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UNIVERSITY OF MISSOURI

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The Soils of Sullivan County

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THE SOILS OF SULLIVAN COUNTY, MISSOURI.

BY

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DESCRIPTION OF AREA.

Sullivan county is located in north-central Missouri, midway between the Mississippi and Missouri rivers, and fourteen miles south of the Iowa state line. It is bounded on the north by Putnam county; on the east by Adair and Putnam counties; on the south by Linn county, and on the west by Grundy and Mercer counties. The county lies between parallels $40^{\circ}-2'$, and $40^{\circ}-23'$ north latitude, and meridians $92^{\circ}-50'$ and $93^{\circ}-21'$ west longitude. The latitude is about the same as that of Quincy, Ill., and the longitude that of Des Moines, Iowa. In shape, the county is almost square, being twenty-seven miles wide east and west, and twenty-four miles long north and south. The county contains 648 square miles, or 414,720 acres.

TOPOGRAPHY.

The surface and geological features, as well as the agricultural conditions of the area, are typical of that part of the state lying between Thompson Fork of the Grand River to the west, Grand and Missouri rivers to the south, Chariton River to the east, and the state line on the north. This region is generally called the "rolling prairie" of North Missouri. It differs from the black prairie region of Northwest Missouri in that it is more thoroughly dissected, and has a lighter colored soil. From the Northeast Missouri prairie, it also differs on account of greater erosion and a slightly deeper soil.

The rocks forming the basal structure of Sullivan county belong to the Upper Carboniferous system. Wherever these rocks are exposed they consist of shales and limestones. The weathering of this material, however, has had practically no influence in the formation of the soil of the county. The most extensive outcrops of limestone are in the vicinity of Milan, but numerous smaller ones are found in various parts of the county. They occur on the steepest slopes along the larger streams where erosion is now active.

During early Quaternary times, Sullivan county like all of North Missouri, was covered by ice. Upon receding, the glaciers and the streams that issued from them, left the entire country covered with a layer of drift, twenty to one hundred feet in thickness, consisting of clay, sand and bowlders. After the deposition of the drift, and before severe erosion took place, there was spread over the entire county a layer of almost pure silt as a result of water or wind action. On the eroded areas all traces of this silt layer have been removed, so that at present it is found only on the tops of the flat ridges. On account of its rather flat surface, it was wet, and this favored the growth of prairie grasses and the subsequent incorporation of organic matter.

Physiographically the area including Sullivan county and parts of adjacent counties, after the deposition of the drift and before the creeks which now drain it had cut its surface into valleys and hills, was a smooth plain, sloping gently southward. The elevation of this plain in the vicinity of the north line of the county was about 1075 feet above sea level, while that along the south line was about 900 feet. In addition to the southward slope, the eastern border of the county had a faint slope to the eastward.

While this was the original shape it has been so badly cut to pieces by creeks and their tributaries that very little of the old smooth plain is left. The most extensive remnants of it lie in the vicinity of Green City, though small patches are found in all parts of the county. As a rule, the flat prairie consists of long narrow ridges occupying the divides between the larger streams. It constitutes about twenty per cent of the area.

DRAINAGE.

The streams that have been most active in converting the smooth plain into a hilly and rolling country are Medicine, Locust and Yellow Creeks. These streams with their numerous tributaries have invaded all parts of the county so that dissection is complete everywhere. It is deepest in the eastern half of the county, for here the streams have cut down to a great depth without removing all of the original upland plain. In the western part of the county, erosion has made further progress, and nearly all of the country is worn down so as to have a gently rolling to undulating surface. Farthest away from the larger drainage lines the slopes have a gentle grade, and even near some of the larger creeks they may be one-half mile in length, and seventy-five feet in height. But near most of the larger creeks they become more steep, and frequently rise at a high angle to 150 feet above the bottoms. Along these bluffs they are sometimes too steep to be tilled.

Elsewhere, they constitute the main farming land of the county. In general, the slopes in the western part of the county are much longer and more gradual than in the central and eastern part. The hilly and rolling land constitutes about seventy per cent of the area.

All the larger streams are skirted by alluvial flats varying in width from one-fourth to one and one-fourth miles. On an average, these lands are about ten feet above low water mark, and with the exception of the higher portions, are subject to overflow during spring freshets. Low, shallow depressions in the larger flood-plains often remain covered with water the greater part of the year. With the exception of a few low tracts marking the former meanders of the streams, the bottoms present an even plain. As a rule they are highest near the stream, and lowest along the bluffs. They comprise about ten per cent of the area.

The general altitude of the county is about 1000 feet above sea level, and the top of the prairie about 200 feet higher than the streams, as may be seen from the following elevations:

Green City, 1050 feet, on the prairie.

Pollock, 948 feet, on the prairie.

Milan, 843 feet, in Locust Creek bottom.

Browning, 763 feet, in Locust Creek bottom.

Newton, 870 feet, in Medicine Creek bottom.

Harris, 858 feet, in Medicine Creek bottom.

Osgood, 815.5 feet, in Medicine Creek bottom.

Gault, 789 feet, in Medicine Creek bottom.

There are two drainage systems in the county. That of Chariton River lies in the eastern part of the county while that of Grand River occupies the rest.

The eastern system includes Muscle and Spring Creeks. These two streams, flowing in a southeasterly direction, drain the eastern border of the county.

The western system, embracing about six-sevenths of the county, includes the following streams: East Yellow, Pawpaw, East Locust, Locust, West Locust, Muddy and Medicine Creeks. Locust Creek flows from north to south through the center of the county. Pawpaw and East Locust empty into Locust Creek one and one-half miles north of Browning. Medicine Creek coming in from the north does not vary more than two miles from the western border, and leaves the county near Gault. With the exception of Locust and Medicine Creeks, all the other streams have their sources in the northern part of the county. Their average fall is about six feet per mile.

A characteristic feature of all the streams in the county, as in all north-central Missouri, is that they flow due south. Since the

main streams are often only two to four miles apart, their main tributaries in many cases flow parallel to them for long distances. Those flowing into the streams in the normal direction are short. The resulting topography of alternating valleys and ridges is fittingly described as the region of the "Devil's washboard."

The many branching tributaries of the larger streams have worked back into the upland until with but few exceptions the boundary between minor drainage systems consists of an irregular ridge which, in places, broadens into long, narrow flats of limited extent. These lateral branches being short, and having a fall of over 150 feet, have cut down very rapidly. They have cut two to five feet, and in many cases deeper, and sometimes, in cases of the deepest are cut ten to twenty feet wide at the top. The removal of the forests, and the breaking up of the prairie, aided the streams in their destructive action. The continued growing of corn on the same land for many years also explains why some areas are badly dissected with draws and ditches. Man has made little attempt to check the ravages of the streams. In a few places further encroachments are resisted by filling the ditches with brush and other rubbish, and by seeding the adjoining land in grass.

TIMBER.

About one-half of Sullivan county was originally covered with timber. Belts of timber one-half to three miles in width extended along all the principal streams. Elm, white oak, black oak, hickory, wild cherry, maple, walnut, pin oak, cottonwood and sycamore are the prevailing varieties of trees. White oak is most abundant in the eastern half of the county. Practically all the timber has been removed as cordwood and railroad ties, so that at present, only small tracts are found along the streams and in the rougher portions. Unbroken prairie is being slowly occupied by forests, and wherever they exist they are drawn upon for fencing material and firewood. These forests, if carefully husbanded, would be sufficient for future needs. Old pastures are often taken by "run-oaks," a worthless brush. Several portable saw mills operate in the county. Only rough lumber, used mostly for bridges, is made. To prevent erosion, and on account of the growing scarcity of wood for fuel, posts and lumber, the rougher areas should be kept in timber.

It is supposed that the greater part of Sullivan county is underlaid with coal. Exposures of black shale occur along the creek banks in various portions of the county. They have led to some exploration, and have been the basis of various local coal excitements. Several

coal mines have been in operation near Milan since about 1872. They do not supply more than the local demand. One of the shafts, 193 feet deep, penetrates three beds of coal, one at a depth of 81 feet, another at 120 feet, and the last at 190 feet. The upper bed is sixteen inches thick and is good coal; the middle bed is chiefly black shale. The lowest bed, forty inches thick, is the one worked. This coal bed probably underlies the whole county, but it is believed that it is not everywhere of workable thickness. A few coal bed outcrops were noted in the hillsides near Milan, but generally they are too thin to be of economic importance.

Brick clay and fair building stone is found at several places, but not in large quantities. Most of the rock is suitable only for walling wells, and rough stone work. The largest outcrops are found near Milan. Brick plants at Milan and Newtown supply the local demand.

RAILWAYS.

The three railroads passing through Sullivan county give excellent freight and passenger service. The Carrollton Branch of the Chicago, Burlington and Quincy, completed in 1872, passes through the center of the county from north to south. The Quincy, Omaha and Kansas City, completed in 1878, passes through the center of the county from east to west. The last road to be built was the Chicago, Milwaukee and St. Paul, which follows Medicine Creek along the western border of the county. A railroad in the southeastern part of the county would be an impetus to the development of that section. With the exception of the southeastern corner, no point in the county is more than eight miles from a railroad. The large markets, St. Louis 260 miles, St. Joseph 85 miles, Kansas City 125 miles, Quincy 110 miles and Chicago 370 miles, are thus brought within easy reach.

ROADS.

Wagon roads penetrate every part of the county. As a rule they follow landlines irrespective of topography, and for this reason are generally hilly. In summer and fall they are usually good, but in winter they are often almost impassible. Strong, durable iron bridges and concrete culverts span the streams and ditches. The roads on the bottom lands are extremely muddy throughout the winter when not frozen and during wet seasons. If badly cut up they become almost as hard as rock when they dry out and it is necessary to rework them every spring. The most efficient and economic method of keeping up the roads is by means of the drag and the use of this

implement should be extended. Locating the roads on the ridges, or along the base of the hills, would in many cases effect an improvement. Wherever rock outcrops occur this material should be used for building macadamized roads.

TOWNS.

Milan, the largest town and the county seat, has a population of about 2,500. It is near the geographical center of the county, at the intersection of two railroads, and the location of the Q., O. and K. C. railroad shops, which employ about 250 men. The town owns and operates the waterworks and the electric light plant. Saw and planing mills, flour and brick plants are the chief manufacturing establishments. An implement factory is located at Green City. Newton, Harris, Osgood, Humphreys, Green Castle and Pollock are the other towns, all of which are supported by farming interests. Gault in Grundy county and Browning in Linn county are near the Sullivan county line and are trading points for some of the Sullivan county territory.

HISTORY.

When Missouri was admitted into the Union in 1821 the territory now embracing Sullivan county, then called Highland, was included in Howard county. The absence of navigable streams no doubt explains why this part of the state was not settled as early as the territory along the Mississippi and Missouri Rivers. The early pioneers followed and remained near the larger streams, for all transportation at that time was by boat.

The first settlers to move into Sullivan county were Dr. Jacob Holland and son, in 1836. They resided near the site of the present village of Stottsville. The settlers came in slowly, and in 1840 the population numbered only 200. By the end of 1842, settlements had been made along all the streams, and it would appear that as a general thing, the settlers grouped themselves together according to the state or locality from which they had emigrated. The territory along Medicine Creek was settled by people from Illinois, and along Locust Creek by people from Virginia, Tennessee, and Ohio.

Sullivan county was organized in 1845. In 1850, the population was 2,983. During the next ten years, it increased more rapidly and in 1860 numbered 9,108. Most of the early settlers came from a timbered country and chose, therefore, the timbered and watered sections for their homesteads rather than the unfamiliar and more difficultly tilled prairie land. Moreover, the timber gave them pro-

tection and provided them with building material. The value of the prairie lands was not appreciated until the prairies of Illinois had been settled and cultivated, and the population had overflowed into the region west of the Mississippi.

The early pioneers farmed as much as their crude implements would permit. Corn was their chief crop, enough of it being grown to supply the domestic needs. The prairies furnished a luxuriant pasture for their stock and provided them with game which was plentiful at that time. The grain was taken to Glasgow, seventy miles south on the Missouri River, to be ground into flour. Brunswick, fifty miles south, was the nearest trading point.

After the Civil War, the population increased slowly. The completion of the C. B. & Q. Railroad did much to increase the influx of newcomers. Most of the later settlers came from Illinois, Iowa, Wisconsin and other north central states, and they with the descendants of the early pioneers make up the present population, estimated at about 22,000. About one-fifth of the people reside in towns.

CLIMATE.

The climate of Sullivan county is essentially the same as that of the rest of north central Missouri and south central Iowa. It is continental and subject therefore to great extremes of temperature. The rainfall is usually abundant and occasionally excessive. An extremely dry year occurs occasionally, but not often. For several weeks after Spring weather appears and after grass has begun to grow and fruit trees have bloomed, destructive frosts may occur. The latest date at which these frosts are known to have occurred in the county is about the 15th of May.

The following table shows the climatic data for the observing station at Sublett in Adair County, adjoining Sullivan on the east.

**NORMAL MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE
AND PRECIPITATION.**

At Sublett.

MONTH.	TEMPERATURE.			PRECIPITATION.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December.. . . .	28	64	—19	2.2	—	2.7	4.8
January...	26	64	—17	1.8	0.7	2.7	6.3
February..... . .	23	67	—24	2.3	2.1	1.6	10.2
Winter mean....	26			6.3		7.0	21.3
March.....	38	85	— 1	4.1	3.4	11.3	2.5
April.....	53	89	8	4.6	2.6	6.6	1.0
May...	63	93	27	6.4	0.3	19.2	0.0
Spring mean....	51			15.1	6.3	37.1	3.5
June..	72	102	37	4.3	3.2	3.1	0.0
July..	77	112	47	4.3	0.8	4.0	0.0
August.....	74	101	41	3.5	0.5	4.3	0.0
Summer mean..	74			12.1	4.5	11.4	0.0
September..	66	98	25	5.5	2.6	14.7	0.0
October.....	56	92	16	2.8	1.3	6.2	T.
November.... . . .	39	78	— 2	1.9	—	3.6	1.5
Fall mean.....	54			10.2		24.5	1.5
Annual mean...	51	112	—24	43.7		80.0	26.3

Average date of last killing frost in the spring, May 2, and of first in autumn, October 4.

AGRICULTURE.

The early agriculture of Sullivan county was typical of that practiced in North Missouri at that time. Enough corn was grown to supply meal, and the prairies provided pasture for the live stock and also supplied game. As the population increased, the settlers began to fence in and break up the prairie. The surplus grain and stock was taken to Brunswick, fifty miles south on the Missouri

River, and from there shipped to market on boats. With the advent of the railroad in 1872, an impetus was given to the agricultural industries on account of the greater accessibility of the market.

Stock raising was one of the chief industries from the earliest times. Water was abundant everywhere, and cattle supported themselves the year around on the luxuriant growth of wild grass, and hogs in large numbers grew and fattened on the mast. The quality of the stock was very poor, for the most part scrub cattle and hogs.

The settlers that came into the county after 1860, took up prairie lands, and began the production of corn on a large scale. Grain exports, however, never became of any importance, as there was no means of transportation. All the corn was fed to live stock, and wheat and oats were used to supply the home demand. Barley, rye, flax, broom corn, sorghum, and buckwheat were grown on a small scale. Before the war, tobacco was cultivated extensively, but now it has been almost entirely abandoned. In 1872, three-sevenths of the county was still in timber, and less than half of the area was in cultivation. The pastures consisted of wild grass. Sheep raising was profitable and extensive. In 1872, the exports of all live stock were valued at \$200,000.00 and consisted of the following:

Cattle, 4,500 head.

Hogs, 12,000 head.

Horses, 200 head.

Mules, 500 head.

Improved farm land sold at \$17.00 per acre. Unimproved land, including prairie and timber, was held at \$5.00 to \$6.50 per acre. After 1874, blue grass and other tame grasses were introduced and used to some extent for pasturage. With the building of the railroad stock raising received an impetus, both from improved animals which were introduced and from the fact that driving them to market was no longer necessary, for competitive buyers came into the country. By 1878, most of the hogs were of a high grade, and much pure bred stock was introduced. Very little unsettled land was left in the county in 1883.

Small grains were grown more extensively until 1894 than at the present time. Corn and stock sold at a low price, and small grain growing was more profitable. Moreover, the land still possessed most of its virgin fertility and larger yields were obtained than now. However, the frequent cultivation of the soil aided erosion, and this, combined with the ravages of chinch bugs, discouraged wheat growing and much of the land was seeded back to grass.

The area in wheat in 1891 was 4,000 acres, as compared with 691 acres in 1909. Practically all of it was grown on the timber land, because it was thought that it would freeze out in winter on the prairie for lack of a snow covering. During the period from 1870 to 1880 some spring wheat was grown, but never on an extensive scale. At the present time, sentiment is growing in favor of including wheat in the rotation, and the acreage is increasing from year to year. Much of the soil in Sullivan county is admirably adapted to the crop, and its acreage should be greatly increased. It is not only in many cases more profitable than stock raising, but is also an excellent crop to include in the rotation. Freezing or "heaving" out in winter can be prevented to a great extent by having a large amount of humus in the soil. By providing this condition, larger yields are also insured, and the soil will be improved. Fultz (beardless) and Fulcaster and Mealy (bearded) are the varieties best adapted to this section of the state.

Breaking for wheat is done during August and September, so that the ground can become somewhat compacted before sowing. The grain is drilled the latter part of September at the rate of four to six pecks per acre, and is ready to harvest early in July. The average yield is from twelve to eighteen bushels, with twenty-four bushels per acre a high yield. In case the wheat is sown after corn, the land is usually disked without plowing and the wheat sown.

What has been said of wheat is also true of oats. In 1891, the total acreage devoted to this crop was 13,834 acres, as compared with 3,160 acres in 1909. Oats are grown only in small patches, usually not more than ten acres in extent and are used for feed for the work animals. As a rule the crop is preceded by corn and the land plowed in fall or early spring. The grain is drilled the latter part of March at the rate of two to three bushels per acre, and is ready to harvest in July. Oats fit in admirably in the rotation and for this reason alone its acreage should be greatly increased. It also is a good nurse crop for clover and timothy. Red Rust Proof and Kherson are the recommended varieties.

Corn is the most important cultivated crop, both in acreage and value. On an average a little less than one-fifth of the whole county is grown to this crop. The largest fields were seen in the western part of the county where the topography is more rolling than in the eastern part. Yellow corn is most generally grown. According to experiments by the Missouri Agricultural Experiment Station, Boone County White and Reid's Yellow Dent are the varieties best adapted to this section. The former is especially well adapted to bottom land soils. For short seasons the yellow corn is better

than the Boone County White on account of its earlier maturing qualities.

When meadows or pastures are broken up, they are generally planted to corn. Fields were seen that had been in corn continually for more than twenty years. The grain is generally drilled or checked in rows forty-two inches apart. When the young corn is about one inch high, the fields are gone over with a spike tooth harrow. This keeps a mulch on the surface of the ground, and also destroys the many young weeds. Most farmers give the corn three to four cultivations. Ridge cultivation has been abandoned almost everywhere except on the bottom lands.

Very little if any corn is shipped out of the county; most of it is used to fatten live stock. Only a part of the crop is cut and shocked. The greater part is either husked, or snapped without being husked, and the stalks left standing in the field. Young stock are turned into the fields and browse on these standing stalks during the winter. In spring the stalks are cut up with a cutter and plowed under. The farmers of Sullivan county fail to appreciate the value of corn stover. The Missouri Experiment Station states that corn stover is equal to one-half the same weight of timothy if fed with hay. A few harvesters and binders are used. No doubt better stands and larger yields could be secured if more attention were given to the selection and testing of the seed corn.

In harvesting the corn, the greater part of it is "snapped," the husk being removed with the ear. Many farmers "shuck" it, leaving the husk with the stalk in the field. The former method is used when the corn is fed, and the latter when it is to be put on the market. The farmers claim that the husk retains the moisture and keeps the corn from getting too hard, therefore making it much better to feed, especially to cattle. Corn is usually stored, in rude cribs, sometimes with a roof and sometimes without. A few farmers have found it profitable to pasture the corn fields with sheep. The animals are not turned into the fields until the grain begins to mature.

Next to corn timothy is the most important crop. From one-fifth to one-fourth of the county, including both flat prairies and hilly areas, is grown to this crop. Timothy is usually sown in the fall. A few farmers sow clover with the timothy. It is a general practice to use the meadows for pasture each year after the crop of hay is removed. The average yield is from one to one and one-half tons of hay per acre. Only a small part of the crop is baled and shipped. It is a common practice to mow the meadows four to six, and even eight years before plowing them under. This is a very objectionable practice and, as a rule, such meadows have a poor stand of timothy,

contain many weeds and produce a poor quality of hay. Meadows should not be mowed for more than two to three years. In old meadows, or meadows that are pastured, blue grass will replace the timothy in about two years time.

The production of timothy seed also is of considerable importance in Sullivan county. About 10,000 bushels of seed are exported annually. The average yield is three bushels per acre. The crop is harvested by cutting with a binder or header. After allowing it to cure thoroughly it is thrashed in a huller. The thrashed hay, although of no great feeding value, usually sells at about \$5.00 per ton. No doubt, in many cases, it would be more profitable to substitute clover for timothy as a hay crop, or mix the two.

Blue grass and red top are the other two most important grasses. The latter is used for the production of hay and seed, and is also found in most pastures. Blue grass is used as a pasture grass exclusively. It is well adapted to all the soils, and for this reason makes Sullivan county one of the best stock counties in the state.

In the production of millet hay and seed, Sullivan county holds second place in the state. Practically all of the hay is used at home, but about 29,000 bushels of seed are exported annually. It is not grown as extensively now as in former years. The acreage in millet varies from year to year, being greatest in dry seasons. Since it is sown late in summer, usually in July, and the yield of hay is large, any shortage in timothy or fodder can readily be replaced by millet. The yield of hay is two to four tons, and the yield of seed forty to fifty bushels per acre. Millet is considered a heavy feeder, and leaves the soil in a good physical condition but tends to deplete its fertility. Millet hay, if fed alone, is not a very good feed for horses, as it often causes lameness.

Although clover is grown to a limited extent in Sullivan county, it is not as important a crop as it should be. It is grown most extensively in the eastern part of the county, in the vicinity of Green City. It is generally supposed that the crop does best on the Putnam and Castle silt loams, but it will thrive on all the soils of the county if the proper conditions are provided. Clover is usually seeded with oats or wheat as a nurse crop. If oats are used for this purpose the grain seeding should be thin, about one-third less than usual, where one is particularly interested in the grass and clover. Use early maturing varieties of grain so that they can be removed as early as possible. If the oats are cut for hay it gives the grass and clover a better chance. Clover, when sown alone, is usually at the rate of six to eight pounds per acre. If sown with timothy, use six pounds of clover and five pounds of timothy. It has been found

to be a good practice to go over the field with a harrow after the seed is sown where both clover and timothy are sown in the spring. Harrowing will insure a better stand of clover, will tend to conserve moisture in the soil, will destroy weeds and will not injure the wheat or oats. Where timothy is fall-sown with the wheat this spring harrowing injures the timothy plants. As a rule timothy and clover are grown together.

One of the difficulties in growing clover is that it often "heaves" out badly in winter. This difficulty can be overcome to a great extent by incorporating a large amount of humus in the soil. During rather dry seasons it is almost impossible to get a stand, as the young plants are apt to dry up when the nurse crop is removed. By growing a crop of cowpeas on the land before sowing to clover it will be much easier to get a stand of the latter. Since practically all the soils in Sullivan county are adapted to the growing of this legume, its acreage should be greatly increased. There is no better way to build up land that is deficient in humus, than by turning under a green crop of cowpeas or clover. The stems and leaves contain more of the necessary plant food elements than the roots, therefore, it is advisable to turn under the entire plant.

Cowpeas are practically unknown in the county. Their use is strongly recommended, especially for areas where clover is a failure, since they will grow on almost any soil. They benefit the land the same as clover does but in about one-fourth the time, and with just as great a profit when the method of handling them is once understood. Cowpeas improve the land whether grazed, cut off or turned under. Occasionally a crop turned under green would be of benefit, particularly in case of the heavier types of soils. Besides improving the land physically, and by adding fertility, cowpeas can be made a profitable crop by cutting the pea vines for hay, which makes a very palatable and nutritious feed for all kinds of stock.

Cowpeas can be broadcasted or drilled in the corn at the last cultivation. When planted alone, a good method is to drill the seed with a grain drill, sowing from four to five pecks to the acre. Seeding should not be done until a couple of weeks after corn planting time, when the ground is thoroughly warmed up. The first week in June is the best time to sow. Only early varieties, such as Whippoorwill and New Era, should be planted.

Sorghum was grown more extensively in former years, but is now found only in small patches on a few farms. It is grown mostly in the eastern part of the county, on the white oak lands. It is said that this soil produces the best quality of syrup. It is grown largely for the production of syrup, the yield ranging from fifty to

one hundred gallons per acre. About 5,000 to 6,000 gallons are exported annually from the county. Sorghum is also a good stock feed, yielding from eight to fifteen tons of fodder per acre. It is planted in June, and may be broadcasted or drilled. The largest yields are obtained when the crop is cultivated several times. It is considered a rather exhaustive crop, and should be rotated with other crops, such as clover, cowpeas, and grasses.

According to the acreage, blue grass is the most important crop in Sullivan county, since a little less than one-half of the entire county is devoted to it. Excellent pastures of virgin blue grass are found everywhere. In two years a volunteer growth of this grass will occupy cleared land, and in time it will displace a clover and timothy meadow. The glacial clay soils are admirably adapted to blue grass, and it is for this reason that Sullivan county is pre-eminently a stock country.

Most pastures contain white clover which provides food in the late summer when the blue grass usually is dormant on account of dry weather. If the season is favorable, and the pasture not too closely cropped, the fall growth of the grass provides excellent pasture for late fall and winter grazing, for it often remains green until after Christmas.

As a rule the rougher, poorer land is in pasture, and the better, cultivated, but we find every gradation of pasture land from the rocky hillsides to the rich prairie lands that will raise seventy to eighty bushels of corn per acre. With the poorer pastures it requires two to four acres to support a cow properly for six months but of the better pastures it requires only one to one-half acres. Many farmers make the mistake of turning the stock on pasture too early in spring. Blue grass should not be cropped too short during its early growing period. Only under exceptional conditions is it advisable to put stock on the pastures before May 1st. Many fields were seen that were overrun with weeds, ironweeds, thistle, buckbush, etc. Pastures should be mowed at least once a year, and preferably before the weeds mature their seeds. If necessary they should be gone over with an ax or hoe and all the brush grubbed out.

Rye, buckwheat and tobacco are occasionally grown, but in such small quantities that they are of no economic importance. The white oak lands are probably well suited to the growing of tobacco. No doubt it would be profitable in many cases to sow rye on corn land. Rye, if sown early in fall, will check winter washing, prevent the loss of nitrogen by leaching, will furnish early spring pasture and add humus to the soil if plowed under.

A few apple trees and occasionally a small orchard were seen on the most improved farms. However, hardly enough fruit is grown to supply the home demand. Many of the slopes that are almost too steep for cultivation, would be more profitable if planted with fruit trees. A small orchard on every farm would not only enhance the value of the land, but also add much to the aesthetic appearance of the country. Cherries and peaches do fairly well, but the latter are apt to winter kill. Blight practically excludes the growing of pears. The varieties of apples most generally grown are Ben Davis, Jonathan, Wine-sap and Huntsman. Most orchards are neglected. If more attention were given to pruning, spraying and fertilizing more and better fruit would be obtained. Small fruits are not grown to any extent. Melons do fairly well, especially on the lighter bottom land soils.

The live stock industry is the most important in the county, and is the chief source of income. One-sixtieth of the cattle and one-sixty-third of the sheep in Missouri are raised in Sullivan county. In 1908, the surplus products of all live stock were as follows:

Cattle, 18,788 head.

Hogs, 57,529 head.

Horses and mules, 1,687 head.

Sheep, 7,342 head.

Goats, 1,243 head.

At conservative figures, this represents a value of more than one and one-half million dollars. The cattle are of good quality, mostly grade Herefords and Shorthorns, and the tendency is toward the raising of pure bred stock. That much attention is given to the breeding of stock is evident when we consider that there are about a score of pure bred herds of Herefords, Shorthorns, and Polled Angus in the county. These herds are among the best in the state. Pure bred males are used almost exclusively.

Many of the cattle fed are bought in Kansas City and St. Joseph as feeders. They are "roughed" through the winter in the stalk fields and pastures, and fattened in summer on corn and grass. Although very little or no shelter is provided for the stock there is no doubt but that this would prove profitable, as the winters are sometimes severe.

For the production of live stock, Sullivan county is unexcelled on account of its excellent pastures, abundance of water, and central location in the corn belt. And it is for this reason that the county holds first place among the 114 counties in the state in the number of pure bred stock, and twenty-third place in the number of cattle.

The most popular breed of hogs is the Poland China, with Duroc Jerseys, Berkshires and Chester Whites holding second, third and fourth places respectively. In proportion to the number of cattle, Sullivan county does not produce as many hogs as the counties in the northwestern part of the state because it is not as well adapted to the growing of corn, the essential crop for pork production. The sheep industry, although of much greater importance in former years than now, is growing, and should be encouraged. In 1909, there were about 13,428 sheep in the county. The Shropshire is the most popular breed.

In the number and production of horses, Sullivan county holds thirteenth place in Missouri. A great many young horses and mules are raised and exported annually. The fine blue grass pastures are especially adapted to this industry. The animals are generally sold when one year old. Many saddle and light harness horses are also raised, especially in the vicinity of Milan. The farm horses are of good quality and average about 1,050 pounds in weight. The frequent importation of western range horses tends to retard the breeding of heavier draft horses. In 1909, there were 11,757 horses and 1,364 mules in the county. The exportations in 1908 were 1,687 head.

In all the live stock business, each farmer usually has his specialty, horses mules or cattle.

Dairying is not followed as a specialty, though a small amount of cream is shipped from Milan and Green City. The milk or cream is bought according to its fat content, and this fact should give an incentive to the breeding of high grade cows yielding rich milk. Only a few farmers use hand separators. The dairy industry should be enlarged for it is not only profitable, but also a good way of improving the land. The excellent pastures, abundance of water, and good shipping facilities would all combine to make this an important industry.

A source of income that is of considerable importance on most farms is poultry. Large droves of turkeys were seen in all parts of the county. These fowls can be raised at a very small cost, since they range over a wide territory. The soil and climate of Sullivan county is well adapted to the raising of all kinds of poultry. The surplus farmyard products for 1908 represented a value of over \$353,000.00. Over 2,000,000 pounds of poultry, dressed and undressed, and over 751,000 dozen of eggs were exported.

The cultural methods practiced in Sullivan county are, as a rule, good. Plowing is generally five to six inches deep, except on the prairie land where it is usually not over four inches. Deeper plowing should be practiced, for by this means the feeding area of the

roots of crops could be increased. Moreover, the capacity of the soil to hold water would be made greater, and in addition, washing would be checked.

When wheat follows corn the land is disked and harrowed before seeding. Very little fall plowing is done. On the prairies and places where there is little danger of washing fall plowing is recommended.

For corn, shallow cultivation is preferable to deep cultivation. Often the fields are left level until the last cultivation when the soil is ridged up in the rows and the crop "laid by" as it is called. But little attention is given to soil washing and the formation of gullies that often result from ridged cultivation. The practice of "ridging" crops should be abandoned, as yields are not only materially reduced by a loss of soil moisture, but some of the roots which lie close to the surface in midsummer are broken off, thus diminishing the crop's feeding capacity. Level cultivation when practiced upon the uplands gives the best results, as the soil retains a larger quantity of moisture and crops suffer less from the effects of summer droughts. The necessity of conserving moisture is evident when we consider that on account of the impervious subsoil, the zone of root action is limited to the surface two to three feet.

Commercial fertilizers are not used. Only a small amount of barnyard manure is made. It could be made more effective by the use of the spreader, since by this method it would be applied over a larger area. In so far as practicable, it should be spread as soon as made. The feeding of large numbers of cattle results in the production and spreading of manure over large areas. Since by the present system of farming not enough manure is made to keep the soil properly supplied with organic matter, green leguminous crops, such as cowpeas and clover, should be plowed under occasionally.

Chemical analysis shows that the soils of Sullivan county are deficient in humus, nitrogen and phosphorus. Potassium is present in sufficient quantities so that at present no attention need be given to supplying this element. By keeping the soil well supplied with humus by methods mentioned above, by using manures and growing legumes an abundance of nitrogen will be provided. Phosphorous can be supplied by using phosphatic fertilizers such as bone meal or rock phosphate. The former gives the quickest results and is generally applied on wheat land at the rate of 100 to 150 pounds per acre. Rock phosphate is much cheaper than bone meal but slower in its action. About 500 to 800 pounds are used per acre once in a four or five year rotation, usually before corn.

The following general suggestions would conduce to a stronger agriculture in the county. Careful tillage methods, a beneficial system of crop rotation, a study of adaptability of crops to special soils, and systems of permanent soil improvement. Growth of trade centers, ready marketing facilities, introduction of new lines of remunerative agriculture, higher prices, and increased demand for farm products, are all combining to bring about a recognition of the wisdom of such changes.

Only a little hired farm labor is employed in Sullivan county. As a rule it is of satisfactory quality. Farmers who do not operate more than 100 acres usually do their own work. Wages range from \$25.00 to \$30.00 per month in addition to board and laundry. No doubt better and steadier labor could be had if the farmers would give employment during the entire year instead of only during the summer months. Day laborers can generally be had at \$1.50 to \$2.00 per day.

The average size of the 3100 farms in the county is 130 acres. There are at least a dozen farms that contain more than 1000 acres. Practically all the larger farms are in pasture and grass and are used primarily for the production of live stock.

Land rent is usually on the share basis of one-half or one-third the produce. Whenever money rent is given it varies from two to five dollars per acre, depending on location and quality of the land. It is supposed that about one-third of the farms are burdened with a mortgage, but these obligations are being paid off rapidly.

The average price of farm land in Sullivan county ranges from \$25.00 to \$75.00 per acre. The rougher portions and the timber areas in the eastern two-thirds of the county sell from \$20.00 to \$35.00 per acre. The prairie and gently rolling land with good improvements is held at \$40.00 to \$75.00 per acre. Land values have been steadily going up during the past five years, and the tendency is to still higher prices. In the vicinity of Milan where coal is known to underlie the surface, values are a little higher than for land used for agricultural purposes only.

Most farms are well fenced. Formerly, rail fences were used almost exclusively, but practically all of these have been replaced with modern woven wire fences. A common practice is to have woven wire at the bottom of the fence, and two or three strands of barbed wire above this. Osage orange hedges are found in all parts of the county. Very few of them are properly trimmed and cared for. The importance of either improving and taking better care of these hedges or doing away with them entirely should be impressed upon every farmer, for when allowed to grow up in brush and briars, as is the

case on many farms, a harbor is furnished for injurious insects, weeds and animals and valuable land is wasted.

The country houses are mostly one-story structures, but they are kept in a good state of repair, and are usually surrounded by well kept lawns. The use of more paint, and the building of more artistic houses would add much to the appearance of the country. Other farm buildings, such as barns, are usually small. Implement sheds and corn cribs are either lacking or are very temporary structures. No doubt great loss to crops and implements could be avoided by proper housing.

School houses and churches are well distributed over all parts of the county. Telephone lines and rural mail routes connect almost every farm home with the towns. Further evidence that the farmers are of the most progressive kind is shown by the attention that is given to the breeding of live stock, better cultural methods, crop rotation, and the improvement and introduction of new crops.

THE SOILS IN GENERAL.

The soils of Sullivan county are all of glacial and alluvial origin, and on this basis may be divided into two general groups, the upland and lowland soils. Whatever residual soil has been formed from the underlying shales, limestones and sandstones lies deeply buried beneath the surface. Only a few outcrops occur along the deep stream cuts, but they are so small in extent that they are of no economic importance. They have contributed only indirectly in the formation of the soil.

The drift that was deposited over the entire county by the glaciers consisted of a mixture of clay, sand and boulders. Erosion and weathering have caused great changes in this drift material. The streams with their innumerable tributaries modified the surface from a smooth plain, to a rolling and hilly topography. The surface few feet have also been modified by leaching and oxidation, and the carrying away in suspension of the finer particles of earth.

The fundamental color of the Kansan boulder clay, as it is sometimes seen at the bottom of deep cuts, is blue. The change in color is a matter of oxidation, and it is most marked where the oxidation has been most active. The effects of weathering extend down twenty and even forty feet below the surface. The iron content has reached a high degree of oxidation, and the soil grains are stained brown, reddish yellow, or red brown. These colors in a soil and subsoil invariably indicate that condition of mineral and organic constituents which may be considered the normal state of a good, productive soil in this region. Such thoroughly aerated and oxidized soils have very

few if any undesirable chemical or physical properties and are well suited to general farming. It is this modified drift which gives rise to the Shelby Loam, the principal soil type of the area.

After the deposition of the drift, and before it became eroded to any considerable extent, there was deposited over the entire county, as a result of wind or water action, a layer of almost pure silt, averaging about thirty-two inches in thickness. Erosion has removed this layer everywhere except on the tops of the high flat ridges. Wherever it still remains and in an undisturbed condition, it gives rise to the type of soil mapped as Putnam Silt Loam.

A typical section of the drift with the undisturbed silt would give the following layers:

Gray silt, $1\frac{1}{2}$ feet.

Red clay or silty clay, 1 foot.

Gray or mottled clay, yellow or blue, passing at 6 to 12 feet into blue clay with little or no mottling.

This blue clay usually extends down to the lower part of the drift. Boulders occur most abundantly near the bottom of the drift. The lower part is sometimes quite sandy, and contains a considerable amount of the underlying residual material.

Along its outer edge, and on the narrow ridges where the Putnam Silt Loam has been modified to a certain extent by weathering and erosion, it has been mapped as a separate phase.

The bottom land soils have been derived primarily from the material washed out of the upland soils. The assorted material gave rise to the Wabash Silt Loam, Wabash Clay Loam and Wabash Sandy Loam. The Wash type is partly alluvial and partly colluvial in origin. A characteristic of the soils of the Wabash series is that they have a black color, and a high content of organic matter.

Since all the soils in Sullivan county are derived from a common source, and acted upon by the same condition in every part of the county, they are comparatively uniform, and show a well marked relationship to one another.

The following table gives the names of the several soil types shown on the accompanying map:

Shelby Loam.
Putnam Silt Loam.
Putnam Silt Loam, well drained phase.
Putnam Silt Loam, White Oak phase.
Wabash Silt Loam.
Wabash Clay Loam.
Stream Wash.

THE SOILS IN DETAIL.

THE SHELBY LOAM.

The soil of the Shelby Loam to a depth of four to ten inches is a dark gray to a reddish brown sandy clay loam. The subsoil down to thirty-six inches is a yellow mottled tenaceous clay loam, growing heavier with depth. The depth and color of the soil vary largely with the topography. On the steeper slopes where erosion is active and the content of organic matter is low the soil is shallow and is practically the same as the subsoil. On the gentle slopes and undulating portions where erosion is not very active the soil is usually dark and of good depth. The sand content is highest in those areas where erosion is furthest advanced. The clay and silt are carried away in suspension, leaving the coarser particles at the surface. It is for this reason that the Shelby Loam in the western part of the county, where erosion has made further progress, is slightly sandier than in the eastern part. The presence of the sand is not objectionable since it tends to give the otherwise clayey soil a loamy structure.

The sand grains are mostly quartz, are usually of large size and are waterworn. Iron pipes, lime concretions and calcareous streaks occur throughout this soil type. Occasionally a thin lens of cherty waterworn gravel is seen. The diameter of the gravel varies from one-fourth to one and one-half inches. Boulders of great variety in size are met with; on Spring Creek a granite boulder six by eight feet is exposed, and near Bairdstown there is one twelve feet high, twenty-five feet long and fourteen feet across the top, a red feldspathic granite.

As has already been stated, the Shelby Loam is derived from the weathering of the Kansan drift. This drift that was deposited over the entire country is everywhere quite uniform, and consequently the resulting soil shows only slight variations in its physical properties. When dry the Shelby Loam is easy to cultivate and assumes a crumbly structure. If cultivated when wet large clods form and are pulverized with difficulty.

Occupying, as it does, all the gently rolling to rough topography, the Shelby Loam is the dominating soil type, occurring in every section of the county. Practically all of the western half of the county is covered by it. That part of the type draining into Medicine Creek has a gently rolling topography and for this reason is a better soil agriculturally.

The drainage of the Shelby Loam is everywhere excellent, in fact the water runs off so fast in many places that serious erosion results. All of the type slopes more or less, and for this reason care must

be taken to prevent washing. Brush, straw, etc., should be used to fill up the ditches. A few of the rougher areas should be put in timber to prevent the adjoining lowlands from being submerged with the material brought from the slopes. Crops that require intertillage should not be grown in succession. The most practical and effective way, however, of preventing washing, is to sow the land in grass and use it for pasture and meadow.

Originally nearly all of this type was covered with timber. The prevailing varieties were burr, black, and pin oak, hickory, walnut, elm and ash. Cottonwood and maple were found on the lower slopes. The trees were large in early times, but all of these have been removed, and those that remain are not of commercial size. At the present time only small tracts of timber remain along the streams and on the rougher land, mostly in the eastern part of the county.

On account of its wide distribution the Shelby Loam is used for the production of all the staple crops. Probably about one-half of the cultivated area of this type is in pasture. Corn, hay, oats, wheat and clover are the most important crops in the order named. The yield of corn per acre varies from twenty to thirty bushels, but as much as seventy-five bushels are sometimes secured on the better portions. Oats yield fifteen to thirty bushels, and hay one to one and one-half tons per acre. The Shelby Loam is not a typical corn soil, and large yields are not secured unless the best cultural methods are practiced and the soil kept well supplied with organic matter. The best fields of corn were seen in the western part of the county where the soil is loamier and the slopes more gentle.

Oats are well adapted to the type. Wheat does fairly well, but is grown only to a very limited extent. Clover does well if the proper conditions are provided. It may be possible to grow alfalfa on this type, but thus far all attempts have been a failure. No doubt this was mostly due to wrong methods of handling. In all probability the soil was not sufficiently fertile to permit the alfalfa to make a good growth. Cowpeas thrive on this soil if rightly handled. There is every reason to believe that the sandier areas along the foot of the bluffs are well adapted to truck and tobacco.

The Shelby Loam is peculiarly well adapted to the various grasses. Blue grass, timothy and red top thrive on it everywhere. Blue grass will take possession of land that is left uncultivated for two or three years.

Fruit does fairly well. As a rule fruit trees do best on the lower part of the slopes, because there the subsoil is not as heavy as near the top of the hills.

A rotation well suited to the Shelby Loam is the following:

- Corn one year
- Oats one year

Clover, or clover and timothy... one or two years

Another legume may be included in this rotation by drilling cow-peas in the corn at the last cultivation. On the steeper lands, and whenever the rotation is to be prolonged, it is best to use the land for pasture from two to four years.

The most important factors to be considered in the management of this soil type, is to maintain the supply of organic matter, and to prevent washing. Smooth, shallow and frequent cultivation should be practiced, for this not only conserves moisture, but it also enables the soil to take up more water and thus prevents washing. The presence of a large amount of humus in the soil also increases its water-holding capacity. Moreover, since the Shelby Loam is deficient in nitrogen the necessity of incorporating a large amount of organic matter by applying manure and growing legumes is obvious.

The following table gives the results of mechanical analysis of typical samples of the Shelby Loam:

Mechanical Analyses of the Shelby Loam.

Number	Description	Sand	Silt	Clay
622, 642, 661, 665, 737, 747, 758, 763, 787.....	Soil	Per cent 39.93	Per Cent 37.94	Per cent 13.48
625, 637, 651, 657, 729, 759, 778, 785, 791.....	Subsoil 8 to 20 inches	38.63	34.97	18.77
623, 647, 662, 670, 728, 746, 777, 782, 794.....	Lower Subsoil 20 to 36 inches	35.59	32.41	26.42

THE PUTNAM SILT LOAM.

The soil of the Putnam Silt Loam to a depth of six to ten inches consists of a black or dark gray silt loam. When dry it is friable and easy to work, but when wet, it is sticky and puddles readily. If cultivated when wet, large clods form which are extremely difficult to pulverize.

The subsurface from ten to eighteen inches is a gray, yellow mottled clay. Below this there is sometimes a distinct layer six to twelve inches in thickness and having a brownish red color. It is supposed that this layer marks the base of the zone of rapid percola-

tion, and has been formed by the clay particles washed out of the surface soil. It is almost impervious to water and for this reason is generally, though incorrectly, called hardpan. A sharp line separates this material from the soil and subsoil. The latter to a depth of thirty-six inches is a gray or drab mottled clay loam.

The Putnam Silt Loam occupies the high flat ridges, and is locally known as prairie. Although small areas are found in all parts of the county, this type has its greatest development in the eastern and southwestern parts of the county. The prairie belts vary from forty to one hundred and sixty rods in width, and are often several miles in length.

As has already been stated, the Putnam Silt Loam is derived from the silt layer that was spread over the entire country after the deposition of the drift. As a result of erosion this layer has been removed from all the broken areas, and is now only found on the tops of the ridges. The tributaries of the streams are heading farther and farther back in the upland, and are thus continually reducing the acreage of this type. As a rule most of the Putnam Silt Loam has sufficient slope to insure good surface drainage. It is possible that in a few places tiling would be beneficial. The tiles should not be put deeper than two and one-half feet as a rule, and in filling up the ditch the surface dirt should be put next to the tiles.

The Putnam Silt Loam was originally covered with a heavy growth of wild grasses, and this favored the subsequent incorporation of a large amount of organic matter in the soil. However, continuous cropping with no returns to the land has greatly depleted the supply of humus.

Corn, timothy, oats, clover and wheat are the principal crops grown on this type. Corn does only fairly well, and in dry or wet seasons is usually a failure. The average yield per acre for corn and oats is about twenty-five bushels, and for hay one to one and one-half tons. Since the soil of this type has a tendency to be cold and wet until late in spring those varieties of corn that require a short growing season are best adapted to it. Oats are grown quite extensively and do well. Clover does fairly well, and more of it is grown on this type than on any other. The Putnam Silt Loam is pre-eminently a grass soil, and it is for this reason that the greater part of it is used for meadow and pasture. Much of the timothy is used for seed.

One of the chief objections to the Putnam Silt Loam is that it is not very drought resistant. The texture of the soil is such that it will readily give up its moisture content. Moreover, on account of the heavy subsoil the zone of root action is limited to the surface two to three feet. The necessity of frequent shallow cultivation is obvious. Level cultivation should be practiced instead of ridged cul-

tivation so as to reduce to a minimum the surface area from which evaporation can take place. Harrowing the meadows and pastures to aid the rain water in entering the soil is more than ordinarily important on this type.

Fall plowing, which is a good practice on all the Sullivan county soils, is of especial significance for the Putnam Silt Loam. If plowed in the fall, the soil will freeze more thoroughly with a resulting good physical condition, will hold more water, and can be worked earlier in spring. Deep plowing should also be practiced so as to increase the zone for congenial root growth.

The necessity of growing cowpeas on the Putnam Silt Loam can not be over-emphasized. Cowpeas give the soil a mellow structure in addition to supplying the much needed organic matter.

The following rotation is recommended for this type:

Corn, with cowpeas two years
 Oats one year
 Wheat one year
 Clover, or clover and timothy two years

In order that this rotation will supply sufficient organic matter, cowpeas should be sown in the corn to be pastured off or plowed under.

The Putnam Silt Loam is considered one of the best soils in the county, and upon it occur the best farm improvements.

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

Mechanical Analyses of Putnam Silt Loam.

Number	Description	Sand	Silt	Clay
		Per cent	Per cent	Per cent
648, 744, 745, 759, 764, 769.....	Soil	11.30	63.98	15.65
649, 653, 741, 748, 756, 761.....	Subsoil	10.90	60.68	21.93
668, 732, 733, 738, 750, 762.....	Lower Subsoil	10.16	49.30	33.01

PUTNAM SILT LOAM, WHITE OAK PHASE.

A distinct phase of the Putnam Silt Loam is the rough hilly land in the northeastern part of the county locally called "white oak hills." Although the soil of this area is the same as the Shelby Loam in its general properties, yet it possesses several minor char-

acteristics that are of economic importance and warrant a special description. The greater part of the land of this phase is found in Townships 63 and 64, Ranges 18 and 19, along Spring Creek. To the east, along Chariton River in Adair county, it is in many places the most extensive type of land. It occurs also in a few other places in the county, in small areas.

The typical white oak land, so called on account of the characteristic growth of white oak, occupies the narrow ridges or inter-stream divides. The adjoining slopes are included in this phase, since they are covered with the same characteristic growth, and are modified to a great extent by the soil washed from the hilltops.

On the ridges the soil to a depth of eighteen inches is a yellowish gray heavy silt loam. The content of organic matter is very low, and when wet the soil is sticky. The subsoil from eighteen to thirty-two inches is a heavy brownish gray clay. This layer undoubtedly corresponds to the heavy, brown layer found in the Shelby Silt Loam, but differs from the latter in having a greater thickness and a lighter color. Below thirty-two inches the subsoil is a mottled silty clay blending into the yellow mottled sandy clay. The soil on the slopes differs from that on the hill tops in that it contains more sand, and has a somewhat lighter subsoil. A distinguishing characteristic of the soil of this phase is the low content of organic matter.

The white oak land is extremely rough, the roughest in the county. Deep gulches finger out from the streams into the uplands and so thoroughly dissect the country as to render the greater proportion of it uncultivable. The steep slopes and the impervious nature of the subsoil cause rapid erosion. At the present time (1910) about eighty per cent of the type is covered with timber. White oak predominates, with scrubby pin oak, blackjack, hickory and burr oak of secondary importance. In many places this timber is being removed rapidly. The cleared areas are used for pasture, although a few small tracts were seen in corn. Many farmers claim that this land is a better grass soil than the flat or rolling prairie. Blue grass thrives on it, and will take possession of the land within two years when cleared.

On account of its rough topography and low degree of fertility, the white oak land is of little value for the growing of cultivated crops. Moreover, it is not drought resistant. Corn yields about fifteen bushels per acre. The only value of this land is for pasture, for which it seems to be well adapted. It is especially well suited for sheep pasture. The rougher portions would probably be most profitable if left in timber. Land of this type sells for \$15.00 to \$30.00 an acre.

The following table gives the results of mechanical analysis of typical samples of the white oak land:

Mechanical Analyses of Putnam Silt Loam, White Oak Phase.

Number	Description	Sand	Silt	Clay
		Per cent	Per cent	Per cent
630 638, 644, 660, 731 . . .	Soil	25.44	52.05	16.33
632, 643, 645, 666, 742 . . .	Subsoil	19.75	49.46	24.67
624, 629, 635, 672, 743 . . .	Lower Subsoil	25.31	33.04	34.19

THE PUTNAM SILT LOAM, WELL DRAINED PHASE.

The soil of this type to a depth of eight to twelve inches consists of a black or dark gray silt loam. It is quite crumbly and easy to cultivate, but when wet has a tendency to be sticky. The subsurface from twelve to twenty-four inches is a gray mottled silty clay. The subsoil down to thirty-six inches is a yellow silt clay, resembling the subsoil of the Shelby Loam. When wet the subsoil is not as tenacious as the subsurface.

This phase is derived from the Putnam Silt Loam by weathering. It differs slightly from the latter, containing a little more sand and proportionately less silt. It is also easier to cultivate on account of having a greater depth, loamier structure, and a larger content of organic matter. Its gently rolling topography provides excellent surface drainage.

The well drained phase of the Putnam Silt Loam has its most extensive development in the eastern part of the county. It is found in two topographic positions. The upland phase occupies the narrow ridges or divides between the streams. It also always forms a border around the Putnam Silt Loam. The belts in which it occurs seldom attain a width of more than one-half mile. Like the Putnam Silt Loam, its area is constantly being encroached upon by the erosion of smaller streams.

The lowland phase occupies the second bottoms or lower slopes adjoining the large streams. It is slightly siltier than the upland phase, and is of greater depth. Like the Putnam Silt Loam, this soil was originally covered with prairie grass.

Practically all of this type is in a high state of cultivation. Corn is the principal crop and does well. Yields range from thirty to sixty bushels per acre. Timothy, oats, clover and wheat are the next most important crops in the order named. It is a better corn and clover soil than the level type of Putnam Silt Loam. Practically all the wheat produced in the county is grown on these two soil types. Yields average from fifteen to twenty bushels per acre. The acreage of this crop should be greatly extended. As a fruit and truck soil it is superior to the flat prairie.

Since they are closely related, the crop rotations, and methods of handling suggested for the Putnam Silt Loam are also applicable to this phase. It is of chief importance to keep the soil well supplied with organic matter, which can be easily done by applying manure, and occasionally growing and turning under legumes.

The two types of soil are generally held at the same price, and wherever they occur in large areas, they sell for \$60.00 to \$90.00 per acre.

The following table gives the results of mechanical analysis of typical samples of the Putnam Silt Loam, well drained phase.

Mechanical Analyses of Putnam Silt Loam, Well Drained Phase.

Number	Description	Sand	Silt	Clay
655, 658, 736, 754, 766, 776	Soil	Per cent 17.08	Per cent 58.29	Per cent 16.36
640, 656, 735, 751, 752, 773	Subsoil	16.37	57.60	19.88
636, 755, 760, 770, 793, 798.....	Lower Subsoil	15.08	50.04	29.18

THE WABASH SILT LOAM.

The soil of the Wabash Silt Loam to a depth of ten to fifteen inches is a black or dark gray silt loam. When wet, it is black, and is somewhat sticky. The subsoil down to thirty-six inches is composed of material very much the same as the soil, but is lighter in color on account of containing less organic matter. It contains a little more clay than the soil, and grows heavier with depth. The presence of a small amount of sand, together with the included organic matter, causes this soil to be cultivated with comparative ease. In texture and handling qualities it resembles the Castle Silt Loam.

The Wabash Silt Loam is a bottom land having been derived from the deposition of the fine material washed out of the upland soils. The type has its greatest development along Medicine, Locust and Yellow Creeks, with smaller areas along the minor tributaries. Its surface is smooth with a gentle slope away from the stream. The greater part of the type is subject to overflow, but since most of the overflows come early in spring when there are no growing crops, not much harm is done. Leveeing, with open ditches and tile drains, would be effective in controlling the excessive moisture conditions of this type.

In most places the water table stands within five or six feet of the surface. Capillarity brings this water up, so that crops seldom suffer from drought. In fact, fairly dry seasons seem to favor the largest yields.

As practically all of the Wabash Silt Loam was originally heavily timbered, and was more or less swampy, it favored the accumulation of a large amount of organic matter in the soil.

Continued cropping for more than thirty years has not exhausted but materially decreased this supply, and such system of farming should be practiced as will replenish the worn out stock. Deep plowing and frequent cultivation are of especial importance in order to keep down the weeds that are troublesome on this type.

About fifty per cent of the Wabash Silt Loam is mown for hay. The acreage of cultivated crops varies with the precipitation, and is greatest in dry seasons. It is the best corn soil in the area. Yields range from thirty to eighty bushels per acre. Boone County White is the variety best adapted to it, especially if the season is a long one. Wheat and oats do well, but the latter is apt to lodge on account of rank growth. Clover does well on the better drained portions. The timothy grown on this land is apt to be coarse, and is of inferior quality. Hay yields from two to three tons, and wheat from fifteen to twenty-five bushels per acre. As a fruit and truck soil it is the best in the area. Alfalfa could possibly be grown with success on this type, and the crop should be given a trial.

If good drainage is provided, and the soil kept supplied with a large amount of organic matter, this is an extremely productive soil, and its productiveness can easily be maintained. It is too valuable in other ways to make its use as pasture or meadow desirable. Farmers operating the Wabash Silt Loam have been very successful. Most of the land brings from \$50.00 to \$80.00 per acre, but sales at \$100.00 an acre are occasionally made.

The following table gives the results of mechanical analysis of typical samples of this soil:

Mechanical Analyses of Wabash Silt Loam.

Number	Description	Sand	Silt	Clay
641, 646, 650, 671, 730, 774	Soil	Per cent 13 44	Per cent 57.68	Per cent 17 33
633, 639, 664, 669, 734, 767	Subsoil	18 93	50.33	24.96

THE WABASH CLAY LOAM.

The Wabash Clay Loam is the heaviest soil in the county. It is composed very largely of clay and silt, but contains a considerable amount of organic matter. The soil is black or dark gray in color, and is about twelve inches deep. When wet it is sticky and puddles readily. The subsoil is very similar in composition to the soil, except that it contains a smaller amount of organic matter, and has a slightly lighter color. Occasionally it contains iron stain mottlings. Locally this type is called "gumbo." It is difficult to cultivate, and requires careful manipulation for the successful production of crops. If cultivated when wet, large clods form, which are extremely difficult to pulverize. When dry the soil is very hard. Cracks form in it permitting rapid evaporation of the moisture. In order to secure a good seed bed, cultivation must be done when the moisture conditions are just right.

The Wabash Clay Loam occurs in basin-like depressions in the floodplains of the larger streams. The greatest development of the type is along Medicine and Locust Creeks. Areas of this type too small to indicate on the map are included with the Wabash Silt Loam. The clay loam occupies a relatively lower position than any other bottom land type. Its formation is due to the deposition of sediment from standing water. All of the type is subject to frequent overflows. Some of the lower areas are covered with standing water for several months each year. Only a small per cent of the type is in cultivation, and most of it is in grass. Crops are uncertain even on the cultivated portions.

It is supposed that the Wabash Clay Loam never was timbered, but was covered with a rank growth of water-loving grasses. The decay of the latter accounts for the large amount of organic matter now found in this soil. Little or no weathering is required to make

it productive, since it is not only composed of the most available plant food matter of the upland soils, but receives fresh supplies at every flood.

Deep plowing, construction of open and tile drains, and the building of levees are all essential to secure the best results from this type. The incorporation of a large amount of organic matter is also desirable, in order to give the soil a loamier structure. By providing these conditions, this could be made the most productive soil of any in the county.

Wherever well drained this type is grown to corn, and large yields are obtained. The poorly drained areas yield a large amount of coarse hay. Clover and timothy do well if the moisture conditions are made favorable. As a corn soil, it will always be one of the best in the county.

Most of the land of the Wabash Clay Loam type is held at \$40.00 to \$50.00 per acre.

The following table gives the results of mechanical analyses of typical samples of this type:

Mechanical Analyses of Wabash Clay Loam.

Number	Description	Sand	Silt	Clay
		Per cent	Per cent	Per cent
663, 749, 768, 795	Soil	6.57	48.47	33.36
659, 740, 771, 786	Subsoil	4.43	44.96	40.40

WABASH SANDY LOAM.

This a dark gray to black sandy loam occurring only in some of the short bends of the larger creeks. The area in the county is very small though it is not at all improbable that a considerable number of small occurrences were missed in the survey. It is very low land and subject to overflow many times during the year. It is, on this account, of very little value. It was not considered of sufficient importance to warrant the time and expense of collecting a sample so that no mechanical analysis can be given.

STREAM WASH.

The type of soil mapped as Stream Wash, consists of the narrow strips of lowland found along all the smaller streams in every part of the county. It is principally of colluvial origin and shows considerable variation in texture. Typically the soil of this type is a

black or dark gray loam, or fine sandy loam. It is loose and easily tilled. The subsoil down to thirty-six inches is a dark gray loam. The sandy phase of this type is found along the steep slopes where washing is great. In general the Stream Wash occupies a position relatively higher than the other lowland types. It seldom if ever overflows, and as its structure allows rapid seepage, the moisture conditions are good. The content of organic matter is high.

All of the Stream Wash is in cultivation, and it is considered one of the most fertile soils in the county. It is used almost exclusively as corn and grass land, and is well adapted to these crops. Clover, oats and wheat also do well. It is very probable that alfalfa could be grown successfully on this type, and the crop should be given a trial. As a truck soil it is one of the best in the area. Corn yields from forty to seventy bushels, and hay one and one-half to two tons per acre. Deep plowing and the occasional turning-under of a green legume to keep up the humus supply, are of prime importance in the management of this type.

Since the Stream Wash is small in extent, and is always included with other soil types, it is hard to assign a value to it, but it should be worth at least \$60.00 to \$70.00 per acre when compared with other soils in the area.

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

Mechanical Analyses of Stream Wash.

Number	Description	Sand	Silt	Clay
		Per cent	Per cent	Per cent
627, 631, 667, 775, 781....	Soil	29.53	45.89	16.45
626, 652, 788	Subsoil	18.88	52.22	20.48
628, 634, 654, 772, 783....	Lower Subsoil	31.59	42.85	20.23

SUMMARY.

Sullivan county is located in north central Missouri, and is included in the rolling prairie region. It comprises 648 square miles, or 414,720 acres.

The topography varies from flat prairies, occupying the high interstream divides, to gently rolling and even hilly land along the streams. In general the western part of the county is not as steeply eroded as the central or northern part. The wide flood-plains along the streams are about 200 feet lower than the top of the prairie upland.

Excellent surface drainage is provided by the two drainage systems, the eastern and western. All the drainage is to the south.

About fifty per cent of Sullivan county was originally covered with timber but all of this has been removed except small tracts along the streams. Thin beds of coal underlie a large part of the county.

Three railroads pass through the county and afford good transportation facilities to Kansas City, St. Joseph and other large markets. Wagon roads are numerous.

Settlement began in 1836. The county was organized in 1845. Population increased slowly until after the completion of the railroad in 1872. The early settlers farmed a little and raised stock. The present population is about 22,000, one-fifth of which is found in the towns.

The mean annual precipitation is about forty-four inches, well distributed throughout the growing season. The mean annual temperature is fifty-one and extremes are rare. The growing season is about twenty-six weeks.

The agriculture is based on stock raising. Large numbers of cattle, hogs, sheep, horses and mules are exported annually. All the live stock is of good quality, and many pure bred cattle are kept. Corn is the most important cultivated crop. It is grown most extensively in the western part of the county. Yields range from twenty-five to fifty bushels per acre. Enough oats are raised to supply the home demand. Wheat growing is of practically no importance. The acreage of this crop should be greatly increased. Clover is found on only a few farms. About three-fifths of the entire county is used for meadow and pasture. Excellent blue grass pastures make the county pre-eminent as a stock country. Meadows are used for the production of both hay and seed. Yields average one to one one-half tons of hay. Fruit, truck and sorghum are crops of minor importance.

The cultural methods are as a rule good. Deeper plowing should be practiced, and washing of the soil guarded against. A more systematic rotation of crops is also needed, and this should be planned to include clover and cowpeas. More organic matter should be added to the soil.

The improvements on the farms are generally good.

All the Sullivan county soils are of glacial or alluvial origin. Six types were mapped.

The Shelby Loam, formed from the glacial drift, is the most extensive and occupies all the rolling and hilly land. The greater part of the type is in grass, but where it is not too steep, it is well adapted to corn, oats, wheat and clover. The land sells for \$30.00 to \$70.00 an acre.

The Putnam Silt Loam or flat prairie occupies the high, flat inter-stream divides. The soil is a very uniform silt loam with a rather impervious clay subsoil. The type is well adapted to grass, oats and wheat. Corn does well if the cultural and moisture conditions are just right.

The well drained phase of the Putnam Silt Loam is found adjacent to the level phase, and also on the second bottoms of the larger streams. It is a good grass, corn and oats soil, and is generally considered better than the flat prairie. Land of these two upland types sells for \$50.00 to \$80.00 an acre.

The Wabash Silt Loam is a bottom land soil. The greater part of the type is subject to overflow. It is the best corn soil in the area. The type commands \$50.00 to \$70.00 an acre.

The Wabash Clay Loam is a heavy clay soil occupying depressions in the large creek bottoms. It is subject to overflow, poorly drained, and difficult to till. If well drained, it is an excellent corn soil. It is valued at \$30.00 to \$50.00 an acre.

The Stream Wash is found in narrow belts along all the smaller streams in every part of the county. In texture, it varies from a silt to sandy loam. It has good drainage, and is an excellent corn and grass soil.