Soil Survey of An Area in Atchison County Kansas.

By

H. A. McLenon.

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Location and Boundary of the Area.

The area of this survey consists of a strip of territory three miles wide and twenty-six miles long, and comprises about 49,280 acres or 77 square miles. The survey runs through the central part of Atchison county. Its southern boundary is the parallel road running west from the city of Atchison and thirty miles south of the fortieth parallel or the Kansas Nebraska line. Meridian 95 degrees 20 minutes west longitude crosses the survey near the center.

Atchison County.

The following is taken from a news paper publication of Atchison County by F. D. Coburn.

"Atchison County is in the northeastern part of the state on the Missouri river. It is in the second tier of counties south of the Nebraska state line and has an area of 423 square miles or 270,720 acres. It was organized in 1855 and named for D. R. Atchison a senator of the United States from Missouri. It is divided into eight townships, and ranks twelfth, with a population of 30,026. It is bounded on the north by Doniphan and Brown counties, on the east by the Missouri river, on the south by Leavenworth and Jefferson counties, and on the west by Jackson county.

"The surface is gently undulating, except along the

Missouri river, where there are numerous prominent bluffs. The average width of "bottoms" is from one-fourth of a mile to a mile and a half, and this in the aggregate constitute about fifteen per cent of the area. Timber is found on all of the streams, in belts varying in width from one-fourth of a mile to a mile and a half. The foremost varieties are black walnut, burr oak, black and white oak, hickory, red and white elm and honey-locust.

"Limestone and sandstone are plentiful. A rich vein of coal, averaging three feet or more in thickness, has been found just outside the corporate limits of the city of Atchison and is being rapidly developed. There is an abundance of clay in the county for making vitrified brick.

"Springs are numerous and well water is found at depths of twenty-five feet. Small streams course through all portions. Besides the Missouri river, on its eastern boundary, there is the Deleware river with its several tributaries in the western part, Stranger creek in the center flowing southeast, and Independence and Deer creeks in the north.

"Atchison county is a rich agricultural, livestock and dairy region. Winter wheat and corn are the leading grain crops. There are fully a quarter of a million bearing fruit trees, more than half of which are apple.

"There are seventy-eight organized school districts and a school population of 8,283. The county high school is at Effingham, seventeen miles west of Atchison, on the Missouri Pacific railroad.

"Two lines of the Missouri Pacific traverse the county, one entering on the eastern border, the other on the northern, converging at Atchison in the east. A branch of the Burlington & Missouri River railroad, connecting with the main line in Nebraska, enters the county in the northeast and terminates at Atchison. A line of the Atchison Topeka & Santa Fe railroad, with terminus in Atchison, branching at Hawthorn, in the south, connects--one branch via Topeka and one via of Kansas City--with the main lines of the eastern and western divisions of that road. The Chicago, Rock Island & Pacific, Hannibal & St. Joseph and Kansas City, St. Joseph & Council Bluffs railroads cross the Missouri river from Missouri at Atchison, and connects that city with all important Eastern and Northeastern points. The Leavenworth, Kansas & Western railroad crosses the southeast corner. There are 90.66 miles of railroad, main track.--F. D. Coburn."

History of Settlement and
Agricultural Development of Atchison County.

The first real authentic record of the presence of white men in Atchison county was on July 4, 1804 when the Lewis and Clark expedition which was proceeding up the Missouri river landed at the present site of Atchison and made a few brief observances of the eighteenth anniversary of the county's birth. This was the first Fourth of July celebration in Kansas and Geo. Shannon a brother of Wilson Shannon who afterwards became Territorial Governor of Kansas was one of the Participants. The Party named a small stream near their

landing place Fourth of July creek. This name has since been changed to Clay creek. About four miles farther up the river, they named another stream Independence creek which name it bears at the present time.

The first permanent settlement of importance was made at Atchison in 1854. Other early settlements were made at Sumner and Monrovia.

The early settlers came chiefly from Illinois, Ohio, Indiana and Missouri. The first claims were located along the streams where timber growth was found, and logs for building purposes could be easily obtained. It was thought by the early settlers that the prairie land could never be utilized for agriculture except for grazing and hay. The timber at that time was not nearly so extensive nor so large as it is to-day. The reason for this was that prairie fires were constantly being started by indians and campers and the tree growth confined to the lower and damper ground. Settlers who were unable to obtain land with timber, set out a large number of trees which have now grown into large, beautiful groves.

Each settler preempted 160 acres of land and the area cultivated depended upon his equipment. Each year, however, the cultivated area was increased. Most of the breaking was done with oxen and the first crops raised were corn and wheat.

The only market was at Atchison where steamboats came up the river from St. Louis. Owing to a lack of accessible markets and equipment the progress in Agricultural development was slow.

In 1860 came one of the greatest calamnities that has

A Country Home

ever happened to the people of Atchison county. From the 19th of June 1859 until November 1860, over sixteen months, not a shower fell to soak the earth. All vegetation perished save the prairie grass which grew along the creeks in the early spring. The settlers were left destitute and many would have suffered starvation had it not been for abundant donations made from the East. Though a large amount of seed corn and wheat were sent from the east a great many were unable to put out crops in 1861 on account of lack of seed.

From 1861 to 1865 little progress was made in agriculture on account of nearly all the able bodied men being in the army during the Civil war. After the war, however, progress became more rapid. The prices of farm products became better, better farming was done and larger crops grown. The settlers were beginning to learn the value of the rich prairie upland, and many immigrants of the better class came in from the East. The year 1874 was memorable on account of the grasshopper pest.

From the very first corn and wheat have been the leading agricultural crops. The acreage of corn averaging about twice that of wheat. The following are the ten leading crops in order of their value for the year 1906 according to the Fifteenth Biennial Report of the Kansas State Board of Agriculture. Corn, wheat, grasses and legumes, oats, Irish potatoes, prairie grass, sorgum for forage and grain, millet and Hungarian, Kaffir corn and Rye.

The most important organization of the farmers of this county is the farmers institute which was organized in 1905. It is to be hoped this organization will be the means of a

more careful study of agriculture and agricultural conditions of this county.

Climate.

The climate of Atchison county is humid. The average annual rain fall being 32.08 inches at Horton near the northwest corner of the county and 36.92 inches at Atchison in the east end. From the table below which was taken from the Government report it may be seen that more than 70 percent of the annual rainfall occurs during the growing season from April to September inclusive.

The nedessity of careful conservation of soil moisture is caused by seasons which are occassionally accompanied by drouth. Several times since the settlement of the county the annual precipitation has fallen below 30 inches. The topography of the surface and the condition of the soil is such that considerable water is lost in surface run off and in such years unless the moisture is carefully conserved the yield of crops will be greatly reduced.

The following tables compile the records of the Weather Bureau stations at Horton and Atchison, show the normal monthly and annual temperatures and precipitation and dates of first and last killing frosts.

Normal monthly and annual

temperature and precipitation.

Month	Horton		Atchison	
	Temperature	Precipitation	Temperature	Precipitation
	°F	Inches	°F	Inches.
Jan.	27.5	1.10	27.5	1.17
Feb.	26.9	1.12	27.2	1.25
March	39.4	1.98	40.0	2.28
April	54.7	2.85	54.9	3.72
May	63.8	4.67	64.4	5.14
June	73.2	4.55	73.3	4.75
July	77.1	4.24	77.3	5.14
August	75.7	4.13	76.5	4.30
Sept.	68.1	3.29	69.1	3.56
October	57.2	1.99	58.2	2.66
Nov.	40.9	1.04	41.6	1.30
Dec.	30.6	1.12	31.2	1.65
YEAR	52.9	32.08	53.4	36.92

Dates of first and last killing frosts.

Year	Horton.		Atchison.	
	Last in spring	First in fall	Last in spring	First in fall
1897	Apr. 19	Nov. 2	Mar. 29	Oct. 29
1898	Apr. 7	Oct. 20	Apr. 2	Oct. 17
1899	Apr. 9		Apr. 9	Sept 29
1900	Apr. 13	Oct. 8	Apr. 13	Nov. 8
1901	Apr. 18	Sept 17	Apr. 18	Sept 18
1902	Apr. 23	Oct. 14	Apr. 2	Oct. 14
1903	May 1	Oct. 18	May 3	Nov. 6
1904	Apr. 17	Oct. 23	Apr. 17	Oct 23
1905	Apr. 16	Oct. 21	Apr. 12	Oct 21
1906	Apr. 15	Oct. 10	Apr. 15	Oct. 10
1907	Apr. 15	Oct. 12	May 15	Oct 13
Average:	Apr. 16	Oct. 14	Apr. 15	Oct 17.

Physiography and Geology.

Atchison county is located about 100 miles east of the geographical center of the United States. Its elevation varies from 795 feet above sea level at Atchison to 1150 feet on the highest uplands. The main divide between the Kansas and Missouri rivers enters the county on the north, north east of Huron and runs in a south easterly direction, leaving the county on the south about six miles west of the Missouri river. South and west of this divide the county is drained by the Deleware river and Stranger creek which flow into the Kansas river. East and north of this divide, the drainage is to the Missouri river, chiefly by Independence, Clay, Deer and Walnut creeks. Independence creek and Deleware river are the largest streams in the county.

The surface is gently rolling except along the Missouri river where bluffs are prominent. The surface in general becomes more rolling as the larger streams are approached. The slope of the streams is gradual and as a result wide bottoms varying from one-fourth of a mile to a mile and a half wide have been formed.

Bottom lands are generally well drained and along the larger streams are fairly well covered with timber. Considerable damage is often done to crops growing on these bottoms by the streams overflowing their banks. This might be guarded against in the wider bottoms in the southern part of the county along Deleware river and Stranger by building dikes.

Owing to the ease with which the loessial soils of this part of the state wash many ravines and ditches are threatening

serious damage to the best farm land in the county. It is very important to the agricultural interests of the county that steps be taken to prevent their extension. The expense necessary to check these washes is becoming greater every year.

The soils of Atchison county are almost wholly made up of glacial till and a buff colored silty material known as loess which was deposited during the latter Quaternary period. At a few of the deeply eroded places in the county are found out crops of sandstone and limestone. Carbonaceous shales are also found and in a few places the earth and rock is stripped back and an inferior quality of coal is taken out. The limestones are fassiliferous and belong to the Upper coal measures.

The glacial material which is a part of the Kansas drift is only exposed where the overlaying mantle of loess has been removed by erosion. The larger and better class of soils are made up of the loess. As to the manner of deposition of these loesses various theories have been presented. The following is taken from the report of Iowa Academy of Sciences 1897. This report was prepared by J. E. Todd who has made a careful and able study of the Quaternary Deposits of Missouri.

"Degradation of Loess."

J. E. Todd, Vermillion, S. D.

"One of the most difficult problems connected with the loess is to explain its blanket-like distribution, by which it appears to be continuous over high and low altitudes alike.

"In southwestern Iowa, and eastern Nebraska the altitude of its base or junction with the drift varies from 100 to 200

feet. As a rule its upper and lower surfaces are approximately parallel, the lower being less convex and frequently showing a culmination somewhat one side of that of the upper. There is sometimes trace of a washing of the surface of the underlying till, especially at medium levels, as shown by a line of gravel or sand. The position and character of the junction of the loess and drift at lower levels is not so often shown and is therefore little known.

"The generally received opinion, I think, is that the drift was deeply eroded before the deposition of the loess. This view as we shall see only aggravates the difficulty of the problem. If the surface of the drift was very uneven, as at present, it is difficult to see how rivers, lakes, and winds could have deposited the loess as we find it. This will appear as we proceed to consider the solutions which have been presented and in some cases urged. These we will survey very briefly, as our time is short.

"1. The Lacustrine theory was first suggested, and for a long time, for perhaps fifty years, was considered fairly satisfactory. It ran through various form, from a semi-marine or estuarian origin on one hand to the result of small, local, often shifting lakes, on the other. The first was forbidden by the utter absence of marine forms of life, and the following objections lie more or less forcibly against all:

"a. There is no trace of barriers sufficient to account for their existence.

"b. There is no trace of beach deposits, either of ridges or shelves.

"c. There is serious difficulty in accounting for the observed distribution of material, so uniform in thickness and character, in a currentless body of water. And if currents are postulated they would have tended to follow deeper valleys and would have differentiated the loess more than we find to be the case.

"2. The Aeolian hypothesis, first suggested by Richthopen for the loess deposits of China 20 years ago, has had some distinguished advocates who have accepted it for similiar formations elsewhere.

"More commonly, however, it has been held as a supplemental theory.

"The following objections lie against its general application:

"a. It does not accord with the distribution of the loess in general, while it may explain its occurence at different levels, it does not explain its common occurence on windward slopes, nor its greater thickness near streams on both sides alike.

"b. It cannot be harmonized with the frequent occurence of coarse material in the loess, in some localities.

"c. It does not explain the horizontal banding, and the flat areas on the same level which are frequently exhibited by the loess.

"3. We may notice also an Aguoaeolian theory which suppases, that streams were flowing at lower levels, sluggish and varying much in volume at different seasons, so that broad bars of fine material contributed dust and fine sand to the

winds when the water was low, which was borne up and spread over the adjacent highlands.

"There is little doubt that such a condition has existed often and has been somewhat efficient in many localities, but it is certainly inadequate for our main purpose. The objections against the preceeding theory would be applicable here also, especially the extensive flat areas lying at nearly the same altitudes mentioned under c.

"Before presenting our remaining theory we will call attention to certain facts connected with loess and loams generally. These facts relate to the properties of loess itself, and to its erosion as sometimes displayed. We must also consider underlying formations so far as they affect the problem.

"1. The rigidity of loess. It consists chiefly of grains of quartz. These are cemented by carbonates of lime and iron and chinked more or less with clay. It stands like a rock if it is kept dry throughout.

"2. It is on the otherhand very plastic when wet to a certain degree. Water, particularly if charged with a little carbonic acid, dissolves the cement, and the clay serves as a lubricant to the rounded quartz grains. We have only to notice the behaviorof it when thrown from a well, or to mix a little of it with water to be impressed with this fact.

"This property is further exhibited in roads passing through cuts in loess, and in the rapid wash from hills and hillsides after a continued rainy season. Two and three feet of sediment have been deposited on the flood plains of adjacent after a single flood.

"3. The porosity of loess and loams generally is marked. Water is quickly absorbed in any direction, by capillary action. This has been often noted in it as a subsoil. It affords admirable under drainage and on the other hand furnishes moisture from below in time of drouth.

"This character tends to promote plasticity and to render that character more general. By promoting absorption it decreases much the surface erosion.

"4. The easy and perfect recementation or "setting" of loess after being wet, or the sudden change from placticity to rigidity.

"When water mixes with loess as sometimes on a side hill after soaking rains, or in sudden rainfall, it flows down, covering the surface below, and accumulating as a talus, and as soon as the water has soaked out of it, it is as firm and solid as the original loess. It may be almost impossible to show that it is a secondary formation except by inference from its relation, unless there be some fragment of plant, or shell, or position of concretions, or distribution of color to reveal the fact.

"5. The vertical cleavave or column structure of the loess is a well recognized feature which has an important bearing on our subject. Several things, probably aid in producing this. The lateral shrinking in drying, the prevalent vertical direction of the roots of plants, and the formation of light faults by the unequal settling of different portions because of the plasticity of its lower portions, or of underlying clays or sands, are some of the more important.

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"As illustration of this property we may refer to the way in which we frequently find half way up a steep slope, especially at the end of a spur running out toward a bottom land, a vertical cliff 10, 15, 25 or 50 feet in height. Also the irregularly terraced appearance which steep bluffs often show. From excavations in such I have noted that these are caused by a succession of nearly parallel faults running with strike of the slope which extends vertically through the dry, rigid portion of the loess to the moist lower layers, or to the drift clays below. They might be compared to crevasses in a glacial rapid.

"This same property appears often in the sides of cannon-like ravines. In fact, the cutting back of a ravine is first due to the concentration of water in a depression in the lower surface of the loess, which escapes as a spring. This washes away the buttressing or enclosing material, the plastic loess escapes, the superincumbent mass settles down, becomes in turn moistened, plastic and washes away, and the process is repeated backward, following the vein of water. The sides also recede until their base has risen above the plastic effect of the water. But wet weather may further widen the canyon or cause it to throw out branches. The vertical clevage and inherent rigidity of the dry loam cause it to stand indefinitely, while the underlying drift clay is being eroded. In a dry climate this stage might continue long, as it occurs to-day in similiar formations in central Nebraska and Dakota.

"To understand still better the origin of the wide vertical range of the loess, we need also to study somewhat the under-

lying formations. The most prevalent underlying formation of the loess in the Missouri valley is bowlder clay or till. This though quite impervious, is usually traversed by oblique seams which cross each other, dividing the mass into polygonal blocks. These seams are followed more or less by infiltrating water.

"There is without doubt more or less motion along these seams, in fact they are not unlikely due to strains produced by gravity upon the mass, or else by contractions caused by consolidation or drying. More over, the upper portions of this till are often quite easily rendered plastic by standing water.

"Again, below the bowlder clay, which varies much in thickness and is sometimes subdivided, there is usually a layer of sand several feet in thickness. This, if exposed by the formation of ravines becomes a very unstable foundation and the suberincumbent till and loess are let down bodily. Much of southeastern Nebraska seems to owe much of its roughness to these relations.

"We are now fairly prepared to consider a theory to account for the problematic conditions indicated at the outset. I present it for your criticism. If I mistake not it will explain much, if not all, of the difficulties found.

"We may suppose that the preglacial surface was uneven as in unglaciated areas generally. The advance of glaciers spread over it a blanket of bowlder clay, and left a surface similiar to that inside of the Wisconsin moraine.

"Upon this was spread by the flooded streams flowing from

the melting ice sheet, either of the same, or some subsequent epoch of the ice age, and also by streams burdened with Tertiary silts and clays from the west, the sheet or succession of sheets of loess. At this stage the surface of eastern Nebraska, western Iowa and northern Missouri, was a silt covered plain similiar to that of the lower Mississippi at present. Possibly more uneven and more sloping. We cannot conceive that deep rivers were the rule in this work but shallow overburdened streams more like the Platte of the present day, or the Hoang Ho of China.

"As the amount of water declined the channels would become more contracted as in a low water stage. The beginning of a northward differential elevation and a not improbable lowering of base level by the change in the course of the Missouri river, as the writer indicated in his Missouri report, may have begun a rapid trenching of the water logged deposits.

"In such conditions the erosion of valleys, we may suppose, went on much more rapidly than later, because of copious springs and great plasticity of the deposits.

"As the drift loess dried out there would be a recolation or redevelopment of the preglacial valleys, so that the post glacial streams would approximately correspond to the pre-glacial, as has been pointed out by McGee and others.

"The first erosion was probably largely by ravines, cutting down sooner or later to the underlying till and drawing off the surplus waters from the loess by springs. Here different suppositions may be considered.

"If the dryness of the climate was sufficient to render

the loess rigid, the springs and streams may have had fair opportunity to erode the drift, not only by corrosion, but by sapping and undermining. It is not difficult to suppose that the appearance at that stage may have been not very unlike what is now seen in the "bad lands" of South Dakota, where rigid loams over-lie firm clays or rocks.

There may have been successive local base levels, each having its labyinthine ravines, alluvial fans, and terraces.

If, on the contrary, there was much rainfall, so as to keep much of the loess plastic, there would be very low or not abrupt banks, but a general slow mud flow more or less rapid down the slopes. In such a case the early topography would have been a succession of flat upland and sag-like valleys with sides gently sloping or marked with landslides of greater or less extent.

"In time the valleys would reach their lower base level, the loose deposits would become more perfectly drained, the breaks would be gradually worn off by erosion though some stand as shoulders on the hillsides to the present time, and the region gradually put on its present aspect.

"It should be remembered that this theory is intended to have special application to the widest and probably oldest loess deposits. Some of the lower and more conspicuous are evidently of much later date. They are simply heavy deposits capping high terraces of deposition along the principal streams."

Soils.

Four distinct types of soil were recognized in this survey. All of these except the Yazoo silt loam which is alluvial are upland soils. The Yazoo silt loam is divided

into two classes, namely: the Yazoo silt loam and the sandy phase of the Yazoo silt loam.

The name and approximate extent of each are given in the following table.

Soil.	Acres.	Per cent.
Marshall fine sandy loam.	24,147	49
Marshall silt loam.	14,291	29
Miama silt loam.	5,420	11
Yazoo silt loam.	5,420	11
Total	49,278	100

Marshall Fine Sandy Loam.

The Marshall fine sandy loam is variable in color owing to a variation in amount of sand and organic matter but in general is a dark colored sandy loam from six to twenty inches deep. The content of sand varies from 40 to 60% most of which is very fine sand. The per cent of clay on the tillable ground varies from 8 to 12%. The subsoil is from a buff colored sandy loam to a sandy clay or silt. It is a noticeable fact that the soil contains more sand and less clay than the subsoil thus making the soil easily tillable and the subsoil heavy enough to be of good texture for the growth of the roots of plants and the rise of capillary moisture.

The Marshall fine sandy loam occurs between the Marshall silt loam and the Yazoo silt loam except in the eastern and western ends of the county where it is separated from the Yazoo silt loam by the Miama silt loam. It grades gradually into the Marshall silt loam and continues to become more sandy and gravelly as it approaches the streams. The type is derived

Wet area caused by water seeping out along line of contact between the Marshall fine sandy loam and the Marshall silt loam.

Atchison County Corn

from the loessial mantle and the glacial till, namely: the Kansas drift. The higher elevations of this type resemble the Marshall silt loam and are perhaps gradually encroaching upon it as the finer silt and clay of the Marshall silt loam is carried away leaving the sand behind. The lower altitudes are derived from the glacial till and in many places contain considerable gravel and bowlders. The type is developed by erosion and is always found in the vicinity of streams.

The surface of the Marshall fine sandy loam is rolling to hilly. It slopes towards the streams and is badly cut with small draws and ditches. The larger part of the area is sufficiently level to cultivate, but close to the larger streams the steepness of the land makes cultivation difficult.

In general the surface and subdrainage is good, though in some localities the subdrainage is poor. In only a few places however is both sub and surface drainage poor. These areas occur where the water seeps out along the line of contact between this type and the Marshall silt loam and forms springs which keep small areas continually boggy.

The Marshall fine sandy loam in general has too small an amount of organic matter. This is in part due to the rapid erosion and to the fact that the sandy soil being easily tilled, has too little organic matter worked into it.

The soil produces fair yields of corn, wheat, oats, emmer, and is well adapted to the grasses and clover. The yields of all could be greatly increased by the ploughing under of such legumes as alfalfa, clover or cowpeas.

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The following table is the result of a mechanical analysis and determination of the volatile matter of a typical sample of the soil and subsoil of the Marshall fine sandy loam.

Mechanical Analysis of
Marshall fine sandy loam and
determination of volatile matter.

Locality	Description	Coarse gravel: 2 m m or larger	Fine gravel 2-1 m m	Coarse sand 1 to 5 m m
		P. ct.	P. ct.	P. ct.
6 miles W. of Lancaster. 1 mile N. of parallel.	Soil 0 to 16 inches. Subsoil 16 to 31 inches.	0	.09	2.
		1.3	.3	.8

Locality	Description	Medium sand .5 to .25 mm	Fine sand .25-.1 mm	Very fine sand 1 to .05 mm.
		P. ct.	P. ct.	P. ct.
6 miles west of Lancaster: 1 mile north of Parallel.	Soil 0 to 16 inches.	5.	17.	34.
	Subsoil 16 to 31 inches.	2.7	9.6	37.5

Locality	Description	Silt .05-.005mm	Clay .005-0 mm.	Volatile matter.
		P. ct.	P. ct.	P. ct.
6 miles west of Lancaster: 1 mile north of parallel.	Soil 0 to 16 inches.	34.	8.4	4. 7
	Subsoil 16 to 31 inches.	28.5	20.4	3.8

Marshall Silt Loam.

The Marshall silt loam to the depth of 12 to 20 inches has a dark brown color when dry and a striking black color when wet. The soil contains about 18 to 20 per cent clay and is heavy and plastic especially when the usual amount of organic matter is lacking.

The subsoil is a heavy silt loam somewhat lighter in color and heavier in texture than the soil owing to a smaller content of organic matter. The clay content of the subsoil is about the same as that of the soil. The subsoil as a whole is impervious and as a result water percolates down through it very slowly.

The Marshall silt loam is located on the highest areas of the survey and grades gradually into the Marshall fine sandy loam, so that it is difficult to determine the exact boundary line. The change occurs however on the slopes and in but few places does this type extend down to the Yazoo silt loam of the larger streams.

This type is derived entirely from the loessial mantle found generally over the Mississippi valley. The soil particles constitute the more finely divided materials derived from the breaking down of rocks of almost every description and of many geological formations. The deeper loesses are of about the same mechanical composition as the soil and are but little different from it except in point of organic matter, it is due to this fact that this soil when badly eroded can be brought back to its original productiveness again by working organic matter into it and bringing it to a proper tilth.

The surface of this type is the most regular of any in the survey. It becomes more rolling as it approaches the streams and it is on the sides of these hills that the soil is the thinnest. The deeper soil being found on the more level areas. The thinner soils of the hillsides are generally more of a brownish color, are heavier in texture and have a less amount

of organic matter than the soils of the more level areas.

The drainage of the type as a whole is excellent, though the surface drainage is better than the subdrainage owing to the impervious character of the subsoil. The subdrainage could be greatly improved by growing deeper rooted crops and by deeper cultivation. This is greatly needed as the run off from rains is so large that crops suffer for want of moisture whenever the rains are not evenly distributed through the growing season. On many farms the amount of organic matter is becoming low, and as the soil contains only a small per cent of sand a continued rain for several days causes the surface soil to run together and become almost impenetrable to water. Thus, when the rains come in close succession the loss of water by surface run off is greatly increased and when followed by dry weather the yeild of crops necessarily reduced.

The Marshall silt loam being derived from the loess is very easily eroded and in many places gulches with almost vertical walls are cutting their way back into the fields and destroying the best farms.

This type is especially adapted to corn and clover. The chief rotation is corn, oats, wheat and clover. All the staple crops of this part of the country give the largest yields on this soil. Alfalfa is only beginning to be raised, but promises to become a valuable crop. The average yield of corn is about 30 bushels, of wheat 20, and oats 30.

A Menace_ found on many of the best farms of the Marshall silt loam .

The following table is the result of a mechanical analysis and determination of volatile matter of a typical sample of the soil and subsoil of the Marshall silt loam.

Mechanical Analysis and
determination of volatile matter
of Marshall silt loam.

Locality	Description	Coarse gravel: 2 mm or larger	Fine gravel: 2-1 mm	Coarse sand: 1 to .5
		P. ct.	P. ct.	P. ct.
4 1/2 miles west of Lancaster	Soil 0 to 14 inches.	0	1	0. 2
	Subsoil 14 to 36 inches.	0	0	0.2

Locality	Description	Medium sand: .5 to .25 mm	Fine sand: .25 to .1 mm	Very fine sand: .1 to .05 mm
		P.ct.	P. ct.	P.ct.
4 1/2 miles west of Lancaster	Soil 0 to 14 inches.	0.3	0.6	19.5
	Subsoil 14 to 36 inches:	0.3	0.64	15.0

Locality	Description	Silt: .05 to .005 mm	Clay: .005 to 0 mm	Volatile matter
		P.ct.	P. ct.	P. ct.
4 1/2 miles west of Lancaster	Loil 0 to 14 inches	61.0	18.0	7.0
	Subsoil 14 to 36 inches.	65.0	19.0	5.0

Miama Silt Loam.

The Miama silt loam differs from the Marshall silt loam chiefly in its color and topography, rather than in any variation in mechanical composition or derivation. The soil

is about 10 inches in depth and consists of a redish silt loam. It contains about fifteen per cent clay and a very small amount of sand and when wet is very sticky and plastic. When dry it is loose and incoherent. The subsoil is a heavy silt loam and closely resembles the soil in appearance. It has a slightly smaller clay content then the soil but is heavier on account of the small amount of organic matter which it contains. The appearance of the type as a whole is of a heavy clay loam and is spoken of by many people of the county as the clay hills.

The greatest extent of the Miami silt loam is in the eastern part of the survey between the Missouri river bottom and the Marshall fine sandy loam. The only other occurence of this type of soil is in the western end of the survey along the Deleware river. The elevation of this type does not in general exceed 1000 feet.

The Miami silt loam has its origin from the loess deposits but in the west end of the county the type has many exposures of glacial drift, which consist of cherty gravel, sands, clays and bowlders.

The surface is extremely rolling and hilly, and along the Missouri river is a continuous line of precipitious bluffs. Deep ravines have been cut by the streams and in several places the bed rock is exposed. At a point a short distance above Atchison limestone is quarried in considerable quantities. Several out crops of limestone are found in this type along the Deleware river in the western end of the county.

1566

The type as a whole is well drained and but few wet areas were found, they being the result of small springs. Owing to the roughness of the surface only a small per cent of the type is cultivated. A considerable portion of the roughest part is covered with timber and is used as pasture land. The chief crops grown are corn, wheat, and grasses. Clover does well. But little alfalfa is being grown at present but its introduction has begun. Quite a number of farmers have set out orchards and vineyards which seem to be bringing in fair returns.

Owing to the rapidity of erosion this soil is very poor in humus and as a result does not have the excellent tilth of the Marshall silt loam. Much improvement could be made in its physical condition and the yields of crops increased if more farm manure was applied and more legumes grown and turned under. This would also to some extent prevent its washing.

The following table is the result of a mechanical analysis and determination of volatile matter of a typical sample of the soil and subsoil of the Miama silt loam.

Mechanical analysis and
determination of volatile matter
of Miama silt loam.

Locality	Description	Coarse gravel: 2mm or larger	Fine gravel: 2 to 1mm.	Coarse sand: 1 to .5 mm.
		P. ct.	P. ct.	P. ct.
1/2 mile south of Soldiers Orphans home	Soil 0 to 18 inches.	0	T	T
	Subsoil 18 to 36 inches:	0	T	T

Locality	Description	Medium sand: .5 to .25 mm.	Fine sand: .25 to .1 mm.	Very fine sand .1 to .05 mm.
1/2 mile south of Soldiers Orphans home:	Soil 0 to 18 inches. Subsoil 18 to 36 inches.	P. ct. T T	P. ct. 0.24 0.2	P. ct. 16.8 17.8

Locality	Description	Silt .05 to .005 mm.	Clay .005 to 0 mm.	Volatile matter.
1/2 mile south of Soldiers Orphans home:	Soil 0 to 18 inches. Subsoil 18 to 36 inches.	P. ct. 67.5 69.0	P. ct. 15.5 13.2	P. ct. 4.5 3.6

Yazoo Silt Loam.

The soil of the Yazoo silt loam is a dark heavy silt loam containing from 10 to 15% clay and a large amount of organic matter to the depth of two feet. The percentage of sand is small, being almost entirely very fine sand. The soil grades gradually into the subsoil which consists of a dark brown silt loam of practically the same mechanical composition as the soil. The soil and subsoil differing only in color and amount of organic matter which gives the subsoil a heavier texture.

The Yazoo silt loam is an alluvial soil and is found to a greater or less extent along all the streams of the survey. It varies in width from a few yards to about a mile and a quarter. Its largest areas are along the Deleware river and is known as the Deleware "bottoms." Other areas are found along Stranger, Independence and Deer creeks in the central and

eastern part of the survey.

This type of soil is derived from material washed from the hill sides and higher land. It is composed largely of reworked loesses and the finer material which has been washed from the exposed glacial till. The soil is gradually becoming deeper by the addition of sediment from occassional overflows of the streams. Areas of this type above the exposures of glacial till is composed entirely of reworked loess and with the exception of being deeper and containing more organic matter is almost identical the same as the Marshall silt loam.

The surface of the Yazoo silt loam is generally level and is only broken by the winding of the streams. At several places this type has been built up till it is slightly higher near the stream than back next to the hills. In such case the surface drainage is poor and the soil remains wet and water logged in wet seasons. These areas are not very extensive, but considering the high productivity of the soil of this type tile drainage is recommended.

The Yazoo silt loam is the most productive of any type in the survey. It is particularly adapted for corn and wheat. Its yields range from 40 to 70 bushels of corn and 20 to 40 bushels of wheat. Wheat does better after the land has been corned for several years as the richness of the soil causes wheat to grow to rank if not following corn. This type would be an ideal soil for alfalfa but as yet the chief legume is red clover. Until recently a large part of this bottom land was occupied by timber. The chief trees being black walnut, black and white oak, burr oak, red and white elm, honey locust and hickory.

1569.

The following table is the result of a mechanical analysis and determination of volatile matter of a typical sample of the soil and subsoil of the Yazoo silt loam.

Mechanical analysis and
determination of volatile matter
of the Yazoo silt loam.

Locality	Description	Coarse gravel: 2mm or larger	Fine gravel: 2 to 1mm	Coarse sand: 1 to .5 mm.
Deleware bottom near Parallel.	Soil 0 to 18 inches.	P. ct. 0	P. ct. 0.18	P.ct. T
	Subsoil 18 to 41 inches.	0	T	T

Locality	Description	Medium sand: .5to.25 mm	Fine sand: .25to.1 mm	Very fine sand: .1 to .05 mm
Deleware bottom near Parallel.	Soil 0 to 18 inches.	P. ct. 0.18	P. ct. 1.0	P. ct. 19.0
	Subsoil 18 to 41 inches	0.1	0.6	20.0

Locality	Description	Silt: .05to.005 mm	Clay: .005to 0 mm	Volatile matter
Delaware bottom near	Soil 0 to 18 inches.	P. ct. 68.0	P. ct. 12.2	P. ct. 7.1
Parallel	Subsoil 18 to 41 inches	65.6	13.2	4.4

Sandy Phase of Yazoo Silt Loam.

A sandy phase of the Yazoo silt loam has been developed in the extreme eastern end of the survey between the bluffs and the Missouri river. It is an alluvial soil and has been formed by depositions of the river during its overflows.

1590

The soil is a dark heavy silt loam and is variable in its mechanical composition. To the depth of 6 or 10 inches the soil is extremely heavy in texture and along close to the bluff it is termed gumbo by the farmers. Farther from the bluff approaching the river the soil becomes more sandy.

The subsoil has a lower clay content but is higher in sand than the soil thus giving it a lighter texture.

The sandy phase of the Yazoo silt loam is very fertile and seems to be well adapted to corn. One place was pointed out where corn had grown for twenty-five years without rotation. This record has doubtless been made possible by occasional overflows. A large part of the area of this type is covered with willows.

The following table is the result of a mechanical analysis and determination for volatile matter of a typical sample of the soil and subsoil of the sandy phase of the Yazoo silt loam.

Mechanical analysis and
determination of volatile matter
of sandy phase of Yazoo silt loam.

Location	Description	Coarse gravel: 2 mm or larger	Fine gravel: 2 to 1 mm	Coarse sand. 1 to .5 mm
		P. ct.	P. ct.	P. ct.
1 1/2 miles north of Atchison east of R. R. tracks:	Soil 0 to 10: inches.	0	T	T
	Subsoil 10 to 34 inches:	0	T	T

1571

Location	Description	Medium sand .5 to .25 mm	Fine sand .25 to .1 mm	Very fine sand .1 to .05 mm
1 1/2 miles north of Atchison east of R. R. tracks	Soil 0 to 10 inches.	P. ct. 0.09	P. ct. 0.4	P. ct. 33.5
	Subsoil 10 to 34 inches.	.06	.5	49.2

Location	Description	Silt .05 to .005 mm	Clay .005 to 0 mm	Volatile matter
1 1/2 miles north of Atchison east of R. R. tracks	Soil 0 to 10 inches.	P. ct. 55.0	P. ct. 11.0	P/ ct. 5.6
	Subsoil 10 to 34 inches.	43.0	7.5	4.0

Hardpan.

Scattered throughout the survey are spots and patches where the subsoil is so compacted and solidified that the downward percolation of water is almost impossible. The soil on these hardpan spots varies from 2 to 10 inches and may be easily recognized from the surrounding soil by the scanty growth of vegetation. The areas are generally basin shaped and hold water near the surface until it has evaporated. They are generally small and occur in all the types of this survey.

Several spots were examined in the Marshall silt loam and found to consist of 2 to 6 inches of soil under which is found a stratum of heavy ashy gray clay loam varying from 20 to 25 inches in thickness. Beneath this impervious stratum is found the ordinary silty material which is found in the subsoil of the Marshall silt loam. A mechanical analysis of a sample of a hardpan spot in the Marshall silt loam shows the

first twenty-four inches to contain from 27 to 28 per cent clay and a very small amount of sand. 1572

These spots are known as buffalo wallows by the old settlers and there is fairly good evidence to believe that some of them at least were formed by the buffalos puddling the soil during wet weather. The higher percentage of clay in these spots as compared with the surrounding soil causes this soil to puddle much more easily. An examination of the soil particles with the microscope shows them to be more rounding than the particles of the surrounding soil. This might be explained by the fact that a compact soil freezes more readily than a loose one and the physical disintegration resulting from the oft repeated freezing and thawing would round the particles. The microscope also shows that there are a large number of clay particles much smaller than the average sized clay particles of the surrounding soil.

Little has been done towards improving these soils but it is my opinion that were these spots loosened by dynamite, given a dressing of quick lime and sown in some deeprooted crop as cowpeas, they would soon become productive. Until the soil is well drained little improvement can be made.

The following table is the results of a mechanical analysis and determination of volatile matter of a typical sample of the soil and subsoil of a hardpan spot occurring in Marshall silt loam.

1573

Mechanical analysis and

determination of volatile matter

of Hardpan.

Locality	Description	Coarse gravel: 2mm or larger	Fine gravel: 2 to 1 mm	Coarse sand: 1 to .5 mm
		P. ct.	P. ct.	P. ct.
4 1/2 miles west of Lancaster.	Soil 0 to 10 inches.	0	0	T
	Subsoil 10 to 24 inches	1.3	0.3	0.35
	Subsoil 24 to 37 inches	.09	.08	0.3

Locality	Description	Medium sand: .5 to .25 mm	Fine sand: .25 to .1 mm	Very fine sand: .1 to .05 mm
		P. ct.	P. ct.	P. ct.
4 1/2 miles west of Lancaster.	Soil 0 to 10 inches.	0.3	0.8	14.6
	Subsoil 10 to 24 inches	0.3	0.6	11.0
	Subsoil 24 to 37 inches	0.4	6	12.7

Locality	Description	Silt: .05 to .005 mm	Clay: .005 to 0 mm	Volatile matter
		P. ct.	P. ct.	P. ct.
4 1/2 miles west of Lancaster.	Soil 0 to 10 inches.	56.5	27.9	5.3
	Subsoil 10 to 24 inches	61.2	26.5	3.3
	Subsoil 24 to 37 inches	68.0	18.7	

Agricultural Methods.

The methods of farming in Atchison county are those of general agriculture. The growing of crops, raising of live-

Winter Sport

stock and dairying are generally carried on on every farm. The raising of corn and stock perhaps occupies more attention and time of the farmers than any other occupation.

No definite rotation system is used but the usual method is corn, oats or some spring grain, wheat and clover with other grasses. Pasture is seldom incorporated in the rotation as the topography of the surface and the ease with which the soils wash is such that almost every farm is fenced off with permanent pastures along the draws and steeper places. Of late years the yield of oats has not been enough to pay for their sowing and many farmers have changed from oats to Emmer. This crop yields from 25 to 40 bushels and fits in the place of oats very well in the usual rotation. However it is doubtful if it can take the place of oats as a feed.

The growing of corn, spring grain, wheat and clover as practiced is not keeping up the proper amount of organic matter in the soil and as a result the soils on many farms are loosing the excellent tilth they once had and are naturally giving smaller yields. The turning under of more green manuring crops is very necessary. The impervious nature of the subsoil in this county would naturally suggest that the deeper rooted green manuring crops would be the more efficient. No crops would better serve for this purpose than cow peas and alfalfa. Benefit may be obtained from cow peas more quickly than from Alfalfa because of the fact that the soil need not be innoculated for them. Prof. Ten Eyck of the Kansas State Agricultural College says, "In my judgment there is no better annual crop, adapted to Kansas condition, which may be used in rotation or as a green manuring crop than cow peas. A good crop of cow peas ploughed under green would be equivalent to the application

1515

of a light dressing of barnyard manure. The New Era and Whipoorwill varieties are well adapted for growing in Kansas."

In preparing the soil for corn the general practice is to use the lister. There are several objections to its use on most farms in this county. The heavy rains which this locality is subject to causes severe erosion at best, and the practice of listing with the consequent deep furrows tends to greatly increase the amount of washing. Single listing is often the practice and the amount of loose earth to absorb during rains is not sufficient, so that a larger per cent of water is lost by surface run off than is necessary. In single listing the hard unstirred soil between the rows is not favorable for the growth of lateral roots. The injury to the soil in raising corn in this county comes almost entirely from washing. Deep ploughing is one of the most effective means of checking erosion.

Ploughing in general in this county is too shallow. This is partly due perhaps to the fact that more ploughing is done in the fall when the ground is hard and dry and at this season of the year the draft of a plough is very heavy. It is also noticed that the general practice of ploughing is at the same depth every year. This has been continued so long in some fields that the bottom of the furrows have a hard impervious texture, generally termed plough sole, and which acts in many respects like hardpan. This can only be broken up by ploughing a half to an inch deeper each year.

The grain crops in Atchison county are all harvested with the binder and the grain placed in shocks where on the majority of farms it remains till it is threshed. Owing to the fact that it takes considerable time for threshing machines to get around

to all the grain and that rains are liable to set in, this practice is not a good one. More grain would be saved and would go on the market in better condition if it was placed in stacks soon after cutting. Corn is usually harvested by husking in the field. The stalks being pastured in the winter. When other forage is short the green corn is often cut and shocked.

The raising of hogs and cattle is the important live stock industry. The predominating breeds are Shorthorn cattle and Poland China hogs. Dairying is seldom carried on except in connection with other general agriculture. Most farmers sell their cream. Commercial fertilizers are almost unheard of and will not be needed for many years at least, especially if stock raising and dairying is continued.

Most farms are equipped with improved machinery. Too little care is taken of it. The implements often being left in the field where they were used last or pulled up under a tree.

Agricultural Conditions.

In passing through Atchison county one cannot help but be impressed with the appearances which indicate the great prosperity of the people. On most of the farms are seen good dwellings and barns. An excellent school system is maintained there being seventy-eight organized districts. A county high school is maintained at Effingham near the center of the county, which gives fine courses and prepares pupils for entrance to the State University or State Agricultural College. Almost every home is supplied with a telephone and rural free delivery. Outside the city of Atchison the occupation of nearly the whole population is Agriculture so that the chief source of wealth of the county is from the soil.

A Farm Dwelling

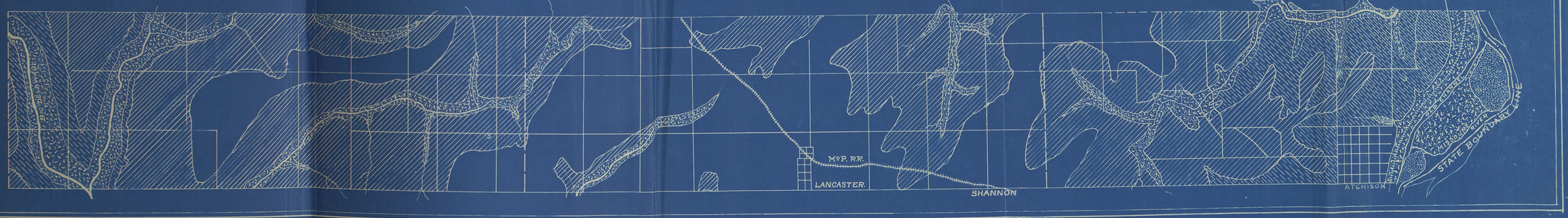
Hay Harvest

A few years ago only about half the farms were operated by the owners. The other half was farmed by tenants and as naturally expected the tenants did not keep up the land as well as did the owners. The tenant system is not nearly so popular of late years but the effects of long continued renting is easily seen on the qields of crops and the appearance of the fields at the present time. Probably the most common method of renting land at present is on shares, the renter giving from two-fifths to one-half of the harvested crop. By this system the owner can control to a certain extent the rotation of crops on the land.

One of the most difficult and most unsatisfactory problems that the farmer has to deal with is the labor question. The demand is not sufficiently large to induce laborers to seek employment in this part of the state and as a result the class to be dealt with are shiftless and inefficient. The use of improved farm machinery is doing much to solve this problem. The average wage paid is from twenty to twenty-five dollars per month where hands are employed throughout the year and from $1 to $1.50 per day for day laborers.

The value of the land varies considerably with its proximity to market and the fertility of the soil. But the prices run from $30 to $35 an acre for the rough land and as high as $125 for the best upland of the Marshall silt loam. The average price the country over is about $75 per acre. Farm land was never higher in price in the history of the county than at present and the tendency is toward still higher prices.

SOIL SURVEY OF ATCHISON COUNTY



Yazoo silt loam.

Miama silt loam.

Marshall fine sandy loam.

Marshall silt loam.

Sand.