itself would more than suffice for the needs of maximum crops, the maintenance of an adequate sulfur supply presents little reason at present for serious concern. There are regions, however, where the natural stock of sulfur in the soil is not nearly so high and where the amount returned thru rainfall is small. Under such circumstances sulfur soon becomes a limiting element of crop production, and it will be necessary sooner or later to introduce this substance from some outside source. Investigation is now under way to determine to what extent this situation may apply under Illinois conditions.

Physical Improvement of Soils

In the management of most soil types, one very important matter, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, increase the moisture-holding capacity of the soil, slightly retards capillary rise and consequently loss of moisture by surface evaporation, and helps to overcome the tendency of some soils to run together badly.

The physical effect of organic matter is to produce a granulation or mellowness, by cementing the fine soil particles into crumbs or grains about as large as grains of sand, which produces a condition very favorable for tillage, percolation of rainfall, and the development of plant roots.

Organic matter is undergoing destruction during a large part of the year and the nitrates produced in its decomposition are used for plant growth. Altho this decomposition is necessary, it nevertheless reduces the amount of organic matter, and provision must therefore be made for maintaining the supply. The practical way to do this is to turn under the farm manure, straw, cornstalks, weeds, and all or part of the legumes produced on the farm. The amount of legumes needed depends upon the character of the soil. There are farms, especially grain farms, in nearly every community where all legumes could be turned under for several years to good advantage.

Manure should be spread upon the land as soon as possible after it is produced, for if it is allowed to lie in the barnyard several months, as is so often the case, from one-third to two-thirds of the organic matter will be lost.

Straw and cornstalks should be turned under, and not burned. There is considerable evidence indicating that on some soils undecomposed straw applied in excessive amount may be detrimental. Probably the best practice is to apply the straw as a constituent of well-rotted stable manure. Perhaps no form of organic matter acts more beneficially in producing good tilth than cornstalks. It is true, they decay rather slowly, but it is also true that their durability in the soil is exactly what is needed in the production of good tilth. Furthermore, the nitrogen in a ton of cornstalks is one and one-half times that of a ton of manure, and a ton of dry cornstalks incorporated in the soil will ultimately furnish as much humus as four tons of average farm manure. When burned, however, both the humus-making material and the nitrogen are lost to the soil.

It is a common practice in the corn belt to pasture the cornstalks during the winter and often rather late in the spring after the frost is out of the ground. This trampling by stock sometimes puts the soil in bad condition for working. It becomes partially puddled and will be cloddy as a result. If tramped too late in the spring, the natural agencies of freezing and thawing and wetting and drying, with the aid of ordinary tillage, fail to produce good tilth before the crop is planted. Whether the crop be corn or oats, it necessarily suffers and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The effect becomes worse if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

In a program of permanent soil improvement one should adopt at the outset a good rotation of crops, including, for the reasons discussed above, a liberal use of legumes. No one can say in advance for every particular case what will prove to be the best rotation of crops, because of variation in farms and farmers and in prices for produce. As a general principle the shorter rotations, with the frequent introduction of leguminous crops, are the better adapted for building up poor soils.

Following are a few suggested rotations which may serve as models or outlines to be modified according to special circumstances.

Six-Year Rotations

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover, or clover and grass)
Fourth year —Clover, or clover and grass
Fifth year —Wheat (with clover), or grass and clover
Sixth year —Clover, or clover and grass

In grain farming, with small grain grown the third and fifth years, most of the unsalable products should be returned to the soil, and the clover may be clipped and left on the land or returned after threshing out the seed; or, in livestock farming, the field may be used three years for timothy and clover pasture and meadow if desired. The system may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

The two following rotations are suggested as especially adapted for combating the corn borer:

First year —Corn
Second year—Soybeans
Third year —Small grain (with legume)
Fourth year—Legume
Fifth year —Corn (for silage)
Sixth year —Wheat (with sweet clover)

First year —Corn
Second year—Soybeans
Third year —Small grain (with legume)
Fourth year—Legume
Fifth year —Wheat (with alfalfa)
Sixth year —Alfalfa

Five-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover, or clover and grass)
Third year —Clover, or clover and grass
Fourth year —Wheat (with clover), or clover and grass
Fifth year —Clover, or clover and grass

First year —Corn
Second year —Soybeans
Third year —Corn
Fourth year —Wheat (with legume)
Fifth year —Legume

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover
Fifth year —Wheat (with clover)

The last rotation mentioned above allows legumes to be grown four times. Alfalfa may be grown on a sixth field rotating over all fields if moved every six years.

Four-Year Rotations

First year —Corn
Second year —Wheat or oats (with clover)
Third year —Clover
Fourth year —Wheat (with clover)

First year —Corn
Second year —Corn
Third year —Wheat or oats (with clover)
Fourth year —Clover

First year —Corn
Second year —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover

First year —Wheat (with clover)
Second year —Clover
Third year —Corn
Fourth year —Oats (with clover)

Alfalfa may be grown on a fifth field for four or eight years, which is to be alternated with one of the four; or the alfalfa may be moved every five years, and thus rotated over all five fields every twenty-five years.

Three-Year Rotations

First year —Corn
Second year —Oats or wheat (with clover)
Third year —Clover

First year —Wheat or oats (with clover)
Second year —Corn
Third year —Cowpeas or soybeans

By allowing the clover, in the last rotation mentioned, to grow in the spring before preparing the land for corn, we have provided a system in which legumes grow on every acre every year. This is likewise true of the following suggested two-year system:

Two-Year Rotations

First year —Oats or wheat (with sweet clover)
Second year —Corn

Altho in this two-year rotation either oats or wheat is suggested, as a matter of fact, by dividing the land devoted to small grain, both of these crops can be grown simultaneously, thus providing a three-crop system in a two-year cycle.

It should be understood that in all of the above suggested cropping systems it may be desirable in some cases to substitute barley or rye for the wheat or oats. Or, in some cases, it may become desirable to divide the acreage of small grain and grow in the same year more than one kind. In all of these proposed rotations the word *clover* is used in a general sense to designate either red clover, alsike clover, or sweet clover, or it may include alfalfa used as a biennial. The mixing of alfalfa with clover seed for a legume crop is a recommendable practice. The value of sweet clover, especially as a green manure for building up depleted soils, as well as a pasture and hay-crop, is becoming thoroly established, and its importance in a crop-rotation program may well be emphasized.

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experimental Fields on Soil Types Similar to those Occurring in Whiteside County)

The University of Illinois has operated altogether about fifty soil experiment fields in different sections of the state and on various types of soil. Altho some of these fields have been discontinued, the large majority are still in operation. It is the present purpose to report the results from certain of these fields located on types of soil described in the accompanying soil report.

A few general explanations at this point, which apply to all the fields, will relieve the necessity of numerous repetitions in the following pages.

Size and Arrangement of Fields

The soil experiment fields vary in size from less than two acres up to 40 acres or more. They are laid off into series of plots, the plots commonly being either one-fifth or one-tenth acre in area. Each series is occupied by one kind of crop. Usually there are several series so that a crop rotation can be carried on with every crop represented every year.

Farming Systems

On many of the fields the treatment provides for two distinct systems of farming, livestock farming and grain farming.

In the livestock system stable manure is used to furnish organic matter and nitrogen. The amount applied to a plot is based upon the amount that can be produced from crops raised on that plot.

In the grain system no animal manure is used. The organic matter and nitrogen are applied in the form of plant manures, including the plant residues produced, such as cornstalks, straw from wheat, oats, clover, etc., along with leguminous catch crops plowed under. It was the plan in this latter system to remove from the land, in the main, only the grain and seed produced, except in the case of alfalfa, that crop being harvested for hay the same as in the livestock system. Some modifications have been introduced in recent years as will be explained in the descriptions of the respective fields.

Crop Rotations

Crops which are of interest in the respective localities are grown in definite rotations. The most common rotation used is wheat, corn, oats, and clover; and often these crops are accompanied by alfalfa growing on a fifth series. In the grain system a legume catch crop, usually sweet clover, is included, which is seeded on the young wheat in the spring and plowed under in the following spring in preparation for corn. If the red clover crop fails, soybeans are substituted.

Soil Treatment

The treatment applied to the plots has, for the most part, been standardized according to a rather definite system, altho deviations from this system occur now and then, particularly in the older fields.

Following is a brief explanation of this standard system of treatment.

Animal Manures.—Animal manures, consisting of excreta from animals, with stable litter, are spread upon the respective plots in amounts proportionate to previous crop yields, the applications being made in the preparation for corn.

Plant Manures.—Crop residues produced on the land, such as stalks, straw, and chaff, are returned to the soil, and in addition a green-manure crop of sweet clover is seeded in small grain to be plowed under in preparation for corn. (On plots where limestone is lacking the sweet clover seldom survives.) This practice is designated as the *residues system.*

Mineral Manures.—The yearly acre-rates of application have been: for limestone, 1,000 pounds; for raw rock phosphate, 500 pounds; and for potassium, usually 200 pounds of kainit. When kainit was not available, owing to conditions brought on by the World war, potassium carbonate was used. The initial application of limestone has usually been 4 tons per acre.

Explanation of Symbols Used

0 = Untreated land or check plots
M = Manure (animal)
R = Residues (from crops, and includes legumes used as green manure)
L = Limestone
P = Phosphorus, in the form of rock phosphate unless otherwise designated (aP = acid phosphate, bP = bonemeal, rP = rock phosphate, sP = slag phosphate)
K = Potassium (usually in the form of kainit)
N = Nitrogen (usually in the form contained in dried blood)
Le = Legume used as green manure
Cv = Cover crop
( ) = Parentheses enclosing figures, signifying tons of hay, as distinguished from bushels of seed
| = Heavy vertical rule, indicating the beginning of complete treatment
|| = Double vertical rule, indicating a radical change in the cropping system

In discussions of this sort of data, financial profits or losses based upon assigned market values are frequently considered. However, in view of the erratic fluctuations in market values—especially in the past few years—it seems futile to attempt to set any prices for this purpose that are at all satisfactory. The yields are therefore presented with the thought that with these figures at hand the financial returns from a given practice can readily be computed upon the basis of any set of market values that the reader may choose to apply.

THE MT. MORRIS FIELD

The Mt. Morris experiment field was established in 1910 at Mt. Morris in Ogle county. The soil represents fairly well the type Light Brown Silt Loam, altho the plots are not altogether uniform in this respect. The plots considered here comprize four series under a rotation of corn, oats, clover, and wheat, with soil treatments as indicated in the accompanying table. The application of straw to the residues plots has been discontinued in these later years. In 1922 the application of limestone, and in 1923 the application of rock phosphate, were indefinitely suspended in order in observe the residual effect of these materials.

FIG. 3.—CORN ON THE MT. MORRIS FIELD

The two pictures represent the extremes in soil treatment on this field. Where the untreated land has produced as a fourteen-year average 44.6 bushels of corn an acre, the land under the residues, limestone, phosphate, potash treatment has yielded 67.2 bushels. The most profitable treatment on this field, however, has been that of residues and limestone, which has produced 62.2 bushels an acre.

TABLE 7.—MT. MORRIS FIELD: SERIES 100, 200, 300, 400, SUMMARY OF CROP YIELDS
Average Annual Yields 1913-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn	Oats	Wheat	Clover[1]	Soy-beans
		14 crops	*14 crops*	*12 crops*	*10 crops*	*2 crops*
1	0	45.3	58.5	23.3	(1.96)	(1.56)
2	M	59.5	67.4	28.1	(2.53)	(1.70)
3	ML	64.4	70.5	34.4	(2.97)	(1.80)
4	MLP	64.3	71.5	35.9	(2.92)	(1.92)
5	0	44.6	54.9	23.5	(1.61)	13.5
6	R	51.2	59.4	25.8	(1.77)	16.0
7	RL	62.2	68.8	32.7	(2.24)	18.9
8	RLP	65.6	70.2	36.2	(2.23)	20.7
9	RLPK	67.2	70.4	36.3	(2.24)	20.0
10	0	43.6	52.4	24.6	(1.79)	(1.68)
	Crop Increases					
	M over 0	14.2	8.9	4.8	(.57)	(.14)
	R over 0	6.6	4.5	2.3	(.16)	2.5
	ML over M	4.9	3.1	6.3	(.44)	(.10)
	RL over R	11.0	9.4	6.9	(.47)	2.9
	MLP over ML	− .1	1.0	1.5	−(.05)	(.12)
	RLP over RL	3.4	1.4	3.5	−(.01)	1.8
	RLPK over RLP	1.6	.2	.1	(.01)	− .7

[1]Some clover seed evaluated as hay.

A summary of the results of the work is given in Table 7, in the form of the average annual crop yields for the years since the complete soil treatments have been in effect.

In looking over these results, one may observe first the beneficial effect of farm manure (M). The annual crop increases due to the use of manure alone amount to over 14 bushels an acre for corn, nearly 9 bushels of oats, almost 5 bushels of wheat, and about ½ ton of clover. Organic manure furnished by "residues" (R) has likewise proved beneficial to all crops, but not in the same degree as stable manure.

Limestone (L) in addition to organic manures has been used with good effect, the improvement being especially marked in the residues system.

Rock phosphate (P) has produced no significant effect applied with manure and limestone. In the corresponding residues system the increases in yield obtained from rock phosphate are somewhat larger, but they have not been sufficient to cover the cost of the phosphate applied.

Potassium (K), in the combination used in these experiments, has produced no results of significance.

THE DIXON FIELD

A summary of the results of the Dixon experiment field are presented here, inasmuch as the soil of this field is similar to some of that found in Whiteside county. This field includes about 21 acres and is laid out into two general systems of plots, a major and a minor system. The results from the major system will be considered here.

The rotation practiced has been wheat, corn, oats, and clover. The treatment of the plots and management of the crops were, for the most part, maintained up to 1922 according to the general plan described above on page 47. The more important modification of the plan has been the discontinuance, within the last few years, of the applications of limestone, phosphate, and straw residues.

Table 8 gives a summary of the results in terms of the average annual crop yields obtained since the plots have been under complete treatment.

In considering these results, the most striking feature to be observed is the outstanding effect of farm manure (M). The average annual increase due to the use of manure alone has amounted to nearly 20 bushels of corn an acre, more than 12 bushels of oats, nearly 7 bushels of wheat, ⅔ of a ton of clover, and ⅓ of a ton of soybean hay.

Organic manure (R) in the form of crop residues has also produced increases in yields altho not to the extent of those produced by animal manure.

Limestone (L) in addition to organic manures has, with a single exception, effected more or less improvement, probably sufficient to cover the expense of application.

Rock phosphate (P), as usual, shows up to best advantage when used with residues on the wheat crop. The effect on other crops, however, has been such that the increases in yield are not sufficient to cover the cost of the application under existing market conditions.

TABLE 8.—DIXON FIELD: SERIES 100, 200, 300, 400, SUMMARY OF CROP YIELDS
Average Annual Yields 1912-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn 15 crops	Oats 14 crops	Wheat 11 crops	Barley 1 crop	Clover[1] 9 crops	Soybeans 4 crops
1	0	36.3	49.0	20.3	43.3	(1.73)	(1.46)
2	M	55.6	61.7	26.9	46.4	(2.44)	(1.78)
3	ML	59.7	65.5	31.0	55.2	(2.70)	(1.92)
4	MLP	62.3	67.3	34.2	58.3	(2.82)	(1.97)
5	0	42.6	54.4	21.7	49.5	(1.35)	11.8
6	R	50.5	58.7	24.8	53.8	(1.47)	13.5
7	RL	56.4	62.6	28.0	54.5	(1.77)	13.3
8	RLP	57.7	65.1	32.9	59.0	(2.04)	13.3
9	RLPK	61.1	64.6	33.7	56.9	(2.18)	14.0
10	0	41.3	52.0	20.0	45.4	(1.89)	(1.45)
	Crop Increases						
	M over 0	19.3	12.7	6.6	3.1	(.71)	(.32)
	R over 0	7.9	4.3	3.1	4.3	(.12)	1.7
	ML over M	4.1	3.8	4.1	8.8	(.26)	(.14)
	RL over R	5.9	3.9	3.2	.7	(.30)	− .2
	MLP over ML	2.6	1.8	3.2	3.1	(.12)	(.05)
	RLP over RL	1.3	2.5	4.9	4.5	(.27)	0.0
	RLPK over RLP	3.4	− .5	.8	− 2.1	(.14)	.7

[1] Including some seed crops evaluated in this summary as hay.

Altho potassium (K) has produced an average increase of 3.4 bushels an acre in corn, the effects on other crops are such as to render its use unprofitable in growing these common field crops.

THE UNION GROVE FIELD

The University maintained a soil experiment field in Whiteside county for about seventeen years. The field lay about 1½ miles northwest of Union Grove on land represented on the soil map as Brown Silt Loam Over Gravel. The soil was described at the time of the establishment of the field as a "brown silt loam over sandy loess"; the experimental results, however, will doubtless apply also to other soil types in the region possessing somewhat similar characteristics.

The field was laid out into five series of plots. On these series two different systems of cropping were carried on, designated in the records as the major and the minor rotations.

The Major Rotation

The major rotation consisted of corn, corn, oats or barley, and clover on Series 100 and 200. The soil treatments were similar to those described on page 47 except that potassium was supplied in 100 pounds of potassium sulfate an acre a year, and commercial nitrogen in the form of dried blood was supplied annually to Plot 19 at the rate of 200 pounds an acre. In 1916 this plot was divided, dried blood being applied to the east half and gluten meal at the annual acre rate of 376 pounds to the west half.

TABLE 9.—UNION GROVE FIELD: SERIES 100, 200

Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1907 Corn[1]	1908 Oats[2]	1909 Clover[2]	1910 Corn[4]	1911 Corn[4]	1912 Oats	1913 Clover	1914 Corn	1915 Corn	1916 Barley	1917 Soy-beans	1918 Corn	1919 Corn	1920 Barley	1921 Clover	1922 Corn	1923 Corn
101	L	31.7	35.8	(2.49)	30.1	40.9	52.0	(4.00)	40.8	16.9	44.7	(1.55)	36.1	31.1	19.3	(2.11)	40.3	42.0
102	RL	36.4	43.0	.. (3) ..	43.2	58.1	63.6	.75	64.7	32.3	53.9	17.7	64.8	63.8	25.0	(2.92)	58.2	39.1
103	ML	35.1	40.0	(2.79)	43.0	56.8	61.3	(4.38)	67.2	42.7	60.2	(2.41)	70.6	73.9	26.7	(3.07)	77.9	57.8
104	CvML	39.4	49.5	(2.85)	52.7	52.4	60.5	(3.95)	63.8	35.8	55.9	(2.38)	71.9	71.2	30.4	(3.29)	58.2	41.8
105	L	33.9	45.5	(2.85)	29.0	38.6	37.0	(3.64)	46.8	15.3	41.7	(1.50)	22.6	27.1	20.1	(2.17)	32.8	30.5
106	LP	33.8	43.8	(2.83)	30.4	46.4	50.9	(3.77)	43.8	19.9	54.9	(1.30)	38.0	31.3	20.8	(2.41)	34.8	36.5
107	RLP	45.1	52.2	.. (3) ..	39.3	68.3	70.8	1.08	71.5	37.9	62.2	14.8	67.7	61.4	28.5	(2.97)	51.4	43.6
108	MLP	39.4	49.8	(2.70)	45.7	61.3	48.6	(3.38)	74.3	38.7	61.5	(2.20)	70.2	63.1	31.2	(3.22)	83.2	53.7
109	CvMLP	40.4	49.4	(2.85)	41.0	59.8	60.0	(3.88)	72.1	45.6	57.7	(2.30)	71.3	63.6	27.5	(3.56)	87.3	57.6
110	L	36.9	46.9	(2.83)	33.0	48.9	50.8	(4.44)	53.4	18.7	47.7	(1.62)	35.4	33.3	22.5	(2.57)	37.9	38.1
111	LPK	40.9	49.5	(3.37)	44.0	66.3	57.7	(4.60)	74.0	38.2	60.9	(1.60)	68.4	64.9	28.1	(3.72)	74.2	56.0
112	RLPK	54.4	53.9	.. (3) ..	54.8	77.2	69.8	.67	79.6	40.7	64.3	16.8	76.5	70.7	30.0	(4.06)	89.2	56.3
113	MLPK	50.6	53.4	(3.01)	51.8	70.4	54.8	(3.29)	72.0	42.1	56.7	(2.25)	72.0	82.3	37.6	(4.00)	90.2	64.8
114	CvMLPK	52.0	46.7	(2.79)	47.7	68.8	59.2	(3.17)	73.1	36.3	61.9	(2.18)	74.0	72.9	29.2	(3.93)	89.0	65.4
115	L	43.3	43.3	(2.09)	30.0	39.0	46.4	1.17	51.3	16.4	45.0	14.2	25.1	25.9	19.2	(1.61)	36.8	37.2
116	R	42.3	40.3	.. (3) ..	42.0	59.1	59.4	1.50	63.4	26.4	54.5	15.9	51.6	52.1	24.5	(1.74)	42.3	42.0
117	RP	42.9	42.8	.. (3) ..	42.6	60.3	67.2	1.92	70.3	38.2	58.6	12.7	56.9	56.1	25.0	(2.24)	47.0	43.0
118	RPK	47.3	44.1	.. (3) ..	54.2	72.1	69.7	1.58	77.9	42.9	58.8	16.4	64.5	59.0	31.8	(3.39)	76.7	47.6
119	RLNPK	50.6	53.3	.. (3) ..	56.7	74.2	70.5	.83	76.2	41.2	57.6	17.1	75.4	69.1	31.4	(3.65)	92.9	67.8
120	0	33.1	35.2	(2.12)	28.6	35.6	54.1	(2.97)	44.7	14.5	45.5	(1.08)	29.3	33.4	12.3	(0.00)	38.8	33.5

[1]Nitrogen, phosphorus, and potassium only. [2]No lime or manure. [3]Growth plowed down. [4]No lime.

TABLE 9.—*Concluded*

Bushels or (tons) per acre

Plot No.	Soil treatment applied	1907 Clover[1]	1908 Corn[2]	1909 Corn[3]	1910 Oats[3]	1911 Soybeans[3]	1912 Corn	1913 Corn	1914 Oats	1915 Clover	1916 Corn	1917 Corn	1918 Barley	1919 Clover	1920 Corn	1921 Corn	1922 Barley	1923 Soybeans
201	L	.....	63.6	57.6	68.3	23.1	54.5	35.9	51.6	(3.12)	36.8	33.0	39.0	(4.05)	42.2	43.6	27.0	4.8
202	RL	.....	56.6	61.5	74.2	25.3	73.4	45.1	49.8	1.42	50.4	43.9	52.8	(2.45)	63.2	61.7	36.2	8.2
203	ML	.....	61.2	60.6	67.8	24.1	84.9	51.5	48.3	(3.34)	50.0	50.7	55.2	(4.31)	63.3	71.9	47.3	7.0
204	CvML	.....	56.1	59.9	72.3	25.0	85.5	48.9	45.3	(2.98)	52.1	50.9	55.2	(4.51)	71.3	74.9	46.3	7.2
205	L	.....	58.8	61.6	64.5	23.0	55.7	34.7	47.2	(2.59)	34.9	32.1	38.8	(4.10)	49.5	40.1	29.8	4.8
206	LP	.....	54.4	60.0	65.5	23.8	66.5	34.7	51.7	(3.00)	35.2	38.4	50.0	(4.13)	45.3	41.3	32.5	3.7
207	RLP	.....	55.9	56.1	81.3	25.2	76.4	46.0	59.8	1.25	49.3	48.8	59.2	(2.55)	59.6	59.0	39.4	6.9
208	MLP	.....	57.5	61.6	75.0	24.8	88.0	50.4	45.6	(3.65)	49.0	54.2	54.8	(3.83)	62.2	77.6	46.0	9.5
209	CvMLP	.....	55.9	61.0	80.0	24.9	85.6	51.4	50.2	(3.42)	51.6	54.2	53.4	(3.34)	67.1	79.9	49.4	9.8
210	L	.....	55.1	51.2	57.7	22.8	58.3	30.7	50.3	(2.68)	34.1	33.4	37.9	(3.57)	15.8	44.4	26.1	5.9
211	LPK	.....	55.1	52.2	55.0	23.0	69.9	44.1	50.3	(3.28)	47.1	51.3	39.5	(3.33)	63.2	78.1	38.2	10.2
212	RLPK	.....	56.5	49.1	65.3	23.5	77.7	49.4	61.7	.92	55.1	64.6	55.0	(2.00)	70.2	70.1	41.7	10.0
213	MLPK	.....	51.8	45.9	58.8	22.8	88.0	50.6	55.8	(3.05)	53.5	60.2	51.6	(3.72)	67.5	69.6	54.8	13.4
214	CvMLPK	.....	39.0	41.2	60.8	22.8	85.5	50.8	50.6	(3.04)	52.6	57.9	50.7	(3.46)	71.2	71.5	49.9	12.6
215	L	.....	30.2	33.6	55.0	21.8	20.1	19.1	48.9	1.58	28.1	22.7	34.2	(3.32)	35.3	35.7	27.9	2.3
216	R	.....	31.2	36.6	60.6	23.8	54.1	28.8	57.0	1.33	39.2	35.8	54.7	(2.21)	43.4	51.7	32.9	7.2
217	RP	.....	32.2	37.2	67.5	22.9	68.5	29.3	65.8	.92	44.5	41.3	47.2	(2.21)	46.8	49.5	37.7	6.5
218	RPK	.....	49.5	40.2	66.4	24.5	77.4	41.1	63.3	.92	48.7	50.5	49.2	(2.42)	61.3	63.2	42.8	9.9
219	RLNPK	.....	51.1	47.6	73.0	24.5	81.7	47.2	62.2	1.50	54.3	57.3	58.9	(2.52)	59.8	66.3	47.7	12.0
220	0	.....	30.4	32.2	49.5	21.4	27.2	19.5	55.0	(1.69)	23.5	23.2	39.4	(3.26)	36.9	33.4	25.2	5.4

[1]No treatment; all plots harvested together. [2]Nitrogen, phosphorus, and potassium only. [3]No lime or manure.

TABLE 10.—UNION GROVE FIELD: SUMMARY OF GRAIN YIELDS
Average Annual Yields 1912-1923—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn *12 crops*	Oats *2 crops*	Barley *4 crops*
1	L	37.8	51.8	32.5
2	RL	55.0	56.7	42.0
3	ML	63.5	54.8	47.3
4	CvML	60.5	52.9	47.0
5	L	35.2	42.1	32.6
6	LP	38.8	51.3	39.6
7	RLP	56.0	65.3	47.3
8	MLP	63.7	47.1	48.4
9	CvMLP	65.6	55.1	47.0
10	L	38.6	50.6	33.6
11	LPK	60.8	54.0	41.7
12	RLPK	66.7	65.8	47.8
13	MLPK	67.7	55.3	50.2
14	CvMLPK	66.7	54.9	47.9
15	L	29.5	47.7	31.6
16	R	44.2	58.2	41.7
17	RP	49.3	66.5	42.1
18	RPK	59.2	66.5	45.7
19	NRLPK	65.8	66.3	48.9
20	0	29.6	54.6	30.6
	Crop Increases			
Limestone				
	L over 0	5.7	−6.5	2.0
	LR over R	10.8	−1.5	.3
	LRP over RP	6.7	−1.2	5.2
	LRPK over RPK	7.5	− .7	2.1
Residues				
	R over 0	14.6	3.6	11.1
	RL over L	19.7	8.6	9.4
	RLP over LP	17.2	14.0	7.7
	RLPK over LPK	5.9	11.8	6.1
Manure				
	ML over L	28.2	6.7	14.7
	MLP over LP	24.9	−4.2	8.8
	MLPK over LPK	6.9	1.3	8.5
Phosphorus				
	PL over L	3.5	3.2	7.0
	PR over R	5.1	8.3	.4
	PLR over LR	1.0	8.6	5.3
	PLM over LM	.2	−7.7	1.1
	PCvLM over CvLM	5.1	2.2	0.0
Potassium				
	KLP over LP	22.0	2.7	2.1
	KRP over RP	9.9	0.0	3.6
	KLRP over LRP	10.7	.5	.5
	KLMP over LMP	4.0	8.2	1.8
	KCvLMP over CvLMP	1.1	− .2	.9

In 1919 it was planned to harvest the first crop of clover as hay on all plots and the second crop as seed on the residues plots. The limestone applications were discontinued in 1920 after the plots had received a total of 14,000 to 16,000 pounds an acre. Beginning in 1921 all clover was harvested as hay and the return of the straws discontinued. In 1922 the application of manure was discontinued on Plot 4, as was also the application of phosphate to Plots 9 and 14.

The results from this field are presented in detail in Table 9, which gives the yields produced for the various soil treatments for each year thruout the entire course of the experiments. Table 10 gives a summary of the grain yields during the period after the complete treatments had been begun, the upper part of the table showing the average annual yields secured and the lower part certain comparisons of the various treatment combinations.

In considering the results it is to be observed that this land is not altogether uniform in productiveness, as is evidenced by the rather wide discrepancies appearing in the replicated lime plots; and therefore considerable allowance must be made in drawing conclusions based upon minor differences. However, some of the comparisons are measured by differences so large and so consistent as to carry significance.

Limestone.—For studying the effect of limestone, the results for the four plots receiving limestone alone, Nos. 1, 5, 10, and 15, are averaged together. The results were rather erratic if the negative response shown by the two oats crops be considered significant. However, limestone appears on the whole to have returned some profit, especially where used in combination with residues, or with residues and minerals.

Residues.—The beneficial effect of crop residues stands out prominently, large increases in yield appearing without exception wherever residues were applied, whether used alone or in combination with other fertilizer materials.

Manure.—The high fertility value of animal manure is likewise demonstrated. Naturally, the greatest effect is seen where manure is used with limestone alone, for the manure itself contains a certain amount of both phosphorus and potassium, so that when these substances are applied as supplementary fertilizing materials, the full value of the manure cannot come into play.

Phosphorus.—Phosphorus in the form of rock phosphate appears to have been somewhat beneficial, but in no combination used were the crop increases sufficient to cover the expense of its application.

Potassium.—Used in certain combinations, potassium sulfate produced very marked effects on the corn crop, resulting in large increases in yield. The most remarkable increase of this kind was on the plot where potassium sulfate was added to limestone and rock phosphate. Here the average increase in corn yield amounted to 22 bushels an acre. In those combinations in which farm manure was a constituent, no such beneficial effect appears, probably because of the fact that considerable potassium is contained in animal manure.

The Minor Rotation

The minor series, numbered 300, 400, and 500, were plotted in 1913 and discontinued in 1919. A nine-year rotation of potatoes and alfalfa was established, the potatoes growing three years on a given series and the alfalfa six years. There were only four plots in each series and these were similar to certain

TABLE 11.—UNION GROVE FIELD: SERIES 300, 400, 500
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1913 Potatoes	1914 Potatoes	1915 Potatoes	1916 Alfalfa	1917 Alfalfa[3]	1918 Alfalfa seeding	1919 Alfalfa
301	0	46.8	59.2	66.8	(1.60)	....	....	(.60)
302	M	112.2	142.3	265.0	(5.35)	....	....	(1.37)
303	ML	83.7	113.6	237.4	(5.54)	....	....	(1.42)
304	MLP	91.7	117.5	251.8	(5.67)	....	....	(2.11)
		Alfalfa[1,2]	Alfalfa[1]	Alfalfa[1]	Potatoes	Potatoes	Potatoes	Alfalfa
401	0	....	(3.30)	(4.74)	68.4	54.6	18.7	(1.22)
402	M	....	(3.55)	(4.72)	143.5	149.2	107.8	(2.07)
403	ML	....	(3.81)	(4.87)	123.3	152.5	97.9	(2.22)
404	MLP	....	(3.58)	(5.00)	115.2	134.2	105.6	(2.37)
		Alfalfa[1,2]	Alfalfa[1]	Alfalfa[1]	Alfalfa[1]	Alfalfa[1,3]	Soybeans[1]	Potatoes
501	0	....	(3.03)	(4.47)	(4.12)	....	(3.00)	25.2
502	M	....	(3.32)	(4.50)	(4.12)	....	(3.22)	42.3
503	ML	....	(4.40)	(5.24)	(4.99)	....	(3.33)	34.5
504	MLP	....	(5.34)	(5.57)	(5.88)	....	(4.40)	35.2

[1]No manure. [2]All plots harvested together; the yield was 5.57 tons per acre. [3]Killed by a heavy freeze in April.

of those in the larger series except that manure was applied at the rate of 15 tons an acre for each potato crop.

The yields for all crops harvested in this rotation are recorded in Table 11. Because of so much incompleteness in carrying out the full treatment program, no tabulated summary is presented, but certain observations of interest can be made by a glance at the figures as they stand. The beneficial effect of farm manure on the potatoes is apparent. Rather strangely, the best yields were made on the plots treated with manure alone. The limestone seems to have had a

FIG. 4.—ALFALFA ON A PORTION OF THE UNION GROVE EXPERIMENT FIELD

In some seasons excellent yields of alfalfa were produced on this field without soil treatment, as seen in this picture. As an average for five seasons, however, where untreated land produced 3.9 tons of hay an acre, land receiving limestone yielded 4.7 tons. Where both limestone and rock phosphate had been applied, the yield increased to 5.1 tons an acre.

detrimental effect and apparently the rock phosphate was unable to overcome this effect.

It may be noted that some excellent yields of alfalfa were produced on this land, especially on the treated plots, altho an unfortunate freeze occurred in 1917 which killed the stand, thus cutting severely the profits from this crop.

THE VIENNA FIELD

Whiteside county, as indicated in the descriptions of certain of its soil types, includes considerable land that is subject to destruction thru erosion or washing. Yellow Silt Loam, which occupies over 38 square miles in the county, is particularly susceptible to this kind of damage. Operators of land in Whiteside county will therefore be interested in experiments conducted on the Vienna field, in Johnson county, to test out different methods of reclaiming badly gullied land and preventing further erosion.

The Vienna field is representative of the sloping, erodible land so common in the extreme southern part of the state. When the experiments were started the whole field, with the exception of about three acres, had been abandoned because so much of the surface soil had washed away, and there were so many gullies that further cultivation was unprofitable. For the purpose of the experiments the field was divided into different sections (see Table 12.) These were not entirely uniform; some parts were much more washed than others, and portions of the lower-lying land had been affected by soil material washed down from above. The higher land had a very low producing capacity; on many spots little or nothing would grow.

TABLE 12.—VIENNA FIELD: HANDLING HILLSIDE LAND TO PREVENT EROSION
Average Annual Yields 1907-1915—Bushels or (tons) per acre

Section	Method	Corn *7 crops*	Wheat *7 crops*	Clover *3 crops*
A	Terrace	31.4	9.0	(.68)
B	Embankments and hillside ditches	32.4	12.7	(.97)
C	Organic matter, deep contour plowing, and contour planting	27.9	11.7	(.80)
D	Check	14.1	4.6	(.21)

Section A included the steepest part of the field and contained many gullies. The land was built up into terraces at vertical intervals of 5 feet. Near the edge of each terrace a small ditch was placed so that the water could be carried to a natural outlet without much washing.

Section B was used to test the so-called embankment method. Ridges were plowed up which were sufficiently high so that when there were heavy falls of rain the water would break over and run in a broad sheet rather than in narrow channels. At the steepest part of the slope, hillside ditches were made for carrying away the run-off.

Section C was washed badly but contained only small gullies. Here the attempt was made to prevent washing by incorporating organic matter in the soil and practicing deep contour plowing and contour planting. With two exceptions, about 8 loads of manure an acre were turned under each year for the corn crop.

Section D was washed to about the same extent as Section C. It was farmed in the most convenient way, without any special effort to prevent washing.

Limestone was applied to the entire field at the rate of 2 tons an acre. Corn, cowpeas, wheat, and clover were grown in a four-year rotation on each section except the one designated as D, which included but three plots.

Careful records were kept for nine years. The results, summarized in Table 12, indicate something of the possibilities in improving hillside land by protecting it from erosion. The average yield of corn from the protected series (A, B, and C) was 30.6 bushels an acre, as against 14.1 bushels on the check series (D). Wheat yielded 11.1 bushels on the protected series, in comparison with 4.6 bushels on the check, and clover yielded ⅘ of a ton on the protected series and but ⅕ of a ton on the check.

Figs. 5 and 6 serve further to indicate what may be done with this type of soil even after it has become badly washed and gullied.

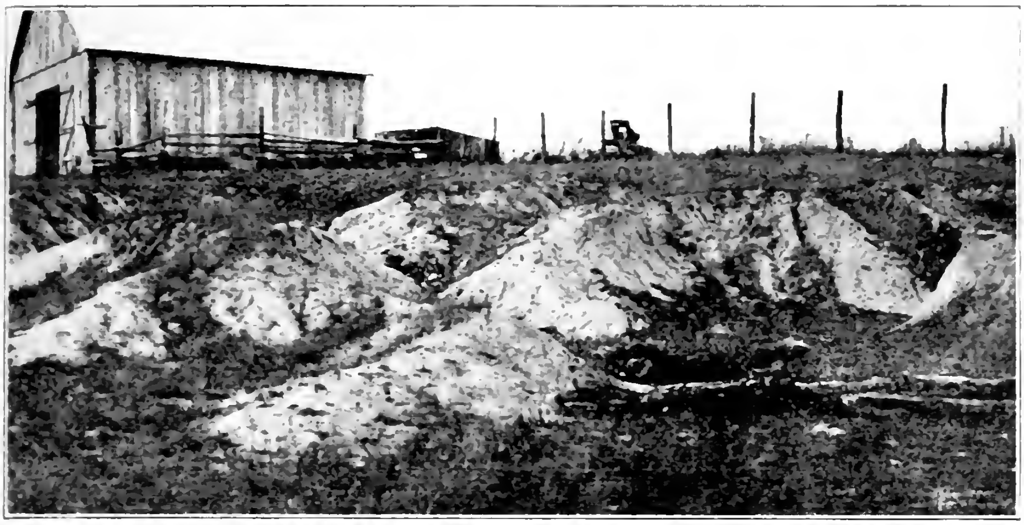


FIG. 5.—PROPER SOIL AND CROPPING METHODS WOULD HAVE PREVENTED THIS CONDITION

This abandoned hillside is just over the fence from the field shown in Fig. 6. Yellow Silt Loam is particularly susceptible to this kind of damage.

FIG. 6.—CORN GROWING ON AN IMPROVED HILLSIDE OF THE VIENNA EXPERIMENT FIELD

This land had formerly been badly eroded. It was reclaimed by proper soil treatment and cropping. Compare with Fig. 5.

THE OQUAWKA FIELD

Since there are considerable areas of Dune Sand, Terrace, in Whiteside county, experiments on that type conducted by the University in Henderson county, near the Mississippi river, will be of interest. The field was established in 1913. It is divided into six series of plots. Corn, soybeans, wheat, sweet clover, and rye, with a catch crop of sweet clover seeded in the rye on the residues plots, are grown in rotation on five series, while the sixth series is devoted to alfalfa. When sweet clover seeded in the wheat fails, cowpeas are substituted. Table 13

TABLE 13.—OQUAWKA FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1915-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn *12 crops*	Soy-beans *12 crops*[1]	Wheat *12 crops*	Sweet clover[2] *8 crops*	Rye *10 crops*	Alfalfa *9 crops*
1	0	20.2	(.99)	8.7	0.0	12.1	(.42)
2	M	25.3	(1.19)	12.0	0.0	13.7	(.92)
3	ML	33.4	(1.61)	16.1	1.03	24.7	(2.37)
4	MLP	33.9	(1.56)	16.4	1.05	23.4	(2.45)
5	0	19.7	(.77)	10.7	0.0	12.7	(.40)
6	R	21.2	(.82)	12.2	0.0	12.9	(.45)
7	RL	37.2	(1.17)	15.1	1.41	24.0	(2.11)
8	RLP	37.0	(1.25)	15.6	1.28	24.1	(2.10)
9	RLPK	39.2	(1.20)	14.9	1.49	26.0	(2.17)
10	0	18.6	(.71)	9.6	0.0	10.3	(.29)
	Crop Increases						
	M over 0	5.1	(.20)	3.3	0.0	1.6	(.50)
	R over 0	1.5	(.05)	1.5	0.0	.2	(.05)
	ML over M	8.1	(.42)	4.1	1.03	11.0	(1.45)
	RL over R	16.0	(.35)	2.9	1.41	11.1	(1.66)
	MLP over ML	.5	(− .05)	.3	.02	− 1.3	(.08)
	RLP over RL	− .2	(.08)	.5	− .13	.1	(− .01)
	RLPK over RLP	2.2	(− .05)	− .07	.21	1.9	(.07)

[1] Eleven regular crops, together with the extra crop described in the following footnote, averaged as 11 crops since the extra crop was a substitute for the red clover which killed out. Several crops which were harvested as seed are evaluated in this summary as hay.
[2] Some hay evaluated as seed. In 1918 the sweet clover was killed by early cutting for a hay crop. Soybeans were seeded in July and the ensuing crop is included in the soybean average.

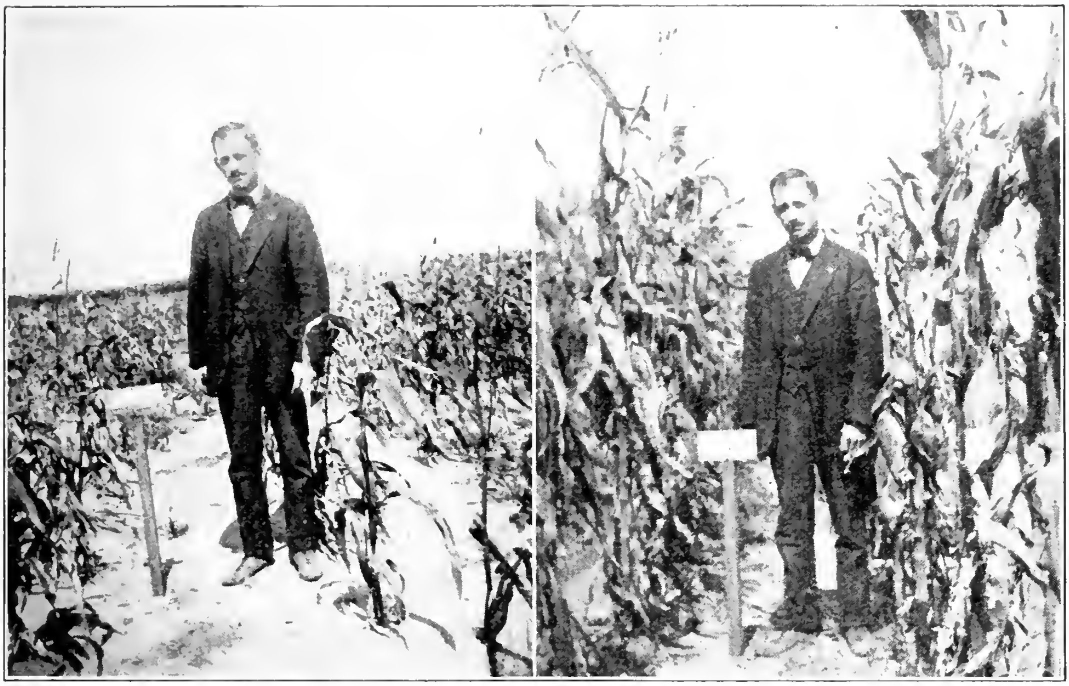
indicates the kinds of treatment applied; the amounts of the materials used were in accord with the standard practice, as explained on page 47.

Limestone (L), it will be noted, has had a remarkably beneficial action on this sand soil. Where it has been used in conjunction with crop residues, the yield of corn has been practically doubled. It has also produced good crops of rye and fair crops of sweet clover and alfalfa.

This land appears to be quite indifferent to treatment with rock phosphate (P). The analyses show, however, that the stock of phosphorus in this type of soil is not large; and as time goes on and the supply diminishes under the production of good-sized crops, the application of this element may become profitable. It is also quite possible that a more available form of phosphate could be used to advantage on this very sandy soil.

Altho the results show an increase of about 2 bushels of corn from the use of potassium salts (K), with ordinary prices this would not be a profitable treatment. The slight increases from the use of potassium appearing in the other crops are scarcely significant.

A significant fact which the above summary does not bring out is that improvement in crop yields under favorable treatment has been progressive, as evidenced by a very marked upward trend in production after the first few years. The yield of corn, for example, under the limestone-residues (RL) treatment



Catch crop, crop residues
Yield 27 bushels

Catch crop, crop residues, limestone
Yield 43 bushels

FIG. 7.—CORN ON THE OQUAWKA FIELD, DUNE SAND, TERRACE

These pictures show the effect on the corn crop of the use of limestone in the residues system. Following the application of limestone, sweet clover makes a thrifty growth, which in turn benefits the corn and other crops in the rotation. As the average of the last rotation the plot at the left has produced 27 bushels of corn an acre, while that at the right has given a yield of 43 bushels.

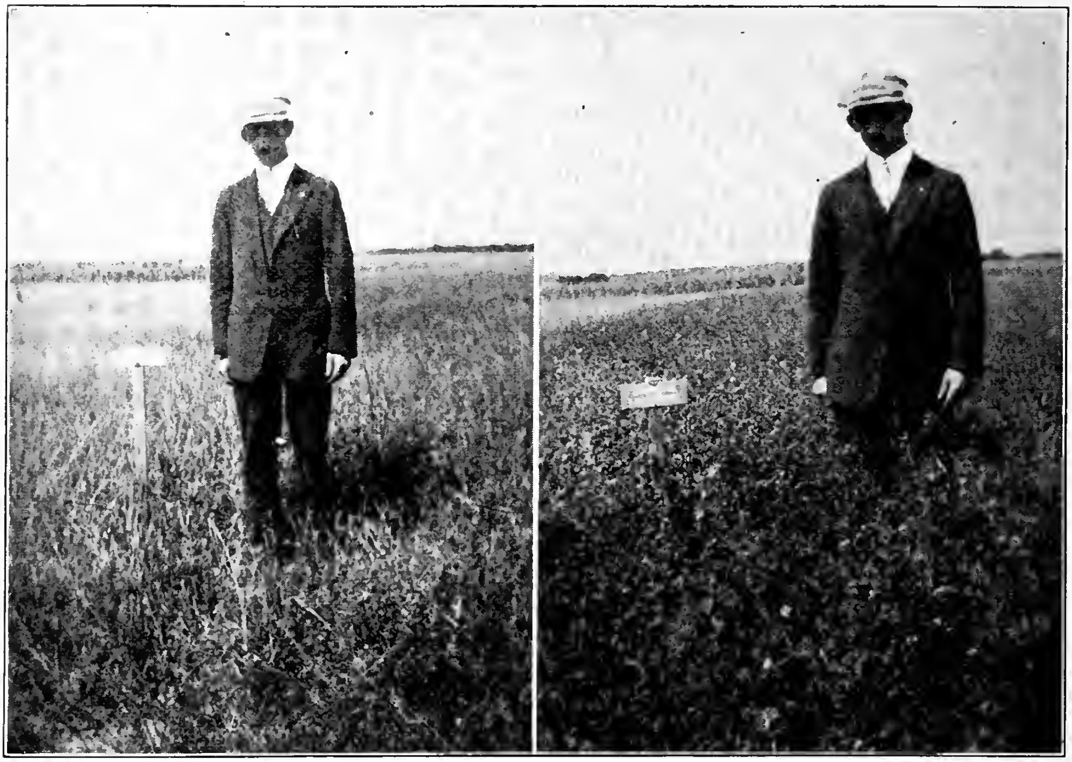
has been 37.2 bushels an acre as an average for the 12 crops since full treatment started, but if we take an average of the last five crops, the yield rises to 42.9 bushels. Likewise the wheat yield under this same treatment for the eleven-year average is 15.1 bushels, but the average for the last five years is 22.3 bushels.

Experience thus far shows rye to be better adapted to this land than wheat, and both alfalfa and sweet clover grow better than soybeans. With these two legume crops thriving so well under this simple treatment, we have promise of great possibilities for the profitable culture of this land, which hitherto has been considered as practically worthless.

THE MANITO FIELD

The Manito experiment field, in Mason county, which was in operation from 1902 to 1905, gives some interesting results of the effects of soil treatment on Deep Peat.

The field consisted of ten plots which received the treatments indicated in Table 14. Where potassium was applied, the yield was three to four times as large as where nothing was applied. Where approximately equal money values of kainit and potassium chlorid were used, slightly greater yields were obtained



Manure
Yield: Nothing

Manure and limestone
Yield: 4.43 tons per acre

FIG. 8.—ALFALFA ON THE OQUAWKA FIELD

These pictures show the possibility of improving this unproductive sandy land of the Oquawka field. Both plots were seeded alike to alfalfa. Where manure alone was applied, the crop was a total failure, but where limestone in addition to manure was applied, nearly 4½ tons of alfalfa hay was obtained as the season's yield.

with the potassium chlorid, which, however, supplied about one-third more potassium than the kainit. However, either material furnished more potassium than was required by the crops produced.

TABLE 14.—MANITO FIELD: DEEP PEAT
Annual Crop Yields—Bushels per Acre

Plot No.	Soil treatment 1902	Corn 1902	Corn 1903	Soil treatment 1904	Corn 1904	Corn 1905
1	None	10.9	8.1	None	17.0	12.0
2	None	10.4	10.4	Limestone, 4000 lbs.	12.0	10.1
3	Kainit, 600 lbs.	30.4	32.4	Limestone, 4000 lbs., kainit, 1200 lbs.	49.6	47.3
4	Kainit, 600 lbs., acidulated bone, 350 lbs.	30.3	33.3	Kainit, 1200 lbs., steamed bone, 395 lbs.	53.5	47.6
5	Potassium chlorid, 200 lbs.	31.2	33.9	Potassium chlorid, 400 lbs.	48.5	52.7
6	Sodium chlorid, 700 lbs.	11.1	13.1	None	24.0	22.1
7	Sodium chlorid, 700 lbs.	13.3	14.5	Kainit, 1200 lbs.	44.5	47.3
8	Kainit, 600 lbs.	36.8	37.7	Kainit, 600 lbs.	44.0	46.0
9	Kainit, 300 lbs.	26.4	25.1	Kainit, 300 lbs.	41.5	32.9
10	None	[1]	14.9	None	26.0	13.6

[1]Yield not recorded for 1902.

The use of 700 pounds of sodium chlorid (common salt) yielded no appreciable increase over the best untreated plots, indicating that where potassium is itself actually deficient, salts of other elements cannot take its place.

Applications of 2 tons of ground limestone per acre produced no increase in the corn crops, either when applied alone or in combination with kainit, either the first year or the second.

Reducing the application of kainit from 600 to 300 pounds for each two-year period reduced the total yield of corn from 164.5 to 125.9 bushels. The two applications of 300 pounds of kainit (Plot 9) appear to be insufficient.

THE TAMPICO FIELD

An experiment field representing a large area of the unproductive peaty land in Whiteside and neighboring counties was temporarily conducted by the University for three years beginning in 1902. This field was located about 5 miles northeast of Tampico on the soil type mapped as Peaty Loam. The soil is described as consisting of "black peaty material, rich in organic matter to a

FIG. 9.—CORN ON THE TAMPICO FIELD, PEATY LOAM

The application of potassium in some form is an absolute necessity in order to produce corn on this black peaty soil. On the plot at the left the crop was a failure, altho lime, nitrogen, and phosphorus had been applied. The plot at the right, receiving lime, nitrogen, and potassium, produced 58.7 bushels of corn an acre.

depth of 16 inches. Between 16 and 30 inches, the material is lighter in color and quite sandy, with little organic matter. The subsoil below 30 inches is almost pure coarse sand."

This field consisted of but a single series of 10 plots. The plan of treatment is indicated in Table 15. Nitrogen was applied in 800 pounds of dried blood an acre a year and phosphorus in 200 pounds of bone meal. The potassium was furnished by 200 pounds an acre of potassium chlorid applied in 1902 and by the same quantity of potassium sulfate applied in each of the two years following. Slaked lime was applied at the rate of 450 pounds an acre in 1902. Corn was the only crop grown during the three-year test.

The results in terms of annual corn yields are recorded in Table 15. According to notations in the records the plots were not altogether uniform with respect to topography. Plots 9 and 10, lying a little higher than the others, were more favorably located for the excessively wet seasons of 1902 and 1903, thus causing

TABLE 15.—TAMPICO FIELD: ANNUAL CROP YIELDS
Bushels per acre

Plot No.	Soil treatment applied	1902 Corn	1903 Corn	1904 Corn
101	None	0.0	0.0	0.0
102	Lime (and potassium after 2 years)	0.0	0.0	26.9[1]
103	Lime, nitrogen	0.0	0.0	0.0
104	Lime, bone meal	0.0	0.0	0.0
105	Lime, potassium	34.1	45.4	45.2
106	Lime, nitrogen, bone meal	0.0	0.0	0.0
107	Lime, nitrogen, potassium	37.6	58.7	44.1
108	Lime, bone meal, potassium	35.3	46.8	43.0
109	Lime, nitrogen, bone meal, potassium	56.5	65.9	44.0
110	Nitrogen, potassium, bone meal	49.4	58.6	35.6[2]

[1] 125 pounds potassium sulfate per acre was applied to Plot 102 in 1904. [2] No potassium was applied to Plot 110 in 1904.

the nitrogen and phosphorus treatments on these plots to appear at an unfair advantage. In 1904, with a more nearly normal rainfall, this undue advantage disappeared and these plots yielded no more than the corresponding plot treated with potassium (Plot 105). This lack of response from both the nitrogen and the phosphorus treatments is not surprising if the composition of Peaty Loam type be taken into consideration; by reference to the tables of plant-food content (page 11 to 13) it will be observed that this type of soil is extraordinarily high in nitrogen and also very rich in phosphorus.

The lime was without effect but, as a matter of fact, this land does not need lime, as evidenced by the high calcium content shown in the analyses of samples of this soil type.

The outstanding feature of these results is shown in the response to potassium fertilization. Every plot from which potassium was omitted was invariably a total crop failure; while every plot treated with a potassium salt produced each year a fair yield of corn.

These experimental results on the Tampico field are borne out in the practical experience of farmers in the vicinity, and the conclusion is that some potassium-bearing mineral is essential in any scheme to make this land productive.

List of Soil Reports Published

1 Clay, 1911
2 Moultrie, 1911
3 Hardin, 1912
4 Sangamon, 1912
5 LaSalle, 1913
6 Knox, 1913
7 McDonough, 1913
8 Bond, 1913
9 Lake, 1915
10 McLean, 1915
11 Pike, 1915
12 Winnebago, 1916
13 Kankakee, 1916
14 Tazewell, 1916
15 Edgar, 1917
16 DuPage, 1917
17 Kane, 1917
18 Champaign, 1918
19 Peoria, 1921
20 Bureau, 1921
21 McHenry, 1921
22 Iroquois, 1922
23 DeKalb, 1922
24 Adams, 1922
25 Livingston, 1923
26 Grundy, 1924
27 Hancock, 1924
28 Mason, 1924
29 Mercer, 1925
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33 Saline, 1926
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