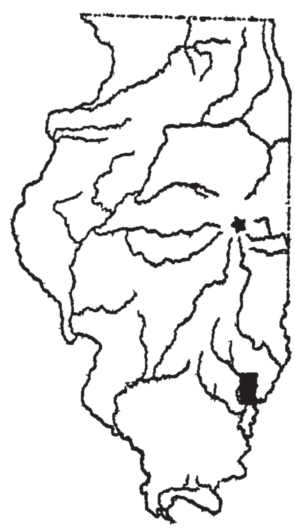
UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

SOIL REPORT No. 46

EDWARDS COUNTY SOILS

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



URBANA, ILLINOIS, JULY, 1930

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

[1]Engaged in Soils Extension as well as in Soil Experiment Fields.

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 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 Edwards county was conducted, and Mr. H. C. Wheeler, who, as leader of the field party, was in direct charge of the mapping.

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SUPPLEMENT

EDWARDS COUNTY SOILS

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

LOCATION AND SETTLEMENT OF EDWARDS COUNTY

EDWARDS COUNTY is located near the Wabash river in southeastern Illinois It is nearly rectangular in shape, measuring 22 miles north and south by about 11 miles east and west. It is one of the smallest counties in the state, comprizing only 218.41 square miles. The population in 1920 was 9,431, more than half of which was rural; there were only four towns with more than 500 and none with over 2,000 inhabitants. Albion is the county seat.

In the section of the state where Edwards county is located no one special type of farming greatly predominates, tho grain farming is probably the most important. The soils of the county are generally light colored and vary from poor and marginal to rich and highly productive. The rainfall, temperature, and growing season are favorable for a wide variety of crops. Markets are readily accessible. Both truck and railroad transportation are well developed. Recently built paved roads, together with secondary gravelled roads, make it possible for every farmer to be within a mile or two of an all-weather road. Educational facilities and social life are considerably above the average of rural development. Farm buildings and equipment indicate moderate prosperity in all but a few communities in the county.

HISTORY OF AGRICULTURAL PRODUCTION

The first settlement in Edwards county was established at Albion in 1818. Some of the early settlers having emigrated from England, it was natural that the early agriculture was patterned after that practiced in England during the forepart of the nineteenth century. The raising and marketing of livestock were the chief agricultural enterprises. Livestock was placed on flatboats which were drifted down Bon Pas creek and Little Wabash river to Wabash river, and thence down to Shawneetown, Paducah, and other marketing points. It is reported that corn sold for 10 cents a bushel and hogs for $1.25 a hundred at Albion in 1820. The early settlers soon realized that the prairie land was better adapted to the growing of small grain and hay than to corn because the weather frequently remained cold and wet into late spring. Wheat soon became an important crop and was the first grain to be shipped from the county

The amount of land in farms increased gradually from 1818 until 1850, at which time 57,000 acres were utilized for farming The increase following 1850 was rapid, and by 1880 almost 90 percent of the total area of the county was turned to farm use. The number of farms increased in correspondence with the increase in total acreage utilized, reaching a peak of about 1,300 near the year 1910. There has been some decline since then, only 1,137 farms being reported in 1925. The size of the farms has remained almost stationary, averaging 101 acres in 1910 and 105 acres in 1925.

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[1] E. A. Norton, Assistant Chief in Soil Survey Mapping; 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.

The percentage of tenantry has never been great in this territory; it has hovered around 20 percent for the past forty years.

The principal crops grown in Edwards county are those common in north-central United States. The following data, taken from the United States Census of Agriculture in 1925, gives the acreage, production, and yield per acre of the more important crops:

Crops	*Acreage*	*Production*	*Yield per acre*
Corn (total acreage)	30,366	......	......
Corn harvested for grain	28,702	852,678 bu.	29.7 bu.
Corn cut for silage	668	4,517 tons	6.7 tons
Corn cut for fodder	619	......	......
Corn hogged off	377	......	......
Wheat, winter	11,694	109,955 bu.	9.4 bu.
Oats, threshed	6,760	188,021 bu.	27.8 bu.
Hay (total acreage)	21,082	20,131 tons	.9 ton
Hay, timothy alone	3,073	......	......
Hay, timothy and clover	1,262	......	......
Hay, clover (red, alsike, and mammoth)	2,340	......	......
Hay, alfalfa	34	......	......
Hay, tame grasses	11,339	......	......
Hay, annual legumes	2,522	......	......

The above Census figures are for but a single year, that of 1924. For the past ten-year period, 1919 to 1928, the U. S. Department of Agriculture and the Illinois Department of Agriculture give the average yields of the four most important crops in Edwards county as: corn, 26.6 bushels an acre; wheat, 12.2 bushels; oats, 20.5 bushels; hay, 1.1 tons. These average yields are somewhat higher than the averages for the surrounding counties but are considerably below the all-state averages. The predominance of the acreage given over to

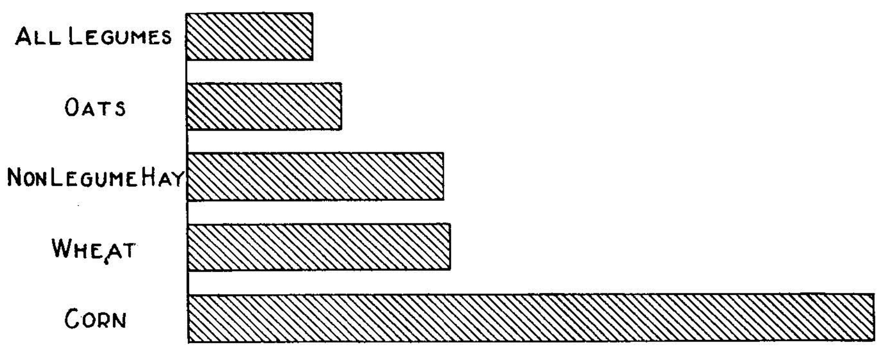

FIG. 1.—RELATIVE ACREAGE OF FIELD CROPS IN EDWARDS COUNTY, 1924

The diagram brings out the small proportion of land devoted to legumes. A well-balanced system for soil improvement demands a much larger acreage of legume crops. (Data from the 1925 Census)

corn, oats, wheat, and tame hay (Fig. 1) indicates that more diversification might well be practiced if production is to keep pace with waning fertility. The legume acreage, according to the Census figures, was less than one-tenth of the total acreage. At least one-fourth of the cropped area should be in legumes every year.

Fruit and vegetable crops are not commercially important in Edwards county. A few orchards have been developed profitably, but practically all the fruit and vegetables raised are consumed locally. A few peaches and apples are trucked out of the county in years of local crop abundance. Good markets are readily accessible both by truck and railroad and undoubtedly special vegetable crops could be grown profitably if produced on a commercial basis.

The character of the livestock interests in the county in 1925 is shown by the following data taken from the Census:

Animals and Animal Products	*Number*	*Value*
Horses	3,993	$213,589
Mules	1,181	81,730
Cattle (total)	7,649	265,595
Dairy cows	2,280	....
Dairy products	......	109,126
Sheep	3,120	30,892
Hogs	14,517	152,793
Chickens and eggs sold	......	446,737
Wool	......	7,103

The total value of the livestock in Edwards county in 1925 was $926,494. No one particular class stands out as most important, and this bears out the statement that farming in the county is not specialized. Fig. 2 shows diagrammatically the relative value of different classes of livestock. In accord-

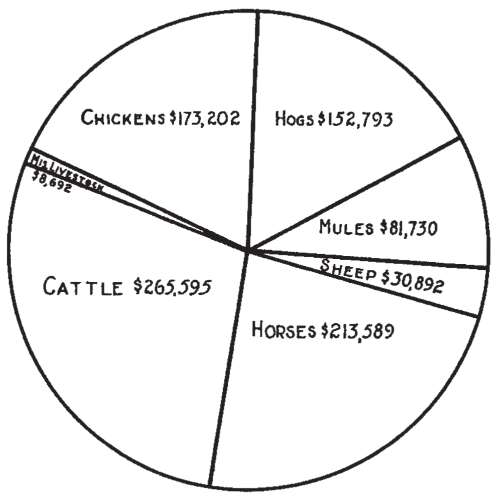

FIG. 2.—RELATIVE VALUE OF DIFFERENT CLASSES OF LIVESTOCK IN EDWARDS COUNTY (Data from the 1925 Census)

ance with estimates made by the U. S. Department of Agriculture and the Illinois Department of Agriculture, little change has taken place in the number of livestock in Edwards county since 1925. The number of horses and cattle has decreased slightly; the number of sheep and hogs has increased.

CLIMATE

The climate of Edwards county is typical of that prevailing in this part of the Mississippi valley. It is characterized by a wide range between the extremes of winter and summer and by an abundant rainfall. The greatest range in temperature for any one year of a thirty-two-year period, as recorded at the weather station located in Albion from 1897 to 1918 and in Fairfield from 1918 to 1929, was 123 degrees in 1899. The highest temperature was 108° in 1914; the lowest, 21° below zero in 1899. The average date of the last killing frost in the spring is April 15; the earliest in autumn is October 22. The average length of growing season is 190 days, which is ample time to mature all the common crops grown in the region. Occasionally early frosts produce soft corn in backward seasons or in seasons following a very wet spring. Winter wheat is often injured, particularly on flat ground, owing to a sudden drop in temperature following a rainy period in winter or early spring. Hot early summer weather often cuts the yield of spring-sown small grain. A prolonged period of hot weather, coupled with drouth, frequently reduces the yield of corn.

The prevailing wind in spring and summer blows from the south; in winter it comes from the northwest. Spring winds are usually brisk and summer winds mild except before thunder showers. A series of strong northwesterly gales bringing cold waves, which are followed by periods of relative calm, characterize the winter winds. Edwards county lies within the region subject to tornadoes but none resulting in serious destruction are known to have visited the area.

The average annual rainfall, as recorded at Albion and Fairfield for the last thirty-two years, is 41.53 inches. The rainfall during the growing season thru this period averaged 22.72 inches. The wettest year on record, 1898, had a total rainfall of 55.09 inches; the driest year, 1924, had 31.43 inches. For the wettest and driest months respectively, the records show that March, 1898, had a total rainfall of 12.39 inches, while October, 1908, had only a trace. Some of the yearly precipitation falls as snow in the winter months. The records show a yearly average of 16 inches of snow. Sleet storms are not uncommon. Occasionally hail storms occur in late spring and summer, but damage as a result of them is usually local.

The data in Fig. 3 taken by themselves would indicate that the rainfall in Edwards county is well distributed and that serious drouths were not to be expected. Average monthly precipitation, however, is not the sole index to moisture conditions; at least six other factors are important. These are: type of soil, rate at which rain falls, lapse of time in days between precipitation periods, temperature, wind, and kind of crops grown. The upland soils in Edwards county are of such nature that water moves thru them either freely or else very slowly, and a period of about twenty days without precipitation during the hot summer months reduces the moisture in the soil to a minimum for plant growth. Records show that every few years periods of twenty days or more elapse without enough rainfall for crop needs. A few serious drouths have been experienced. Crops such as corn, meadows, and pastures, which have a heavy moisture demand in July and August, are most seriously affected.

The rate at which rain falls has an important bearing not only on the amount of moisture that becomes available to plants but also on soil erosion. No records on the rate of rainfall are available, but much of the water which

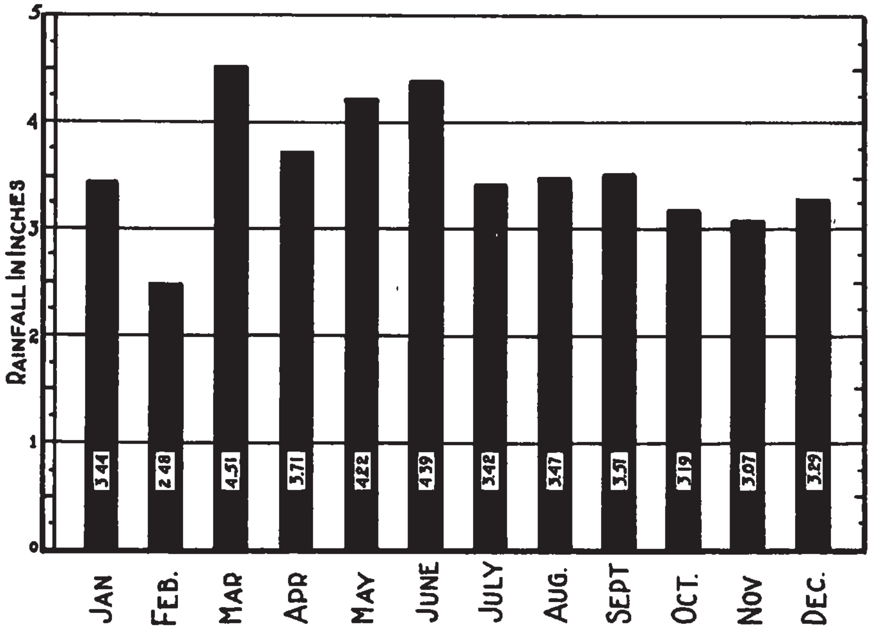

FIG. 3.—AVERAGE MONTHLY DISTRIBUTION OF RAINFALL IN EDWARDS COUNTY

falls, both from prolonged spring rains and from hard, dashing thunder showers in summer, is more destructive than beneficial. Several such rains occur in the county nearly every year. They make the control of erosion on cultivated areas, particularly on rolling land, a serious problem. Equally as important as the loss from erosion is the loss from overflow on the flat bottom lands. Losses from these two agents of destruction were particularly noticeable during the wet years of 1927 and 1928.

PHYSIOGRAPHY AND DRAINAGE

The general elevation of Edwards county is between 400 and 540 feet above sea level. The remnants of the former flat plain in the northern part of the county stand at an elevation of slightly over 500 feet. Most of the bottom land lies at an elevation slightly below 400 feet, giving a general relief of somewhat more than 100 feet. The north half of the county is badly cut up by numerous steep gullies which have forced their way back into the once flat upland. All that remain of this original plain are a few disconnected level tracts, most of which are included in an area that appears as a ridge one to two miles wide running in a northeast-southwest direction thru the northern part of the county. The central and southern parts of the county are made up of a series of ridges and irregular upland areas separated by broad, flat bottom lands. The slopes of these ridges are smoother than those of the gullied country to the north. The altitudes of a few towns in Edwards county are as follows: Albion, 531 feet above sea level; Browns, 403; Grayville, 397 (bottom land); West Salem, 508. The altitude at the point of the entrance of Bon Pas creek into Wabash river is 380 feet above sea level.

Natural drainage in Edwards county is well established. Bon Pas creek and Little Wabash river, which flow south along the eastern and western borders of the county, drain most of the area. A few sections in the southeast corner of the county drain directly into Wabash river. Fig. 4 shows the stream courses and other physiographic features of the county. All the up-

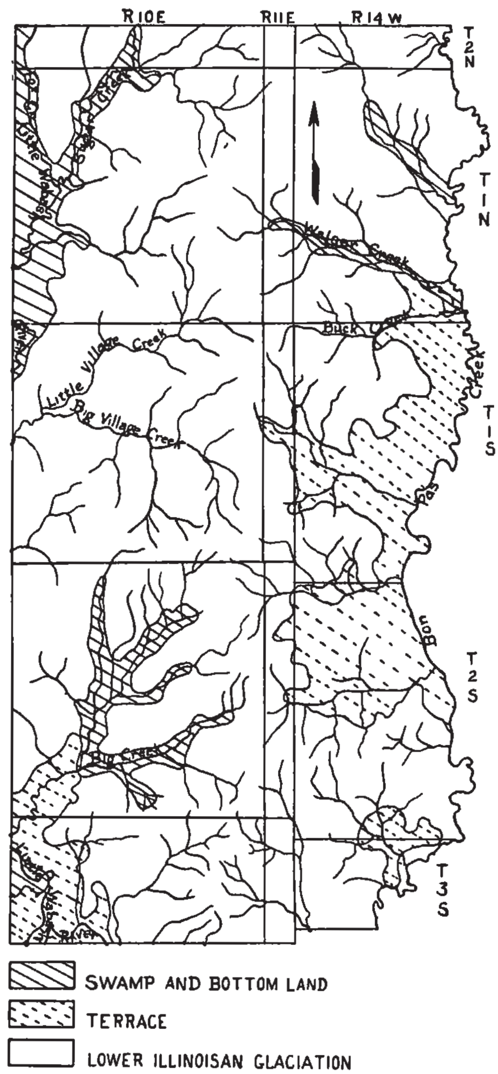

FIG. 4.—DRAINAGE MAP OF EDWARDS COUNTY SHOWING STREAM COURSES AND OTHER PHYSIOGRAPHIC FEATURES

land except a few flat areas lying on the original plain in the northern part of the county are well drained. The lowlands along Bon Pas creek drain well except in time of high water when there is no outlet to Wabash river. The lowlands along Little Wabash river remain wet late into early summer and overflow following every heavy rain.

The soils in the county as a whole are well drained, primarily because they lie on rolling surfaces. The problem on these rolling surfaces is not to provide drainage but to protect the soil from erosion. The flat upland areas have a sticky, plastic subsoil which makes underdrainage impossible. Surface-ditching must be provided in these areas. The lowland soils can be artificially drained provided an outlet can be obtained. Dredging, ditching, and tiling are the methods to employ in procuring better drainage in the bottom-land soils.

SOIL FORMATION

The few remaining nearly-level upland tracts in northern Edwards county indicate that this area was formerly a part of that unusually flat plain which stretches across central-southern Illinois. Erosion has dissected that part of the plain in Edwards county, forming numerous gullies and small bottom lands. The soils developed on these flat upland surfaces are gray in color, have compact, plastic, almost impervious subsoils, and are not highly productive. The remaining ridges and generally uneven upland terrain in the central and southern parts of the county indicate that this area was not originally flat but was rolling. The soils developed on these rolling surfaces are yellowish in color, friable, and moderately productive. Such a contrast in topography and soil development in adjacent areas can be explained only by recounting some of the events of earlier earth history.

ORIGIN OF TOPOGRAPHY AND SOIL MATERIAL

The bedrock which serves as a foundation for the loose surface mantle covering the country was formed during a remote period in geological time. The name Carboniferous is assigned to this period because its formations include many important coal-bearing strata. During Carboniferous times the land was submerged and a shallow sea extended over much of the territory now known as central United States. Existing in this sea were enormous swamps, the vegetation of which was periodically buried by an avalanche of sediment. Gravel, sand, silt, and clay were swept down into the sea during flood periods. This covering of sediment excluded air and pressed heavily on the buried vegetable material, causing the transformation of this material into coal. Altho the coal beds are of great commercial importance, their total thicknesses are insignificant in comparison with the enormous thicknesses of shale and sandstone formed from the sediments deposited during this period. Thin seams of limestone were formed locally during relatively brief intervals when the water in the sea became deeper. All these formations outcrop in Edwards county but most of the immediate bedrock surface consists of shale and sandstone.

With the general withdrawal of the sea and the emergence of the land the Carboniferous period came to a close. The elevation of the land above the sea exposed the rock surfaces to weathering and erosion. For an extended period—that is, for thousands upon thousands of years—rock destruction and removal went on ceaselessly until the country became rough and broken, cut by numerous gullies and stream valleys. The hilly land thus produced was very different from the present land surface and entirely unsuited to farming. A change in regional climate closed this cycle of erosion and ushered in another geological period. During this period the material that later formed the mineral portion of the present soil was deposited.

The climate during this geological period, known as the Glacial epoch. was cooler than at present. Snow and ice collected in regions to the north in such amounts that the mass pushed outward from these centers of accumulation. Moving chiefly southward, these great masses of ice known as glaciers pushed across the country until they reached a place where the climate was warm enough to melt the ice as rapidly as it advanced. In this movement the ice gathered up all sorts and sizes of materials, including clay sand, gravel, boulders, and even immense masses of rock. Some of these materials were carried hundreds of miles and rubbed against surface rocks and each other until largely ground into powder. When a glacier reached the limit of its advance the rock material carried by it accumulated along the front in a broad, undulating ridge, or moraine. With rapid melting the glacier receded and the material was deposited somewhat irregularly over the surface previously covered. Each advance and retreat leveled off ridges, hills, and high land, and filled in valleys. The mixture of materials deposited by the glacier is known as glacial drift, a term frequently referred to in describing soil types.

At least six great ice sheets moved southward, each of which covered a part of North America, altho the same parts were not covered during each advance. The movements of these individual ice sheets were separated by long periods of time during which the climate became so warm that the country was clothed with vegetation. At least one of the glaciers, known as the Illinoian, reached Edwards county. The Illinoian glaciation completely covered the county and buried or destroyed the deposits which might have been left by an earlier ice sheet. The deposits left by the Illinoian were a heterogeneous gravelly mass of drift, varying in thickness from a few feet on the old ridges to a hundred feet or more in the valleys. The northern part of Edwards county was leveled off to a flat plain, but the deposits in the central and southern parts were not thick enough to hide completely the previous topography, altho it was made much smoother than it was before glaciation.

Associated with the withdrawal of an ice sheet and the exposure of the deposited material to weathering forces was the accumulation of a silty, wind-blown material on top of the glacial drift. This wind-blown material is called loess. It was derived largely from the sediment deposited from the immense volumes of water which flowed from the melting ice sheet. This water filled the drainage channels and overflowed adjacent lowlands. Following each flood state the water would recede and the sediment deposited would dry and be picked up by the wind and redeposited on the upland as dust. Undoubtedly some fine material was also left on the surface directly by the receding glacier and more accumulated as weathering broke down the larger particles. When dry this was also blown about by the wind, collecting chiefly on the south side of ridges and other obstructions. The lack of vegetation on the land surface at this time gave the wind much more force near the earth's surface than it otherwise would have had.

Most of the loess deposited over Edwards county came from the Wabash river valley, as indicated by a thinning out of the material in all directions away from the bottom land. Local deposits, particularly along Little Wabash river, signify that the smaller stream valleys furnished some of this material. The thickness of the loess deposit over Edwards county varies from a few inches in the northern part to eight or ten feet on the bluffs along Wabash river. Altho none of the ice sheets following the Illinoian actually touched Edwards county, they furnished sediment to the Wabash river valley, which was blown over the upland as loess. Some loess accumulation took place following the Iowan glaciation but it was not widespread. The material deposited following the Wisconsin glaciation was confined to a very narrow belt along Wabash river. The difference in age of loess deposition explains in part the variation in soil productivity in Edwards county.

Erosion was continually active thruout the entire Glacial period except for the time that ice actually covered the land surface. Enough time has elapsed since the recession of the Illinoian glacier so that the region has been again reduced to a somewhat hilly topography. Only small tracts of the original surface remain. The large, flat valleys in the southern half of the county indicate that erosion has made rapid progress in tearing down the upland, while the narrow bottom lands and steep gullies in the northern part indicate a younger stage of topographic development.

SOIL DEVELOPMENT

Many processes have acted upon the original material deposited as loess or drift to work it over into the soils 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 forces form soil out of this parent material. The manner in which these forces act depends upon the environmental factors such as climate, topography, drainage, vegetation, and biological agencies. The environmental factors in addition to the parent material determine soil characteristics.

A most important process in soil development is oxidation. It occurs when the soil material is exposed to the air, and it proceeds with great rapidity when conditions are favorable. Leaching is another fairly rapid soil-forming process. Water in contact with the soil material dissolves certain substances, some of which react chemically upon one another and thru the leaching process they are translocated from one depth to another or else are washed away. Lime is one of the readily soluble compounds and its continuous loss finally causes soil acidity to develop. Finely divided particles in suspension are also carried down by the water, and under certain circumstances they accumulate in the subsoil to such an extent as to form an almost impervious stratum. Such a layer impedes moisture movement both downward and upward, and the result is a poorly drained soil in wet seasons and a drouthy soil in dry seasons.

Alternate wetting and drying, freezing and thawing, and other climatic changes also influence the development of soil. The decay of vegetable material and its incorporation into a soil produces a dark color and adds nutrient material, particularly nitrogen.

One of the most pronounced characteristics produced by weathering is the arrangement of the soil into layers, or zones. Differences in the arrangement, thickness, and characteristics of these zones constitute one of the chief characteristics for separating soils into types.

In studying soil types, as many readily observable characteristics as possible are examined. Some of these characteristics have an important bearing upon productivity; others may have no known practical relation whatsoever, but may be useful in identifying types. The size of the individual soil particles and the amount of organic matter in the soil largely determine the ease with which it may be cultivated. The character of the subsoil determines underdrainage. Young soils are usually more productive than old or mature soils because they have not been so thoroly leached of their readily available plantfood materials. The age of the soil frequently determines its reaction, whether acid, neutral, or alkaline. Soil color influences soil temperature, an important factor in the germination of seeds sown in spring.

In describing a soil the characteristics of the individual strata that make up the soil profile are considered. For practical purposes these various layers, or zones, in the soil can be grouped into surface, subsurface, and subsoil. Each of these may have two or more subdivisions. The surface layer is the upper 3 to 10 inches. This is the part of the soil that is cultivated and in which most of the plant roots are found. The subsurface layer, lying immediately below the surface, is usually lighter in color. The subsoil generally begins at depths of 12 to 24 inches; it has two important divisions. The upper subsoil is more compact and plastic than any other soil layer. It varies from a slightly compact and plastic consistence in soils developed under good drainage to an extreme compactness and plasticity in soils developed under poor drainage, becoming in some soils almost impervious to water. The lower subsoil is more friable than the upper subsoil, and is usually grayish yellow in color. It begins at 25 to 60 inches.

Soils in bottom lands or in areas subject to overflow, including some of the low-lying upland, and those on steep slopes show little or no development into surface, subsurface, and subsoil. The continued deposition on overflow land and the removal of material on steep slopes proceed too rapidly to allow layers to develop. The surface layer on overflow land is often rather thick, and that on steep slopes is likely to be thin or it may be entirely absent.

SOIL GROUPS

The accompanying colored map gives the location and boundary of each soil type and indicates the position of streams, roads, railroads, and towns. The list of soil types, the area of each in square miles and in acres, and also the percentage of the total area as recorded on the map are shown in Table I. The soil types are arranged into groups in accordance with the geological province in which they are located, the upland soils being further separated on the basis of original vegetative cover. These groups are as follows:

Upland Prairie Soils, including the upland soils which have developed under a dominant grassland vegetation.

TABLE 1.—SOIL TYPES OF EDWARDS COUNTY, ILLINOIS

Soil type No.	Name of type	Area in square miles	Area in acres	Percent of total area
	Upland Prairie Soils			
330	Gray Silt Loam On Tight Clay[1]	11.07	7 085	5.07
	Upland Timber Soils			
334	Yellow-Gray Silt Loam[1]	83.74	53 594	38.34
335	Yellow Silt Loam[1]	53.81	34 438	24.64
332	Light Gray Silt Loam On Tight Clay	1.52	973	.70
344	Yellow-Gray Fine Sandy Silt Loam	1.67	1 069	.77
345	Yellow Fine Sandy Silt Loam	1.86	1 190	.85
365	Yellow Sandy Loam	.10	64	.05
		142.70	91 328	65.35
	Terrace Soils			
1531	Deep Gray Silt Loam	9.74	6 234	4.46
1534.1	Yellow-Gray Silt Loam On Clay	8.02	5 133	3.67
1521	Drab Clay Loam[1]	7.71	4 934	3.53
1526.1	Brown Silt Loam On Clay	3.13	2 003	1.43
1564	Yellow-Gray Sandy Loam	.62	397	.28
1560	Brown Sandy Loam	.50	320	.23
1560.6	Light Brown Sandy Loam	.16	102	.07
		29.88	19 123	13.67
	Swamp and Bottom-Land Soils			
1331	Deep Gray Silt Loam	27.09	17 338	12.40
1354	Mixed Loam	7.08	4 531	3.24
1337	Yellow-Brown Silt Loam	.59	377	.27
		34.76	22 246	15.91
	Total	218.41	139 782	100.00

[1]This is the name under which the type was mapped. Later investigation has shown the desirability of making certain differentiations within the type; these are discussed under "Description of Individual Soil Types," beginning on page 19.

Upland Timber Soils, including nearly all the upland areas that are now, or were formerly, covered with forests.

Terrace Soils, including soils originally developed from material deposited by flowing water but which are now not subject to frequent overflow.

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

Extensive field and laboratory study of soils has materially increased the knowledge of their characteristics since the time Edwards county was mapped. Thus the gradual accumulation of many new facts has made it possible to recognize, classify, and map soils upon a somewhat more comprehensive basis than formerly. A soil map of the county made at the present time would differ from the map presented here chiefly in showing a few more soil types, each having distinct characteristics and differing from one another in agricultural value as well as in treatment and fertilizer requirement. Several types, particularly Yellow-Gray Silt Loam, would now be divided into two or more types.

An inspection of the soils of this county was made just prior to the publication of this report, and in the section in which descriptions of the individual soil types are given (pages 19 to 33) the necessary modifications are described and discussed in such a way that it should not be difficult to recognize each new type in the field even tho it is not differentiated on the map.

For explanations concerning the classification of soils and further interpretation of the map and tables, the reader is referred to the first part of the Appendix, pages 34 to 36.

INVOICE OF THE ELEMENTS OF PLANT FOOD IN EDWARDS COUNTY SOILS

Three Depths Represented by Soil Samples

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

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

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

For convenience in making application of the chemical analyses, the results presented in Tables 2, 3, and 4 are given in terms of pounds per acre. It is a simple matter to convert these figures to a percentage basis in case one desires to consider the information in that form. In comparing the different strata, it must be kept in mind that the composition of each is based on different quantities of soil, as indicated above. The figures for the middle and lower strata must be divided by two and three respectively before being compared with each other or with the figures for the upper stratum.

Wide Range in Organic Matter and Nitrogen

None of the soils in Edwards county contain very large amounts of organic matter and nitrogen. In fact the general deficiency of these constituents makes it particularly important that their increase be given first consideration in planning to care for the fertility of the soil. The rolling topography prevailing over much of the county contributes to the loss of much surface soil by erosion, and it is the surface soil where the greatest accumulation of organic matter and nitrogen occurs. The analytical results thus tend to emphasize the need of preventive measures against erosion from the standpoint of saving the organic matter now present in the soil and that accumulated thru improved farm practices.

Without exception, the sandy types are among the lowest in the county in their content of organic matter and nitrogen. The decay of organic matter within the soil is essentially an oxidation process, the rate of which depends largely upon the air supply with which the organic matter comes into contact. Sandy soils being extremely well aerated are generally low in organic matter. Moreover it is a difficult problem to maintain organic matter in them. With them more than with any other type frequent plowing down of green manures and crop residues is needed unless stock-feeding operations make an abundant supply of farm manure obtainable.

The rapid decrease in organic matter and nitrogen in the lower levels of the soil may be observed by comparing Tables 3 and 4 with Table 2 after

TABLE 2.—EDWARDS COUNTY SOILS: PLANT-FOOD ELEMENTS IN 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 (300)							
330	Gray Silt Loam On Tight Clay	27 660	2 840	810	470	22 720	4 490	4 510
	Upland Timber Soils (300)							
334	Yellow-Gray Silt Loam.......	29 720	2 880	970	400	27 380	4 610	5 210
335	Yellow Silt Loam.............	18 210	1 740	620	360	31 890	5 470	4 700
332	Light Gray Silt Loam On Tight Clay...............	19 520	2 020	620	300	21 300	4 100	4 400
344	Yellow-Gray Fine Sandy Silt Loam....................	16 360	1 540	660	300	33 600	4 320	5 200
345	Yellow Fine Sandy Silt Loam..	15 300	1 620	740	380	34 160	6 900	5 420
365	Yellow Sandy Loam..........	9 160	1 060	700	260	28 840	6 820	9 320
	Terrace Soils (1500)							
1531	Deep Gray Silt Loam.........	24 820	2 560	900	420	30 720	6 120	5 080
1534.1	Yellow-Gray Silt Loam On Clay......................	25 060	2 200	1 020	380	30 140	5 200	5 400
1521	Drab Clay Loam.............	42 210	3 660	1 090	610	37 200	13 870	15 050
1526.1	Brown Silt Loam On Clay.....	37 360	3 260	800	480	32 080	6 340	10 780
1564	Yellow-Gray Sandy Loam.....	19 040	1 740	960	280	29 400	6 960	10 740
1560	Brown Sandy Loam...........	32 200	2 900	680	240	28 620	5 400	10 400
1560.6	Light Brown Sandy Loam.....	16 900	1 480	860	240	28 540	5 220	13 100
	Swamp and Bottom-Land Soils (1300)							
1331	Deep Gray Silt Loam.........	25 030	2 500	1 200	530	31 530	6 400	5 830
1354	Mixed Loam[1]................	....	....	....	....	....	....	....
1337	Yellow-Brown Silt Loam......	20 340	1 940	1 040	380	36 580	11 480	13 240

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 general 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]The results of chemical analyses of Mixed Loam are not included on account of the heterogeneous character of this type.

correcting for the different thicknesses of the strata sampled, as explained on page 12. For example, Gray Silt Loam On Tight Clay, the first type listed, contains 27,660 pounds of organic carbon per 2 million of surface soil. In the second stratum the organic carbon content falls to 15,670 pounds per 2 million pounds of soil (one-half the value given in Table 3), while the lower stratum contains only 6,570 pounds per 2 million of soil (dividing by 3).

Phosphorus Content Generally Low

While some variation is to be observed in the total phosphorus content of the various soil types in Edwards county, the amounts present are in general rather low. This should not be taken to mean that phosphate fertilizers will necessarily bring good response at the present time but it does indicate that phosphate application may be expected to become necessary with continued cropping.

A convenient chemical test for use in the field has been recently devised at the Illinois Experiment Station which indicates the presence of available phosphorus in the soil and hence the relative need for phosphate treatment. Information concerning this test is furnished in Bulletin 337.

TABLE 3.—EDWARDS COUNTY SOILS: PLANT-FOOD ELEMENTS IN 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 (300)							
330	Gray Silt Loam On Tight Clay	31 340	3 580	1 380	680	50 600	14 720	8 440
	Upland Timber Soils (300)							
334	Yellow-Gray Silt Loam........	25 510	3 010	1 520	540	58 360	14 860	8 060
335	Yellow Silt Loam............	14 740	1 960	1 240	480	63 120	17 820	6 600
332	Light Gray Silt Loam On Tight Clay..............	23 520	2 520	1 040	400	42 880	7 760	8 080
344	Yellow-Gray Fine Sandy Silt Loam....................	13 520	1 040	1 520	420	68 000	17 320	10 440
345	Yellow Fine Sandy Silt Loam..	11 560	1 720	1 840	440	71 560	20 920	11 160
365	Yellow Sandy Loam..........	7 120	1 000	1 360	120	59 520	7 480	26 240
	Terrace Soils (1500)							
1531	Deep Gray Silt Loam.........	24 520	2 800	1 440	640	61 600	12 080	11 000
1534.1	Yellow-Gray Silt Loam On Clay	16 480	2 000	1 520	440	63 840	11 960	8 560
1521	Drab Clay Loam.............	54 740	4 900	1 720	570	73 380	27 260	29 900
1526.1	Brown Silt Loam On Clay.....	47 440	3 880	1 200	560	64 800	19 280	19 120
1564	Yellow-Gray Sandy Loam.....	17 360	2 080	1 920	440	63 200	7 840	10 400
1560	Brown Sandy Loam...........	39 200	3 640	1 000	600	58 440	12 280	19 680
1560.6	Light Brown Sandy Loam.....	12 400	1 240	1 440	120	59 880	13 960	20 200
	Swamp and Bottom-Land Soils (1300)							
1331	Deep Gray Silt Loam.........	19 600	2 240	2 020	510	61 820	12 080	9 160
1354	Mixed Loam[1]................	......	......	......	......	......	......	......
1337	Yellow-Brown Silt Loam......	27 240	3 000	1 920	600	73 920	23 680	26 000

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

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

A part of the soil phosphorus is converted by growing plants from inorganic to organic combinations, with the result that a considerable portion of the phosphorus, especially of the surface soil, is organic. Investigations at the Illinois Station have shown that approximately 25 percent of the total phosphorus in the surface soil of Gray Silt Loam On Tight Clay, one of the types found in Edwards county, is organic. The phosphorus which is thus converted into organic form is in part obtained from the lower strata and left in the surface, with the result that the surface soil usually contains slightly more of this element than is found in the middle and lower strata, as may be observed by a comparison of Tables 2, 3, and 4.

Sulfur Returned to Soil in Rainfall

There is some degree of correlation between the amounts of sulfur and organic carbon found in the soil. This is because a considerable tho varying proportion of the sulfur in the soil exists in the organic form, that is, as a constituent of organic matter. The soils of Edwards county contain on the whole less than one-half as much sulfur as phosphorus, the amount in the sur-

TABLE 4.—EDWARDS COUNTY SOILS: PLANT-FOOD ELEMENTS IN 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 (300)							
330	Gray Silt Loam On Tight Clay	19 710	3 090	1 590	630	78 930	22 590	15 720
	Upland Timber Soils (300)							
334	Yellow-Gray Silt Loam	16 070	2 570	1 950	480	90 150	31 200	14 640
335	Yellow Silt Loam	13 050	1 950	1 740	570	86 790	21 900	10 650
332	Light Gray Silt Loam On Tight Clay	18 780	3 000	1 500	480	66 780	20 640	12 900
344	Yellow-Gray Fine Sandy Silt Loam	12 300	1 320	2 400	300	112 500	36 000	19 860
345	Yellow Fine Sandy Silt Loam	10 440	1 740	2 340	360	101 100	28 380	26 340
365	Yellow Sandy Loam	10 320	1 320	2 940	240	94 560	13 320	34 980
	Terrace Soils (1500)							
1531	Deep Gray Silt Loam	27 300	3 300	1 920	840	93 480	21 960	15 540
1534.1	Yellow-Gray Silt Loam On Clay	18 120	2 580	2 040	480	96 420	28 560	13 740
1521	Drab Clay Loam	39 090	4 380	2 400	870	110 730	47 100	44 400
1526.1	Brown Silt Loam On Clay	34 320	3 660	2 160	600	105 540	45 240	42 000
1564	Yellow-Gray Sandy Loam	15 660	2 100	2 820	120	91 080	13 440	25 860
1560	Brown Sandy Loam	37 500	3 900	2 040	660	93 540	15 300	28 560
1560.6	Light Brown Sandy Loam	12 120	1 740	2 580	420	91 140	16 860	30 960
	Swamp and Bottom-Land Soils (1300)							
1331	Deep Gray Silt Loam	18 000	2 460	2 610	510	94 380	22 350	13 920
1354	Mixed Loam[1]	......	......	......	......	......	......	......
1337	Yellow-Brown Silt Loam	31 680	4 080	3 060	960	115 020	34 560	32 520

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

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

face soil ranging from 240 to 610 pounds an acre. Like phosphorus, the sulfur content generally decreases with depth, partly because some of the sulfur is in combination with organic matter, which decreases with depth, and partly because organic sulfur is less subject to leaching than calcium sulfate (gypsum), the chief inorganic form of sulfur found in soils.

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

These figures afford some idea of the amounts of sulfur added by rain, and also of the wide variations in quantity under different conditions. Considering the amounts which are brought down in rainfall in addition to the soil supply, the facts would indicate that apparently there is little or no need for sulfur fertilizers in Edwards county. In order to determine definitely the response of crops to applications of sulfur fertilizers, experiments with gypsum are being conducted on a number of experiment fields in various parts of Illinois.

Potassium Content Relatively Uniform Thruout County

The potassium content of the various types exhibits less variation than any other element studied. It ranges in the surface soil from 21,300 pounds an acre in Light Gray Silt Loam On Tight Clay to 37,200 pounds in Drab Clay Loam. It will be noted, also, that the concentration of potassium remains practically constant thruout the entire depth which has been sampled and analyzed.

Calcium and Magnesium Vary Widely

Soils in general exhibit wide variations in the content of calcium and magnesium, and Edwards county is no exception to this rule. In the surface soil, magnesium varies from 4,100 pounds an acre to 13,870 pounds, while calcium varies from 4,400 pounds to more than 15,050 pounds. The presence of calcium in amounts of this magnitude is no indication that the soil may not need liming. In acid soils fairly large amounts of calcium are to be found. Much of it is locked up, however, by combination in silicate minerals, which decompose so slowly that calcium is not liberated in sufficient quantities to maintain a neutral reaction or to supply the calcium needs of growing crops.

Soils recently formed from young soil materials very frequently contain calcium carbonate (limestone) even in the surface stratum. Since calcium carbonate is readily soluble in soil water, it gradually leaches downward to greater and greater depths. Thus in no case do we find calcium carbonate in the surface soil in Edwards county, and only two soil types—Brown Silt Loam On Clay, Terrace, and Yellow-Brown Silt Loam, Bottom—were found to contain it in the lower sampling stratum.

In the noncarbonate upland soils, variations in the amounts of calcium and magnesium at the different depths give some indication of the movement of these elements in soil formation. In the surface soil the calcium usually exceeds the magnesium in amount, either as a result of the preponderance of calcium in the soil-forming materials or as a result of plant growth. In the second stratum (6⅔ to 20 inches) we find the magnesium content gaining on the calcium and equalling or exceeding it in most cases, while in the lower stratum sampled the magnesium exceeds the calcium in every upland type but one, being much more abundant than near the surface The calcium content, on the other hand, is but slightly higher or even lower in most cases in the lower depths as compared with the surface soil.

It is significant that this divergence in amounts of calcium and magnesium with increasing depth is increasingly pronounced in the more-mature types. These variations may be explained as due to the greater leachability of the calcium as compared with magnesium or to reabsorption of magnesium in the lower strata.

Local Tests for Soil Acidity Often Required

It is impracticable to attempt to obtain an average quantitative measure of the calcium carbonate content or the acidity of most soil types because, while some samples will contain large amounts of calcium carbonate, others will contain none or may actually have a lime requirement due to the soil acidity. We thus have what may be considered positive and negative values ranging, perhaps widely, on the opposite sides of the zero or neutral point, the numerical average of which could have no significance whatever, since such an average would not necessarily even approach the condition actually existing in a given farm or field. It is for this reason that the accompanying tables contain no figures purporting to represent either the lime requirement or the limestone present in the different soil types. The qualitative field tests made in the process of the soil survey are much more numerous than the chemical analyses made in the laboratory, and they give a general idea of the predominating condition in the various types as to acidity. These tests, therefore, furnish the basis for some general recommendations which are given in the descriptions of individual types on pages 19 to 33. To have a sound basis for the application of limestone the owner or operator of a farm must usually determine individually the lime requirements of his different fields. The section in the Appendix dealing with the application of limestone (page 41) is pertinent and should be read in this connection.

Supplies of Different Elements Not Proportional to Crop Removal

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

By adding together the corresponding figures for all three strata, we have an approximate invoice of the total plant-food elements within the feeding range of most of our field crops, since the major portion of their feeding range is included in the upper 40 inches. One of the most striking facts brought out of this consideration of the data is the great variation within a given soil type in the relative abundance of the various elements present as compared with the amounts removed by crops. In one of the important types in the county—Gray Silt Loam On Tight Clay, Upland—we find that the total quantity of nitrogen in all three strata is 9,510 pounds. This is about the amount of nitrogen contained in the same number of bushels of corn. The amount of phosphorus is a little over one-third as much, or 3,780 pounds, but this amount is equivalent to the phosphorus in about two and one-half times as much corn, namely, 22,200 bushels. In the surface stratum, however, which is the zone of most intensive crop feeding, we find the relative amounts of nitrogen and phosphorus more nearly in accord with the rate of removal of these elements by crops. Here the nitrogen is equivalent to 2,800 bushels of corn, and the phosphorus to 4,700 bushels, or somewhat less than twice the nitrogen equivalent.

Other types show marked contrast to Gray Silt Loam On Tight Clay, just discussed, with respect to total content in relation to rate of removal by crops. However, in most soils, except those which are peaty, phosphorus is more abundant than nitrogen when considered in terms of crop equivalents rather than as an absolute amount.

Service of Chemistry in Soil Investigation

The foregoing discussion should not be taken to mean that it is possible to predict how long any certain soil could be cropped under a given system before it would become exhausted. Nor do the figures alone indicate the immediate procedure to be followed in the improvement of a soil. It must be kept in mind that the *amount* of plant food as determined by the chemical methods in vogue fails, of itself alone, to measure the ability of a soil to produce crops. The *rate* at which these elements are liberated from insoluble forms and converted to forms that can be used by growing plants is a matter of at least equal importance, as explained on page 39, and is not necessarily proportional to the total stocks present. One must know, therefore, how to cope with the peculiarities of a given soil type if he is to secure the full benefit from its stores of the plant-food elements. In addition, there are always economic factors that must be taken into consideration, since it is necessary for one to decide at how high a level of productive capacity he can best afford to maintain his soil.

The chemical soil analysis made in connection with the soil survey is seen to be of value chiefly in two ways. In the first place, it reveals at once outstanding deficiencies or other chemical characteristics which alone would affect its productivity to a marked extent, or point the way to corrective measures. It should be borne in mind, however, that fairly wide departures from the usual are necessary before the chemical analysis alone can be followed as a guide in practice without supplementary information from other sources. An example of the direct use of the results of chemical investigations is the marked shortage of potassium in peat soils associated with the need for potassium fertilizers. Another case is the determination of the lime need of soils by chemical tests. It is probable that the results of chemical soil analyses are frequently misused by attempting to interpret small differences in the amount of a certain plant-food element as indicative of fertilizer needs. For example, differences of 100 or 200 pounds of phosphorus per acre in soils containing 1,000 pounds or thereabout in the surface soil should not be considered of any significance as to the probable response of the soil to phosphate fertilization. Or, for example, in the case of nitrogen, where the ordinary chemical analysis does not distinguish between active and inactive forms, 100 pounds of active nitrogen added to the soil by plowing down a crop of clover may be of more importance to the succeeding crop than 1,000 pounds of soil nitrogen, only a small part of which may be in a form that plants can use.

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

DESCRIPTION OF SOIL TYPES

In the following descriptions of individual soil types an effort is made to describe the types as they would be mapped at the present time. It will be observed that several of the types as they appear on the soil map are now acknowledged to include two or more types. The situations in which these new types occur, particularly the topographic positions, are so stated that, in most cases, the soils can easily be recognized in the field even tho not differentiated on the accompanying map.

UPLAND PRAIRIE SOILS

The upland prairie soils of Edwards county occupy 11.07 square miles and are confined to relatively small, isolated areas. All the prairie land which occupies a true upland position is located on a remnant of the original plain which now appears as a flat-topped ridge one to three miles wide running in a northeast-southwest direction across the north-central part of the county. The settlement of Samsville is located on this ridge. The reason for the existence of even isolated areas of prairie soil on the present upland in this section of the state remains debatable. Normally, forests invade the land, particularly in a country where the temperature and rainfall are so nearly optimum for the development of forest vegetation as here. This prairie condition may be due to some accidental cause, such as forest fires continually nipping the new growth; or it may be due to poor drainage conditions hindering the rapid advance of the forest. The prairie land is relatively flat, and prior to artificial drainage was probably saturated with water or even covered with shallow lakes or ponds during a portion of each year. These shallow ponds were probably dry only in late summer and autumn, at most not more than a few months each year. Forest vegetation would have difficulty in making a start in a soil which remained water-logged most of the year, whereas prairie grass, which matures in a relatively short time, could make some growth during each dry season. The establishment of a thick grass sod on the ground would further impede forest advance by making it difficult for the seeds to take root in the soil.

The remaining portion of the area mapped as upland prairie soil occupies a position on bench lands or terrace formations. These areas occur as isolated patches just above the overflow areas along some of the major stream courses. They were built up very largely from slope wash accumulated from surrounding higher land. Some wash is still being deposited on them following heavy rains. Their position at the base of slopes makes them subject to seepage. Under these conditions the soils have been unable to reach the stage of development of those on the upland. The characteristics of these soils resemble those of the upland prairie, and indications are that their development is in the same direction as that of soils on the true upland. They are spoken of as youthful prairie soils in the sense that they are not as yet maturely developed.

The upland prairie soils of Edwards county range in color from brownish gray to gray in the surface stratum, owing to variation in the amount and condition of the organic matter. The surface color of the prairie soils is darker than that of the timbered soils because the decayed vegetable material derived from the prairie grass that once grew on them was protected from rapid oxidation. Undoubtedly these soils were at one time as dark and fertile as those of central Illinois today, but because of their great age, acidity, and loss of mineral plant food, the common prairie soils in southern Illinois have become incapable of supporting a luxuriant plant growth.

Gray Silt Loam On Tight Clay (330)

All the upland prairie soils of Edwards county were formerly classified as Gray Silt Loam On Tight Clay and appear as such on the accompanying map. This type is now recognized however to include several types, each having definite characteristics, and each of which is associated with a characteristic topographic expression. The original name, Gray Silt Loam On Tight Clay, has been retained for the designation of one of these types and new names applied to the others. The new names adopted are Deep Gray Silt Loam On Tight Clay and Gray Silt Loam On Orange-Mottled Tight Clay.

Deep Gray Silt Loam On Tight Clay. This type occurs almost entirely on the bench land or terrace formations. A few small areas are found in small depressions at the heads of drainage courses or at the base of gentle slopes in the upland. This type was originally poorly drained and swampy, much of it having been covered by a growth of brush with a few swamp oak. It has received, and in many places is still receiving, a silty wash brought down as a result of sheet erosion from adjoining higher land. Some of it has been artificially drained by a system of surface ditching which tends to divert the water that formerly flooded the land. Its topography is nearly level with usually a very gentle slope toward the bottom land.

The surface soil of this type varies from 6 to 11 inches in thickness and is a brownish gray, friable silt loam. Small rounded iron pellets are frequently found lying on top of the ground. The subsurface soil is friable, gray, and rather thick. Below 16 inches and above the subsoil the subsurface material is usually light gray and ashy. The subsoil begins at depths varying from 22 to 30 inches, depending upon the rate at which material is being deposited on the surface. Other characteristics of the subsoil are largely dependent upon the rate of surface deposition. It varies from a thick, yellowish gray, compact, plastic clay in areas where little or no material is deposited to a relatively thin, grayish yellow, medium-compact and plastic clay loam where deposition is frequent. Below 40 to 50 inches the material in the lower subsoil becomes more friable and usually more sandy.

Management.—Deep Gray Silt Loam On Tight Clay can be so managed as to return a moderate yield on the investment. The first defect to be corrected in the management of this type is poor drainage. Some means must be provided to keep run-off water from covering the land. This can most effectively be done by running a deep, open ditch from the bottom land to the source of overflow. Following that, a system of either shallow surface ditches or tile must be provided to remove the excess water which accumulates from the rainfall. Tile are of little value unless they can be laid above the compact subsoil. Only in those areas where the subsoil is at least 24 or more inches below the surface should tile drainage be employed. Tile should be placed not more than 4 to 6 rods apart. Shallow, open ditches should be 3 to 4 rods apart.

This soil is acid and is low in organic matter. The next step in increasing its productivity is to apply enough limestone to sweeten the land, after testing each field in detail. Clover, preferably sweet clover, should be included in the rotation. Plowing under clover will correct the nitrogen deficiency and add active organic matter. Clover should be grown and plowed under every third or fourth year. After the acidity and nitrogen deficiency have been corrected, trials of phosphate and potash fertilizers are suggested. A trial application is suggested because there are no definite data to indicate possible results. The system of crop rotation, chosen from the list suggested in the Appendix (page 49) which most nearly meets the needs of a particular situation should give a fair return on this soil provided it is properly managed.

Gray Silt Loam On Tight Clay. This type is found on the flat uplands and in the center of some of the areas which occur as bench lands and terraces. Only a very small portion of the total prairie soil area would now be mapped as this type. Its chief characteristic is a thick, very compact and plastic subsoil which makes water movement thru the soil very slow. It is wet in spring because it lies too flat for water to drain off the surface and the tight subsoil prevents underdrainage. It is drouthy in late summer because moisture cannot move up to the surface from below.

The surface soil is about 8 inches thick and is a friable, light brownish gray silt loam. The first 5 or 6 inches of the subsurface is a gray silt loam, and the lower 5 to 7 inches is a very light gray, ashy silt loam. The subsurface is separated by a sharp line from the subsoil, which is a dark gray, very compact and plastic clay. A pale red or orange mottling often occurs in the upper few inches of the subsoil, which is encountered at depths varying from 18 to 22 inches. This tight, sticky subsoil is rather thick in the original upland areas, often 3 feet or more. Sand and small rounded pebbles begin to appear below 40 inches but they do not seem to have any effect on its imperviousness The subsoil of this type developed on bench lands or terraces is neither so tight nor so thick as that in the upland, seldom being over 20 inches.

Management.—Since it is practically impossible to drain this type adequately, it is questionable how much treatment can be given with profit. Tile will not draw, and open surface-ditching is the only means of drainage. This however is not effective unless a good outlet can be established. The soil is very acid. Following liming it will grow sweet clover but not alfalfa. Any additional fertilizer treatment should be limited at first to a trial basis. Corn should probably not be grown, but hay, particularly red top, can be included in a rotation with sweet clover and a small grain. Even under the best of management, only a small rate of return can be expected from this land.

Gray Silt Loam On Orange-Mottled Tight Clay. This type is found almost entirely in the upland. It occurs on gently rolling areas and has fair natural drainage. The plots of Series 100 on the West Salem soil experiment field are located on land very similar to this type.

The surface soil is 6 to 7 inches thick, and is a friable, brownish gray silt loam. The subsurface is yellowish gray in the upper part and gray with pale red or orange mottling in the lower part. The subsoil begins at 14 to 18 inches and is a dark gray, profusely orange-mottled, very compact and plastic clay. The lower subsoil below 24 to 26 inches is yellowish gray in color and not so compact or plastic as the upper. Some sand and small pebbles occur in the lower subsoil.

Management.—Altho this type cannot be successfully tile-drained, it has enough slope so that shallow open surface-ditching, if the ditches are placed 2 to 3 rods apart, will remove most of the excess surface water. It is extremely acid, a condition which can be corrected by applying limestone. Before liming, each field should be tested in detail to learn the amount required to neutralize the acidity. Following liming, clover should be grown and turned under. The results from the plots in Series 100, West Salem field (see Supplement, page 52), indicate that the application of phosphate and potassium fertilizers with limestone and organic matter substantially increase the yield. It should be kept in mind, however, that even after full treatment is applied, only fair crop yields are returned and complete crop failures sometimes occur.

Slick Spots

Slick spots are peculiar soil formations which occur within all the above-described prairie soil types, and they are also found in association with Yellow-Gray Silt Loam On Tight Clay and Light Gray Silt Loam On Tight Clay (upland timber soils), as well as with Deep Gray Silt Loam (a terrace soil). These spots are not shown on the map since they usually are small. They can be easily identified, however, by the extremely light color of the surface soil. They are commonly called "scalds" or alkali spots. They usually occur in small areas 50 to 100 feet in diameter, altho occasionally a larger area covering as much as 20 to 30 acres is found.

Slick spots are found in regions of relatively flat topography where a shallow deposit of soil material has accumulated over an impervious substratum. The leaching and removal of chemical bases from the superimposed material that would naturally take place was interrupted in these areas by the slowly pervious material below, and the leached bases were thrown out of solution, accumulating as salts and concretions such as magnesium sulfate and calcium carbonate. This accumulation of chemicals made the soil highly alkaline and produced an excess of salts which acted either to unbalance the plant-food situation or even to prohibit plant growth. Vegetation on these spots is either stunted or completely lacking and only in the most favorable years is any crop harvested from them.

The surface soil varies in thickness from 2 to 7 or 8 inches and in color from very light gray to gray. It is always lighter in color than the surrounding soil. The subsurface is usually very thin, is light gray in color, and contains many black, rounded pellets. The subsoil begins at 8 to 16 inches and is sharply differentiated from the overlying material. It has a peculiar greenish-yellow color, and when exposed and dry stands out in characteristic columnar form, over which a white salty material accumulates. It is extremely hard and tough when dry but offers little resistance to pressure when wet. It takes up water very slowly when thoroly dry, but absorbs it readily when wet. Many bad mud holes develop on the roads which run thru these spots, and in cultivated fields the toughness of the subsoil forces the plow to the surface.

Management.—Little is known about the management of slick spots. Most of these areas will grow sweet clover without treatment. If the surface soil is acid, as is sometimes the case, a light application of limestone must be made. Until such time when treatment can be applied, it is suggested that a legume such as sweet clover be grown in so far as this is possible. Practical experience has shown that the application of animal manure gives relatively small returns on these spots.

UPLAND TIMBER SOILS

Forests have overspread at one time or another more than nine-tenths of the upland area in Edwards county. The upland timber soils, as mapped, occupy 142.70 square miles, about two-thirds of the total area of the county. These soils are characterized by a yellow to yellowish-gray color which is due to their low organic-matter content. This lack of organic matter is the result of the growth of forest trees over long periods of time. 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 completely destroyed by forest fires. Much of the original timber in the county has been cut off and the areas cleared and cultivated, but the soil still retains the effects left by the long-continued forest growth. Japanese clover, or lespedeza, a legume which will grow in an acid soil, has spread over the timber soil in this region. It affords some pasture but is particularly beneficial in retarding erosion on cleared, uncultivated areas by checking run-off.

The same situation with respect to differentiation of types exists in the upland-timber soil group as was noted for those in the upland-prairie soil group, in that each type shown on the soil map would now be separated into two or more types. These new separations will be described in order as they correlate with the types shown on the map.

Yellow-Gray Silt Loam (334)

Yellow-Gray Silt Loam as mapped occupies 83.74 square miles, nearly 40 percent of the total area of the county. It includes three types, each of which is associated with a characteristic topographic expression. These types are named: Yellow-Gray Silt Loam On Tight Clay, Yellow-Gray Silt Loam On Compact Medium Plastic Clay, and Reddish Yellow-Gray Silt Loam.

Yellow-Gray Silt Loam On Tight Clay. This type occurs on flat or very gently sloping land. Most of it is confined to the flat areas between Fox and Sugar creeks in the northwest part of the county. Small areas of it surround some of the land mapped as upland prairie on bench-land formations. Both the surface drainage and underdrainage of this type are poor. Slick spots occur frequently. In many respects this type resembles the prairie type Gray Silt Loam On Tight Clay.

The surface soil is 4 to 5 inches thick and is yellowish gray in color. Cultivation, by mixing the surface with the subsurface, has thickened this surface stratum and has also lightened its color. The upper subsurface is gray in color, and the lower subsurface ashy white. Except for being somewhat more yellowish in color, the subsoil of this type is similar to that of Gray Silt Loam On Tight Clay.

Management.—For suggestions regarding the management of this soil the reader is referred to the management discussion of Gray Silt Loam On Tight Clay (page 22). Better drainage can usually be secured in this type than in its corresponding prairie type because this type lies closer to an outlet. The plots of Series 200 and 300 on the Raleigh field are located on soil similar to this type and should be studied in this connection (see pages 60 to 62).

Yellow-Gray Silt Loam On Compact Medium-Plastic Clay. More than half the area shown on the map as Yellow-Gray Silt Loam would now be classified as Yellow-Gray Silt Loam On Compact Medium-Plastic Clay. It is the predominant upland type in the central and northern parts of the county. This type is found on the intermediate slopes in the upland. It has fair to good surface drainage and fair subsurface drainage.

The surface soil is 6 to 7 inches thick. The color of the virgin soil is brownish yellow, but following continued cultivation it changes to yellowish gray. The subsurface is friable and is yellowish gray in color. Just above the subsoil the subsurface is a pale yellowish gray and slightly resembles the gray layer so characteristic of soils developed on flat topography under poor drainage. The subsoil begins at 15 to 18 inches and is a moderately compact, somewhat plastic clay loam, grayish yellow in color. The lower subsoil below 32 to 40 inches is often more friable than the upper. Sand and small pebbles frequently occur in the subsoil of this type in the northern part of the county.

Management.—Yellow-Gray Silt Loam On Compact Medium-Plastic Clay is one of the best upland soils in Edwards county. It has been mistreated by farmers in the past, robbed of its fertility, and then in the face of erosion left without a protective cover. At present not much of this type is very productive, but it has possibilities of improvement. Better drainage should be provided by artificial means. Tile will not draw for any great distance and will not carry excess water away swiftly, but in the spring they will often make a difference of 10 to 15 days in the time when the soil becomes dry enough for cultivation. A system of shallow surface ditches should be provided to collect and carry off the water in order to prevent excessive slope wash. These ditches should be constructed in such a way as to carry off the water slowly and not to allow deep gullies to develop. To prevent surface wash on the more sloping areas, shallow terraces should be constructed following the contours. A crop or vegetative cover should be kept on the land during the winter and spring as a further protection against sheet-washing.

The soil is acid and in need of nitrogen and organic matter. Limestone should be applied in amounts needed to sweeten the land, and then a legume, preferably sweet clover, seeded and turned under. This practice will correct the nitrogen deficiency and furnish active organic matter, thus enriching the soil as well as putting it in better physical condition. The results obtained on the plots of Series 100 on the Enfield experiment field, which are located on this soil type, indicate that the use of some potassium fertilizer would pay if used on land on which sweet clover had been turned under (see page 63).

Reddish Yellow-Gray Silt Loam. This type occurs on the rolling upland and is confined to the central and southern parts of the county. It has developed under good natural drainage on rolling, preglacial topography. The natural slope of the land has given erosion a better chance to remove the loose soil where the protective timber cover is cleared off. Much of this soil type, particularly in the southern part of the county, is badly gullied and sheet-washed. It takes only a few years of exposure to erosion to reduce this soil to a state of unproductiveness.

The surface of the virgin soil of this type is 6 inches thick and is brownish yellow in color. Following a few years of cultivation the color changes to yellow. The subsurface is friable and its color is yellow with a reddish cast. The subsoil begins at 11 to 15 inches and is a slightly compacted, non-plastic, silty clay loam, reddish yellow in color. The subsoil gradually becomes more friable below 25 inches. It maintains the yellow color but loses the reddish cast and thin streaks of gray appear.

Management—Reddish Yellow-Gray Silt Loam is potentially one of the best upland soils in Edwards county. It is largely unproductive at present because of gross mismanagement. It is naturally well drained but must be protected against destructive erosion. With additions of fresh organic matter the soil will absorb water faster. A protective vegetative cover should always be kept on the land during winter and early spring. This soil type will respond to terracing probably better than any of the other types mentioned. Circular 290 of the Illinois Agricultural Experiment Station is suggested as a source of information on the details of soil terracing.

This type is acid but not strongly so. A moderate application of limestone will usually sweeten the soil for sweet clover growth. Several crops of clover should be grown and turned under to add nitrogen and organic matter. The application of phosphate on land of this type which has been previously built up by limestone and legumes would probably pay. The results obtained from the Elizabethtown and Unionville fields, which are located on soil resembling this type, corroborate this statement. Potassium used in addition to phosphate does not give significant increases (see pages 64 to 67). The application of manure has given very beneficial results, and probably as much return can be obtained per ton when applied on this type as on any other in the county.

Reddish Yellow-Gray Silt Loam will grow alfalfa after lime has been applied and manure or a legume crop turned under. It is not particularly adapted to growing corn because of the lack of sufficient moisture during the ripening of the crop. It is better suited to winter and spring small grains, cowpeas, soybeans, and special crops such as vegetables and fruits. Most of the successful peach orchard sites are located on this type. Information relative to the treatment of the soil for special crops may be obtained by writing direct to the Agricultural Experiment Station.

Yellow Silt Loam (335)

Yellow Silt Loam as mapped occupies 53.81 square miles, nearly 25 percent of the total area of the county. Properly, it includes two types: Reddish Yellow Silt Loam, and Yellow Silt Loam. These types occur on very rolling to rough topography and are subject to destructive erosion.

Reddish Yellow Silt Loam. This soil type is found only in the central and southern parts of the county on the very rolling to steep slopes. It has developed in the region of preglacial topography and has been protected from devastative erosion by a vegetative cover. Under cultivation the soil is soon washed away and the land made unproductive unless properly managed.

The surface of the virgin soil of this type is 4 to 5 inches thick, friable in texture and brownish yellow in color. Cultivation changes the surface color to reddish yellow. The subsurface is thin, friable, and reddish yellow. The subsoil begins at 8 to 11 inches, and is a non-plastic, only very slightly compacted, reddish yellow silt loam. The lower subsoil is even more friable than the upper and is yellow in color.

Management.—Reddish Yellow Silt Loam is not adapted to general grain farming. Following treatment such as suggested for Reddish Yellow-Gray Silt Loam it can be utilized for growing alfalfa, winter small grains, vegetables, fruits, or put in permanent pasture or vineyard. The success of any project on this type of soil depends largely upon the prevention of erosion. Terracing and keeping the soil under a vegetative cover during the rainy seasons and the frequent addition of fresh organic matter are the means by which this can be accomplished. The reader is referred to the discussion of results on the Elizabethtown field, which is located on soil similar to this type (see page 64).

Yellow Silt Loam. This type is found on the steep gullied slopes thruout the county. In the northern part of the county it is found in the steep gullies which break abruptly from the flat upland. Most of these gullies have never been cleared of timber. In the southern part of the county Yellow Silt Loam occurs in patches on the steep hillsides of preglacial ridges as well as along the small bottom lands. Most of the small patches are the result of recent erosion following clearing of the timber from the land. Occasional outcrops of sandstone and shale rock are found in this type.

Yellow Silt Loam has little or no soil development because the surface is removed faster than the soil forms. The gullies along small streams in the northern half of the county are sandy and gravelly. Erosion has exposed the boulder clay deposited by the glacier. The eroded areas in the southern half of the county are usually silty, being the lower deposits of the loess.

Management.—The Yellow Silt Loam in the northern part of the county cannot be cultivated because of its steepness of slope. It should be used for forestry. Some of that in the southern part may be built up in the manner suggested for Reddish Yellow Silt Loam and used as permanent pasture or orchards. Present conditions do not warrant the expenditure of much money in its development in view of the fact that there is a large acreage of better land in and surrounding the county which is not fully utilized. Perhaps it should be reforested at present and held in reserve until some future time when the agricultural economic situation demands its return to cultivation.

Light Gray Silt Loam On Tight Clay (332)

Light Gray Silt Loam On Tight Clay occurs on the very flat, exceptionally poorly drained, depressional areas in the northern half of the county. It is found on the remnants of the upland plain. A few areas of this type are mapped on the flat land between Sugar and Fox creeks in the northwestern part of the county. These areas more nearly resemble Yellow-Gray Silt Loam On Tight Clay, and the reader is referred to the discussion of that type (page 24) for information concerning these areas. Typical Light Gray Silt Loam On Tight Clay has very poor surface drainage and underdrainage. During wet weather the soil is soft and mushy, while in dry weather it bakes and becomes very hard. The areas of this type are spoken of as "post oak" or "hickory flats" because of the kind of timber which once grew on them. Black pellets, known as "buckshot," are abundant over the surface of this soil.

The surface of the virgin soil is 2 to 3 inches thick and is brownish gray in color. Cultivation has mixed some of the gray subsurface material with the surface and furthered organic-matter decay so that the surface soil in plowed fields of this type have a pale yellowish color. The upper subsurface is gray and the lower subsurface ashy white. Both the surface and subsurface contain numerous small, rounded black pellets. The subsoil is thick, very tough and hard when dry and sticky when wet. Water penetrates it very slowly and it is termed an impervious clay.

Management.—Fortunately the total area of this type in the county is small, for this is the poorest of all the soils. It cannot be successfully drained, it is extremely acid, very low in organic matter, and generally unproductive. Altho it is not well adapted to pasture land or meadow, that seems to be the best possible use for it. (See account of Sparta field experiments, page 62.)

Yellow-Gray Fine Sandy Silt Loam (344)

Yellow-Gray Fine Sandy Silt Loam occupies a total area of 1 67 square miles in Edwards county and is all found within three miles of Grayville. This soil resembles Reddish Yellow-Gray Silt Loam, differing from it in having a thicker surface soil and one that is coarser in texture. The upper soil material of this soil type was deposited as loess considerably later than that covering most of the county. It is therefore a younger, less-leached, and more-productive soil. It lies on rolling topography and is well drained.

The surface soil varies from 8 inches in thickness along the west border of the area to 12 inches near the Wabash river bluffs. It is brownish yellow in color, very friable, and of a coarse, silty texture. The subsurface and subsoil are very similar to those of the Reddish Yellow-Gray Silt Loam.

Management.—In favorable years this soil will grow red clover without lime. It takes only 1½ to 2 tons of limestone to sweeten it in order to grow sweet clover or alfalfa. The same management practices should be used on this type as those suggested for Reddish Yellow-Gray Silt Loam (see page 25). Somewhat better returns can be expected because it is naturally a more-productive type.

Yellow Fine Sandy Silt Loam (345)

Yellow Fine Sandy Silt Loam occupies 1.86 square miles in Edwards county and occurs as the more-rolling to steep phase of Yellow-Gray Fine Sandy Silt Loam. With the exception of having a darker and coarser surface soil, this type is similar to Reddish Yellow Silt Loam; it is also more youthful and more productive. With these exceptions in mind the reader may refer for the description and management of this type to the discussion of Reddish Yellow Silt Loam, page 27

Yellow Sandy Loam (365)

One area, 64 acres in extent, of Yellow Sandy Loam, located just west of where Bon Pas creek enters the Wabash river, was mapped in Edwards county.

This area has dune-like topography and lies considerably lower than the upland but higher than the surrounding terrace land. The type is formed from a deposit of 10 to 30 feet of medium to coarse sand resting on limestone bedrock.

Yellow Sandy Loam has a shallow, brownish-yellow sandy-loam surface soil. Below 6 to 8 inches the soil becomes sandy and yellow in color. At 20 to 25 inches a reddish cast appears, and this is accompanied by a slight compaction. Below 30 inches the material becomes loose and very sandy.

Management.—This soil is slightly acid but with a small application of limestone will grow excellent clover and alfalfa. Wheat usually produces a good crop. Corn is an uncertain crop because of the drouthy nature of the soil. However, in years of favorable moisture supply a good corn crop can be produced. The available information from experiment fields indicates that limestone with manure or legumes is the most profitable treatment.

TERRACE SOILS

The terrace formations in Edwards county were made during or shortly after glacial times by overloaded and flooded streams which deposited an immense amount of material in the old channels. Later as the streams diminished in size and cut their channels deeper, new bottom lands were developed, leaving the old flood plains above overflow except in high flood stages. The soils on the terraces mapped along Bon Pas creek and Wabash river appear to be younger than those along Little Wabash river. The soil material from which the terraces were formed was for the most part washed down stream from above. That along Bon Pas creek was probably mixed more or less with sediment from Wabash river back water and kept under water or in a marshy condition longer than that along Little Wabash river.

Deep Gray Silt Loam (1531)

Deep Gray Silt Loam, Terrace, occupies 9.74 square miles and is found along all the principal streams in the county. It is derived very largely from more or less recent wash accumulating from the immediately surrounding upland. Most of the areas of this type have a flat topography and lie in such a position adjacent to the upland as to receive considerable run-off. Drainage is often difficult on account of the considerable distance to a stream channel. Many of the areas are wet in the spring and early summer.

This type has a dark gray silty surface soil varying from 6 to 12 inches in thickness. There is little or no soil development below the surface; the soil gradually becomes lighter in color without much change in texture or compaction with increasing depth. Occasionally on slightly higher land a thin, somewhat compact and plastic band occurs in the soil at a depth between 20 and 30 inches. Black, rounded pellets are abundant on top and thru the soil.

Management.—The reader is referred to the discussion of Deep Gray Silt Loam On Tight Clay (page 21) for suggestions regarding the management of this terrace type.

Yellow-Gray Silt Loam On Clay (1534.1)

Yellow-Gray Silt Loam On Clay occupies a total area of about 8 square miles in Edwards county. Most of it lies adjacent to the Bon Pas and Little Wabash stream channels. The soil material from which this soil developed was deposited as alluvium during high water. The areas of this type do not overflow at present except during high flood stages of the Wabash river. At these times the outlets of smaller streams are blocked and back water from them covers the area of this soil type. The water seldom gets very deep, nor does it remain long, and little sediment is deposited. The topography of this soil type is flat, but because of its position adjacent to stream channels it has fair surface drainage. Timber originally covered the land, but most of the areas are now cleared and cultivated.

The surface soil of Yellow-Gray Silt Loam On Clay is 4 to 6 inches thick, yellowish gray in color, and a friable silt loam in texture. The subsurface varies in thickness from 8 to 15 inches, is somewhat grayer in color than the surface, and of a silty clay-loam texture. The upper subsoil, which begins at 12 to 20 inches, is a pale drabbish-gray loam, plastic but not highly compact. The lower subsoil is more yellowish and friable. Rounded concretions of lime are often present in the lower subsoil. Small black rounded pellets are present on the surface.

Management.—Tile placed 6 to 8 rods apart and shallow surface ditches around the field will effectively drain this soil. It is moderately acid and low in organic matter. The application of limestone as needed and the growing and turning down of clover will considerably increase its productive capacity. Phosphate and potassium fertilizers should be given a trial—phosphate just ahead of wheat and potassium in preparing for corn.

Drab Clay Loam (1521)

What are now regarded as two distinct types were mapped as Drab Clay Loam in Edwards county. Together they occupy 7.71 square miles. That part of the total area along Bon Pas creek has been reclassified as Black Clay Loam, and the original name, Drab Clay Loam, is retained for that in the Little Wabash river valley.

Black Clay Loam. This soil type is potentially the richest soil in Edwards county. It was derived from alluvial material which has remained under swampy conditions until artificially drained. Most of the areas are now protected from overflow, altho during high water and continued rainy seasons difficulty is experienced in getting the water off the land.

The surface soil is 8 to 11 inches thick. It is drabbish brown to black in color and of clay-loam texture. The subsurface is drabbish black with some yellow spots. The subsoil begins at 15 to 18 inches and is a plastic, slightly compact clay loam, drabbish brown in color, heavily splotched with yellow. Below 30 inches the subsoil is drabbish yellow and not so plastic as above. Concretions of lime and the remains of snail shells and other fresh water fossil shells are abundant in this type.

Management.—This soil can be effectively drained with tile if an outlet can be established. It will grow clovers without limestone applications. A legume crop should be plowed under every three or four years to maintain a supply of active organic matter. It is questionable whether any commercial fertilizers can be applied with profit, particularly if farm manure is plentiful and can be used on the land at frequent intervals.

Drab Clay Loam. This type is found in the Little Wabash valley. It was derived from alluvial material brought down by the stream. It has been kept under swampy conditions most of the time. The areas are covered with water following each heavy rain and because of the lack of drainage the water remains until it evaporates.

The surface soil is 6 to 8 inches thick and is a grayish-drab silty clay loam. The subsurface is more nearly gray in color and somewhat heavier in texture than the surface. The subsoil is imperfectly developed and variable in its characteristics. At some places it becomes silty and at others it takes the nature of a clay loam. It is always gray in color and is somewhat compact and plastic.

Management.—Drab Clay Loam is a good soil if it can be properly drained. The difficulty of drainage is in securing an outlet. In all probability a proper outlet will never be obtained until the stream channels are dredged. This is particularly true of Big creek. When an outlet is established this soil can be tiled and good drainage afforded. Clover should be grown and turned under at regular intervals in order to furnish nitrogen and active organic matter. The land should be tested for acidity. Altho not strongly acid, it often needs light limestone applications to insure good clover growth. Much of the area of this type is now in timber, and until good drainage can be obtained it probably should remain so.

Brown Silt Loam On Clay (1526.1)

Brown Silt Loam On Clay occupies 3.13 square miles in Edwards county. It is located on land slightly higher than the adjoining areas of Drab Clay Loam. As in the latter type, the areas of Brown Silt Loam On Clay occurring along Bon Pas creek are more productive than those in Little Wabash river valley. This type was derived in the same manner as Drab Clay Loam except that its surface deposit was silty and it has had better natural drainage.

The surface soil of this type is variable in color and thickness, depending upon the nearness to surrounding types. Near areas of Drab Clay Loam it is dark brown, and near Yellow-Gray Silt Loam On Clay it is light brown. The subsurface is a drabbish-brown silty clay loam. The subsoil begins at a depth of 15 to 18 inches and is a yellowish-drab, somewhat compact and plastic clay loam. It becomes more friable below 28 to 30 inches. Concretions of lime are often present in the subsoil.

Management.—Brown Silt Loam On Clay is one of the most productive soils in Edwards county. Underdrainage should be provided by tiling. Fresh organic matter should be added by plowing under clovers or farm manure. The addition of other fertilizers is questionable at this time.

Yellow-Gray Sandy Loam (1564)

Yellow-Gray Sandy Loam is a minor type in Edwards county, occupying only 397 acres. It occurs as undulating ridges in the valleys of the larger streams. The soil material was deposited from moving water during flood times. The material varies from a fine to medium sand with enough silt and clay to keep it from being drouthy. The color is grayish yellow on the surface, changing to yellow with a reddish cast in the subsoil. The subsoil is slightly compact but not plastic.

Management.—Yellow-Gray Sandy Loam is naturally well drained. It is somewhat acid and should have a limestone application. Either clovers should be grown, or else manure applied, to be turned under in order to add nitrogen and organic matter. This type of soil grows satisfactory clover and small grain crops following proper treatment.

Brown Sandy Loam (1560)

Brown Sandy Loam is likewise a minor type in Edwards county, occupying only 320 acres. The largest area is in the vicinity of the town of Browns, where it resembles Brown Silt Loam On Clay except that it usually has more fine sand in the surface. For a description and suggestions of management of this area, the reader is referred to Brown Silt Loam On Clay (see page 31).

The remainder of the total area of Brown Sandy Loam occurs as undulating ridges along Little Wabash river. These areas are similar to those of Yellow-Gray Sandy Loam in every respect except for the darker color of the surface soil, which indicates that the Brown Sandy Loam areas are the more fertile.

Light Brown Sandy Loam (1560.6)

One area of Light Brown Sandy Loam containing 102 acres, and located in the Wabash river valley, was mapped. This type tends toward drouthiness because of a medium-sandy subsoil. Its surface is light brown in color and a sandy loam in texture.

Management.—This soil will produce satisfactory clover and small grain crops, particularly wheat, if limestone is applied and fresh organic matter added. Corn does not produce good yields except in years of plenteous rainfall.

SWAMP AND BOTTOM-LAND SOILS

The swamp and bottom-land group of soils includes the bottom lands along streams, the swamps, and the poorly drained lowlands. The soil types are of alluvial formation and the land is subject to frequent overflow. Drainage is the most important consideration in the management of this land. Little, if anything, can be done by the individual to correct this poor drainage condition, since dredging and the deepening of the channels of existing streams are necessary to secure an outlet. Under present economic conditions the starting of drainage projects on this type of land is a questionable venture.

Deep Gray Silt Loam (1331)

Deep Gray Silt Loam is the predominating bottom-land type in Edwards county. It occupies about 27 square miles. The material forming this type is mainly silt brought down from upstream uplands and from surrounding hills and deposited by slowly moving water during flood times. It remains under high moisture conditions thruout most of the year. The bottoms are flat, poorly drained, and often swampy.

The soil is not of sufficient age to have much development. Its color is gray on the surface, gradually becoming somewhat lighter with depth. Its texture is silty thruout except on some of the slightly higher-lying areas, where a noticeable compaction occurs at depths varying from 18 to 30 inches. This compaction is rarely over 8 inches thick. Slick spots (see page 23) occasionally occur in these areas.

Management.—Drainage is the most important consideration in the management of Deep Gray Silt Loam. The difficulty of obtaining good drainage in these bottom-land areas has already been discussed. The soil is medium acid and will not grow clover without lime. On areas where overflow and drainage have been taken care of, the additions of fresh organic matter give good increases in corn. Corn is the chief crop because this soil usually does not dry out until early summer and seldom overflows again until after the corn is harvested.

Mixed Loam (1354)

Mixed Loam occurs in small bottom lands at the heads of streams. It occupies 7.08 square miles in Edwards county. It is subject to overflow after each heavy rain, and is continually receiving new deposits of material brought down from adjoining upland. Flood water quickly drains off this land down to the larger bottom lands. The soil material varies from a silty to a fine sandy texture. Being a youthful soil it has little or no development. It ranges in color from gray to yellow and its texture is friable thruout.

Management.—Altho this type is subject to frequent overflow, crops such as corn, cowpeas, and soybeans can be grown to maturity between spring and fall rains. The soil is slightly acid, but because of continuous deposition no treatment is suggested. Practically the entire area of this type is farmed in corn.

Yellow-Brown Silt Loam

The 377 acres of Yellow-Brown Silt Loam in Edwards county form the first bottom-land along Wabash river. This land overflows when the river leaves its channel, but an average of about seven crops in ten years has been obtained. The soil is fertile, well drained, and not acid. No treatment is suggested under these conditions. Most of the land is farmed to corn year after year.

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.

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 wherever 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 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 respective 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 *Illinoian moraines,* including the moraines of the Illinoian glaciations
300 *Lower Illinoian glaciation,* formerly considered as covering nearly the south third of the state
400 *Middle Illinoian glaciation,* covering about a dozen counties in the west-central part of the state
500 *Upper Illinoian glaciation,* covering about fourteen counties northwest of the middle Illinoian glaciation
600 *Pre-Iowan glaciation,* but now believed to be part of the upper Illinoian
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 Illinoian or older glaciations
1400 *Late river-bottom and swamp lands,* formed by material derived from the Wisconsin and Iowan glaciations
1500 *Terraces,* bench or second bottom lands, and gravel outwash plains
1600 *Lacustrine deposits,* formed by Lake Chicago, the enlarged glacial Lake Michigan

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

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

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

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

FIG. 5.—EXAMINING THE SOIL PROFILE

SOIL SURVEY METHODS

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

An accurate base map for field use is necessary for soil mapping. These maps are prepared on a scale of one inch to the mile, the official data of the original or subsequent land survey being used as the basis in their construction. Each surveyor is provided with one of these base maps, which he carries with him in the field; and the soil type boundaries, together with the streams, roads, railroads, canals, town sites, and rock and gravel quarries are placed in their proper locations upon the map while the mapper is on the area. With the rapid development in road improvement during the past few years, it is almost inevitable that some recently established roads will not appear on the published soil map. Similarly, changes in other artificial features will occasionally occur in the interim between the preparation of the map and its publication. The detail or minimum size of areas which are shown on the map varies somewhat, but in general a soil type if less than five acres in extent is not shown.

Sampling for Analysis.—After all the soil types of a county have been located and mapped, samples representative of the different types are collected for chemical analysis. The samples for this purpose are usually taken in three depths; namely 0 to 6⅔ inches, 6⅔ to 20 inches, and 20 to 40 inches, as explained in connection with the discussion of the analytical data on page 12.

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 micro-organisms. 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 micro-organisms. 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

At least 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

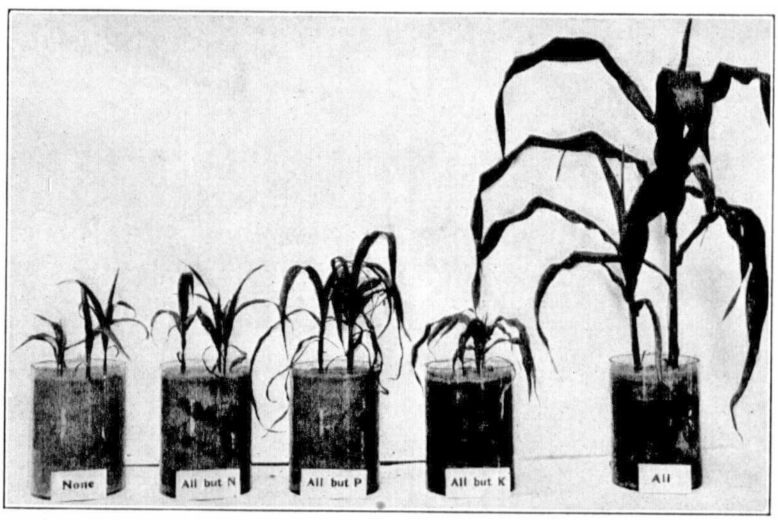

FIG. 6.—ALL ESSENTIAL PLANT-FOOD ELEMENTS MUST BE PRESENT

The jars in which these corn plants are growing contain pure sand to which have been added various combinations of the essential plant-food elements. If a single one of these elements is omitted, the plants cannot develop; they die after the small supply stored in the seed becomes exhausted.

present in plants for the most part, not because they are required, but because they are dissolved in the soil water and the plant has no means of preventing their entrance. There is some evidence, however, which indicates that certain of these elements, notably manganese, silicon, and boron, may be either essential but required in only minute quantities, or very beneficial to plant growth under certain conditions, even tho not essential. Thus, for example, manganese has produced marked increases in crop yields on heavily limed soils. Sodium also has been found capable of partially replacing potassium in case of a shortage of the latter element.

Table 5 shows the requirements of some of our most common field crops with respect to seven important plant-food elements furnished by the soil. The figures show the weight in pounds of the various elements contained in a bushel

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

Produce		Nitrogen	Phosphorous	Sulfur	Potassium	Magnesium	Calcium	Iron
Kind	Amount							
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Wheat, grain	1 bu.	1.42	.24	.10	.26	.08	.02	.01
Wheat, straw	1 ton	10.00	1.60	2.80	18.00	1.60	3.80	.60
Corn, grain	1 bu.	1.00	.17	.08	.19	.07	.01	.01
Corn, stover	1 ton	16.00	2.00	2.42	17.33	3.33	7.00	1.60
Corn cobs	1 ton	4.00	.....	....	4.00	.....	.....	.....
Oats, grain	1 bu.	.66	.11	.06	.16	.04	.02	.01
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.

or in a ton, as the case may be. From these data the amount of an element removed from an acre of land by a crop of a given yield can easily be computed.

PLANT FOOD SUPPLY

Of the elements of plant food, three (carbon, oxygen, and hydrogen) are secured from air and water, and the others from the soil. Nitrogen, one of the elements obtained from the soil by all plants, may also be secured from the air by the class of plants known as legumes, in case the amount liberated from the soil is insufficient; but even these plants are dependent upon the soil for the other elements, 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

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	.....
Superphosphate	.....	140–420	.....
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.

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 minerals contained in the soil, such as potassium and magnesium compounds.

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

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

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

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

PERMANENT SOIL IMPROVEMENT

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

The Application of Limestone

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

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

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

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

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

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

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

The Nitrogen Problem

The nitrogen problem is one of foremost importance in American agriculture. There are four reasons for this: nitrogen is becoming increasingly deficient in most soils; its cost when purchased on the open market is often prohibitive; it is removed from the soil in large amounts by crops; and it is readily lost from soils by leaching. A 50-bushel crop of corn requires about 75 pounds of nitrogen for its growth; and the loss of nitrogen from soils by leaching may vary from a few pounds to over one hundred pounds an acre in a year, 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 69 million pounds of atmospheric nitrogen.

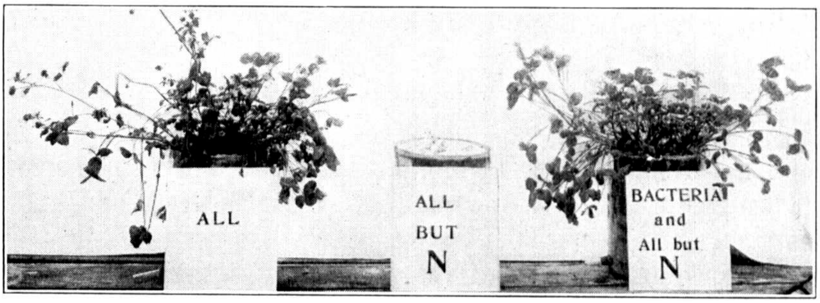

FIG. 7.—LEGUMES CAN OBTAIN THEIR NITROGEN FROM THE AIR

The photograph tells the story of how clover benefits the soil. In the pot at the left all the essential plant-food elements, including nitrogen, are supplied. In the middle jar all the elements, with the single exception of nitrogen, are present. At the right nitrogen is likewise withheld but the proper bacteria are supplied which enable the clover to secure nitrogen from the air.

Leguminous plants such as clover are able, with the aid of certain bacteria, to draw upon the inexhaustible supply of air nitrogen, utilizing it in their food requirements. In so doing these leguminous plants, thru the decay of their own tissues, add to the soil nitrogen that has been taken from the air and transformed into food material that can be assimilated by other kinds of crops that follow.

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.

Different soil types display great variation in phosphorus content. In Illinois soils a range from 320 to 4,900 pounds an acre has been found in the surface 6⅔ inches, depending mainly on the origin of the soil.

The removal of phosphorus by continuous cropping slowly reduces the amount of this element 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 the use of 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 phosphorus-containing materials that are used as fertilizers. The more important of these are rock phosphate, superphosphate, bone meal, and basic slag.

Rock Phosphate.—Rock phosphate is a mineral substance found in vast deposits in certain regions. A good grade of the rock should contain 12 to 15 percent of the phosphorus element. The rock should be ground to a powder fine enough to pass thru a 100-mesh sieve, or even finer.

Superphosphate.—Superphosphate 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. By further processing, different concentrations are produced. The most common grades of superphosphate now on the market contain respectively 7, 8¾, and 10½ percent of the element phosphorus, and even more highly concentrated products containing as high as 21 percent are to be had. In fertilizer literature the term phosphorus is usually expressed as "phosphoric acid" (P_2O_5) rather than the element phosphorus (P), and the chemical relation between the two is such as to make the above figures correspond to 16, 20, 24, and 48 percent of phosphoric acid respectively. Besides phosphorus, superphosphate also contains sulfur, which is likewise an element of plant food. In general, phosphorus in superphosphate is considered to be more readily available for absorption by plants than that of raw rock phosphate.

Bone Meal.—Prepared from the bones of animals, bone meal appears on the market in two different forms, raw and steamed. Raw bone meal contains, besides the phosphorus, a considerable percentage of nitrogen. If the material is purchased only for the sake of the phosphorus, the cost of the nitrogen represents a useless expense. Steamed bone meal is prepared by extracting most of the nitrogenous and fatty matter from the bones, thus producing a more nearly pure form of calcium phosphate, containing about 10 to 12 percent of the element prosphorus and about 1 percent of the element nitrogen.

Basic Slag.—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 is a by-product in the manufacture of steel. It contains a considerable proportion of basic material and therefore tends to influence the soil reaction in the direction of reducing soil acidity.

Comparative Value of Different Forms of Phosphorus.—Obviously the carrier of phosphorus that gives the most economical returns, considered from all standpoints, is the best one to use. Altho this matter has been the subject of much discussion and investigation, the question remains unsettled. The fact probably is that there is no single carrier that will prove the most economical under all circumstances because so much depends upon soil conditions, crops grown, length of haul, and market conditions.

The relative cheapness of raw rock phosphate as compared with the treated material, superphosphate, makes it possible to apply for equal money expenditure considerably more phosphorus per acre in the form of rock than in the form of superphosphate, the ratio being, under present market conditions, roughly speaking 3½ to 1; that is to say, a dollar will purchase about three and a half times as much of the phosphorus element in the form of rock phosphate as in the form of superphosphate, and this is an important consideration if one is interested in building up a phosphorus reserve in the soil.

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 superphosphate 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, the silt loams and clay loams, are well stocked with potassium, altho it exists mainly in a very slowly soluble form. Many field experiments in various sections of Illinois during the past twenty-five years have shown little or no response to the application of potassium in the production of our common grain and hay crops. On the light-colored soils of southern Illinois, however, where stable manure has not been employed, potassium has been applied with profit, the benefit appearing mainly in the corn crop.

Peat soils are usually low in potassium content. It has frequently been demonstrated in field experiments that the difference between success and failure in raising crops on peat land depends on the use of a potash fertilizer.

Potassium has proved beneficial also on the so-called "alkali" spots occurring on certain soil types that are rather high in organic matter, including peat and very dark-colored sandy, silt, and clay loams. The potassium salts in this case appear to exert a corrective influence over what seems to be an unbalanced plant-food condition caused by an excess of nitrate in the soil.

Potassium fertilizer may be procured in the form of one of the salts, such as chlorid, sulfate, or carbonate of potassium, and any of these materials may be applied, where needed, at the rate of 50 to 150 pounds an acre, according to the method of distribution. For our most common crops about the only basis for choosing among these forms is the matter of price, taking into consideration the potassium content. Kainit is another substance containing potassium, but it is combined with magnesium in the form of a double salt. It is therefore less concentrated than the salts mentioned, and so should be applied in larger quantities. An application of about 200 pounds or more of kainit to the acre is suggested.

The Calcium and Magnesium Problem

When measured by crop removals of plant-food elements, calcium is often more limited in Illinois soils than is potassium, tho magnesium may occasionally be the low element. 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 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.

As a general principle, straw and cornstalks should be turned under, and not burned. Corn-borer control, however, may demand unusual measures, even to the burning of the stalks. There also 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.

Systems of Crop Rotation

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 crop rotation will prove best, 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 best 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)
Fourth year—Clover
Fifth Year —Wheat (with 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 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

The first system mentioned above may be reduced to a five-year rotation by cutting out either the second or the sixth year, and to a four-year system by omitting the fifth and sixth years, as indicated below.

Five-Year Rotations

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

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

First year	—Corn	*First year*	—Wheat (with clover)
Second year	—Cowpeas or soybeans	*Second year*	—Clover
Third year	—Wheat (with clover)	*Third year*	—Corn
Fourth year	—Clover	*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	*First year*	—Wheat or oats (with clover)
Second year	—Oats or wheat (with clover)	*Second year*	—Corn
Third year	—Clover	*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 oats or wheat. 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. In connection with livestock production it may be desirable to mix grass with the clover for pasture or hay. 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 Edwards County)

The University of Illinois has conducted altogether about fifty soil experiment fields in different sections of the state and on various soil types. Altho some of these fields have been discontinued, the majority are still in operation. It is the present purpose to report the summarized results from certain of these fields located on soil types 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 forty 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 each crop represented every year.

Farming Systems

On most 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 but certain modifications have been introduced in recent years, as explained in the descriptions of the respective fields.

Crop Rotations

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

Soil Treatment

The treatment applied to the plots at the beginning was usually standardized according to a rather definite system. With advancing experience, however, new problems arose calling for new experiments, so that on most of the fields plots have been divided and a portion given over to new systems of treatment, at the same time maintaining the original system essentially unchanged from the beginning.

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 grains 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.—Limestone has usually been applied at the rate of 4 tons an acre as an initial application, and 2 tons an acre every four years thereafter until a considerable excess has accumulated in the soil. Rock phosphate has been applied at the rate of one ton an acre at the beginning. followed by an annual acre-rate of 500 pounds applied once in the rotation until a considerable excess has accumulated. Potassium has been applied usually in the form of 200 pounds of kainit a year. When kainit was not available, owing to conditions brought on by the World War, potassium carbonate was used.

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, (sP= superphosphate, bP= bone meal, rP= rock phosphate, slP= slag phosphate)
K = Potassium (usually in the form of kainit)
() = Parentheses enclosing figures, signifying tons of hay, as distinguished from bushels of seed

THE WEST SALEM FIELD

A University soils experiment field is located in Edwards county about a mile west of West Salem. It includes 24 acres of the loessial and drift soils characteristic of the region. A diagram showing the arrangement of the plots is presented in Fig. 8. By means of contour lines, the topography, or slope of the land, is also charted on this diagram. It will be observed that in some parts of the field the land is comparatively level while in other parts it is somewhat rolling and has a tendency to wash.

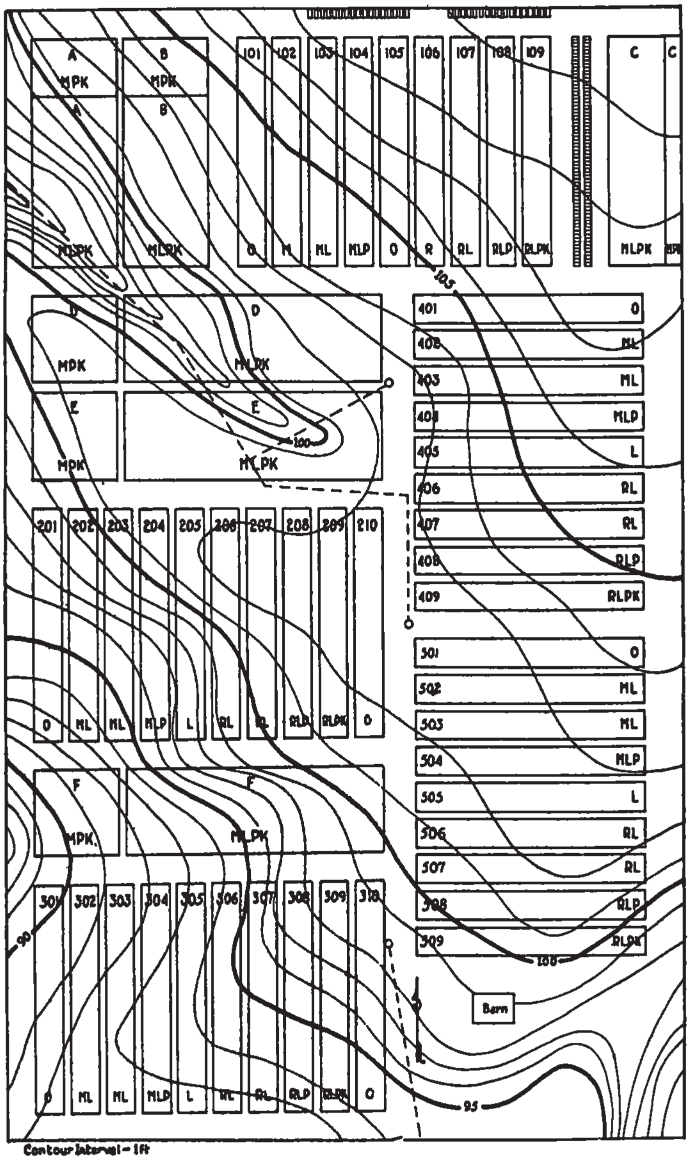

FIG. 8.—DIAGRAM OF THE WEST SALEM SOIL EXPERIMENT FIELD

This diagram shows the arrangement of plots, the soil treatments applied and, by means of contour lines, the natural drainage.

With this variation in the slope of the land it is natural that there would be some corresponding variation in soil type. The predominating types on the field are as follows: Gray Silt Loam On Tight Clay and Yellow-Gray Silt Loam On Tight Clay on the more or less flat-lying portions; Gray Silt Loam On Orange-Mottled Tight Clay and Yellow-Gray Silt Loam On Compact Medium Plastic Clay on the gently rolling areas.

This field has been in operation since 1912 and the experiments as conducted at present may be described under three general headings: the Major Series, the Minor Series, and the Small Plots.

The Major Series

In order to avoid some of the irregularities in the lay of the land, the five groups of plots numbered in the 100, 200, 300, 400, and 500 series and constituting the major series, are distributed over the field in the somewhat irregular fashion shown on the diagram (Fig. 8). Each plot is one-fifth acre in size and there are either 9 or 10 plots in a series. These series are under a crop rotation of corn, soybeans, oats, clover, and wheat. Alsike clover was used until 1920, when sweet clover was substituted, but in 1929 another change was made, the sweet clover being replaced by a timothy-clover mixture.

The soil treatment on these plots follows, in the main, the somewhat standard system described on page 52. An important exception, however, is in the limestone treatment on Plots 2, 5, and 6 which, thru mistake, received the initial application of 4 tons of limestone per acre the same as the regular limestone plots. No more limestone, however, has been added to these plots since this first application in 1912, while the limestone plots proper received their regular periodic applications until 1923.

The rock-phosphate applications were likewise discontinued in 1923, after the phosphate plots had received a total of 4 tons an acre. The practice of returning the wheat straw to the land was dropped in 1924.

Since the results from the West Salem field should be of particular interest in Edwards county, a complete record of all crops grown is included in this Report. The crop yields for every year since the beginning of the experiments on the major series are recorded in Table 7. A summary of these results, showing the average annual yields for the different kinds of crops, including the years since the complete soil treatments have been in effect, will be found in Table 8. The lower part of the table brings out the various direct comparisons between treatments.

In looking over these results one observes first the naturally low plane of productiveness of this land. About 8 bushels of corn, less than 2 bushels of wheat, and absolutely no clover represent the production on an acre of untreated soil, as shown in the results of Plot 1.

On account of the above-mentioned mistake in applying the limestone, these plots afford no test of the effect of organic manures used alone. The effect of manure applied periodically in conjunction with the single application of limestone has proved particularly beneficial to the corn crop, as observed by comparing Plot 2 with Plot 5. A comparison of Plot 6 with Plot 5 shows a beneficial effect produced by crop residues altho less marked than that produced by manure.

Limestone stands out on this land as the prominent agent in soil improvement. Thru the mistake in applying limestone, as explained above, these experiments afford an interesting comparison of two kinds of liming treatment: one in which only an initial application at the rate of 4 tons per acre was made,

TABLE 7.—WEST SALEM FIELD: MAJOR SERIES
Annual Crop Yields—Bushels or (tons) per acre

Plot No.	Soil treatment applied	1912 Oats[2]	1913 Soybeans[4]	1914 Wheat[4]	1915 Corn	1916 Soybeans	1917 Oats	1918 Clover	1919 Wheat	1920 Corn	1921 Soybeans	1922 Oats	1923 Sweet clover	1924 Wheat	1925 Corn	1926 Soybeans	1927 Oats[5]	1928 Mixed hay	1929 Wheat
101	0	14.4	(.32)	.1	15.6	(1.21)	5.8	(0)	1.7	4.7	6.0	4.7	0	2.6	4.4	3.5	....	(0)	4.2
102	M(L)[1]	14.4	(.39)	2.5	39.3	(1.86)	32.8	(.71)	10.8	22.1	8.2	13.0	.81	5.9	14.9	8.5	....	(.51)	17.6
103	ML	11.7	(.36)	2.7	36.6	(1.57)	35.8	(.65)	11.8	33.9	8.8	16.9	1.14	9.7	15.1	10.7	....	(1.24)	21.0
104	MLP	12.0	(.39)	7.4	38.9	(1.68)	41.4	(.72)	19.3	35.7	9.8	18.0	.37	18.8	15.8	10.8	....	(2.01)	28.2
105	(L)[1]	11.7	2.8	2.8	22.4	8.6	32.7	.75	7.6	8.4	7.7	9.7	.66	2.9	5.8	5.2	....	(.35)	11.3
106	R(L)[1]	10.2	3.3	2.3	31.5	11.8	35.2	1.00	9.7	14.1	9.2	12.8	.92	5.8	9.2	5.8	....	(.41)	13.6
107	RL	10.9	3.4	3.3	35.8	13.8	35.2	1.00	14.7	11.2	9.7	14.7	.81	14.4	9.3	8.6	....	(1.04)	15.2
108	RLP	11.1	3.7	7.9	43.7	16.9	40.6	1.25	21.8	25.3	10.6	16.3	.26	27.2	10.7	9.7	....	(1.60)	19.1
109	RLPK	11.3	4.8	8.8	49.3	18.9	49.2	1.25	25.4	44.9	13.7	17.0	.55	30.2	16.9	13.2	....	(1.98)	25.8
110	0	10.8	3.7	.2	16.8	(.97)	17.2	(0)	3.6	11.5	6.3	6.3	0	1.4	7.4	5.0	....	(0)	3.2
		Cowpeas[2]	Oats[4]	Soybeans[4]	Wheat[4]	Corn	Soybeans	Oats	Soybeans	Wheat	Corn	Soybeans	Oats	Sweet clover	Wheat	Corn	Soybeans	Oats Stubble hay	Mixed hay
201	0	(1.05)	7.3	(.18)	3.5	25.4	(1.06)	25.0	(.82)	.2	25.5	10.0	16.7	0	20.6	13.2	0	7.8 (0)	(.77)
202	M(L)[1]	(1.05)	7.3	(.20)	6.6	40.8	(1.22)	38.8	(1.08)	3.5	41.1	10.7	26.9	1.18	20.4	23.3	10.3	28.0 (.29)	(1.17)
203	ML	(.85)	6.4	(.19)	6.2	38.1	(1.03)	35.9	(1.08)	3.8	42.0	10.8	28.3	4.83	15.8	19.5	16.0	35.2 (.47)	(1.30)
204	MLP	(.88)	7.0	(.23)	12.6	41.5	(1.21)	42.7	(1.20)	4.8	43.8	12.7	33.9	5.58	30.7	24.7	18.4	32.5 (.58)	(2.02)
205	(L)[1]	(.82)	5.6	.9	5.2	26.3	5.7	35.0	(.76)	1.0	22.1	7.7	14.1	0	11.0	7.8	3.1	5.6 (.01)	(.20)
206	R(L)[1]	(3)	6.1	.8	6.8	33.4	7.5	33.1	5.8	.9	28.9	8.7	20.8	0	13.4	11.3	7.0	8.9 (.07)	(.44)
207	RL	(3)	5.2	.9	8.2	34.7	8.0	40.2	7.2	2.7	33.8	11.6	29.2	3.92	20.2	16.2	10.2	28.3 (.20)	(.93)
208	RLP	(3)	7.3	1.6	15.7	49.6	10.7	46.1	9.6	3.5	39.8	15.3	29.7	5.08	35.4	27.4	16.5	39.5 (.46)	(1.49)
209	RLPK	(3)	8.6	1.2	22.7	48.0	10.6	49.5	9.7	7.8	39.9	15.8	33.0	5.67	39.8	22.7	21.2	42.0 (.64)	(1.91)
210	0	(.94)	6.1	(.09)	1.7	15.3	(.46)	23.0	3.7	0	19.3	6.8	12.7	0	9.6	10.9	0	6.9 (0)	(.52)
		Corn[2]	Soybeans[4]	Oats[4] Oat hay	Soybeans[4]	Wheat[4]	Corn	Soybeans	Oats	Soybeans	Wheat	Corn	Soybeans	Oats	Sweet clover	Wheat	Corn	Soybeans	Wheat
301	0	14.8	(.67)	1.1 (.11)	(1.40)	0	17.8	(.95)	6.6	(.13)	5.0	24.8	6.4	22.0	1.19	7.4	12.2	(.40)	6.0
302	M(L)[1]	20.2	(.59)	1.2 (.12)	(.90)	.1	29.4	(1.19)	13.0	(.36)	8.5	34.2	8.2	31.6	2.05	14.8	28.4	(1.18)	11.0
303	ML	17.3	(.67)	.9 (.16)	(.90)	.1	34.2	(1.29)	15.6	(.73)	11.7	41.6	11.0	41.1	3.83	28.7	37.2	(1.58)	18.1
304	MLP	12.2	(.64)	1.1 (.19)	(.98)	.3	34.1	(1.41)	17.7	(.56)	14.5	45.0	11.2	42.7	2.78	32.6	51.2	(1.70)	21.2
305	(L)[1]	9.9	4.2	.5 (.21)	6.4	.1	16.7	(.62)	10.6	3.2	7.7	15.6	5.3	12.8	.17	4.7	5.6	(.72)	7.4
306	R(L)[1]	12.8	4.7	.3	8.2	.1	25.0	6.6	15.5	3.5	9.6	22.2	7.6	21.4	.75	11.3	8.9	(.85)	8.7
307	RL	12.5	5.8	1.1	8.2	.1	29.5	7.1	15.8	6.6	11.0	27.2	8.8	34.8	3.00	19.9	15.7	(1.18)	15.7
308	RLP	8.7	5.2	1.7	9.8	.1	29.7	8.8	18.0	6.5	14.8	29.8	10.9	45.3	3.08	28.2	19.4	(1.55)	17.3
309	RLPK	14.7	4.9	1.9	13.6	1.2	47.4	11.8	21.4	10.4	18.8	48.6	12.4	45.3	4.50	34.2	40.8	(1.80)	20.1
310	0	12.9	3.9	.5 (.04)	(.99)	0	10.3	3.4	5.6	(.23)	1.6	12.9	4.1	5.6	0	.9	3.0	(.40)	1.3

[1]Parentheses enclosing the letter L indicate one application of limestone only. [2]No treatment. [3]Growth plowed down. [4]No manure. [5]Crop failure.

TABLE 7.—*Concluded*

Bushels or (tons) per acre

Plot No.	Soil treatment applied	1912 Oats[2]	1913 Corn	1914 Soybeans	1915 Oats	1916 Clover	1917 Wheat	1918 Corn	1919 Soybeans	1920 Oats Stubble clover	1921 Sweet clover	1922 Wheat	1923 Corn	1924 Soybeans	1925 Oats	1926 Sweet clover	1927 Wheat Stubble clover	1928 Corn	1929 Oats
401	0	16.4	5.0	(.40)	13.6	(0)	2.2	9.6	(.80)	1.4 (0)	0	2.8	19.5	3.5	3.3	0	2.6 (0)	5.0	32.3
402	M(L)[1]	16.6	6.4	(.50)	19.1	(0)	6.8	15.9	(1.30)	15.0 (.20)	1.08	11.0	52.0	8.9	23.4	.72	14.5 (0)	15.5	43.6
403	ML	19.5	10.8	(.58)	10.5	(0)	10.1	17.2	(1.25)	16.2 (.25)	1.25	15.8	59.7	11.3	33.3	2.17	22.9 (.55)	28.5	60.9
404	MLP	17.0	9.4	(.81)	24.2	(.76)	16.8	18.0	(1.24)	23.1 (.32)	.92	19.3	57.9	11.8	36.7	1.92	27.8 (.62)	32.4	63.1
405	(L)[1]	15.2	5.4	4.5	28.3	.42	11.2	11.4	3.8	6.4 (.16)	.75	9.1	31.2	6.1	12.2	0	10.3 (0)	13.0	35.3
406	R(L)[1]	17.7	10.6	6.7	21.7	.92	12.5	17.8	5.0	13.3 (.36)	.75	12.7	38.3	7.5	18.6	.42	13.2 (0)	23.8	43.0
407	RL	18.0	9.3	7.4	23.0	.83	13.0	21.7	6.4	16.6 (.44)	1.25	13.6	38.7	10.5	29.4	2.17	16.6 (.47)	32.1	54.5
408	RLP	7.0	20.5	10.2	22.3	1.17	21.6	27.4	7.8	19.4 (.61)	1.25	21.7	50.2	12.7	37.5	1.98	28.9 (.73)	30.3	70.5
409	RLPK	12.2	14.2	9.6	30.9	2.17	23.3	28.2	5.6	15.6 (.71)	1.42	20.3	57.9	12.9	46.1	2.04	33.1 (1.05)	35.0	61.6
		Cowpeas[2]	Wheat[4]	Corn	Soybeans	Oats	Soybeans	Wheat	Corn	Soybeans	Oats	Sweet clover	Wheat	Corn	Soybeans	Oats	Sweet clover	Spring wheat	Corn
501	0	(.44)	.9	7.7	(.98)	2.5	(.33)	0	5.0	(.30)	19.5	0	1.9	6.5	(.18)	0	0	.2	7.9
502	M(L)[1]	(.41)	3.8	12.6	(1.70)	19.4	(.77)	4.5	28.0	(.68)	49.2	2.08	12.2	31.2	(.45)	14.7	.92	7.9	36.3
503	ML	(.46)	5.1	8.6	(1.71)	18.6	(.71)	8.1	32.1	(.42)	52.5	3.25	14.4	35.8	(.52)	18.8	1.50	8.2	42.6
504	MLP	(.68)	3.8	8.6	(1.53)	20.6	(.86)	11.0	36.5	(.73)	56.9	2.33	17.9	40.5	(.55)	23.9	.67	11.6	47.6
505	(L)[1]	(.66)	3.8	8.4	10.9	15.8	8.1	7.6	23.1	5.3	36.7	1.58	8.2	19.6	(.38)	5.5	.06	4.6	14.8
506	R(L)[1]	.. ([3])	5.7	12.4	13.2	18.6	7.4	7.3	24.8	7.2	37.8	2.00	6.9	28.7	(.40)	10.9	.06	6.2	24.6
507	RL	.. ([3])	4.4	11.2	12.0	18.4	6.6	7.2	26.2	8.5	41.7	2.92	7.1	31.9	(.48)	17.5	1.08	7.8	25.3
508	RLP	.. ([3])	7.8	13.5	12.6	23.4	8.5	12.5	32.1	8.6	54.1	3.08	11.7	42.7	(.55)	25.5	.59	12.5	27.8
509	RLPK	.. ([3])	11.1	17.2	13.2	27.0	8.8	18.2	36.6	11.6	54.1	3.33	19.3	51.1	(.55)	37.0	1.17	16.7	52.2

[1]Parentheses enclosing the letter L indicate one application of limestone only. [2]No treatment. [3]Growth plowed down in 1912. [4]No manure.

TABLE 8.—WEST SALEM FIELD, MAJOR SERIES: SUMMARY OF CROP YIELDS
Average Annual Yields 1913-1929—Bushels or (tons) per acre

Serial plot No.	Soil treatment applied	Corn	Oats	Wheat	Soybeans	Legume hay[2]	Sweet clover	Stubble clover
		17 crops	*15 crops*	*14 crops*	*15 crops*	*7 crops*	*7 crops*	*2 crops*
1	0	12.4	10.7	4.1	6.1	(.29)	.19	(0)
2	M(L)[1]	27.7	24.6	10.7	10.4	(.66)	1.29	(.10)
3	ML	31.4	28.0	14.3	11.2	(.81)	2.60	(.40)
4	MLP	34.2	31.8	19.6	12.2	(1.15)	2.13	(.47)
5	(L)[1]	15.2	17.4	7.5	6.1	(.52)	.48	(.08)
6	R(L)[1]	21.4	19.7	9.4	7.8	(.63)	.75	(.18)
7	RL	24.1	26.6	12.8	9.3	(.83)	2.23	(.48)
8	RLP	30.6	32.5	19.7	11.5	(1.14)	2.28	(.67)
9	RLPK	38.3	35.4	23.8	12.9	(1.46)	2.78	(.90)
	Crop Increases							
	M(L) over (L)	12.5	7.2	3.2	4.3	(.14)	.81	(.02)
	R(L) over (L)	6.2	2.3	1.9	1.7	(.11)	.27	(.10)
	(L) over 0	2.8	6.7	3.4	0	(.23)	.29	(.08)
	ML over M(L)	3.7	3.4	3.6	.8	(.15)	1.31	(.30)
	RL over R(L)	2.7	6.9	3.4	1.5	(.20)	1.48	(.30)
	MLP over ML	2.8	3.8	5.3	1.0	(.34)	−.47	(.07)
	RLP over RL	6.5	5.9	6.9	2.2	(.31)	.05	(.19)
	RLPK over RLP	7.7	2.9	4.1	1.4	(.32)	.50	(.23)

[1]Parentheses enclosing the letter L indicate one application of limestone only. [2]Including some seed crops evaluated as hay.

and the other in which the regular periodic applications were continued for twelve years, during which time an average of 8½ tons an acre has been applied. These two liming treatments are indicated in the tables by the use of the symbol L for the regular repeated applications and (L) for the single application.

The single treatment of limestone has produced an annual increase of 6.6 bushels of corn an acre, nearly 11 bushels of oats, about 5 bushels of wheat, and about ½ ton of hay, over the untreated land.

Of great practical concern is the lasting effect of limestone, and in this connection some interesting data are furnished by comparing the crops produced year by year from the single treatment with those produced by the continued application. The figures shown in Table 9 furnish such a comparison. The data include the results of both livestock and grain systems of farming reduced to terms of increase in value per acre of crop yields.

During the first nine years after the single 4-ton application there was a constantly increasing response to the treatment, after which time the beneficial effect gradually diminished. Also, during the first few years the continued applications showed little or no advantage over the single treatment, but as the effect of the single treatment began to decline, the advantage of the continued applications came more and more in evidence. Thus it appears that under the conditions of this experiment a single 4-ton application of limestone was fully as effective as the continued liming treatment for a period of at least nine years.

Regarding the response to rock phosphate on this field it may be said that, considering the cost of material, the gains from its use in the manure system have

TABLE 9.—COMPARISON BETWEEN A SINGLE AND REPEATED APPLICATIONS OF LIMESTONE
West Salem Field 1912-1929

YEAR	Value of crop increases for a single application of limestone[1]	Value of crop increases for repeated applications of limestone[1]	
		Livestock system	Grain system
1912	$− .31	$− .52	$− .28
1913	1.14	1.07	1.34
1914	1.23	1.16	1.27
1915	1.43	1.02	1.55
1916	1.85	1.60	2.07
1917	2.66	2.65	2.95
1918	3.39	3.39	3.92
1919	3.86	4.11	4.67
1920	3.89	4.75	4.44
1921	2.76	3.82	4.05
1922	2.76	3.48	4.62
1923	2.82	4.93	4.61
1924	2.60	6.48	6.31
1925	1.72	5.96	6.55
1926	.93	6.06	6.72
1927	.54	5.77	6.44
1928	.49	6.09	7.33
1929	.97	5.33	6.23

[1]Crop values used were as follows: corn, 50 cents; oats, 30 cents; wheat $1.00; soybeans,$1.00 a bushel; and hay $10 a ton.

been scarcely sufficient to pay the expense. In the residues system, however, phosphate used in connection with residues and limestone has given profitable returns.

Used in combination with residues, lime, and phosphate, the potassium compound has produced profitable increases in crop yield, the beneficial effect being greatest on the corn crop.

The Minor Series

Plots A, B, C, D, E, and F, constituting the minor series, differ in shape and size from the regular plots, as indicated on the diagram in Fig. 8. In the earlier years these plots were used for a five-year rotation of potatoes, corn, soybeans, wheat, and sweet clover, with alfalfa on the sixth plot for a period of six years, after which it was shifted. These plots received manure, limestone, rock phosphate, and kainit. In 1921 the rotation was divided into two three-year rotations. On Plots A, B, and C a rotation of wheat and sweet clover on two plots, with a mixture of timothy, alsike, and red clover on the third plot for a period of three years, was used. On Plots D, E, and F a rotation was planned consisting of corn, wheat (with sweet clover) on two plots, while the hay mixture mentioned above was grown on the third plot for three years. Each plot is divided and one part receives manure, phosphate, and potassium while the remainder receives limestone in addition to this combination.

The annual acre-yields are recorded in detail in Table 10 and these results are summarized in Table 11. The results for the limestone treatment confirm those of the major series in showing the beneficial effect of this material.

TABLE 10.—WEST SALEM FIELD: MINOR SERIES
Annual Crop Yields—Bushels or (tons) per acre

Plot	Soil treatment applied	1913 Pota.	1914 Corn	1915 Soy-beans	1916 Wheat	1917 Sweet clover	1918 Pota.	1919 Kaffir corn	1920 Soybeans	1921 Wheat	1922 Sweet clover	1923 Wheat	1924 Sweet clover	1925 Wheat	1926 Sweet clover	1927 Mixed hay	1928 Mixed hay	1929 Mixed hay
A	MLPK.........	6.7	18.2	5.9	1.0	(1.25)	28.1	(3.00)	5.2	10.6	1.70	11.4	3.70	29.2	1.67	(1.89)	(2.84)	(1.84)
	MPK...........	4.3	5.1	1.9	0	(0)	34.4	(1.71)	1.4	7.8	0	5.0	0	13.7	0	(.33)	(0)	(.56)
		Corn[1]	Soy-beans[1]	Wheat[1]	Sweet clover[1]	Pota.	Sor-ghum[3]	Soy-beans	Wheat Stubble clover	Sweet clover	Wheat	Sweet clover	Tim.	Tim., clover	Tim., clover	Wheat Stubble clover	Sweet clover	Wheat
B	MLPK.........	10.8	1.3	4.3	.85	29.6	.....	(.84)	4.7 (.23)	.78	24.3	.35	(2.57)	(1.14)	(1.21)	19.1 (1.31)	.39	23.5
	MPK...........	10.5	.8	5.9	.11	15.2	.....	(.35)	.4 (0)	0	8.9	.30	(.91)	(.31)	(.28)	22.0 (0)	0	6.8
		Soy-beans[1]	Wheat[1]	Sweet clover[1]	Pota.	Corn	Soy-beans	Wheat	Sweet clover	Tim. mix.	Tim.	Tim.	Sweet clover	Sweet clover	Wheat	Sweet clover	Spring wheat	Sweet clover
C	MLPK.........	3.2	9.5	(2.35)	42.7	34.5	(1.03)	22.3	(1.19)	(.82)	(2.58)	(2.64)	(2.23)	6.25	38.0	1.08	18.2	.51
	MPK...........	2.3	1.0	(1.43)[2]	9.2	11.6	(.38)	7.3	(0)	(.16)	(.99)	(1.14)	(.79)	2.00	16.2	0	5.3	0
		Wheat[1]	Sweet clover[1,3]	Pota.	Corn	Soy-beans	Wheat	Legume hay	Potatoes	Wheat	Corn	Wheat	Corn	Wheat	Corn	Mixed hay	Mixed hay	Mixed hay
D	MLPK.........	} 7.8	.....	123.4	42.8	8.5	10.9	(3.66)	15.2	24.8	54.5	8.6	44.9	18.6	25.5	(1.27)	(2.29)	(1.16)
	MPK...........		.....	45.1	22.8	3.4	7.6	(.29)	14.7	14.9	25.9	4.9	12.4	5.3	12.2	(.26)	(.12)	(.40)
		Oats[1]	Pota.	Corn	Soy-beans	Wheat	Sweet clover	Alfalfa	Alfalfa[3]	Corn	Wheat	Corn	Soy-beans	Tim., clover	Tim., clover	Wheat Stubble clover	Corn	Wheat
E	MLPK.........	6.6	2.8	63.9	12.9	25.6	(1.20)	(1.01)	.....	42.2	18.8	51.9	(1.25)	(.87)	(1.72)	23.9 (1.63)	36.2	18.7
	MPK...........	0	.6	38.6	2.1	8.5	(0)	(0)	.....	31.3	11.9	40.7	(.69)	(.34)	(0)	23.2 (0)	16.0	8.2
		Alfalfa	Alfalfa[3]	Alfalfa	Alfalfa[3]	Alfalfa	Alfalfa	Pota.	Soybeans	Tim. mix.	Tim.	Tim.	Sweet clover	Corn	Wheat	Corn	Spring wheat	Corn
F	MLPK.........	(1.10)	.....	(4.33)	.....	(1.69)	(1.70)	1.9	10.4	(1.44)	(2.47)	(2.51)	(1.47)	21.3	40.2	11.0	10.2	30.4
	MPK...........	(.24)[2]	.....	(.55)[2]	.....	(.36)[2]	(0)	0	7.1	(.66)	(1.53)	(1.53)	(.50)	15.0	20.4	8.0	3.4	25.4

[1]No manure. [2]Growth mostly weeds. [3]No yields taken.

TABLE 11.—WEST SALEM FIELD, MINOR PLOTS: SUMMARY OF CROP YIELDS
Average Annual Yields 1921-1929—Bushels or (tons) per acre

Soil treatment applied	Plots A, B, C Rotation: wheat, sweet clover, mixed hay				Plots D, E, F Rotation: wheat (with sweet clover), corn, mixed hay				
	Wheat *8 crops*	Sweet clover *9 crops*	Stubble clover *2 crops*	Mixed hay *9 crops*	Wheat *8 crops*	Corn *9 crops*	Soy-beans *1 crop*	Stubble clover *2 crops*	Mixed hay *8 crops*
MLPK	21.7	1.83	(1.77)	(1.95)	20.4	35.3	(1.25)	(1.55)	(1.71)
MPK	10.7	.26	(.40)	(.52)	11.5	20.8	(.69)	(.25)	(.60)
Crop Increases									
MLPK over MPK	11.0	1.57	(1.37)	(1.43)	8.9	14.5	(.56)	(1.30)	(1.11)

The Small Plots

In 1929 certain new lines of work of more intensive nature were started on the West Salem field, for which purpose two sets of small plots were laid out. One set, located on old Plot 110, is given over to a study of the relation between soil reaction and the availability of phosphorus in rock phosphate. The other set of small plots is located along the edge of the north border and is to be devoted to a study of the effect of sodium nitrate applied as a top dressing to wheat. Since this small-plot work has just been initiated, no results have yet been obtained.

THE RALEIGH FIELD

Two series of plots on the Raleigh experiment field located in Saline county are fairly representative of Yellow-Gray Silt Loam On Tight Clay as it occurs in Edwards county. The results of Series 200 and 300 on this field are therefore presented here.

The layout and soil treatments on these series of plots are in accordance with the standard plan described above (page 52). The cropping program has included wheat, corn, oats, and a legume in rotation, the legume being either soybeans, clover, or a clover-timothy mixture. A summary of the results in form of the average annual yields is given in Table 12.

The figures show some increases for the use of manure, but very little benefit from residues alone. Limestone used either with manure or with residues has produced very substantial gains. Rock phosphate in combination with organic manure and limestone has produced in general small increases in all crops, but the gains are by far too small to cover the cost of material.

Potassium applied in the form of kainit has produced a 3-bushel increase in wheat and more than a 7-bushel increase in corn, but the effect on other crops is not significant. These results suggest the possibility of reducing the amount of kainit used to about one-half the present quantity, thereby reducing the expense. It might be that such a modification of the practice would result in profitable returns for the use of potassium on this soil.

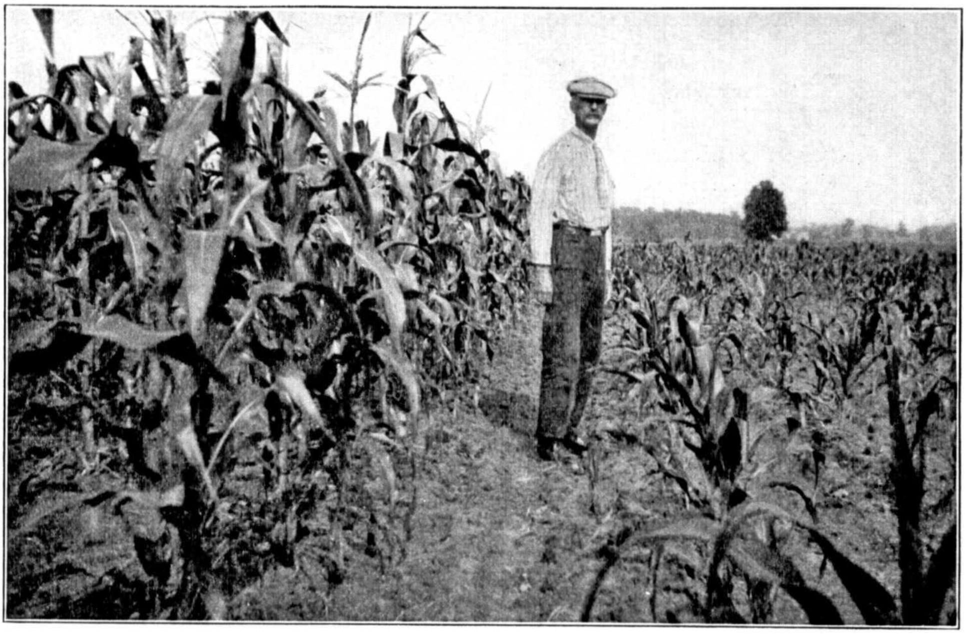

FIG. 9.—CORN ON THE RALEIGH FIELD

At the right no treatment has been applied; at the left, manure, limestone, and phosphate have been applied, the major effect being produced by limestone and manure.

FIG 10—CORN ON THE RALEIGH FIELD

The treatment here is the same as that shown in Fig. 9 except that no manure is used, the organic matter being supplied by crop residues, including stalks, straw, and legumes plowed under.

TABLE 12.—RALEIGH FIELD, SERIES 200 AND 300: SUMMARY OF CROP YIELDS
Average Annual Yields 1912-1929—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Wheat *6 crops*	Corn *10 crops*	Oats *10 crops*	Soybeans *6 crops*	Mixed hay *2 crops*
1	0	2.2	11.4	10.1	(.64)	(.13)
2	M	4.5	23.4	15.6	(.83)	(.06)
3	ML	12.8	40.0	26.3	(1.29)	(.60)
4	MLP	14.6	41.9	25.9	(1.42)	(.68)
5	0	2.6	12.2	10.6	(.46)	(0)
	R	3.9	16.4	13.5	(.51)	(0)
7	RL	10.0	34.8	23.9	(1.00)	(.18)
8	RLP	11.5	39.9	26.4	(1.12)	(.32)
9	RLPK	14.5	47.3	27.3	(1.21)	(.60)
10	0	4.5	19.7	14.0	(.83)	(.06)
	Crop Increases					
	M over 0	2.3	12.0	5.5	(.19)	–(.07)
	R over 0	1.3	4.2	2.9	(.05)	(0)
	ML over M	8.3	16.6	10.7	(.46)	(.54)
	RL over R	6.1	18.4	10.4	(.49)	(.18)
	MLP over ML	1.8	1.9	– .4	(.13)	(.08)
	RLP over RL	1.5	5.1	2.5	(.12)	(.14)
	RLPK over RLP	3.0	7.4	.9	(.09)	(.28)

THE SPARTA FIELD

Field experiments on soil representative of the type Light Gray Silt Loam On Tight Clay have been conducted on the Sparta field. This field, which was established in 1916, is located in Randolph county at the north edge of the town of Sparta. For the present purpose the discussion will be confined to the plots of Series 200, 300, and 400.

These plots are under a crop rotation of corn, soybeans, wheat, and clover, chiefly sweet clover. Formerly cowpeas were sown in the corn as a cover crop on the residues plots, but this practice has been abandoned as unprofitable. The soil treatments are as indicated in the accompanying table, and they have been applied in the manner previously described, page 52, with the exception that the initial application of limestone was at the rate of 5 tons an acre instead of 4 tons. A summary of the average annual yields of the respective crops, including the years since the complete plot treatments have been in effect, are given in Table 13.

The low yields on the untreated plots testify to the natural poverty of this soil, altho this particular piece of land, on account of its favorable location with respect to drainage, is regarded as rather more productive than the general run of the type that it represents. Neither manure alone nor residues alone has much effect in improving crop yields. A sharp increase, however, follows the application of limestone used either with manure or with residues. Without limestone, clover refuses to grow; with limestone, fair crops of clover have been obtained.

TABLE 13.—SPARTA FIELD, SERIES 200, 300, 400: SUMMARY OF CROP YIELDS
Average Annual Yields 1917-1929—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Corn *10 crops*	Soybeans *10 crops*	Wheat *8 crops*	Oats *1 crop*	Clover *1 crop*
1	0	17.3	5.9	3.7	24.4	(0)
2	M	22.4	7.7	6.6	21.9	(0)
3	ML	32.7	14.6	15.9	39.1	(2.06)
4	MLP	34.9	14.8	16.7	40.0	(1.75)
5	0	13.0	3.9	4.9	8.1	(0)
6	R	18.6	5.1	5.0	16.9	(0)
7	RL	26.5	12.8	15.1	34.4	(1.59)
8	RLP	26.1	13.3	16.2	32.5	(1.72)
9	RLPK	33.4	14.2	16.6	34.7	(2.74)
10	0	11.6	3.7	3.9	15.0	(0)
	Crop Increases					
	M over 0	5.1	1.8	2.9	−2.5	(0)
	R over 0	5.6	1.2	.1	8.8	(0)
	ML over M	10.3	6.9	9.3	17.2	(2.06)
	RL over L	7.9	7.7	10.1	17.5	(1.59)
	MLP over ML	2.2	.2	.8	.9	−(.31)
	RLP over RL	− .4	.5	1.1	−1.9	(.13)
	RLPK over RLP	7.3	.9	.4	2.2	(1.02)

Rock phosphate has produced no significant effect whether used with manure or with residues. Potassium seems to have been of some benefit to the corn and clover. It is possible that the application of smaller quantities of potassium directly to these crops would prove a more economical way to use potassium fertilizer on this soil.

On the whole the experimental results on the Sparta field are similar to those of the Raleigh field in showing a very positive need for limestone and organic matter, with the possibility of a profitable response from potassium fertilizer if used in moderate quantity.

It should be observed that altho a very decided response to proper soil treatment is manifested, amounting to several hundred percent increase in yield, yet under the best treatment the general plane of production is relatively low. These experimental results are valuable in indicating principles, but it is easy to perceive that if farming on this land is to be made profitable, other systems of management than the cropping system of these experiments must be employed. Such systems would include the raising of some livestock and perhaps the introduction of certain crop specialties.

THE ENFIELD FIELD

As representing the soil type Yellow-Gray Silt Loam On Medium Plastic Clay, results from experiments of certain plots on the Enfield field are introduced. This field is located in White county about a mile east of Enfield and has been in operation since 1912. The somewhat standard cropping system and

TABLE 14.—ENFIELD FIELD, SERIES 100: SUMMARY OF CROP YIELDS
Average Annual Yields 1915-1929—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Wheat *3 crops*	Corn *4 crops*	Oats *4 crops*	Soybeans *1 crop*	Sweet clover *1 crop*	Mixed hay *2 crops*
1	0	5.4	13.8	11.8	(.99)	(0)	(.07)
2	M	8.6	25.6	18.2	(1.14)	(0)	(.45)
3	ML	16.7	33.9	33.6	(1.62)	(.75)	(2.01)
4	MLP	20.7	36.1	34.7	(1.96)	(.75)	(2.23)
5	0	8.3	14.6	10.8	(.50)	(0)	(.27)
6	R	8.6	18.6	10.7	(.50)	(0)	(.22)
7	RL	19.9	28.5	28.7	(1.35)	(.50)	(1.55)
8	RLP	23.5	30.7	32.5	(1.56)	(.58)	(1.75)
9	RLPK	25.9	39.0	39.0	(1.50)	(.67)	(2.23)
10	0	10.8	20.8	12.0	(1.22)	(0)	(.30)
	Crop Increases						
	M over 0	3.2	11.8	6.4	(.15)	(0)	(.38)
	R over 0	.3	4.0	− .1	(0)	(0)	−(.05)
	ML over M	8.1	8.3	15.4	(.48)	(.75)	(1.56)
	RL over R	11.3	9.9	18.0	(.85)	(.50)	(1.33)
	MLP over ML	4.0	2.2	1.1	(.34)	(0)	(.22)
	RLP over RL	3.6	2.2	3.8	(.21)	(.08)	(.20)
	RLPK over RLP	2.4	8.3	6.5	−(.06)	(.09)	(.48)

soil-treatment methods described on page 52 were established on Series 100, 200, 300, and 400. On account of some variation in soil type, however, only Series 100 will be considered for the present purpose.

The crops grown have been wheat, corn, oats, soybeans, sweet clover, and mixed hay. The annual average yields for the various soil treatments are set forth in Table 14.

According to these data there is considerable response to stable manure even where used alone. There is, however, very little response to residues where used without supplementary treatment. Limestone is highly effective used either with manure or with residues.

Rock phosphate has produced some increases in nearly all crops in both manure and residues systems, but these gains are scarcely sufficient in either system to render the use of this material remunerative. Kainit has made a fairly good record, particularly in the corn and hay yields. In fact these results seem to justify the recommendation of a trial of some form of potassium fertilizer used in moderate quantity along with limestone and organic manure on this soil type.

THE ELIZABETHTOWN FIELD

A description of the soil of the Elizabethtown field corresponds closely to that of the Reddish Yellow-Gray Silt Loam and the Reddish Yellow Silt Loam found on much of the rolling and hilly land in Edwards county. The results of experiments on this field, therefore, should be of interest in connection with the management of these and closely related soil types.

TABLE 15.—ELIZABETHTOWN FIELD, MAJOR SERIES: SUMMARY OF CROP YIELDS
Average Annual Yields 1919-1929—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Wheat *16 crops*	Corn *11 crops*	Soybeans *4 crops*	Sweet clover *3 crops*	Mixed hay *6 crops*
1	0[1]	6.5	19.0	4.7	0	(.18)
2	M	6.5	18.2	4.1	0	(.33)
3	ML	12.3	34.2	6.2	2.01	(1.30)
4	MLP	16.1	40.2	7.8	3.02	(1.81)
5	0[1]	3.9	11.6	2.7	0	(.17)
6	R	4.1	15.4	2.9	0	(.26)
7	RL	9.5	33.3	5.3	2.32	(1.10)
8	RLP	15.1	44.0	7.2	2.67	(1.70)
9	RLPK	16.5	43.6	6.9	2.62	(2.12)
10	0[1]	6.8	21.8	4.4	0	(.14)
	Crop Increases					
	M over 0[1]	2.6	6.6	1.4	0	(.16)
	R over 0[1]	.2	3.8	.2	0	(.09)
	ML over M	5.8	16.0	2.1	2.01	(.97)
	RL over R	5.4	17.9	2.4	2.32	(.84)
	MLP over ML	3.8	6.0	1.6	1.01	(.51)
	RLP over RL	5.6	10.7	1.9	.35	(.60)
	RLPK over RLP	1.4	− .4	− .3	− .05	(.42)

[1]Plot 5 is used in this case as the only check plot.

The Elizabethtown field is located in the southern part of Hardin county on very hilly land. A topographic map shows a range in elevation of 42 feet on that part of the field occupied by the present plots. Erosion is therefore a serious problem. The main experimental work is conducted on four series of plots arranged and treated in the standard fashion described on page 52. The crop rotation first adopted consisted of corn, soybeans, wheat, and sweet clover; but this was changed in 1923 to corn, wheat, timothy-clover mixture, and wheat, with a sweet-clover seeding on the residues plots.

The difficulty of obtaining satisfactory data on land of such rough topography, where washing from one plot to another is an inherent feature of the experiments, is obvious. Nevertheless there are certain effects of soil treatment standing out in such bold relief as to leave no doubt as to their significance. These effects are brought out by the data presented in Table 15, which gives a summary of the annual yields of the various crops under the respective systems of soil treatment.

The results show extremely poor yields on the untreated land, with very little improvement from the use of manure alone and still less from residues alone. A sharp increase in yield, however, follows the application of limestone, particularly where used with manure.

Thru the introduction of rock phosphate into the soil treatment system, still further gains have been produced. These gains in the manure system have been just about sufficient to cover well the cost of material, but in the residues system a very good profit has been realized from the phosphate.

The addition of potassium in the form of kainit to the combination residues, limestone, and phosphate treatment has had no significant effect on crop yields and is therefore applied at a financial loss.

An economic study of the crop-rotation period ending in 1928, in which account is taken of cost of treatment and value of crops, reveals the fact that of the eight different systems of soil treatment under comparison the residues, limestone, rock phosphate combination was the most profitable.

It is not to be inferred, however, that the general plan of farm management represented in these experiments is the best that might be applied on this land. The data show that soybeans do not thrive well on this field; they might well be replaced, therefore, by some better adapted crop. It seems possible that by modifying this cropping program and giving place to some livestock production in the system, a more profitable farming enterprise could be set up than that represented in the simple rotation employed for these experiments.

THE UNIONVILLE FIELD

The Unionville experiment field, whose soil closely resembles the type Reddish Yellow-Gray Silt Loam as found in Edwards county, is located in the extreme southern part of Illinois in Massac county immediately north of Unionville. The land is undulating in topography. The field is thoroly tile-drained.

Only one of the two general systems of plots occupying this field will be considered for the present purpose. This set of plots is made up of four series

TABLE 16.—UNIONVILLE FIELD, SERIES 100, 200, 300, 400: SUMMARY OF CROP YIELDS
Average Annual Yields 1911-1929—Bushels or (tons) per acre

Serial plot No.	Soil treatment	Corn *13 crops*	Soybeans[1] *17 crops*	Wheat *13 crops*	Cotton[2] *13 crops*	Oats *3 crops*
1	0	15.6	(.76)	5.3	171	16.3
2	M	20.8	(.90)	7.4	284	14.0
3	ML	29.4	(1.30)	13.3	464	32.9
4	MLP	29.7	(1.45)	16.5	479	32.9
5	0	13.8	(.58)	5.6	144	12.8
6	R	16.9	(.62)	6.5	130	20.0
7	RL	32.8	(.86)	14.4	233	35.1
8	RLP	36.4	(.94)	18.2	250	40.8
9	RLPK	41.4	(1.16)	20.4	442	41.0
10	0	14.2	(.67)	6.6	152	11.0
	Crop Increases					
	M over 0	5.2	(.14)	2.1	113	− 2.3
	R over 0	3.1	(.04)	.9	− 14	7.2
	ML over M	8.6	(.40)	5.9	180	18.9
	RL over R	15.9	(.24)	7.9	103	15.1
	MLP over ML	.3	(.15)	3.2	15	0
	RLP over RL	3.6	(.08)	3.8	17	5.7
	RLPK over RLP	5.0	(.22)	2.2	192	.2

[1]Including some crops of cowpea hay. [2]Yields in pounds per acre.

of ten plots each. The cropping program adopted in 1912 included corn, cowpeas, wheat, and cotton, but this rotation was changed in 1922 to corn, rye, cowpeas, and wheat, with a sweet-clover seeding on the residues plots. Two years later cotton was restored to the system, replacing rye in the rotation.

In looking over the results of the various soil treatments on this field, (Table 16), one notes the poor yields on the untreated land. Little effect has been produced by manure alone and still less by residues alone. The improvement in yields made by adding limestone is very evident.

Rock phosphate has produced moderate increases in yields, altho these increases are not sufficient to cover the cost of the material under present market conditions. Potassium likewise gives some increases in yields, particularly in corn and cotton, but as applied in the manner of these experiments it scarcely represents a profitable investment.

The above conclusions are based upon all the results obtained over the entire period since full treatment has been in effect on the respective plots. From a financial study of the rotation period ending in 1928 it appears that in the residues system the combination residues, limestone, phosphate, and kainit has proved the most effective soil treatment of those under trial, thus indicating an increasing response to phosphorus and potassium in later years—an effect that is not surprising.

THE VIENNA FIELD

Edwards county, as indicated in the descriptions of several of its soil types, includes much land that is subject to destruction thru erosion or washing. The experiments conducted on the Vienna field, in Johnson county, to test out differ-

TABLE 17.—VIENNA FIELD: HANDLING HILLSIDE LAND TO PREVENT EROSION
Average Annual Yields 1907-1915—Bushels or (tons) per acre

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

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

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

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

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

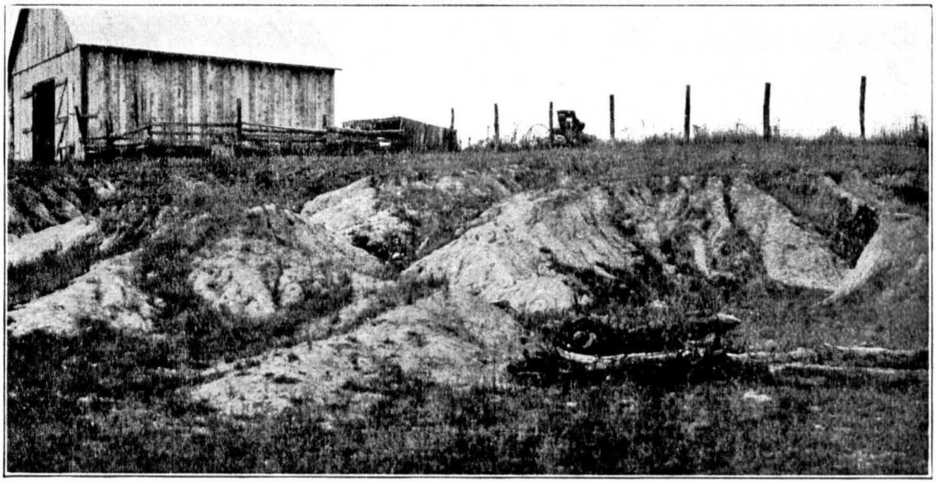

FIG 11.—PROPER SOIL AND CROPPING METHODS WOULD HAVE PREVENTED THIS CONDITION
This abandoned hillside is just over the fence from the field shown in Fig 12

ent methods of reclaiming badly gullied land and preventing further erosion will therefore be of considerable interest.

The Vienna field is representative of the sloping, erodible land so common in the extreme southern part of the state. When the experiments were started the whole field, with the exception of about three acres, had been abandoned because so much of the surface soil had washed away, and there were so many gullies that further cultivation was unprofitable. For the purpose of the experiments the field was divided into different sections (see Table 17). These were not entirely uniform, some parts were much more washed than others, and portions of the lower-lying land had been affected by soil material washed

FIG. 12.—CORN GROWING ON AN IMPROVED HILLSIDE OF THE VIENNA EXPERIMENT FIELD
This land had formerly been badly eroded. It was reclaimed by proper soil treatment and cropping. Compare with Fig. 11.

down from above The higher land had a very low producing capacity; on many spots little or nothing would grow.

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

Careful records were kept for nine years The results, summarized in Table 17, indicate something of the possibilities in improving hillside land by protecting it from erosion The average yield of corn from the protected series (A, B, and C) was 30.6 bushels an acre, as against 14.1 bushels on the check series (D). Wheat yielded 11.1 bushels on the protected series, in comparison with 4.6 bushels on the check, and clover yielded 4/5 of a ton on the protected series and but 1/5 of a ton on the check.

Figs 11 and 12 serve further to indicate what may be done with this type of soil even after it has become badly washed and gullied.

Altho these results show in principle the possibility of improving this land, it cannot be said that the experiments as conducted represent directly the most economical system of farming. However, it appears possible that by modifying the cropping plan in some manner, as for example, substituting sweet clover for cowpeas and giving large place in the farming system to hay and pasture crops, production might be substantially increased and thus a system of farming instituted that would represent a profitable enterprise

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