UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
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THE MISSOURI SOIL SURVEY

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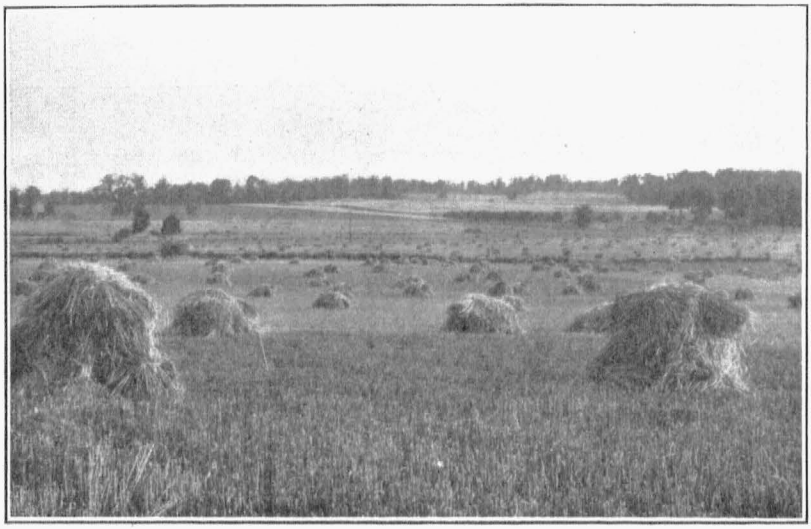


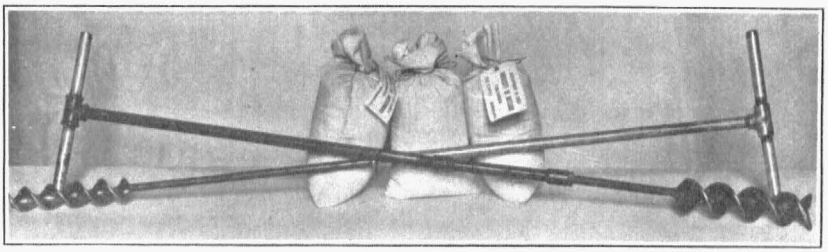
The illustration represents at least six distinct soil types. The Soil Survey has identified 175 soil types in Missouri.

The Missouri Soil Survey is making a systematic study of the soils and agricultural conditions throughout Missouri. It is meeting the increasing demand for a more definite knowledge of the state's soil conditions and soil resources. A soil survey is essentially an inventory of the soils of the state. It is a fundamental investigation of our soil resources on which all systems of agriculture must be based. It corresponds to the work of the geological survey which is investigating the mineral resources, such as coal, iron and oil, to find new deposits and determine the extent of those already known. It is equally important that the state and federal governments should make soil investigations of this kind so that this most important natural resource may be utilized to its greatest efficiency and conserved to posterity. As agriculture is the only permanent basis of our national wealth, the necessity of comprehensive studies in this field is obvious.

The soil survey work consists of field observations, supplemented by laboratory investigations, to determine the location, distribution and general

character of the various types of soils. The adaptations, utilization and deficiencies of each soil are carefully studied. An attempt is made to examine the soil on every 40-acre area, and where the soils are very complex on every 10-acre area. When the boundaries of each type are ascertained accurately they are indicated on a soil map. The examination of the soil is made by the use of a soil auger. If the soil varies greatly, many samplings or borings are necessary, and much time is required for mapping. If the soil is uniform and one type covers large areas, the mapping may proceed rapidly. For a soil survey within a state the unit area is a county. Within a county the section (640 acres) is the unit.

The completed soil map shows as accurately as possible all soils and soil boundaries. The scale of the map is one inch to a mile. In addition to showing the various soil types in colors, all roads, houses, drainage ways and other cultural features are indicated.



Soil auger, for examining soils. Samples taken during the survey consist of three parts: Soil 0 to 7 inches; subsurface 7 to 18 inches; and subsoil 18 to 36 inches.

Accompanying the map is a report which gives a general description of the physical features, climate and agricultural conditions in the county. Each soil type is described as to its general character, its location and the uses to which it is put. The methods of handling the soil are given and a general statement is also made of the range of crop production. Suggestions are made regarding the introduction of new crops and industries, regarding new methods of soil management and systems of farming. All such suggestions are based on results of field and laboratory tests by the Experiment Station.

CLASSIFICATION OF SOILS

The basis for identifying and classifying the soils is complex and cannot be defined in a brief report like this. However, such factors as color, texture, depth and fertility of the soil, character of subsoil, agricultural value, native vegetation, drainage conditions and general surface features—in fact all factors that affect the economic handling and utilization of the soil—are given consideration.

Soil Types. The unit in classification is the soil type. Each type represents all soil that is essentially the same in agricultural value and in physical properties. Thus, any distinct variation in color, texture, surface features, etc. becomes the mark of another type. It should be remembered

also, that only the inherent agricultural qualities of the soil are considered; and acquired qualities, due to the action of man, are normally not given any consideration.

PRINCIPAL COLOR CLASSES USED IN DIFFERENTIATION OF SOIL TYPES

- Organic matter
  - Black
  - Gray
    - Dark gray
    - Light gray
  - White
- Mainly iron oxide with some organic matter
  - Yellow
    - Pale yellow
    - Bright yellow
    - Reddish yellow
  - Brown
    - Light brown
    - Dark brown
    - Reddish brown
  - Red
    - Dull red
    - Brick red
    - Dark red

Soil Classes. On the basis of the fineness of texture of the soil material, soils are grouped into classes, a **soil class** being made up of soils having the same texture, though differing in other respects. A clay loam, for example, may be light colored and of alluvial origin, while another clay loam may be dark in color and of residual origin, yet both these soils belong to the same class, because the two have the same texture. Thus there may be different kinds of clays, silts, sands, etc., but the class to which any soil belongs depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position or agricultural value.

BASIS OF SOIL CLASSES

Soils containing less than 20% silt and clay

Coarse sand—
Sand—
Fine sand—
Very fine sand—

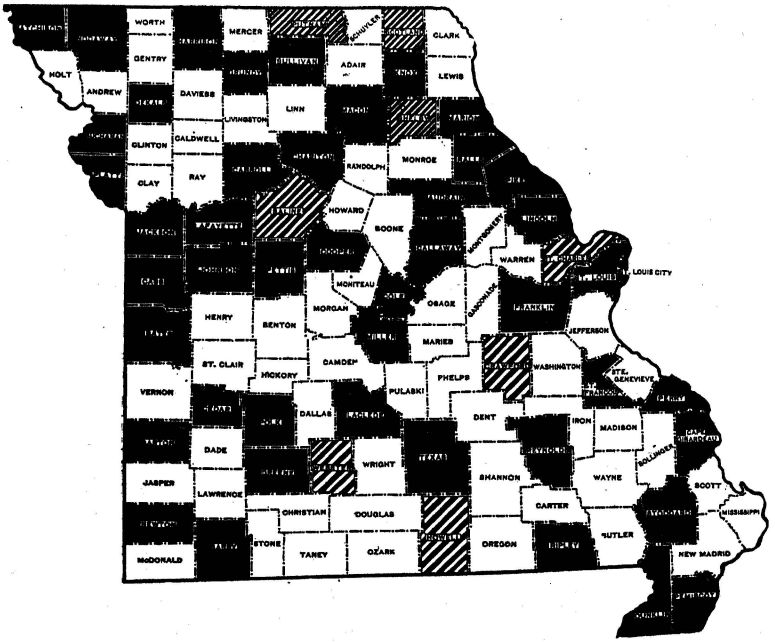
Soils containing between 20-25% of silt and clay

Sandy loam—
Fine sandy loam—
Sandy clay—

Soils containing over 50% of silt and clay

Loam—
Silt loam—
Clay loam—
Silty clay loam—
Clay—

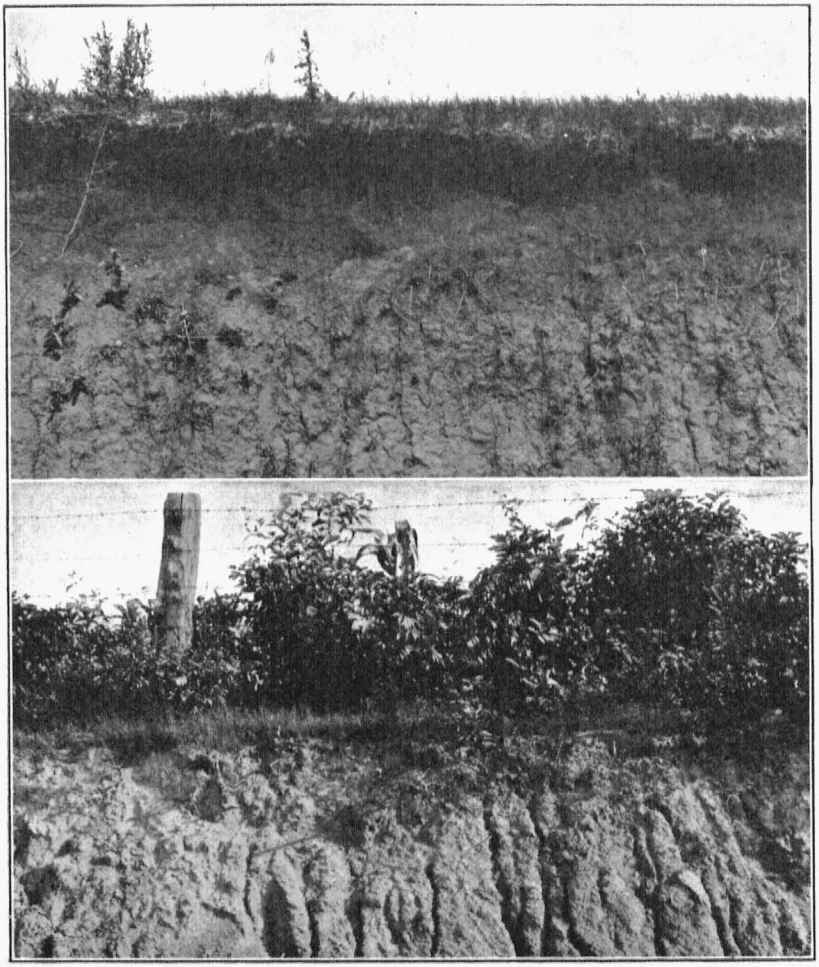
Where a number of soils are closely related as to source of material, method of formation, topographic position and coloration, so that the different soils constitute merely a gradation in the texture of an otherwise uniform material, such a group is called a soil series. A complete soil series consists of material similar in other characteristics, but grading in texture from stones and gravel on the one hand, through the sands and loams, to a heavy clay on the other. The Wabash series, for example, includes black soils that range in texture from sand to clay. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the soil survey. By uniting the name of the soil class with the name of the soil series, we get the name of the soil type, which is the basis or unit of classifying and mapping soils. Through such a classification, a definite basis for systematic and thorough investigations of soils is made possible.



Map showing the number of counties covered by detailed surveys up to 1921. Counties with cross hatching were surveyed by U. S. Bureau of Soils previous to 1908.

PROGRESS OF THE SOIL SURVEY

The Missouri Soil Survey was organized in 1905, but actual field work was not started until 1907. In the spring of 1908 the state organization began cooperating with the United States Bureau of Soils. Through this cooperative arrangement a detailed survey has been made of 45 counties, representing a total of 28,688 square miles or 41.7 per cent of the area of the state. In the northern part of the state north of the Missouri River, 18 counties have been surveyed, a total of 10,914 square miles. South of the Missouri River, 27 counties with a total area of 17,774 square miles have been covered. Previous to 1908, eight counties (5001 square miles) had been surveyed by



ABOVE: Marshall silt loam, a typical "corn belt" soil. It is black, deep and well drained.

BELOW: Clarksville silt loam. The shallow light colored ridge lands in the southern half of the state need careful farming to produce profitable yields.

the United States Bureau of Soils, but this work was done before accurate methods had been worked out so that the detail in these counties is not sufficient and they will have to be resurveyed. At the present rate of progress of about three counties a year it will require about twenty years to complete the detailed survey of the entire state. It would be highly desirable if this could be completed sooner.

Under the cooperative agreement with the United States Bureau of Soils, the soil survey reports are published and distributed by that Bureau, and therefore are not available from the College of Agriculture. The College, however, has just adopted the policy of publishing separate soil reports on each county, which will include the same soil map as that in the Bureau reports. The state reports will include the chemical composition of the soils; data on various soil treatments, the results of the findings of the College on its various experimental fields with reference to the use of fertilizers, crop rotation, etc.—data that is not included in the Bureau reports. Specific recommendations regarding soil management will be given for each soil type.

The soil survey during the past ten years has collected 591 complete soil samples consisting of 1513 individual samples from 69 counties. Thirty-eight counties in North Missouri supplied 230 complete or 677 individual samples, while 341 complete or 799 individual samples came from 30 South Missouri counties. Only 35 counties have been sampled completely, that is, samples collected from each soil type found in the county. Each complete sample usually consists of three parts, the surface, subsurface and subsoil, the latter extending to a depth of 36 inches.

The soils of Missouri are as diverse as is the State's agriculture. More than 174 distinct and separate soil types belonging to 70 series have been established and mapped. These range in texture from stony loams to clay, and in color from almost white through gray, yellow, brown and red to jet black.

The soil conditions are practically as varied as those of all the states bordering on Missouri. Most of northern Missouri is similar to southern Iowa and to parts of Illinois. The soils of western Missouri are like those of eastern Kansas. The Ozark and Southeast Lowland regions are comparable to the soils of Arkansas, Kentucky and Tennessee. A little less than one-half the state is prairie. In origin, the soils of about two-fifths of the state are glacial, one-tenth alluvial and the remainder residual. In brief, the function of the Soil Survey is to determine the distribution, the needs and the possibilities of the 174 or more different soils distributed throughout the state.

TABLE I. SUMMARY OF SOIL GROUPS AND TYPES IN 36 OF THE 53 COUNTIES SURVEYED.

	Acres	Square miles	Percent of state
Total area of the 36 counties	15,084,160	23,569	34.29

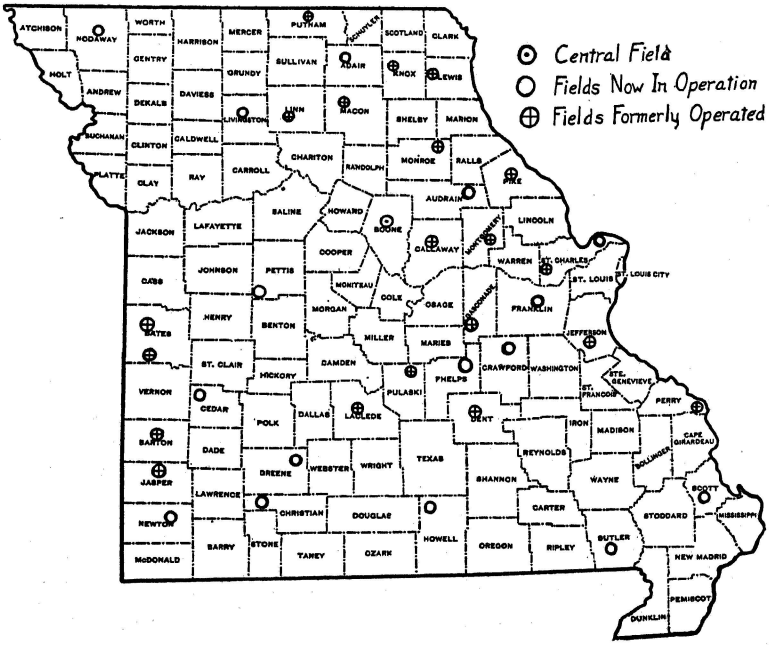
Soil groups	Number of series	Number of types
Glacial and Loessal	12	15
Residual soils of the western prairie and Ozark border region	20	51
Residual soils of Ozark region	9	23
Alluvial soils of northern Missouri:		
Second bottom or terrace	8	15
First bottom	8	23
Alluvial soils of southern Missouri:		
Second bottom or terrace	6	14
First bottom	7	33
Total	70	174

VALUE OF THE SOIL SURVEY

The work of the Soil Survey is accumulating a fund of information in regard to soils which will assist in solving the broad problems in connection with the State's soil resources and the utilization of those resources for the support of a growing population. The department of soils of the College of Agriculture receives annually hundreds of letters from Missouri farmers, land companies, prospective land buyers and non-resident land owners, asking for information about soils. These inquiries cover a wide range of subjects, such as the kinds of soils in different regions, land values, kinds of crops grown, needs of various soils, how best to build up soils and what fertilizers to use. To give such information it is essential that the soil conditions in every part of the state should be known to the Station workers.

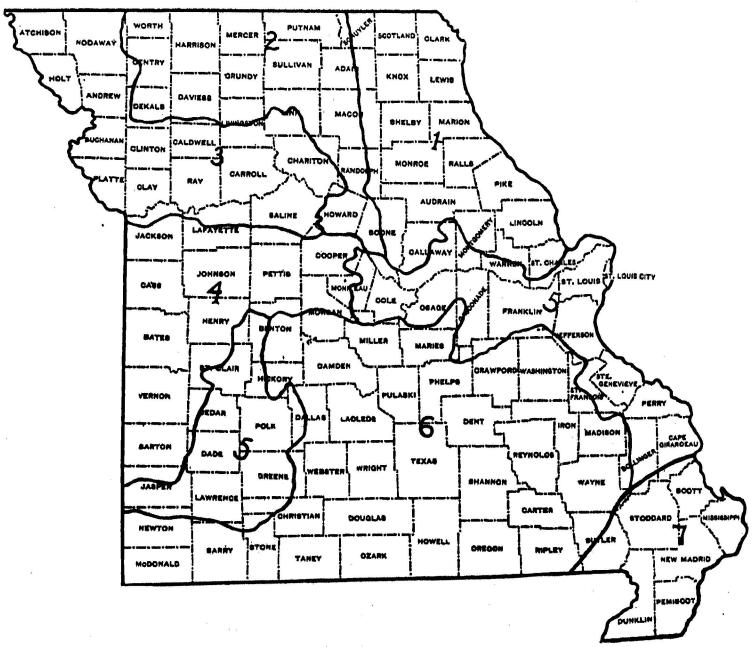
In general, the most complex upland soils in the state are found in the southwestern part, in that region beginning near the southern edge of Pettis county and extending south to Springfield and west to the Kansas line. In this region, which is bordered on the east by the Ozark Upland and on the west by the Prairie Plains, the soils vary within short distances from hilly and stony to level and stone-free, from light or brown colored timberland to black prairie, and from sandy loams to clay loams. The eastern part of the Southeast Lowland also has great complexity of soils. The soils of the glacial and loessal region in the northern part of the state, and the residual soils of the Ozark Region are relatively uniform over large areas.

Map showing number and distribution of soil samples taken for chemical analysis.



Soil experiment fields on important soil types.

A very important adjunct to the Soil Survey without which the latter loses much of its practical importance, is the conducting of experimental fields. In Missouri all experimental work with fertilizers and all variety tests with crops are carried on with reference to soil types. The Soils Department maintains about 15 experiment fields distributed on various soil types throughout the state for the purpose of determining the best systems of soil management adapted to each. At present only the larger and more important types are selected for the location of these fields since funds are not available for covering all the types, although it is proposed to extend these to other types as rapidly as funds permit. Through this



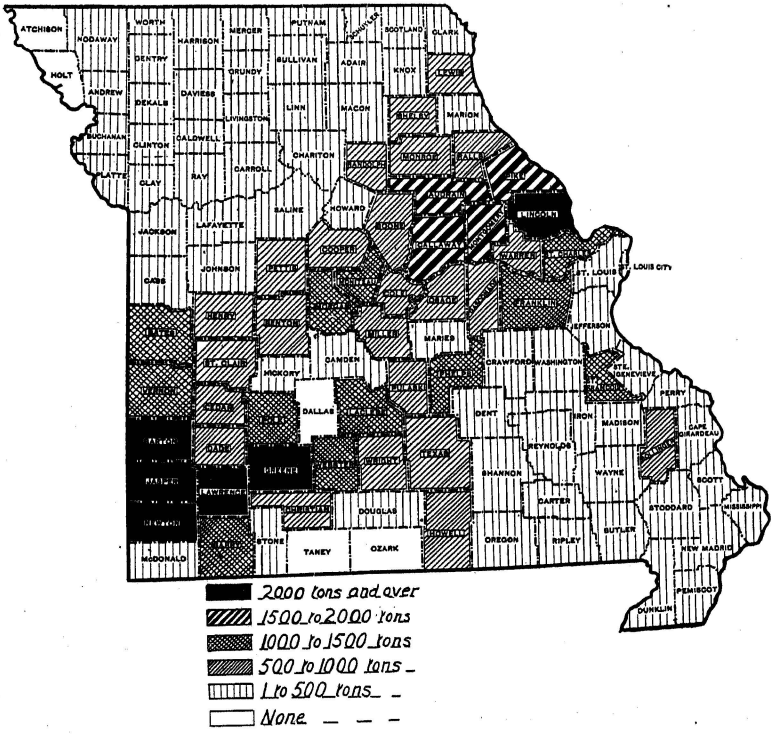
SOIL REGIONS OF MISSOURI.—1. Northeast level praries. 2. Rolling prarie (glacial. 3. Black prarie (loess). 4. Southwest prarie. 5. Ozark border. 6. Ozark upland. 7. Southeast lowland (Mississippi bottom).

work a large amount of valuable information has been accumulated, and since the distribution of the soil type is known, the results may be applied to the farms located on the same type of soil—it matters not how widely separated they may be from the experiment field.

The steadily increasing use of commercial fertilizer in Missouri, is accompanied by a greater demand for information regarding its use. It is the purpose of the soil survey and the experiment fields to determine what fertilizers are best adapted to the soils of the state. Table II shows the approximate amounts of fertilizer used each year during the past decade.

TABLE II—SHOWING AMOUNT OF FERTILIZER USED IN MISSOURI BY YEARS.

Year	Tons
1910	31,600
1911	41,600
1912	38,400
1913	60,000
1914	60,000
1915	57,200
1916	41,200
1917	65,200
1918	87,200
1919	64,000



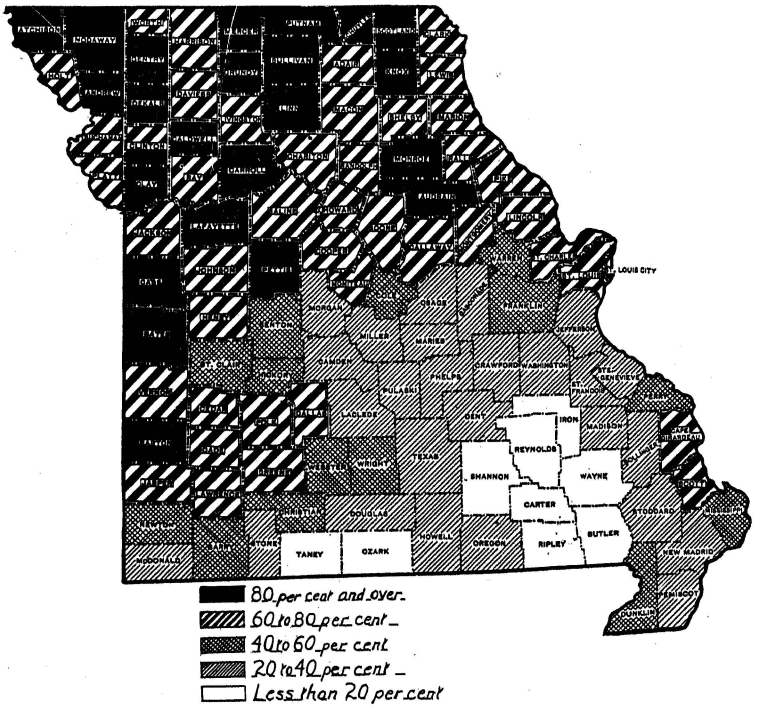
Map showing the amount of commercial Fertilizer used in 1919 by counties.

The accompanying map indicates that fertilizer is used most extensively on the light colored prairie soils in the northeastern and southwestern parts of the state. Our knowledge with reference to the value of fertilizer on the better soils of the Corn Belt is limited as yet. Its use must be put on a more practical and profitable basis, and this is possible only if the general soil conditions and soil needs are known.

The Soil Survey provides county agents and other extension workers

with reliable information with reference to the general soil and agricultural conditions in the county in which they are working. From the soil map the county agents can better plan work in the way of soil treatment for the various soil areas in his county, and also apply these Experiment Station findings to his local conditions.

The large number of persons who are buying land for the pursuit of general farming or for the production of special crops usually make investigations before undertaking the new venture. Such inquiries always cover certain soil and climate features and a desire to secure information which will enable them to compare the conditions personally known to themselves with those of new localities under consideration. In the last

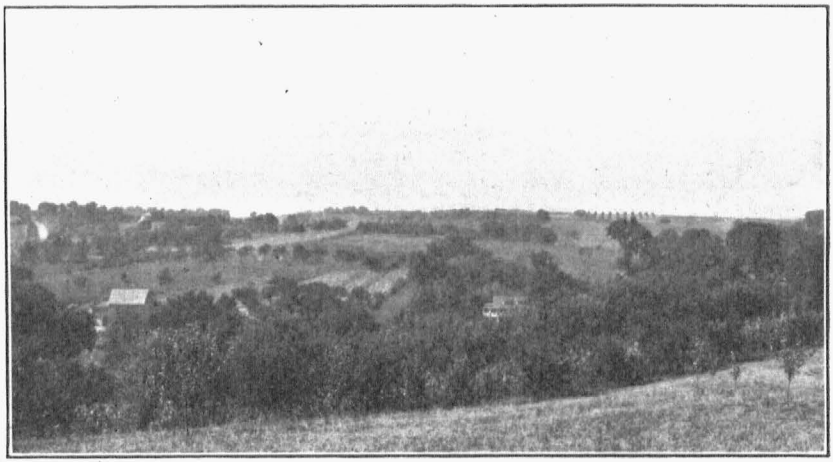


Map showing percentage of improved land by counties. (From U. S. Census 1910).

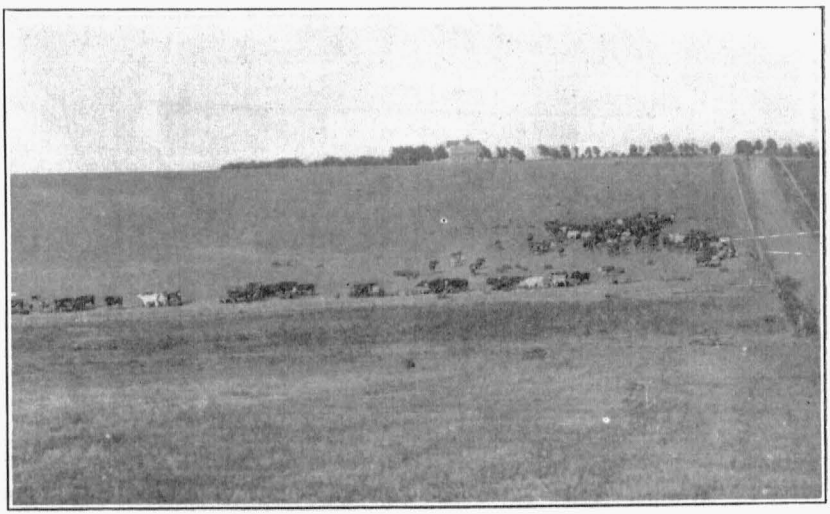
few years there have been very many inquiries from people outside of Missouri regarding Missouri lands while people within the state are constantly inquiring as to the soil conditions in those parts with which they are not familiar. Whenever possible a Soil Survey report has been supplied, as this is far more satisfactory than any reply by letter. By this means individuals are helped to find the location and the kind of land they desire, whether it be land now in cultivation or yet to be cleared or drained.

The Soil Survey maps and reports are of much value to land appraisers of the Federal Farm Loan Bank and other farm loan organizations. An

important provision of the Federal Farm Loan Act is that all loans shall be based on the productive capacity of the soil. Land investment companies that deal in land use these reports in determining soil resources and the agricultural possibilities of areas they desire to purchase and develop. Educational institutions are making an increasing use of soil maps and reports in the study of soils and crops, as well as in the study of the broader aspects of agricultural economics and farm management.



The superiority of the brown loess soils for fruit production is universally recognized.



Fattening cattle and hogs is an important industry where corn and bluegrass are the principal crops.

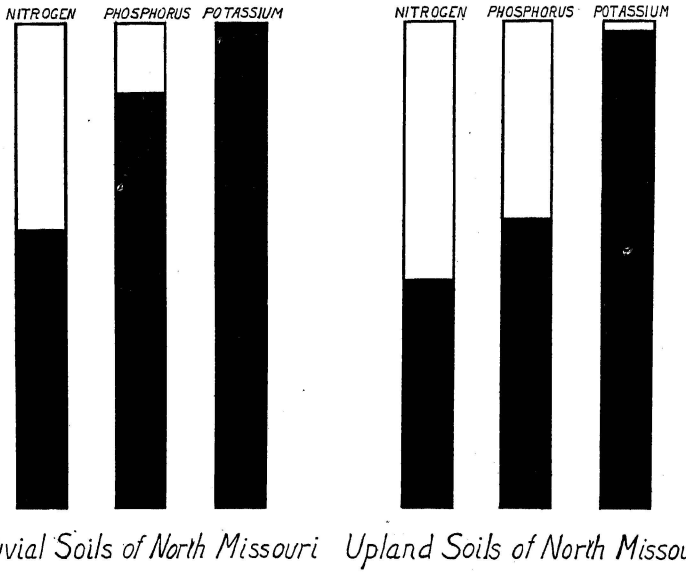
With the survey of each county there are collected soil samples of each soil type and these are analyzed and studied in the laboratories. The analysis shows the total plant food present as well as the need for lime; and these data afford an indication of the principal needs of the soil. By this means it has been found that most Missouri soils are low in organic matter and nitrogen and more or less deficient in phosphorus. In general, the soils of southern Missouri are more deficient in phosphorus than the soils of northern Missouri, but in nearly all parts of the state the use of phosphatic fertilizers has given good returns. As an average of many years the use of bonemeal and acid phosphate on the outlying experiment fields has given a return of more than 400 per cent on the investment or cost of the fertilizer treatment. In the same way, the soil areas most in need of lime are being shown. Most of the light colored prairie soils and the timbered ridge lands have a lime requirement of from one to four tons an acre.

Average of All Soils of Missouri

The Soil Survey maps show to the farmer the relationship of the soil on his own farm, not only to the other soils in the immediate neighborhood, but also to soils of the same character in widely separated regions. By this means he can correlate the crops grown and the farm practices used on his own place with the crops and farm methods on similar soils in other places. This may lead to the adoption of new crops or new methods of soil management, and promote the growing of specialized crops.

Alfalfa growing in Missouri has been accompanied with varying success, but the area devoted to this crop is constantly increasing. There are some who believe that alfalfa can be grown on practically any soil; and, while this may be true under proper soil treatment, it is well known that this valuable legume is grown **successfully** on less than one-third of the upland soil area in the state. In general, it can be assumed that all Missouri soils with tight, heavy, compact subsoil are not well suited to alfalfa. Thus practically all of the level prairie land in northeastern Missouri as well as in southern Missouri is not suited for this crop. Likewise, all the Ozark Upland that has a compact subsoil, will not grow alfalfa successfully. Aside from the creek and river bottom lands or valleys, there is a small per cent of Ozark land that can be considered as alfalfa soil. The most extensive and best upland alfalfa soils are the loess or wind-formed soils including both the brown silt loam and the black prairie. These soils are not only very productive, but have a deep and mellow subsoil which permits good development of the alfalfa roots. The

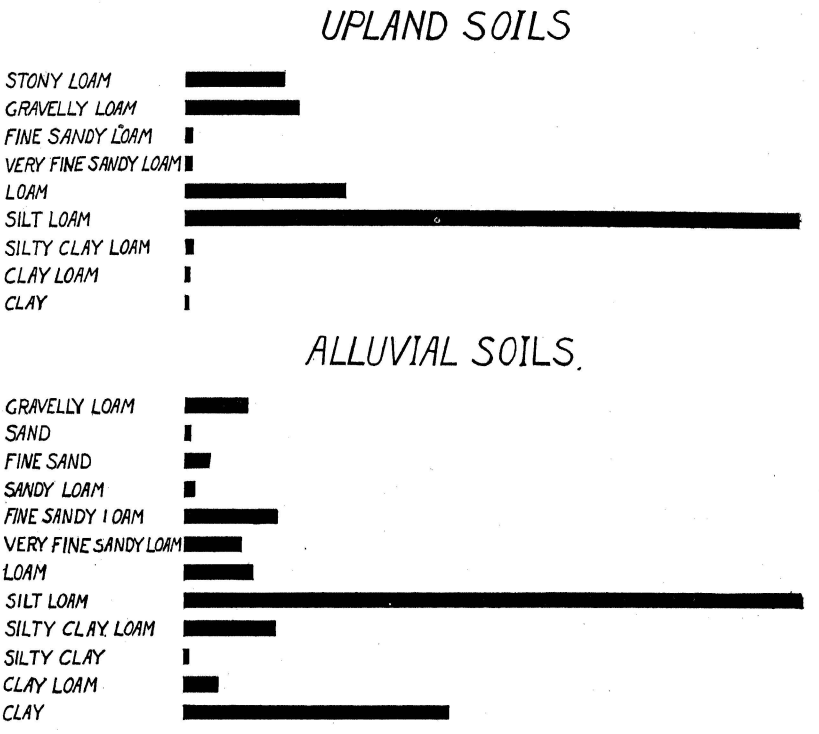
red limestone soils found throughout the southern part of the state have subsoils favorable to alfalfa. The loess soils mentioned above make up one of the most important and extensive soil groups in Missouri not only



Composition of Missouri soils. The shaded portion of each column shows the percentages of Nitrogen, Phosphorus, and Potassium present in the surface 7 inches of an acre as compared with the following standard of a very fertile soil: Nitrogen 6000 lbs.; Phosphorus 2000 lbs.; Potassium 30,000 lbs. This arbitrary standard for a fertile soil is represented by full length of columns.

for alfalfa but for many crops. They include both the brown river-hill land (Knox silt loam and Memphis silt loam) and the black prairie (Marshall silt loam). The latter occurs mainly in the northwestern part of the state. Along the Mississippi River the loess extends from Cape Girardeau on the south to Quincy on the north, in a belt varying in width from two to fifteen miles. Along the Missouri river it extends from St. Louis to the northwestern corner of the state, covering several counties in the latter region.

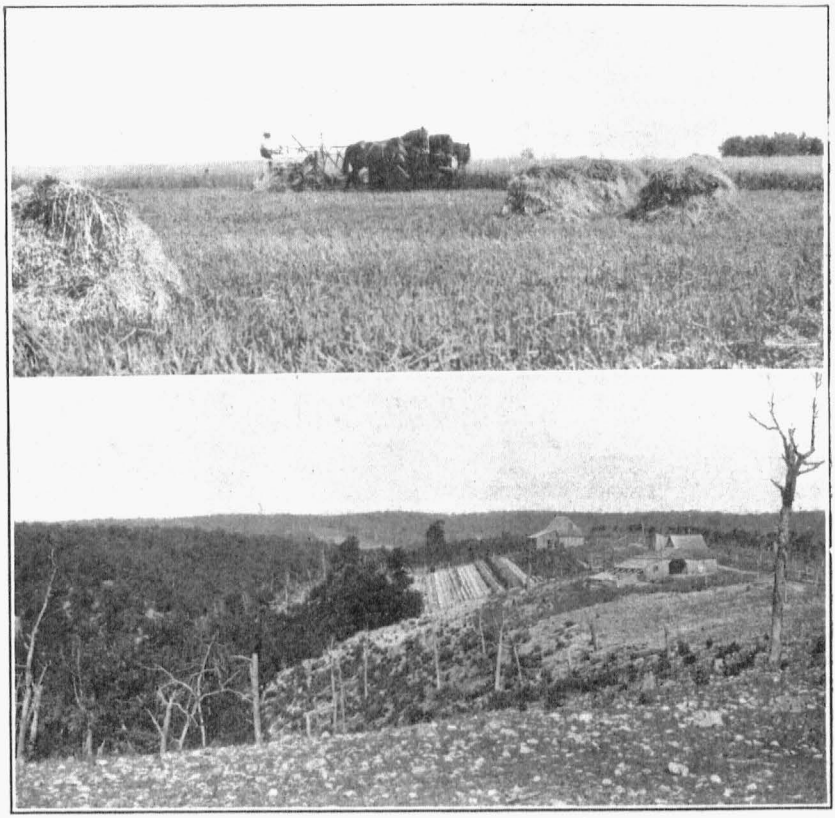
The brown loess or river-hill land is especially known as a fruit soil, and many orchardists claim it is the best fruit soil that can be found any-



Comparative area of different soil classes based on texture.

where. Missouri probably contains a larger amount of this kind of soil than any other state in the Union. It is a soil of good fertility, usually well supplied with lime, and has a deep, open subsoil which permits the best root development. Trees seem to be healthier, grow better, live longer, and produce fruit of higher quality than on almost any other soil in the state. It is natural, therefore, that fruit growing should be an important industry on this soil. In spite of the fact that the number of orchards on this soil is still rather limited, more than half of the apples produced in Missouri are raised on the narrow strip of loess along the Missouri River in the northwestern part of the state. Twelve northwest

Missouri counties contain approximately 28,000 acres of apple orchard. (Bul. No. 67; Mo. State Board Hort.) These orchards are grouped in a comparatively few localities because of better shipping facilities at these places, and because many believe that these sections are peculiarly suited to orcharding. However, the loess at these fruit centers is little if any different from that elsewhere in the state, and wherever the soil survey shows that the deep loess occurs, it is reasonably certain that the growing of apples would be successful as far as the soil is concerned. Since the soil



Some soils are suited to the highest type of farming; some are suited only to grazing and forestry. The Soil Survey classifies all types of land.

survey has shown the extent of this soil, the possibilities that exist in this part of the state are at once apparent.

The value of the loess for fruit production is entirely a matter of soil condition, for from a climatic standpoint such as late spring frosts, southern Missouri is more favorably suited than northern Missouri. The soil survey is also showing the soils of the Ozark region which are adapted to fruit. Here too are large areas of excellent fruit soils. It is reported[1]

(1) Quarterly Bulletin No. 67. Missouri State Board of Horticulture.

that in the decade from 1890 to 1900, more apple trees were set in the Ozark district than were growing previous to that time in all the United States. This was before the days of the soil survey and there was a lack of intelligent discrimination in selecting land. In fact, many of the orchards were planted on soils that are now recognized as among those most poorly adapted to fruit of any in that region. While the Ozarks include some very good fruit soils they also have some of the poorest. These two extremes are often found adjacent and only costly experience has shown the necessity of discriminating between the two. In general, the red limestone soils are well suited to apple trees. Soils of this character are most extensive in the border counties of the Ozark region. The general distribution and location of the soils suitable for orcharding is now known and it is therefore not probable that such costly errors in tree planting will again be committed.

Much of the hilly and stony land in the Ozark region should remain in forest. The Soil Survey classifies such land, and points out its extent and distribution.

On account of the great diversity of soils in Missouri the possibilities for the extensive growing of special fruits and crops are very great. Five counties in the southwestern part of the state lead in the production of strawberries. Similar soils are found throughout the Ozark region and the loess soils are unexcelled for small fruits. Missouri falls far short of producing enough potatoes to supply the State's demand. Along the Missouri and Mississippi River bottoms and in the Southeast Lowland are soils that are almost ideally suited to potato production. The growing of tobacco is of minor importance, but the decline in the industry from its former position is not due to unfavorable soil conditions. Missouri ranks third as a watermelon producing state. Large areas of the light sandy soil which is ideal for melon production exist in the Lowland section of the state and elsewhere. The commercial growing of rice is still in its in-

fancy. With constantly accumulating knowledge of the soils of the state the adoption and extension of special agricultural industries will be aided greatly.

There is a widespread opinion that much of the land in Missouri is as yet undeveloped. To certain extent this is true and many persons even in Missouri, do not realize the large amount of undeveloped, unimproved land that still exists. The total land area of Missouri is 43,985,280 acres and the area in farms is 34,774,679 acres, approximately 75 per cent of the total. According to the 1920 cencus, 24,832,966 acres of the land in farms is classed as improved. It has been estimated that the area of cut-over timberland in Missouri is about 13,221,000 acres, or approximately 30 per cent of the State's area. Of the cut-over land, probably 2,754,000

More than a million acres of Missouri land need drainage for successful cultivation. An area several times as large has already been reclaimed.

acres are suited only for timber growth. This, in the main is steep, rough land, or land so stony that timber should be the only crop. A total of 3,084,000 acres is suited to general farming. This area would make 19,275 farms of 160 acres each. The remainder of the cut-over land, about 7,383,000 acres, is adapted to grazing, and to the growing of grasses but not the cultivating of farm crops. The Soil Survey not only points out the general location of these undeveloped lands, but also indicates the best uses to which such land is to be put in the light of experiences and practices on similar lands which have been developed.

In the Ozark region much of the undeveloped land suitable for farming is widely distributed and occurs in small and irregular areas. The undeveloped farming land in the Southeast Lowland region occurs in rather large bodies, frequently containing many thousands of acres. One of the wrongs committed by land exploiters in this state lies in their failure to recognize a diversity of soils, a failure which results in misleading the

purchasers. Some types of soil are better fitted for forests than for fields and should be devoted to timber production without pretense that they are capable of higher development. Others are fit to be cleared and farmed under present conditions; still others should wait until the demand for arable lands has absorbed most of that of higher grade.

Missouri has been an important lumber producing state, but its supply of commercial saw timber is rapidly reaching exhaustion. With it there is a decline in all the wood-working industries and a greatly reduced income to those parts of the state that are largely dependent on their forest products. Missouri will eventually have to adopt some system of forestry and the sooner this is done the better. There is no reason why millions of acres should be lying waste when there is a crying demand for all kinds of timber for lumber and fuel. It is reasonable to believe that

In some of the hilly parts of the state, non-agricultural land frequently adjoins good farming land. Soil maps show all soil variations five or more acres in extent.

the people would object to taking farming land for such purposes, but there is an abundance of land suited only for timber and until this is utilized for its proper purpose the state is not meeting its opportunities. The soil survey is pointing out the purely forest lands and in this way is doing the essential preliminary work for a future forest policy.

The lands in Missouri that were originally either marshy or subject to periodical overflows, amount to about four and one-half million acres. Approximately one million acres are as yet not sufficiently well drained for successful cultivation. The majority of the land of this type is in the Lowland region, but there are extensive areas of bottom land along the large streams, notably the Missouri, Grand, Osage and Chariton, that can be reclaimed. The soil is predominantly a black clay loam of high fertility and when drained is well suited to corn, wheat, alfalfa and grass.

It is the purpose of the Agricultural Experiment Station through the

Soil Survey to aid in the development of the various classes of soils in a variety of ways, such as the determination of their possibilities and limitations, their plant food requirements, crop adaptations and most profitable methods of handling. There is as yet much that is not known about our soils. To know them requires much time in study and experimentation, and essential to all this is the systematic classificaion of the soils.

Alfalfa is an important crop on Marshall silt loam, a typical black prarie soil.