

Issued September 9, 1916.

**U. S. DEPARTMENT OF AGRICULTURE,**

**BUREAU OF SOILS—MILTON WHITNEY, Chief.**

**IN COOPERATION WITH THE UNIVERSITY OF MISSOURI AGRICULTURAL  
EXPERIMENT STATION, F. B. MUMFORD, DIRECTOR;  
M. F. MILLER, IN CHARGE SOIL SURVEY.**

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**SOIL SURVEY OF DEKALB COUNTY,  
MISSOURI.**

**BY**

**H. H. KRUSEKOPF, IN CHARGE, R. C. DONEGHUE, AND  
M. M. McCOOL, OF THE UNIVERSITY  
OF MISSOURI.**

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**CURTIS F. MARBUT, INSPECTOR IN CHARGE.**

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**[Advance Sheets—Field Operations of the Bureau of Soils, 1914.]**



**WASHINGTON:  
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1916.**

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## LETTER OF TRANSMITTAL.

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UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., August 9, 1911.*

SIR: During the field season of 1910 the survey of Pemiscot County begun in 1909 was completed. The selection of this area was made after a conference with the State authorities, with whom the Bureau of Soils is cooperating. Pemiscot County is located in the lowland section of southeast Missouri, much of which formerly was in a poorly drained condition and uncultivable. Many of the soils are very productive, and since the installation of drainage systems, the extension of which continues, great progress has been made in agriculture. The differentiation of the soils by the bureau should lead to greater diversification of crops and the adjustment of soil types to crops grown. Cotton, corn, and alfalfa are the principal crops raised at present.

I have the honor to recommend that the accompanying manuscript report and map be published as advance sheets of Field Operations of the Bureau of Soils for 1910, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

HON. JAMES WILSON,  
*Secretary of Agriculture.*

## CONTENTS.

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	Page.
SOIL SURVEY OF DEKALB COUNTY, MISSOURI. By H. H. KRUSEKOPF, IN CHARGE, R. C. DONEGHUE, and M. M. MCCOOL, OF THE UNIVERSITY OF MISSOURI.....	5
Description of the area.....	5
Climate.....	7
Agriculture.....	8
Soils.....	13
Shelby loam.....	15
Grundy silt loam.....	17
Marshall silt loam.....	20
Crawford stony loam.....	21
Wabash loam.....	21
Wabash silt loam.....	22
Wabash clay.....	23
Summary.....	24

---

## ILLUSTRATIONS.

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### FIGURE.

FIG. 1. Sketch map showing location of the Dekalb County area, Missouri....	5
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### MAP.

Soil map, Dekalb County sheet, Missouri.



# SOIL SURVEY OF DEKALB COUNTY, MISSOURI.

By H. H. KRUSEKOPF, In Charge, R. C. DONEGHUE, and M. M. McCOOL,  
of the University of Missouri.

## DESCRIPTION OF THE AREA.

Dekalb County, Mo., lies in the northwestern part of the State, midway between Kansas City and the Iowa State line and 15 miles east of St. Joseph. It is bounded on the north by Gentry County, on the east by Daviess and Caldwell Counties, on the south by Clinton County, and on the west by Buchanan and Andrew Counties. It is nearly square in outline and measures 21 miles east and west and 20 miles north and south. The county has an area of 417 square miles, or 266,880 acres.

Dekalb County is included within the physiographic division of the State known as the Rolling Prairie of northwestern Missouri. It occupies a broad, rolling, well-dissected plain, with a gradual slope to the south and southeast. Broad, flat bottoms are developed along the larger streams. The surface varies from flat to moderately hilly, although more than 80 per cent of the area is only gently rolling. No considerable part of the county is too flat to have good surface drainage. The most extensive smooth area occurs in the south-central part of the county, north of Osborn, tapering to a point 4 miles north of Amity. A number of long, flat ridges, which represent interstream divides, varying from a few rods to several miles in width and from 1 mile to 6 miles in length, occur in all parts of the county. The roughest land is in the east-central section along Grindstone Creek, where a few of the hills are precipitous. The larger streams have cut their channels to only moderate depths, and their widely branching intermittent tributaries have made only shallow incisions in the original surface, so that the ridges and hills are rounded and the slopes gradual.

The chief characteristics of the topography are the level plains, rounded ridges, and gentle slopes. The configuration, due entirely to erosion, has been developed upon an original wide, unbroken plain,

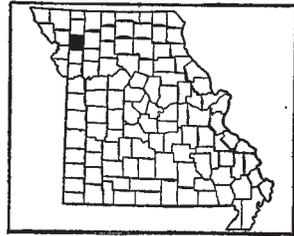


FIG. 1.—Sketch map showing location of the Dekalb County area, Missouri.

sloping gently to the south. The remnants of this plain, which constitute the flat prairie and minor plateaus, are steadily being encroached upon by the streams.

The average elevation of the flat prairie land varies from 1,080 feet above sea level in the northern part of the county to 1,000 feet in the southern part. The altitude of the stream valleys varies from 850 to 900 feet. The difference in elevation between the valleys and the adjoining uplands is never more than 100 feet, and the slopes are seldom too steep for cultivation.

The drainage of the eastern part of Dekalb County flows into Grindstone Creek, which enters the southern part of the county near Osborn, and follows a northeasterly course, uniting with the Grand River about a mile north of Santa Rosa. Lost Creek is the principal tributary of this stream. The western part of the county drains southward through Big Third Fork, Little Third Fork, and Castile Creek into the Platte River. In general, the eastern drainage system has cut to greater depths than the western system. With the exception of the larger creeks, the streams are dry except during wet weather. A characteristic feature of the stream development is the relatively great width of the flood plains of the larger streams.

Springs are rare in the county. Occasionally in places at the foot of stream bluffs small quantities of water seep from seams of the indurated rock, but there are no springs of importance. There is, however, no difficulty in obtaining an abundant supply of water by means of dug wells. The wells usually are 35 to 65 feet in depth, though borings have been made to 165 feet. The depth of the wells generally is equal to the thickness of the layers of unconsolidated material.

At the time of the first settlement of this region only a small part of the county was forested. White and black oak, walnut, hickory, hazel brush, and sumac predominated on the uplands, and elm, maple, sycamore, hickory, walnut, and oak in the bottoms. At present no merchantable timber remains. The forested areas are now confined to narrow strips along the larger streams, particularly Grindstone Creek, and represent the roughest land.

Dekalb County was created from a part of Ray County in 1845. The first settlement in the region was made in 1824. During the following 30 years the population increased to a few hundred, most of the settlers coming from Kentucky and Tennessee. The completion of the Hannibal & St. Joseph Railroad in 1859 did much to increase immigration, and settlers from Illinois and other near-by States came into the county. The present population consists mainly of descendants of the early settlers. In the 1900 census the population of the county is reported as 14,418; in the 1910 census it is given

as 12,531, or approximately 30 persons to the square mile. Practically all the population is engaged in agricultural pursuits.

Maysville, the county seat, has a population of 1,051, according to the 1910 census. Union Star, Stewartsville, Osborn, Clarksdale, Weatherby, and Santa Rosa are smaller towns and the centers of farming communities. Cameron, in Clinton County, and King City, in Gentry County, are trading points just across the county line which receive some of the products of Dekalb County.

Dekalb County has 68 miles of railroad. A branch of the Chicago, Rock Island & Pacific passes through the center of the county from east to west, and the main line crosses the southeastern corner. The Quincy, Omaha & Kansas City Railway crosses the eastern part of the county, and branches of the Chicago, Burlington & Quincy extend through the northwestern and southern sections. These railroads furnish good transportation facilities to the large markets, such as Kansas City, St. Joseph, and Chicago.

The wagon roads follow land lines, irrespective of topography, and for this reason generally are moderately hilly. They usually are in poor condition during the spring and winter months.

Aside from its soil, Dekalb County has no natural resources of economic importance. Several small limestone quarries supply a poor grade of rough building stone. The cutting of walnut logs is no longer of any importance. Farming, in its varied forms, is the predominant industry and has reached a high stage of development.

#### CLIMATE.

The climate of Dekalb County is essentially the same as that of all northern Missouri. The mean annual temperature is about 53° F., as compared with a mean of 54.6° for the State, while the mean annual precipitation is about 35 inches, as compared with a mean of 39.17 inches for the State. Zero weather is rare during December, but occurs in January and February, although it seldom lasts more than three days at a time. The annual snowfall averages about 20 inches. There is seldom more than a 6-inch fall at one time. Late frosts, which sometimes injure fruit trees, occur in April and occasionally in May. The average date of the last killing frost in the spring, as determined from records covering a period of 12 years, is May 1, and that of the first killing frost in fall October 8. This gives a normal growing season of 160 days. Pastures can be used eight months of the year.

The precipitation is well distributed throughout the year, the heaviest rainfall occurring during the growing season, from May to September, and the lightest in the winter months. Occasional droughts, four to six weeks in duration, may occur in August and September, but are usually withstood by the soil without serious damage to crops.

The following tables are compiled from the records of the Weather Bureau stations at Gallatin, Daviess County, and Fairport, Dekalb County. The records of the Gallatin station cover a period of 16 years and those of the Fairport station a period of 14 years.

*Normal monthly, seasonal, and annual temperature and precipitation.*

Month.	Gallatin, Daviess County (elevation 808 feet).						Fairport, Dekalb County (elevation 535 feet).		
	Temperature.			Precipitation.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
December.....	30.3	68	-24	1.47	0.60	2.50	1.15	1.45	1.74
January.....	27.0	66	-12	1.20	1.05	5.13	1.15	.49	3.94
February.....	25.9	72	-22	1.64	2.34	1.39	1.39	1.16	1.30
Winter....	27.7	72	-24	4.31	3.99	9.02	3.69	3.10	6.98
March.....	40.2	85	1	2.59	2.24	5.25	2.14	2.98	2.97
April.....	54.8	92	12	3.54	3.54	3.63	3.01	2.42	4.20
May.....	64.3	94	32	5.76	1.12	10.14	5.00	1.59	8.36
Spring....	53.1	94	1	11.89	6.90	19.02	10.15	6.99	15.53
June.....	73.0	101	38	4.72	1.52	10.10	4.95	2.68	10.71
July.....	77.2	112	36	4.70	2.15	5.69	4.14	1.78	6.50
August.....	76.2	102	48	4.54	4.50	5.39	4.33	1.20	4.24
Summer...	75.5	112	36	13.96	8.17	21.18	13.42	5.66	21.45
September.....	69.2	108	30	4.18	1.86	8.10	4.19	5.31	10.50
October.....	58.2	92	22	2.61	0.52	5.78	2.22	1.72	4.26
November.....	41.6	75	1	1.67	2.63	1.02	1.42	.50	1.25
Fall.....	56.3	103	1	8.46	5.01	14.90	7.83	7.53	16.01
Year.....	53.2	112	-24	38.62	24.07	64.12	35.09	23.28	59.97

AGRICULTURE.

The agricultural development of Dekalb County was easily and rapidly accomplished. There were no extensive forests to be removed, and large areas of prairie land were available for immediate cultivation. The prairie land was well suited to grain growing, as operations could be conducted on a large scale, and bringing the land under cultivation required little expenditure of money and time.

Natural conditions in Dekalb County also favored stock raising. The extensive prairies furnished abundant summer pasturage for large herds of cattle and the dry grass provided forage until late in

the winter. In favorable years the stock could go through the winter without feed other than that obtained from the range. The timbered areas in the bottoms and elsewhere furnished an abundant supply of mast for raising hogs and preparing them for market. Under such favorable conditions the agriculture of Dekalb County from the time of its earliest settlement has been based on the growing of the staple crops, together with the raising of live stock.

With the advent of the first railroad in 1859 an impetus was given to agriculture, markets being made more accessible. Prior to that time the surplus grain and stock were shipped from Liberty, 40 miles south of the county, on the Missouri River, by boat. Corn, oats, wheat, rye, and flax were the principal crops grown, but the sale of these products furnished a relatively small part of the farmers' income. The Missouri Agricultural Report for 1874 contains the following statement:

The cultivated grasses are being introduced for pasture, and do finely. Bluegrass is gradually superseding the grass pastures. Farmers and stock growers are paying considerable attention to improved breeds of stock.

Prior to 1880 grain farming was of more importance than stock raising. The latter industry then became more profitable, and much of the land was seeded with grass. The area devoted to corn was greatly reduced, and the acreage in wheat and oats was decreased more than one-half.

The present agriculture of the county consists of a combination of grain farming and stock raising. Corn is and always has been the most important cultivated crop. The average total area devoted to this crop during the last six years has been approximately 100,000 acres, or about 37 per cent of the total area of the county. The 1910 census reports 86,325 acres in corn in 1909. The average yield is about 27 to 30 bushels per acre. Very little corn is shipped out of the county, most of it being used for fattening stock. Only a small part of the crop is cut and shocked. The greater part is either husked or snapped, the stalk fields being used as forage ground for stock.

Next to corn, oats are the most important crop. The acreage varies greatly from year to year. This crop was grown most extensively in the period from 1870 to 1880; since then the acreage has steadily decreased. In the 1910 census the total area in oats is reported as 13,976 acres. The yields, too, are variable, and range from almost complete crop failures to 50 or 60 bushels per acre, depending on the season. For 1913 a total of 11,571 acres is reported in oats.

The acreage in wheat also fluctuates from year to year. The 1910 census reports a total of 6,558 acres in this crop. The average yield per acre is about 17 bushels, although maximum yields of 36 bushels are reported. The area in 1913 was 7,568 acres, with an average yield of 23 bushels per acre. There is at present a tendency toward

a more extensive production of this cereal. The soils are well adapted to the crop and the present high prices make wheat growing more profitable than stock raising. Commercial fertilizers give best results when used on some small grain such as wheat. The continuous production of corn has decreased the productiveness of many fields, making the adoption of some system of crop rotation almost imperative. Wheat, being the most profitable of the small grains and a good nurse crop for clover and grasses, promises to become an important crop in the rotation.

A small acreage is sown to rye as a cover crop and for early spring pasture. Kafir corn and sorghum are of some importance as forage crops. A few farmers grow cowpeas, usually in the corn fields, for pasture or as a green manuring crop. Some tobacco is grown, and the results obtained justify the more extensive production of this crop. Broom corn is no longer grown on a commercial scale.

Fruit growing is of no economic importance in Dekalb County, although the soils are fairly well adapted to fruits. The occasional injury resulting from early spring frosts minimizes the profits obtained from this source. A small orchard sufficient to supply the home demand is found on almost every farm. On account of the lack of near-by markets, bush fruits and truck crops are not grown on a commercial scale.

The average total area in hay during the last five years has been about 34,000 acres. The 1910 census reports 32,213 acres in hay and forage crops. The average yield is approximately  $1\frac{1}{2}$  tons per acre. The hay grasses consist of timothy, redtop, and clover. Sometimes clover is sown alone, but more often it is seeded with timothy. When it is grown alone, the second cutting is used for seed; when it is mixed with timothy the fields are used for pasture after the first crop has been removed for hay. After two or three years the land usually is plowed and put in corn. The acreage devoted to clover is small, although the crop thrives, especially on the Shelby loam soil. The plants are sometimes injured in the winter by "heaving." The growth of the dairy industry is doing much to encourage the growing of clover. All the hay produced is used locally. Alfalfa is not grown extensively in Dekalb County, but there is no apparent reason why the crop could not be made to thrive on the better areas of the Shelby loam and on the well-drained alluvial soils. It is an important crop on the Shelby loam in eastern Nebraska, and there seems to be no reason why the same soil should not produce this crop successfully in Dekalb County with proper attention.

The county lies in the center of the bluegrass-seed producing region of Missouri, and large quantities of the seed are sold annu-

ally. The yield of seed is from 8 to 14 bushels per acre, 12 bushels being a fair average. The seed is harvested during the first two or three weeks in June.

With its excellent pastures, favorable climate, and desirable location with respect to markets and the corn belt, Dekalb County is an important live-stock region. A permanent bluegrass pasture in which white clover frequently is sown forms a part of every farm. Bluegrass is indigenous to the soils, and grows voluntarily in fields left uncultivated for two years. The general prosperity of the region is due to the live-stock industry, and as a source of income it has always held first place. The 1910 census reports 17,114 cattle and 3,052 calves sold or slaughtered, 2,880 horses and mules sold, and 77,389 hogs and 9,336 sheep and goats sold or slaughtered on farms.

In addition to the large number of cattle raised each year, feeders are brought in from St. Joseph and Kansas City and prepared for market. Well-bred cattle are raised almost exclusively in this county. Hog raising is carried on in conjunction with cattle raising, and is a source of revenue on every farm. Small flocks of sheep are found in all parts of the county, and it is probable that their number could be increased with profit. Each year western sheep are brought into the county to be fed for market. A few horses and mules are raised for sale on almost every farm. Even where the farm is not devoted mainly to live stock, the raising or fattening of stock is an important and profitable adjunct. This is true of the small farms as well as of those upon which operations are on a more extensive scale.

All parts of Dekalb County are well suited to dairying, and the tendency is toward an extension of this industry. Few farms make a specialty of dairying, but there are many farms on which 10 to 15 milch cows are kept. Both milk and cream are shipped out of the county. Dairying has its greatest development in the vicinity of Clarksdale and Maysville. St. Joseph and Kansas City are the principal markets for the products.

There have been few changes in the general agricultural practices in Dekalb County during the last 50 years, and the stability indicates that those prevailing are the most suitable for the region. The rotation of crops is often practiced more because of convenience in management than because of its beneficial effects upon the soils and the resulting increase in crop yields. The usual practice is to grow corn two or three years and oats one year, after which the land is seeded down to remain in mowing land or pasture for several seasons or until the sod runs out and requires renewal. This system is often varied by substituting wheat for oats. In the creek bottoms grass is seldom allowed to remain more than one season, as the alluvial soils are in great demand for corn.

Agricultural methods on the important upland types are quite well adapted to present conditions. The live-stock industry creates a good demand for hay, corn, and grain, and rotations are planned to supply these crops. Improved farm machinery is in general use, and as a rule good systems of cultivation are practiced. Barnyard manure is rather carefully saved, and this is supplemented by feeding large numbers of cattle on the fields.

In general the soils of the county are in fair physical condition, but in many places corn is grown too frequently and the stalks are burned, resulting in injury to the tilth of the soil. This condition of poor tilth is becoming more serious on many farms and is one of the factors that limit crop yields. The remedy is to increase the organic-matter content by plowing under crop residues, such as corn stalks, straw, and clover, instead of selling them from the farm or burning them, as is often done. The occasional turning under of a legume as a green-manuring crop also would prove beneficial. The growing of clover aids greatly in the restoration of the organic-matter content. As a large part, probably 35 per cent, of the agricultural land of the county is in sod, much of which is permanent pasture and mowing land, the improvement of the sod is of great importance. The reseeding of old sod land is profitable, and top dressing with manure gives good results.

The census of 1910 reports a total of 2,186 farms in Dekalb County. The average size of the farms is given as 120.5 acres. There are only a few holdings of more than 500 or less than 25 acres. Of the total land area of the county, 96.9 per cent is reported in farms, and of the farm land 93.3 per cent is reported improved. The percentage of improved land in farms is exceeded by only one county in the State. Of the total number of farms, 67.5 per cent are reported operated by the owners; practically all the remainder are operated by tenants. As a rule the tenants are grain farmers and the owners stock farmers. There is great need of a system of longer leases, in order to make possible the use of farming methods that will maintain the productiveness of the soil.

The average value of farm land is reported in the 1910 census as \$68.44 an acre, showing a decided increase over the average value of \$31.90 an acre reported in 1900. Land values range from \$75 to \$150 an acre, the higher prices prevailing nearer the towns. The range in prices has no absolute relation to the class of soil. In general land values are increasing. Few farms change hands and the improvements that are made are of a permanent type.

The total value of all farm property in the county is reported in 1910 as \$24,769,693, practically twice that reported in 1900.

## SOILS.

The soils of Dekalb County may be classed in three broad groups—glacial, loessial, and alluvial. In area the glacial soils rank first and the alluvial soils next.

The geological formation covering practically all the county is the Kansan drift of the Pleistocene period. Only a small part of the soil in the county is residual from the basal rocks, but the underlying limestone and shale have entered largely into the formation of the glacial debris covering them. Along the western boundary of the county the surface material has the characteristics of loess, and may have been deposited by the wind.

The basal rocks consist of alternating beds of limestone and shale and in places thin beds of sandstone, belonging to the Upper Coal Measures. It is only along the deeper stream cuts, particularly in the eastern part of the county, that the more resistant limestone beds are exposed, giving rise to the Crawford soil. The soil material derived from weathering of this rock is characterized by a dark-brown color. It is everywhere thoroughly mixed with material from the overlying glacial till. On account of its small extent and rough topography, the Crawford soil is of negligible importance.

The glacial material consists of a heterogeneous mass of sand, silt, and clay, and is known to geologists as belonging to the Kansan stage of glaciation. This mass of material, forming most of the soil of the county, was largely brought into the area from the north. A considerable percentage of the drift, however, is of local origin, and consists of material ground from the underlying limestone and shale. Owing to the varied sources of the deposit, it includes quite a wide range of mineralogical material.

The greater part of the drift occurs as a mixed mass of different-sized particles, ranging from the finer grades of sand, with some silt and clay, to boulders. This intimate amalgamation of material was due to the grinding and mixing action of the glacier passing over rock surfaces and the transportation of the material to the point of deposition. In this work of transportation the glacier was aided by streams that flowed from beneath its southern edge. So great in extent was this mass of material and so powerful were the agents of distribution that the resulting glacial deposits cover not only Dekalb County, but practically all of northern Missouri, the original depth ranging from 50 to 150 feet. The material, being very susceptible to erosion, has become greatly modified in topography, so that now the surface has the appearance of a thoroughly dissected plain. The surface layer of drift has been modified also by leaching and oxidation and the carrying away in suspension of the finer particles of earth,

leaving a yellow to brownish-yellow, sticky, sandy clay, with an accumulation of sand at the surface. Many concretions of lime carbonate and white, calcareous streaks, together with occasional iron pipes, are found. It is this modified drift which gives rise to the Shelby loam.

Overlying the glacial drift is a layer of fine earth that is generally considered to be loess. Its true mode of origin has never been definitely determined. Some geologists believe it to have been deposited by wind, others by water, and still others hold it to be merely the thoroughly weathered surface layer of the Kansan drift. In depth it varies from 3 to 10 feet, the greater depth usually occurring in the western part of the county. Erosion has reduced its occurrence to the flat ridges known locally as prairies. Similar material is encountered on the terraces of the larger streams of the county. The weathering of this material has given rise to the soils mapped as the Grundy silt loam and the Marshall silt loam. These soils differ greatly in their physical characteristics. The Grundy soils occupy level upland prairies, and have black surface soils with drab or brown impervious subsoils of fine texture and close structure. The Marshall soils have a gently rolling topography and dark-brown, mellow subsoils. On the crests of the narrow ridges and along the outer border of the Grundy silt loam, where weathering is further advanced, the Grundy silt loam, rolling phase, is mapped. It differs from the typical soil in that it is slightly more eroded and has had much of the clay content washed out.

The material carried by the drainage from the uplands and deposited and assorted in the flood plains of the streams gives rise to three soil types classed with the Wabash series. The Wabash loam occurs along the smaller streams, and is both alluvial and colluvial in origin. The Wabash silt loam and Wabash clay comprise the larger areas of bottom land. The latter is found only where the flood plains are wide. In general, the Wabash soils are characterized by their dark color and high content of organic matter.

The following table gives the name and the actual and relative extent of each soil type mapped in Dekalb County:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Shelby loam.....	145,088	54.4	Marshall silt loam.....	3,840	1.5
Grundy silt loam.....	17,024	24.9	Wabash clay.....	2,240	.8
Rolling phase.....	49,472		Crawford stony loam.....	1,152	.4
Wabash silt loam.....	28,800	10.8	Total.....	266,880	.....
Wabash loam.....	19,264	7.2			

## SHELBY LOAM.

The surface soil of the Shelby loam consists of a dark-brown to brown loam or fine sandy loam, grading at about 8 to 10 inches into a dark-brown to grayish-brown heavy loam which becomes heavier with depth. The subsoil from about 15 to 40 inches is a rather stiff, tenacious sandy clay, yellowish to reddish brown in color, and frequently mottled with gray and brown in the lower part.

The depth and the color of the dark surface material vary somewhat with the topography. In the gently rolling areas where the soil is well supplied with organic matter it is much deeper and is darker in color than on the steeper slopes where erosion is more active. In general, the Shelby loam in the northern and western parts of the county averages darker in color than in the eastern and southern parts.

Quartz gravel and sand are disseminated throughout the 3-foot soil section, and large granite and conglomerate boulders are sometimes present. Large masses of lime concretions and calcareous streaks are present in the subsoil and are a characteristic of the type. Although the subsoil consists largely of clay, the content of sand is sufficient to give it a somewhat friable structure and to make it sufficiently porous to permit the ready percolation of water. When exposed to the weather the subsoil breaks up into small cubes.

Occasionally pockets of steel-gray to bluish, very sticky clay are found immediately below the surface soil. Areas where these occur probably indicate the location of small basins or pools during glacial times. Thin lenses of waterworn chert gravel are sometimes seen in the subsoil in road cuts. The lower strata consist of a heterogeneous mass of clay, sand, gravel, and boulders, which constitute the unweathered glacial till from which the type is derived. The thickness of this till ranges from 10 to 90 feet or more.

That the glacial till in places is largely composed of ground-up material from the local rocks is indicated by the character of the soil. Around Stewartville, in the area drained by Castile Creek, there is a variation of the Shelby loam, resembling the white-oak lands (Lindley loam) in northeastern Missouri. It contains less sand and more clay, is lighter in color, contains less organic matter, and is less productive than the typical soil. This variation is no doubt largely derived from decomposed shale. On the lower slopes along Grindstone Creek a variation of the Shelby loam is encountered where the soil is almost a sandy loam in texture. The material here is apparently derived largely from the underlying sandstone and shale.

The Shelby loam is by far the most extensive soil type in Dekalb County. Except for comparatively small areas of Marshall silt loam, it comprises all the rolling and hilly upland. It is characterized by

a remarkable uniformity in its physical properties and natural productiveness in all parts of the county. Surface drainage is everywhere thorough, and frequently excessive. The native vegetation of the rolling land consisted of prairie grass. The more broken areas were covered with a growth of white and black oak, hickory, elm, ash, linden, and walnut.

Probably one-half the type is used for the production of corn, and the remainder mainly for oats, hay, and pasturage. Corn yields range from 35 to 50 bushels per acre. A small acreage is annually devoted to wheat, and yields of 12 to 20 bushels per acre are obtained. The prevailing opinion is that this rolling land is not so well adapted to wheat as are the level prairie lands. The Shelby loam is an excellent grass soil, and bluegrass is indigenous to it. Where this grass is established and properly cared for it grows luxuriantly and remains indefinitely.

Clover does well on this soil under proper conditions. Yields average from 1 to 1½ tons of hay per acre. Where surface and subsoil drainage are complete, and where the soil is rich in organic matter, alfalfa gives fair yields. Only a small part of the type is suited to orcharding, although home orchards do well in the more elevated and rolling areas. It is probable that the Shelby loam will continue one of the leading soils for general farming and will not be used to a large extent for the production of special crops, except the vegetables and fruit required for home use. It is not well adapted to grain growing alone, but is admirably suited to combined grain and stock farming. Under this system the marked adaptation of the soil to the production of grass can be utilized in the most profitable way, the productiveness of the soil maintained, and erosion controlled.

The rolling topography causes considerable loss by erosion unless good soil management is practiced, and it is advisable to grow winter cover crops, such as rye, wheat or oats. Where fall plowing is done it should be at least 8 inches deep and the land left as rough and open as possible through the winter in order to absorb the moisture. Land given shallow fall plowing, or fall-plowed land which is not left open and rough, washes badly.

Of chief importance in the management of this type is the maintenance of the organic-matter and nitrogen supply. A rotation of crops is one of the first essentials, and should be based on some legume, such as clover. Clover does well on most of this soil type, and there is little difficulty in maintaining the organic-matter content, provided clover is grown frequently, the hay is fed back on the land, and occasional green crops are turned under. Crop rotation alone is not sufficient for maintaining the organic-matter content, and, in addition, either the crops must be fed and the manure carefully

returned to the soil or, if the crops are sold, legumes should be grown for turning under.

The Shelby loam is not greatly in need of lime, but where it is found to be acid the application of 1 to 2 tons of ground limestone per acre is beneficial. The lime is best applied after the ground is plowed, so that it can be thoroughly mixed with the soil by subsequent cultivation.

On the Shelby loam in Dekalb County very little commercial fertilizer is used. Wherever phosphates in readily available form have been tried good results have followed, particularly with wheat. Applications of a good grade of acid phosphate or steamed bone meal on wheat, at the rate of about 150 pounds per acre, have proved beneficial. Such treatment also goes far to insure a good stand of clover when this crop is to follow wheat in the rotation. Fertilizers alone can not be depended upon to maintain the productivity of the soil, but should be supplemented by manure, preferably applied before corn. Under the live-stock system of farming the need of fertilizers has not been felt to any marked degree, but with increased grain growing or with neglect in manuring the use of fertilizers, especially on such crops as alfalfa, wheat, and oats, will in many cases prove profitable.<sup>1</sup>

Land values on the Shelby loam type of soil range from \$50 to \$100 an acre, averaging somewhat lower than those on the Grundy silt loam.

#### GRUNDY SILT LOAM.

The surface soil of the Grundy silt loam to a depth of 8 to 12 inches is a uniform silt loam, black or dark brown to dark gray in color. It contains a fair supply of organic matter and is friable, loose, and easily tilled. The subsurface soil, extending from about 10 to 16 inches, typically is a dark grayish brown, heavy silt loam. It usually contains a slightly larger percentage of clay than the surface soil, especially as the rolling phase of the type is approached. In the smooth, poorly drained areas there is a subsurface layer, 1 to 3 inches in thickness, of light-gray silty material. This stratum corresponds to the light ashen gray layer in the related Putnam silt loam of the northeastern Missouri prairies, but is shallower and much darker in color.

The subsoil is a dark-brown to drab, heavy, plastic clay, changing at about 24 inches to a yellowish-gray, plastic clay, mottled with brown and gray. At a depth of 4 to 6 feet the yellowish-gray clay of the glacial till, which everywhere underlies the Grundy silt loam,

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<sup>1</sup> See "Soil Experiments on the Rolling Glacial Land of North Missouri," Bul. No. 128, Missouri College of Agriculture.

is encountered. The upper stratum of the subsoil, as exposed in stream or roadside cuts, is characterized by its chocolate-brown color. It is rather impervious to water, and is often, though improperly, called "hardpan." On exposure it cracks and crumbles readily. The lower subsoil usually is quite loamy. In general the subsoil of the Grundy silt loam is not so stiff or compact as the corresponding layer in the related Putnam silt loam.

The Grundy silt loam occupies the flat to very gently rolling land locally known as "prairie." Throughout its extent the type has a nearly level to slightly undulating topography. The slope generally is sufficient to give adequate natural drainage. Artificial drainage, however, would no doubt prove beneficial in a few small areas, as at the heads of shallow draws, where crops are sometimes injured in excessively wet seasons. The type is more backward in the spring than the Shelby loam.

The largest bodies of the Grundy silt loam occur in the southern part of the county in the vicinity of Osborn and to the northwest of this place around Amity. Smaller areas are encountered on the high interstream divides. The original vegetation consisted of wild prairie grasses.

All the type is in cultivation. Corn, grass, oats, wheat, and clover are the important crops, ranking in the order named. The Grundy silt loam is an excellent grass and small-grain soil. For timothy and redbtop it is superior to the Shelby loam, although bluegrass does better on the latter type. In recent years the acreage of wheat has greatly increased, and excellent results have been obtained. Although many farmers state that the Grundy silt loam is not so good a soil as the Shelby loam, the improvements on it indicate a degree of prosperity not equaled on any of the other soil types in the county. On account of the heavy subsoil, the type is only fairly well suited to the production of alfalfa. As a fruit soil it is about equal to the Shelby loam.

The high value of the Grundy silt loam for the production of corn, primarily, and of oats and hay in proper rotation with corn, has led to the use of almost all the type for the production of general farm crops. The returns from this system of general farming have been so satisfactory that the introduction of any special crops upon the type has not been undertaken.

While the Grundy silt loam is in a fair physical state, continuous cropping to corn or corn and oats, with the burning of the stalks, is impairing its condition; the soil is becoming more difficult to work, it runs together more, and aeration, granulation, and absorption of moisture take place less readily than formerly. The remedy is to increase the organic-matter content by plowing under manure and crop residues, such as cornstalks, straw, and clover. The addition of

organic matter is not only of great value in improving the physical condition of this type, but it is of even greater importance in adding nitrogen and because of its power, as it decays, to liberate potassium in the soil and phosphorus from the phosphate contained in or applied to the soil.

The occasional difficulty of growing clover on the Grundy silt loam largely results from a deficiency of lime in the soil. This condition can be corrected by the application of limestone at the rate of about 2 tons per acre, following with 1-ton applications once in four to six years. With continued cropping and leaching, applications of limestone will ultimately be needed on all the type.

The prevailing rotation of corn, oats, and clover will not maintain the productiveness of the type unless great care is used to return to the soil all crop residues and all manure made from this rotation. It is recognized by the majority of farmers that proper crop rotation is needed for the maintenance of the productiveness of this soil. Commercial fertilizers are not applied, although the soil responds readily to their use. The use of phosphatic fertilizers has given good returns, and apparently is necessary in order to insure maximum yields.<sup>1</sup> Deep-rooted crops, such as mammoth clover and sweet clover, may well replace red clover at times in order to avoid clover sickness and to render the dense clay subsoil more permeable to air and water.

In general the Grundy silt loam includes the most improved and highest priced land in the county. The greater part of the type is valued at \$100 to \$150 an acre.

*Grundy silt loam, rolling phase.*—The surface soil of the Grundy silt loam, rolling phase, consists of a friable, dark-brown to black silt loam, which grades below into somewhat lighter colored material extending to a depth of about 18 inches. The subsoil is a yellowish-brown to grayish-brown silty clay or clay loam, changing to a yellowish clay in the lower part. Along the outer margins of areas of the phase and on the narrower ridges the subsoil consists of glacial till and contains some sand. The surface soil usually contains a small percentage of fine sand, and the change from soil to subsoil is less distinct than in the main type. The bench-land areas are lighter in color and texture than the upland areas.

In some places where this phase occurs on narrow ridges much of the surface soil has been removed and the heavy clay subsoil is encountered near the surface. Such areas frequently are covered with a scrubby growth of white oak. They are best adapted to use as pasture. Where cultivated they require large additions of organic matter to improve the physical properties of the soil and to insure

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<sup>1</sup> See "Soil Experiments on the Dark Prairies of Central and Northeast Missouri," Bul. No. 127, Missouri College of Agriculture.

fair yields. On account of their small extent these areas are not indicated on the soil map.

The Grundy silt loam, rolling phase, represents sections of the type modified in surface features and in structure by erosion. It includes all the narrow ridges and forms a belt surrounding the more nearly level areas of the main type. It occurs also along some of the larger streams, occupying the second bottoms and low, gradual slopes. The topography is gently rolling, and the surface drainage generally is good. The slopes usually are not steep enough to permit destructive washing.

The boundaries between the main type and the phase are necessarily drawn somewhat arbitrarily, as the two grade into each other almost imperceptibly. Erosion tends to convert the outer margin of the rolling phase into Shelby loam, while the flat prairie is gradually being converted into the rolling phase by the same agency. This change is taking place more rapidly now than formerly, when washing was largely prevented by prairie grasses.

Like the typical Grundy silt loam, the rolling phase is all under cultivation. It is used for the same crops, and the soil treatment is the same as on the main type. It is not so droughty, however, and is generally considered the most desirable of the upland soils. In very dry or very wet seasons it is more productive than the flat prairie land, as it has better surface drainage.

#### MARSHALL SILT LOAM.

The soil of the Marshall silt loam to a depth of 10 to 12 inches is a black to dark-brown, mellow silt loam. This grades into a brown to light-brown silt or silty clay loam. The subsoil below about 24 inches is a brownish, friable silty clay mottled with gray and yellow. The lower subsoil frequently passes into a yellowish-brown clay loam resembling the lower subsoil of the Grundy silt loam. Both surface soil and subsoil are free from sand and gravel, and the material usually is uniform to a depth of 6 or 8 feet.

This type is derived from the fine silty material generally called loess, which overspreads a large part of northwestern Missouri. It is probable that the loess at one time covered a large part of Dekalb County, but owing to the action of erosion the thick deposits are now confined to the valleys in the western part of the county. These areas represent the eastern edge of the extensive loess soils that comprise nearly all the upland west of Dekalb County to the Missouri River.

The Marshall silt loam is confined to the valley of Big Third Fork in the western part of the county. The type rises gradually from the outer margin of the flood plain and has a gently rolling topography.

Practically all the type is in cultivation, being used for the production of corn and grass almost exclusively. It is especially desirable as grass land. The yields of corn average higher than on any of the other upland soils. On account of its mellow subsoil it is especially adapted to the growing of alfalfa and other deep-rooted crops. As a general-farming soil the Marshall silt loam is one of the most desirable types in the county. The content of organic matter in the soil is high, and the supply is easily maintained. Manure, crop residues or legume crops should be turned under in order to maintain the organic-matter and nitrogen content, but the addition of commercial fertilizers probably would not prove profitable. The installation of tile drains in a few of the flat areas would prove beneficial.

#### CRAWFORD STONY LOAM.

The Crawford stony loam includes areas occupied by rock outcrops or strewn with rock fragments to such an extent that cultivation is impracticable. The soil material is variable, but usually consists of a dark-brown or yellowish-brown silty clay or clay loam, underlain at a depth of 10 to 24 inches by beds of limestone or yellowish-drab shale. It is derived in part from the weathering of limestones and shales and in part from glacial till.

The type occurs in the eastern part of the county on steep slopes where the overlying drift has been removed and the bedrock exposed. A number of areas are too small to map.

Practically all the Crawford stony loam is forested or covered with brush. Some of the smoother areas could be used for pasture or orchard sites. Bluegrass and white clover do well on this soil. Most of the type would best remain forested, because when it is cleared erosion becomes destructive.

#### WABASH LOAM.

The Wabash loam is the most variable soil type in the county. The surface soil ranges in texture from fine sandy loam to clay loam, although dominantly it is a loam. Along the steeper slopes where washing is more marked the soil generally is quite sandy, while in the gently rolling areas the sand content is relatively low. Where the type occurs within areas of the Grundy silt loam the texture is a silt or silty clay. At a depth of 15 to 18 inches the surface soil grades into a black or dark-gray silty clay, carrying some sand and continuing to a depth of 3 feet or more. There usually is not enough sand in the subsoil to give it a friable texture, and the lower part is almost sand free. The surface soil is characterized by its black color and high content of organic matter.

This type occurs along the small streams and draws in all parts of the county and is both alluvial and colluvial in origin. It lies

relatively higher than the other bottom-land soils and is rarely overflowed. Very frequently, however, tributary streams of steep gradient which descend from the upland are raised to flood level by heavy showers, and under such conditions carry down large quantities of local material, which is deposited in the form of low alluvial cones at the point where the Wabash loam adjoins the upland slopes. At the heads of some draws, where the type has a flat surface, the moisture conditions could be improved by the use of tile drains.

The Wabash loam is one of the most productive soils of the county. It is well suited to all the field crops commonly grown in the region, and particularly to corn and grass. Where it has good underdrainage it is also well suited to alfalfa. Wheat and oats usually make too rank a growth and are likely to lodge.

#### WABASH SILT LOAM.

The surface soil of the Wabash silt loam is a dark-brown or dark-gray to black, mellow silty loam. The darker material occurs where there has been a tendency toward the accumulation of a mucky surface soil. The soil is lighter brown on the low undulations, which have better drainage and are not subject to annual overflow. The surface-soil material grades almost imperceptibly into the black or dark-gray silty clay loam or clay loam subsoil. Owing to the alluvial origin of the type, there are minor variations in texture, and frequently a drab or gray clay is present in the lower part of the subsoil, while veins and pockets of sand are encountered in places in the surface soil or subsoil. Some fine sand has accumulated on the low ridges. In general, the type is more uniform in texture and slightly heavier in the western part of the county than in the eastern part. This difference is probably due to the fact that in the western part the soil material is largely derived from the upland silt loams and from loess, while the glacial till is the source of the valley soil in the eastern part of the county.

The Wabash silt loam includes the broad, level first bottoms or overflow lands along the larger streams in the county. In many places the frequent overflows of the different streams have built up the areas of this soil type which immediately adjoin the stream channels to elevations somewhat greater than that of the material farther back in the same bottoms. In such locations the material usually is somewhat coarser than the general average of the type, and small areas of fine sandy surface soil are encountered. The natural drainage is good, although practically all the type is subject to overflow. Such wet areas as are sometimes found at the foot of the upland slopes can be easily and effectively drained by open ditches or by tile drains. The water table is seldom encountered at a depth of less than 8 feet. Droughts hardly ever seriously affect

crops on this type. The occasional overflows constitute the only limitation to the use of this soil.

Originally the Wabash silt loam contained large quantities of organic matter. Continued cropping for more than 30 years has materially decreased, though it has not nearly exhausted, this supply. The organic content, together with the silty nature of the material, tends to make the surface soil very mellow and desirable for cultivated crops.

This type is particularly desirable for the production of corn. Probably more than three-fourths of the type is devoted to this crop. Yields range from 40 to 100 bushels per acre. In the higher lying areas wheat and oats do well, but are likely to lodge on account of their rank growth.

Grasses thrive in the low-lying areas and next to corn they constitute the most important crop. Timothy and redtop particularly give heavy yields of hay. The areas that are not subject to overflow are well suited to the production of alfalfa and clover. It is not probable, however, that with the present demand for corn any large area of this type will be devoted to the production of other crops. The type is inherently strong and durable and enhances the value of farms in which it is included.

To maintain the productiveness of the Wabash silt loam the only need is the practice of good methods of farming. Even the systematic rotation of crops is not so important where the land is subject to occasional overflow, but where it lies high or is protected from overflow by dikes a rotation including leguminous crops should be practiced, and ultimately provision should be made in such protected areas for the incorporation of organic matter and, if acid, for the addition of lime.

#### WABASH CLAY.

The surface soil of the Wabash clay is a black or drab, heavy, plastic clay or clay loam, having an average depth of about 10 inches, although not infrequently extending to a depth of 15 inches or more. The subsoil, which continues to a great depth, usually is a bluish-black, sticky, waxy clay, with occasional iron stains. The surface soil when wet is stiff and sticky and adheres to the moldboard of the plow. It cracks and granulates as the water evaporates, forming crevices which sometimes have a depth of 12 to 20 inches and a width of 1 to 2 inches. The subsoil is retentive of moisture, owing to its texture and the low position of the type. Locally the Wabash clay is known as "gumbo."

The Wabash clay occupies level or depressed positions within the broader alluvial lands. It comprises the areas of deposition of the finest sediments carried by the overflow waters. Practically all the

type is flooded each season. It retains an excess of moisture until far into the summer, and is consequently not well suited to agriculture in its natural condition.

The natural productiveness of the Wabash clay, where it is properly protected from overflow, makes it a desirable soil. However, very little attempt has been made to produce other than a few general farm crops. Where well drained the type is devoted to corn, and yields ranging from 60 to 80 bushels per acre are obtained. Crops, however, are uncertain, and in wet seasons usually are a failure. The poorly drained areas yield large quantities of coarse hay. Areas not subject to overflow are admirably adapted to clover and timothy.

To improve this soil it is necessary to provide both surface and underground drainage and to protect the land from floods. In many cases the physical properties of the soil can be greatly improved by plowing under corn stalks and other coarse material. It should be remembered that the difficulty of working clay soils is in proportion to their deficiency in organic matter.

#### SUMMARY.

Dekalb County lies within the gently rolling prairie region of the northwestern part of Missouri. It has an area of 417 square miles, or 266,880 acres. The topography varies from level to rolling; prevailingly it is gently rolling. The most extensive area of level land is in the south-central part of the county. Elevations range from about 850 to 1,080 feet above sea level.

Regional drainage is well developed; the streams of the eastern part of the county have cut to greater depths than those of the western part. With the exception of the larger drainage ways, the streams are dry except during wet weather. The flood plains of the larger streams are very wide in proportion to the size of the drainage course.

The population of Dekalb County in 1910 was 12,531. Maysville, the county seat, is the largest town in the county, with a population of 1,051 at the last census.

Transportation is furnished by the Chicago, Rock Island & Pacific, the Chicago, Burlington & Quincy, and the Quincy, Omaha & Kansas City Railways.

The climate is mild and well suited to general farming. The mean annual temperature is about 53° F. The average annual precipitation of about 35 inches is well distributed throughout the year. There is a normal growing season of 160 days.

The agriculture of the county consists principally of general farming and stock raising. Dairying is becoming important. Practi-

cally all the live-stock and dairy products are marketed in St. Joseph. Corn is the most important cultivated crop. Oats are grown on nearly every farm for home use. Wheat is an important crop on the level prairie lands, and its acreage is gradually being increased. Timothy and clover are grown extensively. The county is noted for its excellent bluegrass pastures. Owing to improved methods of farming crop yields are increasing.

The 1910 census reports 2,186 farms in Dekalb County. The average size of the farms is given as 120.5 acres. Of the total land area of the county, about 97 per cent is in farms, and of the farm land about 93 per cent is improved. The average value of farm land in 1910 is given as \$68.44 an acre. About 67 per cent of the farms are operated by the owners and practically all the remainder by tenants.

The glacial soil, represented by the Shelby loam type, comprises about 67 per cent of the upland of the county. It is characterized by a dark surface soil and heavy clay subsoil. It is productive and well adapted to corn, grass, and other staple crops.

The loessial soils include the Grundy and Marshall silt loams. The Grundy silt loam and its rolling phase are excellent grass and small-grain soils, all under cultivation. The Marshall silt loam is very productive and is highly prized for corn, grass, and alfalfa.

Owing to its small extent and rough topography, the Crawford silt loam is a negligible factor in the agriculture. It is derived from resistant limestone beds along the deeper stream cuts, mainly in the eastern part of the county. Practically all the soil is forested.

The alluvial soils are classed with the Wabash series. Although subject to occasional overflow, they comprise some of the most productive land in the county. They are used for the production of corn almost exclusively, but are well adapted to grass, wheat, and, where well drained, to alfalfa.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,* That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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