U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION,
C. F. CURTISS, DIRECTOR; W. H. STEVENSON, IN CHARGE SOIL SURVEY;
P. E. BROWN, ASSOCIATE IN CHARGE.

SOIL SURVEY OF MARSHALL COUNTY, IOWA.

BY

A. H. MEYER, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND E. I. ANGELL, OF THE IOWA AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]

WASHINGTON:
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1921.

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U. S. DEPARTMENT OF AGRICULTURE,

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., December 8, 1920.

SIR: In the extension of the soil survey in the State of Iowa during the field season of 1918 a survey was undertaken in Marshall County. This work was done in cooperation with the Iowa Agricultural Experiment Station.

I have the honor to transmit herewith the manuscript report and map covering this work and to request their publication as advance sheets of Field Operations of the Bureau of Soils for 1918, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. E. T. MEREDITH,
Secretary of Agriculture.

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MAP.

Soil map, Marshall County sheet, Iowa.

SOIL SURVEY OF MARSHALL COUNTY, IOWA.

By A. H. MEYER, of the U. S. Department of Agriculture, In Charge, and E. I. ANGELL, of the Iowa Agricultural Experiment Station.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Marshall County is situated in the central part of the State of Iowa, its southwestern corner being about 30 miles from Des Moines, the State capital. The county, which is in outline a square, has an area of 572 square miles, or 366,080 acres.

Marshall County lies entirely within the glaciated region. Its area includes three distinct topographic divisions which coincide more or less closely with the areas occupied, respectively, by the Wisconsin, Iowan, and Kansan drifts.

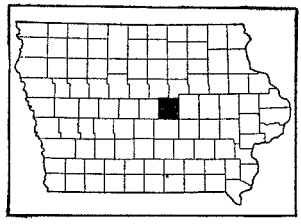

FIG. 1.—Sketch map showing location of the Marshall County area, Iowa.

The first division is represented by a wedge-shaped area on the western margin of the county, whose apex is approximately at the southwest corner, while its base extends a little more than 4 miles on the north line of the area. The characteristic features of the region are numerous depressions and sloughs, and kettle holes, kames, eskers, and drumloidal hills. As a whole the drainage is imperfect, and this, when taken in conjunction with the unique surface features, is indicative of topographic youth. The limits of this Wisconsin drift area are marked in many places by a well-defined terminal moraine. It is feebly developed in Marshall County, except west of State Center, where it is readily recognized. However, the boundary line between the Wisconsin drift and the rest of the county is well marked as a whole.

The second division occupies an area of scarcely more than 50 square miles in the northeast corner of the county, in which the topography, except where erosion has modified it in the vicinity of the large streams, is characterized by a monotonous plain surface, interrupted by an occasional gentle swell and poorly drained depressions. As a whole the region is moderately well drained.

The third topographic division constitutes more than four-fifths of the surface of the county. The features here are purely erosional. The upland is dissected by a network of small streams which gives the surface a billowy aspect. Short V-shaped valleys and convex hills are the rule in the broken areas and are indicative of an instability of the surface configuration. The larger streams meander through broad valleys, almost devoid of salient topographic forms. The divides are better defined than is usual in this type of topography, but the head branches of the opposing drainage systems often interlock. Nevertheless the original constructional surface exists throughout the region in elongated ridges or narrow isolated areas, and on the larger areas even shallow depressions occur. The tops of hills and upland flats appear to reach the same general level, and at one time the region was undoubtedly a smooth plain with only slight irregularities coincident with the development of that surface feature.

In general the hilly to broken areas in the county are represented on the map by the Clinton silt loam type of soil.

There are some alluvial terraces along the larger streams of the county, but as a rule they are small. The terraces lie from 5 feet to 20 feet above the present flood plain of the streams. They are flat, benchlike, and uneroded.

The greater part of the first-bottom land occurs along the Iowa River and its tributaries. The bottoms are in general level, but the surface is interrupted in places by low ridges with intervening depressions, sloughs, and old channels of the streams.

The upland has an average elevation of 1,000 feet above sea level; the highest point recorded, 1,116 feet, occurs on the divide between the Iowa and the North Skunk Rivers, where the Chicago & North Western Railroad crosses it, and the lowest point, about 850 feet, in the Iowa River Valley, where it leaves Marshall County. Thus the total range of elevation is about 266 feet. The general slope of the county is southeastward.

The Iowa River is the master stream of Marshall County and drains about four-fifths of its area. This drainage system is of asymmetric type, with the larger tributaries coming from the south and west. Rock, Burnett, and Asher Creeks are the principal tributaries from the north, while Timber, Linn, Minerva, and Honey Creeks are the more important branches from the south and west. The Iowa River has reached base level and is approaching old age. It furnishes water power at Marshalltown. About 3 square miles in the northeastern part of the county are drained by Wolf Creek, which is a branch of Cedar River. The southwestern part of the county is drained by North Skunk River.

There is a complete system of drainage ways in the county and adequate drainage is provided for practically all sections. Springs

are numerous in the southern part of the county, and on many farms furnish most of the water for stock during the summer. All the first bottoms are overflowed annually, but rarely are the overflows of a destructive nature, and the water seldom remains more than 18 hours on the surface of the flood plains. However, in the season of 1918 a destructive flood occurred, and practically no crops were harvested from the bottom lands.

The first permanent white settlements in Marshall County were in Timber Creek precinct in 1848. The county was organized in 1849 with Marietta as the county seat. Most of the early settlers came from Illinois, Indiana, Michigan, and the New England States. Later some foreigners, including Germans, Norwegians, Irish, and English, settled in the county. Only a small percentage of the present population is of foreign birth.

The total population of Marshall County, according to the 1920 census, is 32,630, of which 51.8 per cent is reported as rural. The rural population, which is uniformly distributed throughout the county, has a density of 29.5 persons per square mile. There has been a slight increase in the population since 1910.

Marshalltown, the county seat, with a reported population of 15,731, is located in the east-central part of the county, and is a distributing point for retail and wholesale products, as well as a manufacturing point. The Soldiers' Home for Civil War Veterans is located in Marshalltown.

The 1920 census gives the population of Albion, 392; Clemons, 207; Laurel, 195; Gilman, 490; Legrand, 320; Edenville (Rhodes, P. O.), 439; Ferguson, 207; Liscomb, 347; Melbourne, 481; St. Anthony, 203; and State Center, 975. Bromley, Haverhill, Green Mountain, Lamoille, Dillon, Vancleve, Dunbar, Marietta, and Minerva are other towns of local importance. Minerva Junction, Luray, Capron, Malta, Moningers, and Pickering are railroad shipping points. Bangor is a small inland town.

Marshall County is well supplied with railroads, few points being more than 7 miles from a railroad station. The Chicago North Western and the Chicago, Milwaukee & St. Paul Railroads cross the county from east to west, giving direct connection with Chicago and Omaha. The Chicago Great Western Railroad, from Kansas City to Minneapolis, crosses from northeast to southwest and gives access to the markets of Kansas City and the Twin Cities. The Minneapolis & St. Louis Railroad traverses the area from northwest to southeast and gives connection with St. Louis. The Story City branch of the same system extends northwestward from Minerva Junction and terminates at Story City in Story County. From State Center the State Center branch extends southeastward and joins the main line at Newburg in the adjoining county.

There are many excellent graded roads through the county, including the Lincoln Highway. Most of the roads follow section or land lines. At present all roads are of earth construction. The more important highways are dragged as soon as practicable after each rain, but little attention is given to the minor roads.

Chicago, Omaha, and Kansas City constitute the principal markets for the county, though most of the hogs are shipped to Mason City, Waterloo, and Cedar Rapids. In the local towns there is a good demand for dairy products, berries, and vegetables.

Rural mail delivery and telephone lines reach practically all parts of the county. Most of the public schools are well kept and are accessible to all communities. There are several consolidated schools in the area.

CLIMATE.

The climate of Marshall County is marked by rather wide seasonal variations. The winters are fairly long and cold and the summers hot. The spring usually is cool, with considerable precipitation, while the fall season is long, with moderate temperatures and only occasional periods of rainy weather. The mean annual temperature at Marshalltown is reported by the Weather Bureau station as 46.9° F. The lowest temperature recorded is —31° F., and the highest is 108° F.

The average date of the last killing frost in the spring, as recorded at Marshalltown, is April 20, and that of the first in the fall is October 13. The latest killing frost recorded in the spring occurred on May 20 and the earliest in the fall on September 13. There is an average growing season of about 176 days, which is sufficiently long to mature all ordinary crops.

The mean annual precipitation is 32.25 inches, being heaviest during the months of May, June, and July, and lightest during the months of November, December, January, and February. The greater part of the rainfall in the summer occurs in thunderstorms. In May and June the rainfall usually is well distributed and periods of drought are almost unknown. In July the distribution is less favorable and during August and September the total rainfall is lighter, short periods of drought occasionally occurring in these three months. Crop failures are unknown, but the yield of corn is sometimes reduced by drought and hot winds.

The average annual snowfall is about 27 inches, but as a rule snow remains on the ground only for short periods. Usually very little snow falls before the last of October. About 6.3 inches falls in December, 8 inches in January, 6.4 inches in February, and 4.7 inches in March with generally some snowfall in April.

The prevailing wind direction for the year is from the northwest, but in June, July, and August the winds are mainly from the south, southeast, or southwest. Tornadoes are very rare.

The following table gives the normal monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau station at Marshalltown, situated in the east-central part of the county. The records cover a period of 25 years. The elevation of this station is 947 feet.

Normal monthly, seasonal, and annual temperature and precipitation at Marshalltown.

(Elevation, 947 feet.)

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1881).	Snow, average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	23.1	62	−24	1.35	0.43	1.58	6.3
January	16.2	62	−31	1.14	1.92	0.56	8.0
February	19.1	65	−30	1.14	0.33	2.92	6.4
Winter	19.4	65	−31	3.63	2.68	5.06	20.7
March	32.4	90	−14	1.88	0.34	1.37	4.7
April	48.3	94	10	2.70	1.89	1.57	0.2
May	60.5	94	20	4.51	3.31	2.96	T.
Spring	47.1	94	−14	9.09	5.54	5.90	4.9
June	69.2	101	39	4.26	2.57	8.43	0
July	74.0	108	44	4.17	1.05	13.88	0
August	71.8	103	39	3.17	3.38	1.98	0
Summer	71.7	108	39	11.60	7.00	24.29	0
September	63.4	102	22	3.74	3.51	6.75	T.
October	50.6	93	9	2.72	0.37	8.33	0.1
November	34.6	76	− 8	1.47	0.70	2.58	1.3
Fall	49.5	102	− 8	7.93	4.58	17.66	1.4
Year	46.9	108	−31	32.25	19.80	52.91	27.0

AGRICULTURE.

The soils of Marshall County originally supported a luxuriant growth of prairie grasses, with marginal strips of timber along the larger streams. The first settlers located along the streams, where there was an abundance of fuel and game to supply their needs while the land was being put under cultivation. Owing to trouble with Indians very few crops were raised the first few years, and at times the settlers were forced to live in stockades for protection. Conditions soon became more stable and the early settlers began to

raise wheat, flax, and corn. Vegetables for home use and small quantities of buckwheat, rye, oats, and barley were grown. Flax and spring wheat were the main cash crops during the early stages of the agricultural development of the county. In 1873 corn was the leading crop, which rank it has continued to hold, and corn and spring wheat were the main cash crops. Hay ranked third in acreage and was an important crop. Barley, flax, buckwheat, and rye were secondary crops. From 1885 to 1890 the ravages of the chinch bug caused considerable loss in the spring-wheat crop, and it was discontinued, the Turkey, a winter variety, being introduced. The growing of winter wheat was expanded until about 1902, when it began to decrease in acreage and now it is a secondary crop. Oats have held an important place as a feed crop since the more extensive development of the agricultural resources of the county.

The present agriculture consists mainly of grain production, though dairying and the raising of hogs and other live stock are becoming more important. Corn, oats, timothy and clover mixed, timothy alone, wheat, coarse forage, and clover alone are the most important crops, ranking in the order named. The type of farming is remarkably uniform over the entire county.

Corn is the main crop, about 34.2 per cent of the total area of improved farm land being devoted to its production in 1919. The 1920 census reports that 109,578 acres produced 4,880,935 bushels, giving an average yield of 44.5 bushels per acre. The acreage devoted to corn has held rather steady since 1879, with a slight decrease since 1900. Reids Yellow Dent, Pride of the North, Whipple Yellow Dent, Iowa Silver Mine, White Cap Dent, and Boone County White are the principal varieties. Most of the corn planted is White Dent, as this type is considered the better yielder. A very small amount of Bloody Butcher is also produced.

On tenant farms most of the corn is sold, while on farms operated by the owners the greater part is fed to hogs and other live stock. All told about two-thirds of the corn crop is fed on the farms. It is a common practice to husk corn from the standing stalks, pasturing cattle and horses in the fields during the fall and winter. A few farmers cut some of the corn for winter roughage, and on farms with silos some corn, usually 10 to 15 acres, is cut for ensilage. There were approximately 140 silos in Marshall County in 1918, and the number is increasing.

According to the 1920 census there was a total of 66,610 acres in oats, with a production of 2,063,905 bushels in 1919, an average yield of 31 bushels per acre. The acreage in oats has varied very little since 1880. The crop is less profitable than corn. The early maturing varieties are the most popular, including the Albion (Iowa 103), the Richland (Iowa 105), the Kherson, and some Early Champion.

The Green Russian, the most widely grown variety, is midseason in maturing and in common with other oats maturing later than the early varieties named above, it is not as good a yielder. It is probably being replaced rapidly by Albion, is a later variety, and in common with all late maturing oats is not as good a yielder. Some Early Amber and Iowa Silvermine also are said to be grown. Early Amber probably is a local name for Kherson. Most of the crop is fed to horses and other live stock. The remainder finds its way mainly to outside markets.

The acreage in wheat is very small, though considerably larger than in 1914. The increased production is largely due to the urgent request of the Government for more breadstuffs and not to wheat becoming a crop more favored by the farmer, as wheat can not compete with corn in this section as a cash crop. In 1916 there were produced 12,603 bushels of winter wheat, principally Turkey, from a total of 905 acres, an average of 13.9 bushels per acre; and 8,872 bushels of spring wheat, Marquis and Java, from a total of 610 acres, an average of 14.5 bushels per acre. In 1919 there were 8,830 acres in wheat, according to the 1920 census. Wheat is grown mainly to supply the family with flour, but not nearly enough is produced to meet the demand. The total value of cereals is reported in the 1920 census as $8,515,285 and of other grains and seed as $120,714.

Timothy and clover mixed is the leading hay crop. The 1920 census reports 34,589 acres in tame hay in 1919, yielding 58,419 tons, and 193 acres in wild hay, yielding 276 tons, the average yield per acre for tame hay being 1.7 tons and for wild hay 1.4 tons. During the progress of the survey excellent stands of clover and timothy mixed were seen. The 1920 census reports 24,327 acres in timothy and clover mixed, 2,375 acres in timothy alone, 7,544 acres in clover alone, 4,022 acres in coarse forage, 193 acres in wild grasses, 80 acres in millet, and 282 acres in other tame grasses. Some red-clover seed and timothy seed are produced. Ordinarily clover yields 2 to 4 bushels of seed per acre and timothy 4 to 8 bushels. The State board of agriculture reports in 1916, 2,763 acres in timothy, yielding 16,642 bushels of seed, and 888 acres in clover, yielding 835 bushels. Practically all the hay is fed to work stock and cattle. A small amount is sold locally. Considerable alfalfa and prairie hay are imported from the West.

The growing of alfalfa is in the experimental stage. The 1920 census reports 61 acres in 1919, yielding 174 tons. Owing to the ease of producing clover and timothy mixed, alfalfa has been given very little attention. Most of the surface soils are acid, but practically all soils in the county are calcareous below the depth of 4 to 8 feet, and, as alfalfa is a deep-rooted crop, it should do well

after it is once thoroughly established. Sweet clover grows luxuriantly along deep road and railroad cuts, where the calcareous subsoil has been exposed. A few patches of alsike clover were encountered during the progress of the soil survey and the stands were good. The total value of hay and forage crops is reported in the census of 1920 as $1,627,932.

The less important crops of Marshall County are potatoes, barley, rye, buckwheat, rape, and flaxseed. Only 2 acres were reported in sweet potatoes. Potatoes are reported by the 1920 census in 1919 on 895 acres, with an average yield of 49.1 bushels per acre. The main varieties are Rural New Yorker and Early Ohio, with a few Early Rose. The production is inadequate to meet the local demand, as about 70 carloads were shipped into Marshall County in 1917.

The main special crops grown in the county are sweet corn, sorghum, soy beans, Sudan grass, popcorn, pumpkins, tomatoes, and cabbage. In 1918 about 1,750 acres of sweet corn were grown in the vicinity of Marshalltown and about 1,000 in the vicinity of Gilman, some of which is grown in the adjoining counties. The State board of agriculture reports 2,264 acres in sweet corn in 1916, yielding 6,333 tons, and 47 acres in popcorn, producing 45,235 pounds. The canning factories at Marshalltown and Gilman contract with the farmers for the sweet-corn crop, the agreement specifying the number of acres and the price, which depends upon the price of field corn. In 1918 the farmers received $14 a ton. Stowells Evergreen is the most popular variety, with some Country Gentleman and Early Evergreen. The by-product, such as wormy corn, cobs, and husks, is stored in a silo, and is used for cattle feed by the canning factory or sold to the farmer at a nominal price.

A large number of farmers grow a small patch of sorghum for sirup and also for feed. This crop does well and furnishes the farmer with a cheap sirup. Early Amber is the main variety grown. The 1920 census reports 81 acres in sorghum, yielding 310 tons, with a production of 4,036 gallons of sirup.

Soy beans do well and, though now grown to a very limited extent, promise to become a more important crop. They are planted in rows 3 feet apart and cultivated like corn. Ito San and Black eyebrow are the main varieties grown.

Some Sudan grass is produced in the area, and the crop apparently does very well. It was grown on about 100 acres in 1918. It produces about 450 pounds of seed per acre, which finds a very ready market at 20 cents a pound. After Sudan grass has obtained a good start it makes excellent pasturage.

Pumpkins are primarily grown for the canning factory at Marshalltown, but also for the local market and for feed. In 1918 there

were about 400 acres in pumpkins. This crop is grown between the rows of corn. The canning factory pays $5 per ton for pumpkins. The Kentucky Field is the variety most popular.

The production of tomatoes on a commercial scale is largely confined to the vicinity of Marshalltown. They do fairly well and are a profitable crop, the canning factory at Marshalltown taking most of the crop at $15 a ton. In 1918 there were about 180 acres devoted to their production, eight varieties being grown, four major ones, Stone Perfection, Livingston Perfection, Livingston Favorite, and John Bear, and four minor ones, Delaware Beauty, Success, Matchless, and Landrett.

Cabbage is grown for the local market as well as for the canning factory, Succession and All Season being the most popular varieties. In 1918 there were about 80 acres in this crop. The canning factory paid $9 a ton for the crop of that year.

On sandy soils of the county some watermelons and cantaloupes are grown on a commercial scale. They do well and are profitable crops. Producing truck crops for marketing fresh, however, receives but little attention, owing to distance from large markets. There is some trucking in the vicinity of Marshalltown, but the demand is rather limited. The 1920 census reports 1,786 acres of vegetables, other than potatoes, in the county in 1919 and the value of vegetables produced as $332,649.

Most of the farmers have small orchards of apple, plum, cherry, and pear trees. These fruits do well when properly cared for, but mainly for lack of care the trees in most orchards are gradually dying and less fruit is produced now than 10 years ago. There are no strictly commercial orchards in the county. About 100 carloads of apples, 31 carloads of pears, 5 of peaches, and 20 of all other fruits were shipped in 1918. The value of all orchard products, including small fruits and nuts, is given in the 1920 census as $84,403. The number of apple trees is given as 35,958 trees, with 245 peach trees, 23,128 grapevines, 5,023 plum trees, and 6,748 cherry trees.

The 1920 census reports 61 acres in strawberries, yielding 115,982 quarts; 18 acres in blackberries, yielding 13,789 quarts; and 29 acres in raspberries, yielding 12,049 quarts. All small fruits do well.

Large amounts of concentrated feed stuffs such as tankage, cottonseed meal, oil meal, bran, shorts, and hay are shipped into the county annually.

Dairying is receiving increased attention. Most of the farmers keep dairy cows, chiefly Shorthorn grades and a few Holstein. The number of cows per farm varies from 3 to 10 head, with upward of 30 or more on the dairy farms in the vicinity of Marshalltown. Most of the dairying is of the summer type, and in the winter not enough

milk and butter is produced for home use. Most of the cream is separated on the farm, the surplus being shipped to the local creameries at State Center, Clemons, and Marshalltown, and to outside points. Some butter is made on the farms and sold at local markets. The 1920 census reports the total value of all dairy products, excluding home use, as $529,985. There were 16,154 dairy cattle in the county January 1, 1920.

There are a number of herds of beef cattle, mostly on the farms with considerable permanent pasture. The cattle are mainly Shorthorns, though there are some herds of Aberdeen Angus and Hereford. A number of farmers feed one or two carloads of cattle obtained from stockyards with good results. In other cases a few head are fattened on the farm each year and sold when prices are most favorable. Most of the beef cattle are marketed in Chicago; some go to Omaha. The 1920 census reports 35,289 beef cattle in the county.

Considerable attention is being paid to the breeding of farm and draft horses and mules. Nearly every farmer raises one or two colts each year and some as many as four or more, the Percheron and Belgian being the favorite breeds. About one-tenth of the colts are mules and one of the best mule farms in the State is located at Melbourne. The 1920 census reports 16,154 horses and 981 mules in the county. Most of the horses are shipped to New York.

There are only a few large flocks of sheep in the county, but the high price of wool has a tendency to increase the number. In 1916, 1,095 sheep were shipped in from Kansas City and Omaha for feeding. In 1918 several hundred were shipped from Mexico. The 1920 census reports 12,992 sheep on the farms and the total amount of wool clipped as 80,664 pounds. Most of the sheep are shipped to Chicago. The Shropshire is the favorite breed.

The raising of hogs is the most important live-stock industry. Nearly every farmer fattens 30 to 40 hogs each year and some as many as 150. On tenant farms not nearly so many hogs are kept, which is also true of other live stock. Pork production is profitable at the prevailing prices. Hog cholera is well under control and the losses are small, but in 1918 more or less sickness was caused among hogs by influenza. Most of the hogs are marketed in Mason City, Waterloo, and Cedar Rapids. Nearly every farmer butchers enough hogs to supply the home with meat the year around. Duroc-Jersey, Poland-China, Chester White, Hampshire, and Berkshire are the leading breeds, and there are a large number of registered herds, more than in any other section of the State. According to the 1920 census there were 88,950 hogs on the farms valued at $2,003,040.

The 1920 census reports 301,832 chickens and 1,225,322 dozens of eggs, with a total value of all poultry and eggs of $723,828. Prac-

tically every farmer keeps a small flock of chickens, ranging from 40 to 150. Most of the eggs and poultry are handled by a local firm at Marshalltown, which ships them to Chicago, New York, and Boston. About 35 carloads of chickens and 70 carloads of eggs are shipped out of Marshalltown each year.

Considerable more attention is paid to the adaption of crops to the different soils than a few years ago. The farmers recognize that the Tama silt loam and Carrington loam are best suited to corn, oats, and grass, that the Clinton silt loam and the steep slopes of the Shelby loam are best suited to grass and for use as pasture, and that the bottom-land soils are well adapted to corn and less well to the small grains.

About 30 per cent of the land is plowed in the fall and the remainder in the spring. If conditions allow, oats and wheat stubble are plowed in the fall. If corn land is put in oats it is usually double disked. It is necessary to exercise considerable care in the preparation of the silt loam upland soil types. Considerable barnyard manure is used. According to the census of 1920, the total expenditure for fertilizers in this county in 1919 was $15,466, 26 farms reporting their use.

The farm buildings, especially the houses, usually are well painted and kept in good repair. There are many large modern houses in the county. The barns are for the most part small, but as a rule are substantial and well kept. There are only a few hedge fences in the county. Most of the cross fences are barbed wire, though woven wire is coming into more general use.

The work stock consists mainly of medium-weight draft horses and on most farms the four-horse hitch is used. There are about 60 kerosene and gasoline tractors in the county. The farm equipment consists of gang or sulky plows, disk harrows, straight-tooth harrows, rollers, drills, corn planters, mowing machines, cultivators, rakes, tedders, hay loaders, corn pickers, elevators, shredders, shellers, ensilage cutters, gas engines, potato planters, sprayers, diggers, binders, tractors, and wagons. Thrashing machines are favorably distributed for use by farmers in all sections immediately after harvest.

Definite systems of rotation are followed by only a few progressive farmers. The general tendency is to keep the land in corn two years or even longer, following with one year of oats and from two to three years of clover.

There is an adequate supply of farm labor during normal times. As a result of war conditions, labor has become very scarce and is demanding about 75 per cent increase[1] in wages over normal times. The wage paid ranges from $40 to $60 a month, with board and wash-

[1] This refers to conditions existing in 1918.

ing. Most of the laborers are hired from March to October or December, though a few farmers employ labor by the year, as it is easier in this way to get efficient men. Where they are hired only to October 1, the laborers are paid additional rates of 6 to 8 cents a bushel for husking corn. The daily wage for transient labor is from $3 to $4, with board. The farmers are beginning to hire married men with families, supplying them with tenant houses, milk cows, chickens, gardens, and fruit. Under this plan the wages range from $50 to $60 a month. Most of the farm work in the county, however, is performed by the farmers and their families. The expenditure for labor in 1919 on 1,595 farms reporting was $922,107.

Most of the farms in Marshall County contain 160 acres, though there are a considerable number as small as 80 acres and a few large holdings in the area. According to the 1920 census, 96.7 per cent of the area of the county is in farms, and of the land in farms 90.5 per cent is improved. The average size of the farms is 152.9 acres.

About 52.6 per cent of the farms are operated by the owners and practically all the rest by tenants. Both the cash and share systems of renting, as well as a combination of the two, are practiced, the cash system being most popular. Cash rents vary from $6 to $14 an acre for general farm land, depending largely on the character of the soil. Under the share system the owner receives one-half the product of the farm, the tenant furnishing all implements and stock. A cash rent is always asked for the hay and pasture land.

The value of farm land in Marshall County ranges from $50 to $350 an acre, depending on the soil, topography, improvements, and distance from railroad points. In the 1920 census the average assessed value of farm land is reported as $232.71 an acre.

SOILS.[2]

Upon the basis of physiographic position, the soils of Marshall County may be divided into three groups—upland, terrace, and first-bottom soils. The upland group embraces the Tama, Muscatine, Clinton, Knox, Carrington, Shelby, Lindley, and Clyde; the terrace group includes the Waukesha, Bremer and Buckner; and the first-bottom group the Wabash series.

The soils are derived from glacial drift and a silty deposit usually designated as loess. Excepting the western part of the county, soils from the silty material are encountered over the entire area. The

[2] Marshall County is bounded by Story County on the west and Tama County on the east. Both these areas were surveyed many years ago and at a time when soil surveying was in its infancy. Owing to the many improvements both in the scientific and technical work of the survey since these areas were mapped, the Marshall County map fails to join up along the county lines with these counties. To make them agree would require change in the Marshall map that would destroy its accuracy and value.

oxidized material of the subsoil has a brownish to yellow color, whereas the unoxidized material has a light-gray color streaked with iron stains and carries numerous lime concretions. As a rule, the oxidation extends to a depth of 5 feet or more. The silty material ranges from a thin film to 20 feet in depth, and, as a rule, rests upon a stratum of sand.

The original constructional surface is discernible over the entire area of silty material. Owing to the flat and slightly undulating topography, a translocation of the fine material from the soil to the subsoil has taken place throughout the entire area of silty soils. The subsoils are uniformly heavier than the soils.

The glacial drift in the western part of the county was deposited by the ice at the close of the Wisconsin epoch of the glacial period. The upper part of the drift is oxidized to a faint dull yellow color and the carbonates have been removed from it to a depth of several feet. It is succeeded downward by a blue bowlder clay less massive than that of the Kansan. It is rather friable and open. Below four feet it effervesces profusely with hydrochloric acid. Granite, gneiss, and quartzite bowlders, mainly granite, are much more common than in the older drift. They are, however, of a smaller size than in the Iowan drift. Fresh basic rocks are scarce. The material of this formation has given rise to a loam soil.

The Iowan drift occupies the northeastern corner of the county. It is very thin, seldom more than 10 feet in thickness. In many places the only evidence of its presence consists of bowlders. The Iowan till is light to bright yellow in color and is imperfectly oxidized and leached. It is sandier than the Kansan drift, lacking the tough, plastic character of the latter. The bowlders are usually larger, consist mainly of granite, and show less weathering than those of the older drifts. Where the silty covering has been removed the Iowan drift forms a loam soil.

The retreat of the Kansan ice sheet was closely followed by a period of vigorous erosion, the working over of the newly deposited drift, and the accumulation of beds of gravel, known as the Buchanan gravel.

Below the Wisconson drift, Iowan drift, and the silty material lies the Kansan drift. The material is composed essentially of bowlder clays, containing pockets of sand and gravel and occasional bowlders of moderate size. The color to considerable depth is almost wholly due to the state of oxidation and the formation may be arbitrarily divided into an upper oxidized portion and a lower unoxidized portion. The oxidized zone varies in color from a bright yellow to a deep reddish brown, while the unoxidized part assumes some shade of blue. Lime concretions are found below 5

feet. The pebbles and bowlders consist mainly of granite, greenstone, and gneiss. The Kansan drift varies from a few feet to 100 feet in thickness.

Below the Kansan drift lies the Aftonian material, which consists largely of stratified sand and gravel with small bowlders laid down in large part through the agency of moving water. Many of the pebbles and small bowlders have polished, striated, or faceted surfaces, yet the granite members are oftentimes in an advanced stage of decay. The maximum thickness of this material is about 30 feet. This does not occur as a continuous stratum but as sand or gravel trains.

The materials so far described lie on a very uneven surface of bedrock belonging to the Pennsylvania and Mississippian divisions of the Carboniferous system. In a few cases these beds are exposed in the lower parts of the river bluffs. Most of such exposures are in the eastern part of the county.

The terraces of Marshall County are inextensive. The material forming them, which consists of silt mixed with some coarser particles, was deposited at a time when the streams were flowing at a higher lever. The material has been derived largely from the loess and till deposits.

Important areas of alluvial soils occur in the first bottom of the Iowa River and its larger branches, with small areas widely distributed along the smaller streams throughout the county. These soils are of recent origin and are constantly receiving additional sediments from the overflow waters of the streams. The material comes from loessial and glacial deposits.

The Tama series includes types with dark-brown surface soils and a lighter, yellowish-brown subsoil. The series comprises the dark-colored noncalcareous upland silty soils, which predominate in the prairie regions of the central west. The soils are characterized and distinguished from those of the Clinton series by their larger content of organic matter in the surface zone and by their friable, more open subsoils. The topography is rolling to steeply rolling. The series is represented in Marshall County by a single type—the silt loam.

The types included in the Muscatine series have dark-brown soils with an average depth of about 15 inches, and a heavier black subsurface layer showing a slight concentration of clay, extending to 20 or 24 inches. This passes gradually into a gray silty clay subsoil, mottled with yellow and brownish yellow. The lower part of the subsoil is lighter in texture than the upper part. This series is confined to the flat and slightly undulating upland divides and is derived by thorough weathering under an excess of moisture from the deep silty beds. The silt loam is the only representative of the series in the county.

The Clinton series includes types with prevailingly light-brown to grayish-brown soils and a brownish-yellow subsoil. The subsoil is heavy and compact and possesses a granular structure. These soils occur mainly in the central prairie States. They are derived from silty material and have been weathered and leached of carbonates to great depths. The topography is steeply rolling to broken and the surface drainage is excellent. The silt loam is the only member of the Clinton series encountered in Marshall County.

The Knox soils are prevailingly light brown and the subsoil is light yellow or light grayish yellow. The loamy fine sand is the only member of the Knox series encountered in Marshall County.

The Carrington soils are derived through weathering of glacial till, with little or no modification from silty material. The series is developed in the central and western prairie region and consists entirely of grass-land soils developed under well-drained conditions but a humid climate. The soil is dark brown, and the subsoil is lighter colored, generally light brown or yellowish. The topography is gently undulating to rolling, though some areas are nearly flat. In Marshall County the Carrington loam and fine sandy loam have been identified.

The types of the Shelby series are characterized by dark-brown soils, and a yellow, reddish-yellow, or light-brown, tenacious, sandy clay subsoil. These soils are derived from glacial drift. Only the Shelby loam is mapped in Marshall County.

The Lindley series includes types with light-colored surface soils and yellow or pale-yellow subsoils. They are derived from glacial deposits. The series is represented in Marshall County by a single type—the loam.

The soils of the Clyde series are black with mottled gray and yellow or yellowish-brown subsoils. They are derived from glacial debris and occupy flat to depressed positions. The drainage is poor. The subsoils are not highly calcareous. One type, the silty clay loam, is mapped.

The surface soils of the Waukesha series are dark brown to black and the subsoil is yellow or brownish yellow and as heavy as or slightly heavier than the surface soils. They are derived from water-laid material on terraces or from outwash plains. The topography is mainly flat to undulating and the drainage is good. The silt loam is the only member mapped in Marshall County.

The surface soils of the Bremer series are dark brown to black. The subsoil is bluish gray mottled with brownish yellow, heavy textured, and with a very compact granular structure. They are similar to the Wabash series but lie above overflow. The material is alluvial in origin. One type, the silty clay loam, was mapped in Marshall County.

The soils of the Buckner series range in color from brown to dark brown. The soils of this series differ from the Waukesha soils in having loose, silty, or sandy subsoils, distinctly lighter in texture than the surface soils. They occur on terraces. The topography is flat to undulating and the drainage thorough. The Buckner loam is the only member of this series recognized in Marshall County.

The surface soils of the types in the Wabash series are prevailingly black, ranging to dark brown, and contain a high percentage of organic matter. The subsoil is dark brown or dark brownish gray. These soils lie in the first bottoms of streams in the central prairie States and extend for long distances along the Mississippi River. The material is derived principally from the silty upland material and associated soils of the region. The Wabash areas are flat and poorly drained. Three types, the loam, silt loam, and silty clay loam, were mapped.

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

Areas of different soils.

Soil.	Acres.	Per. cent.	Soil.	Acres.	Per cent.
Tama silt loam	217,600	59.4	Wabash silty clay loam	4,096	1.1
Carrington loam	37,440	10.2	Lindley loam	3,584	1.0
Shelby loam	25,792	7.0	Carrington fine sandy loam	3,136	0.9
Wabash silt loam	25,536	7.0	Clyde silty clay loam	2,624	0.7
Muscatine silt loam	17,792	4.9	Knox loamy fine sand	1,664	0.5
Clinton silt loam	10,816	2.9	Bremer silty clay loam	704	0.2
Wabash loam	5,248	1.4	Muck	64	0.1
Waukesha silt loam	5,184	1.4			
Buckner loam	4,800	1.3	Total	366,080	

TAMA SILT LOAM.

The Tama silt loam consists of a dark-brown, moderately heavy silt loam, 10 to 12 inches deep, having a decidedly smooth feel, grading through a layer of brown heavy silt loam about 4 inches thick into a brownish-yellow silty clay loam, the color becoming lighter with depth. The subsoil has an open friable structure and this condition becomes more pronounced with depth. As a rule, the color of the subsoil is uniform, though occasionally the lower part is mottled with light gray and streaked with rusty iron stains. The soil as well as the subsoil is acid according to the litmus test, although lime concretions are usually encountered at a depth of 6 feet. As the color indicates, the soil is high in organic matter.

The depth of the soil is variable and depends upon the topographic position. In the flatter areas and on the gently arched divides it is

15 to 18 inches deep, while on the shoulders of hills and along gullies the depth is only 6 to 8 inches and often the brownish-yellow subsoil is exposed. On the lower parts of slopes the soil is darker in color and deeper owing to the deposition of colluvial material, and at the foot it is commonly 24 inches or more in depth. Included with this type are small narrow strips of colluvial material occurring along intermittent streams. Where the Tama silt loam gives way to the Clinton silt loam the surface soil is lighter in color and the subsoil has more of the characteristics of the Clinton silt loam.

The Tama silt loam is the most extensive soil type in the county and occurs as the base type, except in the extreme western part of the county, where it gives way to the Carrington loam. This type is throughout its extent more or less interspersed by the Shelby loam, except in the northeastern corner, where it is interspersed by the Carrington loam.

In general the topography is rolling to steeply rolling, except in the northeastern part of the area, where it has a gently rolling topography. The drainage is good and the physical condition of the soil is such that it withstands protracted droughts. Where the slopes are steep there is considerable wash, though less than would be expected on such slopes, on account of the favorable texture and structure of the soil. The type lies at an elevation of 900 to 1,100 feet above sea level.

The Tama silt loam originally supported a thick growth of prairie grasses common to this region, but none of the native vegetation remains. Approximately 95 per cent of the type is under cultivation. It is considered by farmers as one of the best upland corn soils of Iowa. About one-half of the farm land is devoted to the production of corn and the remainder is largely oats and clover and timothy with some wheat. In average seasons corn yields 45 to 60 bushels per acre and occasionally as much as 75 bushels. About one-half of the corn crop is sold. Oats, ranking second in acreage, ordinarily yield 35 to 50 bushels per acre. Wheat is largely a war crop and the acreage will no doubt be considerably decreased after next season (1919). The yields are low usually ranging from 12 to 15 bushels per acre. Clover and timothy are the principal hay crops, though some millet and sorghum are grown. Clover does well and in favorable seasons yields from 1½ to 2½ tons per acre. The acreage of alfalfa is very small and its production is still in the experimental stage. Small patches of barley and rye are produced. The oats and hay produced are chiefly fed to the work stock.

This soil is friable, silty, free from stones, and very easy to handle. It can be cultivated under a wide range of moisture conditions without clodding or baking badly on drying. Liberal amounts of barnyard manure are applied but no commercial fertilizer is used.

The value of the Tama silt loam ranges from $150 to $300 an acre, depending on topography, location, and improvements, and the condition of the land.

The Tama silt loam is very productive soil, and it is only where the same fields have been devoted to the same crops for long periods of years that the soil has materially declined in productiveness. Deeper plowing is needed on most farms, and though the type is naturally high in organic matter it is advisable to rotate the cereal crops with leguminous crops every four or five years in order to maintain the supply. On steep slopes where erosion is a serious factor the type should be kept in cover crops as much as possible.

MUSCATINE SILT LOAM.

The Muscatine silt loam occurs as two distinct phases in Marshall County. The more extensive, which approaches in character the Grundy series, occurs in that part of the county north of the Iowa River. It is a black heavy silt loam, passing gradually at 12 inches into a black silty clay loam, which in turn grades at 20 inches into a light-gray silty clay mottled with yellow and yellowish brown. Below 40 inches the subsoil becomes lighter in texture and light gray in color. Lime concretions are occasionally encountered in the lower subsoil. The change from one soil horizon to another is gradual, though each stratum has distinct characteristics. The upper as well as the lower subsoil is granular in structure and very compact. When dry it is hard and when wet it is inclined to be plastic.

The other development, apparently the typical Muscatine silt loam, occurs south and west of the Iowa River. It is a black smooth silt loam, 15 inches deep, with a subsurface soil from 15 to 24 inches deep, consisting of a black heavy silt loam. Below this there lies a gray silty clay, finely mottled with yellow and brownish yellow. In this soil there is only slight concentration of clay in the zones below the soil. The texture and structure are similar to those of the Tama silt loam.

The type occupies only about 14 square miles, the individual areas being distributed throughout the silty soils of the county. They occupy high slightly undulating to flat divides, and undoubtedly represent the original constructional surface of the silty plain in the county. The type is well drained in normal seasons; in wet seasons the run-off is too slow for good drainage.

The agriculture on the Muscatine silt loam is the same as that on the surrounding Tama silt loam, but, owing to its smooth surface, it is more desirable for farming purposes. The land is valued at $250 to $300 an acre.

CLINTON SILT LOAM.

The Clinton silt loam is a light-brown to brown, friable, smooth, silt loam, from 6 to 8 inches deep, underlain by a brownish-yellow silty clay. The subsoil has a cubical or granular structure and is very compact, being hard when dry and plastic when wet. The soil horizons are distinct but pass gradually from one to another. Light-gray mottlings and yellowish-brown or reddish iron stains may occur in the lower section of the subsoil. In timbered areas the soil has a darker color, due largely to leaf mold, which would soon disappear with cultivation. The typical soil contains very little black organic matter.

The Clinton silt loam is rather inextensive in this county, having a total area of a little less than 17 square miles. It is developed in the southwestern part of the county, 2 miles south of Marshalltown, and in small isolated areas along the bluffs of the Iowa River.

This soil has an extremely dissected topography and is thoroughly drained. The valleys are V-shaped, have very steep slopes, and are from 100 to 200 feet deep. As a result the type is subject to severe erosion.

Practically all this type originally was forested, the chief growth being bur oak, white oak, red oak, hickory, butternut, red elm, dogwood, sumac, prickly ash, and hazel brush. At least 20 per cent and probably more is still in forest, though it is slowly being cleared.

Owing to the steep slopes the growing of small grains is impracticable, although some oats are grown where the topography is most favorable. This is the most important grain crop. It is used largely for feeding purposes. At present corn is the principal cereal. This is also mainly fed to live stock. On the lower slopes and where there is sufficient organic matter corn does well, yielding from 20 to 40 bushels per acre, but on the high crests and steep slopes the growing corn has a yellowish appearance and unless heavily manured makes a stunted growth. Clover and timothy do fairly well.

Owing to its dissected surface the type is hard to manage, notwithstanding the favorable texture of the soil. As more live stock is kept on this soil than on the smoother soils, a larger supply of barnyard manure is available. This is applied to the fields, but commercial fertilizers are not used.

This type is valued at $90 to $125 an acre, depending largely on the proportion of land suitable for cultivation.

For the improvement of the Clinton silt loam it is necessary to handle it with considerable care in order to prevent erosion and gullying. With this end in view the fields should be kept in pasture grasses as much of the time as possible, the cultivated areas should be plowed deeper, and more organic matter should be incor-

porated with the soil. When the timber is stunted the areas should be cleared and used for pasture, but where the trees are making good growth the land can well be given over to systematic production of forest products. Grass crops do well and dairying and stock raising should prove profitable on this type. Where transportation and market conditions are favorable, the commercial production of apples should meet with success.

KNOX LOAMY FINE SAND.[3]

The surface soil of the Knox loamy fine sand is a brown loamy fine sand 6 to 8 inches deep. The soil passes gradually into a loose, open, and incoherent brownish-yellow fine sand, which at 20 inches changes in color to yellow or grayish yellow.

The principal areas lie north of Quarry, north of Marshalltown, and southeast of Albion. It occurs in small isolated areas along the edge of the upland adjoining the first bottoms of the Iowa River. The Knox areas lie at a lower elevation than the areas of the Clinton silt loam.

Wind action has given this type a hummocky surface. The soil is extremely leachy and the drainage is thorough to excessive. This type is apparently derived from the beds of sand underlying the silty material.

Originally this soil was covered with a scrubby growth of bur oak, but about 60 per cent is now under cultivation, and is devoted to truck and cereal crops. Watermelons and cantaloupes do well and are grown with profit. Potatoes are well adapted to this type, and are of a higher quality than those grown on the heavier soil types. The yield of corn is rather low, ranging from 15 to 20 bushels per acre. Oats do fairly well, yielding from 15 to 25 bushels per acre.

The Knox loamy fine sand works up into a very mellow seed bed, and can be tilled under almost any moisture condition. Small quantities of manure are added to the tilled areas but no commercial fertilizers are used. Land values range from $50 to $100 an acre.

For the improvement of the Knox loamy fine sand, it is recommended that green crops, particularly legumes, be turned under to increase the organic matter content. The growing of truck crops could be extended with profit.

CARRINGTON FINE SANDY LOAM.

The Carrington fine sandy loam consists of a dark-brown fine sandy loam 10 to 15 inches deep, possessing a loose, friable structure,

[3] The Knox loamy fine sand as mapped in this area is not typical, but this material has been mapped under this name in the early Iowa reports, and as no series has been established to take care of it the name is retained in this report.

resting on a subsoil of brownish-yellow to yellow fine sandy loam of a very open and porous structure. A few bowlders are scattered on the surface of this soil.

This type is found principally on the slopes between the stream terraces or first bottoms and the higher lying silty upland. It is most typically developed on the south side of Minerva Creek, between Clemons and Marietta, and occurs in smaller areas along Honey Creek and the upper course of the Iowa River in Marshall County.

The type occurs on slopes or is characterized by a gently rolling to rolling surface, but it is not gullied or eroded, and has a topography favorable to farming. Owing to the open sandy subsoil, crops suffer from lack of moisture during ordinary periods of drought.

About 85 per cent of this type is utilized for crop production. Corn, the principal crop, does well in seasons of favorably distributed rainfall. The average yield is 30 or 35 bushels per acre. Oats, ranking second in acreage, yield from 30 to 35 bushels per acre.

Owing to its sandy texture, this soil is very easily handled and does not require heavy farm equipment. Liberal quantities of manure are applied, but no commercial fertilizers are used. Land values on this type range from $90 to $150 an acre.

For the improvement of the Carrington fine sandy loam, it is recommended that leguminous green manure crops be turned under. The increasing of the organic matter content is of greatest importance.

CARRINGTON LOAM.

The soil of the Carrington loam consists of a dark-brown, heavy loam 8 to 12 inches deep, containing a relatively high percentage of silt and fine sand. In the flatter areas the soil is deeper than elsewhere and the color approaches black. The subsoil is a brownish-yellow heavy loam to clay loam somewhat gritty, moderately friable, and showing no zone of clay concentration. The change from soil to subsoil is gradual, not only in color and texture but also in structure. There is a scattering of bowlders on the surface, but they are nowhere abundant enough to interfere with cultivation. The soil is high in organic matter.

The Carrington loam is the second most extensive type in the county, covering about 58 square miles, or 10 per cent of the total area. It forms practically half the area of Liberty and Minerva Townships and the western tiers of sections in State Center Township and the northern half of Eden Township in the western part of the county and is a minor type along stream courses in the northeastern part of the county. It differs from the Shelby loam in that it occupies less steep slopes and has a deeper soil, while the subsoil is not as heavy and contains less grit and pebbles.

In the large body in the western part of the county the surface is gently rolling to rolling. In the areas in the northeastern part of the county the topography is moderately sloping. The soil here is more or less modified by material from the silty uplands. The type is well drained, but with proper tillage and crop rotation it is very retentive of moisture. Only on the steeper slopes has there been any serious erosion.

The type originally was prairie, but about 95 per cent of it is now in cultivation, the rest being in permanent pasture and farmsteads. Corn is the most important cash crop, though a large part of the corn produced is fed to hogs. About one-third of the type is in this crop. The average yield is about 45 bushels per acre, though much higher yields are obtained with careful cultivation. Oats rank second to corn in acreage. The yield is ordinarily from 35 to 40 bushels per acre. The crop is largely fed to work stock. Wheat, barley, and rye are unimportant crops. Clover and timothy do well, and in favorable years yields of 1½ tons to 2½ tons of hay per acre are obtained. Some timothy and clover are grown alone for seed with profitable returns. The growing of alfalfa is in an experimental stage. A few potatoes are grown, but scarcely enough to supply the home demand. Some sorghum is produced for sirup.

As on the Tama silt loam the four-horse hitch is used almost entirely in the preparation of the seed bed on this type; gang plows generally are used for turning the soil. Owing to its favorable texture, this type is very easy to handle under proper moisture conditions, but when plowed too wet it bakes and clods. Only small quantities of barnyard manure are applied and no commercial fertilizers are used.

The price of farm land on the Carrington loam ranges from $200 to $250 an acre.

On most farms on this soil deeper and more thorough tillage would prove beneficial and leguminous crops should be grown to maintain the supply of organic matter.

SHELBY LOAM.

The surface soil of the Shelby loam is a medium-brown to dark-brown silty loam, containing a relatively high percentage of fine sand, sand, and grit. At an average depth of 8 inches the soil passes into a yellow gritty, silty clay loam or clay loam. Where the Kansan drift proper comes within the 3-foot section, the subsoil is a stiff, tenacious, reddish-brown clay, but as a rule the admixture of silty material with the upper zone of the drift has created a moderately friable subsoil. The subsoil contains considerable gravel and rock

debris and some gravel usually is scattered over the surface. A few bowlders are present, though in most fields these are not sufficiently numerous to interfere with cultivation. The soil is relatively high in organic matter.

The Shelby loam occurs as small elongated areas scattered throughout the Tama silt loam. As a matter of fact the types are so closely associated that the boundaries are not sharp, though distinct enough to be readily recognized. The type is principally found in the southern half of the county, occurring around the heads of streams and along drainage courses. The type lies at a lower level than the Tama silt loam. The drainage is thorough and the soil is droughty where gravel trains lie near the surface, but where the subsoil is typical it withstands drought well. The type is subject to destructive erosion, gullies 10 to 15 feet deep, with numerous branching laterals, being very common.

The Shelby loam may be developed from either of the glacial drift sheets formed in the county, but has been more or less influenced by wash from the silty upland soils. The large bowlders and pebbles on the surface and the gritty or sandy clay subsoil distinguish it from the Tama silt loam.

The native vegetation on the Shelby loam consists of the prairie grasses common to this region, only a small part having been originally forested. About 45 per cent of the Shelby loam is under cultivation and the remainder is largely in permanent pasture, with some hay land. The same crops are grown as on the Tama silt loam but the yields are lower, corn yielding 25 to 35 bushels, oats 25 to 30 bushels, and clover and timothy 1 to 1½ tons per acre.

Owing to the steeper surface and the larger quantities of stony material present, this soil is much less desirable than the Tama silt loam, with which it is closely associated. When cultivated too wet the Shelby loam clods and bakes and large checks and cracks form. A heavy farm equipment is required in cultivating it except in the sandy spots. Liberal amounts of manure are applied but no commercial fertilizers are used. Land values range from $100 to $150 an acre.

For the improvement of the Shelby loam means should be employed to prevent gullying on the steep slopes, and such areas should remain in permanent pasture or cover crops as much of the time as practicable. The content of organic matter should be maintained by growing and turning under leguminous crops.

LINDLEY LOAM.

The Lindley loam consists of a light-brown to a grayish-yellow loam containing a high percentage of coarse sand and some fine

gravel, passing at an average depth of 6 inches into a subsoil of yellow loam to clay loam of a friable structure also containing gravel. The soil is low in organic matter.

This type is of very small extent, covering in all only about 4 square miles. It is developed chiefly in the southwestern part of the county in association with the Clinton silt loam. It is derived from the Kansan drift and the Wisconsin drift, and occupies a topographic position similar to that of the Shelby loam, lying on steep slopes along the heads and courses of drainage ways. It is thoroughly drained, except where it receives seepage water from the higher lying land.

The type was originally forested with oak, elm, sumac, and hazel brush, and much of its area is still in woodlots or permanent pasture. Where the topography is favorable for cultivation, oats, corn, and clover do well.

CLYDE SILTY CLAY LOAM.

The Clyde silty clay loam consists of a black silty clay loam 15 to 18 inches deep, underlain by a light-gray silty clay loam mottled conspicuously with brownish yellow and rusty brown. The surface soil is plastic and sticky when wet and hard when dry, while the subsoil, which is somewhat lighter in texture, is less plastic, the change from soil to subsoil being gradual in every respect. Where the Clyde occurs in connection with the Carrington fine sandy loam, sand wash from the higher surrounding till is common and the surface material may have a light loam to sandy loam texture. The subsoil contains some iron concretions and lime concretions, but according to the litmus test the soil is neutral in reaction. A high percentage of organic matter gives the soil its characteristic dark color.

This type occurs as small depressed areas in association with the Carrington and Tama series in the extreme northeastern part of the county. The total extent of this type is a little more than 4 square miles. The Clyde silty clay loam is derived from glacial material occupying the lowland along streams and small depressions in the upland and is very poorly drained.

Most of this type is used for pasture and hay land, but some reclaimed by artificial drainage is excellent farm land. The soil is well adapted to corn and most of the reclaimed land is devoted to this crop. It gives an average yield of 50 bushels per acre. Oats are not a success, as they lodge before ripening. This type is well adapted to wild grasses and, when drained, to timothy and red top. Hay yields ordinarily range from one-half to 2½ tons per acre.

The Clyde silty clay loam can not be worked under as wide a range of moisture conditions as the associated soils and is in general more difficult to handle. If cultivated when too wet it tends to puddle, and

large clods difficult to pulverize are sometimes formed. When dry, checks and cracks an inch wide are commonly found, but by proper cultivation these can be prevented in fields occupied by intertilled crops. This type is not fertilized, as the land is naturally very productive. Land values range from $150 to $200 an acre.

WAUKESHA SILT LOAM.

The surface soil of Waukesha silt loam consists of a dark-brown, smooth, friable silt loam, high in organic matter and about 18 inches deep. This passes downward through a brown heavy silt loam into a brownish-yellow silt loam, which is slightly heavier and more compact than the surface soil. The subsoil becomes lighter in color with depth, being yellowish in the lower part and has an open, friable structure. The section of this type is very similar to that of the Tama silt loam.

The Waukesha silt loam is the most extensive terrace soil in the county, covering about 8 square miles. It occurs as small isolated areas along the Iowa River and the smaller streams of the county.

This type occupies distinctly benchlike areas, the surface of which has been modified to some extent by erosion. The areas lie 10 to 20 feet above the present flood plain. While well drained, the type withstands drought over long periods.

Originally this soil was covered with a luxuriant growth of prairie grasses, but nearly all the type is now under cultivation, being planted to the staple crops. Corn yields 50 to 55 bushels, oats 40 to 50 bushels, and clover and timothy 1½ to 2½ tons per acre.

The methods of cultivation and fertilization are similar to those on the Tama silt loam. The productive capacity of the soil has been somewhat impaired by the failure to grow clover. Land of this type varies in value from $250 to $300 an acre.

For the improvement of this soil there is a general need for more thorough cultivation and the growing of leguminous crops. Under long continued cultivation the content of organic matter has been depleted, and every means should be employed to restore the soil with this valuable constituent.

BREMER SILTY CLAY LOAM.

The Bremer silty clay loam consists of a black silty clay loam, 18 to 20 inches deep, passing gradually into a dark slate colored plastic silty clay mottled faintly with yellowish brown. At 26 inches the color changes to a yellowish gray or bluish gray mottled faintly with yellowish brown. In many places there is below 8 inches a subsurface layer of black silty clay. The soil is very high in organic matter, has a characteristic crumbly cubical structure, and checks

and cracks considerably during periods of dry weather. The subsoil is very hard when dry and plastic and impervious when wet. The Bremer silty clay loam is similar to the Wabash silty clay loam, except that it lies above overflow.

This type is inextensive, covering only a little more than 1 square mile. It is developed in the second bottoms of the Iowa River and Minerva Creek and lies from 10 to 15 feet above the high-water mark of overflows. The surface is flat to depressed and the drainage is poor. Surface ditches are necessary to remove the surplus water where the land is to be cultivated.

This type is largely used for growing corn, to which crop it is well adapted. Corn yields on the average 50 bushels per acre. Wheat also does well, the yields ordinarily ranging from 20 to 30 bushels per acre.

The Bremer and the Wabash silty clay loams are the most difficult soils in the county to handle and require heavy farm equipment for best results. When cultivated too wet the soil clods, though under favorable moisture conditions it works up into a mellow seed bed. No fertilizers are used. The value of this land ranges from $200 to $250 an acre.

BUCKNER LOAM.

The Buckner loam consists of a dark-brown loam 15 to 18 inches deep, underlain by a subsoil of yellowish-brown light-textured loam to sandy loam. There is a textural range in surface soil from silty loam to light-textured loam, and the type as mapped includes small areas of sandy loam. The subsoil contains a small percentage of coarse sand and very fine gravel and has an open porous structure. This type is usually underlain by fine gravel and sand beds at depths ranging from 4 to 6 feet. The soil is acid according to the litmus test. The content of organic matter is fairly high.

The Buckner loam covers about 7½ square miles, confined largely to the valleys of Minerva Creek and the Iowa River. The type occurs on terraces lying from 10 to 20 feet above the present flood plain. The best developed areas lie along Minerva Creek, where the material represents outwash from the Wisconsin drift.

In general the surface is flat, but in detail it is slightly relieved by low ridges, knobs, shallow depressions, and the channels of a few streams. Owing to the sandy subsoil the drainage is thorough. During long droughts crops on this soil suffer considerably from lack of moisture, especially where the beds of sand lie close to the surface.

Originally this type supported a growth of prairie grasses; now it is practically all under cultivation. Corn is the leading crop and is well suited to this soil, yielding in normal seasons 35 to 45 bushels

per acre. Oats rank second in acreage and are also a successful crop, yielding from 30 to 40 bushels per acre. Clover and timothy do well, returning 1½ to 2 tons of hay per acre. This type is well adapted to potatoes, and most farmers grow enough for home use.

Owing to its stone-free nature, smooth surface, and friable structure, land of this type is very easily handled. Some clodding takes place if plowing is done when the soil is too wet. Liberal applications of barnyard manure are made to the fields of this type.

Land values range from $125 to $250 an acre, depending on location and improvements.

WABASH LOAM.

The Wabash loam consists of a dark grayish brown to almost black loam to silty loam 10 to 12 inches deep, relatively high in fine sand, passing into a black loam subsoil which extends to a depth of 3 feet, becoming somewhat heavier with depth. The difference in color between soil and subsoil is largely due to difference in moisture content. Both soil and subsoil are friable and open. Overwash of gray sand and also streaks of gray sand through the soil section are common and in places the type approaches in character the loam of the Cass series.

There is a little more than 8 square miles of the Wabash loam in Marshall County. It is entirely confined to the first bottoms along the streams flowing through or heading in the Wisconsin drift. The topography is flat and the drainage is generally adequate, but the land is overflowed annually. Along the larger streams it is forested.

Most of the Wabash loam is in pasture and on some of the land the native grasses are cut for hay, yields ranging from 1 ton to 2½ tons per acre. About 10 per cent of the type is devoted to the production of corn, which yields 40 to 50 bushels per acre.

Land of this type is held for $100 to $150 an acre, the price depending on the character of the land.

WABASH SILT LOAM.

The soil of the Wabash silt loam, to an average depth of about 20 inches, consists of a heavy, smooth, nearly black silt loam. This is underlain by a slightly heavier and more compact silt loam, usually somewhat lighter in color than the soil, though it is not uncommon to find little difference in the material either in color or texture to a depth of 3 feet. In places the lower subsoil is a dark-colored compact silty clay loam. The surface soil is high in organic matter. Throughout the type in places variable amounts of sand have been mixed with the soil and in local spots the type has received an overwash of sand during the heavy flood of 1918.

This is the most important bottom land soil in the county, having a total area of approximately 40 square miles. It occupies the first bottoms along the Iowa River, Minerva, Asher, Linn, and Timber Creeks, and along the smaller streams of the county.

The surface is generally flat, with only slight topographic relief where old cut-offs occur. Originally the drainage was poor, but by clearing and straightening the channels of streams, the conditions have been very much improved. All the land of this type is subject to overflow.

Along the stream channels the type originally was forested with white elm, white ash, willow, cottonwood, box elder, and walnut, a large part of which remains. Other parts of the type support a luxuriant growth of marsh grasses. About 75 per cent of this soil is devoted to the production of staple crops and the acreage in cultivation is being extended. Corn is the principal crop, the acreage being five times that in small grain. Higher yields of corn are obtained on this land than on any other soil in the county, the yields ordinarily ranging from 50 to 60 bushels per acre, and with good cultivation in favorable seasons reaching as much as 80 bushels. About one-half of the corn is fed and the rest sold. Kherson oats do fairly well, yielding from 30 to 40 bushels per acre. The long-straw varieties are likely to lodge. On farms that do not include some upland scarcely enough oats are grown for the feeding of work stock. A large part of the type is hay land and pasture, and the raising of beef cattle has been more extensively developed than on the upland. No crop rotation is practiced, and many cases are reported where fields have been in corn continuously for 10 years or longer. Occasionally corn is alternated with oats or wheat. No barnyard manure or commercial fertilizers are used on this soil.

The flat topography, silty texture, and friable structure of this soil make it very easy to handle, but in the spots of heavier material there is a tendency for the soil to clod when cultivated too wet.

The Wabash silt loam ranges in value from $150 to $250 an acre, depending on location and drainage conditions.

Improved drainage is the principal need on this type. In the better drained situations ditches would serve the purpose, while in the low, poorly drained areas, tile should be laid about 3 rods apart.

WABASH SILTY CLAY LOAM.

The Wabash silty clay loam consists of black, crumbly, silty clay loam 6 to 8 inches deep, grading into a black, sticky, clay, which changes in color between 24 and 36 inches into a dark slate, mottled slightly with yellowish brown. The change in color and texture from one soil horizon to another is very gradual. The soil as well

as the subsoil has a granular structure. When dry the material is hard and compact, and when wet plastic and impervious.

The Wabash silty clay loam is a rather extensive bottom-land type, with an approximate area of 6½ square miles. It occurs only in the first bottoms of the Iowa River. The topography is flat to slightly depressed and drainage owing to the impervious character of the subsoil, is very poor. The type is subject to annual overflows.

The original vegetation on the Wabash silty clay loam consisted of slough grasses and water-loving plants. Most of the land now is under cultivation. It is largely devoted to the production of corn, oats, and hay. Corn yields 50 to 55 bushels, oats 30 to 40 bushels, and hay 1 to 2 tons per acre. In dry seasons a fairly good quality of wild hay is produced. When the rainfall is above normal the grasses are too coarse to be of much value. In wet seasons the cultivated crops also are practically a failure because of the frequent overflows. Owing to the abundance of pasturage and hay, more live stock is kept on farms of this type than on the upland.

The Wabash silty clay loam is much harder to handle than the Wabash silt loam, but under favorable moisture conditions the soil granulates and can be worked up into a mellow seed bed. The type receives no fertilization.

This land is valued at $100 to $150 an acre, depending largely on the drainage conditions. The establishment of efficient drainage by supplementing the present ditches with tiles about 3 rods apart is necessary over a large part of the type.

MUCK.

Muck is composed largely of partly decomposed vegetable matter, with which is mingled varying quantities of mineral soil material washed in from the higher surrounding land. In this area the organic deposits vary in depth from 24 inches to about 4 feet. The proportion of mineral material increases with depth, and in the lower parts the type carries a high percentage of clay, in many instances the mass being a mucky clay. As a rule, Muck rests on a substratum of black clay, which changes to a lighter color in the lower depths.

Muck is developed in wet depressions in the Carrington soils. It is small in extent, covering in all approximately 60 acres. The soil is wet the year round, owing to seepage and run-off from the higher land.

The natural growth is marsh grass, and most of the type is used for pasture. All the areas could be readily drained, when they would become productive for a number of crops.

SUMMARY.

Marshall County lies in the central part of the State of Iowa. It has an area of 572 square miles, or 366,080 acres.

The topography varies from gently undulating to steeply rolling and broken, with most of the area rolling. The elevation of the county above sea level ranges from 850 to 1,116 feet, the greater part lying between 950 to 1,050 feet. The general slope of the county is southeastward. The county lies within the drainage basins of the Skunk and Iowa Rivers, important tributaries of the Mississippi River, and all parts of it are well drained.

According to the census of 1920, Marshall County has a population of 32,630, of which 51.8 per cent is classed as rural. The principal town is Marshalltown, the county seat. The transportation facilities are good and the county is provided with excellent earth roads. All parts of the county are provided with rural mail delivery, telephone service, and good schools.

The climate of Marshall County is well suited to agriculture. There is an average growing season of 176 days. The mean annual precipitation is 32.25 inches and the mean annual temperature is 46.9° F.

Grain farming is the main type of agriculture. Corn, oats, timothy and clover mixed, timothy alone, wheat, coarse forage, and clover alone are the most important crops. The raising of hogs and beef cattle and dairying are important industries.

Systematic crop rotations are not practiced. Liberal amounts of barnyard manure are applied but scarcely any commercial fertilizer is used. The farm buildings are substantial and the surroundings present an appearance of thrift and prosperity.

Most farms consist of 160 acres, though the average size is reported in the 1920 census as 152.9 acres. About 52.6 per cent of the farms are operated by the owners and practically all the remainder by tenants. About 96.7 per cent of the area of the county is reported in farms, and of the land in farms 90.5 per cent is improved. The value of farm land (1918) ranges from $50 to $350 an acre. Land is rented mainly by the cash system, rents ranging from about $6 to $14 an acre.

The county lies entirely within the Glacial and Loessial region, with only a small area belonging to the River Flood Plain province. The soils of the Glacial and Loessial region are derived from the weathering of silty material usually considered loess and drift. The silty material has given rise to the Tama, Muscatine, Clinton, and Knox soils, and the drift to the Carrington, Shelby, Lindley, and Clyde soils. The second bottoms are occupied by the Waukesha,

Bremer, and Buckner soils. The recent deposits along the streams are classed with the Wabash soils.

The Tama silt loam is by far the most extensive type in Marshall County. It is well suited to the production of corn, oats, and hay. The utilization of the Muscatine silt loam is similar to that of the Tama. The Clinton silt loam is chiefly devoted to corn, as it is too hilly for the extensive production of small grains. The Knox loamy fine sand is well adapted to the growing of watermelons and truck crops.

The Carrington loam is one of the more extensive soil types of Marshall County. This soil, together with the Tama silt loam, dominates the agriculture of the county. The Carrington fine sandy loam is largely used for the production of corn and oats. The Shelby loam and Lindley loam are best used for pasture.

The Waukesha silt loam and Buckner loam are well adapted to corn, oats, and hay. The Bremer silty clay loam is largely used for growing corn.

The bottom soils are best suited to corn, though some oats and hay are produced.

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[PUBLIC RESOLUTION—No. 9.]

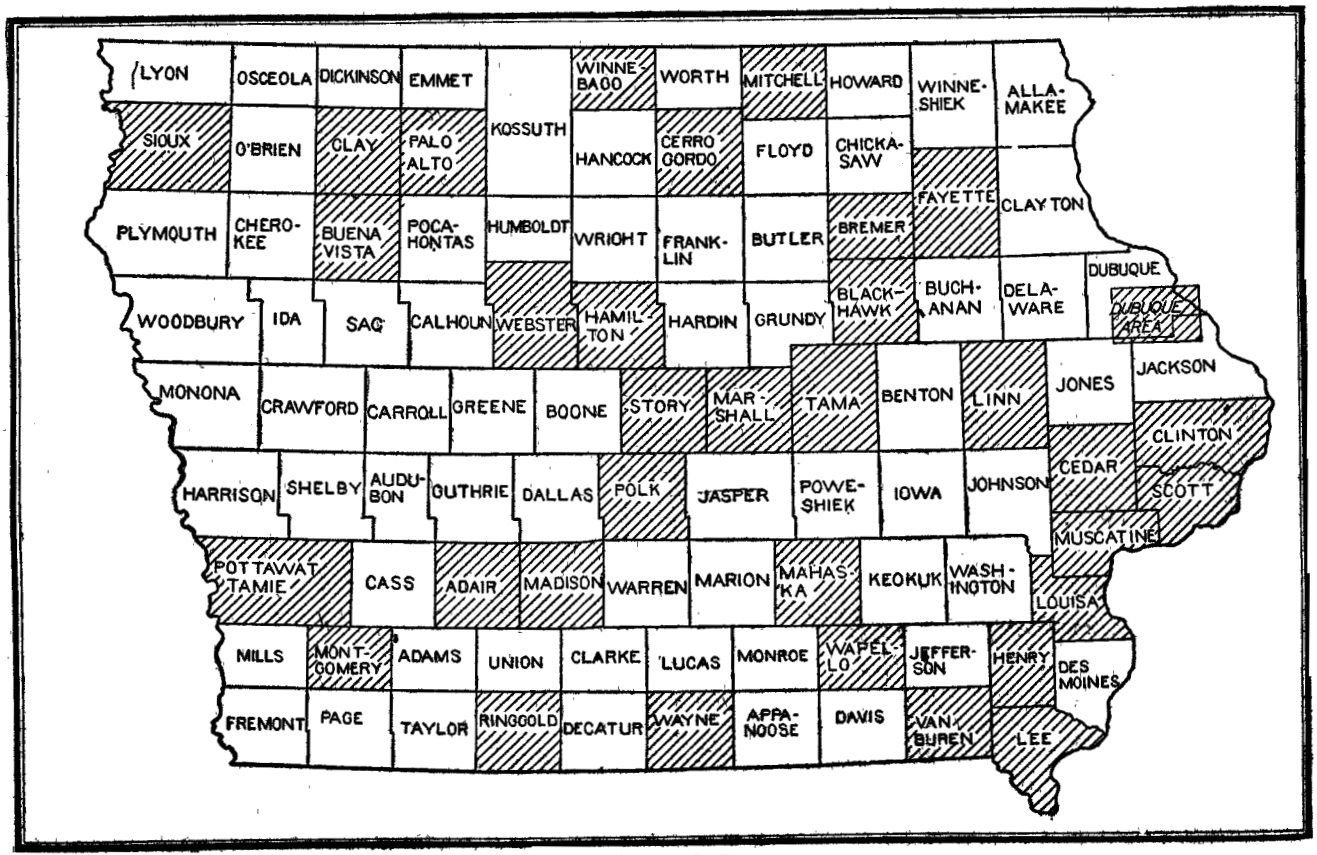
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

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



Areas surveyed in Iowa.

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