



Issued January 15, 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.

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SOIL SURVEY OF HARRISON COUNTY,  
MISSOURI.

BY

E. S. VANATTA, OF THE U. S. DEPARTMENT OF AGRICULTURE,  
AND E. W. KNOBEL, 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:  
GOVERNMENT PRINTING OFFICE.  
1916.

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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF SOILS,  
*Washington, D. C., July 17, 1915.*

SIR: The field operations of the Bureau of Soils for 1914 included a soil survey of Harrison County, Mo., undertaken in cooperation with the University of Missouri Agricultural Experiment Station, F. B. Mumford, Director.

I have the honor to transmit herewith the manuscript and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1914, as authorized by law.

Respectfully,

MILTON WHITNEY,  
*Chief of Bureau.*

Hon. D. F. HOUSTON,  
*Secretary of Agriculture.*

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### MAP.

Soil map, Harrison County sheet, Missouri.



# SOIL SURVEY OF HARRISON COUNTY, MISSOURI.

By E. S. VANATTA, of the U. S. Department of Agriculture, and E. W. KNOBEL, of the University of Missouri.

## DESCRIPTION OF THE AREA.

Harrison County, Mo., is located in the northwestern part of the State, lying about 110 miles southwest of Des Moines, Iowa, and 75 miles northeast of St. Joseph, Mo. It is bounded on the north by Ringgold and Decatur Counties, Iowa, on the east by Mercer and Grundy Counties, on the south by Daviess County, and on the west by Gentry and Worth Counties, Mo. It is the fourth county east from the Missouri River. It has a length of approximately 30 miles and a width of 24 miles, and contains 721 square miles, or 461,440 acres.

Topographically, Harrison County embraces three distinct divisions—upland, terraces, and bottom lands. Originally the surface of the county was probably a smooth or gently undulating plain, at the level of the present uplands. Drainage, which has been quite active, has eroded this plain and brought about the present surface configuration. The topography of the greater part of the upland is rolling, consisting of narrow ridges with a general southerly trend, and of stream breaks. The latter show considerable variation in topography. Near the watershed ridges the valleys are shallow and the slopes rather gradual, while as the main streams are approached the valleys become deeper and the slopes steeper. The area in general most rolling occurs throughout the western and northwestern part, and a gently undulating prairie of considerable size occurs in the southeastern part of the county. Entering the county at Gilman City, with a width of 3 to 6 miles, this prairie gradually becomes narrower toward the north, until at Ridgeway it is a mere ridge. It remains intact, however, forming the divide between Big Creek and Grand River, and running slightly to the northeast to Andover, where it again spreads out into a prairie region. Some of the other watersheds are sufficiently broad to afford rather extensive areas of gently rolling prairie.

The terraces of the county are inextensive, the larger occurring along Grand River and along the lower course of Big Creek. Their surface varies from level to gently undulating, and for the most part they lie above overflow. The slope from the terraces to the adjoining upland is usually gentle, while the transition to the first bottom is abrupt.

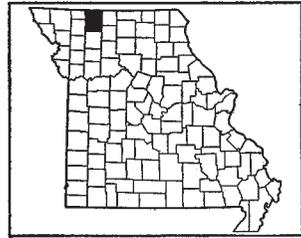


FIG. 1.—Sketch map showing location of the Harrison County area, Missouri.

The first bottoms have a general occurrence along the various drainage courses in the county, are gently undulating to flat, and are subject to overflow. Frequently the larger bottoms are marked by depressions, oxbow lakes, and old channels. The larger bottom-land areas are locally referred to as "prairie land."

The stream valleys are comparatively wide and the channels meandering. The flood plain of Thompson Fork of Grand River has an average width of  $1\frac{3}{4}$  miles. The valleys of the West and East Forks of Big Creek and Shain Creek in the northern part of the county are comparatively wide, but from the latitude of Washington Center southward to within a few miles of Bethany are narrow—frequently too narrow to be mapped accurately. Through this belt the stream valleys are extremely crooked, winding back and forth in large loops or "goosenecks." Below Bethany the valley of Big Creek is rather broad, the width varying from half a mile to a mile. In general, the channels of the small branches are deep.

The eastern part of the county, about one-third of its area, is drained by Thompson Fork of Grand River and its tributaries. The central part is drained by Big Creek, the East and West Forks of which cross the north line near the center, and join near Bethany. Big Creek and its tributaries drain about half the county. The remainder is drained in a southwesterly direction to West Grand River.

Springs are of rare occurrence in the county. Occasional seeps occur along the foot of some of the stream bluffs. A good supply of excellent water is encountered at depths ranging 30 to 75 feet.

The first permanent settlement in Harrison County is supposed to have been made on Big Creek, several miles below the present site of Bethany, in 1837. Several settlements were made along Sugar Creek during the year 1838. These settlements were naturally made along stream courses in the edge of the timber in locations most convenient to water, fuel, shelter, and game. The early settlers came from the older portions of the State and from eastern States.

The county was organized February 14, 1845, prior to this time having been included in Daviess County. As first organized it extended north only as far as the north line of township 65 N., as at that time the location of the Iowa-Missouri boundary had not been definitely determined and it was thought that another county would be formed between Harrison County and the State line. In 1850 the State line was established just 7 miles north of the Harrison County line, and in 1851 the county was reorganized to include the 7-mile strip.

The population of Harrison County is largely American. The negro population is very small and confined mainly to Bethany and Cainesville. According to the census the population gradually increased until about 1900, since which time it has decreased. In 1880 it was 20,304; in 1890, 21,033; in 1900, 24,398; and in 1910, 20,466. About 65 per cent of the present population is rural.

Bethany, the county seat, located in the south-central part on Big Creek, was founded in 1845. In 1910 it had a population of 1,931. A large flour and feed mill is located here. Cainesville, a town of about 1,000 population, is located on Thompson Fork in the northeastern part of the county. A large coal mine constitutes the main industry of the town. Ridgeway, in the east-central part, and Gilman City, in the southeastern part of the county, are towns of slightly less than 1,000 population. New Hampton, Blythedale, Melbourne, and Andover are small railroad towns. Eagleville, Mount Moriah, Martinsville, Hatfield, Blue Ridge, Pawnee, Washington Center, Bridgeport, and Akron are small inland towns.

Railroad transportation facilities in Harrison County are rather inadequate, especially in the northwestern part, where there is a strip of country lying 12 miles or more from the nearest railroad. A line of the Chicago, Burlington & Quincy Railroad, extending from St. Joseph, Mo., to Des Moines, Iowa, traverses the county, passing through Bethany. This road was completed through the county during the year 1881. In 1884 the Des Moines & Osceola Narrow Gauge, now a standard branch of the Burlington Route, was completed from Leon, Iowa, where it connects with the branch described above, to Cainesville. The Quincy, Omaha & Kansas City Railroad, built more recently, crosses the two southeast townships. These roads give good shipping facilities to the Kansas City, St. Joseph, Omaha, and Des Moines markets.

The wagon roads of Harrison County are earth roads and follow land lines, except where the topography prevents. They are well graded and dragged and except for a few weeks in late winter and spring are kept in good condition. Substantial concrete culverts are rapidly supplanting the old plank bridges. There is a very general adoption of the use of the automobile by the farmers of the county.

The rural free delivery of mail and the telephone reach most farms. Farm buildings and other improvements are good and denote a general condition of prosperity.

#### CLIMATE.

The climate of Harrison County is that of all north Missouri. A comparison of the climatological statistics with those of the more central counties in the State will show nearly identical normal precipitations, a difference in mean temperature of about 2° F., and a very slightly shorter average growing season. Serious injury to live stock or crops by reason of extreme climatic conditions is of rare occurrence.

The average rainfall for the county is 35.53 inches. During a normal year the greater part of the rainfall occurs during the spring and summer months, when most needed by the growing crops. Climatic injuries to plant growth are usually the result of long-con-

tinued rains during the spring months, followed by short droughts, probably causing the most injury to crops upon the prairies and the bottom lands, or result from long protracted summer droughts, which decrease the yields very perceptibly on all save perhaps portions of the lower lying bottom lands. Proper drainage will tend to a large extent to prevent injury from excessive rainfall, and methods designed to conserve soil moisture will do much to alleviate injury at present suffered from drought. Occasional losses from spring and fall overflow occur in the larger stream bottoms. The snowfall is generally sufficient to protect the wheat and grasses during the winter months.

The average date of the last killing frost in the spring is April 26, and of the first in the fall October 8. The latest recorded frost in spring occurred May 19 and the earliest in the fall September 13. The length of the average growing season is 165 days, which is sufficient for the proper maturing of all general farm crops. Alfalfa may be cut three times, and bluegrass, with good fall rains, may be pastured until Christmas. Fruits, with the exception of peaches, are rarely injured by weather extremes.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded by the Weather Bureau station at Bethany:

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

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	° F.	° F.	° F.	Inches.	Inches.	Inches.
December.....	29.0	66	-29	1.46	1.33	2.16
January.....	24.6	67	-22	1.40	1.22	1.07
February.....	24.9	75	-27	1.41	2.50	.33
Winter.....	26.2			4.27	5.05	3.56
March.....	38.4	88	- 5	2.45	2.78	.69
April.....	50.5	90	9	3.09	1.79	1.40
May.....	62.3	94	17	5.15	1.39	8.30
Spring.....	50.4			16.69	5.96	10.39
June.....	71.7	100	40	4.21	5.13	9.93
July.....	75.1	109	47	4.38	.37	5.55
August.....	74.0	105	40	4.39	.29	7.56
Summer.....	73.6			12.98	5.79	23.04
September.....	66.4	103	23	3.52	2.79	10.66
October.....	53.8	92	17	2.41	2.45	2.75
November.....	39.2	78	- 6	1.66	1.00	3.12
Fall.....	53.1			7.59	6.24	16.53
Year.....	50.8	109	-29	35.53	23.04	53.52

## AGRICULTURE.

Harrison County originally supported a heavy growth of prairie grasses over the gently rolling prairies and wide bottom areas, and a timber growth, consisting mainly of white, black, and bur oak, hickory, walnut, elm, ash, linden, maple, sycamore, buckeye, and locust on the more rolling areas, and in the breaks and smaller valleys.

The agriculture of the county dates back to the year 1837, when the first pioneer settled on Big Creek. Various kinds of live stock were brought in by the early settlers, but it is doubtful whether more than enough to supply the home was raised for some time. The main crops were corn, wheat, oats, barley, rye, and buckwheat. Flax, broom corn, tobacco, sorghum, and various truck crops were grown to a limited extent. A small quantity of maple sirup and sugar was made.

In 1880 the main grain crops were corn, oats, wheat, and rye, named in order of their importance. The same order of importance was maintained up to the time of the census of 1910. During the last three years, however, there has been a great increase in the acreage of wheat and it is probable that at present this crop ranks second only to corn in acreage.

The present agriculture of Harrison County consists mainly of a combination of grain and stock farming. Corn, wheat, oats, timothy, clover, and alfalfa are the main field crops. Large numbers of cattle, hogs, sheep, and some horses and mules are annually raised and fattened. It is quite probable that more live stock is raised and fed in the rolling northwestern part of the county than in any other part of equal extent. In the more level uplands and bottom lands less area is given over to pasture and more grain is grown. Dairying is carried on only to a limited extent. Orchard, small fruit, and truck crops are grown only in an amount sufficient to supply the home demand.

Corn is the leading grain crop of the county. In 1909, according to the census 95,144 acres produced 1,601,047 bushels, an average of 16½ bushels per acre. During the period 1900-1910 there was a decrease in acreage of about 18,000 acres. This has been partly accounted for by an increased acreage of wheat and oats, the remaining area probably being put in pasture land. Reids Yellow Dent, Leaming, St. Charles White, Boone County White, and strains closely allied thereto, are the varieties most commonly grown. The best average yields are obtained upon the better drained first-bottom and terrace soils, and upon the more rolling Putnam and gentler Shelby slopes. Fall plowing is commonly practiced for corn.

The greater part of the corn crop is fed in the county. Most of it is husked or snapped from the standing stalk, and the stalks pastured during the winter months. A considerable proportion of the crop is

cut for fodder, especially when wheat is to be seeded the same fall. Ordinary field corn is also commonly used for ensilage.

Although third in point of acreage in 1909, there is little doubt that at present wheat ranks second in Harrison County. In 1909 there were 5,177 acres of wheat (an increase of 4,000 acres over 1899), which produced 51,723 bushels, approximately 10 bushels per acre. Both bearded and smooth-head varieties of winter wheat are grown, Turkey Red and Fulcaster being the most common of the former, and Fultz, Poole, and Red Cross of the latter. Wheat is always sown with a drill and usually at the rate of 5 to 6 pecks per acre.

Wheat quite commonly follows oats in the crop rotation, or may follow corn if it has been cut. It is usually grown in the same field for two or more years in succession. Generally the last crop is followed by clover, or clover and timothy, and serves as a nurse crop for the grass. If to be thrashed soon after cutting, wheat is usually left in the shock until thrashing time; otherwise it is stacked. It is grown on all the soils of the county, with the exception of the Genesee fine sandy loam, but during a normal year it does best on the silt loams and the Shelby loam. Wheat is strictly a cash crop and is usually sold direct from the thrashing machine. In late years it has been a profitable crop.

According to the census of 1910 there were 15,286 acres of oats in Harrison County, which produced 320,211 bushels, not quite 21 bushels per acre. This is an increase in acreage of about one-third over that given by the census of 1900. Owing to the droughts of the last few summers the oat yield has been very low and the acreage has decreased until it probably is now as low as or lower than that of 1900. This crop produces the most satisfactory yields upon the upland and terrace soils of the county. The Texas Red, a rust-proof variety, is most commonly grown. Oats are not so profitable a crop as wheat but are at times desirable in the crop rotation, following corn and preceding wheat. The greater part of the crop is fed on the farm.

Rye is grown to only a small extent in Harrison County. It is usually sown for winter and spring pasture, and later either plowed under for green manure or allowed to ripen and harvested as grain.

Very small acreages of kafir and milo are grown for stock feed. A small tonnage of sorghum cane is annually produced. Sorghum is grown mostly for sirup.

Timothy is the predominant single hay crop in the county. According to the census of 1910 there were 14,153 acres devoted to this grass, which yielded 15,401 tons, or a little more than a ton per acre. Very often, especially if free from other grasses, the crop is cut with a binder and later thrashed for the seed; otherwise it is mowed, cured in the shock, and either stacked in the field or stored

under shelter. Some fall pasture is afforded by the aftermath of this crop. Timothy may be grown upon any soil type in the county, but is probably best adapted to the silt loams.

By far the greater part of the acreage in tame grasses in the county consists of clover and timothy mixed. According to the census of 1910 there were 44,398 acres, which yielded 47,563 tons. Besides this there were 364 acres in clover alone. The timothy is usually sowed in the fall and the clover the following spring. Owing to the droughts of the last few seasons considerable difficulty has been experienced in getting a stand, especially of the clover.

As yet alfalfa is grown only in small fields. This is a crop demanding a rich, fairly deep soil, not acid, and well drained, with a fairly permeable subsoil. The more fertile areas of Shelby loam seem best adapted to the legume, although favorable results are also obtained upon the deeper and better drained Grundy, Chariton, and Wabash silt loams. Three cuttings, yielding 2 to 3 tons for the season, are obtained. Alfalfa also affords excellent pasturage, especially for hogs. After becoming established this plant is exceedingly drought resistant, which has been an important cause of its rapidly increasing popularity.

Cowpeas and soy beans are grown to some extent on the upland soils of the county. They are especially well adapted for the areas of poor soils on which clover is rather a doubtful crop. As a catch crop in case of the failure of clover they are proving a success. They are often drilled in with corn that is to be pastured with hogs or cut for ensilage.

A considerable area is devoted to millet, in 1909 there being 4,610 acres, which produced 4,730 tons of feed. Millet is often used for hay, being cut when rather green. It may be cut for seed or may be pastured and later plowed under as green manure. The greater part of this crop is grown in the rougher upland region.

Bluegrass thrives in every part of the county. Perhaps 40 per cent of the total area is devoted to it. It has apparently become thoroughly established in this region, as bluegrass and white clover appear in and soon spread over meadows of long standing, or newly cleared areas. It is an excellent pasture grass and has contributed largely toward making this the important stock-farming section that it is.

In 1910 there were 393 acres of wild grasses in the county, which produced 485 tons of hay. These are mainly water-loving grasses at present confined to a few low, poorly drained areas in the larger bottoms.

Vegetables are grown near the various towns of the county to supply the local market. Elsewhere they are grown only for home use. Melons of good quality are also produced in sufficient quantities

to supply the local market. Ordinarily, enough Irish and sweet potatoes are produced to meet the home demand.

There are no large commercial fruit orchards in Harrison County, though most farms possess orchards ranging from 1 acre to 10 acres in size. The subsoils are rather too heavy to permit the best results with fruit trees. More profitable results might be obtained if the trees were more carefully cultivated, pruned, and sprayed. Apples are the leading fruit. The Duchess of Oldenburg and the Maiden Blush are the leading summer varieties; Jonathan, Grimes Golden, and Winesap the leading early winter varieties, and the Ben Davis and Ralls the leading winter varieties grown in the county. Peaches, plums, cherries, and pears are generally grown in sufficient quantity for home use. Grapes and the various small fruits are grown to a smaller extent. The value of all orchard products, including small fruits and nuts, is given in the census of 1910 as \$222,654. Fruits and nuts are thus seen to be a considerable item in the agricultural output.

Live stock forms the product of great importance in Harrison County. In 1909, according to the census, \$2,475,856 worth of live stock was sold or slaughtered. Of the animals disposed of, there were 31,929 head of cattle, 3,399 horses and mules, 84,556 hogs, and 12,862 sheep and goats.

There are very few herds of purebred beef cattle in the county, the majority being good grade stock, usually headed by a purebred male. Stock raising and feeding are carried on throughout the county, probably most actively in the northwestern part. In addition to those raised in the county a number of cattle are bought on the market and brought in and fattened. Shorthorn, Angus, and Hereford are the most common breeds.

The large number of hogs sold is accounted for by the fact that on nearly every farm a number of hogs are raised and fattened. The surest profits are obtained by feeding them in connection with cattle. Poland China, Duroc Jersey, Chester White, and Berkshire are the chief breeds. There are several purebred herds in the county.

The number of horses and mules sold is comparatively small. As a whole, the quality of draft horses and mules is above the average. Several good Percheron, Belgian, Shire, and Clydesdale stallions and a number of purebred and high-grade mares are owned in the county. Nearly every farmer raises one or more colts every year, and in this way keeps up his supply of work horses, and occasionally has a surplus to sell. A number of good mules are raised in Harrison County.

The sheep are, as a rule, owned in small flocks. The Southdown, Hampshire, and Shropshire are the most prominent breeds. A number of goats are kept for the purpose of clearing off brushy land. In 1909 wool, mohair, and goat hair was sold to the value of \$46,291.

Dairying is carried on in only a small way. The cream is sold at local markets and the skim milk fed to the hogs. A system of winter dairying might well be followed in order to solve the problem of an even yearly distribution of labor. The number of silos in the county is gradually increasing. The ensilage is fed to both dairy and beef cattle. In 1909 the dairy products sold amounted to \$192,911.

The poultry products of the county are practically all produced by the average farm flock of 50 to 200 hens. The Leghorn, Wyandotte, Plymouth Rock, Rhode Island Red, and Orpington are the principal breeds. A small number of turkeys, ducks, and geese are raised on many farms. In 1909 poultry and eggs valued at \$482,096 were sold.

In this region of fairly uniform soils and of general farm practices not a great deal of attention is given to crop adaptation. Practically all of the farm crops common to this region are grown on each soil type. While it is known that on some of the soils corn does better than the small grains and on other soils the results are reversed, little effort is made to determine whether some other crop might not be more profitably grown.

During the early history of the county farm practices were crude and at times wasteful. The seed bed for the growing crop was often carelessly prepared and cultivation was insufficient. Little attention was given to seed selection, crop rotation, and fertilization. However, the numbers of live stock carried served to keep up the soil fertility to some extent, and fields after several years of cultivation were put to grass and old pastures broken up. In later years there has been a general tendency among the better farmers toward more thorough farming practices. Considerable care is given to the preparation of the seed bed, seed is carefully selected and graded, cultivation is thorough, and crop rotation, including the use of legumes to increase the nitrogen content of the soils, adopted. A rather unsystematic crop rotation is practiced by the majority of the farmers.

One of the main problems to be dealt with in Harrison County is that of soil conservation. Over a large area drainage is excessive and attended by severe erosion, though in some areas it is still deficient. In the former various precautions are taken in order to protect the surface soil from all unnecessary washing. The steepest slopes may be kept in bluegrass pasture. Cultivated areas may be plowed deep, all available organic matter incorporated in the soil, and cover crops made use of. Small washes may be retarded by sodding the edges and filling with brush. The larger ones may be filled by means of a system of dams and tiles.<sup>1</sup>

Commercial fertilizers are used to some extent, usually with wheat. A complete fertilizer is used by some on run-down land. It is quite

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<sup>1</sup> Christophers. See Bul. No. 180, U. S. Dept. of Agr.

probable that phosphates, applied in connection with barnyard manure and the turning under of an occasional crop of legumes, such as clover or cowpeas, would be sufficient for the majority of these areas. As a rule, stable and barnyard manure is carefully saved and applied. Manure spreaders are quite commonly used throughout the county. The burning of straw stacks and stalk fields is still practiced by a few farmers, but much of such roughage finds its way back to the soil.

As a rule, the farm improvements of Harrison County are good. The buildings are of good size, well built and cared for, and indicate a general condition of thrift and prosperity. The greater number of the fences are of barbed wire or a combination of barbed and woven wire. There is a large mileage of hedge fence, particularly along farm lines. The fact that it stunts the growing crop for a strip of 12 or 15 feet on each side makes a hedge rather an undesirable fence. As a rule, farm machinery is of fair quality, but poorly cared for.

Farm labor is scarce and has become a serious problem, especially on the average-sized farm. The gradual extension of the use of labor-saving machinery is tending partially to solve this problem. Monthly wages range from \$20 to \$30, with board and lodging. Day laborers are paid from \$1.50 to \$3 with board, depending upon the season and character of work to be done. Most of the farm labor is hired between the months of March and December. A number of farmers, however, in order to get more efficient help, hire their hands for the entire year. On a number of farms the work is done by the family, the children and women sometimes working in the field. More even distribution of the season's labor is yet to be effected. The amount paid out for labor, as reported by 1,381 farmers in Harrison County in the census of 1910, was \$125.91 each.

According to the census of 1910, 95.3 per cent of the total area of the county, approximately 439,752 acres, was contained in farm land. Eighty-one per cent of this, or about 357,958 acres, was improved. The average size of the farms is given as 130.2 acres. This is a slight increase over the average size in 1880, which was 124 acres. There is little doubt that in the last few years the average size of the farms has increased considerably, as there is a growing tendency toward the absorption by certain farms of the neighboring smaller farms, as attested by the number of vacant farm homes. The latest census shows that 69.9 per cent of the farms are operated by their owners, 29.7 per cent by tenants, and 0.4 per cent by managers.

Cash and share rental and a combination of the two are the systems of renting followed. Cash rents vary from \$2.50 to \$5 per acre for general farming land, depending upon the crop and the nature of the soil. Share rents vary from two-fifths of the production where the tenant furnishes all stock, implements, seed, etc., to one-half where the owner furnishes a part of the equipment, the details of which

are arranged in various ways. In a combination of the two cash rents are commonly paid for buildings, lots, and pastures, and shares for the grain and meadow crops. Under the various systems the tenant is to harvest, deliver, and crib or store the products paid as rent. Ordinarily land values range from \$25 to \$125 an acre.

#### SOILS.

The soils of Harrison County are varied in regard to character of the material and the method of their formation. Physiographically they may be divided into three groups—upland, terrace, and first-bottom soils. The upland types, which are by far the most extensive, compose the Shelby, Lindley, Grundy, and Putnam series; the terrace soils are included in the Chariton and Calhoun series; and the first-bottom soils are classified as the Wabash and Genesee series. In texture the upland soils are loams and silts, the terrace soils silts, and the first-bottom soils very fine sand to clay. The color of the soils ranges through various shades of gray and brown to black.

The soil material of the upland is of glacial origin, having been deposited during the Kansan glacial epoch. The fine-grained material, such as the clay, silt, and fine sand, is probably both of local origin from the underlying sandstones, shales, and limestones and of glacial origin of northern derivation. The coarser material, such as the gravel, cobblestones, and boulders, is predominately of northern origin, probably 80 per cent of it consisting of red quartzite, gneiss, and other crystalline rocks wholly unlike the underlying country rock. The quartzites came from the northwest Iowa region, while the others must have come from the Great Lakes region, or from still farther north in Canada. The rest of the coarse material is of local origin.

Originally this drift layer seems to have been covered by a mantle of gravel and stone-free silty material, with a probable depth of 5 to 25 feet, of either wind or water-laid origin. Since its deposition, however, the whole country has been severely eroded, so that the mantle has been completely removed from the surface, except on the smooth upland areas, the narrow watershed ridges, and the adjacent upper, more gentle slopes. Through leaching processes the finer soil particles have been carried down below a depth of 12 to 18 inches, resulting in a silty soil underlain by a silty clay loam to silty clay. This weathered soil material constitutes the soil areas mapped in this county as the Grundy silt loam and the Putnam silt loam.

Erosion, upon removing this upper soil material, exposed the underlying glacial material which occurs on the stream slopes and the crests of the narrowest ridges. Where the country has been most thoroughly dissected the largest area of glacial soil occurs. Through erosion and leaching the finer soil particles have been carried down, resulting in a soil of coarse silt loam to loam in texture underlain by a

gritty silty clay. Oxidation has been much more complete in this formation than in the one overlying, as evidenced by the brown coloring in its upper subsoil. In addition to rock fragments, numerous calcareous streaks and concretions occur in the subsoil. This soil material gives rise to the Shelby and Lindley soils.

In a few of the roughest areas, where erosion has been most severe, the glacial material has been entirely removed, resulting in small outcrops of the underlying limestone. These areas occur mainly along Sugar Creek in the southeastern part of the county and along Big Creek near Bethany. The stony soil in such areas probably belongs in the Crawford series, but it is very much mixed with the overlying glacial drift, and is not of sufficient extent to warrant separation. It is indicated on the map by the rock-outcrop symbol.

Along the larger streams of the county terrace formations occur, giving rise to two soil series. Where the material has developed into a dark-colored soil very much like the Grundy in physical character, it is identified as a member of the Chariton series of soils. Where the surface soil is gray, on the other hand, rather poorly drained, and carries iron spots and concretions, it is mapped as Calhoun silt loam.

The bottom soils of Harrison County are of more recent origin and in many places are still in process of formation. They are derived mainly from work of Shelby and Putnam soils, and with one exception consist of stratified deposits of silts and clays. The Wabash series, represented by the Wabash silt loam, colluvial phase, along the intermittent streams, and the Wabash silt loam, silty clay loam, and clay along the larger streams, constitutes the greater part of the first-bottom lands in the county. A narrow strip of soil, lying adjacent to the channel of the larger streams, especially in bends and along the narrow first bottom formed by their degradation, has been mapped as a member of the Genesee series. Being added to mainly by the deposit of swiftly moving water, its texture is uniformly coarse.

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

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Shelby loam.....	229,568	49.8	Chariton silt loam.....	4,160	0.9
Grundy silt loam.....	118,336	25.6	Wabash clay.....	3,200	.7
Wabash silt loam.....	41,336	9.0	Genesee fine sandy loam.....	2,368	.5
Colluvial phase.....	35,592	7.7	Calhoun silt loam.....	2,112	.5
Lindley loam.....	12,544	2.7			
Putnam silt loam.....	6,528	1.4	Total.....	461,440	
Wabash silty clay loam.....	5,696	1.2			

## SHELBY SERIES.

The soils of the Shelby series are dark brown in color while the subsoils are yellow, reddish-yellow, or light-brown, tenacious sandy clays noticeably heavier than the surface soils. They are derived from the Kansan drift. In Harrison County the series includes only the loam type.

## SHELBY LOAM.

The surface soil of the Shelby loam consists of a dark grayish brown to dark-gray coarse silt loam to loam to a depth of 8 or 10 inches. The differences in the color are due to variations in amount of organic-matter present. Typically, the subsoil is a light yellowish brown to yellow silt loam to about 12 inches, where a tenacious gritty clay, of a yellowish-brown, heavily mottled with drab and light reddish brown, color is encountered. With depth the mottling gradually becomes less pronounced, the color at 24 inches being light yellowish brown, faintly mottled as above. Quite often the color of the subsoil becomes considerably lighter below 24 inches, approximating a gray or drab shade slightly mottled with yellow and brown, otherwise it remains the same as above. Ordinarily, the organic content of the soil ranges from low to medium. Varying amounts of glacial boulders and gravel, consisting of rounded fragments of granite, limestone, quartzite, gneiss, and diabase, occur throughout the soil and subsoil, although rarely so large as to hinder cultivation. Iron concretions occur throughout the subsoil. A considerable quantity of lime is contained in the subsoil, mainly in the form of lime concretions, which are particularly noticeable in the deeper road cuts.

A narrow Transitional-Zone area between the Putnam silt loam and the Shelby loam has been included with the latter when glacial material is encountered within 24 inches. Over these areas the soil is undoubtedly of similar origin to that of the Putnam series, being dark and of a silty nature, while the subsoil is of glacial origin. Ordinarily the subsoil, the upper portion in particular, is slightly heavier and more plastic than that of the typical soil. In color it differs in that the drab predominates in the upper portion, the brown mottling increasing and predominating at 24 inches, and the color below often being a light drab or gray mottled with light brown and yellow, as in the typical soil. In a few instances the rock formation underlying the Shelby loam has been exposed, giving rise to areas of a different soil, too small, however, to be mapped separately. These areas are largely of limestone origin, and had they occurred in sufficient area would have been mapped as the Crawford series. They are indicated by the rock-outcrop symbol. There is also a noticeable variation in the depth and color of the soil throughout the type.

On the crests of the broader glacial ridges, on the more gentle slopes, and on the lower part of the steeper slopes, the soil ranges from 10 to 14 inches in depth and is of a rather dark grayish brown color, while along the crests of the narrower ridges, on the shoulders of the hills, and on the steeper slopes, the soil is more shallow, in severe cases of erosion the subsoil being exposed, and the color considerably lighter.

The Shelby loam is the most extensive soil type in the county. It occurs along all but the most gentle slopes. In all instances, save in the prairie region in the southeastern part of the county, it reaches high up the stream slope, often including the crests of the narrower ridges. The topography varies from rolling to strongly rolling or broken as it approaches the Lindley loam. The surface configuration, especially in the more extensive areas of the type, presents a rather billowy appearance, the ridges occurring with regularity and being of a similar height and appearance. These areas are often referred to as the "washboard country."

Drainage is good to excessive. Owing to the loose structure and texture of the soil and the heavy subsoil erosion is frequently active, and unless properly handled severe washing and gullyng occur. Long protracted droughts inflict serious injury to growing crops upon this type.

This soil is derived mainly through weathering from the Kansan drift, but it is more or less influenced by originally overlying silt layers.

Originally the greater part of the type was timbered, although some of the wider topped glacial ridges supported a growth of prairie grasses. The timber growth was composed largely of oak and hickory.

The greater part of the Shelby loam has been cleared. Probably over 50 per cent of it is in pasture and hay land. Portions of the rougher lying areas are in timber or timbered pasture. In places a growth of scrub oak and buckbrush is tolerated, rendering such tracts unutilizable. Farm practices vary from general farming to stock farming. Beef cattle of good quality are produced and fattened. During a normal year crop yields are good. Corn yields 25 to 60 bushels, wheat 15 to 20 bushels, oats 20 to 40 bushels, and timothy and clover 1 to 2 tons per acre. Alfalfa, wherever tried, has usually succeeded. Inoculation and the incorporation of organic matter are necessary for the best results. Bluegrass makes an abundant pasture growth during all but a few weeks in a droughty summer and fall. Some millet is grown for hay. Sorghum is grown to a small extent for the production of sirup. Orchards, small fruits, and vegetables produce well, but are grown mainly for home use, with an occasional surplus for the local market.

A more or less systematic rotation of corn, oats, wheat, and timothy and clover is followed, the period of growing each crop being dependent upon the condition of the soil and, in a way, upon the season.

In comparison with the other main upland type, the Grundy silt loam, the Shelby loam is much more liable to destructive erosion, and hence is more often sowed to hay and pasture crops. On account of the calcareous nature of the subsoil, when properly supplied with organic matter it is well suited to the legumes and is probably the better of the two upland soils for the growing of alfalfa. Under proper care crop yields on the better lying areas are equal to and at times superior to those on the Putnam silt loam.

Owing to its sand content this soil may apparently be cultivated under a wider range of moisture conditions than is possible on the Grundy silt loam. With its more rapid drainage, it becomes tillable sooner after heavy rains. However, erosion is a factor that must be carefully guarded against.

A considerable amount of fertilizer, in the form of barnyard manure, is produced and applied upon fields of this soil. Commercial fertilizer is frequently applied with the wheat.

A great range of quality in farm buildings exists, some of the poorest as well as the best being located upon this type. They are not so well kept on the average as those on the Grundy silt loam. The selling value of the average farm land varies from \$60 to \$100 an acre, depending largely upon its topography and proximity to market.

#### LINDLEY SERIES.

The soils of the Lindley series are typically yellowish brown, ranging from gray on the one hand to brown on the other. They are usually shallow, the dark soil layer being rarely more than 8 inches thick. The subsoil is yellowish to yellowish brown or in rare cases reddish brown, usually free from mottling or faintly mottled with gray. It is usually heavier than the soil, though it contains in many cases a considerable percentage of sand and gravel. Lime concretions are almost always present in the lower subsoil. The topography is usually rather rough and the soils, especially the medium textured members, were originally covered with oak and hazel brush. These soils are derived by weathering from the Kansan drift and occur in association with the Shelby soils. In Harrison County the series is confined to the loam member.

#### LINDLEY LOAM.

The surface soil of the Lindley loam consists of a brownish or yellowish-gray to light grayish brown loam with an average depth of 5 inches. Its content of organic matter is low. Typically the subsoil consists of a light yellowish brown sandy silt loam to about

10 or 11 inches, where it becomes a plastic, gritty silty clay of a light yellowish-brown color, faintly mottled with gray and reddish brown. The mottling increases with depth, and at 30 inches the main color is considerably lighter. At 36 to 40 inches the light-gray or drab color often equals or even predominates over the yellowish brown. Comparatively large amounts of glacial pebbles, identical with those of the Shelby loam, occur throughout the 3-foot soil section. Iron concretions occur in the subsoil.

A number of small areas have been included with the Lindley loam that are of different origin, but are small and irregular and affect its agricultural value little. These areas are formed mainly from the underlying rocks, which have been exposed by erosion along some of the rougher breaks. The soil is derived from the weathering of the exposed rock (mainly limestone) modified to some extent by drift from the till lying higher up the slope. Fragments and ledges of limestone and of the rocks of the glacial till appear over the surface and throughout the soil section in such quantities as to make the areas quite stony. Had these areas been separated they would have been mapped in the Crawford series. They are indicated by the rock-outcrop symbol.

The Lindley loam differs from the Shelby in depth and color of the surface soil and in topography. It occurs along the steeper slopes of the large streams and has been subjected to severe erosion, which has resulted in the soil mantle becoming very thin and unproductive. Its origin is the same as that of the Shelby loam. This soil has its largest occurrence along Big Creek.

The Lindley loam was originally forested, rather stunted oaks and hickory predominating. Where the timber has been partially removed, a growth of brushy oak and buckbrush has sprung up and taken possession of the land. In their present state such tracts furnish only a very small amount of pasturage. A few of the better lying areas have been cleared and put in cultivation. The same crops are grown as upon the Shelby loam. Bluegrass is apparently indigenous to this soil. Owing to its low organic content and tendency to erosion, it would seem that this soil should give the best results when used as pasture or timbered pasture land. It is valued at \$25 to \$60 an acre, depending upon its location, relation to surrounding soils, and topography.

#### GRUNDY SERIES.

The soils of the Grundy series are dark gray to black in color, with a faintly developed subsurface gray layer. The upper subsoil is a heavy plastic silty clay mottled dark drab and yellowish brown. The deeper subsoil is a moderately friable silty clay loam predominantly yellowish brown in color, with gray or bluish-gray mottling. In Harrison County only the silt loam type is mapped.

## GRUNDY SILT LOAM.

The surface soil of the Grundy silt loam to an average depth of 14 inches consists of a dark-gray silt loam of slight brownish cast, black when wet, smooth, and medium textured. Its content of organic matter is usually moderate to good. The subsoil is a somewhat lighter gray or drab silt loam, with a faint yellowish brown mottling, grading through a silty clay loam into a rather plastic silty clay at 18 inches. The color at this depth is drab, well mottled with yellowish brown, and it gradually becomes lighter with depth, being at 30 to 36 inches very light gray, mottled with light yellowish brown. The subsoil from 18 to 36 inches is plastic and heavy. Iron concretions occur throughout the subsoil.

The type as mapped is very uniform with no observed variations of importance. The whitish subsurface layer characteristic of the Putnam series is absent or only faintly developed.

The Grundy silt loam is mapped throughout the upland region of the county. Its largest occurrence is in the southeastern part, where it forms the large prairie mentioned early in this report. It also occurs on the crests of the larger ridges and as gentle slopes adjacent to the larger streams. It is most restricted in the northwestern part of the county, where it occupies the crests of only the highest ridges.

The topography of the Grundy silt loam varies from very gently undulating to gently rolling. The more level areas are found through the large prairies; the more rolling along the crests of the ridges and on the stream slopes. Drainage in the more level areas is very often poor.

Owing to the heavy texture of the subsoil, the run-off is large during heavy rains. Serious erosion occurs at times on the more rolling areas. It may be checked considerably by building up the organic content of the soil and preventing gullying. Crops on this soil are severely injured by long summer droughts.

The origin of the Grundy silt loam is not definitely determined. It is thought to be either of loessial formation or an outwash from the receding glaciers of the Kansan age.

A dense growth of prairie grasses originally occupied this type. Practically all of this soil has been improved and is at present under cultivation or in pasture and hay land.

Although in a few areas grain farming has been largely followed, there is a growing tendency toward the adoption of a system of general farming consisting of combined grain and stock farming. Owing to the fact that this soil brings a higher price yet produces no better pasturage than the Shelby loam, stock raising can not be made so profitable. Considerable numbers of live stock are, however, annually marketed. Nearly every farmer raises hogs, a few calves, a few sheep, and one or more colts.

General farm crops produce well. During a normal year corn yields 25 to 60 bushels, wheat 15 to 25 bushels, oats 25 to 50 bushels, and hay 1 to 2 tons per acre. In a number of fields alfalfa is successfully grown. Provided with a deep soil, good drainage, liming, and inoculation, good results should be obtained. The hay usually is a mixture of timothy and red clover, although either is at times grown alone, usually for seed. Some alsike clover is grown on the more poorly drained areas. Sorghum and millet are grown, the latter usually in the event of the failure of an earlier sown crop.

Orchard fruits, small fruits, and truck crops are usually grown for home use, with an occasional surplus for the local market.

A general rotation of the common farm crops—corn, oats, wheat, and timothy and clover—is followed. Frequently corn is grown several years continuously. The methods of cultivation are usually good. Fall plowing for corn is quite generally practiced. Owing to the topography, the fields are for the most part regular and of good size, and as a result farm machinery is heavier and more effective than on the more rolling Shelby loam. Considerable manure is applied to the fields in cultivation. Commercial fertilizer is sometimes used with wheat. Although not so fertile as when first put under cultivation, this soil is apparently managed in a way that will tend to maintain its present state of productiveness.

The farm improvements upon this type are as a rule good and well kept, averaging better than those on any other soil type in the county. The selling price ranges between \$75 and \$125 an acre, varying with topography, condition of the soil, improvements, and the nearness to market.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Grundy silt loam:

*Mechanical analyses of Grundy silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
343419.....	Soil.....	0.0	0.7	1.3	1.5	4.7	71.7	19.9
343420.....	Subsoil.....	.0	1.4	1.8	1.8	3.6	64.8	26.7

PUTNAM SERIES.

The Putnam series includes gray to light-brown soils overlying impervious drab or brown subsoils of fine texture and close structure. One of their principal characteristics is the presence of a whitish silty layer between the soil and the subsoil. The soils occupy level to gently undulating upland prairies, and are derived from loessial deposits. The Putnam soils differ from the true Shelby in contain-

ing little or none of the glacial till, though this usually underlies the Putnam at variable depths. In Harrison County the series is represented by its silt loam member.

#### PUTNAM SILT LOAM.

The Putnam silt loam is a grayish-colored soil. Owing to a slight accumulation of organic matter in the upper part of the surface soil, this section is somewhat darker than the lower part, and the type may be considered as consisting of three sections. Typically, the surface soil is a brownish gray to gray, brownish gray when wet, silt loam of a loose, open structure, to a depth of 4 to 6 inches. From this to depths ranging from 10 to 12 inches the material is a mottled gray and pale-yellow or yellowish-gray to white, smooth silt loam. The content of organic matter is very low. The subsoil consists of a yellowish-brown, mottled with gray, heavy silt loam to silty clay loam, grading at about 15 inches into a plastic silty clay very faintly mottled as above. The gray mottling again becomes more noticeable at about 24 inches and increases in prominence to 30 to 36 inches, where the gray color predominates, the soil material here being a very light drab mottled with yellowish-brown, plastic clay. Iron concretions occur throughout the subsoil.

Where the type is most perfectly developed the line of demarcation between the subsurface soil and subsoil is quite sharp. In these areas the upper subsoil is a dull-brown plastic silty clay, the gray mottling appearing and predominating at about 24 inches, as in the Grundy silt loam. A variation in color, due to increased amounts of organic matter, often occurs where the Putnam silt loam grades into the Grundy. The material from which this soil is derived comprises only a thin layer over the underlying glacial till.

The Putnam silt loam differs from the Grundy type mainly in color and depth. Erosion has probably been a large factor in bringing about these differences. The fact that this soil has mostly been timbered partly explains its light color, as areas in timber at present are considerably lighter than those under cultivation. This soil is very much inferior to the Grundy soil in point of productiveness.

The Putnam silt loam occurs in small areas scattered through the rougher portions of the county. It is usually encountered upon more or less steep slopes and on the crests of narrow ridges. The topography is rolling. Owing to a rather loose structure, heavy subsoil, and sloping position, the type is subject to excessive drainage and erosion is often severe. Crops on it are seriously injured by drought.

This soil is probably derived from thin layers of the same deposit as that forming the Grundy silt loam. Originally the greater part of it supported a growth of rather stunted oak and hickory. Some of

the ridge areas lying adjacent to the Grundy type were probably occupied by a prairie vegetation.

The greater part of this soil is at present under cultivation, and the timbered areas are generally utilized as wooded pasture. General farming is practiced. The soil yields fairly well of the common farm crops, although small grains and grasses produce better and are more certain crops than corn. Normally, corn yields 20 to 35 bushels, wheat 12 to 20 bushels, oats 20 to 35 bushels, and timothy and clover hay three-fourths ton to 1½ tons per acre. Bluegrass makes an excellent growth, although it is badly injured by long summer droughts. Sorghum and millet produce well on this soil. Orchard and small fruits and vegetable products are grown in sufficient quantity for home use.

The rotation and cultivation of crops are very much the same as those practiced on the Grundy silt loam. The main problems in managing this soil are the preventing of erosion and the building up of the content of organic matter. Land values range from \$50 to \$90 an acre, depending upon the improvements, drainage, condition of the soil, and nearness to market.

#### CHARITON SERIES.

The soils of the Chariton series are dark gray to black in color. There are usually three layers of material in the 3-foot section. The upper layer is light, the lower intermediate, and the middle layer, which usually extends from about 16 to 24 inches in depth, heavy. The Chariton soil material occurs as an ancient flood-plain deposit, and is derived almost exclusively from the Kansan drift till and the silty layer that overlies it in the Middle Western States. The series in Harrison County includes only the silt loam member.

#### CHARITON SILT LOAM.

The soil of the Chariton silt loam consists of a dark-gray, black when wet, medium-textured silt loam to a depth of about 14 inches. In general, the supply of organic matter is medium to good. The subsoil is a dull-brown, faintly mottled with drab, heavy silt loam passing at about 16 inches through a dull-brown, heavily mottled with dark-drab, silty clay loam into a dark-drab, mottled with yellowish-brown, plastic silty clay at 20 inches. The texture and structure remain heavy throughout. The color of the subsoil changes with depth, the drab becoming lighter until at 36 inches the subsoil is very light drab or almost gray, mottled with yellowish brown. Iron concretions occur throughout the lower subsoil.

In several instances the underlying glacial till outcrops along the break or slope between this and the adjoining bottom lands. Such an area, of sufficient size to warrant separation, occurs in sections 29

and 20, T. 62 N., R. 28 W., along Big Creek, and has been mapped as Shelby loam.

This type is nearly identical with the Grundy silt loam in regard to color and texture of soil and subsoil, and probably in point of origin, differing mainly in topography, and might be considered as a terrace phase of the latter soil.

The Chariton silt loam occurs in irregular areas along the larger drainage courses of the county. The greater part of it lies along Thompson Fork of Grand River and the lower course of Big Creek.

This is a terrace soil, lying from 6 to 30 feet above the adjoining first bottoms. Its topography varies from level to undulating. Areas of practically the same elevation, but of more rolling topography due to more complete erosion, have been included in the Grundy silt loam. Drainage is ordinarily sufficient, except over the more level areas, where artificial drainage is necessary for the best results. Its power to resist drought compares favorably with that of the better Grundy areas.

Originally this type existed as prairie land. Practically all of it has been brought under cultivation, and at present is farmed to cultivated crops or is in pasture. General farming is followed. Much live stock is fed, and a considerable part of the grain grown on the adjoining bottom lands is used in fattening the animals pastured upon the Chariton areas. During a normal year, corn yields 30 to 60 bushels, wheat 15 to 30 bushels, oats 25 to 50 bushels, and timothy and clover hay 1 to 2 tons per acre. Bluegrass makes a heavy growth. Alfalfa is being grown in a small way on the deeper and better drained areas. Orchard and small fruits and vegetable crops produce well. These products are seldom grown except for home consumption.

A general rotation of corn, oats, wheat, and timothy and clover, in which corn is the most important and longest grown crop, is usually practiced.

Although, in common with the upland soils of the county, the fertility of this soil has been somewhat depleted by the farm practices of the past, the present cultural methods tend to hold and perhaps increase it. The use of heavy and effective farm machinery is made possible by the topography and character of this soil. A considerable quantity of barnyard manure is annually applied. The main problems encountered in the improvement of soil of this type are proper surface and under drainage and the increase of organic matter.

Farm improvements, including buildings, fences and machinery, average very good. The selling price varies from \$75 to \$125 an acre, depending upon the condition of the soil, topography, and location.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Chariton silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
343409.....	Soil.....	0.0	0.6	1.2	1.4	4.0	76.0	16.7
343410.....	Subsoil.....	.0	.9	1.0	2.2	5.4	64.8	25.6

#### CALHOUN SERIES.

The soils of the Calhoun series are of gray color and heavy texture. The heavy clay subsoils are of gray or drab color and tenacious, waxy structure. Iron concretions are common, and in places there is a substratum of sandy material. These soils occupy poorly drained, flat stream terraces on which water stands after rains. They are not subject to overflow. The material is of alluvial origin, derived principally from the silty soils of prairie regions. In Harrison County this series is represented by the silt loam member.

#### CALHOUN SILT LOAM.

The soil of the Calhoun silt loam consists of a light-yellowish to brownish-gray silt loam to a depth of about 5 inches, where it becomes a gray, nearly white, faintly mottled with pale yellow, silt loam extending to a depth of about 14 inches. The slightly darker color of the upper soil is due to the presence of some organic matter, which in this soil is very deficient. Small iron concretions and stains are present in the lower portion of the soil. Beginning at about 14 inches, the subsoil grades through a light-drab silty clay loam mottled with rusty brown to about 17 inches, where the soil is a yellowish-brown plastic silty clay very faintly mottled with slight grayish streaks. At about 30 inches the gray mottling increases rapidly and at 36 inches predominates, the soil section here having a very light drab or gray mottled with bright yellowish brown color and a plastic silty clay texture. Iron concretions occur throughout the subsoil.

The Calhoun silt loam is quite similar in character and color of soil and subsoil to the Putnam silt loam. It differs in point of origin and position. The crop adaptations are similar.

This type occurs in small scattered areas bordering the larger creek courses. It is confined mainly to the western three-fourths of the county, there being only a few areas along the Thompson Fork of Grand River or its tributaries.

The soil occupies rather low terrace or second-bottom areas, varying from 6 to at times 15 feet in height above the adjacent first bot-

toms. The surface configuration is usually level to very gently undulating. Both surface drainage and underdrainage are often deficient. Owing to the generally small size of these areas a convenient outlet for drainage may usually be had. Growing crops on this soil are subject to serious injury from drought.

Originally the broader, more extensive areas of this type were occupied by prairie vegetation, and the smaller by forest. At present only a very few small areas are forested, the remainder being in cultivation or in grass and hay land.

General farming, as carried on over the upland region of the county, predominates. The soil is easily tilled. Owing to its light nature and susceptibility to drought, it is not so well suited to the production of corn as to the small grains and grasses. During a normal year corn produces 20 to 35 bushels, wheat 15 to 20 bushels, oats 20 to 40 bushels, and hay 1 to 1½ tons per acre. Bluegrass makes an excellent pasture growth. Orchard and small fruits and vegetable products are grown in sufficient quantity for the home supply.

Proper drainage and an increase in the content of organic matter are the most urgent needs of this soil. Some barnyard manure is occasionally applied. Commercial fertilizers are sometimes drilled in with wheat.

As a rule farm improvements on this soil are good. Land values range from \$50 to \$90 an acre, varying with the condition and topography of the soil, the location with reference to adjoining soils, and the nearness to market.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Calhoun silt loam:

*Mechanical analyses of Calhoun silt loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
343401.....	Soil.....	0.0	0.5	1.0	1.6	3.4	80.0	13.5
343402.....	Subsoil.....	.0	.9	1.2	2.3	4.0	60.5	31.0

#### WABASH SERIES.

The Wabash series includes alluvial soils of dark-brown to black color and high organic-matter content, and slightly lighter drab or gray subsoils. The members of this series are typically developed in the first bottoms of streams of the Central Prairie States. They extend for long distances down the Mississippi Valley. The material is derived principally from the loessial and associated soils. In Harrison County the series includes the silt loam, with a colluvial phase, silty clay loam, and clay members.

## WABASH SILT LOAM.

The soil of the Wabash silt loam consists of a dark grayish brown to dark-gray, black when wet, smooth, medium-textured silt loam. The subsoil consists of a grayish heavy silt loam, grading through a silty clay loam into a plastic silty clay at 24 to 30 inches, of very dark drab color mottled with brown and reddish-brown streaks. The lower subsoil is usually very heavy and plastic. Small iron concretions are numerous in the subsoil. Typically the organic-matter content of the soil is high.

A considerable degree of variation in the depth and color of the soil is encountered. In the narrower bottoms and adjoining the stream courses in the large bottoms the soil as a rule is lighter in color and structure and deeper. At times the soil in these areas, upon being dried out, is quite gray, and the heavy subsoil layer is not encountered within 36 inches. In the wider stream bottoms, back from the stream channel, the soil is quite dark and the heavy subsoil often comes within 18 or 20 inches of the surface.

The Wabash silt loam is the most important first-bottom soil in the county. It occurs along Thompson Fork of Grand River, Big Creek, and their larger tributaries.

The topography of this type varies from flat or very gently undulating over the wider areas to very gently undulating and in places billowy in the narrower areas. Owing to the present degrading action of most of the streams in the county a strip of lower first bottom, often too narrow to be shown separately, has developed, giving the main first bottom the appearance of a first terrace.

At present surface drainage is fair to good. Occasional overflows do serious damage, especially when coming during the growing season. Originally this soil was poorly drained. Clearing the land and clearing out the stream channels have been largely responsible for the improved conditions. The straightening of the tortuous channels, especially those of the larger streams, would probably lessen the present extent of overflow.

Originally the wider areas of the Wabash silt loam were occupied by a growth of prairie grasses. Skirting the streams along the wider bottoms and covering the narrower valleys was a heavy timber growth, composed mainly of cottonwood, walnut, elm, ash, willow, linden, maple, locust, and hickory. The greater part of this type has been cleared and put under cultivation. The present tree growth is confined mainly to timbered pastures, badly dissected areas, and strips bordering the stream courses.

Over areas where entire farms lie on this soil general farming, consisting of the feeding of some stock and the production of large quantities of corn and wheat, prevails. Grain farming is often fol-

lowed on the areas of smaller size. Corn, to which this soil is particularly well adapted, produces 40 to 60 bushels per acre, and occasionally, under very favorable conditions, as much as 80 bushels per acre. Wheat growing is becoming quite general on the better drained areas, yields of 20 to 35 bushels per acre being obtained. Oats are not extensively grown, probably owing to their tendency to lodge. Ordinarily yields of 20 to 45 bushels per acre are obtained. Timothy and clover meadows yield  $1\frac{1}{2}$  to 2 tons of hay per acre. Heavier yields of alfalfa are obtained on this type, where it lies above frequent overflow and has good surface drainage, than on any other soil in the county. Three cuttings, yielding  $2\frac{1}{2}$  to 4 tons per acre, are obtained each year. Bluegrass makes a luxuriant growth and a considerable acreage of this type is devoted to it, especially the lower, poorly drained areas.

Orchards are apparently long lived and produce well. Small fruits and vegetables also produce well upon this soil. These crops are grown only for home use.

The rotation practiced on this soil consists mainly of corn, oats, and wheat, and an occasional hay crop. Corn is sometimes grown in the same field for several consecutive years.

Owing to its smooth surface and deep silty and friable soil this type is easily tilled. The well-drained areas may be cultivated under a wide range of moisture conditions and are not likely to bake or clod. It is quite resistant to drought and crops are not so seriously injured during protracted spells of dry weather as on the upland soils.

Where it composes the entire farm this soil has been fertilized and kept in nearly its original state of productiveness. Where it comprises isolated fields it has usually been fertilized less and cropped to grain continuously, and as a consequence has declined somewhat in productiveness.

The value of this land ranges from \$60 to \$125 per acre, depending upon drainage and location.

*Wabash silt loam, colluvial phase.*—The Wabash silt loam, colluvial phase, consists of a dark-gray to black, medium to heavy silt loam to a depth of 20 to 24 inches, containing a relatively large proportion of organic matter. The subsoil grades from the dark-colored silt loam through a compact yet light-textured brownish-black silty clay loam into a plastic drab clay at a depth of 28 to 30 inches. Iron concretions occur in the lower subsoil.

There is a wide variation in the color and texture of the various areas of this soil, the material ranging from a black, rather shallow, heavy silt loam or silty clay loam to a dark-gray silt loam often of the same texture to a depth of 30 inches. Beyond the fact that the heavy

areas usually occupy flat, rather depressed positions, whereas the lighter are of undulating topography, there is little regularity in the distribution of the two.

The colluvial phase of the Wabash silt loam occupies a considerable acreage in Harrison County. It occurs along all the intermittent streams, and in a few instances comprises an area of gradation between the upland and the alluvium of the larger streams. It is composed of wash from the adjacent Putnam and Shelby soils.

Originally a timber growth similar to that occurring upon the main type occupied the whole of this phase.

The farm practices followed upon this soil, except on the larger areas, are dependent to a certain extent upon those of the adjoining slope, as since these areas are as a rule very narrow it is hardly practical to fence them separately. They support a luxuriant growth of bluegrass, and as water may usually be reached within a short distance of the surface are excellently adapted for pasture, for which they are more used than for any other single purpose. Corn is the principal grain crop. It produces 30 to 75 bushels per acre. Wheat produces 20 to 30 bushels, and oats 20 to 35 bushels. Oats are likely to lodge during seasons of considerable rainfall. Hay grasses yield heavily. Alfalfa may be successfully grown on the better drained land, especially the higher sloping areas bordering the larger stream bottoms. Drainage is generally good, and this soil is markedly drought resistant.

Farm practices are necessarily much the same as those on the adjoining upland. Very little fertilizer, however, is applied to this soil. It is easily cultivated and can be worked under a wide range of moisture conditions. Probably there is no case in which this soil forms an entire farm, and values are therefore influenced by that of the surrounding soil. The land values range from \$60 to \$125 an acre.

#### WABASH SILTY CLAY LOAM.

The soil of the Wabash silty clay loam, locally called "gumbo," consists of a very dark gray, brownish-black when wet, heavy silty clay loam to light silty clay, with a depth of 9 to 12 inches. In the heavier areas the soil has a slight tendency to break into cubes and check, as does the heavier type, the Wabash clay. It has a relatively large content of organic matter. The subsoil is a heavy, plastic silty clay of dark-gray to grayish-black color, with faint brown mottling, grading at 18 to 24 inches into a plastic clay. The color grades into dark bluish drab with a faint brown mottling at 24 to 30 inches. Numerous iron concretions occur in the subsoil.

This type, to a certain extent, represents a transitional stage between the Wabash clay and Wabash silt loam, and consequently varies as one or the other of these types is approached.

The Wabash silty clay loam occurs mainly in the wider bottom areas along Thompson Fork of Grand River, the lower course of Big Creek, and the other larger creeks of the county. It commonly lies back from the stream front, in the middle of the bottom and at times adjoining the bluff, in long, slightly depressed strips paralleling in a general way the course of the drainage channel. The surface is flat. This in connection with a rather low position causes a condition of poor drainage. It is further subject to occasional overflow. Artificial drainage has been necessary in order to bring this soil under cultivation. It is drought resistant and produces heavier yields in dry years than in those of more than normal rainfall.

Originally areas of this soil supported a growth of prairie grasses and in the lower areas some water grasses. Now the greater part of this soil is under cultivation. The better drained areas are largely given over to grain farming, and the more poorly drained are utilized as pasture.

Corn is the crop for which this soil is best suited, and yields of 35 to 70 bushels per acre are obtained. Boone County White, a large-stalked, heavy-producing strain, is probably the variety now giving the best results upon it. Wheat is grown to a considerable extent and produces 20 to 30 bushels per acre. Oats are not widely grown, as they are not very profitable. Hay, timothy and red clover, produces 1 to 2 tons to the acre. Alsike clover is well adapted to the poorly drained areas. Bluegrass makes a heavy growth.

The Wabash silty clay loam is a difficult soil to handle. If plowed when too wet it clods, and if allowed to become dry it gets hard. Under the right moisture conditions, however, an excellent seed bed may be obtained. Some barnyard manure is supplied to this soil, but no commercial fertilizer is used.

Drainage is the main problem on this soil. An increase in the number and size of the drainage ditches and the installation of under-drainage systems of tiles are necessary for its proper utilization.

The selling price of this land ranges from \$60 to \$100 an acre.

The table following gives the results of mechanical analyses of samples of the soil and subsoil of this type:

*Mechanical analyses of Wabash silty clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
343413.....	Soil.....	0.0	0.2	0.4	3.4	9.4	61.8	24.8
343414.....	Subsoil.....	.0	.3	.4	3.3	4.5	59.9	31.7

## WABASH CLAY.

The soil of the Wabash clay, locally known as "gumbo," consists of a very dark gray to black silty clay to clay, with a depth of about 9 inches. The surface, upon drying, cracks and checks, and the soil breaks up into small cubes. The subsoil quickly changes from a dark-gray or black to a dark bluish drab, heavy, plastic clay slightly mottled with brown streaks. In the lower depths the subsoil usually becomes of a slightly lighter color, approximating a drab plastic clay with slight brown mottling. Iron concretions appear throughout the soil and subsoil section. The organic-matter content of the soil is high.

This type occupies irregular areas through the first bottoms along Thompson Fork of Grand River and the lower course of Big Creek. It lies back from the stream front, usually in the central part of the bottom, and sometimes next the bluff line. Quite often it is separated from the higher lying Wabash silt loam by strips of Wabash silty clay loam.

The Wabash clay occupies low, depressed areas and has a flat surface. Some ditching has been done, but more is needed to drain it properly. Surface drainage should be supplemented by underdrainage with tiles. This soil is subject to occasional overflow, but is damaged more by run-off and seepage from the hills. It is a drought-resistant soil. In its present condition crops are a failure during wet seasons, but in dry seasons very good yields are obtained.

A large part of this soil has been brought under cultivation. It is devoted to pasturage and some grain farming. Corn and wheat produce well in seasons of low rainfall. Under good conditions corn produces 40 to 70 bushels and wheat 20 to 30 bushels per acre. Hay, consisting of timothy and red clover on the better drained areas and of timothy and alsike clover on the lower areas, produces 1 to 2½ tons per acre. About 50 per cent of the type is in pasture, the grass comprising bluegrass and some wild water-loving species.

The Wabash clay is the most difficult soil in the county to handle. If plowed when too wet it clods and bakes, and if allowed to become too dry before plowing it is very hard to break. Under the proper moisture conditions a fairly mellow seed bed may be obtained. Fall plowing for corn is ordinarily practiced. Disking the field before plowing has given very good results, causing the soil to turn easier and to break down into better tilth. Very little if any manure is applied to this soil, and no commercial fertilizer.

The Wabash clay is a strong, productive soil and apparently its fertility has been but little impaired in the fields most continuously cropped. Land values range from \$60 to \$90 an acre, depending largely upon drainage and location.

## GENESEE SERIES.

The soils of the Genesee series consist of dark-brown to grayish-brown alluvial sediment. The sandy members are prevailingly light brown to gray and the loams and silt loams darker brown. They are encountered mainly in the northeastern glaciated region. The soils of this series are subject to either annual or more frequent overflow. Only the Genesee fine sandy loam type is recognized in Harrison County.

## GENESEE FINE SANDY LOAM.

The soil of the Genesee fine sandy loam consists of a light grayish brown to brownish-gray fine sandy loam to a depth of about 14 inches. Thin lenses of silt occur in the lower part. The subsoil consists of a fine sandy loam of a slightly lighter color than the soil, being light brownish gray with a slight yellowish tint. Thin lenses of silt and fine sand occur in this section of the soil profile.

A certain degree of variation occurs in the texture of this soil. In places it is composed of alternating sandy ridges and silty depressions and in others of alternating sandy and silty layers.

This type is inextensive, comprising a total area of about 4 square miles. It has its largest occurrence in the first-bottom lands of Big Creek. It also occurs in small areas along Thompson Fork of Grand River and the lower courses of some of the other larger streams.

This soil is a first-bottom formation, lying next to the drainage course. Nearly always it occupies the low, narrow first-bottom areas formed by stream degradation, giving the adjacent Wabash series the appearance of a terrace. A few areas occur which are on a general level with the main first bottom, and are apparently the result of stream aggradation. The lower areas are subject to frequent overflow, and the higher to occasional or annual overflow. The topography is gently undulating to billowy. Owing to the loose texture and structure of the soil and subsoil, this type is susceptible to injury from drought.

The Genesee fine sandy loam is an alluvial soil formed from the deposits of moving water. It is derived from the coarser soil particles eroded from the Shelby, Grundy, and Putnam soils.

Practically all of this type, save for a fringe of trees skirting the stream bank, is cleared and in cultivation. Corn, hay, and grass are the main crops grown on this soil. Corn yields 40 to 75 bushels in a normal year. Timothy and clover mixed produce 1 to 2 tons of hay per acre. Bluegrass furnishes heavy pasturage. But for its liability to overflow, this type is well suited to alfalfa. Very little thought is given to crop rotation.

The soil is easily cultivated and attains a tillable condition at an early season. Owing to its frequent overflow and the consequent deposits the productiveness of this soil is apparently maintained naturally.

Areas of this soil are small and the price is markedly influenced by the quality of the type with which any particular area may be associated. It is hardly as valuable as the Wabash silt loam, owing to its liability to injury from overflow and drought, although in a favorable season it produces a corn yield equal to that of any soil in the county.

In the following table the results of mechanical analyses of samples of the soil and subsoil of this type are set forth:

*Mechanical analyses of Genesee fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
343405.....	Soil.....	0.0	0.4	4.2	32.0	14.6	38.8	9.9
343406.....	Subsoil.....	.0	.2	4.7	31.4	13.0	40.2	10.5

#### SUMMARY.

Harrison County is located in the northwestern part of Missouri. It lies along the Iowa State line and is the fourth county east from the Missouri River. It has an area of 721 square miles, or 461,440 acres.

There are three main topographic divisions in the county, the uplands, terraces, and bottom lands. The surface configuration of the first is gently undulating to broken, of the second gently undulating, and of the third flat to gently undulating. The bottom lands are subject to overflow.

The eastern third of the county is drained by Thompson Fork of Grand River and its tributaries, the central half by Big Creek and its tributaries, and the western sixth by several minor creeks which flow into West Grand River, to the southwest of Harrison County. The general direction of the drainage is to the south.

The first settlement in Harrison County was made in 1837. The early settlers came from the longer settled portion of Missouri and from eastern States. The county was organized February 14, 1845.

The population of Harrison County in 1910 was 20,466, about 65 per cent of which was rural.

Bethany is the county seat. It is located on Big Creek, in the southcentral part. It had a population of 1,931 in 1910.

Railroad transportation facilities are rather poor, some points being 12 miles from the nearest railroad. Good shipping facilities to Kansas City, St. Joseph, and Omaha are afforded the central and southern townships.

Extreme climatic conditions are rare. The mean annual rainfall is 35.53 inches. Snowfall is generally sufficient to protect winter wheat and grasses. The average length of the growing season is 165 days, sufficient for all the general farm crops.

General farming, a combination of grain and stock farming, is commonly practiced.

Corn, wheat, oats, timothy, clover, and alfalfa are the main crops. Bluegrass pastures probably occupy 40 per cent of the area of the county.

Truck crops are produced in sufficient amount to supply home consumption. Orchard and small-fruit products are grown for home use, with an occasional surplus for the local market.

Large numbers of cattle and hogs, and some sheep, horses, and mules are raised in the county. Dairying is carried on only in a small way.

A rather indefinite rotation of the farm crops is practiced. Farm improvements are good.

In 1910, 95.3 per cent of the total area of the county was in farms, and 81.4 per cent of the farm land was improved.

The soils of Harrison County have been classified into 8 series, including 10 soil types, 1 with a phase.

The Shelby loam is the most extensive soil. It is of glacial origin. Its topography is rolling to broken. It was originally timbered. A considerable area is devoted to bluegrass pasture. Corn, wheat, oats, timothy, clover, and alfalfa produce well on the type.

The Lindley loam occupies broken areas along stream courses. It is closely associated with the Shelby loam. On account of its topography the greater part of it is best suited to use as pasture land.

The Grundy silt loam occurs over the prairie in the southeastern part of the county and along the crests of the higher, broader ridges. Its topography is level to gently rolling. General farming, including stock raising and feeding, predominates. The main problem to be solved is that of proper surface and under drainage and the maintenance of a sufficient organic-matter content.

The Putnam silt loam occurs along the points of the wider ridges and along the stream slopes somewhat more rolling than those occupied by the Grundy silt loam. It is inferior in point of productiveness to the Grundy type, to which it is closely related.

The Chariton silt loam is a terrace soil occurring in irregular areas along the larger streams. Its topography is level to gently undu-

lating and conducive to thorough tillage. The soil closely resembles that of the better Putnam areas and crop adaptations are very similar.

The Calhoun silt loam is a gray to white terrace soil occurring mainly along the streams of the western two-thirds of the county. It is best adapted to the small grains and grasses.

The Wabash silt loam is the principal first-bottom soil in the county. It occurs along all the larger stream courses and is partly subject to overflow. It is the best corn soil in the county and also makes excellent bluegrass pastures. The colluvial phase occurs along the intermittent streams. It has the same adaptations as the main type.

The Wabash silty clay loam occurs in the central portion of the larger stream bottoms in strips paralleling, in a general way, the stream course. It is subject to occasional overflow. The greater part of the soil area is devoted to the growing of corn, wheat, and bluegrass.

The Wabash clay occupies rather depressed areas in the central portion of the larger bottoms. It is liable to injury through overflow or from the run-off and seepage from the hills. It is the most difficult soil in the county to handle. It is well suited to bluegrass. Good yields of corn and wheat are obtained in dry years.

The Genesee fine sandy loam occurs mainly along the lower course of Big Creek. It lies adjacent to the stream channel, often being formed by its degradation. It is subject to frequent overflow. It is not drought-resistant. Corn and bluegrass are the principal crops produced upon it.



[PUBLIC RESOLUTION—No. 9.]

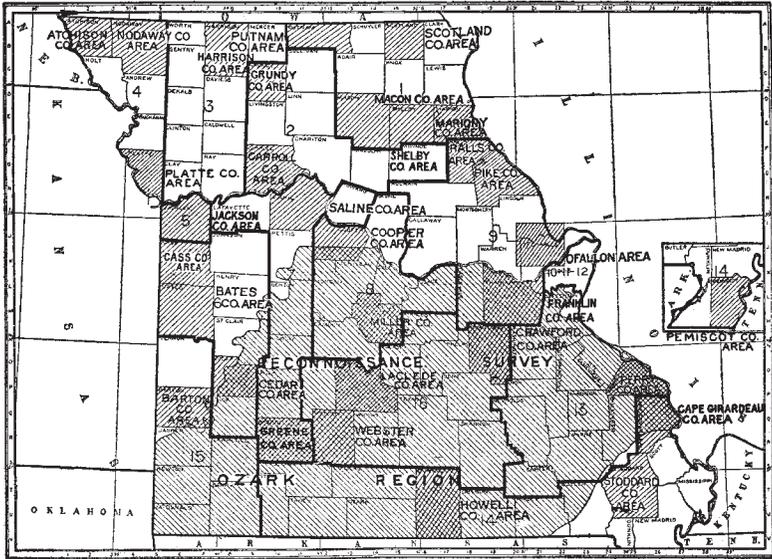
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

*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.]



Areas surveyed in Missouri.

# **NRCS Accessibility Statement**

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