UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 39

LOGAN COUNTY SOILS

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

URBANA, ILLINOIS, OCTOBER, 1927

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

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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 the form of a Supplement. This Supplement should be referred to in connection with the descriptions of the respective soil types found in the body of the report.

While the authors must assume the responsibility for the presentation of this report, it should be understood that the material for the report represents the contribution of a considerable number of the present and former members of the Agronomy Department working in their respective lines of soil mapping, soil analysis, and experiment field investigation. In this connection special recognition is due the late Professor J. G. Mosier, under whose direction the soil survey of Logan county was conducted, and to Mr. F. A. Fisher and Mr. O. I. Ellis who, as leaders of the field parties, were in direct charge of the mapping.

CONTENTS OF SOIL REPORT NO. 39

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BY R. S. SMITH, E. E. DeTURK, F. C. BAUER, AND L. H. SMITH[1]

LOCATION AND CLIMATE OF LOGAN COUNTY

Logan county is in almost the exact center of the state of Illinois. It has a total area of 616.43 square miles, three-quarters of which is upland.

The climate of Logan county is typical of central Illinois. It is characterized by a wide range between the extremes of winter and summer and has an abundant, usually well-distributed rainfall. The great range in temperature for any one year for the sixteen-year period from 1910 to 1925, as recorded at the Lincoln Weather Bureau Station, was 130 degrees, in 1914. The highest temperature recorded was 105°, in 1918; the lowest, 29° below zero, in 1914. The average date of the last killing frost in spring is May 4; the earliest in the fall, October 13. The average length of the growing season is 162 days.

The average annual rainfall, as recorded for this sixteen-year period at Lincoln, was 35.54 inches. The average rainfall by months for this period was as follows: January, 1.91 inches; February, 1.48; March, 3.12; April, 3.45; May, 4.30; June, 3.47; July, 2.95; August, 3.40; September, 3.82; October, 2.90; November, 2.07; December, 1.99.

AGRICULTURAL PRODUCTION

Logan county is agricultural in its interests, over 90 percent of the land being suitable for farming. According to the Fourteenth Census of the United States there were 2,234 farms in the county in 1920, a decrease of 86 since 1910 and 171 since 1900. About 65 percent were operated by tenants, an increase of about 6 percent in twenty years.

The principal crops are those common to the corn belt, as shown by the following figures for the year 1919.

Crops	*Acreage*	*Production*	*Yield per acre*
Corn	126,220	5,191,270 bu.	41.1 bu.
Oats	56,193	1,692,878 bu.	30.1 bu.
Wheat	89,448	1,852,127 bu.	20.7 bu.
Timothy	4,820	6,179 tons	1.28 tons
Timothy and clover mixed	2,957	3,857 tons	1.30 tons
Clover	13,232	14,494 tons	1.09 tons
Alfalfa	783	2,029 tons	2.59 tons
Silage crops	659	6,002 tons	9.10 tons
Corn for forage	869	2,393 tons	2.75 tons

These figures are for but a single year. For the ten-year period 1916 to 1925 the U. S. Department of Agriculture gives the average yield of corn as 40.5 bushels; oats, 35.0 bushels; winter wheat, 21.4 bushels; tame hay, 1.29 tons.

The total value of all livestock and livestock products produced in 1919 was $5,858,500, or a little over one-third the value of crops produced that year. The

[1] R. S. Smith, in charge of 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.

following figures, taken from the 1920 Census, show the character of the live-stock interests in the county.

Animals and Animal Products	*Number*	*Value*
Ho-ses	17,999	$1,781,591
Mules	2,342	323,669
Beef cattle	8,778	548,118
Dairy cattle	13,287	894,089
Sheep	4,760	55,518
Swine	47,721	896,473
Chickens and other poultry	280,562	272,718
Chickens and eggs produced	......	679,102
Dairy products produced	......	373,954

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 and immediately following this remote period, the material that later formed the mineral portion of the soils was being deposited. At that time snow and ice accumulated in the region of Labrador and to the west of Hudson Bay to such an amount that the mass pushed outward from these centers, chiefly southward, until a region was reached where the ice melted as rapidly as it advanced. In moving across the country from the far north, the ice gathered up all sorts and sizes of material, including clay, silt, sand, gravel, boulders, and even immense masses of rock. Some of these materials were carried for hundreds of miles and rubbed against surface rocks and against each other until largely ground into powder. When the ice sheet, or glacier, reached the limit of its advance, the rock material carried by it accumulated along the front edge in a broad, undulating ridge or moraine. With rapid melting, the terminus of the glacier receded, and the material was deposited somewhat irregularly over the area previously covered. The mixture of materials deposited by the glacier is known as boulder clay, till, glacial drift, or simply drift. The average depth of this deposit over the state of Illinois is estimated at 115 feet.

Previous to the ice invasion this region generally was not well suited to agriculture because of its rough and hilly character. Logan county was covered by the Illinoisan glaciation and in the northeast corner by the Wisconsin glaciation. The general effect of these glaciers was to change the surface from hilly to gently undulating by rubbing down the hills and filling the valleys. Several moraines were formed in this county.

Altho it did not touch the county, a later ice sheet, known as the Iowan, played an important role in the formation of the soils. During the time when the melting ice front of this Iowan glacier lay to the north of the area now comprizing Logan county, immense volumes of water, heavily laden with fine sediment, flowed from the ice. This water filled the drainage channels and overflowed the adjacent lowlands, forming terraces. Following each flood state, the water would recede and the sediment which had been deposited would be picked up by the wind and redeposited on the upland.

This wind-blown deposit, known as loess, varies from 60 to 75 inches in thickness over much of the county and apparently it is the material from which the upland soils of Logan county are formed.

PHYSIOGRAPHY AND DRAINAGE

The topography of Logan county is favorable to good surface drainage with the exception of a few areas, notably in the vicinity of Elkhart, in the region south of Mt. Pulaski, and between Hartsburg and Emden. Even these relatively flat-lying areas, however, are sufficiently undulating so that drainage may be provided without difficulty. The north corner of the county in the region

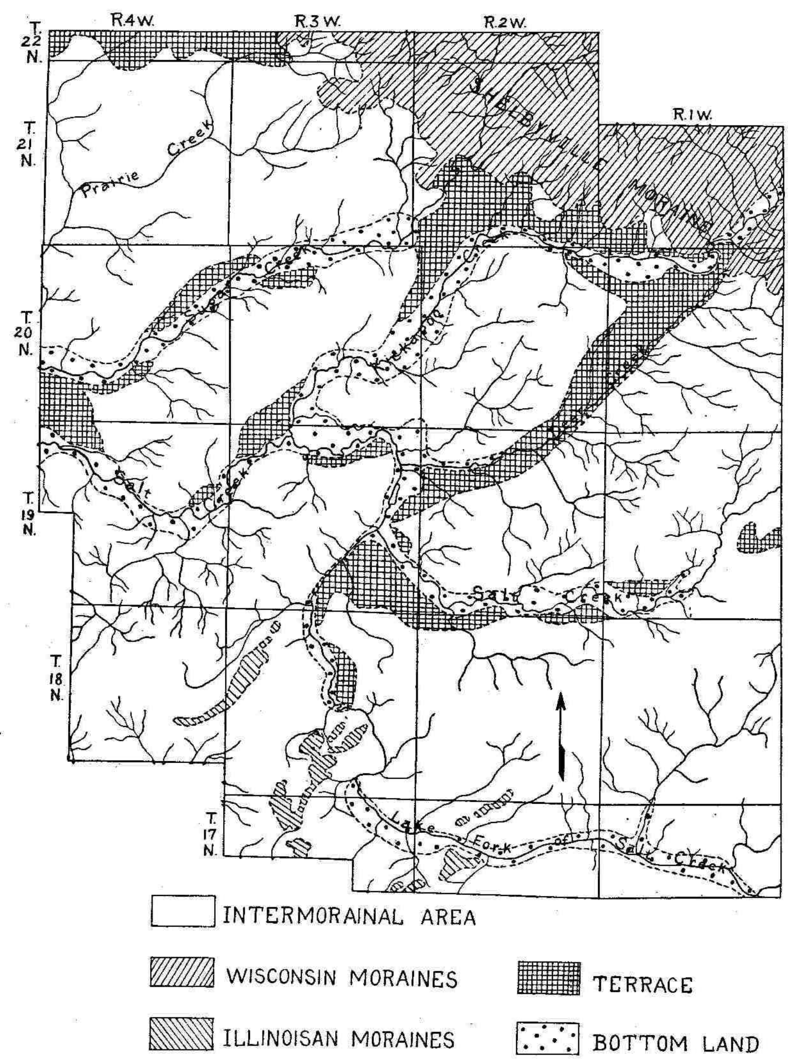

FIG. 1.—DRAINAGE MAP OF LOGAN COUNTY SHOWING STREAM COURSES, GLACIATIONS, AND TERRACE AND BOTTOM-LAND AREAS

of San Jose is rolling and has a dune-like topography. The soil map shows a number of morainal hills south and west of Mt. Pulaski.

The drainage of the county is well taken care of by Salt creek and its tributaries. All the drainage of the county finds its way into Sangamon river thru Salt creek, with the exception of a few square miles in the southwest corner, which drain directly into the Sangamon. The wide bottoms and terraces along Salt creek and its tributaries, Deer creek, Kickapoo creek, and Sugar creek, show that stream action was much more vigorous at one time in the history of this region than it is now.

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. When first deposited, the general composition of any soil material, particularly loess, is rather uniform. With the passing of time, however, various physical, chemical, and biological agencies of weathering form soil out of the parent material by some or all of the following processes: the leaching of certain elements, the accumulation of others; the chemical reduction of certain compounds, the oxidation of others; the translocation of the finer soil particles, and the arrangement of them into zones or horizons; and the accumulation of organic matter from the growth and decay of vegetable material. One of the very pronounced characteristics observed in most soils is that they are composed of more or less distinct strata, called horizons. As explained somewhat more fully in the Appendix, these horizons are named, from the surface down: A, the layer of extraction; B, the layer of concentration or accumulation; and C, the layer of less-altered material, or the layer in which weathering has had less effect. The development of horizons in a soil is an indication of its age.

SOIL GROUPS

The soils of Logan county have been divided into four groups, as follows:

Upland Prairie Soils, dark colored and usually rich in organic matter, the organic matter having been derived from the decaying roots of the wild prairie grasses which occupied this land for thousands of years.

Upland Timber Soils, including those zones along stream courses over which forests grew for a long period of time. These contain in general less organic matter than the prairie soils.

Terrace Soils, including bench lands and second bottoms formed by deposits from flooded streams overloaded with sediment, perhaps at the time of the melting of the glaciers.

Swamp and Bottom Lands, which include the flood plains along the streams and some poorly drained muck and peat areas. The soil map shows the Swamp and Bottom Lands as divided into two groups, the Old and the Late. This division, as made, was geological, but according to the present-day conception of the matter it has no significance in a soil classification; hence for the purpose of describing the various swamp and bottom-land types, the two groups are combined into one.

TABLE 1.—SOIL TYPES OF LOGAN COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	Upland Prairie Soils (200, 400, 900)			
226, 426, 926	Brown Silt Loam	369.66	236 582	59.97
420, 920	Black Clay Loam	83.66	53 542	13.57
428, 928	Brown-Gray Silt Loam On Tight Clay	.39	250	.06
260, 460	Brown Sandy Loam	1.15	736	.19
		454.86	291 110	73.79
	Upland Timber Soils (200, 400, 900)			
234, 434, 934	Yellow-Gray Silt Loam	35.91	22 982	5.83
235, 435, 935	Yellow Silt Loam	5.98	3 827	.97
464	Yellow-Gray Sandy Loam	.14	90	.02
419	Brown Clay Loam	.39	250	.06
		42.42	27 149	6.88
	Terrace Soils (1500)			
1527	Brown Silt Loam Over Sand or Gravel	38.35	24 544	6.22
1520	Black Clay Loam Over Sand or Gravel	4.16	2 662	.68
1566	Brown Sandy Loam Over Sand or Gravel	.33	211	.05
1536	Yellow-Gray Silt Loam Over Sand or Gravel	3.17	2 029	.50
1528	Brown-Gray Silt Loam On Tight Clay	5.72	3 661	.93
		51.73	33 107	8.38
	Swamp and Bottom-Land Soils (1300, 1400)[1]			
1326, 1426	Deep Brown Silt Loam	39.96	25 574	6.49
1320, 1420	Black Clay Loam	12.00	7 680	1.95
1319, 1419	Brown Clay Loam	8.26	5 286	1.34
1354, 1454	Mixed Loam	7.11	4 550	1.15
		67.33	43 090	10.93
	Miscellaneous			
	Sand or Gravel Pit	.07	45	.01
	Water	.02	13	<.01
		.09	58	.02
	Total	616.43	394 514	100.00

[1]These 1300 and 1400 groups are differentiated on the map but not in the descriptions, as explained on page 4.

Table 1 gives the list of soil types in Logan county, the area of each in square miles and in acres, and also the percentage of the total area. The accompanying map, shown in 2 sections, gives the location and boundary of each soil type which has been mapped in the county.

For explanations concerning the classification of soils and the interpretation of the map and tables, the reader is referred to the first part of the Appendix.

INVOICE OF THE ELEMENTS OF PLANT FOOD IN LOGAN COUNTY SOILS

In order to obtain a knowledge of its chemical composition, each soil type is sampled in the manner described below and subjected to chemical analysis for its important plant-food elements. For this purpose samples are taken usually in sets of three to represent different strata in the top 40 inches of soil; namely, an upper stratum (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 per acre of dry soil in the upper stratum, and to two times and three times this quantity in the middle and lower strata respectively. 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 and which are referred to in describing the soil types as "horizons A, B, and C." 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, being 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 therefore is 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 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 discussion of the individual soil types which follows, 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 29).

THE UPPER SAMPLING STRATUM

In Table 2 are reported the total quantities of organic carbon, nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium in 2 million pounds of surface soil of each type in Logan 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, averages ten times that of the total nitrogen in the upper sampling stratum. 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 ratio usually becoming narrower as the depth increases.

The ranges in amount of organic matter and nitrogen are very wide. The upland prairie soils are for the most part relatively high in these constituents, averaging 42,080 pounds of organic carbon in an acre, while the upland timber soils are fairly low, with an average content of 26,090 pounds of this element. Black Clay Loam, Upland, contains the largest amount of organic carbon of any soil in the county. The amount found in this type is 69,970 pounds an acre, with a nitrogen content of 6,220 pounds. The lowest amounts are to be found in the more or less sandy types, such as Brown Sandy Loam and Yellow-Gray Sandy Loam which, because of their loose, open character, permit the rapid oxidation of the organic matter.

Other elements are not so closely associated with each other as are 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. Most of the Logan county soils are fairly well supplied with sulfur, only the two sandy types above mentioned, and also the two terrace types, Yellow-Gray Silt Loam and Brown Sandy Loam, exhibiting very low values. The range in the surface soil is from a minimum of 340 pounds an acre in Yellow-Gray Sandy Loam to 1,120 pounds in Black Clay Loam, Upland. The sulfur content of the soil is consistently 75 to 80 percent as high as the phosphorus in the upland soils, but only 50 percent as high in the terrace and bottom-land soils. No explanation is apparent for this variation. The sulfur available to crops is affected not only by the supply in the soil 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 large. At Urbana during the eight-year period from 1917 to 1924 there was added to the 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 Spring Valley, in Bureau county, the rainfall during six summer months in 1921 brought down 34.5 pounds of sulfur an acre, or an average monthly precipitation of 5.75 pounds. The maximum for a single month was 8.77 pounds, in June. At Toledo, in Cumberland county, from April to November, 1922, the average precipitation was 3 pounds an acre a month. The precipitation at the various points in the state in a single month has varied from a minimum of ¾ of a pound to over 10 pounds an acre. These figures will afford some idea of the amounts of sulfur added by rain and also of the wide variation in these amounts under different conditions.

On the whole, the above facts would indicate that the sulfur added from the atmosphere supplements that contained in the soil, so that there appears to be no need for sulfur fertilizers in Logan 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, one of which is in Logan county. These fields are at Raleigh, Toledo, Carthage, Hartsburg, and Dixon. The data from the Hartsburg experiment field are given in the Supplement of this Report, page 50.

With regard to total phosphorus, the two upland sandy soils, Brown Sandy Loam and Yellow-Gray Sandy Loam, are very deficient, containing only 600 and 480 pounds an acre, respectively, in the surface 2 million pounds. Yellow Silt Loam is but little better, with 640 pounds of this element. Since in the first two of these three types the phosphorus percentage is no higher in the deeper layers, not much could be expected in the way of continued high production on these soil types without phosphate fertilization. The other soils of the county range from 780 pounds an acre in Brown-Gray Silt Loam On Tight Clay to 1,860 pounds in Black Clay Loam Over Sand or Gravel. The three bottom-land types are all rather high, containing 1,640 pounds of phosphorus per 2 million pounds of surface soil.

The potassium content of the soils of Logan county is relatively uniform. Except for the two sandy types, Brown Sandy Loam and Yellow-Gray Sandy Loam, the range is from approximately 30,000 to 38,000 pounds an acre, with an average of 34,000 pounds. The two sandy types above mentioned contain only about three-fourths as much potassium as the mean of the rest of the county and have the additional handicap of carrying a considerable proportion of their potassium content in the coarse sand grains. The relatively small surface exposed in the case of the coarse particles greatly lowers the solubility and availability of the potassium in sand soils. This is partly offset by the greater depth of the feeding zone for crop roots in sandy soils as compared with the heavier types. While the Experiment Station has carried out no field experiments in the management of either Brown Sandy Loam or Yellow-Gray Sandy Loam, it would appear from the above considerations that these are the only soil types in Logan county which would be at all likely to respond to potassium applications for the production of our common field crops; and even on these types the use of well-planned rotations, the return of crop residues and manure, and the plowing down of sweet clover will go a long way toward maintaining an adequate supply of this element in the available condition for growing crops.

The amounts of calcium and magnesium in soils usually vary greatly and this is the case in the soils of Logan county. The range in calcium content in the upper 6⅔ inches is from 4,740 pounds to 18,890 pounds in 2 million pounds of soil, while the extremes in magnesium content are even farther apart. Magnesium has never been found deficient for crop growth in the soils of Illinois, nor indeed in the United States. Calcium, however, in strongly acid soils may become available too slowly, at least for certain crops such as alfalfa and sweet clover. This is a defect which is corrected by liming.

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 being compared with each other or with the data for the upper stratum, which is 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 exhibit no consistent change in amount with increasing depth. This is true particularly of potassium. Others exhibit more or less marked variation in amount at the different levels. Furthermore, these variations as a rule go 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 and the nature 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 all of the soil types diminish rather rapidly in organic matter and nitrogen with increasing depth, and that this diminution is very marked even in the middle stratum. It should be remembered that this stratum, extending to a depth of 20 inches, includes in many cases portions of the A_2, and even of the B horizon, or subsoil. The sulfur content decreases with increasing depth in nearly all cases. This is to be expected since a portion of the sulfur exists in combination with the soil organic matter, which is more abundant in the upper strata, and since 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

TABLE 2.—PLANT-FOOD ELEMENTS IN THE SOILS OF LOGAN 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 (200, 400, 900)							
226, 426, 926	Brown Silt Loam	46 250	4 410	1 020	850	35 170	7 980	9 820
420, 920	Black Clay Loam	69 970	6 220	1 460	1 120	31 930	12 490	18 890
428, 928	Brown-Gray Silt Loam On Tight Clay	33 340	3 220	780	680	29 440	4 700	6 860
260, 460	Brown Sandy Loam	18 780	2 100	600	440	27 340	4 280	5 920
	Upland Timber Soils (200, 400, 900)							
234, 434, 934	Yellow-Gray Silt Loam	20 350	2 080	860	570	35 450	3 890	6 680
235, 435, 935	Yellow Silt Loam	27 480	2 200	640	500	35 380	4 320	8 520
464	Yellow-Gray Sandy Loam	10 260	880	480	340	25 580	3 040	4 740
419	Brown Clay Loam	46 280	3 900	1 220	980	32 520	12 240	17 160
	Terrace Soils (1500)							
1527	Brown Silt Loam Over Sand or Gravel	47 950	4 850	1 360	680	31 600	5 770	10 670
1520	Black Clay Loam Over Sand or Gravel	44 720	5 700	1 860	1 100	37 340	10 060	18 540
1566	Brown Sandy Loam Over Sand or Gravel	24 120	2 110	1 060	400	32 250	4 980	7 360
1536	Yellow-Gray Silt Loam Over Sand or Gravel	20 460	2 460	900	400	35 380	4 640	5 280
1528	Brown-Gray Silt Loam On Tight Clay	37 340	3 960	1 310	670	33 840	4 360	7 600
	Swamp and Bottom-Land Soils (1300, 1400)							
1326, 1426	Deep Brown Silt Loam	48 570	5 030	1 640	840	38 650	10 560	15 070
1320, 1420	Black Clay Loam	54 700	5 620	1 640	800	34 140	9 960	15 900
1319, 1419	Brown Clay Loam	48 540	5 500	1 640	780	35 700	10 140	16 460
1354, 1454	Mixed Loam[1]	......	......	......	......	......	......	......

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

[1]On account of the heterogenous character of Mixed Loam, chemical analyses are not included for this type.

plant residues at the expense of the underlying strata. The second stratum (6⅔ to 20 inches) furnishes a considerable proportion of the phosphorus thus moved upward, as is attested by the smaller amounts found by analysis in 12 of

TABLE 3.—PLANT-FOOD ELEMENTS IN THE SOILS OF LOGAN 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 (200, 400, 900)							
226, 426, 926	Brown Silt Loam	65 400	6 490	1 770	1 310	70 010	19 540	19 910
420, 920	Black Clay Loam	80 100	7 550	2 440	1 650	64 770	26 890	35 060
428, 928	Brown-Gray Silt Loam On Tight Clay	22 760	3 000	1 200	840	69 800	13 560	10 280
260, 460	Brown Sandy Loam	35 480	3 640	1 160	960	56 160	10 160	13 520
	Upland Timber Soils (200, 400, 900)							
234, 434, 934	Yellow-Gray Silt Loam	15 020	2 040	1 680	760	76 700	14 700	9 280
235, 435, 935	Yellow Silt Loam	23 840	2 440	1 840	680	71 800	14 640	17 240
464	Yellow-Gray Sandy Loam	13 880	1 720	1 000	360	52 440	7 000	11 360
419	Brown Clay Loam	52 200	4 920	1 720	1 280	66 840	24 320	30 480
	Terrace Soils (1500)							
1527	Brown Silt Loam Over Sand or Gravel	72 950	7 830	2 320	1 130	66 660	14 080	20 750
1520	Black Clay Loam Over Sand or Gravel	68 400	6 600	2 960	1 520	67 240	23 400	34 880
1566	Brown Sandy Loam Over Sand or Gravel	44 160	4 030	1 490	960	61 900	11 500	14 360
1536	Yellow-Gray Silt Loam Over Sand or Gravel	16 280	2 160	1 880	520	80 720	13 080	18 080
1528	Brown-Gray Silt Loam On Tight Clay	27 220	3 620	2 100	780	71 400	8 720	13 860
	Swamp and Bottom-Land Soils (1300, 1400)							
1326, 1426	Deep Brown Silt Loam	81 500	8 860	2 960	1 360	78 700	23 720	29 440
1320, 1420	Black Clay Loam	63 320	7 520	2 480	840	72 800	18 680	28 240
1319, 1419	Brown Clay Loam	57 720	6 320	2 640	1 240	69 760	22 080	30 400
1354, 1454	Mixed Loam[1]	....	......	......	......	....	....	....

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

[1]On account of the heterogeneous character of Mixed Loam, chemical analyses are not included for this type.

the 15 types in the county. The analyses indicate that the lower stratum has also contributed to some extent in this upward movement of phosphorus.

Two important basic elements, calcium and magnesium, have undergone some shifting in the different levels, as exhibited by analyses of upland types. In the surface soil 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. In the middle stratum the calcium content remains the same or diminishes as compared with the upper. The magnesium content, on the other

TABLE 4.—PLANT-FOOD ELEMENTS IN THE SOILS OF LOGAN 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 (200, 400, 900)							
226, 426, 926	Brown Silt Loam	42 830	5 440	2 330	1 400	105 050	36 870	31 400
420, 920	Black Clay Loam	46 670	5 080	3 170	1 540	97 810	47 600	76 510
428, 928	Brown-Gray Silt Loam On Tight Clay	18 660	3 120	2 820	1 320	103 320	38 640	22 920
260, 460	Brown Sandy Loam	36 420	3 600	1 740	660	84 780	25 980	47 700
	Upland Timber Soils (200, 400, 900)							
234, 434, 934	Yellow-Gray Silt Loam	14 730	2 430	2 970	870	110 820	34 200	24 390
235, 435, 935	Yellow Silt Loam	19 080	2 400	2 700	720	95 940	23 040	22 020
464	Yellow-Gray Sandy Loam	13 140	1 560	1 560	1 140	83 280	11 340	16 140
419	Brown Clay Loam	43 020	4 080	2 880	900	100 680	42 600	46 680
	Terrace Soils (1500)							
1527	Brown Silt Loam Over Sand or Gravel	49 290	5 430	3 030	1 190	98 490	26 900	29 690
1520	Black Clay Loam Over Sand or Gravel	39 420	4 560	3 840	1 320	101 520	39 240	40 980
1566	Brown Sandy Loam Over Sand or Gravel	29 250	2 860	1 460	840	94 330	17 740	19 900
1536	Yellow-Gray Silt Loam Over Sand or Gravel	17 580	2 880	3 420	900	117 900	23 880	27 120
1528	Brown-Gray Silt Loam On Tight Clay	18 570	3 420	3 150	780	105 600	21 570	22 740
	Swamp and Bottom-Land Soils (1300-1400)							
1326, 1426	Deep Brown Silt Loam	87 660	8 520	3 780	1 770	114 120	32 700	42 030
1320, 1420	Black Clay Loam	55 860	6 120	3 240	840	100 680	29 520	39 900
1319, 1419	Brown Clay Loam	41 160	4 740	3 360	1 620	108 360	33 660	42 360
1354, 1454	Mixed Loam[1]	......	......	......	......	......	......	......

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

[1]On account of the heterogeneous character of Mixed Loam, chemical analyses are not included for this type.

hand, increases in both the middle and lower strata. These two elements are unequally removed from the soil by leaching, the calcium being dissolved and carried downward to a greater extent than magnesium. Consequently the magnesium content tends to become high in the middle and lower strata, while the calcium content of the lower sampling strata is, on the average, little or no higher than the upper. This spread between these two elements in the lower depths is greatest in soils of extreme maturity and cannot be observed at all in soils so young as to show indistinct stratification. In line with this idea it would appear that Logan county soils are, for the most part, in youth and middle age, none being in extremely advanced stages.

Potassium, another important basic plant-food element, is present in much larger amounts than either calcium or magnesium, and does not exhibit any marked variation in amount in the different depths. Wherever any differences do occur, they are only slight considered in proportion to the total amounts present.

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.

Examining the data in this manner the tables reveal that there is not only a wide diversity among the different soils with respect to a given plant-food 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 one of the most extensive soil types in the county, Brown Silt Loam, Upland, we find that the total quantity of nitrogen in an acre to a depth of 40 inches amounts to 16,340 pounds. This is about the amount of nitrogen contained in the same number of bushels of corn. The amount of phosphorus, 5,120 pounds, contained in the same soil is equivalent to that contained in 30,100 bushels of corn, while in the same quantity of this soil there is present 210,230 pounds of potassium, the equivalent of that contained in more than one million bushels of corn. In marked contrast to this soil, Yellow-Gray Silt Loam, an important upland timber soil type, contains in the 40- inch stratum less than one-half as much nitrogen, or 6,550 pounds per acre, an amount equal to that in 6,550 bushels of corn. The phosphorus content of Yellow-Gray Silt Loam is slightly higher than that of Brown Silt Loam, namely, 5,510 pounds in an acre, which is equivalent to that contained in 32,400 bushels of corn. The potassium content is about the same as in Brown Silt Loam.

In the case of calcium the legumes utilize and remove from the soil much larger quantities than do the grain crops, and the comparisons will therefore be of more interest if one of these crops is used. A ton of red clover contains approximately 29 pounds of calcium, while 100 bushels of corn contain only about one pound of this element. The 61,130 pounds of calcium in the 40-inch depth of Brown Silt Loam, therefore, are equivalent to that in 2,100 tons of red clover hay, while that in Yellow-Gray Silt Loam is only two-thirds as high, namely, 40,350 pounds, or the equivalent of 1,400 tons of the same hay.

It is obvious from the above comparisons that the outstanding differences between these two important soil types, so far as chemical composition is concerned, lie in their calcium, nitrogen, and organic matter.

These considerations 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 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. Much depends upon the nature of the crops to be grown, in their utilization of plant-food materials, and much depends upon the availability of the plant-food substances. 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. Such figures, 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 Logan county occupy 454.86 square miles, or nearly three-fourths of the area of the county. The dark color of the prairie soils is due to the accumulation of organic matter which is derived, very largely, from the fibrous roots of the prairie grasses. The network of grass roots which once covered these areas 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. On the native prairies the stems and leaves were usually burned in part by prairie fires or disappeared in part by decay. This surface accumulation, which was constantly renewed, added but little organic matter to the soil directly, but the decay of the prairie-grass roots was retarded considerably by it.

The upland prairie soils in this county include some areas of recent timber growth, where certain kinds of trees have spread over the prairie, but this forestation has not been of sufficient duration to produce the characteristic timber soils. These areas of greater or less width are found along the border of most timber tracts, so that the timber actually extended a little farther than the soil would indicate.

Brown Silt Loam (226, 426, 926)

Brown Silt Loam, as it is mapped in Logan county, occupies nearly 370 square miles, or about 60 percent of the area of the county. It varies in character depending on topography. Three divisions of the type as mapped are recognized at the present time. Each of these is described below so that it may be recognized in the field.

1. Light Brown Silt Loam. This type occurs on the higher areas and on slopes where the surface drainage is good. The A_1 horizon, or surface, is about 7 inches thick and is a light brown silt loam, frequently having a yellowish cast. The A_2 horizon, or subsurface, extending to a depth of about 18 inches, is a yellowish brown silt loam. The B horizon, or upper subsoil, is a friable, non-mottled, dark reddish yellow silty clay loam. The C horizon, or lower subsoil, which is found at a depth of about 36 inches, is a very friable, slightly mottled silt loam or fine sandy loam.

Management.—The character of the profile of Light Brown Silt Loam, together with its topographic position, affords perfect surface and underdrainage. Some care must be exercised in preventing erosion, as many of the slopes are steep enough to allow rapid runoff if the surface is bare. This soil is not as high in organic matter and nitrogen as it should be and it is usually medium acid. Limestone should be applied at the rate of 2 to 3 tons an acre, and clover grown every 3 or 4 years as a source of organic matter and nitrogen. The best information available on the treatment of this type comes from the Mt. Morris experiment field which is located in part on Light Brown Silt Loam. The results from this field show a very marked response to manure. Where limestone was applied in addition to manure, a further increase was secured which was sufficiently large to pay a good profit on the cost of the limestone. Another treatment which gave very good increases on this field was residues and limestone used in combination. Potash has not increased the yields on this field. Rock phosphate when used in addition to manure has not increased yields, and when used in addition to residues, the yields have been increased just about enough to pay for applying half a ton of rock phosphate per acre once in the rotation. For further description of the Mt. Morris field, including the data, see page 40.

2. **Brown Silt Loam.** This type occupies intermediate topographic positions. It differs from the preceding type, Light Brown Silt Loam, in having a darker and usually thicker A_1 horizon, or surface, a less yellow A_2 horizon, or subsurface, and a heavier, less friable, and somewhat mottled B horizon, or upper subsoil.

Management.—Brown Silt Loam is somewhat less acid than Light Brown Silt Loam but requires limestone to grow alfalfa or sweet clover. It was originally well supplied with organic matter and has been subject to but little loss of soil material thru erosion. The Kewanee experiment field is located, for the most part, on this soil type. A description of the work on this field, including the experimental data, will be found on page 42. Unfortunately, the Kewanee field has several draws crossing the plots which are a much heavier soil, so that the results from the field cannot be applied to Brown Silt Loam with as much confidence as would otherwise be the case. It is almost certainly true, however, that the presence of the heavier type on the Kewanee field has the effect of diminishing the increases due to treatment. This field shows very good results for manure on corn and oats, but less effect on wheat. Limestone has given profitable increases, particularly in the residues system. Rock phosphate has increased the yield of wheat on the manure plots by 5.5 bushels, but has had little or no effect on the other crops in the rotation. On the residues plots, rock phosphate has caused very satisfactory increases in the yield of corn, oats, and wheat, but has had little effect on the yield of clover hay. A comparison of rock and acid phosphate on the Kewanee field, which has been in progress too short a time to allow final conclusions, suggests that better results might be secured on this soil type with acid phosphate than with rock phosphate. This tentative suggestion is strengthened by the results from the Bloomington field (see page 44), which is located in part on this soil type. Steamed bone meal has been used as the source of phosphorus on this field and the increases caused by its use have been very striking. The only concrete suggestion for the phosphate fertilization of this soil type which can be made at the present time is to make a trial of one of the more available forms of phosphates, applying it for the wheat crop.

3. **Brown Silt Loam on Clay.** This type occupies the nearly level or only gently sloping areas in the upland prairie region. It is characterized by a dark brown A_1 horizon, or surface, about 9 inches thick and a brown A_2 horizon, or subsurface, containing pale yellow spots. The B horizon, or upper subsoil, is usually a strongly mottled, brownish yellow, somewhat compact and plastic, clay loam. At a depth of 32 to 40 inches, the more friable C horizon, or lower subsoil, is found.

Management.—This type is either not acid or only slightly so. The subsoil, while more compact and plastic than that under either of the preceding types discussed, drains well with tile. The Aledo experiment field is located on Brown Silt Loam On Clay and the results from this field may be used as a guide in the treatment of this soil type in Logan county. Manure has given very good returns. Limestone has failed to give very convincing increases and its indiscriminate use could hardly be advised on this soil unless alfalfa or sweet clover is to be grown. Rock phosphate has not caused increases in yield on the manure plots but its use on the residues plots has resulted in sufficiently large increases to justify advising its use when manure is not available. Phosphate comparisons have been in progress on the Aledo field since 1916 and the reader is asked to turn to page 45 of the Supplement to this Report and make a study of the results as an aid in solving his phosphate problem on Brown Silt Loam On Clay.

Black Clay Loam (420, 920)

Black Clay Loam is extensively developed in Logan county, occupying all told nearly 84 square miles, or about 13½ percent of the total area of the county. The A_1 horizon, or surface, which is about 10 inches thick, is black clay loam. The A_2 horizon, or subsurface, is 9 or 10 inches thick. It is drabbish black clay loam. The B horizon, or upper subsoil, varies considerably. In some places it is a deep heavy gray clay, and in others, drab clay resting on very friable yellow fine sandy loam. The pond, or alluvial, formation of this type explains the subsoil variations.

Management.—Black Clay Loam rarely needs limestone to grow sweet clover. Some areas of the type contain sufficient alkali to be harmful. It is a productive soil and needs no treatment other than fresh organic matter to help keep it in good physical condition. Clover should be grown every third or fourth year and turned under directly or as manure. The reader is asked to turn to page 50, where the results and discussion of the Hartsburg experiment field, which is located on this soil type, will be found.

Brown-Gray Silt Loam On Tight Clay (428, 928)

Brown-Gray Silt Loam On Tight Clay, Upland, is a minor type in Logan county, aggregating only 250 acres. The reader is referred to page 20, where a description of Brown-Gray Silt Loam On Tight Clay, Terrace, will be found. The two types as developed in Logan county are identical except in origin.

Brown Sandy Loam (260, 460)

Brown Sandy Loam is a minor type in Logan county. It occurs as small areas in the northwestern part of the county and aggregates only 1.15 square miles. The dune-like topography of the region where this type occurs suggests its wind origin and the nearness of the sandy terrace on the west also suggests the same origin. The A_1 horizon, or surface, to a depth of 7 or 8 inches is a light brown sandy loam. Below this depth the color changes gradually from yellowish brown to yellow and the texture becomes coarser. The areas which have been undisturbed by the wind for a long period of time have developed a finer texture and some compaction in the subsoil.

Management.—The occurrence of this type in small areas makes it usually necessary to crop this soil in the same way that the adjacent land is cropped. It is possible, however, to provide for larger additions of leguminous organic matter and manure than are given to the adjacent silt loams and clay loams. Limestone should be applied at the rate of about 2 tons an acre, and sweet clover should be grown once in the rotation. The sweet clover can well be utilized by plowing it down in the spring of the second year for corn. No mineral fertilizer treatment is advised except on a trial basis.

UPLAND TIMBER SOILS

The upland timber soils are not extensively developed in Logan county. They cover only about 42 square miles, or less than 7 percent of the area of the county. They occur adjacent to most of the streams. They are usually characterized by a yellow or yellowish gray color, which is due to the low organic-matter content. This lack of organic matter has been caused by the long-continued growth of forest trees. As the forests invaded the prairies, the following effects were produced: the shading of the trees prevented the growth of grasses, the roots of which are mainly responsible for the large amount of organic matter in the prairie soils; and the trees themselves added very little organic matter to the soil, for the leaves and branches either decayed or were destroyed by forest fires. The timbered soils are divided into two groups, the undulating and the eroded.

Yellow-Gray Silt Loam (234, 434, 934)

Yellow-Gray Silt Loam as shown on the soil map occurs most extensively in the south-central, west-central, and north-central parts of the county. It aggregates a total of about 36 square miles and is by far the most important light-colored or timber soil in the county. The A_1 horizon, or surface, is a brownish gray silt loam and varies from 6 to 8 inches in thickness. The A_2

horizon, or subsurface, varies from 6 to 8 or 10 inches in thickness and is a yellowish gray or grayish brown silt loam. The B horizon, or upper subsoil, varies in compactness, color, and thickness. In the rolling areas it is reddish brown, in the flat areas, drabbish, and on intermediate topography it is pale yellow with gray mottling.

Management.—In the above description of Yellow-Gray Silt Loam no attempt was made to describe the different kinds of Yellow-Gray Silt Loam which occur in Logan county and to point out their correlation with topography. In planning the management of this type, however, attention should be paid to differences in the type, particularly with reference to the subsoil. The rolling areas have a pervious subsoil but because of their topography are subject to erosion. They should be cropped in such a way as to have a vegetative cover on the land as much of the time as possible. The more gentle slopes have a less pervious subsoil but are not subject to serious erosion if reasonable care is taken to control it. The flat areas have a relatively impervious subsoil, tho not so impervious that tile will not draw. Drainage of these flat areas, however, must be effected in part by surface ditches and open furrows. The type as a whole is acid and limestone should be applied. The flat areas are usually more acid than the rolling ones. All phases of the type are low in nitrogen and organic matter. These constituents should be secured by growing clover, preferably sweet clover, and plowing it down in the spring of the second year for corn. No experiment field data are available upon which to base fertilizer recommendations, but it is suggested that one or more of the phosphates be tried, particularly for the wheat crop. See "The Phosphorus Problem," page 32.

Yellow Silt Loam (235, 435, 935)

Yellow Silt Loam is a minor type in Logan county because of its small total acreage, less than 6 square miles, and because of its relatively low agricultural value. The character of this type varies, depending largely on the rapidity of erosion. In places a shallow surface soil has been developed, while in other places the removal of the soil material by erosion is more rapid than the development of the soil horizons.

Management.—Yellow Silt Loam should, for the most part, be used for permanent pasture, orchard, or timber. There are areas having a slope sufficiently gentle to be farmed successfully if care is taken to reduce erosion to the minimum. A very good use to make of the less steep slopes is to seed alfalfa after applying limestone. If the alfalfa is preceded by sweet clover, little difficulty should be encountered in getting a stand.

Yellow-Gray Sandy Loam (464)

Yellow-Gray Sandy Loam is a very minor type in Logan county, totaling less than a hundred acres. It may be handled in the same way as Brown Sandy Loam (see page 17).

Brown Clay Loam (419)

Brown Clay Loam, Upland, is a shallow lake or pond formation. The moisture conditions during its development have been such that the organic matter has decayed without the formation of the black pigments; consequently a brown rather than a black soil has resulted. There are about 250 acres of Brown Clay Loam in the upland in Logan county.

The A_1 horizon, or surface, is about 8 inches thick and is a brown clay loam. The A_2 horizon, or subsurface, extends to a depth of about 19 inches and is a drabbish brown clay loam. The B horizon, or upper subsoil, is a medium compact, medium plastic, brownish drab clay loam. It contains many pale yellow and reddish brown spots. The C horizon, or lower subsoil, is a medium friable, drab and pale yellow clay loam.

Management.—This soil should be handled in the same way as Black Clay Loam, Upland (see page 16). It is a productive soil and, so far as is known, does not contain alkali in harmful amounts.

TERRACE SOILS

Relatively small areas of terrace soils occur in Logan county. These soils were formed in remote times by overloaded and flooded streams which deposited an immense amount of material in the old channels. Later as the streams diminished in size or cut their channels deeper, new bottoms were developed, leaving the old flood plains above overflow, thus forming terraces.

These terrace formations which were built up, for the most part, during and immediately following the Glacial period, were later covered to varying depths with wind-blown material from which the present soils were formed.

Brown Silt Loam Over Sand or Gravel (1527).

Brown Silt Loam Over Sand or Gravel is the most important terrace type in Logan county. It covers a little over 38 square miles and is a productive soil. It is very similar to Brown Silt Loam On Clay, Upland, except in origin. See page 16 for the description of that type and for suggestions regarding its management.

Black Clay Loam Over Sand or Gravel (1520)

Black Clay Loam Over Sand or Gravel occupies a little over 4 square miles in Logan county. It differs in no essential, except in origin, from Black Clay Loam, Upland. See page 16 for a description of that type and for suggestions regarding its management.

Brown Sandy Loam Over Sand or Gravel (1566)

Brown Sandy Loam Over Sand or Gravel is a minor type in Logan county, occupying only one-third of a square mile. It is very similar to Brown Sandy Loam, Upland, except in origin, and the reader is asked to turn to the discussion of that type, page 17.

Yellow-Gray Silt Loam Over Sand or Gravel (1536)

Yellow-Gray Silt Loam Over Sand or Gravel is similar to the flat Yellow-Gray Silt Loam, Upland. The underlying sand or gravel is sufficiently deep not to cause a drouthy condition, and yet its presence improves the underdrainage. Limestone should be supplied and clover grown as is suggested for Yellow-Gray Silt Loam, Upland (page 17).

Brown-Gray Silt Loam On Tight Clay (1528)

Brown-Gray Silt Loam On Tight Clay, Terrace, occurs for the most part along Deer creek northwest of the village of Beason. It occupies a total of 5.72 square miles in Logan county. It is important to note the characteristics of this type carefully, as it resembles Brown Silt Loam, Terrace, very closely in the surface and is often mistaken for it.

The A_1 horizon, or surface, to a depth of 8 or 9 inches is a grayish brown silt loam which may entirely lose its gray cast when moist. The A_2 horizon, or subsurface, is gray silt loam and extends to a depth of 18 or 20 inches. Immediately below the gray subsurface layer or horizon, the plastic, heavily mottled tight clay B horizon, or upper subsoil, is found. This horizon extends to a depth of about 36 inches and rests on a gray, more friable, C horizon. Some areas of this type do not correspond to the above description in that the tight clay horizon is much deeper because of silting in. These deeper areas, while not separated out on the map, are better soil because of the greater depth of the tight clay.

Management.—Brown-Gray Silt Loam, Terrace, varies in its need for lime, some areas showing no acidity at all, while others need 2 to 3 tons of limestone an acre. Before applying limestone, each field should be tested in detail with the assistance of the county farm adviser or the Agricultural Experiment Station. Underdrainage is not effective on this type except on the areas in which the tight clay lies below the depth at which the tile are placed. Surplus water must be removed by open furrows and ditches. Sweet clover grows well on this soil and improves very materially the grain crops that follow it. No fertilizer applications, except manure, are advised for this type until the nitrogen and organic-matter contents of the soil are increased by means of legumes.

SWAMP AND BOTTOM-LAND SOILS

This group includes the bottom lands along the creeks of the county. These bottoms were formed at a time when the creeks carried much more water than they do at the present time. Much of this land is subject to overflow. On the soil map, the Swamp and Bottom-Land Soils are divided into two groups but these groups are combined into one in the following descriptions for the reason explained on page 4.

Deep Brown Silt Loam (1326, 1426)

Deep Brown Silt Loam is a productive soil, easily worked, and where subject to overflow is non-acid. It is a young, immature soil, and has not developed distinct horizons. The surface is a brown to dark brown silt loam, frequently

16 or even 18 inches thick. Below this dark-colored surface, the color gradually assumes a drabbish cast with increasing depth. Often at a depth of 36 to 40 inches it becomes gray, showing a high water table.

Management.—Deep Brown Silt Loam requires no fertilizer treatment other than the plowing down of legumes, particularly on the non-overflow areas, and the use of limestone where acidity has developed.

Black Clay Loam (1320, 1420)

A total of 12 square miles of Black Clay Loam, Bottom, occurs in Logan county. It is found in situations where the rate of flow of the sediment-carrying current was so slow that only fine particles could be carried and deposited. The surface is black clay loam, averaging about 10 inches thick. The subsurface and subsoil are not distinctly developed because of the youth or immaturity of the soil. Below 10 inches the color becomes intensely drab and changes to gray or grayish drab at about 26 inches.

Management.—Black Clay Loam, Bottom, is productive but rather difficult to work because of its fine texture. Fresh organic matter should be plowed down frequently to keep the soil in a workable condition. Limestone is usually not needed.

Brown Clay Loam (1319, 1419)

Brown Clay Loam, Bottom, occurs in the southern part of the county along Lake fork of Salt creek. The reason for its development rather than the development of Black Clay Loam is not clear. The surface soil to a depth of about 12 inches is a brown clay loam. The subsurface and subsoil horizons are not well defined because of the youth of the soil. The subsurface is a drabbih brown clay loam and extends to a depth of about 20 inches. The subsoil is a drab clay loam with reddish brown spots and is medium plastic and compact. No change in the character of the subsoil is apparent within the 40-inch section.

Management.—Brown Clay Loam, Bottom, is a productive soil, easier to work than Black Clay Loam, Bottom, and for the present needs nothing more than the plowing down of fresh organic matter at frequent intervals, together with improvement in drainage.

Mixed Loam (1354, 1454)

Mixed Loam, Bottom, is of alluvial origin and is very diverse in character. It consists of distinct types occurring in such small areas that they cannot be shown on the map and consequently they are all grouped together and called Mixed Loam. The texture of the surface varies from a sandy loam to a clay loam. The subsurface and subsoil vary in the same way as does the surface. There are a little more than 7 square miles of Mixed Loam in this county.

Management.—The diversity of Mixed Loam calls for different tillage methods where the extremes in the type occur. Some areas are so heavy as to require care in working them at the right moisture content, while others are very sandy. The type in general is not acid and needs only fresh organic matter and intelligent tillage.

APPENDIX

EXPLANATIONS FOR INTERPRETING THE SOIL SURVEY

CLASSIFICATION OF SOILS

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

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

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

Horizon. A layer or stratum of soil which differs discernibly from those adjacent in color, texture, structure, chemical composition, or a combination of these characteristics, is called an horizon. In describing a 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 a stratum or zone are discernible, in which case it is subdivided and described under such designations as A_1, and A_2, B_1, and B_2, etc.

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

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

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

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

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

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

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

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

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

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

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

Not infrequently areas are encountered in which type characters are not distinctly developed or in which they show considerable variation. When these variations are considered to have sufficient significance, type separations are made 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 this report in connection with the description of the particular soil types.

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

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

000 *Residual,* soils formed in place thru disintegration of rocks, and also rock outcrop
100 *Unglaciated,* including three areas, the largest being in the south end of the state
200 *Illinoisan moraines,* including the moraines of the 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, cropping, and fertilizer treatment methods which will result in profitable and permanent crop production on the soil type concerned.

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

CROP REQUIREMENTS WITH RESPECT TO PLANT-FOOD MATERIALS

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

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

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

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

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

PLANT-FOOD SUPPLY

Of the elements of plant food, three (carbon, oxygen, and hydrogen) are secured from air and water, and the others from the soil. Nitrogen, one of the elements obtained from the soil by all plants, may also be secured from the air by the class of plants known as legumes, in case the amount liberated from the

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.

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 320 to 4,900 pounds, and the potassium ranges from 1,530 to about 58,000 pounds. Similar variations are found in all of the other essential plant-food elements of the soil.

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

LIBERATION OF PLANT FOOD

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

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

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

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

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

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

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

PERMANENT SOIL IMPROVEMENT

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

The Application of Limestone

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

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

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

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

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

Fineness of Material.—The fineness to which limestone is ground is an important consideration in its use for soil improvement. Experiments indicate that a considerable range in this regard is permissible. Very fine grinding insures

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

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 nitrogeneous and fatty matter from the bones, thus producing a more nearly pure form of calcium phosphate containing about 10 to 12 percent of the element phosphorus.

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

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

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

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

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

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

The Potassium Problem

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

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

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

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

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

The Calcium and Magnesium Problem

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

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

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

The Sulfur Question

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

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

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

Physical Improvement of Soils

In the management of most soil types, one very important matter, aside from proper fertilization, tillage, and drainage, is to keep the soil in good physical condition, or good tilth. The constituent most important for this purpose is organic matter. Organic matter in producing good tilth helps to control washing of soil on rolling land, raises the temperature of drained soil, 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 be corn or oats, it necessarily suffers and if the season is dry, much damage may be done. If the field is put in corn, a poor stand is likely to result, and if put in oats, the soil is so compact as to be unfavorable for their growth. Sometimes the soil is worked when too wet. This also produces a partial puddling which is unfavorable to physical, chemical, and biological processes. The effect becomes worse if cropping has reduced the organic matter below the amount necessary to maintain good tilth.

Systems of Crop Rotations

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

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

Six-Year Rotations

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

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

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

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

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

Five-Year Rotations

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

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

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

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

Four-Year Rotations

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

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

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

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

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

Three-Year Rotations

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

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

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

Two-Year Rotations

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

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

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

SUPPLEMENT: EXPERIMENT FIELD DATA

(Results from Experiment Fields on Soil Types Similar to those Occurring in Logan County)

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

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

Size and Arrangement of Fields

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

Farming Systems

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

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

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

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 MT. MORRIS FIELD

The Mt. Morris experiment field lies mainly on the soil type Light Brown Silt Loam. This field is located in about the center of Ogle county immediately south of the town of Mt. Morris. The experiments on the major series of plots have been under way since 1910.

The somewhat standard rotation and soil treatment methods described above were established on Series 100, 200, 300, and 400. In 1920 a clover hay crop, as well as the seed crop, was harvested from the residues plots. Beginning with

1921 all clover was removed as hay and the return of the oat straw discontinued. In 1922 the return of the wheat straw was discontinued, as well as the applications of limestone until such time as its need should become apparent. In 1923 the rock phosphate applications were evened up to 4 tons an acre and no more will be applied for an indefinite period. A summary of the results is given in Table 7.

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

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

[1]Some clover seed evaluated as hay.

The outstanding results from these records are those produced by the manure treatment. Over 14 bushels of corn, nearly 9 bushels of oats, 4.8 bushels of wheat, and a half ton of clover hay have been the average annual acre increases in crop yields from the manure plots over the corresponding checks. Residues alone have also produced increases in the crop yields altho the effect is much less pronounced than that of manure alone.

Limestone has been profitably used in both the manure and residues systems but the benefit has been greater in the residues system.

The rock phosphate, as usual, has been somewhat more effective used with residues than with manure, but under present market conditions it has thus far not returned its cost, even with residues. However, as noted above, applications of phosphate have been suspended and the residual effect of the accumulated phosphorus in the soil during the years to come will be awaited with interest.

No significant effect is apparent from potassium as used in these experiments.

FIG. 2.—CORN ON THE MT. MORRIS FIELD

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

THE KEWANEE FIELD

The Kewanee field represents in the main the soil type Brown Silt Loam, altho a draw traversing the field in a winding direction contains a narrow streak of a heavier type designated as Black Clay Loam On Drab Clay. The Kewanee field has been in operation since 1915. The crops grown on the main series of plots are wheat, corn, oats, and clover. The arrangement of plots as well as the systems of soil treatment are indicated in Table 8.

The table gives a summary of the crop yields by annual averages, including the years since the complete soil treatments have been in effect. In the lower part of the table the comparisons expressed as crop increases resulting from the respective soil treatments bring out the following points of interest.

Animal manure used alone has had a very beneficial effect, especially with corn, oats, and clover. Residues alone has had little effect on crop yields.

Limestone used in addition to organic manures has effected more or less improvement in all cases except where used with animal manure on the clover.

Phosphorus, as usual, shows up to advantage on the wheat crop, and in the residues system the rock phosphate has produced a profitable return. A fact which these general averages fail to show is that with both limestone and phosphate the effects have been more favorable in recent years than in the earlier years of the experiments.

Altho an increase of 3.3 bushels of corn appears as a result of potassium application, in view of the insignificant response by the other crops the purchase of potassium fertilizer for use in this kind of a cropping system on this kind of soil would appear not to be profitable.

TABLE 8.—KEWANEE FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1917-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Wheat	Corn	Oats	Clover
		8 crops	*10 crops*	*10 crops*	*9 crops*
1	0	30.2	54.4	58.8	(1.65)
2	M	33.0	64.9	69.5	(2.26)
3	ML	35.9	68.8	72.1	(2.26)
4	MLP	40.6	69.7	70.8	(2.33)
5	0	31.4	55.8	59.6	(1.55)
6	R	33.0	57.9	58.0	(1.59)
7	RL	35.1	66.1	62.2	(1.84)
8	RLP	40.6	70.1	67.6	(2.01)
9	RLPK	40.6	73.4	69.3	(2.08)
10	0	29.7	51.0	55.3	(1.53)
	Crop Increases				
	M over 0	2.8	10.5	10.7	(.61)
	R over 0	1.6	2.1	− 1.6	(.04)
	ML over M	2.9	3.9	2.6	(.00)
	RL over R	2.1	8.2	4.2	(.25)
	MLP over ML	4.7	.9	− 1.3	(.07)
	RLP over RL	5.5	4.0	5.4	(.17)
	RLPK over RLP	0.0	3.3	1.7	(.07)

The Phosphate Experiments

In addition to the above described experiments on the Kewanee field, there are four shorter series of plots numbered 500, 600, 700, and 800, each series having four plots. Alfalfa was grown on these series until 1922, when a rotation of wheat, corn, oats, and clover was started. Limestone had been applied to this land at the beginning. The quantity was 4 tons an acre and a similar dressing was applied in 1919. Rock phosphate was applied to Plots 1 and 3 at the annual rate of 400 pounds an acre, once in the rotation ahead of the wheat. Acid phosphate was used on Plots 2 and 4 at the annual rate of 200 pounds an acre, it being applied twice in the rotation, one-half in preparation for wheat, and one-half before oats seeding.

Table 9 gives a summary of the results obtained to date in terms of average annual crop yields and also the corresponding values of the crops figured at average farm prices for the years in which these crops were produced. The relative profits, of course, will depend upon the market prices of the rock phosphate

TABLE 9.—KEWANEE FIELD, SERIES 500, 600, 700, 800: PHOSPHATE EXPERIMENT
Average Annual Acre Yields and Corresponding Money Values, 1922-1926

Soil treatment	Wheat	Corn	Oats	Hay	Value per acre
	5 crops	*5 crops*	*5 crops*	*5 crops*	
Rock phosphate	44.5	74.4	74.6	3.46	$45.63
Acid phosphate	47.3	73.2	77.6	3.39	46.30
Lime, rock phosphate	40.5	71.8	73.0	3.32	43.33
Lime, acid phosphate	48.1	73.1	75.1	3.40	46.32

and acid phosphate. Acid phosphate usually costs about twice as much, ton for ton, as rock phosphate, and in these experiments one-half as much acid phosphate as rock phosphate was used. If, then, it is considered that equal costs are involved, acid phosphate would appear to have been somewhat more profitable than rock phosphate, especially when used with limestone and disregarding any value for the extra amount of the element phosphorus added to the soil in the use of rock phosphate. It should be borne in mind that a change of market prices, either of materials or of produce, might easily alter these results even to the extent of reversing them.

THE BLOOMINGTON FIELD

The experiments on the Bloomington field are of interest in connection with the management of Brown Silt Loam. This field is located in McLean county, northeast of the city of Bloomington. The work was started in 1902. Altho a fairly long period of years has been covered in these experiments, the field has only a single series of plots, so that only one kind of crop is represented each season. The crops employed have been corn, corn, oats, clover, and wheat; and, since 1905, they have been grown in the sequence named.

On account of irregularities in the land, results from Plots 1 and 10 are not considered altogether reliable, and therefore, are not included in the figures presented. Since these are the only unlimed plots, no conclusions can be drawn regarding the action of limestone on this field.

Commercial nitrogen applied in the form of dried blood was used in the early years up to 1905, when crop residues and clover were substituted. The phosphorus on this field has been applied in the form of steamed bone meal and at the rate of 200 pounds an acre a year.

Table 10 presents a summary of the work by annual average yields. The comparisons in the lower part of the table show the effect of the different plant-food materials in the various combinations in which they have been applied.

The residues treatment, supplying organic matter and nitrogen, shows a beneficial effect on the grain crops, but not on the clover. The outstanding feature of the results on the Bloomington field is the effect of phosphorus applied in the form of steamed bone meal. In all of the grain crops on every plot where bone meal has been applied there is a remarkable response to the treatment as shown by the increases in yields. This response appears in all the combinations, even without the presence of residues, altho in combination with either residues or potassium the effect is accentuated. For example, comparing Plot 3 with Plot 6 (limestone and residues with limestone, residues, and phosphorus) we find the phosphorus treatment has produced an average increase in the yield of corn of about 13 bushels an acre, while the yield of oats has been increased by about 20 bushels, and that of wheat by about 22 bushels an acre. Similar increases, tho not so pronounced, appear in comparing Plot 5 with Plot 8 where potassium instead of residues is present.

Thus it appears that on this field, under this system of farming, the lack of phosphorus is distinctly a limiting factor in production and the application

TABLE 10.—BLOOMINGTON FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields of Grain Crops 1902-1923—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn *10 crops*	Oats *4 crops*	Wheat *4 crops*	Clover[1] *3 crops*
2	L	41.5	44.7	24.1	(.80)
3	LR	47.5	46.2	27.9	(.88)
4	LbP	55.8	54.3	45.7	(2.54)
5	LK	46.2	43.5	25.5	(.90)
6	LRbP	60.6	66.0	49.7	(1.19)
7	LRK	48.6	46.8	27.5	(.82)
8	LbPK	60.9	57.2	44.5	(2.44)
9	LRbPK	64.2	63.1	50.4	(.81)
	Crop Increases				
	For Residues				
	LR over L	6.0	1.5	3.8	(.08)
	LRbP over LbP	4.8	11.7	4.0	–(1.35)
	LRK over LK	2.4	3.3	2.0	–(.08)
	LRbPK over LbPK	3.3	5.9	5.9	–(1.63)
	For Phosphorus				
	LbP over L	14.3	9.6	21.6	(1.74)
	LRbP over LR	13.1	19.8	21.8	(.31)
	LbPK over LK	14.7	13.7	19.0	(1.54)
	LRbPK over LRK	15.6	16.3	22.9	–(.01)
	For Potassium				
	LK over L	4.7	– 1.2	1.4	(.10)
	LRK over LR	1.1	.6	– .4	–(.06)
	LbPK over LbP	5.1	2.9	– 1.2	–(.10)
	LRbPK over LRbP	3.6	– 2.9	.7	–(.38)

[1]Two crops of seed on Plots 3, 6, 7, and 9 evaluated as hay.

of this element in the form of steamed bone meal is attended by a high financial profit. It is of extreme interest to know whether a similar response would follow the use of other phosphorus carriers, such as rock phosphate and acid phosphate. Experiments are now under way designed to answer this question, but they have not been running long enough to furnish reliable results at the present time.

Quite different are the results from the use of potassium on this field. The potassium has been applied mainly in the form of potassium sulfate, but in 1917 when this material became unavailable thru war conditions, potassium carbonate was substituted. There is a moderate increase in the corn yield where potassium has been used and particularly where residues are absent. Otherwise, the small gains shown on some plots are offset by losses on other plots, but these small differences are probably well within the limits of experimental error.

THE ALEDO FIELD

An experiment field on Brown Silt Loam On Clay is located in Mercer county just west of Aledo. This field has been in operation since 1910. From its physical aspects this field should be well adapted to experimental work, the land being unusually uniform in topography and in soil profile.

There are two general systems of plots and they are designated as the major and the minor systems.

Experiments on the Major Series

The major system comprizes four series (numbered 100, 200, 300, and 400) made up of 10 plots each. The plots were handled substantially as described above for standard treatment until 1918, when it was planned to harvest the first crop of red clover on the residues plots for hay and to plow down the second crop if no seed were formed. In 1921 the return of the oat straw was discontinued. In 1923 the rotation was changed to corn, corn, oats, and wheat. In this rotation it was planned to seed hubam clover in the oats on all plots, for use as hay or for soil improvement, and common sweet clover in the wheat on the residue plots for use as a green manure. Since this change, no residues except cornstalks and the green manure have been returned to the residues plots. The limestone applications were temporarily abandoned in 1923. No more will be applied until there appears to be a need for them. The phosphate applications were evened up to a total of 4 tons an acre in 1924, and no more will be applied on the west halves of these plots for some time at least.

Table 11 presents a summary of the results showing the average annual yields obtained for the period beginning when complete soil treatment came into sway. The lower section of this table gives comparisons in terms of crop increases intended to indicate the effect of the different fertilizing materials applied.

In looking over these results we may observe first the beneficial effect of animal manure on all crops, but especially marked on the corn. This suggests the advisability of carefully conserving and regularly applying all stable manure produced on the farm. Residues alone have been beneficial for corn but have shown little effect on the other crops of the rotation.

TABLE 11.—ALEDO FIELD: GENERAL SUMMARY OF CROP YIELDS
Average Annual Yields 1912-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Wheat *12 crops*	Corn *19 crops*	Oats *14 crops*	Clover *6 crops*	Soybeans *3 crops*
1	0	30.1	57.2	57.9	(2.21)	(1.60)
2	M	34.5	71.1	64.5	(2.74)	(1.63)
3	ML	34.6	74.3	67.6	(3.12)	(1.60)
4	MLP	36.6	75.6	68.2	(3.05)	(1.61)
5	0	30.8	60.1	59.7	(2.00)	16.1
6	R	31.4	66.5	61.2	(1.91)	16.5
7	RL	33.5	71.9	66.5	(1.96)	18.8
8	RLP	38.0	74.4	68.0	(2.08)	20.3
9	RLPK	37.3	76.0	70.3	(1.73)	20.9
10	0	30.1	58.3	58.1	(2.38)	(1.62)
	Crop Increases					
	M over 0	4.4	13.9	6.6	(.53)	(.03)
	R over 0	.6	6.4	1.5	–(.09)	.4
	ML over M	.1	3.2	3.1	(.38)	–(.03)
	RL over R	2.1	5.4	5.3	(.05)	2.3
	MLP over ML	2.0	1.3	.6	–(.07)	(.01)
	RLP over RL	4.5	2.5	1.5	(.12)	1.5
	RLPK over RLP	– .7	1.6	2.3	–(.35)	.6

Limestone added to the manure treatment produces no very marked effect; when applied with residues, however, the crop increases are considerably greater.

The addition of rock phosphate to the treatment has had very little effect in the manure system. Somewhat more favorable are the results in the residues system, but even here the margin of profit on these crop increases is too narrow to assure the profitable use of rock phosphate applied in the manner of these experiments. However, the economic story has not all been told, for the application of lime and phosphate on these plots is to be discontinued in order to observe the residual effects. The results of the next few years, therefore, will be awaited with great interest.

For the effect of potassium treatment, Plots 8 and 9 may be compared. No significant response appears as the result of applying potassium, so far as these common field crops show.

A number of problems have arisen out of the experience on this and other experiment fields which call for some revision of the investigations described above, and accordingly certain changes are to be made in the future conduct of these plots which are intended especially to throw more light upon the problems of liming and applying phosphorus. (See Soil Report No. 29, Mercer County Soils.)

Experiments on the Minor Series

The so-called minor system of plots (Series 500, 600, 700, 800) on the Aledo field is given over to a comparison of the effectiveness of different carriers of phosphorus.

In this experiment each series contains four plots. Plot 1 receives residues treatment only; Plot 2 receives residues and phosphorus in one of the forms under test; Plot 3 receives residues, limestone, and phosphorus; and Plot 4 is similar to Plot 3 with phosphorus omitted. On one series steamed bone meal (bP) is used as the carrier of phosphorus and is applied at the rate of 200 pounds per acre per year. On another series acid phosphate (aP) is applied at the yearly rate of 333⅓ pounds per acre. On a third series rock phosphate (rP) serves as the source of phosphorus, applied at the rate of 666⅔ pounds per acre yearly, and on the last series, basic slag phosphate (sP) is applied at the rate of 250 pounds per acre yearly.

The yields for all crops harvested on these plots are recorded in Table 12. Table 13, which is derived from Table 12, shows differences in crop yields presumed to have resulted from applying the various forms of phosphatic fertilizers for the eleven crops harvested since the beginning of the applications up to 1926. In computing these comparisons each phosphate plot is compared with its neighboring non-phosphate plot.

Aside from the soybeans, the figures show without exception more or less crop increase on the phosphorus plots, no matter what the form of carrier employed. The difficulty, however, of arriving at a general conclusion regarding the comparative economy in the use of these different phosphorus materials is obvious, for all depends upon their relative cost, which fluctuates from time to

TABLE 12.—ALEDO FIELD: PHOSPHATE EXPERIMENT
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied[1]	1916[2] Corn	1917[2] Oats	1918[2] Soy-beans	1919 Wheat	1920 Corn	1921 Oats	1922 Clover hay	1923 Corn	1924 Corn	1925 Oats	1926 Wheat
501	R	53.4	85.5	18.9	32.4	72.8	48.9	(2.88)	83.5	58.2	63.9	44.0
502	RbP	61.7	91.7	19.0	34.7	86.4	61.9	(3.25)	82.7	66.0	75.0	59.2
503	RLbP	61.5	90.6	23.2	35.6	87.3	53.3	(3.48)	82.5	66.8	73.4	62.0
504	RL	55.1	80.5	22.6	32.9	77.7	47.7	(2.61)	88.2	60.3	64.5	44.6
601	R	55.2	84.7	19.5	33.0	71.2	53.6	(3.17)	84.7	57.3	64.4	43.3
602	RaP	57.8	87.7	18.7	38.3	87.1	60.9	(3.23)	82.5	65.9	76.1	60.6
603	RLaP	64.7	83.4	23.1	38.2	88.1	52.3	(3.53)	77.6	64.7	78.1	64.4
604	RL	51.9	81.7	24.6	32.8	84.9	50.2	(3.06)	84.1	51.9	64.1	47.3
701	R	54.3	83.1	20.8	34.2	75.6	52.8	(3.41)	82.8	61.2	66.6	44.8
702	RrP	58.8	83.3	23.3	36.7	80.4	63.0	(3.60)	87.8	69.3	70.3	59.2
703	RLrP	57.2	81.2	28.1	36.7	80.2	53.3	(3.82)	86.6	70.8	67.8	57.5
704	RL	52.1	81.7	26.9	34.1	82.0	48.9	(3.15)	84.6	62.5	66.3	49.6
801	R	57.6	73.8	18.0	33.7	68.1	54.8	(2.62)	74.3	58.8	45.0	45.8
802	RsP	56.4	87.8	20.6	38.1	81.0	66.2	(3.66)	80.0	69.1	66.3	60.2
803	RLsP	53.3	78.9	23.7	38.4	83.6	57.0	(3.63)	82.0	70.2	66.7	66.0
804	RL	51.8	77.5	21.8	33.3	70.4	59.8	(2.99)	82.6	59.9	53.9	48.2

[1]Bone meal (bP) at the rate of 200 pounds per acre per year. Acid phosphate (aP) at the rate of 333⅓ pounds per acre per year. Rock phosphate (rP) at the rate of 666⅔ pounds per acre per year. Slag phosphate (sP) at the rate of 250 pounds per acre per year. All minerals applied once in the rotation ahead of the wheat crop.
[2]No residues.

time. Furthermore, the prices received from farm produce likewise fluctuate; and to complicate matters still further, these fluctuations do not necessarily run parallel with those of the fertilizer cost. However, one may readily compute for himself the relative economy of producing these crop increases by applying any set of prices for crops and fertilizers which appear to be most applicable according to prevailing market conditions.

For the purpose of furnishing an illustration of such a computation, the following set of arbitrary prices may be assumed as representing approximately average market conditions for the past ten years: wheat, $1.25 per bushel; corn, 75 cents; oats, 45 cents; soybeans, $1.50; and clover, $15 per ton. For the cost of the various phosphatic materials the following estimates are used: bone meal, $40 per ton; acid phosphate, $24; rock phosphate, $12; and slag phosphate, $20. These values seem to be conservative enough. The figures for crop values represent fairly well the average December 1 farm price quotations for the past decade. Furthermore, it may be pointed out that the quantities of phosphatic materials employed in these experiments are, with the possible exception of the slag phosphate, greater than ordinarily would be used, or need to be used, in good farm practice.

The total value of all the crop increases produced by the various forms of phosphate during the eleven years is shown in Table 13, as is also the total cost of the phosphate applied. From these figures are derived the average annual acre profits shown in the last column of the table.

Reckoned on the basis of the above prices, slag phosphate appears to have furnished the most profitable returns of the four phosphorus carriers in the test, producing an average profit of $5.16 an acre yearly where applied without lime-

TABLE 13.—ALEDO FIELD: AVERAGE ANNUAL CROP INCREASES PRODUCED BY THE VARIOUS FORMS OF PHOSPHATE, AND THEIR VALUE, COMPUTED FROM YIELDS IN TABLE 12
Bushels or (tons) per acre

Comparison of treaments	Wheat *2 crops*	Corn *4 crops*	Oats *3 crops*	Clover *1 crop*	Soy-beans *1 crop*	Value of increase *11 crops*	Cost of phos-phates *11 years*	Profit from *11 crops*	Profit per acre per year
Bone meal, residues, *over* residues	8.8	7.2	10.1	(.37)	.1	$62.93	$44.00	$18.93	$1.72
Bone meal, residues, lime, *over* residues, lime	11.0	4.2	8.2	(.87)	.6	65.12	44.00	21.12	1.92
Acid phosphate, residues, *over* residues	11.3	6.2	7.3	(.06)	– .8	56.41	44.00	12.41	1.13
Acid phosphate, residues, lime, *over* residues, lime	11.3	5.6	6.0	(.47)	–1.5	57.95	44.00	13.95	1.27
Rock phosphate, residues, *over* residues	8.5	5.6	4.7	(.19)	2.5	51.00	44.00	7.00	.64
Rock phosphate, residues, lime, *over* residues, lime	5.7	3.4	1.8	(.67)	1.2	38.73	44.00	–5.27	– .48
Slag phosphate, residues, *over* residues	9.3	6.9	15.4	(1.04)	2.6	84.24	27.50	56.74	5.16
Slag phosphate, residues, lime, *over* residues, lime	11.4	6.1	3.8	(.64)	1.9	64.38	27.50	36.88	3.35

stone, and $3.35 where applied with limestone. Bone meal has given an average profit of $1.72 applied without limestone, and $1.92 applied with limestone. Acid phosphate has returned $1.13 used without limestone, and $1.27 used with limestone. Rock phosphate has produced the lowest money returns, giving a profit of 64 cents an acre a year applied without limestone and a loss of 48 cents used with limestone.

No consideration is given here to the relative phosphorus reserves which should have accumulated in the soil. In considering these figures let it be emphasized again that the order of these values might easily be shifted by a relatively small change in commodity prices.

We may next consider the results from the standpoint of limestone, which was applied at the rate of 4 tons an acre to Plots 3 and 4 of the minor series in 1912, when the land was still under alfalfa. Another dressing of 2 tons an acre was added in 1917, after the present experiments were under way. The effect of this limestone, in terms of crop increase, is set forth in Table 14.

Comparing first the crop yields from Plots 1 and 4, which receive no phosphorus, limestone used with residues alone appears to have been of doubtful benefit to all of the crops excepting soybeans. Considering all treatments as a whole, the soybeans exhibit a consistent gain in yield from the use of limestone, while oats, on the other hand, respond by a consistent loss.

In arriving at the financial results for the use of limestone, a charge of $2 a ton for the 6 tons of limestone applied may be made. This makes a total cost of $12 to charge against the value of the total crop increases for the eleven years. Figured in this manner, we find a profit of 31 cents an acre a year for limestone applied without phosphate of any kind. Where limestone was applied with bone meal, the limestone profit was 5 cents an acre a year, and with acid phosphate

TABLE 14.—ALEDO FIELD: AVERAGE ANNUAL CROP INCREASES PRODUCED BY LIMESTONE AND THEIR VALUE, COMPUTED FROM YIELDS IN TABLE 12
Bushels or (tons) per acre

Comparison of treatments	Wheat *2 crops*	Corn *4 crops*	Oats *3 crops*	Clover *1 crop*	Soybeans *1 crop*	Value of increase *11 crops*	Cost of phosphates *11 years*	Profit from *11 crops*	Profit per acre per year
Limestone, residues, *over* residues	1.4	2.0	− .1	−(.07)	4.7	15.36	12.00	3.36	.31
Limestone, residues, bone meal, *over* residues, bone meal	2.8	.3	−3.8	(.23)	4.2	12.52	12.00	.52	.05
Limestone, residues, acid phosphate, *over* residues, acid phosphate	1.9	.5	−3.6	(.30)	4.4	12.49	12.00	.49	.04
Limestone, residues, rock phosphate, *over* residues, rock phosphate	− .9	− .4	−4.8	(.22)	4.8	.57	12.00	−11.43	−1.04
Limestone, residues, slag phosphate, *over* residues, slag phosphate	3.1	.7	− 5.8	−(.03)	3.1	6.22	12.00	− 5.78	− .53

it was 4 cents. Used with rock phosphate, the crop increases were so small that a loss of $1.04 an acre a year was sustained, and with slag phosphate, there was a loss of 53 cents an acre a year.

Considering the small margin of profit and the possible experimental error, it is doubtful whether limestone, used with phosphates in the manner described has, up to the present time, paid its cost on any of these plots. The Aledo field represents one of these borderline cases, so to speak, in which the upper soil is neutral or only slightly acid and the lime requirement, therefore, is not yet very marked. As time goes on, however, and cropping continues, the need of lime may develop. It is planned to discontinue liming on these plots until its need becomes manifest, and in so doing the annual cost of the limestone already applied will become automatically reduced, so that net returns which hitherto have represented a loss may possibly, sooner or later, result in a positive profit.

THE HARTSBURG FIELD

A University soil experiment field representing Black Clay Loam is located in Logan county just east of Hartsburg. This field was established in 1911 and embraces 20 acres. The soil is uniform with the exception of a small area in the northwest part of the field which on the detailed map is identified as of the type Brown Silt Loam On Clay. A thoro system of tile has been installed whereby good drainage has been effected.

The field was laid out into five series of plots, four of which are made up of 10 fifth-acre plots each, and one of which contains 15 fifth-acre plots, as indicated in the diagram (Fig. 3).

The somewhat standard rotation, including alfalfa and the soil treatment methods described on page 39, were established on the five series. Some modifications were made in the order of treatment given the extra five plots on Series 500.

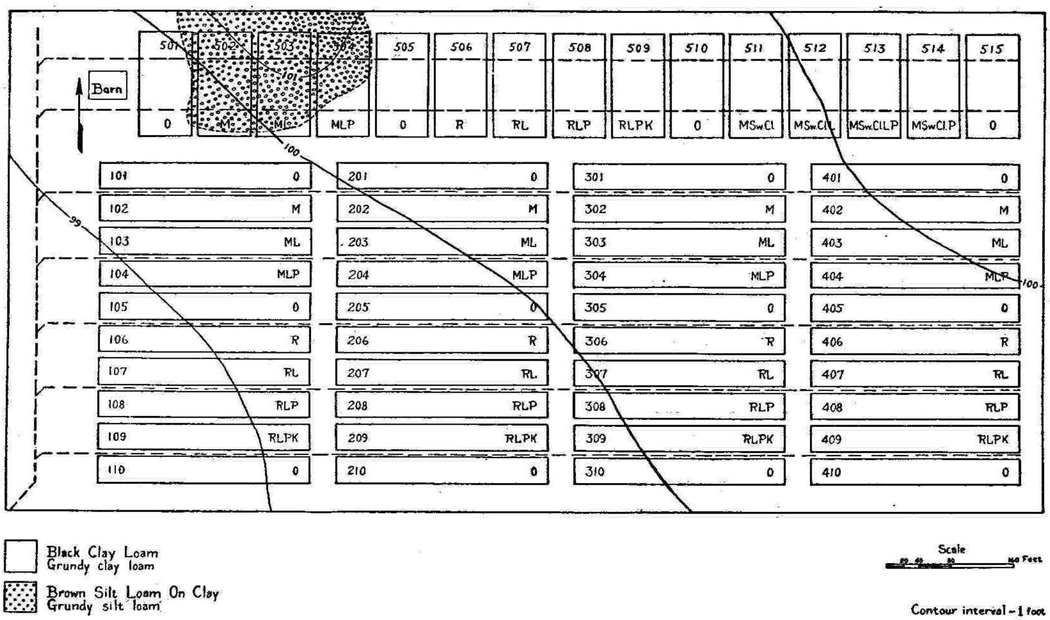

FIG. 3.—DIAGRAM OF THE HARTSBURG SOIL EXPERIMENT FIELD
This diagram shows the arrangement of plots, the soil treatments applied, the location of the different soil types, and by means of contour lines, the natural drainage of this field.

These methods were followed without change until 1918, when it was planned to remove one hay crop and a seed crop of clover from the residues plots. In 1921 it was decided to harvest all the clover as hay. At that time the return of the oat straw was discontinued. In 1922 the return of the wheat straw was discontinued. The only residues plowed under since that time have been the cornstalks, and the green sweet clover before the corn. On this field the sweet clover has grown satisfactorily on the unlimed plots. The application of limestone was also discontinued in 1922 after amounts ranging from 7½ to 10 tons an acre on the different series had been applied, and no more will be added until further need for it becomes apparent. In 1923 the phosphate applications were evened up to 4 tons an acre on all plots, and no more will be applied for an indefinite period. At that time the rotation on Series 100, 200, 300, and 400 was changed to corn, corn, oats, and wheat, with a seeding of hubam clover in the oats on all plots, and a seeding of biennial sweet clover in the wheat on the residues plots. On Series 500 the rotation was changed to corn, oats, wheat, and a mixture of alfalfa and red clover for one year.

Since the Hartsburg field is located in Logan county, a rather complete account of the investigations, including a description of the field and a detailed record of crop yields, is included in this Report. The results of the work described above are given in detail in Table 15, but for convenience in studying them, Table 16 is presented, which gives the average annual yields for the several kinds of crops, including the years since the complete soil treatments have been in effect.

TABLE 15.—HARTSBURG FIELD: ANNUAL CROP YIELDS
Bushels or (tons) per acre

Plot No.	Soil treatment applied	1912 Oats[1]	1913 Clover[3]	1914 Wheat[3]	1915 Corn	1916 Oats	1917 Clover	1918 Wheat	1919 Alfalfa		1920 Alfalfa		1921 Alfalfa	1922 Alfalfa	1923 Corn	1924 Oats	1924 Stubble clover	1925 Wheat	1926 Corn
101	0	39.5	(1.88)	35.9	52.9	62.7	(1.90)	34.0	(1.54)		(3.14)		(3.54)	(4.77)	62.2	80.0	(.83)	33.5	55.2
102	M	30.5	(1.84)	27.9	51.2	59.4	(2.57)	37.3	(1.54)		(2.78)		(3.24)	(4.56)	76.4	85.9	(1.15)	33.3	66.6
103	ML	43.9	(2.03)	36.1	61.9	74.5	(2.51)	39.5	(1.85)		(3.09)		(3.44)	(5.08)	72.0	79.1	(.91)	29.2	68.8
104	MLP	37.2	(1.90)	33.8	64.1	71.2	(2.63)	44.2	(1.90)		(3.82)		(4.19)	(5.37)	76.3	85.3	(1.17)	33.5	74.4
105	0	35.0	2.67	30.2	45.0	53.3	1.75	38.2	(1.82)		(2.44)		(3.21)	(4.63)	72.6	71.3	(.71)	24.8	50.4
106	R	33.0	2.33	30.8	52.1	54.8	2.25	37.3	(1.09)		(3.02)		(3.89)	(5.13)	70.2	71.9	(.75)	31.7	63.6
107	RL	35.3	2.67	32.1	60.5	58.3	2.00	34.1	(1.98)		(3.09)		(3.18)	(5.09)	73.3	64.7	(.68)	23.3	61.6
108	RLP	37.8	2.50	36.0	63.9	60.6	2.50	42.5	(2.92)		(4.17)		(4.17)	(5.59)	72.3	78.8	(.72)	30.5	64.6
109	RLPK	33.0	2.25	36.2	62.7	63.0	2.50	40.5	(2.57)		(4.31)		(4.38)	(5.12)	69.8	78.8	(.80)	33.2	59.2
110	0	31.2	(1.95)	33.7	49.3	56.2	(1.86)	31.4	(1.44)		(2.71)		(3.11)	(4.70)	68.9	78.4	(.75)	30.3	55.4
		Corn[1]	Oats[3]	Soybeans[3]	Wheat[3]	Corn	Oats	Clover	Wheat		Corn		Oats	Clover	Corn	Corn		Oats	Wheat
201	0	32.1	25.5	(1.51)	39.9	32.2	45.6	(3.92)	25.9		48.1		34.8	(2.26)	60.6	53.8		36.3	25.8
202	M	33.4	21.9	(1.90)	41.5	36.0	52.2	(4.03)	24.2		58.3		21.9	(2.52)	69.4	62.4		44.4	27.5
203	ML	45.3	25.6	(1.88)	42.8	45.1	61.1	(4.30)	26.5		63.0		32.7	(2.61)	68.1	72.0		44.1	28.2
204	MLP	38.4	24.1	(1.80)	45.1	41.9	56.6	(4.42)	25.2		61.7		33.0	(2.74)	68.3	62.6		44.4	28.0
205	0	35.0	22.8	22.1	40.7	30.7	42.8	.08	27.4		55.2		30.9	(2.51)	72.6	61.2		42.8	27.0
206	R	36.6	20.5	22.6	40.9	48.2	86.9	1.67	23.2		65.2		30.2	(1.93)	72.5	61.8		44.1	28.8
207	RL	37.0	19.5	21.2	34.3	49.9	78.4	2.17	24.2		67.9		34.2	(1.63)	73.5	60.6		41.3	26.8
208	RLP	40.5	22.3	21.2	39.7	45.2	89.4	1.92	25.8		64.3		36.9	(1.88)	72.5	68.4		42.2	34.0
209	RLPK	38.3	24.8	20.8	41.7	44.2	90.3	2.25	23.8		59.0		39.4	(1.60)	72.1	68.0		42.5	32.8
210	0	39.2	22.3	(1.40)	37.8	31.6	43.1	(3.80)	27.2		47.9		31.6	(2.55)	60.6	55.0		40.6	25.8
		Wheat[2]	Corn	Oats	Soybeans	Wheat	Corn	Oats	Clover		Wheat	Stubble clover	Corn	Oats	Wheat	Corn		Corn	Oats
301	0	......	21.1	25.8	(1.43)	14.4	38.2	33.1	(.69)		19.8	....	48.2	37.0	24.8	40.0		44.0	34.7
302	M	......	21.3	30.9	(1.84)	21.8	48.7	39.8	(.96)		22.0	....	68.0	47.7	39.3	60.0		65.0	46.3
303	ML	......	33.1	36.9	(1.96)	29.0	60.7	53.3	(1.13)		43.1	....	67.3	52.5	42.7	64.0		77.2	49.7
304	MLP	......	30.0	36.9	(2.23)	34.6	63.7	54.1	(1.16)		44.7	....	69.0	52.3	42.5	57.4		71.4	43.4
305	0	......	27.1	33.1	30.8	28.7	43.9	36.6	(.56)	.45	36.5	....	50.1	39.4	32.9	49.0		59.6	43.1
306	R	......	34.2	31.2	28.4	31.5	79.1	63.1	(.59)	.48	37.8	(.42)	60.8	45.8	35.0	68.8		68.6	43.1
307	RL	......	49.5	32.5	30.1	32.7	84.8	58.6	(.43)	.37	34.4	(.68)	63.3	45.9	32.3	73.6		71.4	41.6
308	RLP	......	41.7	36.4	28.2	34.9	85.7	65.3	(.45)	.38	38.2	(.75)	63.1	41.4	34.0	68.0		74.8	42.2
309	RLPK	......	39.5	35.5	28.9	34.5	84.1	59.4	(.38)	.28	37.7	(.65)	63.1	44.7	34.0	76.2		73.8	38.4
310	0	......	26.7	34.5	(2.00)	26.8	49.1	41.9	(.72)		32.2	....	58.3	39.7	30.5	48.8		55.2	36.9

[1]Lime only. [2]Yields not taken. [3]No manure.

TABLE 15.—*Concluded*

Bushels or (tons) per acre

Plot No.	Soil treatment applied	1912 Soy-beans[1]	1913 Wheat[2]	1914 Corn	1915 Oats	1916 Clover	1917 Wheat	1918 Corn	1919 Oats	1920 Soybeans	1921 Wheat	1922 Corn	1923 Oats	1924 Wheat	1925 Corn	1926 Corn
401	0	12.1	26.2	31.3	48.8	(1.40)	19.1	53.2	33.6	(1.15)	19.3	36.2	43.8	17.5	43.8	35.4
402	M	(.99)	24.8	35.0	58.0	(2.07)	31.7	64.0	41.4	(1.45)	22.8	50.1	62.2	26.2	58.0	54.0
403	ML	(1.12)	29.9	46.5	63.1	(2.12)	32.7	70.7	45.5	(1.68)	30.8	58.7	65.8	40.7	66.2	57.2
404	MLP	(1.20)	33.2	39.0	66.2	(2.28)	42.2	71.4	42.8	(1.62)	38.3	57.9	63.1	37.7	65.0	54.2
405	0	15.0	28.7	33.9	46.9	.67	35.8	62.3	36.6	20.8	24.3	40.7	43.8	21.8	50.0	48.8
406	R	17.5	30.6	41.2	51.6	.50	40.3	70.3	42.7	25.1	33.6	41.5	63.6	29.5	79.6	56.8
407	RL	17.3	28.8	43.0	54.2	.75	34.8	71.8	39.2	26.8	31.3	50.3	48.6	36.2	87.8	63.4
408	RLP	17.4	32.1	45.1	53.3	.83	40.8	67.7	40.0	24.1	36.4	48.2	54.7	36.5	88.4	58.0
409	RLPK	17.6	30.9	45.6	52.0	.67	39.7	61.9	37.5	24.0	33.0	51.3	54.4	34.7	82.8	55.0
410	0	16.1	32.4	38.1	50.2	(2.17)	40.7	65.4	40.0	(1.38)	32.4	44.3	48.8	32.2	49.2	47.2
		Alfalfa[3] seeding	Alfalfa[3]	Alfalfa[3]	Alfalfa[3]	Alfalfa[3]	Alfalfa[3]	Alfalfa[3]	Corn[3]	Oats	Clover	Wheat	Corn	Oats	Wheat	Clover-alfalfa
501	0	......	(2.36)	(4.11)	(4.67)	(3.17)	(3.20)	(4.22)	69.9	68.4	(2.12)	40.0	58.0	69.1	33.0	(.61)
502	M	......	(2.89)	(4.23)	(5.20)	(3.66)	(3.84)	(4.76)	72.1	70.0	(2.25)	38.5	66.3	75.8	33.9	(.73)
503	ML	......	(3.20)	(4.51)	(5.35)	(3.85)	(3.65)	(5.11)	74.5	70.8	(2.45)	39.5	68.5	83.4	38.3	(1.10)
504	MLP	......	(3.31)	(4.66)	(5.58)	(3.94)	(4.05)	(5.05)	75.8	73.3	(2.39)	41.3	70.1	82.5	34.8	(1.12)
505	0	......	(1.80)	(3.53)	(4.53)	(3.38)	(3.42)	(4.57)	76.5	57.2	(2.12)	40.7	64.5	65.9	28.3	(.80)
506	R	......	(2.79)	(4.24)	(5.17)	(3.67)	(3.38)	(4.41)	75.6	58.6	(2.84)	40.9	74.3	69.4	34.1	(1.03)
507	RL	......	(2.12)	(3.56)	(4.72)	(3.25)	(3.24)	(4.24)	82.4	62.8	(2.18)	35.2	71.3	70.9	26.2	(1.25)
508	RLP	......	(2.28)	(4.04)	(5.33)	(3.15)	(3.98)	(4.76)	75.5	68.0	(2.37)	39.6	74.6	79.4	29.6	(1.44)
509	RLPK	......	(2.72)	(4.49)	(5.52)	(3.49)	(4.00)	(4.98)	78.8	63.0	(2.18)	40.5	74.3	77.2	30.4	(1.38)
510	0	......	(1.87)	(3.71)	(4.46)	(2.60)	(3.14)	(4.24)	65.1	62.2	(2.27)	37.3	63.8	60.9	26.1	(.78)
511	RM	......	(2.45)	(3.61)	(4.52)	(2.79)	(2.83)	(4.05)	74.2	72.0	(2.22)	37.8	72.4	70.8	30.4	(.82)
512	RML	......	(2.79)	(3.76)	(4.61)	(2.94)	(2.92)	(4.14)	74.3	73.8	(2.15)	36.8	74.7	78.8	30.5	(.99)
513	RMLP	......	(3.71)	(4.63)	(5.03)	(3.36)	(3.45)	(4.57)	68.7	76.7	(2.38)	40.8	66.3	83.9	33.7	(.96)
514	RMP	......	(3.30)	(4.73)	(5.09)	(3.96)	(3.87)	(4.70)	68.0	70.6	(2.67)	41.4	68.2	76.4	29.7	(.00)
515	0	......	(1.79)	(3.92)	(4.19)	(2.81)	(2.39)	(3.20)	59.3	52.2	(1.84)	35.3	51.7	60.2	22.9	(.00)

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

TABLE 16.—HARTSBURG FIELD: SUMMARY OF CROP YIELDS
Average Annual Yields 1913-1926—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Wheat *12 crops*	Corn *19 crops*	Oats *14 crops*	Clover *7 crops*	Soybeans *2 crops*	Alfalfa[1] *11 crops*
1	0	25.6	46.5	46.7	(1.84)	(1.29)	(3.47)
2	M	29.9	57.0	52.6	(2.19)	(1.64)	(3.67)
3	ML	35.0	62.9	58.0	(2.32)	(1.82)	(3.91)
4	MLP	37.2	61.8	57.5	(2.39)	(1.92)	(4.19)
5	0	30.5	52.1	46.0	(1.28)	25.8	(3.33)
6	R	33.6	62.3	54.1	(1.67)	26.8	(3.78)
7	RL	31.0	66.3	52.2	(1.64)	28.4	(3.45)
8	RLP	35.2	65.4	56.3	(1.79)	26.1	(4.04)
9	RLPK	34.6	64.3	55.4	(2.13)	26.4	(4.16)
10	0	31.1	51.6	47.4	(2.02)	(1.69)	(3.20)
	Crop Increases						
	M over 0	4.3	10.5	5.9	(.35)	(.35)	(.20)
	R over 0	3.1	10.2	8.1	(.39)	1.0	(.45)
	ML over M	5.1	5.9	5.4	(.13)	(.18)	(.24)
	RL over R	−2.6	4.0	−1.9	−(.03)	1.6	−(.33)
	MLP over ML	2.2	−1.1	− .5	(.07)	(.10)	(.28)
	RLP over RL	4.2	− .9	4.1	(.15)	−2.3	(.59)
	RLPK over RLP	− .6	−1.1	− .9	(.34)	.3	(.12)

[1]No residues for the first six crops.

The outstanding feature of the results of the Hartsburg field is the large increase in yields produced by organic manures, whether they be in form of crop residues or of stable manure.

The behavior of limestone on this field presents a peculiarity difficult to explain in that limestone has been much more beneficial where applied with animal manure than where used with residues. Used with manure, limestone shows a marked increase in all crops and has given profitable returns on the investment, while in the residues system the effect of this material on several of the crops appears as negative and its use in this system has been attended by a financial loss.

Rock phosphate has found its most effective place in these experiments in the production of wheat and of alfalfa, particularly in the residues system, but its effect on the other crops has been so indifferent that, on the whole, the use of this material has not proved profitable on this field.

The addition of potassium in the combinations here employed has likewise been ineffective.

In 1924 these plots were divided into west and east halves and some new treatments designed to furnish further information regarding the effect of phosphorus fertilizers on this soil were introduced on the east halves. The west halves were continued under the old treatments except that the phosphate applications were discontinued indefinitely after a total of four tons an acre of rock phosphate had been applied. The phosphate applications were likewise suspended on the east half of Plot 9 on all series.

TABLE 17.—HARTSBURG FIELD: SPECIAL PHOSPHATE EXPERIMENTS
Annual Crop Yields—Bushels or (tons) per acre

Serial plot No.	Soil treatment	1924 Series 100 Oats	1924 Series 100 Stubble clover	1924 Series 200 Corn	1924 Series 300 Corn	1924 Series 400 Wheat	1925 Series 100 Wheat	1925 Series 200 Oats	1925 Series 300 Corn	1925 Series 400 Corn	1926 Series 100 Corn	1926 Series 200 Wheat	1926 Series 300 Oats	1926 Series 400 Corn
	West Half-Plots													
1	0	80.0	(.83)	53.8	40.0	17.5	33.5	36.3	44.0	43.8	55.2	25.8	34.7	35.4
2	M	85.9	(1.15)	62.4	60.0	26.2	33.3	44.4	65.0	58.0	66.6	27.5	46.3	54.0
3	ML	79.1	(.91)	72.0	64.0	40.7	29.2	44.1	77.2	66.2	68.8	28.2	49.7	57.2
4	MLrP	85.3	(1.17)	62.6	57.4	37.7	33.5	44.4	71.4	65.0	74.4	28.0	43.4	54.2
5	0	71.3	(.71)	61.2	49.0	21.8	24.8	42.8	59.6	50.0	50.4	27.0	43.1	44.8
6	R	71.9	(.75)	61.8	68.8	29.5	31.7	44.1	68.6	79.6	63.6	28.8	43.1	56.8
7	RL	64.7	(.68)	60.6	73.6	36.2	23.3	41.3	71.4	87.8	61.6	26.8	41.6	63.4
8	RLrP	78.8	(.72)	68.4	68.0	36.5	30.5	42.2	74.8	88.4	64.6	34.0	42.2	58.0
9	RLrPK	78.8	(.80)	68.0	76.2	34.7	33.2	42.5	73.8	82.8	59.2	32.8	38.4	55.0
10	0	78.4	(.75)	55.0	48.8	32.2	30.3	40.6	55.2	49.2	55.4	25.8	36.9	47.2
	East Half-Plots													
1	RL	74.4	(.75)	51.8	40.4	15.8	28.2	41.6	44.6	51.8	63.6	27.7	30.3	35.6
2	MrP	85.3	(1.12)	67.6	56.4	26.8	33.3	46.6	71.8	58.6	72.0	33.7	46.9	52.6
3	MLbP	77.5	(.89)	63.8	64.4	39.3	31.2	49.4	71.4	68.6	69.6	30.0	43.8	54.6
4	MLrP	84.1	(1.38)	67.8	61.6	39.0	36.0	48.4	71.4	64.8	69.2	32.3	45.9	58.8
5	RaP	78.1	(.74)	60.8	44.4	29.8	33.7	49.1	64.4	78.2	71.4	30.2	35.0	37.8
6	RrP	73.8	(.74)	66.8	67.2	45.5	38.7	49.7	69.8	80.2	72.2	34.8	41.3	58.0
7	RLaP	63.8	(.79)	56.8	72.6	39.5	39.8	49.7	81.2	75.4	70.2	34.5	43.8	61.2
8	RLrP	79.8	(.72)	68.0	73.6	43.3	31.5	46.3	70.4	73.0	65.6	33.3	44.4	61.6
9	RLrPK—Gypsum	82.8	(.83)	70.0	76.0	39.8	30.8	45.9	75.8	70.4	56.2	33.5	40.9	63.8
10	RLrP	75.9	(.69)	58.2	46.8	34.3	33.2	42.5	73.6	70.6	65.4	28.3	35.3	47.2

In the new treatments bone meal, acid phosphate, and rock phosphate are being compared in different combinations, as indicated in Table 17. These phosphate fertilizers are applied twice in the rotation, one-half in preparation for the wheat crop and one-half ahead of the first corn crop at the following annual acre-rates: rock phosphate, 500 pounds; acid phosphate, 200 pounds; bone meal, 200 pounds. Gypsum also is being added to Plot 9 at the rate of 200 pounds. Two tons an acre of limestone were given Plots 1–East and 10–East on all series in 1924, more to be added in amounts necessary to maintain good growing conditions for the legumes.

Altho these new experiments have not been under way long enough to warrant an analysis of the results at this time, the yields for the three years are all presented in Table 17 as a matter of record.

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, 1926
33 Saline, 1926
34 Marion, 1926
35 Will, 1926
36 Woodford, 1927
37 Lee, 1927
38 Ogle, 1927
39 Logan, 1927

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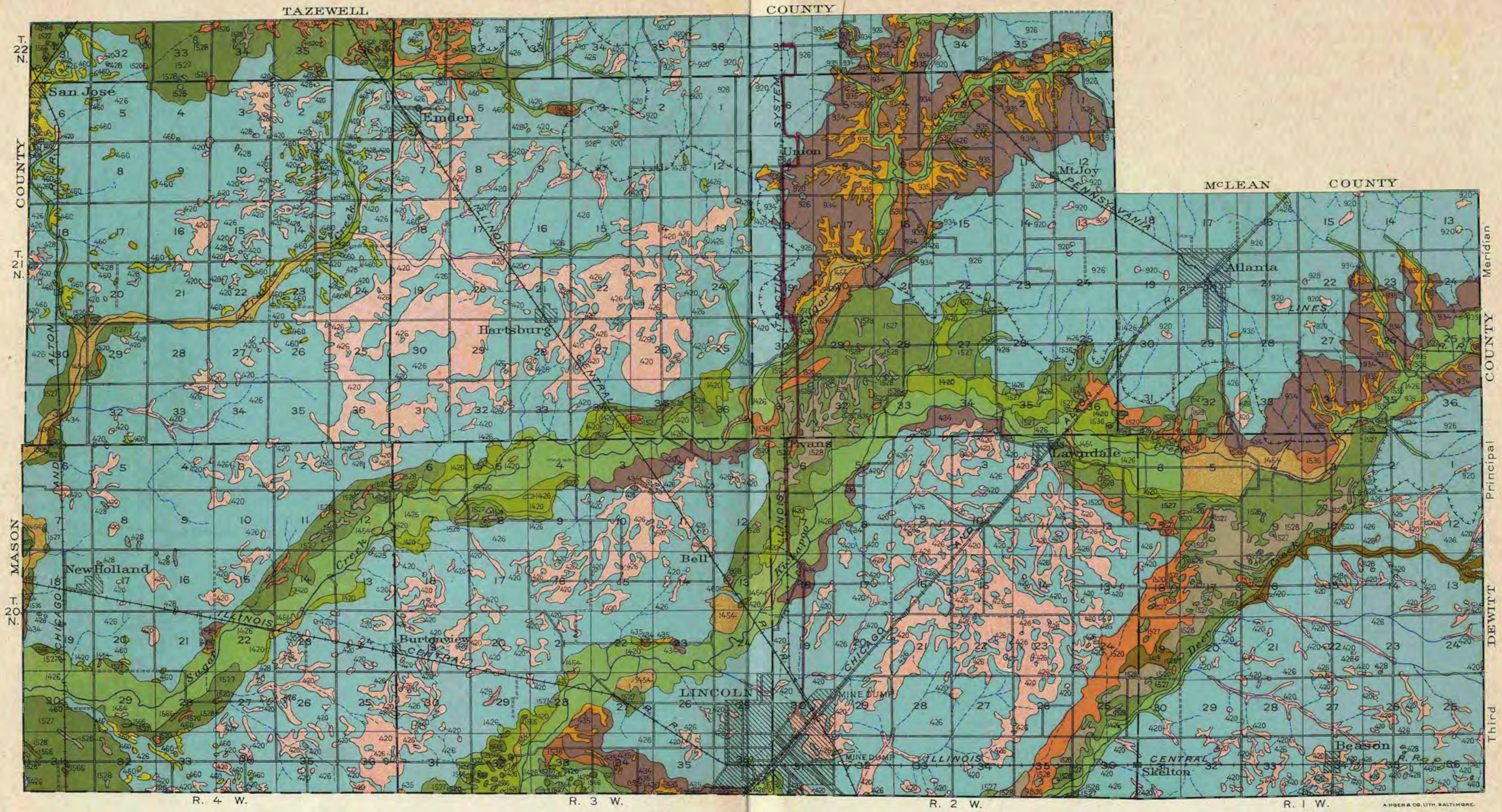


LEGEND

200 Illinoisan Moraines
400 Middle Illinoisan Glaciation
900 Early Wisconsin Moraines

UPLAND PRAIRIE SOILS

- 26 Brown Silt Loam
- 20 Black Clay Loam
- 28 Brown-Gray Silt Loam On Tight Clay
- 60 Brown Sandy Loam

UPLAND TIMBER SOILS

- 34 Yellow-Gray Silt Loam
- 35 Yellow Silt Loam
- 64 Yellow-Gray Sandy Loam
- 19 Brown Clay Loam

1300 OLD SWAMP AND BOTTOM-LAND SOILS

- 1326 Deep Brown Silt Loam
- 1320 Black Clay Loam
- 1319 Brown Clay Loam
- 1354 Mixed Loam

1400 LATE SWAMP AND BOTTOM-LAND SOILS

- 1426 Deep Brown Silt Loam
- 1420 Black Clay Loam
- 1419 Brown Clay Loam
- 1454 Mixed Loam

1500 TERRACE SOILS

- 1527 Brown Silt Loam Over Sand Or Gravel
- 1520 Black Clay Loam Over Sand Or Gravel
- 1566 Brown Sandy Loam Over Sand Or Gravel
- 1536 Yellow-Gray Silt Loam Over Sand Or Gravel
- 1528 Brown-Gray Silt Loam On Tight Clay

RESIDUAL SOILS

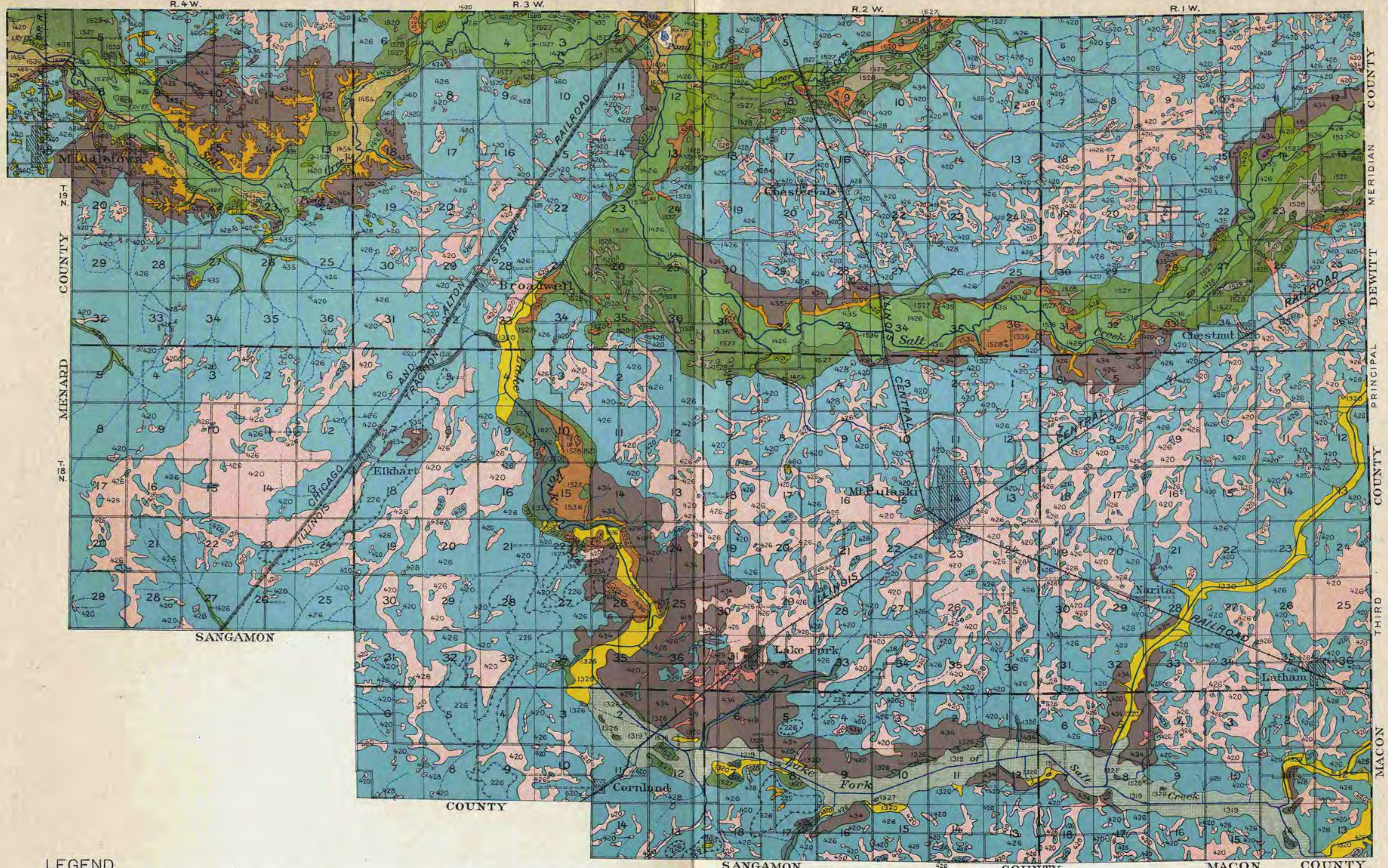
- × Rock Outcrop

CONVENTIONAL SIGNS

- Railroads
- Electric Roads
- Public Roads
- Private Roads
- Morainal Boundaries

Scale: 0 ¼ ½ 1 2 Miles

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



LEGEND

200 Illinoisan Moraines
400 Middle Illinoisan Glaciation
900 Early Wisconsin Moraines

UPLAND PRAIRIE SOILS

- 26 Brown Silt Loam
- 20 Black Clay Loam
- 28 Brown-Gray Silt Loam On Tight Clay
- 60 Brown Sandy Loam

UPLAND TIMBER SOILS

- 34 Yellow-Gray Silt Loam
- 35 Yellow Silt Loam
- 64 Yellow-Gray Sandy Loam
- 19 Brown Clay Loam

1300 OLD SWAMP AND BOTTOM-LAND SOILS

- 1326 Deep Brown Silt Loam
- 1320 Black Clay Loam
- 1319 Brown Clay Loam
- 1354 Mixed Loam

1400 LATE SWAMP AND BOTTOM-LAND SOILS

- 1426 Deep Brown Silt Loam
- 1420 Black Clay Loam
- 1419 Brown Clay Loam
- 1454 Mixed Loam

1500 TERRACE SOILS

- 1527 Brown Silt Loam Over Sand Or Gravel
- 1520 Black Clay Loam Over Sand Or Gravel
- 1560 Brown Sandy Loam Over Sand Or Gravel
- 1536 Yellow-Gray Silt Loam Over Sand Or Gravel
- 1528 Brown-Gray Silt Loam On Tight Clay

RESIDUAL SOILS

- × Rock Outcrop

CONVENTIONAL SIGNS

- Railroads
- Electric Roads
- Public Roads
- Private Roads
- Morainal Boundaries

Scale
0 ¼ ½ 1 2 Miles

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

A. HOEN & CO. LITH. BALTIMORE