UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT NO. 35

WILL COUNTY SOILS

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

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The Soil Survey of Illinois was organized under the general supervision of Professon 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.

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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 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 Will county was conducted.

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WILL COUNTY SOILS

By R. S. SMITH, O. I. ELLIS, E. E. DeTURK, F. C. BAUER, and L. H. SMITH[1]

LOCATION AND CLIMATE OF WILL COUNTY

Will county is situated in the northeastern part of Illinois, about 22 miles south and west of Lake Michigan. The county is irregular in outline and comprizes an area of about 834 square miles. It is located entirely within the area covered by the late Wisconsin glaciation. One hundred forty square miles lie in the Kankakee-DesPlaines terrace.

The climate of Will county has a fairly wide range of temperature between the extremes of winter and summer. The greatest range for any one year in the thirty-year period from 1895 to 1924 was 126 degrees in 1914. The highest temperature recorded during this period was 104°; the lowest, 25° below zero. During this thirty-year period, the temperature reached zero, or below, every winter with the exception of three, those of 1906, 1908, and 1921. During this same period, the winter temperature fell to 10° or more below zero in twenty out of the thirty winters, and the summer temperature registered 100° or more during fifteen summers. The average date of the last killing frost in the spring is May 2, the earliest in the fall, October 10, which gives an average growing season of 161 days.

The average annual rainfall for Will county for the thirty-year period was 32.83 inches. The average rainfall by months for this period was as follows: January, 1.90 inches; February, 1.57; March, 2.73; April, 2.66; May, 3.80; June, 3.44; July, 3.35; August, 3.37; September, 3.56; October, 2.37; November, 2.05; December, 1.90.

AGRICULTURAL PRODUCTION

Will county is agricultural in its interests. It is well adapted to grain, livestock, dairy, or mixed farming because of its large proportion of dark-colored upland soil and because of the nearness of the Chicago and other markets. The dairy industry is centered around Joliet, New Lenox, Mokena, Lockport, and Steger. Nearly all the milk is shipped or hauled directly into Chicago and Joliet. There are very few creameries and cheese factories in the county, and no livestock centers. Beef cattle and hogs are important, but only a very few sheep are found on the farms.

According to the Fourteenth Census of the United States, there were 3,385 farms in Will county in 1919. These had an average of 144.2 acres, of which 127.3 acres were improved. Approximately 90 percent of the county is in farm land. During the past ten years there has been a slight decrease in the number of farms and an increase in tenantry.

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[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.

The principal crops grown are wheat, corn, oats, barley, rye, forage, and hay. The acreage in alfalfa and sweet clover has gradually increased since 1920. The Census reports the following acreage and yield of the principal crops for 1919.

Crops	*Acreage*	*Production*	*Yield per acre*
Corn	129,404	4,271,101 bu.	32.2 bushels
Oats	112,028	3,790,775 bu.	33.8 bushels
Wheat	54,175	954,452 bu.	17.6 bushels
Barley	6,281	161,560 bu.	25.7 bushels
Rye	4,175	54,345 bu.	13.0 bushels
Timothy	20,761	24,937 tons	1.20 tons
Timothy and clover mixed	17,727	21,150 tons	1.20 tons
Clover	3,312	4,031 tons	1.21 tons
Alfalfa	1,984	5,113 tons	2.57 tons
Silage crops	11,235	64,968 tons	5.78 tons
Corn for forage	21,700	25,868 tons	1.19 tons

These figures are for but a single year. For the ten-year period 1911 to 1920 the U. S. Department of Agriculture gives the average yield of corn as 35.6 bushels; oats, 40.6 bushels; winter wheat, 20.2 bushels; hay, 1.19 tons.

The importance of livestock in the agriculture of Will county is shown by the following figures for 1919, also taken from the Census of 1920:

Animals and Animal Products	*Number*	*Value*
Horses	21,197	$1,967,586
Mules	468	54,805
Beef cattle	13,313	1,219,584
Dairy cattle	30,574	2,124,790
Sheep	3,196	37,481
Swine	47,262	972,718
Value of all poultry	.....	392,686
Value of eggs and chickens	.....	942,175
Value of dairy products	.....	1,472,625
Wool	12,994 lbs.	6,774

Fruit and vegetable growing in Will county have been, until recently, limited to small garden patches and orchards for home consumption. However, in the territory adjacent to or near the industrial centers of Joliet, Steger, and Chicago Heights, truck gardening has been on a rapid increase since 1920. Grape growing in the sandy region near Braidwood and Wilmington, formerly a coal mining section, has been on an increase during recent years. Melons also are grown extensively in this region.

Limestone, phosphates, and mixed fertilizers are used extensively in the county. The truck gardeners make liberal use of manure and other fertilizers.

SOIL FORMATION

GLACIATION

One of the most important periods in the geological history of the county, from the standpoint of soil formation, was the Glacial period, during which and immediately following, the material that later formed the mineral portion of the soils was being deposited.

During the Glacial period, three ice sheets, the Illinoisan, early Wisconsin, and late Wisconsin, advanced across the area now occupied by Will county. The last of these great ice advances, the late Wisconsin, built up an extensive system of moraines known as the Valparaiso morainic system, which is concentric to Lake Michigan. The morainic ridge which occurs along the west side of the

county is known as the Minooka ridge. The peculiar topography, known as knob-and-basin topography, which occurs in the northern part of the county, is characteristic of the late Wisconsin moraines.

The thickness of the glacial drift varies from a few feet to 150 feet or more. Probably very little of the surface soil is derived from the underlying drift, since it was covered by a blanket of wind-blown material, or loess. The loess averages about 35 inches in thickness, varying from about 16 inches to 4 or 5 feet.

SOIL DEVELOPMENT

During the time which has elapsed since the last ice invasion, weathering and other processes have been active, resulting in the formation of the soils of the county as we know them today. Since the upland prairie has been occupied, probably continuously, by grass vegetation, organic matter has accumulated, resulting in the formation of productive, dark-colored soils. The agencies of weathering, acting on the soil material, caused the leaching of certain minerals, the accumulation of others, and the movement of particles into layers, zones, or "horizons." Thus, we now have distinct horizons in the upland soils which are designated by the letters A, B, and C. The areas adjacent to streams, which have been occupied by timber, are light-colored because of relative deficiency of the surface soil in organic matter. The bottom-land soils are made up, for the most part, of alluvial material brought down from the uplands of the immediate vicinity. These soils are immature and have not developed horizons, as is the case with the mature upland soils.

PHYSIOGRAPHY AND DRAINAGE

Will county presents striking variations in topography. The upland varies from flat to rolling. In the northern part of the county, adjacent to DuPage and Cook counties, the topography is of the knob-and-basin type, as previously noted. The terraces, which are located principally in the western and southwestern part of the county, vary from flat to undulating. In the portion which borders the Kankakee river, the rolling topography is due to the action of the wind upon the sandy soils, piling them into dune-like formations.

Will county has four distinct drainage basins, namely: Lake Michigan, Kankakee, DesPlaines, and DuPage. The drainage map, page 4, shows the portions of the county within each of these basins. DesPlaines and Kankakee rivers pass thru extensive terraces and old swamp areas, converging one mile west of the Grundy-Will county line to form Illinois river. Will county forms a part of the divide between the Mississippi and St. Lawrence river basins. Since the opening of the Chicago Sanitary District canal in 1900, part of the waters of Lake Michigan have been diverted thru the canal into DesPlaines river at Lockport.

The rivers of the county rarely overflow their banks during periods of high water because of their wide and deep channels. The upland areas of the county are, for the most part, well drained by tile, open ditches, intermittent streams, and creeks. The terraces that are underlain with coarse sand and

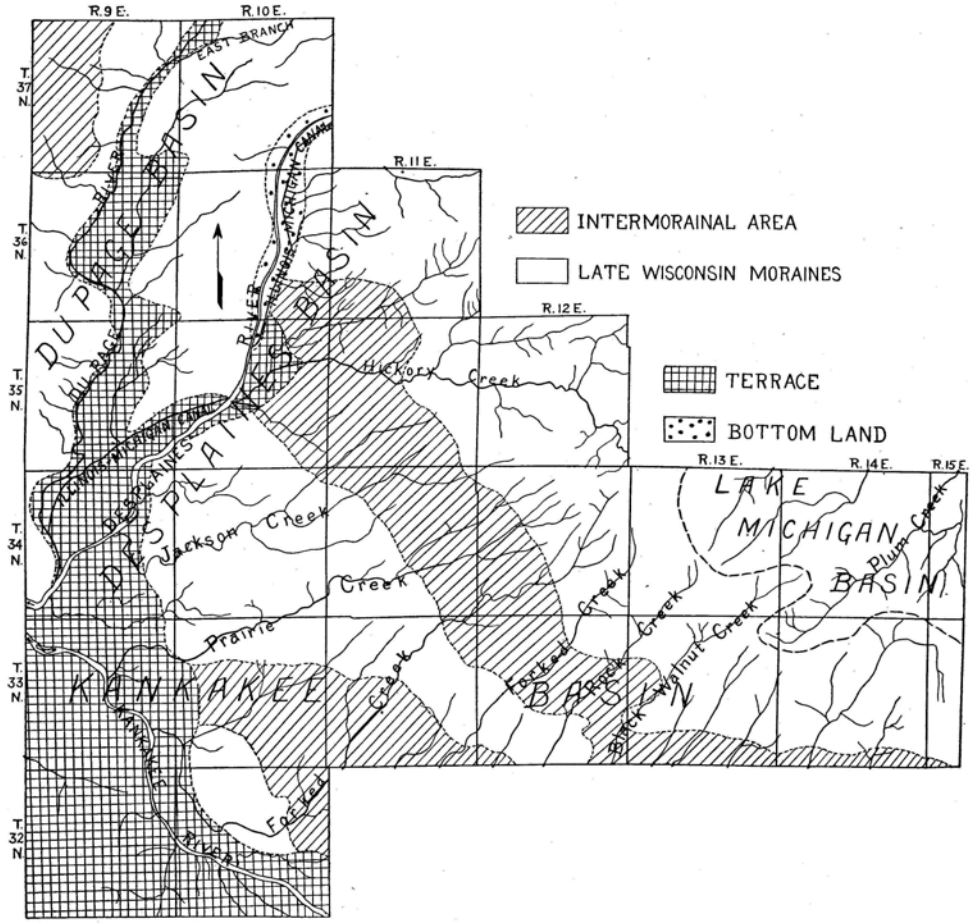

FIG. 1.—DRAINAGE MAP OF WILL COUNTY SHOWING STREAM COURSES AND TERRACE, BOTTOM-LAND, MORAINAL, AND INTERMORAINAL AREAS

gravel have good drainage, while those that are underlain with finer-grained sand and limestone are usually insufficiently drained.

The altitudes of some of the locations in Will county are as follows: Beecher, 720 feet; Frankfort, 764; Joliet, 539; Manhattan, 686; Monee, 800; Wilmington, 549.

SOIL GROUPS

The soils of Will county are divided into four groups, as follows:

Upland Prairie Soils, usually rich in organic matter. These areas were originally covered with wild prairie grasses, the partially decayed roots of which have been the chief source of the organic matter.

Upland Timber Soils, including those soils often found along stream courses on which forests grew for a long period of time. These soils contain less organic matter than the prairie soils because the large roots of dead trees

and the surface accumulation of leaves, twigs, and fallen trees decayed almost completely or were burned by forest fires.

Terrace Soils, formed from deposits laid down by flooded streams during high water at the time of the melting of the glaciers. Large quantities of sand deposited on certain portions of the terrace have been reworked by the wind. These areas constitute the sand dunes in Will county.

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

Table 1 gives a list of the soil types found in Will county, the area of each type, and its percentage of the total area. The accompanying map shows the location and boundary of each type of soil down to areas of only a few acres in extent. For explanations concerning the classification of soils and the interpretation of the maps and tables, the reader is referred to the first part of the Appendix to this report.

TABLE 1.—SOIL TYPES OF WILL COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	Upland Prairie Soils (1000, 1200)			
1026, 1226	Brown Silt Loam	544.46	348 454	65.22
1020, 1220	Black Clay Loam	23.75	15 200	2.84
1028.1, 1228.1	Brown Silt Loam On Tight Clay	.84	538	.10
1026.5	Brown Silt Loam On Rock	2.21	1 414	.26
1060, 1260	Brown Sandy Loam	.12	77	.02
		571.38	365 683	68.44
	Upland Timber Soils (1000, 1200)			
1034, 1234	Yellow-Gray Silt Loam	61.92	39 629	7.42
1035, 1235	Yellow Silt Loam	6.96	4 454	.83
1081	Dune Sand	.22	141	.03
		69.10	44 224	8.28
	Terrace Soils (1500)			
1527	Brown Silt Loam Over Gravel	29.19	18 682	3.50
1560	Brown Sandy Loam	46.26	29 606	5.54
1526.4	Brown Silt Loam On Gravel	18.29	11 706	2.19
1560.4	Brown Sandy Loam On Gravel	1.65	1 056	.20
1526.5	Brown Silt Loam On Rock	17.11	10 950	2.05
1581	Dune Sand	7.16	4 582	.86
1534.4	Yellow-Gray Silt Loam On Gravel	2.36	1 510	.28
1536	Yellow-Gray Silt Loam Over Gravel	1.94	1 242	.23
1567	Yellow-Gray Sandy Loam Over Gravel	2.32	1 485	.28
1561	Black Sandy Loam	5.58	3 571	.67
1566	Brown Sandy Loam Over Gravel	4.34	2 778	.52
1519	Brown Clay Loam	1.23	787	.15
1534.5	Yellow-Gray Silt Loam On Rock	.02	13	.002
1520	Black Clay Loam	1.67	1 069	.20
1590	Gravelly Loam	.05	32	.005
1597.5	Stony Brown Silt Loam On Rock (boulders)	3.17	2 029	.38
		142.34	91 098	17.05

TABLE 1.—SOIL TYPES OF WILL COUNTY, ILLINOIS—*Continued*

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	Late Swamp and Bottom-Land Soils (1400)			
1454	Mixed Loam	19.56	12 518	2.34
1426	Brown Silt Loam	2.38	1 523	.28
1454.5	Mixed Loam On Rock	9.14	5 850	1.09
1463	Black Mixed Sandy Loam On Rock	2.66	1 702	.32
1450.1	Black Mixed Loam On Clay	.86	551	.10
1450	Black Mixed Loam	5.16	3 302	.62
1401	Deep Peat	2.06	1 318	.24
1402	Medium Peat On Clay	.10	64	.02
1410	Peaty Loam	.11	71	.02
1402.5	Medium Peat On Rock	.05	32	.005
		42.08	26 931	5.03
	Residual Soils (000)			
099	Rock Outcrop	.25	160	.03
	Miscellaneous			
	Rock quarry	.71	454	.09
	Gravel pit	.87	557	.10
	Water	8.06	5 158	.97
	Mine dump	.07	45	.01
		9.71	6 214	1.17
	Total	834.86	534 310	100.00

INVOICE OF THE ELEMENTS OF PLANT FOOD IN WILL COUNTY SOILS

In order to obtain a knowledge of its chemical composition, each soil type is sampled in the manner described in the following paragraph and subjected to chemical analysis for 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, an upper stratum (extending from 0 to 6⅔ inches), a middle stratum (6⅔ to 20 inches) and a lower stratum (20 to 40 inches). These sampling strata correspond approximately in the common kinds of soil to 2 million pounds an acre of dry soil in the upper stratum, to two times this quantity in the middle stratum, and to three times it in the lower stratum. This, of course, is a purely arbitrary division of the soil section, very useful in arriving at a knowledge of the quantity and distribution of the elements of plant food in the soil, but it should be borne in mind that these strata seldom coincide with the natural strata as they actually exist in the soil.

By this system of sampling we have represented separately three zones for plant feeding. The upper, or surface layer, includes at least as much soil as is ordinarily turned with the plow, and this is the part with which the farm manure, limestone, phosphate, or other fertilizing material is incorporated.

The chemical analysis of a soil, obtained by the methods here employed, gives the invoice of the total stock of the several plant-food materials, actually

present in the soil strata sampled and analyzed. It should be understood, however, that the rate of liberation from their insoluble forms, a matter of at least equal importance, is governed by many factors, and is therefore not necessarily proportional to the total amounts present.

For convenience in making application of the chemical analyses, the results as presented here have been translated from the percentage basis and are given in the accompanying tables in terms of pounds per acre. In this the assumption is made that for ordinary types a stratum of dry soil of the area of an acre and 6⅔ inches thick weighs 2 million pounds. It is understood, of course, that this value is only an approximation, but it is believed that with this understanding it will suffice for the purpose intended. It is, of course, a simple matter to convert these figures back to the percentage basis in case one desires to consider the information in that form.

With respect to the presence of limestone and acidity in different strata, no attempt is made to include in the tabulated results figures purporting to represent their averages for the respective types, because of the extreme variations frequently found within a given soil type. In examining each soil type in the field, however, numerous qualitative tests are made which furnish general information regarding the soil reaction, and in the discussions of the individual soil types which follow, recommendations based upon these tests are given concerning the lime requirement of the respective types. Such recommendations cannot be made specific in all cases because local variations exist, and because the lime requirement may change from time to time, especially under cropping and soil treatment. It is often desirable, therefore, to determine the lime requirement for a given field, and in this connection the reader is referred to the section in the Appendix dealing with the application of limestone (page 37).

THE UPPER SAMPLING STRATUM

In Table 2 are reported the amounts of organic carbon, nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium in two million pounds of the surface soil of each type in Will county.

In connection with this table attention is called to the variation among the soil types with respect to their content of the different plant-food elements. It will be seen from the analyses that variations in the organic-carbon content of the different soils are accompanied by similar variations in the nitrogen content. The organic-carbon content, which serves as a measure of the total organic matter present, is usually from 10 to 12 times that of the total nitrogen. This relationship is explained by the well-established facts that all soil organic matter contains nitrogen and that most of the soil nitrogen (usually 98 percent or more) is present in a state of organic combination. This close relationship is also maintained in the middle and lower sampling strata.

The range in content of organic matter and nitrogen in the different soil types, is wide, altho the major portion of the soils of Will county are well supplied with these materials. About 75 percent of the total area of the county consists of soils containing 40,000 pounds or more of organic carbon in the

surface 2 million pounds. The remaining area is made up mainly of the upland timber types and sandy soils. The most extensive soil type in the county, Brown Silt Loam, contains in the surface soil an average of 68,340 pounds per acre of organic carbon and 6,910 pounds of nitrogen. In a general way these amounts may be considered adequate for good crop production, but they are subject to gradual depletion, particularly when cultivated crops are largely grown. The part which remains year after year is that which has resisted decay and is of much less value in the soil than more "active" materials. For this reason the addition of fresh organic materials, such as stable manure, stalks, and green-manure crops are necessary to keep the soil permanently in the most productive state.

Other constituents are not so closely associated with each other as organic matter and nitrogen. However, 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 the organic matter. With the exception of Dune Sand, Brown Sandy Loam, and Yellow-Gray Silt Loam, all the types in the county contain fairly large amounts of sulfur. Dune Sand contains only 180 pounds of this element in 2 million pounds of soil; the peat soils, on the other hand, contain amounts ranging from 2,240 to 7,130 pounds. In most cases the sulfur content amounts to about two-thirds that of phosphorus. The sulfur available to crops 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 it 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 was added to soil by the rainfall, 3.5 pounds of sulfur an acre a month as an average. Similar observations have been made in other localities for shorter periods. At Carlinville, in Macoupin county, the rainfall for seven months, April to October, 1922, brought down 34.85 pounds of sulfur an acre, or an average of 5 pounds a month. At Toledo, Cumberland county, from April to November, 1922, the average precipitation was 3 pounds an acre a month. The rainfall at Joliet, in Will county, from April thru September, 1922, carried down 20.62 pounds of sulfur an acre, or an average of 3.44 pounds a month for those months. The extreme range of variation in precipitation of sulfur over the state has varied in the observations taken, from .74 pound to a maximum of 10.22 pounds a month. These figures will afford some idea of the amount of sulfur added by rain and also of the wide variation in these amounts under different conditions. With the sulfur added from the atmosphere supplementing that contained in the soil, it would appear that there is probably no need for sulfur fertilizers in Will county. In order to determine definitely the response of crops to applications of sulfur fertilizers, experiments with gypsum have been started at five experimental fields: namely, Raleigh, Toledo, Carthage, Hartsburg, and Dixon.

Phosphorus is fairly abundant in the upland prairie soils, which constitute approximately two-thirds of the area of the county. The minimum for the surface soil of any type in this group is 1,360 pounds an acre, while the average content is 1,770 pounds. Judging from the chemical composition alone, one would not expect a great need for phosphorus fertilization in these soils. However, there has been obtained a good response for the application of rock phosphate at the Joliet experiment field, as well as on many farms in the county. The Upland Timber soils, as a group, contain the least phosphorus of the Will county types, the lowest figure being only 380 pounds an acre for Dune Sand.

Potassium, as is usually the case, is deficient in Deep Peat, there being only 6,300 pounds in the surface stratum. The Medium Peats contain somewhat more, while the Peaty Loam contains approximately the same amount as Dune Sand, namely, 21,000 to 22,000 pounds. The more or less sandy soils, aside from containing less potassium than the heavier types, carry a large proportion of this element in the sand grains. The relatively small surface exposed in the case of these coarse particles greatly lowers the solubility and availability of the potassium in sand soils, but this is partly offset by the greater depth of the feeding zone for crop roots in sandy soils as compared with the heavier types. The other soil types of the county are well supplied with total potassium, the amounts in the upper sampling stratum ranging from approximately 32,000 pounds to over 48,000 pounds.

Both calcium and magnesium are well supplied in the soils of Will county. Calcium ranges, in the upper 6⅔ inches of soil, from 4,900 to 142,740 pounds an acre. Only one soil type, Dune Sand, contains less than 8,000 pounds of this element. The magnesium content ranges from the very low amount of 1,360 pounds an acre in Black Sandy Loam to 86,100 pounds in Gravelly Loam. These extreme types, however, occupy only small areas. The major portion of the soils of the county contain from one-half to two-thirds as much magnesium as calcium in the surface stratum.

THE MIDDLE AND LOWER SAMPLING STRATA

In Tables 3 and 4 are recorded the amounts of the plant-food elements in the middle and lower sampling strata. In comparing these strata with the upper stratum, or with each other, it is necessary to bear in mind that the data as given for the middle and lower sampling strata are on the basis of 4 million and 6 million pounds of soil, and should therefore be divided by 2 and 3 respectively before comparing them with each other or with the data for the upper stratum, which are on a basis of 2 million pounds.

Considering the data in this way it will be noted in comparing the three strata with each other that some of the elements remain practically constant in amount thruout the entire depth sampled; others exhibit more or less variation at the different levels. Furthermore, these variations as a rule move in certain general directions, and by a careful study of them it is frequently possible to obtain clues as to the age or stage of maturity of the various soils, their agricultural importance and needs, and the nature of some of the processes going on in soil formation.

From this point of view it will be seen, in comparing the three strata with each other, that, with the exception of Deep Peat, all of the soil types diminish rapidly in organic matter and nitrogen with increasing depth, and that this diminution is very marked even in the middle stratum. The sulfur content diminishes markedly with increasing depth except in the case of the Peats. This is to be expected since a portion of the sulfur exists in combination with the soil organic matter, and inorganic forms of sulfur are not tenaciously retained by the soil against the leaching action of ground water. Phosphorus, on the other hand, is not removed from the soil by leaching. It is converted by growing plants into organic forms and tends to accumulate in the surface soil in these forms in plant residues at the expense of the underlying strata. Consequently, almost without exception in Will county the surface soil contains a larger proportion of phosphorus than the middle stratum. The lower stratum usually contains approximately the same proportion of phosphorus as the middle stratum, or slightly more, because it has not been so heavily drawn upon.

The content of potassium in the different depths varies only slightly. Analyses of upland types show, however, that the other two important basic elements, calcium and magnesium, have undergone some shifting in the different levels. The calcium content, on the whole, is much higher than that of magnesium, indicating a more abundant supply of calcium in the soil-forming materials. However, with two exceptions the ratio of the calcium content to the magnesium content diminishes in the middle stratum as compared to the upper. This is accompanied by an increase in the amount of magnesium in the middle stratum and usually in the lower as well. As these two elements leach downward thru the soil, magnesium is more readily absorbed by the soil mass than calcium, and calcium is thus forced out into the solution to be carried farther down. Consequently, calcium does not begin to accumulate until it reaches the lowest level, and in counties farther south, where there is greater rainfall it is frequently carried down several feet. The terrace soils are beginning to show the results of this process, but in the bottom-land soils the effects are masked by those of overflow. This relationship does not exist in those soils in which leaching has not progressed far enough to remove the calcium carbonate.

It is frequently of interest to know the total supply of a plant-food element accessible to the growing crops. While it is not possible to obtain this information exactly, especially for the deeper-rooted crops, it seems probable that practically all of the feeding range of the roots of most of our common field crops is included in the upper 40 inches of soil. By adding together, for a given soil type, the corresponding figures in Tables 2, 3, and 4, the total amounts of the respective plant-food elements to a depth of 40 inches may be ascertained.

Considered in this manner the tables show that there is not only a wide diversity among the different soils with respect to a given plant-foot element, but that there is also a great variation with respect to the relative abundance of the various elements within a given soil type as measured by crop requirements. For example, in the most common soil type in the county, mapped as

Brown Silt Loam, Upland, we find that the total quantity of nitrogen in an acre to a depth of 40 inches amounts to 18,850 pounds. This is about the amount of nitrogen contained in the same number of bushels of corn. The amount of phosphorus, 4,870 pounds, contained in the same soil is equivalent to that contained in 28,650 bushels of corn, while in the same quantity of this soil there is present 226,250 pounds of potassium, the equivalent of that contained in approximately 1,200,000 bushels of corn. Yellow-Gray Silt Loam, the most common timber type in the county, presents a marked contrast in nitrogen content. It contains only 8,830 pounds an acre in the 40-inch stratum, or less than half the amount present in Brown Silt Loam, while the phosphorus and potassium contents are approximately the same in the two types. Deep Peat, on the other hand, as compared with Brown Silt Loam, contains more than six times as much nitrogen, or 119,420 pounds an acre; and nearly twice as much phosphorus, 7,840 pounds; but is strikingly low in potassium, containing only 20,780 pounds, or less than one-tenth as much as is contained in the same area of Brown Silt Loam.

Similar observations with respect to calcium are of more interest when applied to legumes rather than corn. The three kinds of soil discussed above, namely Brown Silt Loam, Yellow-Gray Silt Loam, and Deep Peat contain, respectively, in the 40-inch stratum 155,150 pounds, 87,030 pounds, and 431,190 pounds of calcium an acre. Since a ton of red clover hay contains 29 pounds of calcium, the above amounts are equivalent, respectively, to about 5,000 tons, 3,000 tons, and 15,000 tons of clover hay. All three of these soils contain calcium carbonate, the active material in limestone, within the 40-inch stratum, and this accounts for the high calcium content.

Very few soil types in Will county have been leached free of calcium carbonate thruout the entire 40 inches. Two such types are Dune Sand and Brown Sandy Loam, Upland. These contain, respectively, only 29,680 pounds and 41,680 pounds an acre of calcium (in forms other than carbonate) in the 40 inches, which amounts are equivalent to 1,000 and 1,500 tons of clover hay.

In examining the chemical data from the point of view last developed, that is, from the standpoint of the *total* amounts of plant-food elements in different soil types, one is impressed by the apparent relative abundance of the various elements as compared with the amounts removed in crops. It is obvious that the need for additions of a given element to increase crop yields is not necessarily due to too small a total amount of it in the soil, but that it may be, and usually is, due to *too slow a rate of becoming available.* This is a fortunate situation, since the durability of soils for cropping is due largely to the low solubility of the mineral elements of plant food, and in part to the resistance of the organic matter to complete destruction by decay. If the various essential elements were readily dissolved in the soil and the organic matter subject to complete decomposition, the soil would rapidly become depleted as a result of the leaching action of water, in spite of the great absorbing power of the soil mass. The problem of supplying the needs of crops then becomes one of maintaining a steady transformation of the various elements into available

TABLE 2.—PLANT-FOOD ELEMENTS IN THE SOILS OF WILL 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 (1000, 1200)							
1026, 1226	Brown Silt Loam	68 340	6 910	1 130	950	35 940	9 870	11 750
1020	Black Clay Loam	84 660	9 510	1 290	1 290	38 520	15 130	20 520
1228.1	Brown Silt Loam On Tight Clay	66 340	6 860	1 320	880	40 280	12 280	9 000
1026.5	Brown Silt Loam On Rock	55 940	7 780	1 160	840	33 860	11 860	13 960
1060	Brown Sandy Loam	14 660	2 120	780	200	29 340	3 300	7 660
	Upland Timber Soils (1000, 1200)							
1034	Yellow-Gray Silt Loam	26 610	2 230	790	570	40 650	6 950	6 700
1035	Yellow Silt Loam	29 700	3 600	960	520	48 120	8 940	8 020
1081	Dune Sand	6 120	600	380	180	25 780	2 300	4 900
	Terrace Soils (1500)							
1527	Brown Silt Loam Over Gravel	45 880	6 130	1 320	890	33 260	6 550	9 350
1560	Brown Sandy Loam	33 110	3 610	710	460	24 130	2 670	22 450
1526.4	Brown Silt Loam On Gravel	47 280	4 940	1 190	720	38 270	6 660	9 760
1560.4	Brown Sandy Loam On Gravel	43 480	4 620	1 480	780	29 500	5 560	11 940
1526.5	Brown Silt Loam On Rock	80 540	7 760	1 640	1 100	40 440	9 880	12 440
1581	Dune Sand	10 180	840	680	180	21 480	2 780	6 280
1534.4	Yellow-Gray Silt Loam On Gravel	27 820	3 300	960	500	31 820	5 780	9 740
1536	Yellow-Gray Silt Loam Over Gravel	39 200	4 340	1 200	580	33 000	6 540	11 000
1567	Yellow-Gray Sandy Loam Over Gravel	20 400	2 320	740	480	30 000	3 140	9 340
1561	Black Sandy Loam	57 720	5 980	1 120	780	19 780	1 360	9 540
1566	Brown Sandy Loam Over Gravel[1]	.....	.....	.....	.....	.....	.....	.....
1519	Brown Clay Loam	58 940	5 820	1 700	1 020	42 740	17 560	17 200
1534.5	Yellow-Gray Silt Loam On Rock	25 280	2 840	740	480	33 220	7 740	9 560
1520	Black Clay Loam	121 900	13 340	2 880	1 720	36 220	17 200	28 960
1590	Gravelly Loam	51 580	6 920	1 500	1 100	22 780	86 100	142 740
1597.5	Stony Brown Silt Loam On Rock	68 020	7 640	1 560	1 060	30 000	5 280	12 740
	Late Swamp and Bottom-Land Soils (1400)							
1454	Mixed Loam[2]	.....	.....	.....	.....	.....	.....	.....
1426	Brown Silt Loam	92 780	10 780	1 620	1 400	38 000	12 600	16 980
1454.5	Mixed Loam On Rock[2]	.....	.....	.....	.....	.....	.....	.....
1463	Black Mixed Sandy Loam On Rock[2]	.....	.....	.....	.....	.....	.....	.....
1450.1	Black Mixed Loam On Clay[2]	.....	.....	.....	.....	.....	.....	.....
1450	Black Mixed Loam[2]	.....	.....	.....	.....	.....	.....	.....
1401	Deep Peat[3]	282 980	17 140	1 320	7 130	6 300	4 990	130 280
1402	Medium Peat On Clay[3]	405 000	20 810	570	3 170	10 250	1 890	11 260
1410	Peaty Loam	147 440	15 520	860	2 240	22 800	4 800	16 280
1402.5	Medium Peat On Rock[3]	300 310	16 530	1 990	1 150	9 190	9 330	32 490
	Residual Soils (000)							
099	Rock Outcrop[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]Not analyzed.

[2]On account of the heterogeneous character of the Mixed Loams, chemical analyses are not included for these types.

[3]Amounts reported are for 1 million pounds of Deep Peat and Medium Peat.

forms during the growing season, from the reserves in the soil, or from added fertilizing materials, or from both. The above statements, therefore, are not intended to imply that it is possible to predict how long it might be before a certain soil would become exhausted under a given system of cropping. Neither

TABLE 3.—PLANT-FOOD ELEMENTS IN THE SOILS OF WILL 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 (1000, 1200)							
1026, 1226	Brown Silt Loam	69 780	7 550	1 530	1 090	74 370	23 540	21 200
1020	Black Clay Loam	76 530	8 920	2 270	1 430	66 200	30 600	31 150
1228.1	Brown Silt Loam On Tight Clay	58 600	7 160	1 520	920	79 680	32 200	17 160
1026.5	Brown Silt Loam On Rock	76 720	8 640	2 160	1 240	68 360	18 720	20 240
1060	Brown Sandy Loam	23 660	3 360	1 360	360	57 480	7 720	13 440
	Upland Timber Soils (1000, 1200)							
1034	Yellow-Gray Silt Loam	21 100	2 940	1 200	600	81 020	26 260	12 560
1035	Yellow Silt Loam	17 040	3 200	1 800	560	95 960	28 680	15 320
1081	Dune Sand	5 760	1 040	920	520	51 960	5 160	10 320
	Terrace Soils (1500)							
1527	Brown Silt Loam Over Gravel	63 080	6 720	2 020	1 120	68 260	15 400	17 320
1560	Brown Sandy Loam	36 330	3 930	1 070	710	44 080	6 310	18 390
1526.4	Brown Silt Loam On Gravel	56 520	6 440	2 120	1 260	77 260	20 300	20 900
1560.4	Brown Sandy Loam On Rock	65 880	7 640	3 080	1 400	58 920	11 320	18 360
1526.5	Brown Silt Loam On Rock	65 320	8 600	2 680	1 640	84 480	43 680	59 600
1581	Dune Sand	9 560	1 000	1 440	280	41 160	6 240	14 880
1534.4	Yellow-Gray Silt Loam On Gravel	25 480	3 560	1 800	480	63 200	21 000	19 720
1536	Yellow-Gray Silt Loam Over Gravel	42 600	5 360	2 000	760	66 120	14 960	22 880
1567	Yellow-Gray Sandy Loam Over Gravel	18 240	2 800	1 640	560	64 200	13 000	17 320
1561	Black Sandy Loam	29 720	2 760	1 320	640	34 600	3 640	16 040
1566	Brown Sandy Loam Over Gravel[1]	.....	.....	.....	.....	.....	.....	.....
1519	Brown Clay Loam	76 160	8 160	2 560	1 360	85 520	39 800	35 080
1534.5	Yellow-Gray Silt Loam On Rock	24 160	3 160	1 440	920	60 640	18 800	15 360
1520	Black Clay Loam	164 480	17 520	5 240	2 480	79 680	39 520	56 680
1590	Gravelly Loam[1]	.....	.....	.....	.....	.....	.....	.....
1597.5	Stony Brown Silt Loam On Rock	49 520	5 560	1 880	960	62 640	17 360	19 600
	Late Swamp and Bottom-Land Soils (1400)							
1454	Mixed Loam[2]	.....	.....	.....	.....	.....	.....	.....
1426	Brown Silt Loam	118 280	13 840	3 000	1 920	75 000	25 040	30 440
1454.5	Mixed Loam On Rock[2]	.....	.....	.....	.....	.....	.....	.....
1463	Black Mixed Sandy Loam On Rock[2]	.....	.....	.....	.....	.....	.....	.....
1450.1	Black Mixed Loam On Clay[2]	.....	.....	.....	.....	.....	.....	.....
1450	Black Mixed Loam[2]	.....	.....	.....	.....	.....	.....	.....
1401	Deep Peat[3]	768 720	41 620	2 800	21 220	5 840	9 060	165 160
1402	Medium Peat On Clay[3]	478 920	27 680	1 260	4 580	38 900	12 760	16 740
1410	Peaty Loam	115 240	13 320	1 400	1 600	53 880	12 840	25 920
1402.5	Medium Peat On Rock[1]	.....	.....	.....	.....	.....	.....	.....
	Residual Soils (000)							
099	Rock Outcrop[1]	.....	.....	.....	.....	.....	.....	.....

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

[1]Not analyzed.

[2]On account of the heterogeneous character of the Mixed Loams, chemical analyses are not included for these types.

[3]Amounts reported are for 2 million pounds of Deep Peat and Medium Peat.

do the figures necessarily indicate the immediate procedure to be followed in the improvement of a soil, for other factors enter into consideration, aside from merely the amount of plant-food elements present in the soil. Much depends

TABLE 4.—PLANT-FOOD ELEMENTS IN THE SOILS OF WILL 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 (1000, 1200)							
1026, 1226	Brown Silt Loam	40 570	4 390	2 210	990	120 620	80 050	122 200
1020	Black Clay Loam	38 180	5 350	3 180	1 260	118 220	67 820	70 140
1228.1	Brown Silt Loam On Tight Clay	33 600	5 580	2 100	780	118 740	67 980	44 220
1026.5	Brown Silt Loam On Rock[1]	.....	.....	.....	.....	.....	.....	.....
1060	Brown Sandy Loam	15 480	1 920	1 800	180	84 000	10 320	20 520
	Upland Timber Soils (1000, 1200)							
1034	Yellow-Gray Silt Loam	28 110	3 660	2 160	780	118 470	78 810	67 770
1035	Yellow Silt Loam	27 000	4 680	2 530	840	140 760	140 040	206 220
1081	Dune Sand	7 500	840	1 380	600	76 020	8 040	14 460
	Terrace Soils (1500)							
1527	Brown Silt Loam Over Gravel	36 420	4 410	3 000	930	104 010	23 310	27 000
1560	Brown Sandy Loam	16 800	1 740	1 260	540	68 400	11 520	27 760
1526.4	Brown Silt Loam On Gravel	51 540	6 600	3 000	1 440	109 200	49 200	38 520
1560.4	Brown Sandy Loam On Gravel[1]	.....	.....	.....	.....	.....	.....	.....
1526.5	Brown Silt Loam On Rock[1]	.....	.....	.....	.....	.....	.....	.....
1581	Dune Sand	13 380	1 920	2 100	240	60 780	10 200	23 100
1534.4	Yellow-Gray Silt Loam On Gravel	38 580	4 020	3 360	840	92 940	52 020	49 740
1536	Yellow-Gray Silt Loam Over Gravel	27 840	5 220	3 480	480	99 360	34 380	29 940
1567	Yellow-Gray Sandy Loam Over Gravel	26 280	3 900	2 820	1 020	95 580	30 480	32 460
1561	Black Sandy Loam	24 000	1 920	2 040	480	55 140	2 520	23 460
1566	Brown Sandy Loam Over Gravel[1]	.....	.....	.....	.....	.....	.....	.....
1519	Brown Clay Loam	64 680	7 380	3 660	1 200	126 120	53 520	50 160
1534.5	Yellow-Gray Silt Loam On Rock[1]	.....	.....	.....	.....	.....	.....	.....
1520	Black Clay Loam	143 040	16 380	5 460	1 250	110 940	53 100	65 880
1590	Gravelly Loam[1]	.....	.....	.....	.....	.....	.....	.....
1597.5	Stony Brown Silt Loam On Rock[1]	.....	.....	.....	.....	.....	.....	.....
	Late Swamp and Bottom-Land Soils (1400)							
1454	Mixed Loam[2]	.....	.....	.....	.....	.....	.....	.....
1426	Brown Silt Loam	61 380	7 800	3 360	1 140	122 640	40 680	36 900
1454.5	Mixed Loam On Rock[2]	.....	.....	.....	.....	.....	.....	.....
1463	Black Mixed Sandy Loam On Rock[2]	.....	.....	.....	.....	.....	.....	.....
1450.1	Black Mixed Loam On Clay[2]	.....	.....	.....	.....	.....	.....	.....
1450	Black Mixed Loam[2]	.....	.....	.....	.....	.....	.....	.....
1401	Deep Peat[3]	1335750	60 660	3 720	41 670	8 640	12 000	135 750
1402	Medium Peat On Clay[3]	522 180	33 300	1 670	6 800	96 260	39 240	38 030
1410	Peaty Loam	15 780	2 400	720	900	79 140	42 300	86 880
1402.5	Medium Peat On Rock[1]	.....	.....	.....	.....	.....	.....	.....
	Residual Soils (000)							
099	Rock Outcrop[1]	.....	.....	.....	.....	.....	.....	.....

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

[1]Not analyzed.

[2]On account of the heterogeneous character of the Mixed Loams, chemical analyses are not included for these types.

[3]Amounts reported are for 3 million pounds of Deep Peat and 4½ million pounds of Medium Peat on Clay.

upon the nature of the crops to be grown, as to their utilization of plant-food materials, and much depends upon the condition of the plant-food substances themselves as to their availability. Finally, in planning the detailed procedure for the improvement of a soil, there enter for consideration all the economic factors involved in any fertilizer treatment. The data do, however, furnish an inventory of the total stocks of the plant-food elements that can possibly be drawn upon, and in this way, contribute fundamental information for the intelligent planning, in a broad way, of systems of soil management for conserving and improving the fertility of the land.

DESCRIPTION OF SOIL TYPES

UPLAND PRAIRIE SOILS

The upland prairie soils of Will county cover 571.38 square miles, or 68.44 percent of the total area of the county. These soils are usually dark in color, owing to the accumulation of organic matter which has been derived very largely from the fibrous roots of the prairie grasses that once covered this land. The network of grass roots was protected from rapid and complete decay by the covering of fine, moist, surface soil and by the mat of vegetative material formed by the debris of the dead leaves and stems.

The upland prairie soils in this county include some areas of recent timber growth, where certain varieties of trees have invaded the prairies but have not grown for a long enough period to produce the characteristic timber soil.

Brown Silt Loam (1026, 1226)

Brown Silt Loam, Upland, is the most extensive soil type in Will county, occupying 544.46 square miles, or about 65 percent of the area of the county. The profile of this type as mapped varies considerably in different portions of the county as regards color, texture, thickness, and physical properties of the horizons, and also as regards depth to glacial drift. Most of the type is undulating to rolling, with good natural drainage. Erosion is active on the steeper slopes. Calcareous drift occurs at an average depth of about 25 inches over practically the entire area occupied by this type. In the region near the sandy terrace, an appreciable amount of sand occurs in the surface and subsurface horizons.

The A_1 horizon varies in depth from 6 to 13 inches, in color from light brown to nearly black, and in texture as above noted. The A_2 horizon, which extends to about 15 inches in depth, varies from a yellowish brown to a light brown silt loam, the yellowish tint occurring in the areas which have sufficient slope for good surface drainage. The B horizon, with an average thickness of 10 inches, varies from a slightly compact, lightly mottled, yellow silt loam to a compact, mottled, drabbish yellow silty clay loam, with glacial gravel present in some places. The C horizon is a friable, usually calcareous, yellow silt loam, containing glacial gravel and spotted with yellow iron concretions.

Management.—The variations in Brown Silt Loam in Will county must be recognized in its management if the best results are to be secured. Tests indicate that the higher, lighter-colored areas, unless erosion has exposed the calcareous subsoil, need about 2 to 3 tons of limestone an acre for alfalfa or sweet clover. Many of the low-lying, dark-colored areas need no limestone. Much of this type is becoming too low in organic matter to allow good seed-bed preparation with a minimum amount of work. The regular growth of clover, preferably sweet clover, and the plowing down of part of the crop as a green manure, will be found to be a profitable practice. Sweet clover may be seeded in the small grain and pastured during the fall and then plowed down for corn the next spring. This practice will result in a marked increase in the corn yield, particularly on the lighter-colored portions of the type.

Results secured on the Joliet experiment field (see page 48) justify recommending the application of rock phosphate, particularly if only a small amount of manure is available. Smaller returns from the use of this material are to be expected on the dark-colored portions of the type. The application of potash, in the form of kainit, in addition to residues, lime, and rock phosphate, does not give sufficient increase in yield to pay the cost of material in the quantities employed. The favorable results with corn and wheat suggest that this material might be used in smaller amounts at a profit. However, these results are rather exceptional in this region, and for this reason such use of potash in general farming is advised at present only in an experimental way, and attention is called to the probability that it would not be found to pay on the darker-colored portions of the type.

To summarize: It is recommended that sufficient limestone be used to grow good alfalfa or sweet clover, that a portion of these legumes be plowed down at regular intervals, and that rock phosphate or, if preferred, acid phosphate or steamed bone meal be used. In addition, the trial of one of the potash salts for corn is suggested, particularly on the lighter-colored portions of the type.

Black Clay Loam (1020, 1220)

Black Clay Loam, Upland, occurs in small areas thruout the county with the exception of those portions occupied by the terrace and timber soil types. Numerous narrow strips of Black Clay Loam occur along the small streams. In the northern part of the county where the knob-and-basin type of topography prevails, the depressions, some of which are under water a part of the year, are usually occupied by Black Clay Loam. This type occupies 23.75 square miles, or nearly 3 percent of the total area of the county. The topography is flat and the drainage is usually fair to good.

The A_1 horizon varies from a granular, black, silty clay loam to a clay loam, and has an average depth of about 8 inches. The A_2 horizon extends to a depth of about 16 or 17 inches and is a plastic, black clay loam. The B horizon is a plastic, compact, mottled, drabbish yellow to drab clay loam. The thickness of the upper subsoil is about 28 or 30 inches. Below this, the texture of the subsoil is variable on account of the varying depth to the drift, which

is a calcareous, sandy to silty clay or clay loam, drab or gray in color, and strongly stained with brownish red iron concretions.

Management.—Black Clay Loam is a potentially productive soil and no treatment other than the regular plowing down of a leguminous green manure is advised. An account of field experiments on this type as represented by the Hartsburg field will be found on page 56.

Brown Silt Loam On Tight Clay (1028.1, 1228.1)

Brown Silt Loam On Tight Clay occupies only about four-fifths of a square mile in the county. It is found only in two localities; namely, Sections 15 and 16, Township 34 North, Range 13 East, and Section 2, Township 32 North, Range 10 East. The flat topography of the type, together with its impervious clay subsoil, causes drainage to be poor. These areas were formerly small lake basins.

The A_1 horizon, which is about 8 inches in thickness, is a light to medium brown silt loam. The A_2 horizon, extending to a depth of about 14 or 15 inches, varies from a light brown to yellowish brown silt loam to silty clay loam. The B horizon is a plastic, sticky, very compact, drabbish yellow to yellow clay, which grades into a gray clay stained with red to brown iron concretions. The C horizon is found at a depth of about 36 inches and varies from a slightly compact, grayish yellow to yellow clay loam.

Management.—Drainage is the chief problem in the management of this type. If tile are laid, the laterals should be about 4 rods apart. Difficulty will be encountered in getting an outlet because of the topographic position of the type. The soil is medium acid and requires about 2 tons of limestone an acre to grow sweet clover.

Brown Silt Loam On Rock (1026.5)

Brown Silt Loam On Rock, as a soil, is of little agricultural value aside from its value as permanent pasture. The underlying rock is limestone. Most of the areas are found in the vicinity of Joliet along DesPlaines river where the limestone outcrops occur. Since the bed rock is near the surface, very little soil material occurs and the horizons have not been very definitely developed. The type covers a total area of 2.21 square miles.

The A_1 horizon extends to a depth of 7 to 15 inches and is a brown to dark brown silt loam, well supplied with organic matter. This changes into a rather heavy, silty clay loam directly above the limestone. This layer is only a few inches in thickness. The limestone is often found disintegrated into finely divided material to a depth of 2 or 3 inches.

Management.—This type should be left in permanent pasture unless used as a source of limestone for commercial and agricultural purposes.

Brown Sandy Loam (1060, 1260)

Brown Sandy Loam, Upland, is of minor importance. It occurs as scattering areas in the Brown Silt Loam region, north of the Kankakee river terrace.

These areas are formed from sand material blown by the wind from the terraces onto the upland. Very little horizon development is found, as these areas are of late origin. The type occupies a total of only 77 acres.

The surface soil, extending to about 4 inches in depth, is a brown sandy loam. Below this the soil is an incoherent mass of brownish yellow to yellow sand.

Management.—The organic-matter content of this type is low. Legumes should be grown to correct this deficiency after about 2 tons of limestone an acre have been applied to counteract the slight acidity which occurs. The results from the Oquawka experiment field, page 59, may be studied to advantage in connection with the management of this type.

UPLAND TIMBER SOILS

The upland timber soils of Will county include three types, which cover in total an area of 69.10 square miles, or 8.28 percent of the area of the county. They comprize the irregular zones or belts of light-colored soils along the streams and on the moraines in the eastern part of the county.

These soils are characterized by their yellowish gray color due to the low organic-matter content, which is the result of long-continued growth of timber. After the forests invaded the prairies, two conditions were produced: the shade from the trees prevented the growth of prairie grasses, the roots of which are mainly responsible for the organic-matter content; and the trees themselves added very little to the soil, for the leaves and other debris either decayed completely or were burned by forest fires. Moreover, the organic matter that probably had accumulated prior to the forest invasion was dissipated during the occupation of the land by the trees.

Yellow-Gray Silt Loam (1034, 1234)

Yellow-Gray Silt Loam, Upland, occurs chiefly in the vicinity of DesPlaines river and its tributaries and in the eastern part of the county. The type occupies 61.92 square miles, or 7.42 percent of the total area of the county. In topography it varies from undulating to rolling, having a knob-and-basin character where it occurs adjacent to Cook county. Surface drainage is well established and care must be exercised to reduce erosion to a minimum on the slopes. Very little standing timber is found on this type.

The A_1 horizon, which is about 7 inches deep, varies from a brownish yellow to a grayish yellow silt loam. The A_2 horizon, extending to about 14 inches in depth, is a mottled, grayish yellow silt loam. The B horizon is a slightly plastic, compact, mottled yellow, silty clay loam, slightly stained with red iron concretions. The C horizon, starting at a depth of about 24 inches, is a friable, pale yellow or reddish yellow, gravelly, silty clay loam which effervesces in contact with acid at a depth of about 26 inches.

Management.—Yellow-Gray Silt Loam is deficient in organic matter and nitrogen. Many of the slopes occupied by this type will grow alfalfa and sweet clover without limestone but the more level areas require an application of 2

to 3 tons an acre. Particular attention should be given to the regular plowing down of a leguminous green manure and many of the slopes must be farmed with care to prevent serious erosion.

Results secured on the Antioch field, which is located on soil similar to this type, indicate that some form of phosphate can be used with profit. Bone meal has demonstrated for many years a highly beneficial effect. Recent experiments indicate that rock phosphate will produce a similar effect. For further discussion of these experiments, see page 57.

Yellow-Silt Loam (1035, 1235)

Yellow Silt Loam is an unimportant type in Will county because of its small acreage. There are only 6.96 square miles in the entire county. The character of the type varies greatly, owing to differences in the rate of erosion caused chiefly by differences in the slopes.

The surface soil is usually a yellow or grayish yellow silt loam. It may be a yellow clay or even gravelly glacial drift, depending on the amount of erosion. Where the areas have been left in permanent pasture, there is an accumulation of a thin, dark-colored surface soil. The subsoil varies as does the surface but generally consists of a compact gravelly drift which effervesces with acid.

Management.—It is advised that the Yellow Silt Loam be left in permanent pasture for the most part. The less steep slopes may be successfully farmed if care is used to reduce erosion. If this type is farmed, however, particular attention must be given to plowing down green manures and crop residues at frequent intervals.

Dune Sand (1081)

Dune Sand, Upland, is a minor type in importance. It occupies, all told, only 141 acres in Will county. Nearly all the areas occur in Wesley township (Township 32 North, Range 10 East) and have been formed by the sand having been blown out of the Kankakee terrace and deposited upon the upland.

The surface, to a depth of 2 or 3 inches, is a brownish yellow sand or sandy loam. Below this shallow surface, an incoherent yellow sand occurs without change to the depth of the sand deposit, except for occasional thin layers or bands of silty to clayey material of wind-blown origin.

Management.—This unimportant type is poor agricultural soil. It has a low water-holding capacity, hence is drouthy, and is low in nitrogen and organic matter as well as in the other elements of plant food. It is suggested that anyone interested in the management of this type study the results from the Oquawka experiment field (see page 59) and also write to the Agricultural Experiment Station for further information.

TERRACE SOILS

There are two main terraces in Will county, the DesPlaines river terrace and the Kankakee river terrace. These bench-like formations were built up by

deposits from the sediment-laden streams during the time when immense volumes of water were coming from the melting glaciers. The swift current carried large boulders and much coarse sediment, which were later more or less buried by finer material.

Brown Silt Loam Over Gravel (1527)

Brown Silt Loam Over Gravel occurs along DuPage river and north of Wilmington, adjacent to Kankakee and DesPlaines rivers. The areas along DuPage river have numerous boulders scattered over the surface, many of which have been gathered up and placed in the fence rows. The topography of the type varies from flat to undulating. Drainage is generally well taken care of on account of the gravelly substratum that occurs. In the areas north of Wilmington the drainage is not so good because the gravel layer lies much deeper. The total area of this type is 29.19 square miles, or 3.5 percent of the area of the county.

The A_1 horizon, which is about 8 inches in depth, varies in color from a light brown to dark brown or black, and in texture from a sandy silt loam to a heavy silt loam. The A_2 horizon, extending to a depth of 15 or 16 inches, varies from a yellowish brown to a light brown silt loam. The B horizon, usually yellow in color, varies from a friable to a slightly compact, silty clay or clay loam, with a mixture of some sand. At a depth of 28 or 30 inches yellow sandy loam occurs. Sandy, gravelly material usually occurs at a depth varying from 33 to 45 inches. Often this gravelly substratum is calcareous.

Management.—Brown Silt Loam Over Gravel is a productive soil, well adapted to the growth of any of the crops common to the region. It varies in acidity but ordinarily does not need more than 2 tons of limestone an acre to grow sweet clover. It is excellent alfalfa land. The reader is refererd to the discussion of Brown Silt Loam, Upland, page 15, for suggestions regarding the management of this terrace type.

Brown Sandy Loam (1560)

Brown Sandy Loam, Terrace, occurs principally in the southwestern corner of the county, in the large terrace area formed by the Glacial Kankakee river. The type covers 46.26 square miles, or 5.54 percent of the area of the county. Its topography varies from flat to undulating, the undulations being caused by the wind having blown the sand into ridges. Drainage is poor to fair, owing to the tendency of the open ditches and tile to fill with sand and also to the high water table which exists.

The A_1 horizon, with an average depth of 7 inches, varies from a light brown to a medium brown sandy loam. The A_2 horizon which extends to about 15 inches in depth, is a yellowish brown sandy loam or a yellow sand. In some of the low-lying areas this horizon occurs as a coarse-grained gray sand. The B horizon varies from a yellow silty sandy loam to a yellow sand. Along Horse creek the sand is deposited upon a gravelly material which occurs at a depth of 28 to 40 inches below the surface.

Management.—Brown Sandy Loam, Terrace, as it occurs in Will county, is not a desirable general farming soil. Its drouthy nature, the difficulty of securing proper drainage, and its low content of the elements of plant food are the chief reasons for its relatively low agricultural value. An application of 2 to 3 tons of limestone an acre is needed to grow sweet clover. The only specific recommendations which can be made at the present time for the management of this type are that limestone be applied, sweet clover be seeded for pasture and for green manure, and early maturing crops be grown.

Brown Silt Loam On Gravel (1526.4)

Brown Silt Loam On Gravel occurs mainly on the terrace formation in the vicinity of the towns of Plainfield and Channahon. The topography of the type is flat to undulating. The stratified, calcareous, sandy, and gravelly terrace material underlying the soil varies from a few feet to 50 or more in thickness. To the south of Plainfield an area occurs that has only a thin stratum of gravel deposited upon a limestone bed. The type occupies 18.29 square miles, or 2.19 percent of the area of the county.

The A_1 horizon is about 6 inches in depth and varies from a light brown to a medium brown silt loam. The A_2 horizon, averaging from 10 to 20 inches in thickness, is a light brown to a yellowish brown silt loam, becoming somewhat sandy toward the bottom of the horizon.

Management.—Brown Silt Loam On Gravel is drouthy because of the nearness of the underlying gravel to the surface. It is slightly acid and requires a light application of limestone for sweet clover or alfalfa. Early maturing crops should be grown on this land to escape the drouth. Alfalfa does well because of its deep-rooting habit.

Brown Sandy Loam On Gravel (1560.4)

Brown Sandy Loam On Gravel occurs as scattering areas in the three main river basins, the largest of which is south of Kankakee river at Lorenzo. The type occupies a total area of 1,056 acres. Its topography is undulating. Drainage is excessive on account of the gravelly substratum. The depth to the gravel bed varies from 16 to 29 inches below the surface. In certain restricted areas the gravelly substratum contains numerous stones varying from 4 or 5 inches to 10 or 12 inches in diameter.

The A_1 horizon about 5 inches in depth, is a sandy loam varying in color from light brown to medium brown. The A_2 horizon, which varies in thickness, is a coarse-grained, yellowish brown sandy loam resting on the gravel bed at an average depth of about 20 inches.

Management.—This type is drouthy because of the nearness of the gravel to the surface. Early maturing crops should be grown to avoid so far as possible the effects of this condition. The type is low in organic matter, and it is recommended that legumes be grown to correct this deficiency. A light application of limestone is probably needed for sweet clover or alfalfa, tho the gravel substratum is high in carbonates.

Brown Silt Loam On Rock (1526.5)

Brown Silt Loam On Rock (Limestone) occurs principally on the borders of the DesPlaines river valley. The three main areas are found, in the vicinity of Joliet, between Kankakee and DesPlaines rivers at Drummond, and along DuPage river south of Plainfield. The topography of the type where the limestone occurs near the surface is flat to undulating; where the limestone is deeper, it becomes gently rolling. Drainage is usually poor on account of the irregularity of the contour of the limestone surface and the impossibility of constructing ditches. The type occupies 17.11 square miles, or 2.05 percent of the areas of the county.

The A_1 horizon is a medium to dark brown silt loam of a sandy phase and is about 4 or 5 inches in depth. The A_2 horizon is a silt loam varying from 6 to 20 inches in depth and from light brown to yellow in color. It is compact and sandy in texture just above the limestone which has weathered to a depth of 2 or 3 inches.

Management.—Brown Silt Loam On Rock is, for the most part, adapted only to permanent pasture. The depth to bed rock varies and where it approaches 30 inches, general farming may be carried on successfully, tho proper drainage is difficult to secure because of the basin-like formation of the bed rock. The soil is not acid, or only very slightly so.

Dune Sand (1581)

Dune Sand, Terrace, occurs in the southwestern corner of the county. The dunes vary from a foot or two to as much as 30 feet in height. Blowouts are common thruout the type. Dune Sand, Terrace, occupies a total of 7.16 square miles in Will county.

The surface two or three inches of soil is a yellow to brownish yellow sand. Below this shallow surface an incoherent yellow sand occurs to the full depth of the deposit.

Management.—Dune Sand, Terrace, as it occurs in Will county, is of higher agricultural value than is common for the type because of its finer texture. It contains more or less fine sand with an appreciable amount of silt. It is, however, very deficient in nitrogen and organic matter, and most of the areas of the type are acid. Good sweet clover and alfalfa can be grown on this soil following the application of about 3 tons of limestone an acre, and very satisfactory grain crops can be grown following the above legumes. This land should be cropped in a short rotation in order that frequent additions of nitrogenous organic matter may be made by plowing down clover, preferably sweet clover. The reader is referred to the results from the Oquawka experiment field, page 59, for further suggestions regarding the management of this type.

Yellow-Gray Silt Loam On Gravel (1534.4)

Yellow-Gray Silt Loam On Gravel occupies small, scattering areas thruout the terraces of the county, with the most extensive areas near Plainfield on

DuPage river. It covers a total of 2.36 square miles. The type is undulating in topography.

The A_1 horizon, averaging about 6 inches in depth, is a silt loam, floury in texture, and brownish yellow to grayish yellow in color. The A_2 horizon extends to about 11 inches and is a grayish yellow silt loam. The B horizon is a compact, mottled, yellow silt loam, changing to a layer of compact, sticky, yellowish red clay about 2 to 3 inches in thickness directly above the stratified bed of calcareous gravel. The depth to the gravel varies from 17 to 22 inches.

Management.—Yellow-Gray Silt Loam On Gravel is low in organic matter, usually slightly acid in the surface, and subject to drouth. It is a good soil for alfalfa and sweet clover following the application of about 2 tons of limestone an acre. The selection of early-maturing crops helps to avoid the bad effects of dry weather to which crops growing on this land are sensitive.

Yellow-Gray Silt Loam Over Gravel (1536)

Yellow-Gray Silt Loam Over Gravel comprizes 1.94 square miles of the area of the county. The type occurs in small areas, nearly all of them being located north of Kankakee river and along DuPage river. The topography of the type is undulating and the underdrainage is good.

The A_1 horizon is about 6 inches in depth and varies from a brownish yellow to grayish yellow silt loam. The A_2 horizon, extending to about 14 inches, is a grayish yellow silt loam with an appreciable amount of sand present. The B horizon is a compact, mottled, yellow silt loam, which extends to a depth of about 26 inches. The C horizon is a friable, yellow, sandy silt loam which rests on stratified sand and gravel at a depth of 32 to 45 inches.

Management.—Yellow-Gray Silt Loam Over Gravel is similar to the preceding type excepting that it is not drouthy. It is a fairly good general farming soil and will produce satisfactory crops following the application of sufficient limestone to grow the clovers and the plowing down of fresh organic matter, preferably sweet clover.

Yellow-Gray Sandy Loam Over Gravel (1567)

Most of the areas of Yellow-Gray Sandy Loam Over Gravel are located north of Kankakee river, south of Wilmington. Some of these areas are dune-like in formation, making it difficult to separate consistently this type from Dune Sand. The topography of the type is undulating to gently rolling. It covers an area of 2.32 square miles. Drainage is good on account of the porous condition of the sand and gravel stratum.

The A_1 horizon, which is about 6 inches in depth, is a yellowish gray sandy loam. The A_2 horizon, extending to about 14 inches, is a grayish yellow sandy loam. The B horizon is a coarse-grained yellow sand, becoming slightly compact at about 32 inches owing to the presence of some clayey material. The depth to the gravelly substratum varies from 45 to 50 inches.

Management.—This type requires approximately the same treatment as Yellow-Gray Silt Loam Over Gravel. It is, however, a poorer soil and will not respond so satisfactorily to good treatment and management.

Black Sandy Loam (1561)

Black Sandy Loam occurs in the sandy area south of Kankakee river. The type occupies a total area of 5.58 square miles. In topography it is flat and the drainage is only fair.

The A_1 horizon, which is about 10 inches in depth, is a black sandy loam. The A_2 horizon, to a depth of 28 inches, is a yellow sand. The B horizon is a yellow sandy clay or a grayish yellow sand.

Management.—Black Sandy Loam, even tho very dark in color, is deficient in easily decomposable organic matter. It contains many alkali spots and is very generally in need of improved drainage. The harmful effects of the alkali may be overcome by the application of potash salts at the rate of about 100 pounds an acre for corn.

Brown Sandy Loam Over Gravel (1566)

Brown Sandy Loam Over Gravel occupies a total area of 4.34 square miles. The type is located north of Kankakee river in the vicinity of Wilmington. The topography is undulating. Drainage is good, owing to the presence of the gravelly substratum.

The A_1 horizon is about 8 inches in depth and is a brown sandy loam. The A_2 horizon, extending to about 17 inches, varies from a grayish brown or light brown to a yellowish brown sandy loam. The B horizon, which extends to a depth of about 27 inches is a medium-grained, somewhat compact, yellow sand with some clay present. Below this depth there is a coarse-grained yellow sand with an admixture of fine gravelly material occuring at 34 to 38 inches, underneath which calcareous, stratified sand and gravel are found.

Management.—Brown Sandy Loam Over Gravel is not markedly deficient in organic matter, tho regular additions are needed to keep a supply of readily decaying material present. The surface soil is somewhat acid. About 2 tons of limestone an acre is needed for sweet clover or alfalfa. This is a good soil for truck farming.

Brown Clay Loam (1519)

Brown Clay Loam occurs south of Drummond, occupying a total area of less than a mile and a quarter. The drainage of these areas is insufficient because the topography is flat and also because of the difficulty in getting proper outlets.

The A_1 horizon is a brown to black clay loam about 7 inches in depth. The A_2 horizon, extending to about 17 inches in depth, is a plastic, compact, drab clay loam. The B horizon is a very sticky, compact, drab clay, becoming at 30 inches slightly lighter in color, more compact, and spotted with yellow and red iron concretions.

Management.—Brown Clay Loam can best be utilized, at least for the present, as permanent pasture.

Yellow-Gray Silt Loam On Rock (1534.5)

Yellow-Gray Silt Loam On Rock is a type of minor importance, as it occupies a total area of only 13 acres. The depth to limestone varies from 8 to 15 or 16 inches. Since the limestone is so near the surface, the type is of no agricultural value aside from permanent pasture.

Black Clay Loam (1520)

Black Clay Loam, Terrace, occupies 1.67 square miles, or .2 percent of the area of the county. It is found principally in the DuPage river terrace, where it is associated with Brown Silt Loam. The topography is flat. Most of the areas have been formed under fair drainage conditions.

The A_1 horizon, which is about 7 inches in depth, varies from a black silty clay loam to clay loam. The A_2 horizon, which extends to about 18 inches, is a heavy, plastic, compact, black clay to clay loam. The B horizon is a black to drab clay loam, spotted with yellowish brown iron concretions.

Management.—This type does not need limestone. The B horizon is usually slightly calcareous. The important requirements in the management of this type are the improvement of the drainage on areas which are not now well drained, and some provision for returning fresh organic matter as a means of maintaining a condition of good tilth.

Gravelly Loam (1590)

Gravelly Loam occupies a total area of only 32 acres in Will county. It is found on the slopes from one terrace level to another. The type is non-agricultural. Some of the material is used for road construction. Bluegrass pasture and sweet clover do fairly well on this type except in seasons of extreme drouth.

Stony Brown Silt Loam On Rock (Boulders) (1597.5)

Stony Brown Silt Loam On Rock covers an area of 3.17 square miles. The type is non-agricultural aside from some little use as pasture. Numerous boulders, varying from 10 inches to 2 or 3 feet in diameter, are scattered over the surface and thruout the soil mass. These boulders, probably of Canadian origin, consist of granites, sandstones, serpentine basalts, and limestone. Niagara limestone bed rock underlies the entire area. Drainage is poor on account of the fairly flat topography and the impracticability of constructing outlets thru the boulders and limestone bed rock.

The A_1 horizon is about 4 or 5 inches in depth and is a dark brown silt loam. The organic-matter content is usually high. The A_2 horizon may vary from 3 to 15 inches in depth, depending on the number of boulders present. It rests on limestone bed rock. It is slightly darker in color and heavier in texture than the surface.

Management.—The numerous boulders present make it impossible to use this type for any purpose other than pasture.

LATE SWAMP AND BOTTOM-LAND SOILS

In the group designated as Late Swamp and Bottom-Land Soils are included the bottom lands or flood plains along streams, the swamps, and the poorly drained lowlands. Much of the soil is of alluvial formation and the land is subject to overflow. Some of the soils included in this group are capable of better drainage and if drained would become good farming land; others cannot, at least for the present, be economically drained.

Mixed Loam (1454)

Mixed Loam is found along the small streams in both the timber and prairie areas where the conditions have been such as to allow much mixing of the material deposited. This type cannot be adequately described because of its variations. It is mapped as Mixed Loam because it consists of a mixture of various soil types, which cannot be consistently separated; moreover, the next flood may cause a complete change in its character. The type covers 19.56 square miles, or 2.34 percent of the area of the county.

The A_1 horizon varies in general from a brown to yellowish brown or yellowish gray silt loam or sandy loam.

Management.—Much of this type is subject to overflow, and for this reason can be best utilized as permanent pasture. The frequent overflows maintain the soil in a sweet condition and leave much sediment which is rich in the elements of plant food.

Brown Silt Loam (1426)

Brown Silt Loam, Bottom Land, occurs as overflow land along small streams in the prairie and also along DuPage river. However, it is overflowed little during the growing season. It occupies 2.38 squares miles, or .28 percent of the area of the county.

The A_1 horizon, extending to about 12 inches in depth, is a brown silt loam. The A_2 horizon,which extends to a depth of about 22 inches, is a light brown to medium brown silt loam. Below this the material is a friable, yellowish brown to yellow silt loam, changing at about 30 inches to a slightly compact, grayish yellow silt loam or yellowish silty clay loam.

Management.—The areas which are subject to overflow during the growing season should be left in permanent pasture. This type is rarely acid and it is constantly enriched by fresh soil material deposited after heavy rains.

Mixed Loam On Rock (1454.5)

Mixed Loam On Rock has no agricultural value other than for grazing purposes. Nearly all of this type is located along DesPlaines river north of Joliet. It is a low, flat, poorly drained region, which is more or less covered with water

on account of the irregularity of the rock surface and the shallow channel thru which DesPlaines river flows, permitting the river to spread freely over the entire lowlands. The type covers an area of 9.14 square miles.

Since the limestone is so near the surface, very little soil development has taken place. The surface soil, varying in depth from 4 to 9 or 10 inches, is brown to black in color and varies from a silt loam to a silty clay loam or mixed sandy loam. The soil directly above the limestone is usually darker in color and heavier in texture than at the surface. The soil material is in a more or less water-logged condition the year round.

Management.—The only use which can be made of this land is to leave it in pasture and, wherever possible, to turn the stock in for grazing.

Black Mixed Sandy Loam On Rock (1463)

Black Mixed Sandy Loam On Rock is one of the minor types in the swampy regions of the county, occupying only 2.66 square miles. It occurs as poorly drained areas in depressions in the limestone beds and in old channels in the DesPlaines and DuPage river terraces. With limestone near the surface and numerous boulders scattered over the surface, it is impossible economically to improve the drainage.

The A_1 horizon varies from brownish black to black in color and from a peaty loam to a sandy loam in texture. It is about 6 inches in depth. The soil material below the surface is variable in depth depending on the boulders present and the nearness of the limestone to the surface. It is, however, usually a slightly plastic, fairly compact, drabbish gray to grayish yellow clay.

Management.—This type has no agricultural value other than for grazing.

Black Mixed Loam On Clay (1450.1)

Black Mixed Loam On Clay is found in Township 33 North, Range 15 East, in the region known as Eagle Lake. It is probably a lacustrine deposit. Formerly the area was poorly drained because there was no outlet, but within recent years a channel has been cut thru the upland which gives sufficient drainage to the old lake bed. The type, as mapped, is so variable that a definite profile description cannot be written.

The A_1 horizon is about 8 inches in depth and varies from a brownish black peaty loam to a brown or black sandy loam, with a mixture of clay, silt, and gravelly material consisting of shale and sandstone. The area was formerly covered by a deposit of peat or muck which has been burned off. The A_2 horizon is, in general, a compact clay, varying in color from light gray to gray or drabbish blue to drab. It extends at least to 40 or 45 inches in depth. Layers of shale and a poor grade of coal 2 to 3 inches in thickness are found at a depth of 3 to 5 feet below the surface.

Management.—No limestone is required on this type. Drainage has been fairly well established. Small grains produce fair yields and truck gardening is being practiced on part of the area with varied success.

Black Mixed Loam (1450)

Black Mixed Loam occupies the swampy, poorly drained areas in the upland as well as in the terraces. The individual areas of this type are all small. The type occupies a total area of 5.16 square miles.

The A_1 horizon, extending to a depth of about 7 inches, varies from dark brown to black in color and from a peaty loam, sandy in texture, to a silt or clay loam. The A_2 horizon, which extends to 17 or 18 inches in depth, is a slightly plastic, compact, silty clay or clay loam, brown to black in color. The B horizon is a plastic, compact, gray to drab clay loam, spotted and stained with rusty red iron concretions.

Management.—Drainage is the first requirement in managing this type. Outlets are difficult to secure. In some areas alkali is present and they should be treated with potash salts and with applications of strawy manure if the land is farmed. At the present time this type is utilized almost exclusively for pasture.

Deep Peat (1401)

Deep Peat occupies only 2.06 square miles in the county and occurs in small areas. The two largest areas are found in DuPage and Washington townships (Townships 37 North, Range 10 East, and 33 North, Range 15 East).

The surface 6 or 8 inches is a well-disintegrated black peat, with no fibrous material remaining. Immediately below this surface layer, a brown, fibrous peat occurs, ranging from 35 or 40 inches to 6 or 7 feet in depth. The peat rests on a drab to black clay. Drainage has been provided in certain areas of this type by laying boards in the ditches and placing the tile upon the boards so as to keep the tile in alignment.

Management.—Nearly all the areas of peat are properly drained and are under cultivation. Peat is usually deficient in potassium and this deficiency can be corrected by the application of one of the potash salts at the rate of about 100 pounds an acre. (See results from the Manito field, page 60.)

Medium Peat On Clay (1402)

Medium Peat On Clay occupies a total of only 64 acres in Will county. The type occurs in the vicinity of the Deep Peat areas and in some of the kettle holes in the morainic region.

The surface, extending to a depth of 6 or 8 inches, is a well-decomposed peat, brown to black in color. Below this depth undecomposed brown peat occurs which rests on a somewhat sticky, compact, drab silty clay or clay.

Management.—Nearly all the areas of the type have a slightly alkaline reaction. The subsoil is of such nature that open ditches can be constructed and maintained. Practically all the Medium Peat On Clay is under cultivation. In areas where the alkali is sufficiently concentrated to be harmful, its bad effects can be corrected as was recommended above for Black Mixed Loam.

Peaty Loam (1410)

The only area of Peaty Loam in Will county is located in Township 32 North, Range 9 East, Section 22. It covers an area of 71 acres. The type is high in organic matter and nitrogen. The drainage of this area is only fair because of the flat topography and poor outlet.

The surface 6 or 7 inches varies from a well-disintegrated peaty loam, black in color, to a black sandy loam rich in organic matter. Below this depth a black sandy loam occurs; the sand particles themselves are white. At about 16 to 18 inches an incoherent mass of gray sand occurs.

Management.—Proper drainage is the first problem to consider in improving this type. Alkali is present and the potash treatment, as recommended for Black Mixed Loam, page 28, is the remedy to employ for this difficulty. It should not be applied, however, until after the poor drainage has been corrected.

Medium Peat On Rock (1402.5)

Medium Peat On Rock occurs in areas of Mixed Loam On Rock (1454.5) along DesPlaines river. The type occupies only 32 acres. The deposits occur as poorly drained areas in the depressions of the limestone bed rock and are subject to continued seepage of drainage water. Many hummocks occur in the areas. The drainage is very poor.

This material varies from a partially decomposed, fibrous, black peat to a black muck, which extends to a depth of 6 to 14 inches, depending on the contour of the limestone rock. This type has no agricultural value other than as pasture.

RESIDUAL SOILS (099)

Numerous limestone outcrops, mapped as Residual Soils, occur in Will county. There are eight quarries with shipping facilities in the vicinity of Joliet. The stone occurring in this region is dolomitic and is, for the most part, of high purity. In addition to the quarries with shipping facilities, there are a number of local quarries and numerous outcrops, particularly along the DesPlaines river valley, which may serve as a source of agricultural limestone.

Information regarding the composition of the stone from most of these quarries and for many of the outcrops can be secured from the State Geological Survey, Urbana, Illinois, or from the Agricultural Experiment Station.

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 which may assist in the differentiation of types, but which are not fundamental to it, are native vegetation (whether timber or prairie), topography, and geological origin and formation.

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 matured 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 these strata or zones are discernible, in which case they are 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 whenever 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 the 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 Illinoisan 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 balance 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 Thanksgiving. 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.

A soil auger is carried by each man with which he can examine the soil to a depth of 40 inches. An extension for making the auger 80 inches long is taken by each party, so that the deeper subsoil may be studied. Each man carries a compass to aid in keeping directions. Distances along roads are measured by a speedometer or other measuring device, while distances in the field away from the roads are measured by pacing.

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, crop-

ping, 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 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.

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

Produce		Nitrogen	Phosphorus	Sulfur	Potassium	Magnesium	Calcium	Iron
Kind	Amount							
		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
Oats 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.

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.

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 420 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

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.

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—

[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 preparations which are satisfactory.

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.

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) requires 1 pound of nitrogen.
1 bushel of corn (grain and stalks) requires 1½ pounds of nitrogen.
1 bushel of wheat (grain and straw) requires 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 nitrogenous 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, increases 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 is 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

Of course there should be as many fields as there are years in the rotation. 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 (only the clover seed being sold the fourth and sixth years); 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.

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

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 for five or six years in the combination rotation, alternating between two fields every five years, or rotating over all the 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 —Cowpeas or soybeans
Third year —Wheat (with clover)
Fourth year —Clover

First year —Corn
Second year —Corn
Third year —Wheat or oats (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 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. 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 Experiment Fields on Soil Types Similar to those Occurring in Will 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 corn stalks, 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.

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 fall or 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 JOLIET FIELD

A University soil experiment field is located in Will county about three miles northwest of Joliet on the Lincoln highway. This field has been in operation

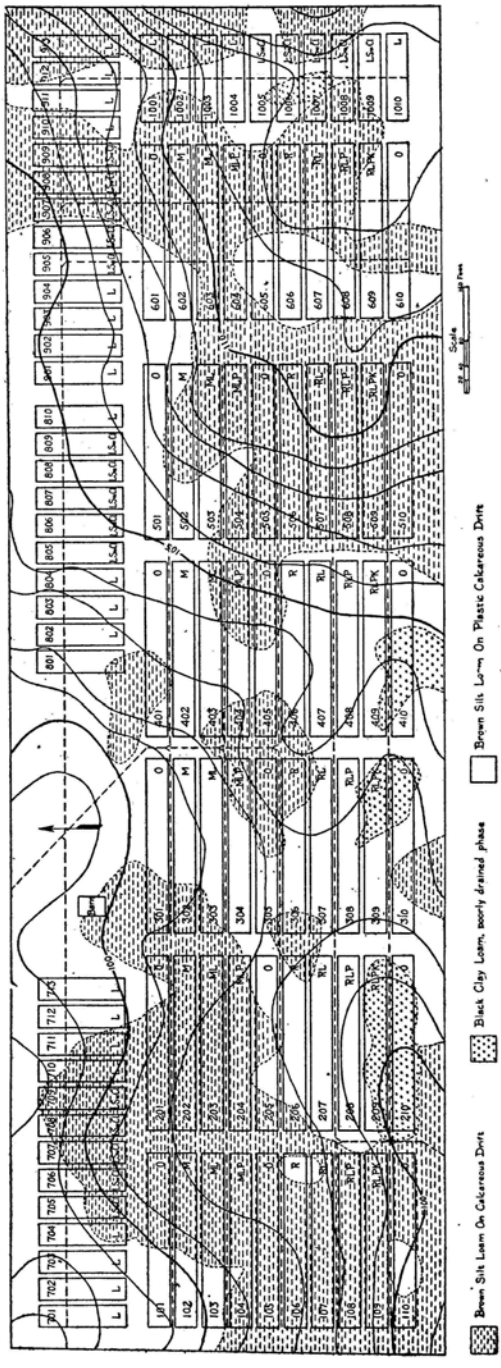

FIG. 2.—DIAGRAM OF JOLIET EXPERIMENT FIELD

This diagram shows the arrangement of plots, the soil treatments applied, the location of the different soil types, and by means of contour lines, the natural drainage of this field.

since 1914. It comprizes 31 acres of prairie soil of loessial and drift origin and shown on the county map as Brown Silt Loam. Based upon certain distinctions in soil profile, however, the Brown Silt Loam may be resolved here into two separable types, Brown Silt Loam On Calcareous Drift and Brown Silt Loam On Plastic Calcareous Drift. Besides these there are present some small patches of Black Clay Loam of the poorly drained phase. The distribution of these soil types, as well as the arrangement of plots, is charted in the accompanying diagram (Fig. 2). The topography of the surface is indicated on the diagram by contour lines.

The field is laid out into two separate systems of plots, each system with its own program of crop rotation and under the various soil treatments, as indicated on the diagram and in the tables which follow.

Series 100 to 600

The original rotation on Series 100 to 600 inclusive was corn, oats, clover, wheat, and soybeans, with alfalfa on the sixth series for six years. In 1921 this rotation was changed to corn, corn, oats, clover, and wheat, with a seeding of sweet clover on the residues plots, and alfalfa on the sixth series for six years. Since 1921 all clover has been removed as hay. In 1921 the return of the oat straw was discontinued, as was also the wheat straw the following year. The application of limestone was likewise discontinued in 1922, to be resumed when need for more lime becomes apparent.

A record of yields of all crops produced on these series is given in Table 7, but for convenience in considering the results these records are summarized in Table 8, in which is shown the average annual yields of the several crops, including the years since the complete soil treatments have been in effect.

In looking over these results, one may observe first a beneficial effect of animal manure on all crops but a most pronounced effect on the corn. This suggests the importance of carefully conserving and regularly applying all available stable manure. Residues alone have produced some increase in the corn, but have had little effect on the yield of other crops.

Where limestone is applied there has usually been some increase in yield. Limestone has been especially beneficial to alfalfa.

Very marked crop increases have followed the application of rock phosphate, so that the use of this material has proved exceedingly profitable on this field.

Profitable response to potassium, in the combination here used, has been secured only in the corn and wheat, so that considering the rotation as a whole, the value of crop increase has not been sufficient to cover the cost of material. Perhaps a smaller amount of the kainit, applied directly to the corn, would return a financial profit.

Series 700 to 1000

The plots now comprizing Series 700, 800, 900, and 1000 were not subdivided until 1921. Series 700 and 800 had been used for a wheat-legume-alfalfa combination, while Series 900 and 1000 had been used for a wheat-legume-timothy combination. This land had all received 2½ tons of limestone an acre without

TABLE 7.—JOLIET FIELD: SERIES 100–600
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1914 Wheat[1]	1915 Soy-beans[2]	1916 Corn	1917 Oats	1918 Soy-beans	1919 Wheat	1920 Alfalfa seeding	1921 Oats[3]	1922 Alfalfa	1923 Alfalfa	1924 Alfalfa	1925 Alfalfa
101	0	16.5	(1.42)	18.1	73.4	(1.13)	28.2	.....	46.7	(1.50)	(1.63)	(1.12)	(.82)
102	M	19.3	(1.50)	29.4	80.1	(1.33)	32.5	.....	45.9	(1.81)	(1.79)	(1.70)	(1.44)
103	ML	20.9	(1.68)	34.0	79.4	(1.32)	35.0	.....	50.8	(2.32)	(2.42)	(2.57)	(2.36)
104	MLrP	21.5	(1.82)	33.4	83.1	(1.53)	39.8	.....	51.4	(2.79)	(3.32)	(3.49)	(3.29)
105	0	18.2	15.2	18.5	70.2	18.8	19.4	.....	41.1	(1.24)	(1.59)	(1.39)	(.55)
106	R	19.9	14.0	18.9	73.8	18.7	23.8	.....	43.3	(1.26)	(1.46)	(1.15)	(.67)
107	RL	20.8	15.8	21.6	73.8	21.2	26.6	.....	47.7	(1.80)	(1.75)	(1.93)	(1.74)
108	RLrP	20.2	15.2	25.0	80.5	23.2	33.6	.....	51.9	(2.73)	(3.51)	(4.21)	(3.61)
109	RLrPK	22.0	16.3	25.1	70.5	23.6	33.8	.....	52.3	(2.82)	(3.54)	(4.03)	(3.46)
110	0	17.4	15.1	18.6	75.5	(1.17)	32.3	.....	46.6	(1.49)	(1.68)	(1.70)	(.54)
		Clover[1]	Wheat[2]	Soy-beans[2]	Corn	Oats	Clover	Wheat	Corn	Corn	Oats	Clover	Wheat
201	0	(2.00)	9.8	(.55)	7.3	75.2	(1.59)	22.6	31.4	28.8	58.9	(1.40)	10.3
202	M	(2.05)	7.9	(.59)	7.9	69.4	(1.67)	33.6	31.7	35.0	67.7	(2.27)	10.7
203	ML	(1.97)	14.3	(.66)	10.4	72.0	(1.60)	36.4	35.5	39.7	63.1	(2.46)	16.2
204	MLrP	(2.02)	20.3	(.63)	14.3	75.2	(1.73)	46.5	39.2	45.4	66.4	(2.82)	24.4
205	0	(1.91)	10.6	8.2	6.0	76.2	1.45	31.7	31.5	31.8	60.2	(1.75)	8.0
206	R	.42	15.6	7.9	7.7	76.9	.29	32.7	38.2	36.9	62.0	(1.56)	7.9
207	RL	1.00	20.0	8.9	11.1	76.7	.54	33.2	45.3	40.5	61.1	(2.00)	14.8
208	RLrP	.92	24.9	11.5	14.6	82.2	.75	47.4	48.6	46.5	71.3	(3.13)	31.8
209	RLrPK	1.83	30.4	15.0	23.4	87.8	.62	48.3	50.7	54.9	67.2	(3.67)	39.2
210	0	1.25	25.2	(1.06)	23.7	81.1	(1.64)	23.8	37.0	35.0	59.4	(2.31)	22.0

[1]Lime only. [2]No manure. [3]Nurse crop for alfalfa seeding in 1921.

TABLE 7.—JOLIET FIELD: SERIES 100–600—*Continued*

Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1914 Oats[1]	1915 Soy-beans[2]	1916 Wheat[2]	1917 Soy-beans[2]	1918 Corn	1919 Oats	1920 Soy-beans	1921 Wheat	1922 Corn	1923 Corn	1924 Oats	1925 Clover
301	0	60.9	10.6	4.1	(1.58)	27.2	35.3	(1.64)	30.4	29.0	36.9	56.6	(.49)
302	M	60.2	(1.42)	5.2	(1.66)	57.2	48.0	(1.62)	33.3	32.7	46.8	60.3	(.63)
303	ML	59.8	(1.69)	8.3	(1.67)	56.3	51.7	(1.81)	40.7	44.4	56.5	63.6	(.90)
304	MLrP	59.5	(1.75)	7.9	(1.78)	59.2	50.6	(1.88)	44.3	45.4	57.2	63.3	(1.13)
305	0	50.2	13.9	6.0	9.4	34.5	37.7	9.4	25.6	23.9	33.1	56.6	(.35)
306	R	53.3	13.0	9.9	8.8	33.2	38.6	9.4	26.9	37.0	45.0	53.9	(.53)
307	RL	60.8	13.7	13.2	8.2	45.6	44.2	11.8	28.5	43.0	54.9	68.8	(.57)
308	RLrP	59.1	15.1	18.7	11.5	55.6	49.2	14.1	37.9	50.9	61.5	76.1	(1.41)
309	RLrPK	68.8	15.0	15.2	12.6	60.2	49.7	15.4	42.9	57.9	68.2	70.9	(1.37)
310	0	52.5	12.8	7.1	(1.39)	38.8	35.0	(1.60)	28.5	23.8	32.4	53.1	(.39)
		Corn[1]	Oats[2]	Clover[2]	Wheat[2]	Soy-beans[2]	Corn	Oats	Clover	Wheat	Corn	Corn	Oats
401	0	44.7	72.5	(1.17)	8.2	(1.26)	28.1	57.3	(.63)	25.9	35.4	36.2	30.2
402	M	46.9	73.0	(1.24)	10.3	(1.35)	32.6	67.5	(.70)	30.4	53.6	41.1	39.1
403	ML	52.4	70.5	(1.16)	10.9	(1.21)	39.5	69.5	(.75)	32.7	57.9	45.2	38.8
404	MLrP	50.2	75.0	(1.64)	19.6	(1.53)	44.3	93.1	(1.13)	38.8	66.1	52.4	50.5
405	0	42.3	67.7	.33	9.8	18.6	29.0	59.8	(.55)	26.6	36.7	35.6	36.1
406	R	50.6	62.8	.42	8.8	18.6	39.0	61.7	(.66)	27.1	49.9	34.0	41.7
407	RL	53.2	63.4	.50	13.4	19.2	41.8	62.5	(.86)	29.1	50.1	40.7	44.8
408	RLrP	51.0	65.0	.50	22.5	23.3	42.9	72.5	(1.29)	39.3	57.4	44.2	53.9
409	RLrPK	53.1	72.0	.42	24.3	22.6	44.4	71.7	(1.31)	40.7	63.0	49.5	53.8
410	0	45.1	63.1	(1.15)	0.0	(1.63)	29.2	58.6	(.75)	27.3	36.7	38.2	30.9

[1]Lime only. [2]No manure.

TABLE 7.—JOLIET FIELD: SERIES 100–600—*Concluded*

Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1914 Soy-beans[1]	1915 Corn	1916 Oats	1917 Soy-beans	1918 Wheat	1919 Soy-beans	1920 Corn	1921 Oats	1922 Clover	1923 Wheat	1924 Corn	1925 Corn
501	0	(1.24)	28.6	70.9	(1.60)	19.8	(.67)	32.8	62.2	(1.44)	16.8	34.2	34.6
502	M	(1.40)	36.3	75.9	(1.74)	21.5	(.88)	48.6	70.3	(1.90)	20.0	44.8	39.0
503	ML	(1.51)	38.3	77.2	(1.84)	31.0	(.94)	51.1	66.4	(1.70)	22.5	49.6	49.9
504	MLrP	(1.28)	47.7	77.7	(1.87)	39.9	(1.06)	48.9	69.1	(2.10)	30.8	55.8	54.3
505	0	12.1	28.5	73.3	10.9	22.0	9.2	36.2	58.3	(1.18)	14.1	34.3	38.4
506	R	11.9	32.4	71.1	11.0	28.8	9.2	46.0	61.1	(1.28)	11.8	37.2	40.4
507	RL	13.3	28.7	63.9	11.0	27.0	12.2	42.8	59.2	(1.46)	16.8	39.9	44.8
508	RLrP	11.9	31.2	59.8	13.4	35.4	14.0	47.4	68.4	(1.88)	28.9	56.6	50.4
509	RLrPK	14.8	43.4	81.4	14.7	39.9	13.3	51.3	69.7	(2.14)	36.5	54.6	56.2
510	0	(1.12)	27.1	74.1	(1.50)	20.8	(.67)	34.5	60.8	(1.30)	11.4	31.2	35.6
		Alfalfa seeding[1]	Alfalfa[3]	Alfalfa[3]	Alfalfa[3]	Alfalfa[3]	Soy-beans[3]	Soy-beans[3]	Corn	Oats	Clover	Wheat	Corn
601	0	.....	(1.79)	(1.46)	(.44)	(1.55)	(.81)	(1.94)	49.4	53.3	(.32)	19.6	42.5
602	M	.....	(2.13)	(1.78)	(.47)	(1.64)	(.74)	(1.97)	51.2	56.1	(.71)	27.3	55.1
603	ML	.....	(2.83)	(2.96)	(.81)	(2.52)	(1.25)	(1.97)	52.6	60.0	(.81)	28.9	56.5
604	MLrP	.....	(3.73)	(4.35)	(1.28)	(2.99)	(1.13)	(2.07)	50.7	60.8	(1.02)	38.4	56.6
605	0	.....	(2.18)	(2.16)	(.71)	(2.01)	(.89)	16.2	51.8	58.4	(.41)	25.9	46.8
606	R	.....	(2.57)	(2.23)	(.74)	(2.06)	(1.12)	16.7	46.1	53.6	(.51)	27.8	54.1
607	RL	.....	(2.90)	(2.88)	(.97)	(2.30)	(1.18)	16.2	53.2	61.9	(.64)	25.7	53.9
608	RLrP	.....	(3.39)	(4.10)	(1.28)	(2.42)	(1.23)	15.7	54.5	62.2	(.83)	37.0	55.0
609	RLrPK	.....	(3.56)	(4.38)	(1.46)	(2.56)	(1.15)	16.2	53.0	63.3	(.91)	37.5	56.9
610	0	.....	(1.90)	(1.72)	(.41)	(1.30)	(.86)	(1.68)	51.5	55.5	(.30)	17.9	45.0

[1]Lime only. [2]No manure. [3]No residues or manure.

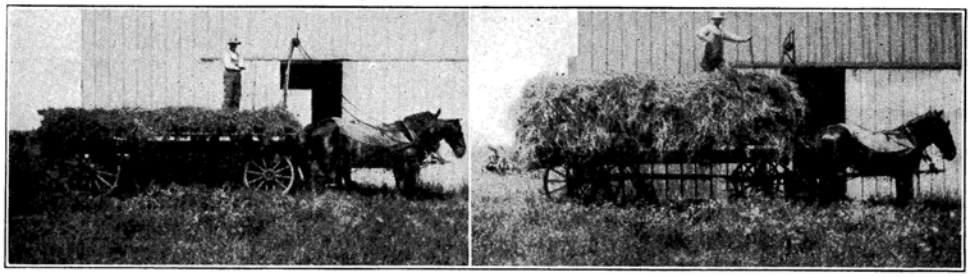

FIG. 3.—ALFALFA ON THE JOLIET EXPERIMENT FIELD

Here are shown the products of two plots both receiving crop residues. Without limestone and rock phosphate, the yield of hay was 1.46 tons an acre. With these materials applied to the land, the yield was 3.51 tons an acre.

further soil treatment. In 1921 it was plotted and put under a rotation of corn, barley, soybeans, and wheat. Hubam clover has been seeded on Plots 5, 6, 7, 8, and 9 in the barley, and biennial sweet clover on the same plots in the wheat. In 1924 another modification was made in the cropping plan, the rotation now being corn, barley, wheat, and legumes (red clover being seeded in the wheat on Plots 1, 2, 3, and 4 on all series and on Plots 11, 12, and 13 on Series 700 and 900, and alfalfa seeded on Plots 5, 6, 7, 8, 9, and 10). The following soil treatments were applied: an additional 8,000 pounds an acre of limestone to Plot 7 on all series; rock phosphate at the annual acre-rate of 400 pounds to Plots 2, 3, 6, 7, and 8; acid phosphate at the acre-rate of 250 pounds ahead of the wheat

TABLE 8.—JOLIET FIELD: Series 100-600, SUMMARY OF CROP YIELDS

Average Annual Yields 1915-1925—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Corn *16 crops*	Oats *11 crops*	Wheat *8 crops*	Clover[1] *6 crops*	Soy-beans *4 crops*	Alfalfa *4 crops*
1	0	31.3	56.4	21.7	(.98)	(1.26)	(1.27)
2	M	40.2	61.8	26.2	(1.31)	(1.39)	(1.69)
3	ML	44.8	63.2	30.4	(1.37)	(1.48)	(2.42)
4	MLrP	48.2	67.4	37.9	(1.66)	(1.59)	(3.21)
5	0	32.3	57.1	21.7	(.95)	12.1	(1.19)
6	R	37.3	58.0	23.3	(.81)	12.1	(1.14)
7	RL	41.1	60.4	25.2	(1.01)	14.1	(1.81)
8	RLrP	46.4	66.2	36.4	(1.55)	16.2	(3.52)
9	RLrPK	50.8	67.0	39.9	(1.67)	16.8	(3.46)
10	0	33.6	57.3	23.0	(1.12)	(1.14)	(1.35)
	M over 0	8.9	5.4	4.5	(.33)	(.13)	(.42)
	R over 0	5.0	.9	1.6	−(.14)	.00	−(.05)
	ML over M	4.6	1.4	4.2	(.06)	(.09)	(.73)
	RL over R	3.8	2.4	1.9	(.20)	2.0	(.67)
	MLrP over ML	3.4	4.2	7.5	(.29)	(.11)	(.79)
	RLrP over RL	5.3	5.8	11.2	(.54)	2.1	(1.71)
	RLrPK over RLrP	4.4	.8	3.5	(.12)	.6	−(.06)

[1]One crop of seed on Plots 6, 7, 8, and 9 is evaluated as hay.

TABLE 9.—JOLIET FIELD: SERIES 700, 800, 900, 1000
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1921 Corn[1]	1922 Barley[1]	1923 Soy-beans[1]	Soil treatment as modified	1924 Wheat	1925 Soy-beans
701	L	48.6	23.8	15.2	LeL	29.5	(1.85)
702	L	55.0	32.1	18.8	LeLrP	28.3	(2.03)
703	L	52.4	26.7	15.0	LeLrPGyp	28.7	(1.72)
704	L	45.6	26.7	16.2	LeL	27.0	(1.70)
705	LeL	41.0	24.6	14.7	LeL	26.7	(1.63)
706	LeL	48.4	29.8	18.7	LeLrP	29.0	(1.82)
707	LeL	45.2	28.3	16.2	LeLrP	27.5	(1.81)
708	LeL	42.0	23.5	14.7	LeLrPKCl	22.7	(1.71)
709	LeL	52.0	25.2	17.2	LeLKCl	19.5	(1.80)
710	L	51.6	27.7	18.0	LeL	19.5	(1.69)
711	L	56.8	29.0	19.8	LeL	17.5	(2.16)
712	L	53.0	24.4	21.2	LeLaP	19.7	(1.46)
713	L	49.2	24.4	18.5	LeLaP	26.2	(1.49)
		Wheat[1,2]	Corn	Barley		Barley	Wheat
801	L	.....	33.0	31.5	LeL	17.9	8.3
802	L	.....	39.8	37.7	LeLrP	16.3	14.0
803	L	.....	47.6	42.3	LeLrPGyp	18.8	16.7
804	L	.....	34.0	35.6	LeL	14.8	9.8
805	LeL	.....	37.0	35.8	LeL	16.0	10.2
806	LeL	.....	35.8	34.8	LeLrP	17.3	12.0
807	LeL	.....	42.2	38.8	LeLrP	17.1	14.3
808	LeL	.....	43.8	40.4	LeLrPKCl	18.1	16.5
809	LeL	.....	43.8	42.3	LeLKCl	17.9	21.0
810	L	.....	39.2	42.7	LeL	21.7	21.8
		Corn[1]	Wheat[3]	Corn		Corn	Barley
901	L	48.8	.....	40.6	LeL	31.8	23.5
902	L	49.6	.....	55.4	LeLrP	46.8	24.4
903	L	53.4	.....	58.2	LeLrPGyp	49.0	22.1
904	L	47.6	.....	49.0	LeL	48.4	21.9
905	LeL	49.0	.....	52.0	LeL	48.0	19.8
906	LeL	53.8	.....	54.4	LeLrP	42.2	23.5
907	LeL	50.8	.....	53.4	LeLrP	49.6	23.8
908	LeL	50.2	.....	46.4	LeLrPKCl	46.4	17.7
909	LeL	45.4	.....	45.4	LeLKCl	41.0	18.1
910	L	54.0	.....	53.6	LeL	38.4	23.5
911	L	62.2	.....	58.8	LeL	48.6	23.5
912	L	52.4	.....	51.8	LeLaP	46.0	21.0
913	L	54.8	.....	52.8	LeLaP	46.0	17.1
		Wheat[1]	Soy-beans[1]	Wheat[3]		Soy-beans	Corn
1001	L	27.7	13.5	.....	LeL	15.0	40.0
1002	L	28.2	13.8	.....	LeLrP	15.7	46.8
1003	L	31.3	15.7	.....	LeLrPGyp	18.2	51.2
1004	L	32.0	15.3	.....	LeL	17.3	47.2
1005	LeL	30.2	14.5	.....	LeL	18.2	47.0
1006	LeL	32.2	15.7	.....	LeLrP	18.2	49.6
1007	LeL	29.5	15.7	.....	LeLrP	17.2	46.4
1008	LeL	29.0	14.8	.....	LeLrPKCl	14.5	50.0
1009	LeL	31.2	17.0	.....	LeLKCl	15.5	51.6
1010	L	29.3	11.8	.....	LeL	15.3	40.0

[1]No legume treatment. [2]All plots harvested together. [3]Crop failure.

crop on Plots 12 and 13; potassium chlorid at the annual acre-rate of 100 pounds to Plots 8 and 9; and gypsum at the annual acre-rate of 100 pounds to Plot 3.

A discussion of the results of the work on these series is scarcely warranted at this time since the experiments of any one system are of such short duration. The crop yields are reported in Table 9, however, as a matter of record, and future developments on these plots will be watched with interest.

THE HARTSBURG FIELD

The results of experiments on the Hartsburg field are introduced as representing the soil type Black Clay Loam, poorly drained phase. This field is located in Logan county just east of Hartsburg. The work began in 1911. The field was laid off into five series of 10 plots each. The crop rotation up to 1923 was wheat, corn, oats, and clover, with alfalfa growing on a fifth series after which it was changed to corn, corn, oats, and wheat on four of the series and to corn, oats, wheat, and an alfalfa and red clover mixture on the fifth series. The soil treatments are as indicated in Table 10. The table summarizes by crops, the yields for the period during which the plots have been under full treatment.

The outstanding feature of these results is the large increase in yields produced by residues, which even exceeds the increase brought about by the use of stable manure.

The behavior of limestone on this field is rather peculiar in that it has been more beneficial where applied with manure than where used with residues. Used with manure, limestone shows some increase in all crops, while with residues the effect on several of the crops appears negative.

Altho rock phosphate has given some increases in wheat yield in both manure and residues systems, the results with other crops have been such as to render the use of this material unprofitable on this field.

The addition of potassium appears to have produced no significant effect upon the yields of any of the crops.

It may be mentioned that new experiments have recently been started on these plots which are designed to answer some of the questions brought out by

TABLE 10.—HARTSBURG FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1913-1925—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Corn[1] *17 crops*	Oats *13 crops*	Wheat *11 crops*	Clover[2] *6 crops*	Soy-beans *2 crops*	Alfalfa[3] *10 crops*
1	0	46.7	47.6	25.6	(2.19)	(1.29)	(3.47)
2	M	56.6	53.0	30.1	(2.59)	(1.65)	(3.67)
3	ML	62.9	58.7	35.6	(2.67)	(1.82)	(3.91)
4	MLrP	61.5	58.6	38.1	(2.80)	(1.93)	(4.19)
5	0	52.6	46.2	30.9	(1.48)	25.8	(3.33)
6	R	62.6	54.9	34.1	(1.91)	26.8	(3.78)
7	RL	66.9	53.0	31.3	(1.82)	28.5	(3.45)
8	RLrP	65.8	57.4	35.3	(1.97)	26.2	(4.04)
9	RLrPK	65.2	56.7	34.7	(1.89)	26.5	(4.16)
10	0	52.7	48.3	31.6	(2.35)	(1.69)	(3.20)
	M over 0	9.9	5.4	4.5	(.40)	(.36)	(.20)
	R over 0	10.0	8.7	3.2	(.43)	1.0	(.45)
	ML over M	6.3	5.7	5.5	(.08)	(.17)	(.24)
	RL over R	4.3	−1.9	−2.8	−(.09)	1.7	−(.33)
	MLrP over ML	−1.4	− .1	2.5	(.13)	(.11)	(.28)
	RLrP over RL	−1.1	4.4	4.0	(.15)	2.3	(.59)
	RLrPK over RLrP	− .6	− .7	− .6	−(.08)	.3	(.12)

[1]One corn crop without residues. [2]One crop of stubble clover included; some seed evaluated as hay on Plots 5, 6, 7, 8, and 9. [3]No residues for the first 6 crops.

the foregoing results. For example, the effect of applying phosphorus in other carriers and in different combinations, as well as testing the residual effect of phosphate already applied, will be tried.

THE ANTIOCH FIELD

The Antioch field is located in Lake county close to the Wisconsin border. The land is slightly rolling and the soil is of the type designated as Yellow-Gray Silt Loam On Calcareous Drift. The field was started in 1902. The work is now confined to a single series of 10 plots.

The rotation first established was corn, corn, oats, and wheat, but in 1911 this was changed to wheat, corn, oats, and clover. Nitrogen was applied in the earlier years in 800 pounds of dried blood an acre a year, but after 1911 the use of commercial nitrogen was discontinued and crop residues and legumes were substituted. Phosphorus was supplied in 200 pounds of steamed bone meal. In 1924 rock phosphate was applied as additional treatment to Plots 2, 3, and 5, which formerly had received no phosphorus. Potassium sulfate has been used mainly as the source of potassium. At the beginning, slaked lime was applied at the rate of 470 pounds an acre. No more lime was used until 1912, when a 2-ton application of limestone was made. This was followed by a 3-ton application in 1918.

The results are presented in Table 11, which is so arranged as to show first a summary, by averages, of the several crops grown from the beginning up to 1923, and second, the annual results of the three different crops obtained since the rock phosphate application in 1924. On account of an abnormality in Plot 1 the results from this plot are vitiated to some extent.

The data show that phosphorus is the one element standing out prominently as producing consistently beneficial results. After bone meal had demonstrated repeatedly this highly beneficial effect, the question arose as to whether the necessary phosphorus could be efficiently supplied on this soil thru the use of rock phosphate. Accordingly rock phosphate was applied to plots which hitherto had not received bone meal. Altho the experiments have not continued long enough for a final test of the relative efficiency of these two phosphorus carriers, the results indicate very favorable effects upon crop yields by the use of rock phosphate. The rock phosphate was first applied in the spring of 1924 in preparing the land for oats. As might be expected, no immediate effect on the oat crop is apparent. In the following year, however, the clover shows a marked response to the phosphate treatment. In considering these clover yields it should be noted that on the residue plots only one crop of hay is harvested, the second crop being plowed under for soil improvement; on all other plots the results represent the combined yields of the first and second crops.

The wheat in 1926 likewise shows a marked response to the rock phosphate treatment. Altho the yields of the newly treated rock phosphate plots are not quite so high as those of the corresponding bone meal plots, it is possible that the latter are at some advantage due to the cumulative effects of the many years of previous phosphatic treatment.

Potassium sulfate as applied in these experiments has not given very consistent results, but, on the whole, it appears that the use of potassium fertilizer

TABLE 11.—ANTIOCH FIELD: CROP YIELDS
Bushels or (tons) per acre

Plot No.	Soil treatment applied	Average annual grain yields 1902-1923			Additional treatment applied in 1924	Annual yields 1924-1926		
		Wheat *5 crops*	Corn *9 crops*	Oats *5 crops*		Oats 1924	Clover[1] 1925	Wheat 1926
1	0.....	14.7	24.5	32.3	....	17.5	(2.37)	26.5
2	L.....	13.3	21.8	26.8	+ rP	25.3	(4.11)	41.3
3	LR.....	18.9	22.5	29.9	+ rP	24.7	(2.69)	44.3
4	LbP.....	35.0	31.0	43.6	....	26.9	(4.51)	48.5
5	LK.....	17.8	23.3	27.8	+ rP	13.1	(4.27)	44.3
6	LRbP...	32.6	34.1	43.3	....	28.4	(3.16)	52.2
7	LRK....	19.2	25.4	26.9	....	20.3	(2.31)	31.7
8	LbPK...	30.3	26.1	38.2	....	30.6	(4.60)	49.3
9	LRbPK .	28.1	38.9	42.6	....	27.8	(2.58)	51.5
10	RbPK...	31.0	38.7	44.7	....	26.6	(2.86)	48.8

[1]Red clover mixed with some volunteer growth of sweet clover. Figures represent the combined yields of first and second crops except on residues plots, where only the first crop is harvested.

on this kind of soil and in this kind of farming does not represent a profitable practice.

The results are also unfavorable for lime. Limestone, however, is abundant in the substrata of this soil type.

Lime applied and residues plowed under — Lime and phosphorus applied

FIG. 4.—CLOVER ON THE ANTIOCH EXPERIMENT FIELD

These pictures illustrate the beneficial effect of phosphorus on the Antioch field. The land at the left has received no phosphorus fertilizer, altho lime has been applied and residues plowed under. That at the right has been treated with bone meal as well as with lime.

THE OQUAWKA FIELD

In 1913 the University established an experiment field on Dune Sand, Terrace, in Henderson county, near the Mississippi river. This field 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 12 indicates the kinds of treatment applied, the amounts of the materials used being in accord with the standard practice, as explained on page 48.

The data make apparent the remarkably beneficial action of limestone on this sand soil. Where limestone has been used in conjunction with crop residues, the yield of corn has been greatly increased. The limestone has also produced good crops of rye and fair crops of sweet clover and alfalfa.

This land appears to be quite unresponsive to treatment with rock phosphate. The analyses show, however, that the stock of phosphorus in this type of soil is not large. As time goes on and the supply diminishes along with the production of good-sized crops, it may be that the application of this element will 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 nearly three bushels of corn from the use of potassium salts, with ordinary prices this would not be a profitable treatment. The slight apparent effects in the other crops are scarcely significant.

TABLE 12.—OQUAWKA FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields, 1915-1925—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn *11 crops*	Soy-beans[1] *11 crops*	Wheat *11 crops*	Sweet Clover[2] *7 crops*	Rye *9 crops*	Alfalfa *8 crops*
1	0	19.8	(1.01)	7.7	0.00	11.9	(.35)
2	M	25.0	(1.20)	10.9	0.00	13.3	(.56)
3	ML	32.2	(1.60)	14.6	1.14	24.5	(2.05)
4	MLrP	31.9	(1.58)	15.0	1.14	23.0	(2.12)
5	0	20.1	(.78)	9.8	0.00	11.7	(.08)
6	R	21.8	(.76)	11.1	0.00	12.7	(.09)
7	RL	36.7	(1.25)	13.9	1.57	24.3	(1.82)
8	RLrP	36.1	(1.25)	14.1	1.43	24.3	(1.79)
9	RLrPK	39.0	(1.17)	13.3	1.67	26.5	(1.87)
10	0	19.1	(.72)	8.8	0.00	10.7	(.02)
	M over 0	5.2	(.19)	3.2	0.00	1.4	(.21)
	R over 0	1.7	−(.02)	1.3	0.00	1.0	(.01)
	ML over M	7.2	(.40)	3.7	1.14	11.2	(1.49)
	RL over R	14.9	(.49)	2.8	1.57	11.6	(1.73)
	MLrP over ML	−.3	−(.02)	.4	0.00	− 1.5	(.07)
	RLrP over RL	−.6	(.00)	.2	− .14	....	−(.03)
	RLrPK over RLrP	2.9	−(.08)	−.8	.24	2.2	(.08)

[1]Eleven regular crops, together with the extra crop described in Footnote 2, are averaged as 11 crops. Several crops which were harvested as seed are evaluated in this summary as hay.

[2]Some hay is here 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 averages.

Manure
Yield: Nothing

Manure and limestone
Yield: 4.43 tons per acre

FIG. 5.—ALFALFA ON THE OQUAWKA EXPERIMENT FIELD

These pictures show the possibility of improving this unproductive sandy land on 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.

A significant fact which the above summary does not bring out is that improvement under favorable treatment has been progressive, as evidenced by a very marked upward trend in production after the first few years. For example, the acre yields under the limestone-residues treatment for the entire 11-year period are: corn, 36.7 bushels; wheat, 13.9 bushels; and rye, 24.3 bushels, but if we take the corresponding averages for the last five years the yields are: corn, 45.7 bushels; wheat, 19.6 bushels; and rye, 25.2 bushels.

Experience thus far shows rye to be better adapted to this land than wheat, and both alfalfa and sweet clover thrive 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 results secured on the Manito experiment field which was located on Deep Peat and which was in operation during the years 1902 to 1905, inclusive, are presented in Table 13.

There were ten plots receiving the treatments indicated in the table. Where potassium was applied, the yield was from three to four times as large as where

nothing was applied. Where approximately equal money values of kainit and potassium chlorid were applied, slightly greater yields were obtained 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.

The use of 700 pounds of sodium chlorid (common salt) produced 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 per acre of ground limestone 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.

TABLE 13.—MANITO FIELD: ANNUAL CORN YIELDS
Bushels per acre

Plot No.	Soil treatment for 1902	Corn 1902	Corn 1903	Soil treatment for 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]No yield was taken in 1902 because of a misunderstanding.

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
30 Johnson, 1925
31 Rock Island, 1925
32 Randolph, 1925
33 Saline, 1926
34 Marion, 1926
35 Will, 1926

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(3) email: program.intake@usda.gov.

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LEGEND

UPLAND PRAIRIE SOILS

- 26 Brown Silt Loam
- 20 Black Clay Loam
- 28.1 Brown Silt Loam On Tight Clay
- 26.5 Brown Silt Loam On Rock
- 60 Brown Sandy Loam

UPLAND TIMBER SOILS

- 34 Yellow-Gray Silt Loam
- 35 Yellow Silt Loam
- 81 Dune Sand

1500 TERRACE SOILS

- 1527 Brown Silt Loam Over Gravel
- 1560 Brown Sandy Loam
- 1526.4 Brown Silt Loam On Gravel
- 1560.4 Brown Sandy Loam On Gravel
- 1526.5 Brown Silt Loam On Rock
- 1581 Dune Sand
- 1534.4 Yellow-Gray Silt Loam On Gravel
- 1536 Yellow-Gray Silt Loam Over Gravel
- 1567 Yellow-Gray Sandy Loam Over Gravel
- 1561 Black Sandy Loam
- 1566 Brown Sandy Loam Over Gravel
- 1519 Brown Clay Loam
- 1534.5 Yellow-Gray Silt Loam On Rock
- 1520 Black Clay Loam
- 1590 Gravelly Loam
- 1597.5 Stony Brown Silt Loam On Rock (Boulders)

LATE SWAMP AND BOTTOM-LAND SOILS

- 1454 Mixed Loam
- 1428 Brown Silt Loam
- 1454.5 Mixed Loam On Rock
- 1463 Black Mixed Sandy Loam On Rock
- 1450.1 Black Mixed Loam On Clay
- 1450 Black Mixed Loam
- 1401 Deep Peat
- 1402 Medium Peat On Clay
- 1410 Peaty Loam
- 1402.5 Medium Peat On Rock

000 RESIDUAL SOILS

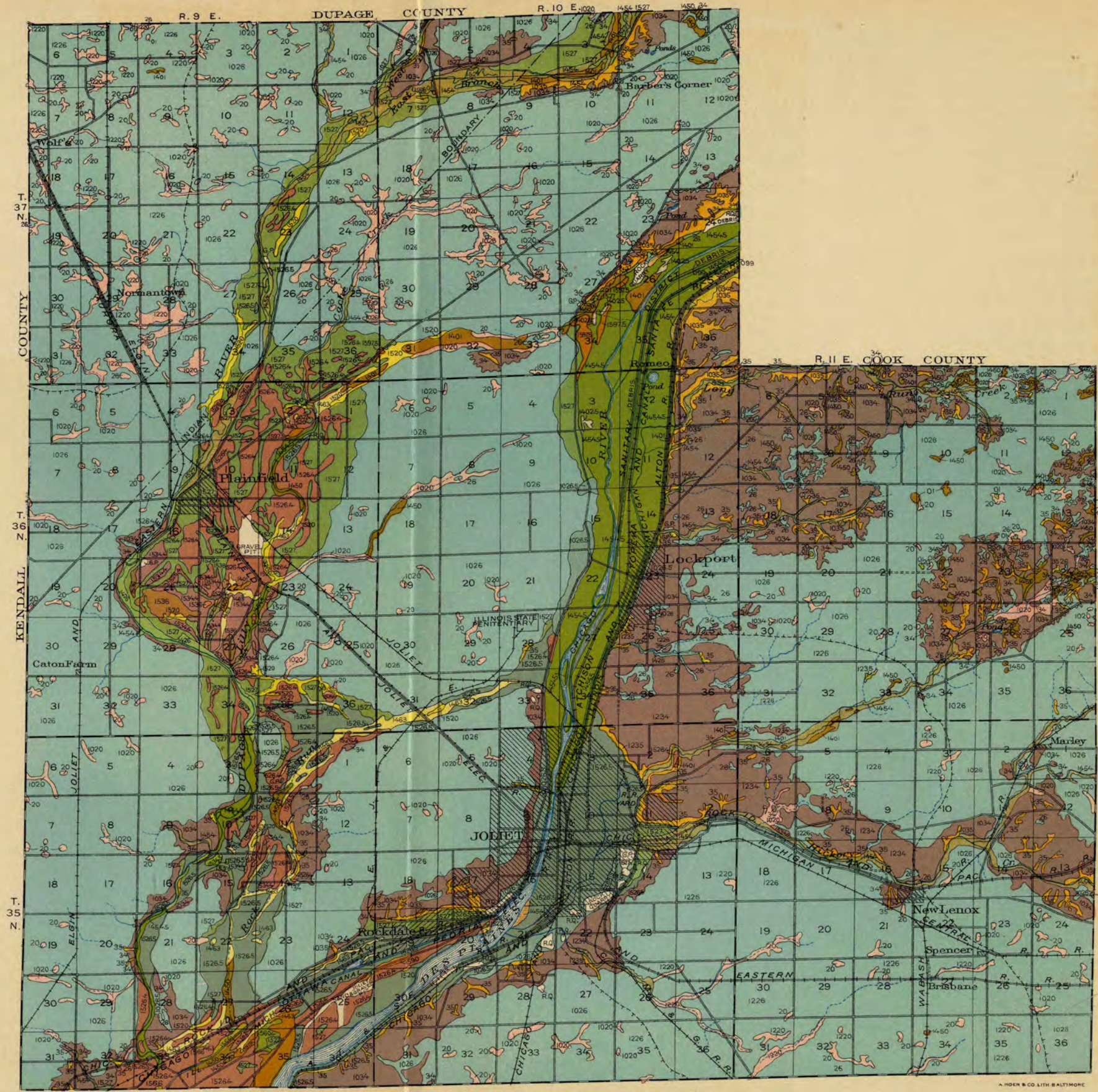
- 099 Rock Outcrop
- Small Areas Of Rock Outcrop
- Mine Dumps

1000 Late Wisconsin Moraines

1200 Late Wisconsin Intermorainal Areas

Scale

0 ¼ ½ 1 2 Miles



SOIL SURVEY MAP OF WILL COUNTY

UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION

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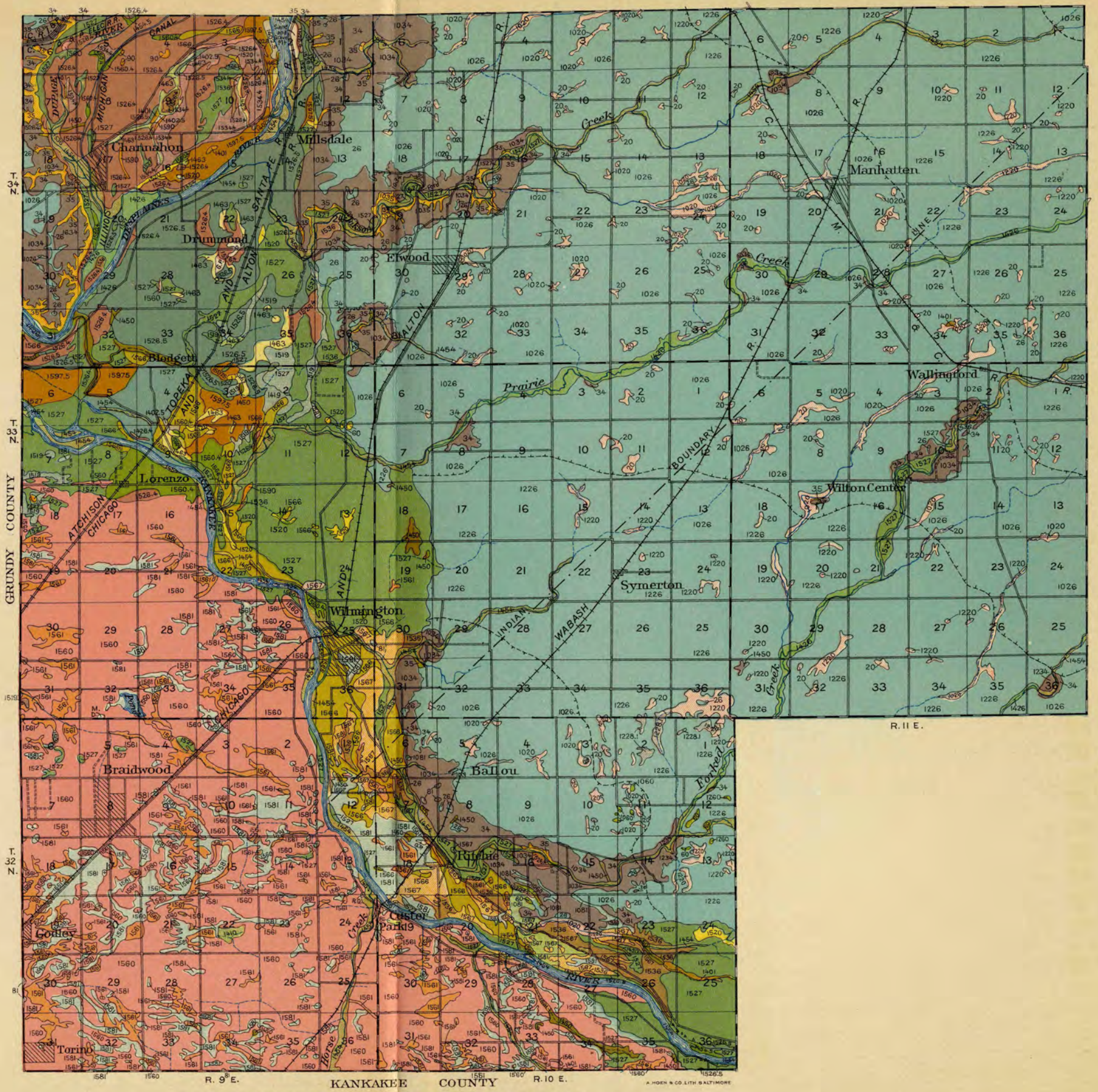

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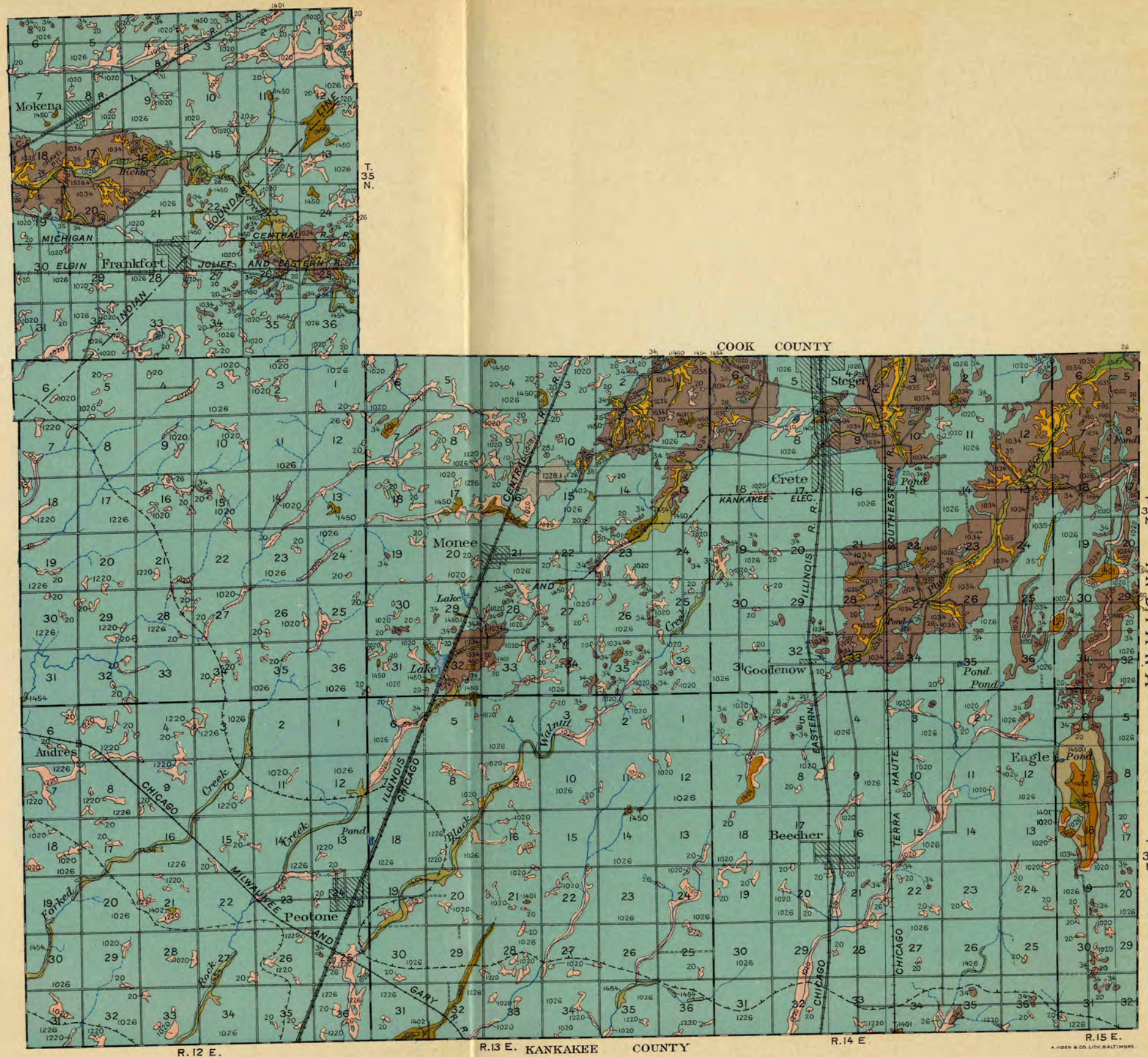

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UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION