Series 1936, No. 9 Issued November 1941

Soil Survey

Story County Iowa

By
H. R. MELDRUM, in Charge, and D. E. PERFECT
Iowa Agricultural Experiment Station
and
C. A. MOGEN
United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PLANT INDUSTRY
In cooperation with the
Iowa Agricultural Experiment Station

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SOIL SURVEY OF STORY COUNTY, IOWA

By H. R. MELDRUM, in Charge, and D. E. PERFECT, Iowa Agricultural Experiment Station, and C. A. MOGEN, Division of Soil Survey,[1] Bureau of Plant Industry, United States Department of Agriculture

Area inspected by THOMAS D. RICE, Inspector, District 3

United States Department of Agriculture in cooperation with the Iowa Agricultural Experiment Station

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COUNTY SURVEYED

Story County occupies the geographic center of Iowa (fig. 1) and includes a total area of 567 square miles, or 362,880 acres. It is bounded on the north by Hamilton and Hardin Counties, on the east by Marshall County, on the south by Jasper and Polk Counties, and on the west by Boone County. Nevada, the county seat, centrally situated on the main line of the Chicago & North Western Railway from Chicago to Omaha, is about 320 miles west of Chicago and 30 miles northeast of Des Moines. The Iowa State College and the Iowa Agricultural Experiment Station are at Ames in the western part of the county.

Story County lies within the till plain formed during the late Wisconsin glaciation, and its configuration apparently has not been greatly modified since the retreat of the ice sheet. The land is predominantly undulating, with some nearly level areas and a few rolling to hilly sections. Swales and shallow saucer-shaped basins are

[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

scattered among the low ridges and flat divides. Drainageways are not well developed, and most of the larger streams flow in what appear to be preglacial valleys. The present drainage system has exerted little apparent influence on the land, except in the narrow strips of rolling to rough and broken land that border the stream valleys. Distinctly rolling areas also occur in the form of morainic ridges on the till plain.

The morainic ridges, which rise slightly above the level of the till plain, consist of belts of low sandy or gravelly knolls. The ridges and their borders are generally rolling with only an occasional patch of sharply rolling to hilly land. In some places the ridges merge with the till plain itself so that the boundaries between the two are very indefinite. The most prominent ridge is in the northern part of the county. It enters near the northwest corner, crosses Lafayette Township from northwest to southeast, turns east and north across the southern parts of Howard, Warren, and Lincoln Townships, then becomes indistinct, and leaves the county almost due east of Zearing. Smaller southwest-northeast ridges, which lie between Story City and Roland and McCallsburg, and between McCallsburg and Zearing, seem to be spurs extending north from the main body of the morainic area. A second fairly prominent ridge enters from the west near the center of Washington Township. It appears first in the form of low swells near Kelley, almost vanishes as it approaches the Skunk River, reappears in northern Union and southern Grant Townships, and continues in a southeasterly direction along the west side of Indian Creek in Indian Creek Township. Outliers extend into the southeastern parts of Collins and New Albany Townships. These morainic ridges, or belts of low hills, range in width from less than 1 to as much as 4 miles in some places.

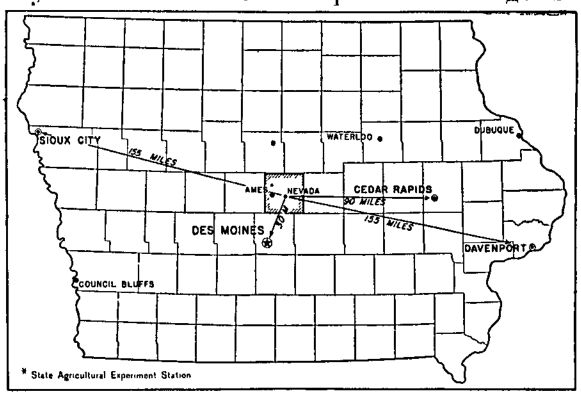

FIGURE 1.—Sketch map showing location of Story County, Iowa.

The principal streams are the Skunk River, which drains the western half of the county, and Indian Creek, which, with its branches, drains most of the eastern part. Drainage of approximately one-half of Lincoln Township in the extreme northeastern part empties into Minerva Creek, which flows southeastward into the Iowa River. Both of the principal streams flow southward through what seem to be preglacial valleys, although the lower half of the valley of the Skunk River in Story County seems to have been modified considerably either during or shortly after the glacial period. The valley is comparatively narrow from the northern county line as far south as section 7, Milford Township (a short distance northeast of Ames), where it widens to some extent. East and south of Ames to the point where the river leaves the county, the width of the flood plain ranges from 1 to 2 miles, and these are by far the widest bottoms. Narrower bottoms occur along the upper half of the Skunk River, along the branches of Indian Creek, and along many of the smaller drainageways. Narrow discontinuous terraces occur along both of the principal streams.

The large streams and some of their tributaries carry water throughout the year, but many of the smaller streams, as well as ponds or sloughs in the till plain, are dry during late summer. In abnormally dry seasons, such as the summers of 1934 and 1936, all the smaller streams become dry and even the larger ones carry only small quantities of water.

Although the ponds or sloughs in the depressed areas in the till plain do not hold water throughout the year, many of them need artificial drainage for satisfactory crop production. Natural drainage is restricted also on the comparatively flat divides, which lie some distance from the stream valleys. One such area occurs in the form of a shallow basin west of Story City between Keigley Creek and the Skunk River. A smaller basinlike area is northwest of McCallsburg in the north-central part of the county. The soils in these basins are somewhat heavier in texture than the Webster soils of the till plain.

At present 106 drainage districts operate 55.25 miles of open ditches within this county. An additional 23 districts lie partly within Story County and partly within an adjoining county.[2] Only a few depressions or flats lack adequate drainage.

Water for farm use generally is plentiful, coming chiefly from shallow bored and dug wells. Many of the old wells have been deepened, and new wells have been put in during late years because of a lowering of the ground-water level. Wells range from 100 to 150 feet in depth in the western part of the county, from 150 to 300 feet in the eastern part, and wells ranging from 200 to 400 feet in depth are not uncommon in the southwestern part. In the northern part near or in the bottoms of the valleys are several small and well-defined flowing well basins. The most important basin, where a large number of flowing wells occur, is in the valley of Keigley Creek, south and west of Story City. A basin near the town of Zearing on the bottom land of Middle Minerva Creek has a number of flowing wells. Several flowing wells have been developed along Dye Creek in Sherman and New Albany Townships. Other flowing wells are widely separated over the county, and springs are numerous in some sections. The depth of the flowing wells ranges from 50 to 100 feet in the Keigley Creek basin, from 60 to 90 feet in the Zearing basin. and from 80 to 120 feet in the Dye Creek basin. Small flows of water are obtained in places at a depth ranging from 25 to 30 feet in the Keigley Creek basin.

The average elevation of the county is about 1,000 feet above sea level, with the prevailing slope toward the south. The average fall in the valley of the Skunk River from the northern county line to the big bend in the river 2 miles north of Ames is about 11 feet per mile. From Ames southward to the Polk-Story line, a distance of about 16

[2] Information furnished by the county engineer.

miles, the total fall is about 60 feet, or an average of less than 4 feet per mile.[3]

The maximum range in altitude is 245 feet. The highest point recorded is 1,075 feet above sea level, on a morainic ridge in section 21 of Lafayette Township, and the lowest recorded point is 830 feet in the valley of the Skunk River where it crosses the southern county line. Elevations of other points are as follows: Nevada, 1,001 feet; Ames, 922 feet; Collins, 1,005 feet; Cambridge, 861 feet; Colo, 1,043 feet; Huxley, 1,035 feet; Kelley, 1,033 feet; Maxwell, 874 feet; Roland, 1,028 feet; Slater, 1,040 feet; Story City, 1,011 feet; and Zearing, 1,053 feet. Cambridge and Maxwell, in the southern part of the county, lie at elevations approximately 150 feet below those of towns in the northern part.[4]

At the time white settlers first occupied this section, a dense growth of prairie grasses covered nearly all of the uplands and strips of trees grew in the stream valleys and on the adjacent rougher or more rolling lands. By far the largest part of the county consisted of grassland. Grasses on the well-drained areas included such species as bluejoint turkeyfoot or big bluestem (*Andropogon furcatus* Muhl.), prairie beardgrass (*A. scoparius* Michx.), Scribner panicgrass (*Panicum scribnerianum* Nash), and various dropseeds (*Sporobolus* spp.). The vegetation in the sloughs and on the poorly drained flats included annual wildrice (*Zizania aquatica* L.), big cordgrass (*Spartina cynosuroides* Roth), reed (*Phragmites communis* Trin.), mannagrass (*Glyceria fluitans* (L.) R. Br.) and a number of other species. Porcupine grass (*Stipa spartea* Trin.), hairy grama (*Bouteloua hirsuta* Lag.), and witchgrass (*Panicum capillare* L.) were among the species growing on the more rolling land and more droughty places.[5]

The trees on the stream bottoms proper differ somewhat from those on the rougher land bordering the valleys. The rolling to hilly land near the streams originally supported a fairly heavy forest growth, mainly of oak, elm, hickory, and ash. The strips of forest in the stream valleys consisted of black walnut, butternut, American planetree or sycamore, maple, willow, oak, elm, and cottonwood. The larger trees were cut soon after the land was settled. At present, the more rolling areas, either in the moraines or along the streams, generally support a mixed growth of trees and grasses, although some of the steeper slopes in the morainic areas support grasses only. An open forest commonly covers the stream bottoms.

The territory now known as Story County was first opened to settlement by white men in 1833 by the treaty known as the Black Hawk Purchase. Indian bands continued to occupy the area from time to time, however, and it was not until 1846, when the Indian tribes were removed to reservations in Kansas, that the section became available for settlement. The first white settlement on record was made in 1848 at Ballard's Grove, about 1 mile northeast of the present town of Huxley. The first homestead entry was filed

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[3] BEYER, SAMUEL WALKER. GEOLOGY OF STORY COUNTY. Iowa Geol. Survey (Ann. Rpt. 1898) 9: [155]–237, illus. 1899.

[4] GANNETT, HENRY. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bul. 274. ed. 4. 1072 pp. 1906.

[5] PAMMEL, L. H., BALL, CARLETON R., and LAMSON-SCRIBNER, F. THE DESCRIPTIVE AND GEOGRAPHICAL STUDY OF THE GRASSES OF IOWA. Iowa Geol. Survey Sup. Rpt. 1903, pt. 2, 436 pp., illus. 1904. See ch. 3, pp. 379–396.

on 160 acres of land in sections 33 and 34, Collins Township, on October 24, 1849; and in the following year several families came in from Jasper County and Fort Des Moines.

The first crop reported was grown in 1851. Grain and flour were supplied for many years, however, from the older settlements to the south and southeast. It is reported that, as late as 1857, corn was hauled from Marion and Mahaska Counties.

The boundaries of Story County were defined and the county was named in honor of the great jurist and student of American law, Joseph Story of Massachusetts, by an act of the General Assembly, approved January 13, 1846. On July 1, 1853, the county seat was laid out on the present site of Nevada, but a railroad line did not reach the town site until July 4, 1864. A bill, providing for the organization of a state agricultural college and model farm for the purpose of affording higher education to the industrial classes, became a law on March 22, 1858. Approximately a year later, the board of trusteees purchased 647½ acres of unimproved land in the western part of the county, which today is the home of Iowa State College and the Iowa Agricultural Experiment Station.

According to the Federal census of 1930, the total population of Story County was 31,141, compared with 26,185 in 1920 and 24,083 in 1910. Of the total population in 1930, 57 percent was classed as rural. Native whites represented 93.8 percent of the total population, foreign-born whites, 5.9 percent, Negroes 0.2 percent, and other races 0.1 percent. Scandinavians predominate among the foreign-born whites.

Nevada, with a population of 3,133 in 1930, is the county seat, and Ames, with a population of 10,261, is the largest town. The populations of smaller towns or incorporated villages in 1930 were as follows: Story City, 1,434; Roland, 759; Maxwell, 721; Cambridge, 639; Slater, 568; Colo, 532; Collins, 489; Zearing, 475; Huxley, 362; McCallsburg, 330; Gilbert, 221; Sheldahl, 209, of whom 81 reside within Story County; and Kelley, 179. All these towns, together with several unincorporated villages, are situated on railways and serve as shipping points and trading centers. Iowa Center, Elwell, Shipley, Midvale, Fernald, and Ontario are small unincorporated villages.

The county is well supplied with railroads. The main line of the Chicago & North Western Railway from Chicago to Omaha crosses the central part in an east-west direction, passing through Colo, Nevada, and Ames. Branches of the same railway extend north and south from Ames, serving Sheldahl, Slater, Kelley, Gilbert, and Story City. The main line of the Chicago, Milwaukee, St. Paul & Pacific Railroad from Chicago to Omaha crosses the southern part through the towns of Collins, Maxwell, Cambridge, Huxley, and Slater. The main line of the Chicago, Rock Island & Pacific Railway between Kansas City and Minneapolis, crossing the central part in a north-south direction, passes through the towns of Cambridge, Nevada, and McCallsburg. A branch line of the Minneapolis & St. Louis Railroad serves Zearing, McCallsburg, Roland, and Story City in the northern part. The Fort Dodge, Des Moines & Southern Railroad, an electric line, serves the towns of Huxley, Kelley, and Ames, principally in the shipment of freight.

The highway system of Story County is well developed. Three United States Highways traverse it: No. 30 from east to west through Colo and Ames; No. 69 from north to south in the western part through Story City and Huxley; and No. 65 from northeast to southwest, coinciding with Nos. 30 and 69 in places. Of the 94 miles included in the primary road system,[6] 56.5 miles are paved and 37.5 miles are graveled. Of the 975 miles of secondary roads, 144 miles are graveled trunk roads, 511 miles are graveled local roads, 38 miles are improved earth roads, and 282 miles are unimproved earth roads. With ample railway facilities and with improved roads, agricultural products can be transported readily to market. Trucking service to all parts of the county is proving a very popular means of transporting farm products.

Rural schools are located at 2-mile intervals in most of the townships, and approximately 50 such schools were operating in 1936.[7] A large number of rural schools have been replaced by consolidated schools in recent years, and new school buildings have been erected in some rural districts and in some of the towns. Roland, McCallsburg, Zearing, Gilbert, Colo, Kelley, Huxley, Maxwell, and Collins have consolidated schools. Other consolidated schools are in Milford, Richland, and Grant Townships.

A few country churches are still maintained, but most of the people attend the larger churches in the towns. Rural mail delivery and telephone service extend into nearly all parts of the county. Several rural electric lines traverse the county and furnish electricity to many farmers. Radios are in common use, 1,206 radio receiving sets being reported on farms in 1935.

The soils are the chief natural resource of this county, and agriculture has been the principal occupation and means of livelihood for the people since the county was first settled. Most of the soils of the uplands, belonging to the Prairie and associated soil groups, are highly productive for cereals and leguminous crops. Minor resources are the clay deposits, some low-grade coal seams, and the limestones that outcrop near some of the larger streams. The principal outcrops of limestone are along the Skunk River and its immediate tributaries north of Ames and also along Onion Creek in Franklin Township. Some of the outcrops are used as a source of limestone for agricultural purposes, and they will become more important as the need for lime increases. Much of the tile used for artificial drainage of the flats and ponded areas in the uplands and the brick used for buildings in the early days were produced from clay deposits within the county. A brick and tile factory now operates at Nevada. No coal mines are now producing, and apparently none of the coal seams has been worked except during the brief period between 1890 and 1900.

CLIMATE

Story County lies in the central part of a large continent in the middle latitudes and is far removed from any large bodies of water.

[6] See footnote 2, p. 3.
[7] Information furnished by the county superintendent of schools.

The climate is of the type commonly referred to as continental, characterized by wide fluctuations in temperature and rainfall from season to season. In general, however, the weather conditions during summer are favorable for a vigorous but not luxuriant growth of plants.

The mean annual temperature, as recorded at the United States Weather Bureau station at Ames, is 48.0° F. Seasonal means of 21.4° and 71.6°, respectively, are recorded in winter and summer. The extreme temperatures range from −37°, the lowest ever recorded, to 109°, the highest. The most severe and prolonged cold spell on record occurred between January 17 and February 21, 1936, when the mean daily temperature approached zero—about 20° below the normal temperature for that period of the year. Occasional hot spells in summer, often accompanied by hot winds from the southwest, raise the daily maximum temperature above 100°. On 22 days in the summer of 1936 (one of the hottest on record), the thermometer rose to 100° or higher.

The average frost-free season is 157 days, a period long enough for the growth and maturing of corn and similar crops. The average date of the last killing frost is April 30, and the latest reported occurred on May 20. The earliest killing frost occurred on September 13, and the average date is October 4. Field work, including the preparation of seedbeds and the planting of small grain, usually is completed before the latest killing frost. Corn usually is planted during May when the danger of frost is slight. The annual grazing period continues about a month and a half longer than the growing season, generally extending into late November and totaling about 200 days. Many permanent pastures become poor in July and August, however, because of hot weather.

The mean annual precipitation recorded at Ames is 31 inches, of which more than 60 percent falls during spring and summer. The actual annual rainfall has ranged from 18.65 inches in 1910 to as much as 51.9 inches in 1881. Annual snowfall averages 21.6 inches, amounting to approximately one-tenth of the annual precipitation. Droughts during the growing season are seldom long and those that seriously damage crops, as in the summers of 1934 and 1936, are harmful because they are accompanied by extreme heat. Rains in early spring, in fall, and, to less extent, in summer are attended by gray overcast skies, and they fall in the form of long rather gentle showers. During the warmer periods in summer, rainfall occurs as electrical storms and thundershowers with brief heavy rains and sometimes hail. Hailstorms occasionally damage crops, but they seldom affect large areas. Late spring rains sometimes hamper but seldom prevent the planting of corn in good season. Ordinarily the weather in late fall is comparatively dry and favors the maturing and harvesting of corn.

Table 1, compiled from the records of the United States Department of Agriculture Weather Bureau station at Ames in the west-central part of the county, presents data that are representative of climatic conditions over the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Ames, Story County, Iowa*

[Elevation, 1,004 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	24.0	61	−29	1.05	0.27	0.89	4.9
January	18.1	62	−37	.75	1.30	.68	5.4
February	22.0	76	−31	.95	.35	2.50	5.6
Winter	21.4	76	−37	2.75	1.92	4.07	15.9
March	34.5	89	−14	1.38	1.32	.94	2.9
April	49.2	95	10	2.75	.50	2.37	.7
May	60.5	100	18	4.40	1.79	2.32	[1]
Spring	48.1	100	−14	8.53	3.61	5.63	3.6
June	69.2	101	36	4.21	2.88	6.70	0
July	74.1	109	39	3.26	1.69	16.31	0
August	71.5	106	36	3.78	2.75	3.25	0
Summer	71.6	109	36	11.25	7.32	26.26	0
September	64.2	102	22	4.32	4.63	7.63	0
October	51.9	90	−7	2.62	1.05	6.24	.3
November	36.8	77	−19	1.53	.12	2.07	1.8
Fall	51.0	102	−19	8.47	5.80	15.94	2.1
Year	48.0	109	−37	31.00	18.65	51.90	21.6

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The pioneers of Story County settled along the main streams, partly because they could obtain the essential water and timber and partly because they believed that the broad treeless prairies never would be suitable for general farming. The hazard of prairie fires and the lack of adequate natural drainage on thousands of acres of land helped to make the upland prairies seem less desirable than the stream valleys and their borders.

In 1853 the physical features of the county still were much the same as they were when the Indians left. Wild prairie grasses grew as tall as a man and were especially abundant in the sloughs and ponds on the level prairies. Wild game—deer, elk, turkeys, grouse, geese, ducks, and cranes—abounded. Farming was restricted to a few small fields near the strips of forest. Grain, principally corn, wheat, and oats, was grown to help supply the home demand. A few head of cattle were kept on most farms, as the prairies afforded excellent grazing.

Population and the number of farms increased slowly up to the time of the building of the railroads in the early sixties, but afterward growth was steady and comparatively rapid. As the demand for agricultural land increased and its value rose, a complete system of artificial drainage was slowly worked out, and now very few poorly drained areas remain.

The following figures, taken from the Iowa Yearbook of Agriculture for 1938, show the utilization of the farm land of the county:

	Acres
Area in farms	347, 834
Used for:	
General farm crops	251, 898
Pasture, all kinds	69, 338
Farmsteads, feed lots, highways	18, 715
Wood lots for timber only	279
Wasteland not used	1, 656
Idle cropland	5, 948

Approximately 95.9 percent of the total area of Story County was in farms in 1938, with 72.4 percent of the farm land utilized for crops and 19.9 percent in pasture.

Table 2 shows the acreages of the principal crops, as reported by the Federal census for the years 1879 to 1934; and table 3 shows the acreage and production of selected crops, as reported by the Iowa State Department of Agriculture for 1935, 1936, 1937, and 1938.

TABLE 2.—*Acreages of principal crops in Story County, Iowa, as reported by the Federal censuses, in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn for grain	90, 556	94, 763	123, 317	124, 444	123, 469	144, 252	96. 865
Oats	15, 742	46, 345	66, 040	60, 267	75, 622	88, 003	75, 620
Wheat	19, 406	792	8, 167	2, 421	5, 315	1, 121	1, 295
Barley	176	78	902	1, 322	252	2, 272	900
Rye	1, 117	469	969	233	287	113	542
Soybeans	----------	----------	----------	----------	----------	245	7, 358
Potatoes	----------	1, 108	1, 419	1, 226	249	369	453
Hay	38, 031	55, 952	41, 889	48, 220	26, 625	19, 008	[1] 27, 996
Timothy and clover	----------	----------	787	35, 394	22, 654	11, 836	3, 629
Alfalfa	----------	----------	3	82	367	5, 619	6, 785
Legumes for hay	----------	----------	----------	----------	54	315	6, 879
Other tame hay	----------	----------	25, 638	1, 182	1, 276	505	[1] 10, 703
Wild hay	----------	----------	15, 461	11, 562	2, 274	733	(2)
Market vegetables	----------	----------	----------	480	1, 647	2, 359	1, 628

[1] Includes sorghums for silage and fodder.
[2] Included with other tame hay.

TABLE 3.—*Acreage and production of selected crops in Story County, Iowa, as reported by the Iowa Yearbook of Agriculture for the years 1935, 1936, 1937, and 1938*

Crop	1935		1936		1937		1938	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn, total	132, 368	5, 956, 560	144, 160	3, 636, 979	149, 597	8, 661, 666	135, 549	7, 468, 750
Husked or snapped for grain	124, 583	5, 604, 518	126, 251	3, 259, 011	143, 408	8, 305, 909	132, 066	7, 281, 563
Cut for silage	2, 956	----------	5, 048	----------	2, 430	----------	1, 383	----------
Cut for fodder	4, 124	----------	12, 006	----------	2, 958	----------	1, 363	----------
Hogged down	705	----------	855	----------	801	----------	737	----------
Oats	95, 064	3, 731, 559	83, 539	2, 925, 961	82, 709	4, 550, 448	80, 076	2, 396, 715
Wheat, total	1, 271	17, 629	1, 245	27, 003	2, 961	60, 142	1, 934	32, 934
Winter	981	15, 302	1, 157	25, 147	2, 834	57, 306	1, 774	30, 931
Spring	290	2, 327	88	1, 856	127	2, 836	160	2, 003
Barley	1, 263	35, 967	781	18, 288	555	19, 855	622	14, 883
Rye	1, 137	18, 051	575	9, 629	1, 100	26, 214	461	8, 610
Soybeans	1, 927	33. 829	1, 663	22, 677	2, 179	45, 097	3, 775	83, 554
		Tons		*Tons*		*Tons*		*Tons*
Hay, total	21, 668	37, 070	20, 299	26, 820	19, 023	35, 249	25, 272	46, 253
Timothy and clover	3, 353	4, 024	6, 182	7, 728	2, 916	3, 324	6, 164	8, 938
Alfalfa	5, 044	12, 761	8, 061	12, 495	9, 688	22, 476	9, 999	23, 998
Soybeans for hay	9, 513	14, 460	3, 040	2, 736	3, 739	5, 646	6, 391	10, 226
Other tame hay	3, 023	4, 892	2, 303	3, 013	2, 102	3, 167	2, 074	2, 447
Wild hay	735	933	713	848	578	636	644	644

As shown in tables 2 and 3, corn has been the leading crop since the first records were obtained. The acreage of corn harvested for grain increased nearly 33,000 acres between 1879 and 1899 but remained fairly stationary from that time until the World War. It reached a maximum in 1929, dropped in 1934, and thereafter increased again.

The greater part of the corn crop—about 90 percent or more—is husked or snapped for grain, and probably 75 percent of the grain is fed to livestock on the farms. The rest is sold and shipped out of the county. From 5 to 8 percent of the corn crop usually is cut for silage and fodder, and corn from a small acreage is hogged down. Varieties of dent corn, chiefly the yellow ones, were grown prior to the introduction of hybrid seed. Strains of Reid Yellow dent were the most popular of the open-pollinated varieties. Hybrid corn has become more popular each year, and approximately 80 percent of the corn acreage was planted with hybrid seed in 1939. As a rule, the highest average corn yields are produced on the medium- to heavy-textured soils of the uplands and on the better drained heavy-textured first-bottom soils that are protected from overflow.

Oats are grown on nearly every farm and rank second to corn in acreage. The crop is included in the rotation principally to serve as a nurse crop for the legume or hay mixture. The acreage in oats increased greatly from 1879 to 1935. A large part of this crop is fed on the farm where grown, and the rest is shipped out and sold at threshing time. Iowar, Iogold, Iowa 105, and Iowa 103 are the most popular varieties. Oats often lodge on the heavier textured soils and therefore are somewhat better adapted to the lighter textured soils.

Although hay is an important crop on all farms producing livestock, the total acreage devoted to hay has declined since 1889. This was the consequence of plowing the wild-hay land and expanding the production of corn at the expense of hay crops. Timothy and red clover comprise one of the most popular mixtures used for hay, although less timothy and clover are now grown than formerly. Alfalfa can be grown successfully on many of the soils without the use of lime to correct acidity, and on them all when properly limed. This crop produces excellent hay and pasture. According to the Federal census, only 3 acres were in alfalfa in 1899, but the Iowa Yearbook of Agriculture for 1938 reports 9,999 acres with an average yield of 2.4 tons per acre. Sweetclover is being grown more extensively during recent years because of its value as forage and as a soil-improvement crop. The Iowa Yearbook of Agriculture reports 9,228 acres of sweetclover grown for all purposes in 1938. Small quantities of sweetclover are used for hay.

Wheat was one of the best paying crops in 1879, when more than 19,000 acres were devoted to this crop. Because of damage from rust, however, the average yield declined from year to year, and at present wheat is produced on only a small acreage as a cash crop. Prior to 1905, varieties of spring wheat were planted principally, but now most of the wheat planted is of winter varieties.

The acreages in barley and winter rye, combined, about equal the acreage in wheat. Rye is grown principally as a cash crop, whereas most of the barley is fed to livestock. Better grades of malting barley are produced farther north, where the seasons are more favorable for the production of grain.

Potatoes are grown on most farms for home consumption, but not in sufficient additional quantities to meet the local demand. Sweet corn is the most important truck crop, followed by green peas, watermelons, and cantaloups. Other minor crops are flax, millet, popcorn, timothy seed, sweetclover seed, and sorghum. In recent years soybeans have become more important; 3,775 acres of soybeans, with an average acre yield of 22.1 bushels, were harvested in 1938.

According to the Iowa Yearbook of Agriculture for 1938, Story County had a total of 69,338 acres devoted to pasturage. Of this acreage, 33,373 acres were plowable pasture, 12,452 acres woodland pasture, and the remaining 23,513 acres consisted chiefly of permanent bluegrass pasture. Pasture is important in the agriculture of this county, as the sale of livestock is the chief source of income on many farms. The feeding of livestock enables farmers to utilize roughages and low-priced grains that do not find a ready market. In addition, the production of manure is valuable for maintaining the productiveness of the soil.

According to the Federal census, livestock on farms on January 1, 1935, included 45,273 cattle, 58,264 hogs, 9,942 horses, 854 mules, 7,548 sheep, and 357,680 chickens over 3 months of age. On April 1, 1930, there were 37,914 cattle, 95,127 hogs, 11,958 horses, 965 mules, 5,682 sheep and lambs, and 383,306 chickens on farms. The number of hogs on farms varies considerably with the different seasons of the year.

Raising and feeding hogs is probably the most important livestock enterprise. Hogs are raised and fattened for market on nearly every farm, although the numbers raised on some farms are small. Most of the hogs are mixed grades, but some purebred herds are kept. Duroc-Jersey, Poland China, Spotted Poland China, Chester White, and Hampshire are the leading breeds. Hogs generally are marketed within the State, many of them being trucked to Des Moines, Mason City, or Waterloo. Most of the hogs shipped out of the State are sent to Chicago.

The raising of cattle is next in importance to the raising of hogs. Many farmers "feed out" or fatten cattle, some of which they have raised themselves, but as a general rule, the larger producers buy in Des Moines, Omaha, or Sioux City feeders that come from the western ranges. The cattle raised on the farms are for the most part grades, but several herds of beef cattle are purebred. Shorthorn, Aberdeen Angus, and Hereford are the more popular types of beef cattle.

Dairy products are an important source of supplementary income. Most of the 104 farms classed as dairy farms in the 1930 Federal census supply milk and cream to the larger towns. Only a small proportion of the farms are devoted entirely to dairying, but a few milk cows are kept on nearly every farm. Generally the milk is separated on the farm and the cream sold to local creameries or to cream stations for shipment to creameries outside the county. Several of the local creameries are cooperative. Purebred dairy cattle are kept on some farms, but the majority are grades of the Holstein-Friesian, Jersey, milking Shorthorn, or Guernsey breeds.

A few permanent flocks of sheep are maintained, but, as a rule, feeders are shipped in each year, fattened for market, and then sold.

Flocks of poultry are kept on most farms and provide an important source of supplementary farm income. The poultry flocks consist largely of chickens, but some turkeys, geese, and ducks are raised. Poultry and produce houses in the towns buy most of the live poultry and eggs from the farms.

Horses and mules supplied most of the farm power until recently, when tractors began to replace the work animals. The number of tractors is increasing, and about one-third of the farms reported tractors in 1935. The number of work animals raised has been increasing slightly of late because of the shortage of good work horses.

Although most of the feed consumed is grown on the individual farm, 1,632 farms, or almost 70 percent of all farms, purchased additional feed in 1929, according to the Federal census. The total expenditure was placed at $384,674, or an average of $235.71 per farm reporting.

Only 155 farms reported the use of any form of fertilizer in 1929, with an average expenditure of $61.85 per farm reporting. This expenditure includes both limestone and the ordinary commercial fertilizers. Applications of limestone are needed for the best growth of legumes on many of the soils on the terraces and on the rolling or sandy uplands. Superphosphate, as well as mixed commercial fertilizers, has been used to some extent for the principal farm crops.

The greater part of the farm labor is supplied by the farmer and his family, but extra help is needed during haying, harvesting of small grain, and corn husking. On a number of farms, hired help is employed by the year, and the farmer provides a tenant house for the man and his family. In 1929, 1,495 farmers reported the hire of extra labor, with an average expenditure of $393.33 per farm reporting. Generally the additional help is paid daily wages during haying and small-grain harvesting, and corn pickers receive from 3 to 6 cents per bushel when corn husking is done by hand.

Table 4 shows the number, average size, and tenure of farms from 1880 to 1935, as compiled from the Federal census reports.

TABLE 4.—*Number, average size, and tenure of farms in Story County, Iowa, in stated years*

Year	Number of farms	Average size	Operated by—		
			Owners	Tenants	Managers
		Acres	*Percent*	*Percent*	*Percent*
1880	2,218	124.0	73.4	26.6	----------
1890	2,193	149.4	69.7	30.3	----------
1900	2,436	146.4	59.7	39.7	0.6
1910	2,385	147.3	53.9	44.8	1.3
1920	2,215	148.1	49.3	49.7	1.0
1930	2,348	151.0	46.0	52.7	1.3
1935	2,403	146.7	43.1	56.1	.8

Of the 2,348 farms reported by the Federal census in 1930, 777 were classed as cash-grain, 745 as animal-specialty, 423 as general, 104 as dairy, 75 as poultry, 31 as self-sufficing, 5 as crop-specialty, 4 as truck, and 97 as abnormal farms. The rest were listed as unclassified. The range in size, as reported by the 1930 census, is from 21 acres on the average truck farm to 178 acres on the average animal-specialty farm. The average size of farm has changed very little since 1890.

Farms operated by owners have been decreasing in number since 1880, with a corresponding increase in the number of farms operated by tenants. According to the Iowa Yearbook of Agriculture for 1938, 61.1 percent of the farm land of the county was operated by tenants and 38.9 percent by owners. The heavy debt burden and the consequent numerous mortgage foreclosures in recent years largely explain the increasing number of tenant-operated farms. The acreage of land held by corporations in Story County in January 1937 was 12.6 percent of the total farm land.[8] Farms operated by tenants are rented mainly on a share-crop basis, the landlord receiving one-half of the corn, two-fifths of the small grain, and cash for hay or pasture land. Cash rents range from $5 to $8 per acre on the better cropland, depending on location, productivity of the farm, and the amount of tillable land.

In general, the farmsteads are conveniently located and well improved. They include the farm dwelling, barns, hog houses, poultry houses, granaries, corncribs, machine sheds, and silos. According to the Federal census for 1930, the average value of land and buildings in this county was $23,321 per farm, or $154.49 per acre. The value of buildings alone averaged $4,842 per farm, of which $2,309 represented the value of farm dwellings. Most of the farm dwellings are well built, and many of the newer houses have all modern conveniences. In 1935 the value of land and buildings was $13,125 per farm, or $89.46 per acre.

Most of the farms are equipped with machinery such as plows, disks, harrows, corn planters, cultivators, grain and corn binders, mowers, hay loaders, hay rakes, and manure spreaders. Many farmers use tractors for power, and a number have mechanical corn pickers. The average value of farm machinery in 1930 was $1,315 per farm.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil[9] and its content of lime and salts are determined by simple tests.[10] Drainage, both internal and

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[8] MURRAY, W. G., and BITTING, H. W. CORPORATE-OWNED LAND IN IOWA, 1937. Iowa Agr. Expt. Sta. Bul. 362, pp. [93]–127, illus. 1937.

[9] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[10] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. For example, Clarion and Webster are names of important soil series in Story County.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. The class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Clarion fine sandy loam and Clarion loam are soil types within the Clarion series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though the differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS [11]

Dark-colored soils formed under a tall-grass vegetation and known technically as Prairie soils and their less well drained associates occupy a large part of the uplands of Story County. Well-drained Prairie soils also occur on terraces along the larger streams, and the stream bottoms consist of dark-colored soils that lack free drainage in many places. The dark-colored soils of the bottom lands are closely related to the Prairie soils of the uplands and terraces but differ from them in profile development because of differences in drainage and length of time of formation. The lighter colored soils, formed under forest cover, that occur in the rolling strips along the larger streams, belong to the group of Gray-Brown Podzolic soils. Locally, along the eastern side of the Skunk River Valley below Ames and in isolated places on the till plain, are sandy deposits that have been covered with grass but, because of their sandiness, have not developed into Prairie soils.

The parent material from which the various upland soils were formed consists of glacial drift left by the last advance of the glacier during the Wisconsin stage. The greater part of the drift consists of calcareous till (materials left in place by the melting of the ice) composed of a mixture of sand, silt, and clay, together with some gravel and boulders. The texture of the till ranges from sandy loam or sand in some places to clay loam, which predominates over most of the county. Where the texture of the till is clay loam and where the surface is very gently sloping so that drainage is free but not excessive, the carbonates have been leached to an approximate depth of 30 inches. Variations in depth of leaching occur where the till is sandy and wherever the relief is either depressed or distinctly rolling.

The parent materials in the bottom lands and terraces consist of sediments washed from the uplands and redeposited. These sediments have been assorted by water so that they include silts and clays, for the most part, with local concentrations of sand and gravel. Gravel may occur on outwash terraces or small valley trains, but there are no boulders in the stream valleys.

In addition to the differences in soils caused by variations in vegetation and parent material, some differences result from pronounced relief. The soils occupying the more rolling or hilly areas normally have shallower profiles with lighter colored shallower surface layers. The steep phases of the Clarion soils illustrate these characteristics.

For purposes of discussion, the soils of Story County are placed in four groups on the basis of natural drainage conditions: (1) Well-drained soils of the uplands and terraces, (2) imperfectly and poorly

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[11] Story County adjoins six Iowa counties that have been previously surveyed. In some places the names of soils as mapped in Story County do not agree with those mapped in adjoining counties. This is due to changes in correlation resulting from a fuller understanding of the soils of the State. By a change of definition soils formerly included in the Carrington series in Hardin, Hamilton, Boone, Polk, Marshall, and Jasper Counties are now included in the Clarion series. Areas of Webster silty clay loam are shown on the Story County map, but similar soils were included with Webster loam in Hamilton County. Webster clay loam was separated in Hamilton and Polk Counties, but because of its small area it is included with Webster silty clay loam in Story County. The soil mapped as Wabash clay along the Skunk River and Indian Creek in Polk County is called Wabash silty clay in Story County. The soils mapped in the Clyde series in Marshall County are included with the Webster soils in Story County. The light-colored soils on the smoother areas along the borders of stream valleys, included with the Conover series in Boone County and with the Miami series in Hamilton County, are separated as Ames fine sandy loam in Story County.

drained mineral soils, (3) poorly drained organic soils, and (4) excessively drained soils. The well-drained soils are subdivided into dark-colored and light-colored soils, according to the color of the surface horizons. The groupings used in the discussion are based on characteristic features of the soils themselves and do not attempt to classify the soils according to productivity. Highly productive soils are included in both the well-drained and the less well drained groups.

In the following pages the soils of this county are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Story County, Iowa*

Soil type	Acres	Percent	Soil type	Acres	Percent
Clarion loam	150,656	41.5	Wabash silty clay loam	5,376	1.5
Clarion loam, eroded phase	9,280	2.6	Wabash loam	6,848	1.9
Clarion loam, steep phase	1,920	.5	Wabash silty clay	4,288	1.2
Clarion fine sandy loam	33,472	9.2	Wabash fine sandy loam	1,728	.5
Clarion fine sandy loam, eroded phase	10,432	2.9	Lamoure silty clay loam	3,584	1.0
Clarion fine sandy loam, steep phase	2,880	.8	Lamoure loam	1,728	.5
Waukesha loam	832	.2	Peat	704	.2
Lindley loam	512	.1	Muck	1,216	.3
Lindley loam, steep phase	3,840	1.1	Dickinson fine sandy loam	2,176	.6
Ames fine sandy loam	1,472	.4	Thurman loamy fine sand	896	.2
Webster silty clay loam	75,840	20.9	O'Neill loam	3,264	.9
Webster loam	30,848	8.5	O'Neill fine sandy loam	1,856	.5
Webster silty clay	1,024	.3	Buckner loam	960	.3
Bremer silty clay loam	1,856	.5	Buckner fine sandy loam	1,152	.3
Bremer loam	704	.2	Sarpy fine sandy loam	1,536	.4
			Total	362,880	

WELL-DRAINED SOILS OF THE UPLANDS AND TERRACES

The well-drained soils of the uplands and terraces occupy 59.3 percent of the total area of the county. Their relief ranges from nearly level or undulating to steep or hilly. Drainage is free and in some places is excessive, but in general most of these soils retain sufficient moisture for the growth of crops during normal seasons. They contain somewhat less organic matter than their poorly drained associates, partly because of a less luxuriant growth of native vegetation and partly because of more rapid decomposition of organic residues. Members of the Clarion and Waukesha series comprise the subgroup of dark-colored soils, and members of the Lindley and Ames series comprise the subgroup of light-colored soils.

The Clarion soils are characterized by dark-brown or black surface layers, which grade into a yellowish-brown layer. Below this the material becomes increasingly lighter colored with depth. Variations in texture in places within the profile correspond to variations in the parent material. The subsoil is highly calcareous, and in many places lime occurs in the upper soil layers. The Clarion soils have been formed from glacial till of the late Wisconsin glaciation. Gravel and boulders occur in small quantities on the surface and throughout the soil mass. The Clarion soils are well suited for general farming and under good soil-management practices can be depended on for satisfactory crops.

The soils of the Waukesha series are characterized by dark-brown or black surface layers underlain by noncalcareous brown or yellowish-brown material. The material in the lower layers is heavier in texture than the surface soil but is not compact or impervious. The Waukesha soils occur on terraces well above overflow and are considered very desirable for general farming.

The Lindley soils have light yellowish-brown or grayish-brown comparatively shallow surface soils and yellowish-brown or reddish-brown subsoils. In most places the subsoil is heavier in texture than the surface soil, although in many places it contains considerable sand and gravel. These soils have been formed from glacial till along the borders of stream valleys where trees were the original vegetation. In this county these soils are used mainly for pasture.

The Ames soils are characterized by light grayish-brown surface soils over highly mottled gray and dull yellowish-brown tough subsoils. These soils have been formed from glacial till on smooth to gently rolling relief, under forest vegetation.

DARK-COLORED SOILS

Three soil types and four phases in two series are included in the group of well-drained dark-colored soils. Clarion loam and Clarion fine sandy loam, with their eroded and steep phases, occur on the uplands. Waukesha loam occurs on terraces and is similar to Clarion loam, both in the appearance of the profile and in productivity, but it differs from that soil in that it was formed from water-laid sediments rather than till. Areas of Clarion loam and Clarion fine sandy loam that have been affected appreciably by accelerated erosion are separated as eroded phases. The steep phases of these two soils occur in rolling or hilly areas, such as those along stream valleys and, to less extent, in terminal or recessional moraines. Much of the total area occupied by soil of the steep phases is too steep for cultivation and is used for pasture.

Clarion loam.—Clarion loam, by far the most extensive soil in the county, occupies low knolls, ridges, and gentle slopes throughout the uplands in association with soils of the Webster series, which occupy the level areas and depressions.

The surface layer of Clarion loam, as widely developed, consists of dark grayish-brown friable loam, ranging from 12 to 16 inches in thickness, which grades into brown or yellowish-brown clay loam. The transitional layer extends to a depth of about 24 inches, below which the clay loam becomes lighter in color and finally changes into grayish-yellow calcareous till at a depth of about 30 inches. Calcium carbonate, or lime, is present in finely divided form, as well as in concretions, in most places below a depth ranging from 30 to 36 inches, and it occurs in some places at a much slighter depth. Pebbles, rocks, and boulders occur throughout the soil mass, in most places becoming more numerous with increasing depth. The material in the lower part of the soil is somewhat sandy in a few areas, although it is predominantly silty clay loam. Under a virgin sod, the topmost 2- or 3-inch layer of the soil consists of very dark grayish-brown loam with a soft-crumb structure, held together firmly in place by fibrous grass roots. In some smooth areas the surface layer is almost black.

In numerous widely scattered areas the profile varies from the one just described. Pockets of sand or gravel are common in small areas on the sides or tops of gentle knolls. Clarion loam approaches the Webster soils in some of its characteristics in places where these two soils are closely associated. Here, the surface layers of the soil mapped as Clarion loam are deeper, darker, and more silty than normal and the lower layers show evidence of restricted drainage. Other less general variations also are included in mapping.

Much of Clarion loam mapped in Lincoln Township occupies gently to strongly rolling relief and has a somewhat lighter colored and shallower surface layer than the typical soil. Some accelerated erosion has taken place on the steeper slopes. In sections 1, 2, 3, and 4 of Lincoln Township there is no lime within a depth of 3 feet in this soil, which closely resembles Carrington loam mapped in adjacent parts of Hardin County.

A light-textured variation of Clarion loam occurs in the southwestern corner of Lincoln Township, in the northwestern corner of Sherman Township, in the northern half of Warren Township, and in the East Indian Creek drainage basin in Richland Township. In such areas the surface layer, to a depth of 12 inches, is dark grayish-brown mellow friable loam containing much fine sand and approaching fine sandy loam in texture. Between depths of 12 and 20 inches the soil material is brown or dark-brown loam or sandy loam, underlain, to a depth of 30 inches, by light-brown or yellowish-brown clay loam containing much grit. The calcareous grayish-yellow glacial till lies below a depth of 30 inches.

Another variation of Clarion loam occupies rather extensive areas in the Middle Minerva Creek drainage basin between Zearing and McCallsburg, in small areas in sections 29, 30, and 31 of Sherman Township, sections 20 and 27 of Richland Township, sections 6, 7, 17, 18, and 20 of Washington Township, and scattered here and there in New Albany, Nevada, and Collins Townships. The soil in these areas consists of moderately dark grayish-brown sandy loam to a depth of 10 or 12 inches. The surface layer is underlain by a yellowish-brown layer, ranging in texture from heavy sandy loam to clay loam. Below a depth of 24 inches the soil material is clay loam, in places either sandy or silty and generally calcareous. Considerable gravel is scattered over the surface of some areas, and pockets of sand and gravel are numerous within the soil mass.

Areas of Clarion loam with shallow and in places gravelly surface layers are near the morainic belts, chiefly in the northern half of the county. Small areas occur in sections 6, 7, and 32 of Franklin Township and in sections 4, 8, 16, 17, and 18 of Milford Township. The relief varies from the usual irregularly undulating surface and is characterized by groups or chains of low hills and ridges interspersed with smoother bodies of Clarion loam. The surface layer of the soil on the low hills and ridges is grayish-brown friable loam ranging in thickness from 4 to 8 inches. In a few places the darker colored surface layer is absent, thereby exposing the lighter colored subsoil material. The deeper layers generally are similar to those of typical Clarion loam. Boulders and gravel are more abundant than in the typical soil, and the texture in places approaches a gravelly loam. Somewhat lower yields are obtained on such areas than on areas of the smoother and heavier textured Clarion loam.

Wherever Clarion loam and Clarion fine sandy loam occur in close association, the soil boundaries must be drawn somewhat arbitrarily. A few small areas of the fine sandy loam are included with bodies of the loam, or vice versa. In a few places, areas of Clarion fine sandy loam too small to be shown on a map of the scale used are included with Clarion loam.

In general, Clarion loam occupies irregularly undulating to gently rolling land, with short gentle slopes ranging from 3 to 6 percent in gradient. In Lincoln Township, however, the gradient ranges from 4 to 8 percent, and in some places in other townships it is only 2 percent. The characteristic relief and the permeability of the soil material are such that problems of erosion control are unimportant on this soil. Areas that are susceptible to erosion do occur, but most of them are included with the eroded and steep phases.

Clarion loam is considered a valuable agricultural soil. It is used almost entirely for growing farm crops or for rotation pasture. Internal and external drainage are good, and the soil can be handled under a wide range of moisture conditions. It retains moisture well, and crops do not suffer from lack of water except during prolonged droughts. Corn, oats, and hay are the principal crops, although some wheat, rye, barley, and soybeans also are grown. Small acreages of sweet corn for commercial canning are grown near the towns of Ames, Roland, Story City, and Cambridge.

Clarion loam is somewhat less fertile than the Webster soils, but under a good system of soil management, which includes the growing of legumes and the plowing under of green manures and barnyard manure, the soil is highly productive. Corn ordinarily yields from 40 to 50 bushels per acre and, in favorable seasons as much as 60 or 65 bushels. The yield of oats is about the same as that of corn; occasionally higher yields are reported. Acre yields of 40 bushels of barley are not uncommon, but yields of 30 to 35 bushels are considered good. Winter wheat is not grown extensively but, when grown, commonly yields from 25 to 30 bushels per acre. Clarion loam is well adapted to growing red clover and timothy for hay or for pasture. Sweetclover grows well without the use of lime on a large part of this soil and is used mainly for pasture and green manure. Alfalfa can be produced without the use of lime on most areas of this soil, and yields ranging from 2 to 3 tons per acre are obtained.

Clarion loam, eroded phase.—Clarion loam, eroded phase, occupies the rolling to strongly rolling land bordering some of the smaller streams in the uplands and the areas adjacent to the larger streams. It also occupies long narrow ridges either near stream valleys or within morainic areas. This soil occurs in close association with the typical soil, differing from it chiefly in relief and in thickness of the upper layers.

The slope of this soil generally ranges from 5 to 15 percent. Most areas with a slope greater than 15 percent are included with the steep phase of Clarion loam, the degree of slope constituting the primary difference between the soil of the two phases. Soil of the eroded phase commonly occurs on rolling areas, whereas soil of the steep phase occurs on hilly, in places almost blufflike, areas.

Typically, Clarion loam, eroded phase, has a 4- to 6-inch surface layer of dark-colored material, which grades through a thin transitional layer of yellowish-brown material into the calcareous till. Calcareous materials generally occur at a depth ranging from 18 to 24 inches, but in some places they are much nearer the surface or even at the surface. In some places the surface layer is entirely lacking or ranges from a mere film to a depth of 8 inches within short distances. Light-colored areas, where the subsoil is exposed, are on the tops or shoulders of many ridges, whereas nearby areas may have dark-colored surface layers several inches thick. Boulders and gravel are common over the surface of this eroded soil.

Inasmuch as soil of the eroded phase is closely associated with typical Clarion loam, a large part of it is farmed in the same way. A few areas are sufficiently large to warrant a different method of management, but even these are seldom retired to pasture or hay. Lower crop yields are obtained from the eroded soil than from typical Clarion loam. Differences in normal seasons are estimated as ranging from 10 to 15 bushels of oats or other small grains per acre and 15 to 25 bushels of corn. Clovers and alfalfa grow well on this soil, however, and in many seasons produce high yields. The rather high concentration of lime so near the surface makes it unnecessary to add liming materials before growing alfalfa or sweetclover. Long-time improvement in the productivity of the soil would require additions of organic matter and measures to reduce sheet erosion after the content of humus had been increased.

Clarion loam, steep phase.—The steep phase of Clarion loam occurs on blufflike slopes facing stream valleys and in the rougher lands extending up short ravines and the larger creeks. The largest single body of this steep soil, which is used mainly for pasture, is in section 22 of Union Township, and small areas are scattered along the Skunk River, Indian Creek, and branches of Squaw, Dye, Wolf, Ballard, and Keigley Creeks.

The gradient of most of the slopes upon which this soil occurs exceeds 15 percent and in some places is as much as 25 percent. In most places the slopes are too steep to allow successful cultivation, and the largest part of the total area is used for pasture. A number of areas support scattered stands of trees, including oak, elm, hickory, maple, and a few walnut.

Clarion loam, steep phase, differs from the eroded phase chiefly in its occurrence on steeper slopes. The profiles of the two soils do not differ greatly; both have shallow surface layers that grade rather abruptly into calcareous parent material. The dark-colored surface layer of the steep phase in few places is more than a few inches thick. In some places it reaches a depth of 4 to 6 inches, and in other places it is entirely absent. Lack of a well-defined surface layer of darker colored soil material is due to accelerated erosion in places where cultivation of the land has been attempted, or it may be due to the normal lack of profile development on steeper slopes.

The small area of this soil is used for pasture, to which it is best adapted.

Clarion fine sandy loam.—The largest continuous areas of Clarion fine sandy loam occur in the drainage basin of Indian Creek, but many smaller areas occur throughout the Skunk River basin. This soil generally occupies high knolls and prominent ridges in morainic areas and low knolls and ridges within larger bodies of Clarion loam on the till plain. Within the morainic areas this soil in places is associated with Dickinson fine sandy loam, from which it differs in the heavier texture of the subsoil. Some of the boundaries separating these two soils are placed rather arbitrarily in the gradational zone between them.

The relief of Clarion fine sandy loam ranges from undulating to rolling with most of the slopes ranging from 5 to 8 percent in gradient. A few slopes are less than 4 percent, and some are as steep as 9 percent. Strongly rolling areas and slopes steeper than 9 percent are separated as eroded or steep phases. On the whole, Clarion fine sandy loam is more rolling and has a more pronounced relief than Clarion loam.

The surface soil consists of dark grayish-brown fine sandy loam 10 to 12 inches thick, below which is lighter brown or grayish-brown compact loam or sandy clay loam. This transitional layer, which in most places is about 8 inches thick, is gritty in many places and is penetrated from above by tongues and streaks of darker colored material. The material between depths of 18 and 28 inches generally consists of yellowish-brown, light-brown, or, in some places, gray or yellow sandy clay loam. Below a depth of 28 inches the calcareous soil material is somewhat gravelly clay loam streaked or mottled with gray. Some variations in the texture of the surface soil occur within the areas mapped as Clarion fine sandy loam; here and there small areas of loam or sandy loam are included.

Natural drainage of Clarion fine sandy loam is free to excessive. The surface is somewhat rolling, and the soil is highly permeable so that it absorbs but does not retain large quantities of moisture. Crops often suffer from lack of water during the dry periods of late summer and readily become damaged during years of drought.

Practically all of Clarion fine sandy loam is under cultivation or in pasture. The sandy character of the soil makes it easy to cultivate, and it can be worked under a wide range of moisture conditions. This soil, however, contains decidedly less organic matter than does Clarion loam, and more attention must be given to maintaining the organic-matter content. Adding barnyard manure and plowing under legumes will aid in maintaining the organic-matter content. Before growing legumes like alfalfa or sweetclover, it is necessary to add lime even though the subsoil generally is calcareous. Yields of the principal farm crops are lower than on Clarion loam, with corn and oats yielding from 10 to 20 bushels less per acre and legume hay about one-half ton less. In wet seasons, however, crop yields from Clarion fine sandy loam often compare favorably with those from Clarion loam.

Clarion fine sandy loam, eroded phase.—This soil includes the rolling to strongly rolling areas of Clarion fine sandy loam but does not include the steep and hilly areas. It differs from the typical soil in that it occupies more rolling land and has a generally shallower surface layer. It is associated with the eroded phase of Clarion loam along the borders of stream valleys and with the typical soil in the morainic belts. The slope ranges from 6 to 15 percent. Probably the largest acreage has a slope between 9 and 12 percent. Areas with a slope greater than 15 percent are included with the steep phase.

The profile differs but little from that on the smoother areas, except that the dark-colored surface layer in most places is shallow and in some places is absent. The average thickness of this layer is between 6 and 8 inches, but rather wide fluctuations in thickness are common. The lower part of the profile does not differ appreciably from the profile of the typical soil.

Where the eroded phase is closely associated with bodies of typical Clarion fine sandy loam, no distinction is ordinarily made in farming the two soils, but in the places where large bodies of the eroded phase occur, the land is used either for hay or for pasture. Where this soil is cultivated, crop yields are considerably lower than they are on the typical soil, with corn ranging from 10 to 15 bushels less per acre and small grain from 5 to 10 bushels less. Drought frequently damages crops on the sandy rolling land because of the free to excessive natural drainage and low water-holding capacity of the soil. Wherever it is possible, the use of the soil for pasture or hay will result in higher production, and where it is being cultivated, additions of organic matter and the use of erosion control measures are highly desirable.

Clarion fine sandy loam, steep phase.—The steep phase of Clarion fine sandy loam occupies steep and hilly slopes along Indian Creek, the Skunk River, and their tributaries. The slope exceeds 15 percent in most places and is greater than 25 percent in some places.

The thickness of the surface layer ranges from 4 to 6 inches. In some places no dark-colored layer exists, but where present it is grayish-brown mellow fine sandy loam. The subsoil consists of yellowish-brown or grayish-brown sandy clay loam. Gravel and boulders are common throughout the soil mass.

Areas of this soil are comparatively inextensive and not very important agriculturally. Most of them are too steep for cultivation and are left in their natural condition and used for pasture. The scattered tree growth consists chiefly of oak, maple, hickory, elm, and some walnut. Where the tree growth is not too thick, bluegrass has come in and provides fair pasture.

Waukesha loam.—Waukesha loam occurs chiefly on terraces along the Skunk River and its tributaries, but a few small areas are along the lower course of Indian Creek. The terraces occupy positions from 10 to 15 feet above the first bottoms; their relief ranges from level to gently sloping. Natural drainage is good, but not excessive, both on the surface and in the soil.

The surface layer of Waukesha loam is brown or dark-brown mellow loam, from 14 to 16 inches thick. Below this, the soil material is light-brown or brown very friable heavy loam, which grades into light yellowish-brown clay loam at an average depth of 32 inches. The material shows little further change in appearance or in texture below a depth of 32 inches, although some gray mottlings occur in places. A few small areas of fine sandy loam and silt loam are included in mapping. In places in the lower parts of the terraces, the surface layer is dark grayish brown or almost black.

Waukesha loam covers a comparatively small area, but it is considered a valuable soil and is used mainly for crops. It is handled in much the same manner as the upland Prairie soils. Yields of the principal farm crops, including corn, oats, clover, barley, wheat, and alfalfa, are comparable to those obtained on Clarion loam.

LIGHT-COLORED SOILS

The light-colored well-drained soils occupy the gently to sharply rolling slopes along streams and the adjacent gently rolling ridges and smooth divides. These soils differ widely in appearance and in agricultural relationships from the more extensive Prairie soils. Their most obvious characteristic, the lighter color of the surface soils, distinguishes them from the well-drained Prairie soils and the associated poorly drained soils. The light color is due to development under a forest cover, and it is generally associated with a lower content of organic matter. The relief in the forested areas is in most places, but not everywhere, more marked than in the prairie areas; consequently, run-off and normal erosion are very active. Soil types and phases included in the subgroup of light-colored soils are Lindley loam, Lindley loam, steep phase, and Ames fine sandy loam. Lindley loam and Ames fine sandy loam are similar in general appearance; both have light-colored surface soils overlying yellowish-brown subsoils. The subsoil of Lindley loam, however, shades from yellowish brown to reddish brown; whereas the corresponding layer of the Ames soil is mottled with gray. The steep phase of Lindley loam occupies slopes where little development of a profile has taken place, and calcareous till occurs at or near the surface.

Only comparatively small acreages of light-colored soils are under cultivation and the larger part of the land is used as woodland pasture. Native trees, including red oak, white oak, hickory, elm, walnut, sycamore, maple, and bur oak, are scattered over most areas of the light-colored soils. The soils are of low productivity when cultivated, but furnish a fair amount of pasture in places where controlled grazing is practiced.

Lindley loam.—Lindley loam occupies only a small acreage in the extreme southeastern part of Collins Township. The relief ranges from undulating to rolling with slopes ranging from 5 to 15 percent. Steep and hilly areas, where the slope exceeds 15 percent, are included with Lindley loam, steep phase.

Lindley loam has a 6- to 8-inch surface layer of light-brown or grayish-brown friable loam or fine sandy loam. It is underlain by yellowish-brown sandy clay mottled with gray and rust brown. Gravel is present throughout the soil and generally is more abundant in the lower part than in the upper part. On the smoother areas a thin pale grayish-brown leached layer intervenes between the surface layer and the brown heavier textured subsoil. This leached zone in few places is more than 2 or 3 inches thick.

Most of this land is under cultivation and produces fair crops. Corn yields range from 20 to 30 bushels per acre, oats 20 to 35 bushels, and mixed hay slightly more than 1 ton. This soil generally is acid and low in organic matter, both of which conditions need to be corrected if maximum productivity is to be obtained. Control of erosion also is necessary on the more rolling areas.

Lindley loam, steep phase.—The steep phase of Lindley loam has a slope greater than 15 percent and therefore has a shallower profile than the typical soil. The principal bodies are in the southeastern part of the county and along the valleys of East Indian Creek, West Indian Creek, and the Skunk River and its tributaries. The areas along the stream valleys are not continuous but occur in association with areas of the steep phases of the Clarion soils and with bodies of Ames fine sandy loam, the latter occupying comparatively smooth divides.

Because of its steep relief, this soil exhibits very little development of a profile. The grayish-brown or light grayish-brown surface soil generally is a little darker than the subsoil, but this layer ordinarily is shallow and, in places, is entirely lacking. Yellowish-brown leached till is exposed on many of the steeper slopes, and calcareous till occurs in the vertical or nearly vertical exposures.

Practically none of this land is under cultivation. Most of it supports a scattered stand of trees, including red oak, bur oak, hickory, elm, white oak, maple, and black walnut; a dense undergrowth of hazel brush and sumac; and only a sparse cover of grass. The forested areas generally are used for pasture and wood lots, the uses for which they are best suited.

Ames fine sandy loam.—Ames fine sandy loam occurs in comparatively small bodies and strips on the uplands bordering the valleys of the Skunk River and Indian Creek. The relief ranges from almost flat and level in some places to undulating and gently rolling in others, and the slope ranges from less than 1 to as much as 8 percent, although in most places it is between 2 and 6 percent. Areas of Ames fine sandy loam in Franklin Township are gently rolling, whereas the areas east of Indian Creek in Nevada and Indian Creek Townships are more nearly level.

Cultivation has thoroughly mixed the originally distinct upper layers, but in forested uncultivated areas the several layers are well defined. Here, a thin layer of loose leaves and partly decayed organic matter covers the surface and grades into the mixed mineral and organic material below. This uppermost layer of mineral soil is grayish-brown fine sandy loam, with a fine soft-crumb structure, from 2 to 4 inches in thickness. The lower boundary of this layer is irregular and wavy; that is, it is not set off sharply from the pale yellowish-gray or gray fine sandy loam of the second layer. The second layer is strongly leached. It has a faintly developed platy structure in place and is very light gray or almost white when dry. The depth of this layer generally ranges from 3 to 8 inches in the smoother areas, and the layer is entirely absent on some of the more rolling areas. Below the leached layer is a transitional zone extending to a depth of 14 to 18 inches, which consists of yellowish-brown silt loam or loam with an irregular soft-nut structure. Between depths of about 14 and 30 inches the soil material is yellowish-brown or olive-brown clay loam or clay with a medium-nut structure. If it is dug out, the material breaks into nut-sized fragments that are hard and intractable when dry but become plastic and sticky when moistened. A gradual change occurs between depths of 30 and 36 inches, from the heavier textured material of the B horizon to the sandier lighter colored loam or clay loam of the soil parent material. Calcareous till commonly lies at a depth of 40 to 48 inches in the smooth areas but is much closer to the surface in some of the rolling areas. Gravel occurs throughout the soil mass but generally is more abundant in the lower layers.

Rather distinct variations in the texture of the surface layers and in the depth of the gray leached layer occur in different parts of the county. In sections 3 and 4 of Indian Creek Township and in section 34 of Nevada Township, the texture of the surface layer is practically silt loam. In section 32, Franklin Township, and in section 4, Washington Township on the other hand, the surface horizon is fine sandy loam or sandy loam. The sandier texture in section 32, Franklin Township, lying as it does just east of the Skunk River Valley, is due, perhaps, to the addition of sandy material brought up from the river bottoms by wind. The gray leached layer is most distinct in the level or nearly level areas, disappearing in the rolling areas. Most of this soil observed, even in rolling areas, showed evidence of leaching, but not all areas were marked by the light-gray platy layer developed in flat areas. Where areas of this soil grade into the darker colored Clarion or Webster soils, the soil included with Ames fine sandy loam has, in places, a surface layer that is darker than typical.

Ames fine sandy loam was originally covered by forest vegetation, but much of the land has been cleared and is now in cultivation. On uncleared areas the vegetation consists of oak, hickory, elm, and maple, with some hazel brush and scrub oak. Wherever the stand of trees is open, the soil supports a cover of bluegrass and affords fair pasture.

Crop yields obtained on cultivated areas of this soil are considerably lower than those obtained on the adjoining Clarion and Webster soils. Corn yields from 25 to 30 bushels per acre, oats 30 to 35 bushels, and red clover approximately 1 ton. This soil is strongly acid, and applications of lime are necessary for the successful growth of alfalfa or sweetclover. Rotations that include a high proportion of legumes or grasses and frequent additions of barnyard manure should be followed if the soil is to be made productive.

IMPERFECTLY AND POORLY DRAINED MINERAL SOILS

The imperfectly and poorly drained mineral soils occupy 37 percent of the total area of Story County. They occur on flats and depressions in the uplands, on the lower parts of terraces, and on the bottom lands along the streams. In the early history of this county most of these soils were too wet to be cultivated successfully, but with the improvement of drainage by means of tile and open ditches they have become some of the most productive soils in this county. The group includes the Webster soils of the uplands, the Bremer soils of the terraces, and the Wabash and Lamoure soils of the flood plains.

The imperfectly and poorly drained mineral soils have a number of characteristics in common. They are generally heavy in texture in the upper layers, but they also have a granular or coarse-crumb structure that renders them favorable for cultivation and the growth of plants. The content of organic matter is normally high in these soils, owing in part to the more luxuriant growth of plants and in part to the slower decay of organic residues on these soils compared with

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better drained soils. Dark colors are commonly associated with abundance of organic matter. The Webster and Lamoure soils contain lime in the upper part of the soil, though generally not in the surface layers, whereas the Wabash and Bremer soils ordinarily do not contain lime.

Webster silty clay loam.—Webster silty clay loam, the second most extensive soil in the county, occupies flat or depressed areas and smooth low-lying strips along intermittent drainageways in the uplands. It also occurs in the form of broad swales, some of which are now occupied by drainage ditches. The largest continuous body of this soil forms a broad swale in Lafayette Township, west of Story City. The surface of the land generally is flat or very gently sloping; very few of the slopes within the depressions or swales occupied by Webster silty clay loam exceed 2 percent and many are more nearly 1 percent in gradient. Because of the comparatively flat surface and the granular structure of the soil, erosion is not a problem.

Webster silty clay loam to a depth of 18 inches consists of black finely granular silty clay loam that is very friable when moist and becomes loose and powdery when dry. Below a depth of 18 inches the soil material is somewhat heavier in texture and the color changes gradually to mottled gray with increasing depth. The transitional layer between the dark surface soil and the light-gray mottled sandy clay below ordinarily consists of dark-gray silty clay, about 16 inches thick. Most of the mottlings are rust brown, first appearing at a depth of 24 inches and becoming numerous below a depth of 44 inches. Pebbles and lime concretions are common below a depth of 34 inches, in a few places occurring above that depth, and finely divided lime is present at an average depth of 18 inches. In most places gritty materials are scattered throughout the lower part of the soil, and a few boulders are within the soil and on the surface.

Some local variations occur in areas mapped as Webster silty clay loam. Although the black surface layer commonly ranges from 16 to 20 inches in thickness, in a few places it is only 12 or 14 inches thick. Some areas of soil in slightly elevated positions have a loam or silt loam texture but are included with the silty clay loam because of their small size. Some depressed areas of poorly drained silty clay or clay, not large enough to be represented on the map, also are included. Some areas of Webster soils, associated with areas of Dickinson fine sandy loam or Clarion fine sandy loam, are sandy in the topmost few inches because of local wash from the surrounding uplands. In the larger areas of this soil, particularly in the area in Lafayette Township, the texture is heavy silty clay loam or silty clay. Where areas of Webster soil adjoin bodies of peat or muck, a narrow transitional zone of soil generally contains a large quantity of organic matter, and in places small areas of peat and muck are included with this soil in mapping.

Some spots around the edges of depressions or on elevated sites associated with the Webster soils are highly calcareous and are known locally as "alkali spots." The soil in such spots is light gray and has a fine soft-crumb structure. These light-colored spots are readily apparent in a plowed field and show up in the poor stands of corn. Alkali spots are more numerous in Webster loam than in Webster silty clay loam, and very few occur in areas of Webster silty clay. The characteristics of these so-called alkali spots and methods of management are discussed more fully in a later section of this report.

When properly drained, Webster silty clay loam is highly productive, and practically its entire acreage is either under cultivation or is in rotation pasture. The soil is inherently fertile and is also relatively "new," as it was one of the last soils to be artificially drained. Prior to the improvement of drainage by ditches or tile, many areas were under water part of the spring and fall and generally were too wet for successful cultivation. The soil drains readily, however, because of its porous granular structure.

Organic matter and plant nutrients are abundant in Webster silty clay loam. Ordinarily, the surface layer contains enough lime to make it neutral or very slightly alkaline in reaction, so that applications of ground limestone are not needed for growing alfalfa or sweetclover.

Where areas of the Webster soils are large and continuous, corn is perhaps grown more often than are all other crops combined. Growing corn for a number of years in succession has been rather common, and high yields are usually obtained, but the use of rotations including legumes or grasses is a much more desirable practice. Where Webster silty clay loam occurs in small patches scattered throughout larger bodies of Clarion loam, or vice versa, the cropping system ordinarily includes the use of small grains and legumes in the rotation more often than on the large areas of this soil.

Corn often yields 75 to 80 bushels an acre on the well-managed Webster soils in favorable years, but the average yields obtained on this soil are between 45 and 55 bushels, depending on the management. During droughty years the production of some corn on the Webster soils is more probable than it is on any other soil of the uplands, whereas in wet years areas lacking adequate drainage do not yield well. Small grains grow rankly on the Webster soils as a rule, and the grain may lodge before the crop can be harvested. With the introduction of new stiff-strawed varieties of oats, such as Iowa 105, however, this difficulty has been partly overcome. Yields of oats range from 40 to 55 bushels per acre but may reach 70 or 75 bushels in good years. Barley yields from 30 to 35 bushels, and winter wheat 25 to 30 bushels. Hay crops, especially sweetclover, thrive on the Webster soils, yielding from 2 to 3 tons on well-drained areas. Alfalfa does well where drainage is adequate. It yields from 3 to 4 tons per acre in three cuttings, but sometimes the crop is damaged by an accumulation of water in depressions during the winter.

Webster loam.—Webster loam is an important agricultural soil in Story County, even though it is not so extensive as Webster silty clay loam or Clarion loam. It occurs in close association with both Webster silty clay loam and Clarion loam, normally occupying an intermediate position between the two soils. Essentially, Webster loam is transitional between the well-drained Clarion soil, on the one hand, and the slow-draining Webster silty clay loam, on the other.

Webster loam differs from Webster silty clay loam chiefly in the color, texture, and thickness of its surface layer, which consists of very dark grayish-brown rather than black loam, only 8 to 10 inches thick. The transitional layer between the uppermost layer and the calcareous till is somewhat thicker and has a distinctly more granular structure in Webster loam than in Webster silty clay loam. The soil material gradually becomes heavier textured with increasing depth, and below a depth of 20 inches it consists of clay loam containing some gritty particles. Between depths of 10 and 20 inches the dark color of the surface layer changes gradually to light gray, and below a depth of 20 inches faint mottles of grayish yellow appear. Numerous pebbles and lime concretions and a few boulders are present in the soil material below a depth of 20 inches. Below a depth of 26 to 30 inches the calcareous till ordinarily is sandy clay loam in texture.

Variations within this soil are numerous, the principal ones being in the texture of the surface layer, which ranges from coarse sandy loam to heavy loam. Within the large body of Webster silty clay loam in Lafayette Township the texture of the surface layer is heavy loam approaching clay loam, but where associated with the Dickinson soils or with Clarion fine sandy loam the texture of the surface layer is more nearly fine sandy loam or very fine sandy loam. In such areas, layers of fine sand, from 12 to 18 inches in thickness, cover the surface in some places.

Small areas of a highly calcareous soil, known locally as "alkali spots," occur as narrow bands around former ponds, and many such areas are included with this soil in mapping. The soil in the alkali spots to a depth of 18 inches is gray very fine sandy loam or silt loam, underlain by lighter colored and in places lighter textured material. The entire soil mass is highly calcareous, the concentration of calcium carbonate being sufficient to injure most crops. These alkali spots are described and discussed more fully in a later section.

The relief of Webster loam is level to slightly undulating. Occurring, as the soil does, in positions between the low knolls or ridges and depressions, it generally has a slight slope, although some areas are very nearly flat. The slope ranges from less than 1 to about 4 percent, but in most places it is less than 2 percent. The gentle slope and the high permeability of the soil material eliminate the danger of harmful erosion.

Drainage is somewhat better in this soil than in Webster silty clay loam, partly because of its greater porosity and partly because of its generally higher position. Artificial drainage is necessary for maximum productivity, however, even though satisfactory crops can be grown in many years without it. Most areas of Webster loam are now tiled and are being cultivated.

Crop yields obtained on Webster loam are similar to those on Webster silty clay loam. Yields of small grains are commonly higher on the loam because its better drainage and slightly lower content of organic matter, compared with those features of the silty clay loam, tend to reduce the hazard of lodging. Similar management practices are followed on the two soils.

Webster silty clay.—Webster silty clay occupies the more depressed and poorly drained areas in the upland and is commonly associated with other Webster soils, which occupy slightly higher ground. The total acreage of this soil is small, so that it has no great agricultural importance.

Webster silty clay consists of black silty clay or clay to a depth of 18 or 20 inches, below which is a dull dark-gray clay that is very plastic when wet. Little change occurs in the soil below a depth of 20 to 24 inches, and the principal change in the entire soil is the gradation from the dark-colored surface soil to the glacial till. This soil contains large quantities of organic matter in the upper layers, and in places a thin layer of muck occurs on the surface of the mineral soil in low ponded areas. The entire soil generally is calcareous. Boulders are numerous in places.

Small roughly circular or oval areas representing the sites of former ponds make up the larger acreage of Webster silty clay, and they occur over the entire county. Artificial drainage has been installed in most of these formerly ponded areas, and they are now cultivated with the rest of the field, but yields are usually low. In seasons of high rainfall, the Webster silty clay areas become wet spots, which handicap farming operations and reduce normal yields. The largest bodies of this soil are in sections 26 and 27 of Palestine Township, section 5 of Lafayette Township, and section 24 of Sherman Township. These areas have not been drained artificially and therefore hold water during most of the year. They are of little value agriculturally, although they do support some coarser vegetation that can be grazed.

Because of its heavy texture, Webster silty clay tends to puddle and bake if it is not worked under optimum moisture conditions, but as the soil occurs in small areas associated with better drained soils, it is not feasible for the farmer to wait for optimum conditions on these silty clay spots before working his fields. The physical condition of the silty clay is, therefore, commonly undesirable. Wherever possible, fall plowing is to be preferred, as freezing and thawing during the fall and spring tend to break up the clods and make the soil more friable. If carefully managed, this soil is highly productive in favorable years, but over a long period crop yields average much lower than those obtained from other Webster soils.

Bremer silty clay loam.—Bremer silty clay loam is confined to smooth areas that appear to be terraces or remnants of small silty outwash plains. This soil occurs principally on the terraces along the lower part of the Skunk River. Very small areas are in section 8 of Lafayette Township, section 30 of Franklin Township, and section 1 of Lincoln Township. Most of this soil is level or slopes very gently toward the first bottoms, with which it merges in many places. It occupies positions only slightly higher than the bottom land, but it seldom is flooded. Some areas of Bremer silty clay loam on outwash terraces lie as much as 20 feet above the first bottoms.

The 18-inch surface layer of Bremer silty clay loam is dark grayish-brown silty clay loam, distinctly plastic when wet. It is underlain by a layer, 14 inches or less thick, of dark grayish-brown silty clay mottled with rust-brown stains. The material in the upper layers changes gradually toward a heavier texture and a dull-gray color with increasing depth. Between depths of 32 and 42 inches the soil material is a dark steel-gray sandy clay, highly mottled and streaked with lighter gray and with rust brown. The soil material shows little change in either color or texture below a depth of 42 inches.

Variations in texture and thickness of the surface layer occur in places. In places where this soil is associated with sandy soils, its surface layer generally is sandier than the layer just described. In areas in Washington Township this layer is thicker and darker colored than is typical and overlies a gritty slate-colored subsoil. The areas of deepest soil are observed on the west side of the Skunk River northwest of Cambridge. In a few areas the surface layer is neutral or slightly alkaline in reaction, instead of slightly acid, as it is normally.

Natural drainage is fair to slow over most of Bremer silty clay loam, although in some areas crops can be grown successfully without the use of ditches or tile. Slow surface run-off from the flatter areas often delays field work, however, and results in damage to crops in wet years. Much of this soil can be farmed without artificial drainage, but in most places some tile is necessary for the highest production.

Productivity of the better drained areas of this soil is high, either for crops or for pasture grasses. Corn yields from 45 to 50 bushels an acre on well-managed tracts in favorable years. Small grains and legumes also do well. Fair to good stands of alfalfa or sweetclover can be obtained without the addition of lime, but applications of lime are helpful in getting good stands.

Bremer loam.—Bremer loam occupies comparatively low terraces with relief similar to that of Bremer silty clay loam. It has good natural drainage, and practically all of it is above normal overflow.

The 15-inch surface layer of Bremer loam is dark-brown or dark grayish-brown friable loam. It is underlain by very dark brown silty clay loam, which passes into brown somewhat gritty clay loam mottled with rust brown. Streaks of yellow are also present in this layer, beginning at or near a depth of 24 inches.

Practically all of this soil is under cultivation, and the crop yields obtained are about the same as or slightly higher than those on Bremer silty clay loam. The organic-matter content of the surface layer is lower than that of Bremer silty clay loam, but the lighter texture of the surface soil makes it easier to cultivate. This soil warms more quickly than the silty clay loam in the spring, because of its better drainage.

Wabash silty clay loam.—This soil occurs in the first bottoms of the principal streams. It occupies level or depressed areas near the outer margins of the flood plains where slowly moving or stagnant water allows silt and clay particles to settle. Drainage is distinctly slow in most areas.

The surface layer of this soil is very dark grayish-brown or black silty clay loam, from 12 to 16 inches in thickness. This grades into grayish-brown rather compact clay extending to a depth of 28 inches. Both of these layers have a poorly developed crumb structure but are moderately friable. Below a depth of 28 inches the soil material shows few changes from dull-gray silty clay or clay mottled with brown and yellow stains, except where layers of fine sand or gravel occur.

Several variations from the soil described are included in mapping. In an area south of Maxwell, in section 27, Indian Creek Township, the soil has a distinct gray layer between depths of 10 and 18 inches but otherwise resembles typical Wabash silty clay loam. In some of the lower depressions along the edges of the stream bottoms, where drainage is very poor, the surface layer consists of black silty clay and grades into dull-gray clay with blue-gray and brown mottlings. These areas remain in a swampy or marshy condition throughout practically the entire year.

Nearly all of the better drained areas of Wabash silty clay loam are in cultivation, and the remaining acreage is used for pasture. Cultivated areas are situated mainly in Grant, Union, Washington, and Franklin Townships, on the flood plains of Squaw Creek and the Skunk River. Most of the cultivated land has slow but fair drainage, though it is all subject to infrequent overflow. Surface ditches have been dug to help carry away excess water during heavy rains.

This soil is highly productive when adequately drained, and in normal seasons yields of corn ranging from 50 to 55 bushels an acre are not uncommon. Wabash silty clay loam is not so well adapted to small grains, however, because of its heavy texture and high content of organic matter. Small grains, particularly oats, tend to grow rankly and lodge before they can be harvested. The soil is well suited to the production of winter wheat, and yields of 25 to 30 bushels an acre are often obtained. This soil is not calcareous, but sweetclover and alfalfa do fairly well without the use of lime.

Wabash loam.—Wabash loam occupies narrow strips along the main streams over the entire county, but it is more extensive along the Skunk River and Squaw Creek. The surface is fairly smooth with some variations in relief where old channels and depressions cut the land.

The surface soil is very dark grayish-brown or black mellow loam averaging 14 inches in thickness. The subsoil, between depths of 14 and 24 inches, is very dark grayish-brown heavy loam or clay loam, faintly mottled with rust brown. Below a depth of 24 inches the soil material is dark-gray silty clay mottled with light gray and rust brown containing many soft iron concretions. Many variations in texture occur in the surface layer of this soil. Near the stream channels the texture in general is sandy, ranging from sand to fine sandy loam, whereas near the outer margins of the bottoms it approaches clay loam.

This is not an important agricultural soil, as its area is not large, and only part of it is in cultivation. Most areas of this soil are used for pasture and provide good grazing during most years. The possibility of overflow and destruction of crops renders cultivation hazardous and uncertain. Along the stream channels this soil supports small belts of scattered trees including oak, elm, hickory, butternut, black walnut, cottonwood, and willow.

Where cultivated and protected from overflow, general farm crops can be grown and good yields are obtained. This soil is easy to cultivate and can be worked under a comparatively wide range of moisture conditions. Corn yields range from 40 to 50 bushels an acre in favorable years.

Wabash silty clay.—Wabash silty clay occupies the broad flat bottoms of the Skunk River in Franklin, Washington, Grant, and Union Townships. This soil closely resembles Wabash clay as mapped in the Skunk River Valley in Polk County just south of Story County. Areas of this soil range from ¼ to 1 mile in width and are several miles in length. Entire farms are included within bodies of Wabash silty clay.

The surface layer of Wabash silty clay consists of black silty clay or clay high in organic matter extending to a depth of 24 inches. In places the texture of the plowed layer is lighter than silty clay because of the deposition and mixing of recent sandy alluvium. The inherent heavy texture of the surface soil is disguised somewhat by the crumbly or granular structure. Between depths of 24 and 44 inches the soil material is steel-gray tenacious clay, massive in place and rather difficult to break down. Between depths of 44 and 50 inches the clay becomes somewhat mottled with brown and yellowish brown and in some places contains appreciable quantities of fine sand. Below a depth of 50 inches is yellowish-gray sandy clay highly mottled with brown and containing many iron concretions. Layers of fine sand may occur in any part of the soil profile.

Because of its low elevation and flat surface, this soil was subject to annual overflow by the Skunk River during early days, but since the stream channel has been straightened the danger of overflow has decreased. Open ditches have been connected to the new channel, in order to hasten removal of surface water from the bottoms and improve the drainage.

Corn and winter wheat are the principal crops grown on Wabash silty clay. Yields of corn ranging from 60 to 75 bushels an acre are common in seasons of normal rainfall, but the average yield is between 45 and 60 bushels. Winter wheat often yields 30 to 35 bushels. During seasons of excessive rainfall crops often suffer because this soil drains slowly, but in periods of drought crops suffer less on this than on any other soil in the county. During the severe drought of 1934 corn returned 35 to 40 bushels an acre in many fields on this soil, whereas, on some of the upland soils it produced only 15 to 20 bushels and in many fields failed completely. This soil does not effervesce when treated with weak acid, but it seems to contain enough lime for the successful growth of sweetclover and alfalfa. Yields of 3 to 4 tons of alfalfa per acre are obtained.

This soil is difficult to handle and can be properly cultivated only within a narrow range of moisture conditions. If it is plowed or worked when too wet, hard clods form, which are difficult to break, but if it is worked in a fairly moist condition a good seedbed can be prepared and maintained. Fall plowing is desirable and should be practiced whenever possible. Careful management and cropping will improve the physical condition of the soil, and, under good management, Wabash silty clay should remain in a high state of productivity for a long time.

Wabash fine sandy loam.—Wabash fine sandy loam is a comparatively inextensive soil and has but little agricultural importance.

It is developed in small areas along the Skunk River, Squaw Creek, Ballard Creek, Indian Creek, and Worle Creek. It usually occurs as recent wash along drainageways issuing from higher lying areas of sandy soils.

This soil consists of dark-brown or almost black friable fine sandy loam to a depth of 10 or 12 inches, below which is more compact and lighter colored material. This material gradually becomes heavier textured with increasing depth, and at a depth of 28 or 30 inches it is dark grayish-brown heavy loam or clay loam. Along the new channel of the Skunk River in Washington, Grant, and Union Townships the soil consists of a layer of gray or dark-gray fine sandy loam or fine sand, 8 to 10 inches thick, overlying Wabash silty clay. Along the two branches of Indian Creek, areas of Wabash fine sandy loam and Sarpy fine sandy loam are so intricately intermixed as to make separation impracticable.

Unless artificially protected, this soil is subject to rather frequent overflow. Small protected areas are in cultivation, and the rest of the land is used largely for pasture. Many of the pasture areas support a scattered tree growth of oak, elm, willow, and some black walnut, in addition to the grasses. Where it can be successfully cropped, this soil produces fair yields of corn and small grain. Wabash fine sandy loam is easily cultivated and warms quickly in spring, but most areas would be improved by additions of organic matter.

Lamoure silty clay loam.—This soil occupies only a small acreage in Story County, chiefly along streams with a low gradient. The largest areas are on the first bottoms of Middle Minerva Creek in Lincoln Township and in the northwestern corner of Warren Township along East Indian Creek. In section 7 of Warren Township, Lamoure silty clay loam occupies an old lake bed or slough that has been recently drained.

To a depth of 8 or 10 inches, Lamoure silty clay loam consists of very dark grayish-brown or black friable silty clay loam having a soft-crumb structure. The favorable structure is due mainly to the high content of organic matter and lime. The layer below this consists of dull grayish-brown clay loam grading into silty clay or clay in the lower part. Below a depth of 30 to 36 inches the subsoil consists of dark steel-gray compact clay mottled with brown and gray. This gives way to gray sandy clay, highly mottled with brown, below a depth of 40 to 50 inches. The clay below a depth of 36 inches has a massive structure in place and is very plastic when wet. In many places gravel is present in the lower layers, and carbonates occur throughout the soil. In some places carbonates are present in large enough quantities to injure crops.

Areas of Lamoure silty clay loam are level, and natural drainage is poor. Ditches and tile drains have been installed in some of the larger areas, which are now being cultivated with fair success. Corn, the principal crop, yields from 50 to 60 bushels an acre in normal seasons. Oats tend to grow so rankly that they lodge, and average yields are low. Hay crops generally do well but are grown only on small acreages. The narrow strips of Lamoure soils along creeks and drainageways are subject to annual overflow and are used chiefly for pasture. Bluegrass makes excellent growth on such areas and affords good grazing.

Lamoure loam.—This is an inextensive soil, occurring chiefly in narrow strips along the smaller streams in the northern part of the county. The most extensive bodies are along Bear Creek and Long Dick Creek in Howard Township. This soil is closely associated with Lamoure silty clay loam along Middle Minerva Creek, Keigley Creek, and East Indian Creek in Lincoln, Lafayette, and Warren Townships, respectively, and small areas border minor streams in Richland, Milford, and Indian Creek Townships.

The 12- to 14-inch layer of the soil is very dark grayish-brown or black friable loam. This grades into dull-gray heavy loam or clay loam. The material gradually becomes heavier. textured with increasing depth, and below a depth of 36 inches it is dark-gray clay loam or clay. Mottlings of yellow and brown are common in the lower part of the subsoil. Along East Indian Creek in the northwestern part of Warren Township, considerable coarse sand occurs in the subsoil at a depth of 24 to 30 inches, and the texture approaches sandy clay. Carbonates are plentiful throughout the entire soil mass.

About 75 percent of the total area of Lamoure loam is in permanent pasture and supports a good stand of grass, and the remaining acreage is used for cultivated crops with various degrees of success. Where drainage has been improved artificially and the land protected from overflow, crop yields are equal to those obtained on Lamoure silty clay loam. Lamoure loam can be worked successfully under a wider range of moisture conditions than the heavy Lamoure soils, and it warms more quickly in the spring.

POORLY DRAINED ORGANIC SOILS

Peat and muck, occupying a total area of only 1,920 acres, or 0.5 percent of the area of the county, comprise the group of poorly drained organic soils. Areas of muck have been mapped in every township in Story County, and peat beds are in all townships except Indian Creek, Washington, and Union. These two organic soils occur together in many places, with peat occupying the central part of an area and muck the surrounding edges where the deposit is thin. The principal difference between the two soils is the relative stage of decomposition of the organic residues. Muck is called black peat by some farmers, in order to distinguish it from brown peat or red peat—terms used to designate raw peat areas.

Peat and muck are derived from plant residues deposited in swampy areas, such as shallow ponds and lakes, where vegetation grows luxuriantly. The residues that fall into the water when the plants die tend to decay slowly. These partly decomposed organic remains gradually accumulate on the bottom of the pond or lake, and deposits of peat are slowly formed. Peat deposits occur in old lake beds, ponds, and marshes in depressions in the till plain uplands or in the bottom lands along the streams. Peat is composed of partly rotted vegetable matter in which the original structure of many plants can be recognized.

Swamp grasses, sedges, rushes, flags, and reeds were the sources of most of the organic residues composing peat in Story County.

Muck represents a more advanced stage in decomposition than does peat. The plant remains in muck soils have decayed sufficiently to have lost their original form and structure and have been reduced to finely divided material. The change from peat to muck begins whenever decomposition processes become more active, through either natural or artificial improvement of drainage or sometimes because of cultivation of the deposit.

Natural drainage is poor in areas of peat and muck, and artificial improvement of the drainage is the first step in the utilization of the land for crop production. Care must be exercised, however, to prevent excessive lowering of the water table while providing adequate drainage. Where adequate drainage can be provided, these soils may be very valuable for the production of truck crops. Difficulties in drainage, problems of weed control, and the possibility of damage from early frosts are serious handicaps in the development of areas of peat and muck soils.

Peat.—Peat beds, ranging in size from 1/4 to 30 acres, are scattered throughout all sections of the county. The largest areas are in sections 4 and 11 of New Albany Township, section 1 of Warren Township, and sections 28 and 33 of Nevada Township. The areas are most numerous in Palestine Township. In its natural undrained condition, peat has no agricultural value, but at least 90 percent of the total acreage has been artificially drained and is either under cultivation or in pasture.

The peat deposits of Story County consist of a dark reddish-brown spongy mass of partly decayed vegetable matter to a depth of 6 to 12 inches. This material is underlain, to a depth ranging from 2 to 3 feet, by less thoroughly decayed, more fibrous, and lighter colored vegetable matter. In the second layer the original form and structure of the plant materials are commonly intact. The depth of peat above mineral soil materials is extremely variable, being greater in the more extensive deposits, but, as a general rule, gray highly calcareous clay lies within a depth of 3 feet.

After peat beds have drained, the first crop planted is usually a mixture of timothy and alsike clover, which can be pastured for several years before cultivation is attempted. When first cultivated, peat deposits are commonly planted to corn, but the crop does not thrive unless special applications of fertilizer are made. Peat warms slowly in the spring, so that corn makes a poor start, and the high nitrogen content encourages prolonged growth in the fall, exposing the crop to damage from frost. Applications of fertilizer containing phosphate and possibly potash greatly benefit corn grown on peat deposits. Commercial fertilizer mixtures, such as 0-20-0 or 0-20-10,[12] are beneficial in most places. Small grains grow too rankly and tend to lodge before they can be harvested, but some mixed-hay crops can be grown successfully.

Vegetable crops are generally suited to peat soils but are grown to only a small extent in this county. Potatoes, onions, and celery

[12] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

are the principal crops produced, and the application of commercial fertilizer containing phosphorus and potash is usually necessary.

Muck.—Muck is widely distributed over Story County in small irregular areas ranging in size from less than 1 acre to about 60 acres. The largest bodies are in section 35 of Palestine Township, section 13 of New Albany Township, and section 14 of Warren Township. Areas are most numerous in Palestine Township. The total acreage of muck, although small, exceeds that of peat.

In many places muck deposits are associated with the Webster soils, and the boundaries between these soils are more or less arbitrary. On account of their small extent, some areas of muck are included with the Webster soils in mapping.

The surface layer of muck consists of black fluffy material extending to a depth of 6 or 8 inches. It is a mixture of mineral and organic matter. This layer includes from 25 to 35 percent of well-decomposed organic residues and a very small percentage of fine sand. The remainder is silt and clay, with silt predominating. Most of the areas have a brown peaty layer, 4 to 6 inches thick, directly beneath the surface layer. This material is lighter colored and not so thoroughly decomposed as the overlying material. The brown peaty layer generally rests on calcareous mineral matter of mottled gray clay. Small shells are numerous on the surface of the muck, as a rule, indicating that it is highly calcareous.

Approximately 90 percent of the total area of muck in Story County has been drained and is either being cultivated or used for pasture. On the whole, this soil is better adapted to general farming than are the peat deposits, but applications of fertilizers containing phosphorus and potassium are usually desirable. Areas of muck are most commonly used for growing corn, some are used for vegetable crops, a few for small grains or hay, and some are pastured. The use of muck for small grains generally is not desirable, as the crops tend to grow rankly and to lodge. Hay crops do well but are not grown to a great extent, perhaps because the farmers think that the muck areas should be sufficiently fertile for the production of cash crops. Corn is commonly subject to frost damage on muck as well as on peat, although perhaps not to the same extent. Application of fertilizers containing phosphorus promotes earlier maturity of the corn crop and increases its chances of escaping frost injury.

Some areas of muck are as highly calcareous as are the "alkali spots" in the Webster soils. Corn commonly suffers injury when grown on such highly calcareous areas, but the damage can be reduced by the addition of potash fertilizers and in some places phosphates also.

EXCESSIVELY DRAINED SOILS

The excessively drained soils have as a common characteristic a high permeability, largely because they are sandy or gravelly. They absorb water readily but do not retain large quantities of it because of their coarse textures, and crops suffer during even short periods of drought. Members of five series, the Dickinson, Thurman, O'Neill, Buckner, and Sarpy, are mapped in Story County and in the aggregate occupy 3.2 percent of the total area.

The Dickinson series, represented by the fine sandy loam, has been formed under grass vegetation from sandy glacial drift, which in places contains appreciable quantities of gravel. The soil has a dark-brown or brown surface layer that grades into lighter colored and sandier material. It occurs in the till plain and in morainic sections.

Thurman loamy fine sand occurs in a band of irregular width along the east side of the Skunk River Valley south of Ames. The soil is formed from sandy materials of variable thickness on the uplands adjacent to the river valley.

The loam and fine sandy loam of the O'Neill series are mapped. These soils have dark-brown surface layers grading through a yellowish-brown transitional zone into light-colored sand or gravel. They occupy terraces along the larger streams, where the relief ranges from nearly level to gently rolling.

The Buckner soils are similar to the Dickinson soils in profile characteristics but were formed from sandy materials on fans and terraces in stream valleys. In general the terraces or fans are 10 feet or more above the flood plain of the stream, and their relief ranges from level to gently sloping. Bodies of Buckner fine sandy loam have developed from local wash and creep, in fanlike areas bordering the uplands.

Sarpy fine sandy loam borders Indian Creek and its two branches in the southeastern part of the county. This soil consists of a mixture of sandy materials and contains a little silt and clay. It lies in the lower parts of the bottoms next to the stream channel. Most of it is subject to annual overflow and has a rough, irregular surface.

Dickinson fine sandy loam.—This soil is widely distributed over the county as small areas in the till plain, but the largest bodies occur in the morainic area crossing Lafayette, Howard, and Milford Townships. The relief is generally rolling or hilly, with a slope ranging from 5 to 15 percent. Within the till plain, Dickinson fine sandy loam generally occurs in the form of mounds, knolls, or ridges scattered throughout larger bodies of Clarion loam. In the moraines the Dickinson soil is associated with Clarion fine sandy loam, and lower layers are calcareous in many places.

Over wide areas the soil has a surface layer of dark grayish-brown fine sandy loam, to a depth ranging from 8 to 16 inches and averaging about 12 inches. The next lower layer, to a depth of 24 to 28 inches, is brown or yellowish-brown fine sandy loam or loamy fine sand. Below this, the soil material is yellowish-brown or yellow incoherent fine sand. In many places pebbles and boulders are in the subsoil, which, in some areas, approaches sandy clay loam in texture. No lime is present in the surface layers of the soil, but the lower layers are calcareous in many places.

As much Dickinson fine sandy loam occurs in small areas closely associated with larger bodies of Clarion soils, almost all of it is under cultivation. The individual areas are comparatively small, generally occupying only a few acres in a field. In seasons of ample rainfall crop yields compare favorably with those on Clarion fine sandy loam, but average yields are low. The soil absorbs water readily but retains very little moisture because of its sandy, porous character. Crops suffer from lack of moisture even during short periods of drought and are sometimes damaged by blowing sand, especially in the spring. Additions of coarse strawy organic matter will help to reduce the hazard from soil blowing, but the productivity of the soil will tend to remain low.

Thurman loamy fine sand.—This soil occurs chiefly on ridges and slopes of the upland along the eastern side of the Skunk River Valley in Grant and Union Townships, and small areas occupy prominent ridges along the valley of Squaw Creek in Franklin and Washington Townships. The total acreage is small.

This soil occurs as deposits of sand, part of which is probably glacial drift, but a part seems to have been brought up by wind action from the valleys of the streams. Certainly the thicker deposits are associated with the wider bottoms of the stream valleys. The sand deposit generally is thicker on the upland immediately bordering the river valley and becomes thinner with increasing distance eastward.

Because of its coarse texture, Thurman loamy fine sand has very little profile development. The 16- to 18-inch surface layer is dark-brown loamy fine sand that is slightly coherent in place. It crumbles readily when removed, however, and loses its structure rapidly under cultivation. Below a depth of 16 inches is a gradational layer about 10 inches thick consisting of brown or yellowish-brown fine sand, and this, in turn, grades into light yellowish-brown or yellow sand. The maximum thickness of the sandy material over glacial till is about 8 feet, but more commonly the sandy clay loam of the till lies from 5 to 6 feet below the surface.

This soil has little agricultural value. After a short period of cultivation the material in the surface layer loses its weak structure and tends to drift rather badly. Great care must be practiced in selection of crop rotations and in farm operations in order to keep the sandy soil from blowing. The crops grown, usually with only limited success, include some melons, vegetables, corn, and small grains, and more recently soybeans.

O'Neill loam.—This soil occupies a larger acreage than any other soil on the terraces. It occurs in all parts of the county along the different streams. The largest single area is south of Ames just below the junction of Squaw Creek with the Skunk River. The terraces occupied by O'Neill loam generally lie from 20 to 30 feet above the normal water level of the larger streams and from 10 to 15 feet above the channels of the smaller streams. The surface ranges from level or undulating to gently rolling.

Numerous variations occur within bodies of O'Neill loam, but only the dominant profile and some of the chief variations are described and the probable range in characteristics indicated. The 10-inch surface layer is dark-brown friable loam. It grades into a 6- to 8-inch layer of dark-brown gritty loam. Below a depth of about 18 inches the soil material is brown compact sandy clay loam, which grades into yellowish-brown sandy loam at a depth of about 24 inches. This material, in turn, generally rests on a bed of coarse sand or gravel from 5 to 20 feet in thickness. In places, more or less gravel and coarse sand occur throughout the soil, but the quantities of both materials generally are less in the upper layers. Small boulders are present in places throughout the soil. This soil contains no calcium carbonate.

The more common variations are those of texture of the surface layers, and small bodies of sandy loam and fine sandy loam are included in many places. Generally speaking, the soil is more sandy and porous and the depth to gravel is less nearer the stream channels, whereas the texture of the surface layer is heavier and the soil is less permeable where the terraces join the upland. The upper layers ordinarily are thinner and the texture is lighter in the more rolling areas.

Bodies of O'Neill loam with a profile varying from the typical one are on the south and east sides of Long Dick Creek, in sections 16, 17, 18, 19, and 20 of Howard Township, and on the south and east sides of Bear Creek, in sections 22, 27, 28, 32, and 33 of Howard Township. In these areas the soil has a 14-inch surface layer of dark-brown or very dark grayish-brown friable loam. Between depths of 14 and 36 to 40 inches the soil consists of yellowish-brown compact sandy clay loam containing fine sand in the upper part and considerable coarse sand in the lower part. Beds of coarse sand and gravel occur at a depth of 36 to 40 inches. This soil is more retentive of moisture than typical O'Neill loam and is better suited for general farm crops. The areas appear to be small outwash plains with level to undulating surfaces.

A few small areas in Warren, Lafayette, and Washington Townships also are included with O'Neill loam, even though the subsoil is calcareous. Such areas have the same general appearance and are formed in the same way as the rest of O'Neill loam.

Practically all of O'Neill loam is under cultivation, and corn, small grains, and hay are the principal crops. Yields of corn range from 25 to 30 bushels an acre, but often yields of 40 to 45 bushels are obtained in seasons of high rainfall. Oats are somewhat better suited to this soil than corn, as the oat crop usually matures before the hot, dry weather begins. Yields of oats commonly equal or slightly exceed yields of corn. Red clover produces 1 to 1½ tons of hay per acre without liming, but the application of ground limestone is usually needed for the best growth of alfalfa and sweetclover.

In dry summers or even during short periods of drought, crops growing on O'Neill loam commonly suffer from a shortage of moisture, as the soil is porous and does not retain large quantities of moisture. The use of more legumes and green-manure crops in the rotation and the application of barnyard manure will help to maintain the content of organic matter in the soil and will increase its productiveness somewhat, but some drought hazard will continue to be associated with crop production on this soil.

In addition to its use for agriculture, bodies of O'Neill loam are commonly the sites of gravel pits or sand pits. Practically all of the graveled roads in this county were surfaced with gravel from local sources, and building sand of good quality is associated with the gravel deposits in most areas.

O'Neill fine sandy loam.—Most areas of this soil occur on lower terraces than O'Neill loam, but in many places the two soils are closely associated. Some areas of fine sandy loam have profiles that appear to be overwashed loam covered by a rather thick layer of sandy materials. In general, the relief of O'Neill fine sandy loam resembles that of O'Neill loam.

O'Neill fine sandy loam consists of dark-brown or dark grayish-brown fine sandy loam, to a depth of 12 to 16 inches, where it grades into brown seemingly more compact fine sandy loam or loamy sand. Both color and texture gradually become lighter with increasing depth, until the soil material passes into beds of coarse sand or gravel between depths of 30 and 36 inches. In places the gravel or coarse sand layers lie more than 3 feet below the surface.

Most areas of O'Neill fine sandy loam are under cultivation, and crop yields are comparable to those obtained on O'Neill loam. Truck crops are grown on small areas of this soil and are sold locally, but the total production is small. Crops growing on O'Neill fine sandy loam commonly suffer from drought in dry seasons, but, perhaps, to less extent than they do on O'Neill loam. Drainage is more rapid than is desirable, but the crops can obtain a larger proportion of the water retained by this soil than on the loam. The use of green-manure crops, barnyard manure, and light applications of lime are recommended where the soil is to be cultivated.

Buckner loam.—Most of the area of Buckner loam occurs on terraces or fans along the Skunk River, but some small areas are along East Indian Creek and Middle Minerva Creek. This soil occupies positions from 10 to 20 feet above the normal water level of the streams and lies well above overflow. The land ranges from level to undulating, and natural drainage is good to excessive.

This soil to a depth of 18 inches consists of dark grayish-brown mellow loam, below which the color becomes more gray and the content of fine sand increases. The gray transitional zone is approximately 6 inches thick, and it is underlain by yellowish-brown loam or sandy loam. The soil material below a depth of 24 inches in most places is yellow coarse sandy loam containing some gravel, but in some places a layer of yellowish-brown sandy clay loam occurs between depths of 36 and 48 inches. At a depth of 4 to 6 feet, beds of fine sand and gravel occur in most areas. No part of the soil is calcareous.

Variations from the profile described in the preceding paragraph are numerous and widely scattered, the principal variations being in the thickness and texture of the surface layer. The texture ranges from sandy loam to loam, and the thickness of the upper layer is as much as 3 feet in some places. Sandy loam or fine sandy loam textures occur in a number of places in Franklin, Howard, Grant, Nevada, Washington, and Union Townships. In many places the texture of the surface layer of this soil varies markedly within a single body.

Most areas of Buckner loam are under cultivation, and crop yields obtained are slightly higher than those on the O'Neill soils. A small acreage is used for growing truck crops, but corn, small grains, and hay are the common crops. This soil is easily worked; it warms quickly in the spring, but does not retain large quantities of moisture, although it holds more than the other sandy soils on terraces. Additions of organic matter, in the form of green manures or barnyard manure, are desirable for improvement of this soil.

Buckner fine sandy loam.—This soil has a dark-brown or very dark grayish-brown surface layer, ranging in thickness from 16 to 24 inches and averaging about 20 inches. The soil material is mellow fine sandy loam containing variable quantities of organic matter. Between depths of about 20 and 32 inches, the color of the soil material changes gradually from dark brown to light grayish brown. Buckner fine sandy loam is developed along the outer edge of the first bottoms of the Skunk River on local fans bordering the uplands. The relief is gently sloping, and drainage is good to excessive.

This is not an extensive soil, but it does have some agricultural importance because of its ease of cultivation and fairly high fertility. Most of it is under cultivaton, and the yields of farm crops compare favorably with those grown on Clarion fine sandy loam of the upland but are somewhat lower than those obtained on Waukesha loam. This soil is somewhat more uniform in character and more productive than Buckner loam. Protection from hill wash and the addition of organic matter would increase the productivity of the soil.

Sarpy fine sandy loam.—Sarpy fine sandy loam occupies a small acreage within the bottoms of the two branches of Indian Creek in Richland, Nevada, and Indian Creek Townships. This soil generally adjoins the stream channel and has an irregular surface because of the crossing of old stream channels. Almost all of the soil is subject to annual overflow and occasional disturbance by the streams.

Most of the areas of soil included with Sarpy fine sandy loam are light in color and somewhat sandy. Some of the included bodies, however, have surface layers of dark grayish-brown fine sandy loam, 10 to 12 inches thick, overlying lighter colored sandier materials. Alternate layers of sand or silt, both light in color, can be observed in some places within a depth of 5 feet, and in places thin gravel beds are present. In general, the soil is lighter colored and occupies larger, more uniform areas in the southern part of the county than it does in the townships farther north.

Sarpy fine sandy loam has little value for growing crops, and almost all of it is used for pasture. Scattered stands of trees, including oak, elm, willow, cottonwood, and black walnut, grow in the bottoms, in addition to the grasses, which furnish some grazing.

PRODUCTIVITY RATINGS

In table 6 the soils of Story County are rated according to their capacities to produce the more important crops of the county and are listed in the approximate order of their general productivity under current farming practices.

TABLE 6.—*Productivity ratings of soils of Story County, Iowa*

Soil [1]	Crop productivity index [2] for— Corn	Oats	Soybeans	Clover and timothy	Alfalfa: With lime	Alfalfa: Without lime	Pasture [3]	General productivity grade [4]	Land classification [5]
Webster loam, drained	100	95	90	100	----	75	150	1	Excellent cropland.
Webster silty clay loam, drained	100	80	90	100	----	75	150	1	Excellent cropland.
Wabash silty clay loam, drained	95	80	90	100	----	45	150	1	Excellent cropland.
Wabash silty clay, drained	95	75	90	100	----	45	150	1	Excellent cropland.
Bremer loam, drained	95	85	90	100	----	45	150	1	Excellent cropland.
Bremer silty clay loam, drained	95	70	90	75	----	45	150	1	Excellent cropland.
Waukesha loam	85	90	90	100	65	50	135	2	Good cropland.
Clarion loam	85	90	75	100	65	50	135	2	Good cropland.
Wabash loam [6]	80	85	80	100	----	45	120	2	Good cropland.
Lamoure silty clay loam, drained	80	70	65	90	----	45	150	2	Good cropland.
Lamoure loam, drained	70	80	60	90	----	45	150	2	Good cropland.
Wabash fine sandy loam [6]	75	80	75	75	----	40	120	2	Good cropland.
Buckner fine sandy loam	60	75	70	70	50	----	110	3	Fair cropland.
Clarion fine sandy loam	60	70	50	75	50	40	110	3	Fair cropland.
Buckner loam	50	75	65	65	50	----	110	4	Fair cropland.
O'Neill fine sandy loam	50	65	70	60	45	----	95	4	Fair cropland.
Webster loam, undrained	50	40	45	50	----	40	140	4	Fair cropland.
Lindley loam	50	60	50	60	50	----	90	5	Fair cropland.
O'Neill loam	50	65	65	50	45	----	95	5	Fair cropland.
Clarion loam, eroded phase	50	75	----	60	----	40	90	5	Fair cropland.
Webster silty clay, drained	60	40	50	----	----	----	115	5	Fair cropland.
Ames fine sandy loam	50	60	45	50	45	----	125	5	Fair cropland.
Bremer loam, undrained	45	35	45	50	----	----	135	5	Fair cropland.
Webster silty clay loam, undrained	45	35	45	50	----	----	135	5	Fair cropland.
Clarion fine sandy loam, eroded phase	40	60	----	55	45	40	90	5	Fair cropland.
Muck, drained	60	----	----	----	----	----	140	5	Fair cropland.
Dickinson fine sandy loam	30	40	40	35	30	----	55	7	Poor cropland.
Bremer silty clay loam, undrained	40	----	----	40	----	----	80	7	Poor cropland.
Thurman loamy fine sand	20	10	20	20	----	----	20	8	Poor cropland.
Lamoure loam, undrained	----	----	----	----	----	----	130	9	Pasture land.
Lamoure silty clay loam, undrained	----	----	----	----	----	----	120	9	Pasture land.
Wabash loam, poorly drained areas	----	----	----	----	----	----	115	9	Pasture land.
Wabash fine sandy loam, poorly drained areas	----	----	----	----	----	----	110	9	Pasture land.
Wabash silty clay loam, undrained	----	----	----	----	----	----	80	9	Pasture land.
Wabash silty clay, undrained	----	----	----	----	----	----	80	9	Pasture land.
Clarion loam, steep phase	----	----	----	----	----	----	60	10	Pasture land.
Clarion fine sandy loam, steep phase	----	----	----	----	----	----	60	10	Pasture land.
Peat, drained	----	----	----	----	----	----	60	10	Pasture land.
Sarpy fine sandy loam	----	----	----	----	----	----	50	10	Pasture land.
Lindley loam, steep phase	----	----	----	----	----	----	40	10	Pasture land.
Webster silty clay, undrained	----	----	----	----	----	----	30	10	Pasture land.
Muck, undrained	----	----	----	----	----	----	20	10	Pasture land.
Peat, undrained	----	----	----	----	----	----	----	----	Nonagricultural land.

[1] The soils are listed in the approximate order of their general productivity under the average current practices, the most productive first.

[2] The soils of this county are given indexes that indicate the approximate average production of each crop in percent of the standard of reference. The standard represents the approximate average yield obtained without use of amendments on the more extensive and better soil types of the regions in which the crop is most widely known.

[3] Owing to limited data these ratings are estimates only.

[4] This classification indicates the comparative general productivity of the soils under dominant current practices. Refer to text for further explanation.

[5] This is a general classification to indicate the physical suitability of the soils for farming or grazing uses. In the actual delineation of land classes on a map other considerations, such as the pattern of distribution of soil types, are important.

[6] Applies to naturally better drained areas. Poorly drained areas are used largely for pasture.

NOTE: Absence of indexes shows that the crop is not grown on the particular soil type.

The ratings compare the productivity of each soil for each crop to a standard of 100. This standard index represents the approximate average acre yield obtained without the use of amendments on the better and more extensive soils in the region where the crop is principally grown. A crop productivity index of 50, for example, indicates that the soil is about one-half as productive for the specified crop as are soils with the standard index. Soils given amendments, such as lime and fertilizers, or small areas of unusually productive soils may have ratings of more than 100 for some crops.

The following tabulation sets forth some of the acre yields that have been set up as standards of 100. They represent long-time average yields of crops of satisfactory quality on the better soils without the use of amendments.

Crop:		
Corn	bushels	50
Oats	do	50
Soybeans	do	25
Clover and timothy	tons	2
Alfalfa	do	4
Pasture	cow-acre-days[1]	100

[1] "Cow-acre-days" is a term used to express the carrying capacity of pasture land. As used here, it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for 360 days of the year rates 360, whereas another soil able to support 1 animal unit on 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days, the rating is 25.

The principal factors determining the productivity of the land are climate, soil, slope, drainage, and management. All these factors must be taken into account and an attempt made to evaluate their combined influence on crop yields in setting up productivity ratings for particular soil types. Crop yields themselves over a long period of time offer the best summation of the combined effect of these factors, and they are used as guides in establishing ratings wherever they are available. Data on crop yields by townships compiled by assessors over a period of years, yields of crops by counties reported by the United States census, and the yields obtained on experimental fields and plots of the Iowa Agricultural Experiment Station have been used in establishing productivity ratings for the soils of Story County. Crop yields by townships and counties do not, of course, give information directly applicable to a particular soil type or types, and an interpretation of the data is necessary. All ratings, therefore, are based partly on inductive estimates rather than on reported crop yields because of a lack of definite information regarding yields from specific soil types. Some of the crop-productivity indexes, such as those for soybeans, are based wholly on inductive estimates. In spite of the limitations that necessarily attach to crop-productivity indexes, it is felt that the ratings provide a reasonably accurate picture of the relative productivities of the different soils of the county.

Current practices in Story County are considered to include the occasional growing of legumes and the return to the land of all barnyard manure produced on the farm. It is assumed that legumes will be grown on the land approximately once in every 6 years and that barnyard manure will be produced in sufficient quantity to cover the entire farm approximately once in 10 or 12 years. The use of lime and commercial fertilizers is not considered to be a part of general current practices. Ratings are given for alfalfa with and without applications of lime, however, since lime is needed on a number of soils before satisfactory stands can be obtained.

Two sets of crop-productivity indexes are given for some soil types, to indicate productivity under natural conditions of poor drainage and under conditions of adequate artificial drainage. Almost the entire acreage of soils, such as Webster loam, Webster silty clay loam, Bremer loam, and Bremer silty clay loam, are artificially drained at present, but occasional scattered areas have been used for crops without artificial improvement of drainage. Production of crops on such undrained areas is ordinarily poor as compared with that on well-drained bodies of these soil types. Ratings given Wabash loam and Wabash fine sandy loam for crops apply only to the better drained areas, which are protected to some extent from stream overflow. Poorly drained areas of these two soils, in common with most of the poorly drained soil types in this county, cannot be used successfully for crops without artificial drainage, and only pasture ratings are given for them in their natural condition. Occasionally areas may be found in some of the soil types where tile drains have been laid, but where present drainage is not entirely adequate. The productivity of such areas will be intermediate between the indexes given for the drained and the undrained areas of the particular soil type.

The soils are listed in the order of their general productivity under dominant current practices in the column headed "General productivity grade." The general productivity grade is based upon a weighted average[13] of the indexes for the various crops, using the average acreage and value of the crop grown in the county as a basis. If the weighted average falls between 90 and 100, the soil type is assigned a grade of 1; if it falls between 80 and 90, it is assigned a grade of 2, and so on. Since it is difficult to measure mathematically either the exact significance of a crop to local agriculture or the importance and suitability of certain crops for individual soil types, the weightings set up are used only as guides in assigning soils to productivity-grade classes. Certain deviations from the classes indicated by the weighted average are permitted in the general rating of the soils.

The column entitled "Land classification" summarizes in a simple way the productivity and use capabilities of the various soils by placing them in a few groups on the basis of their relative suitability for farming and grazing.

Productivity-rating tables do not present the relative roles that soil types play in the agriculture of a county; they indicate rather the productive capacity of the individual soil type. Total agricultural production from any soil will depend on its areal extent as well as on its productive capacity, and the use of soils will depend on their pattern of distribution as much as on their productivity.

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[13] The weights in percentage given each crop-productivity index to arrive at the general productivity grade were as follows: Corn 50, oats 20, soybeans 5, clover and timothy 5, alfalfa 5, and pasture 15. Inasmuch as the total acreages of barley and wheat grown in the county are small, these were combined with that of oats in arriving at the percentage weights. Similarly, clover and mixed clover and timothy hay were combined.

Economic considerations play no part in determining the productivity indexes, and the indexes cannot, therefore, be interpreted into land values except in a very general way. The value of land depends on distance from market, the relative prices of farm products, and a number of other factors, in addition to the productivity of the soil.

LAND USES AND AGRICULTURAL METHODS [14]

Slightly less than 96 percent of the total area of Story County was in farms and 72.4 percent of the total farm land was used for crops in 1938, according to the Iowa Yearbook of Agriculture. Corn occupied 54 percent of the crop acreage, oats 32 percent, tame hay 10 percent, and wheat, barley, rye, soybeans, truck crops, and other minor crops the remaining 4 percent.

Considered both as to acreage and value, corn is the most important crop in the agriculture of this county. In 1938 it was grown for grain on a total area of 132,066 acres with an average yield of 55 bushels an acre. As compiled from the reports of township assessors, the average acre yield of corn in Story County during the 10-year period from 1924 to 1933, inclusive, was 41 bushels as compared to an average of 38 bushels for the State as a whole. Within the county the average acre yields by townships ranged from a low of 37 bushels to a high of 44 bushels. In 1938 more than 97 percent of the corn crop was husked or snapped for grain, slightly more than 1 percent was cut for silage, slightly more than 1 percent was cut for fodder, and less than 1 percent was hogged down or grazed. By far the greater part of each crop is fed to livestock on the farms.

Corn is grown, at least occasionally, on all except the steeper soils, and similar cultural practices are followed on the different soils. In preparing a seedbed for corn, the land is plowed either in the preceding fall or in the spring, depending in part on the texture of the soil, the lay of the land, and the rush of farm work. Fall plowing is preferable on the heavier textured soils of the Webster, Wabash, Bremer, and Lamoure series, as freezing and thawing of the plowed land tends to make the soil more granular. Spring plowing, especially in a wet season, may leave such soils in a cloddy condition and make it difficult to prepare a suitable seedbed for the crop. On the other hand, spring plowing is preferably on the lighter textured soils, on the more rolling land, which might be susceptible to harmful erosion during the fall and early spring, and in fields where sweetclover, seeded with the small grain, is to be plowed under as a green-manure crop. After a field is plowed it is usually double-disked and harrowed, and the corn is planted some time between May 5 and May 15. Most of the corn is planted in checkrows, but that to be used for silage or fodder is sometimes drilled. A field is usually harrowed once or twice, in order to kill small weeds, after the corn is planted. Cultivation is started shortly after the corn plants come through the ground. Fields ordinarily are cultivated three or four times, depending on weed growth and rainfall, and the corn is laid by about the middle of July. Harvesting starts in the lat-

[14] See list of references on p. 59 for more detailed information about the agriculture of Story County. The publications may be obtained from the Iowa Agricultural Experiment Station, Bulletin Section, Ames, Iowa

ter part of October in normal years and continues for approximately a month. Harvesttime has been shortened considerably on a number of farms in recent years by the introduction of mechanical corn pickers, which are used extensively in this county. Picking corn by hand, however, is still the method of harvesting on many farms. After the corn is picked, most of it is stored in covered cribs on the farms.

Oats are the most extensively grown small grain, and they are grown on nearly every farm. They are used as feed for livestock and fit well into a rotation, serving as a nurse crop for a legume or a hay mixture. Oats generally follow corn in the rotation, and the land is prepared by disking the corn-stubble land, to cut the stalks and to loosen the soil. Most of the oats are sown broadcast and then disked or harrowed in, but some are drilled. The crop ordinarily matures between July 4 and July 15 and is then cut with horse- or tractor-drawn binders. Oats are threshed about 2 weeks after cutting and are stored on the farms for feed. In recent years, combines, particularly the smaller sizes, have become popular for harvesting small grains.

The acreage of tame hay is not large, but the crop plays an important part in the successful feeding of livestock. In 1938 the total acreage of all tame hay in Story County was 24,628 acres.

The largest acreage of soybean hay—9,513 acres—in the history of the county was planted in 1935, doubtless because supplementary hay crops were needed to replace clovers and alfalfa that had been killed during the severe drought of 1934. New seedings of clover and alfalfa were established during 1935, however, and the acreage of soybean hay in 1936 was reduced to 3,040 acres, although it was expanded again in 1938 to 6,391 acres. Soybeans are being grown for seed on increasingly larger acreages, and they are also planted with corn that is to be hogged down or used for silage.

Mixed red clover and timothy has been more generally grown than other tame-hay crops, but alfalfa is increasing in popularity. The total acreage devoted to alfalfa in 1938 was larger than that of mixed clover and timothy. Sweetclover is used to a small extent for hay and seed, but most of it is used for pasture or as a green-manure crop. Other tame hays include millet, Sudan grass, and sorghums. The average yield of all kinds of tame hay for 1938 was 1.85 tons an acre, with alfalfa, the most productive hay crop, averaging 2.40 tons.

Most of the clover and alfalfa seedings are made with a small-grain crop, with the seeding coming into production the second year. During the second year of growth of red clover—a biennial—generally one cutting is made for hay and the second cutting left for seed or for pasture. Alfalfa remains on the same land for a period of 4 or 5 years and under normal seasonal conditions is cut three times during the year.

Small-grain crops other than oats are grown only on small acreages in most years. Barley was grown on only 622 acres in 1938, with an average yield of 23.9 bushels an acre, and most of the crop was fed to livestock on the farms. Rye was grown on 461 acres in 1938 with an average yield of 18.7 bushels an acre, and most of the grain was sold. Winter wheat was grown on 1,774 acres in 1938, yields averaging 17.4 bushels an acre, whereas spring wheat was grown on only 160 acres with an average yield of 12.5 bushels. Wheat is generally grown as a cash crop, chiefly in the Skunk River bottoms. Barley and spring wheat are sown and handled in much the same way as oats. Winter wheat and rye are seeded between September 15 and October 1 and usually come through the winter in fair condition.

Pasture of all kinds in Story County totaled 69,338 acres in 1938. About half of the pasture acreage is plowable and is seeded mainly to legume and grass mixtures. The rest is either woodland pasture or permanent grass pasture. Vegetation in permanent pasture consists mainly of bluegrass with some Dutch white clover, although a number of areas are partly forested and provide little grazing. The pasture season starts about May 15 and continues until December 1, with the best grazing in the early spring and late fall. Bluegrass pastures must be supplemented with temporary pastures during the warm part of the summer (late July and August), but ordinarily they revive in the fall. Rotation pastures furnish less forage in the late fall than do well-managed bluegrass pastures.

A common crop rotation followed in this county in the past has been a 2-year rotation of corn and oats, with some fields producing corn continuously. A number of farmers have used rotations that include the growing of a hay crop, commonly a legume, every 3 or 4 years, and this type of rotation is coming into more general use. One of the more desirable rotations used at present consists of corn, corn, oats, and clover, the last-named crop being replaced on some farms by mixed hay or by alfalfa. Such a 4-year rotation is well suited to the better soils of the county, but longer rotations with a larger proportion of legumes and grasses and keeping the land in grass for several years are practices better adapted to the rolling land and the less fertile soils. Applying barnyard manure and plowing under green-manure crops would benefit most of the soils, and such practices are especially desirable on the soils in the more rolling areas, on the sandy soils, and on the light-colored soils. The use of legumes rather than nonlegumes as green-manure crops is preferable. Applications of lime are needed on some soils to insure good stands of the legumes, and inoculation of the legume seed increases the chances of establishing good stands.

The use of fertilizers has been rather limited in Story County, largely because so many of the soils are very fertile and heretofore have been highly productive. Various plant nutrient elements, such as nitrogen, potassium, and phosphorus, are abundant in most of the dark-colored soils, but experiments indicate that applications of some kinds of fertilizer materials to many of the soils result in greater crop yields. The use of commercial fertilizers does not eliminate the need for good crop rotations, applications of lime, the growing of green-manure crops, or the use of barnyard manure, but should be added to such practices.

The soils subsection of the Iowa Agricultural Experiment Station for a number of years has been conducting experiments on soils in many parts of the State to test the effectiveness of various manure, lime, and fertilizer treatments. One series of experiments was established in 1914 on the Agronomy Farm, located near Ames. Tests were planned to study the value of manure, lime, and different phosphate fertilizers under different systems of cropping on an area including Clarion and Webster soils. Four different rotations have been tried, on two series of plots, one of which received treatments approximating those possible on a livestock farm, the other those possible on a cash-grain farm. The four different rotations include one of corn, oats, clover, wheat, and alfalfa, leaving the alfalfa on the same plots for 5 years (in reality a 9-year rotation or a modified 5-year rotation); a 4-year rotation of corn, corn, oats, and clover; a 3-year rotation of corn, oats, and clover; and a 2-year rotation of corn and oats. One series of five plots has been used for trials with manure and limestone under continuous growing of corn. Trial plots are one-tenth of an acre in size, are separated from one another by roadways and plot borders, and are arranged in such a way that all the crops of each rotation can be grown each year. Thus, there are 5 series plots receiving the same treatments under the 9-year rotation, 4 under the 4-year rotation, 3 under the 3-year rotation, and so on.

On the plots given soil treatments possible under a livestock system of farming, manuring at the rate of 8 tons an acre once in 4 years is the basic treatment. All the crop residues above ground, however, are removed from the plots. Ground limestone, in addition to manure, is applied on some of the plots at the rate needed to neutralize soil acidity, as indicated by test. Phosphate fertilizer applications are also made, using either rock phosphate, superphosphate, or mixed commercial fertilizers as the carrier of phosphorus.

On the other plots, where turning under of crop residues is the only method of adding organic matter to the soil that would be used on a cash-grain farm unless green-manure crops were grown, applications of limestone in quantities necessary to neutralize acidity, as indicated by test, and applications of phosphate fertilizer are made. All the corn stover is returned to the plots and plowed under, and only the first cutting of clover is harvested, the second being left on the plots. The rates of application of phosphate fertilizers are the same as those on the manured plots.

Changes have been made in recent years in the kinds and quantities of fertilizing materials applied on these experimental plots. Rock phosphate was applied at the rate of 2,000 pounds an acre once every 4 years until 1925, when the application was reduced to 1,000 pounds. Sixteen-percent superphosphate was used at the rate of 200 pounds an acre annually until 1923, when the amount was reduced to 150 pounds an acre applied to all grain crops in the rotation. Since 1929, 120 pounds of 20-percent superphosphate per acre have been applied to all grain crops in the rotation. A mixed commercial fertilizer containing an amount of phosphorus equivalent to that in the superphosphate applied has also been used in the experiments. A 2–12–2 mixed fertilizer was applied at the rate of 200 pounds an acre prior to 1929. Since 1929 a 2–12–6 mixture has been applied at the rate of 200 pounds an acre.

The experiments with different fertilizer materials and with different rotations are still in progress, and the results obtained during the first 10 years have been reported in Bulletin 241 of the Iowa Agricultural Experiment Station. Additional results are summarized in the following pages, these results indicating in a general way what may be expected from similar management of the better soils in Story County. Most of the area of the Agronomy Farm consists of Clarion loam, but a part of it is Webster silty clay loam, and the experimental data from the farm should be applicable to these and to similar soils.

The effects of various fertilizer treatments and application of lime on the different crops grown in the 9-year rotation are indicated in the data presented in table 7. Most of the experimental plots of this group are on Clarion loam.

TABLE 7.—*Average acre yields of crops and increases following fertilizer treatments in a 9-year rotation for the period 1925–33* [1]

Treatment	Corn [2]		Oats [2]		Red clover [3]		Winter wheat [2]		Alfalfa [3]	
	Average yield	Increase due to treatment	Average yield	Increase due to treatment	Average yield	Increase due to treatment	Average yield	Increase due to treatment	Average yield	Increase due to treatment
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*
Check [4]	58.4	------	45.8	------	1 38	------	26 1	------	2.19	------
Manure	71.3	12.9	52.0	6.2	2 05	0 67	30 4	4.3	3 55	1.36
Manure+limestone	72.6	14.2	55.2	9.4	2.35	.98	34.1	8.0	3 73	1.54
Manure+limestone+rock phosphate	76.1	17.7	58 1	12.3	2.55	1.17	37.5	11.4	3.87	1.68
Manure+limestone+superphosphate	77.6	19 2	64.0	18.2	2.89	1.51	39 7	13.6	3.90	1.71
Crop residues	62.1	3.7	50.2	4.4	.86	------	27 5	1.4	2.20	.01
Crop residues+limestone	65.8	7.4	55.8	10.0	(5)	------	31.6	5.5	1.96	------
Crop residues+limestone+rock phosphate	67.1	8.7	61.1	15.3	------	------	34.8	8.7	2.64	.45
Crop residues+limestone+superphosphate	71.3	12.9	65.4	19.6	------	------	38.7	12.6	2 52	.33

[1] All data are from the Agronomy Farm, Iowa Agricultural Experiment Station. Ames, Iowa.
[2] Nine crops were grown during the 10-year period.
[3] Eight crops were grown during the 10-year period.
[4] Three check plots are included, and the average yields from the three are given.
[5] Only one crop of clover has been harvested, and therefore the data are not given.

Manure brought about increases in the yields of all crops in the rotation, but more particularly in those of clover, corn, and alfalfa. When lime was applied in addition to manure, further increases could be noted in all crops grown, but the effect was not so pronounced. Rock phosphate or superphosate with the manure and lime both increased yields of all crops slightly over those obtained with the manure and lime treatment. Rock phosphate was slightly less effective than superphosphate in increasing yields of corn, alfalfa, and winter wheat, and was much less effective in increasing yields of oats and clover.

In the series of plots on which crop residues were the only source of organic matter, lime increased the yields of corn, oats, and wheat, but not that of alfalfa. Rock phosphate and superphosphate both brought about increases in yield when used with lime, the superphosphate having a greater effect on all crops except alfalfa.

The average yields of corn, oats, and clover on the four series of plots under the 4-year rotation are given in table 8.

TABLE 8.—*Average acre yields of crops and increases following fertilizer treatments in a 4-year rotation for the period 1925–33* [1]

Treatment	Corn [2]		Oats [2]		Red clover [3]	
	Average yield	Increase due to treatment	Average yield	Increase due to treatment	Average yield	Increase due to treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*
Check [4]	51.8	----------	58.3	----------	1.89	----------
Manure	67.5	15.7	56.8	----------	2.45	0.56
Manure+limestone	67.0	15.2	60.6	2.3	2.96	1.07
Manure+limestone+rock phosphate	67.1	15.3	75.5	17.2	3.17	1.28
Manure+limestone+superphosphate	64.4	12.6	77.7	19.4	3.26	1.37
Manure+limestone+mixed commercial fertilizer	65.5	13.7	79.5	21.2	3.12	1.23

[1] All data are from the Agronomy Farm, Iowa Agricultural Experiment Station, Ames, Iowa.
[2] Data represent the average yields from 18 crops, considering corn grown on 2 separate series of treated plots in any 1 year as separate crops.
[3] Data represent average yields from 9 crops.
[4] Four check plots were used, and the data given represent average yields from all four.

Most of the plots used in the 4-year rotation experiment are on Webster soils, and some difficulties in drainage have arisen from time to time. Data from plots receiving no manure are not reported because of fluctuations in yields due to drainage conditions. Definite increases in yields of corn and clover followed application of manure, but yields of oats were slightly lower after treatment. Lime in addition to manure did not greatly change yields of corn and oats but increased the yield of red clover appreciably. Applications of rock phosphate, superphosphate, and mixed commercial fertilizer did not increase the yield of corn when added with manure and lime, but all three fertilizers increased yields of oats and red clover.

The average yields of corn, oats, and clover on the three series of plots under the 3-year rotation are given in table 9. These plots are largely on Clarion loam.

TABLE 9.—*Average acre yields of crops and increases following fertilizer treatments in a 3-year rotation for the period 1925–33* [1]

Treatment	Corn [2]		Oats [2]		Red clover [2]	
	Average yield	Increase due to treatment	Average yield	Increase due to treatment	Average yield	Increase due to treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*
Check [3]	50 6	----------	47.5	----------	1.04	----------
Manure+limestone	68.7	18.1	60.2	12.7	2.03	0.99
Manure+limestone+rock phosphate	66.2	15 6	60.8	13.3	2.35	1.31
Crop residues+limestone	60.4	9.8	48.7	1.2	1.24	.20
Crop residues+limestone+rock phosphate	59.4	8.8	53.0	5.5	1.27	.23

[1] All data are from the Agronomy Farm, Iowa Agricultural Experiment Station, Ames, Iowa.
[2] Data represent the average yields from 9 crops.
[3] Two check plots were used, and the figures given are averages of yields from both.

Applications of manure and lime to plots in the 3-year rotation brought about large increases in the yields of all crops. The addition of rock phosphate plus the manure and limestone did not appreciably alter the yields of corn or oats but did increase the yield of red clover. It will be noted that these experiments do not include the use of superphosphate or of a mixed commercial fertilizer, and conclusions as to the value of those materials must be drawn from the experiments with other rotations. The distinct benefits of manure and limestone, however, are readily apparent in table 9.

The average yields of corn and oats in the 2-year rotation are given in table 10. These plots are located mostly on Clarion loam.

TABLE 10.—*Average acre yields of crops and increases following fertilizer treatments in a 2-year rotation for the period 1925–33* [1]

Treatment	Corn [2]		Oats [2]	
	Average yield	Increase due to treatment	Average yield	Increase due to treatment
	Bushels	*Bushels*	*Bushels*	*Bushels*
Check [3]	37.6		34.3	
Manure+limestone	61.2	23.6	52.6	18.3
Manure+limestone+rock phosphate	59.9	22.3	52.3	18.0
Crop residues+limestone	49.5	11.9	40.9	6.6
Crop residues+limestone+rock phosphate	51.9	14.3	44.7	10.4

[1] All data are from the Agronomy Farm, Iowa Agricultural Experiment Station, Ames, Iowa.
[2] The data represent the average yields from 9 crops.
[3] Two check plots were used, and the figures given are average yields from the two.

The application of manure plus limestone appreciably increased the yields of both corn and oats, but the addition of rock phosphate to the treatment does not appear to have been beneficial. On the series of plots receiving crop residues and no manure, the application of rock phosphate seems to have increased yields slightly. The yields of oats and corn in a corn-oats rotation, either on the check plots or under the different treatments, should be compared with the yields obtained in a rotation including corn, oats, and clover. Data reported in tables 9 and 10 were obtained from plots situated on very similar soil.

The results obtained on the continuous corn plots, most of which are on Clarion loam, are presented for purposes of comparison in table 11.

TABLE 11.—*Average acre yields of crops and increases following fertilizer treatments under continuous cropping to corn for the 10-year period 1925–33* [1]

Treatment	Corn [2]	
	Average yield	Increase due to treatment
	Bushels	*Bushels*
Check [3]	33.2	
Manure	42 8	9.6
Manure+limestone	44.6	11.4
Limestone	35.3	2.1

[1] Data are from the Agronomy Farm, Iowa Agricultural Experiment Station, Ames, Iowa.
[2] Data represent the average yields from 9 crops.
[3] Two check plots are included in each series, and figures given represent average yields from both.

The yields of corn reported in table 11 are considerably lower than those given in the preceding tables, but the beneficial effects of manure on corn yields are still evident. Manure, as might be expected, increased the yield of corn far more than did limestone alone. The effect of limestone, however, is not so much in the way of supplying plant nutrients, many of which are carried in manure, but to correct soil acidity. None of the soil on the Agronomy Farm is strongly acid, and some areas of the Webster soils are slightly alkaline. The principal value of the data given in table 11 is to call attention to the lower yields of corn grown continuously, as compared with the yields obtained in some of the longer rotations.

In general, the experiments at the Agronomy Farm indicate that larger acre yields are obtained under the longer rotations and that increased yields follow applications of manure, lime, and fertilizers carrying phosphorus. Differences in the returns obtained from the different carriers of phosphorus are not significant in most tests, and the selection of the fertilizer to be used should be governed by the nature of the crop to be grown and the cost per unit of phosphorus. It should be noted, however, that applications of rock phosphate were much larger than those of superphosphate or the mixed fertilizer.

Experiments similar to those on the Agronomy Farm at Ames have been carried on cooperatively with individual farmers on different soils in their own fields in various parts of the State. These experiments have consisted principally of fertilizer trials but are made under conditions that more closely approximate those on the farms. The results obtained in experiments on Clarion and Webster soils in the north-central part of Iowa are essentially similar to those already reported. Conclusions applicable to the Clarion and Webster soils can be extended to a number of similar soils in Story County.

The application of manure will benefit crops, particularly corn, on most of the soils of this county. On some of the heavier textured soils with restricted natural drainage, the addition of organic matter in the form of manure, prior to growing small-grain crops, may result in serious lodging. These soils commonly contain an abundance of organic matter, and increases of organic matter are not desirable for small-grain crops. If a crop uses a large supply of nitrogen because of rapid growth during a short time, as corn does, the addition of manure or other forms of organic matter will be helpful rather than harmful. Much of the barnyard manure produced on farms, however, can be used to better advantage on the well-drained uplands, particularly on sandy or light-colored soils. The Dickinson, O'Neill, Buckner, Lindley, and Ames soils, as well as the soil of the two phases of Clarion fine sandy loam and the rolling areas of Clarion loam, have a comparatively low organic-matter content. The application of quantities of barnyard manure to such land will be especially helpful to succeeding crops.

Few farms in Story County produce enough barnyard manure to cover all fields at regular intervals, and additional organic matter must be supplied at times. The chief means of supplying organic matter, other than by manuring, are by plowing under green-manure crops and by keeping the land in grass. In a section where so much of the land is cultivated, keeping the better croplands in grass for long periods has not been practiced extensively. Plowing under green-manure crops is a much more common practice, and for this purpose legumes are commonly used. Inoculated legumes, such as red clover or sweetclover, are excellent green-manure crops.

Good stands of legumes can be obtained on many of the soils in Story County without prior applications of lime. The O'Neill, Buckner, Lindley, Ames, and some areas of Bremer soils, however, are naturally acid, and lime should be added before legumes are seeded, in order to increase the prospects of a good stand. Some areas of Clarion soils, especially the sandy ones, sometimes need lime for the successful production of sweetclover and alfalfa, and it is probable that many more areas of upland soils eventually will need lime in order to grow these two legumes.

Growing more legumes and grasses would necessitate the use of these crops either in the form of hay or as pasture. Many of the existing pastures could be materially improved, particularly on the more rolling lands, by practices such as disking, liming, fertilizing, and occasional reseeding. The use of grass and legume mixtures in pastures is desirable, and applications of phosphorus fertilizers have been found to increase both the quality and the quantity of forage. Recommended seeding mixtures and additional information about pastures may be obtained from Bulletin 331 of the Iowa Agricultural Experiment Station.

"ALKALI SPOTS"[15]

The so-called alkali spots occur in comparatively small areas scattered throughout larger bodies of Webster soils or at the borders of peat and muck deposits. The affected areas range in size from $\frac{1}{10}$ to 3 acres, but wherever they are numerous they reduce the value of the land on which they occur. One of the most common locations of alkali spots is at the edges, or former shore lines, of drained ponds and sloughs, and many slightly elevated spots in large flats of Webster soils are also alkali spots.

These areas are unproductive because of excess calcium carbonate, or lime, which causes injury to plants, especially corn. Other salts also are present in places, but calcium carbonate and bicarbonate almost invariably are present in large enough quantities to be harmful. Carbonates generally occur in large quantities throughout the soil. In spring these spots are readily apparent in plowed fields because of their ash-gray color when slightly moist or when dry, and the soil ordinarily is loose and powdery. Evaporation from the surface tends to increase the salt content in the surface soil, as the dissolved salts are deposited as a white crust on the surface of the land. This process is more pronounced in some areas than in others.

Reclamation of the alkali spots requires drainage of the land and removal of soluble salts. Applications of manure are valuable because they tend to offset the effects of the salts on plant growth and improve the physical condition of the soil. Decomposing horse manure is especially valuable in treating alkali spots, but other farm manures and forms of organic matter are also desirable.

[15] For additional information and results of fertilizer experiments on alkali soils, see the following publication:
STEVENSON, W. H., BROWN, P. E., and BOATMAN, J. L THE MANAGEMENT OF PEAT AND ALKALI SOILS IN IOWA. Iowa Agr. Expt. Sta. Bul. 266, pp. [81]–100, illus. 1930.

Beneficial effects from the application of fertilizers carrying potassium and phosphorus have been noted in experiments on soils with an excessive lime content and also have been reported by many farmers. Extremely high contents of calcium carbonate in the soil seem to decrease the quantities of available potassium and phosphorus present or to render them unavailable to plants. Applications of small quantities of potassium fertilizer, such as muriate of potash, or of fertilizer mixtures, such as 0–20–20, in the hill or row are especially helpful to corn crops.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of environment acting on the soil materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent soil materials; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the relief, or lay of the land, which determines the local or internal climate of the soil, its drainage, moisture content, aeration, and susceptibility to erosion; (4) the biologic forces acting on the soil material, that is, the plants and animals living on and in it; and (5) the length of time the climatic and biologic forces have acted on the soil material.

The most striking single characteristic of the predominant soils of this county is the dark color of their surface horizons. This dark-colored horizon, which generally has a granular or crumb structure, ranges in thickness from as little as 6 inches in the more rolling areas to as much as 20 inches in some of the slightly depressed areas. The deep, dark-colored surface horizon is one of the characteristic features of the Prairie soils and associated poorly drained soils. Such soils as the Clarion, Waukesha, O'Neill, and Buckner belong to the group of Prairie soils, whereas the Webster and Bremer soils, formed under conditions of restricted drainage, are members of a group known as Wiesenboden (poorly drained associates of Prairie soils). Soils in the flood plains of the streams are in process of formation from alluvial sediments washed chiefly from the dark-colored upland soils and have many characteristics similar to those of the Prairie soils or of the Wiesenboden.

In addition to the Prairie soils, small areas of two soils, the Lindley and Ames, are light-colored because they were formed under forest vegetation. The profiles of the Lindley and Ames soils consist of lighter colored surface horizons overlying heavier textured B horizons, which, in turn, grade into the parent material, or C horizon. Soils of these two series are members of the Gray-Brown Podzolic soils or associated intrazonal groups.

The soil parent materials in this county are composed mainly of two types of deposits: (1) Glacial drift, predominantly till but with some outwash; and (2) alluvium. Small areas of wind-blown sand and some of loess are exposed in several places, but these exposures are not large enough to have become parent materials for the formation of soil. Glacial till occupies more than 80 percent of the total area of the county and constitutes the parent materials from which most of the soils have formed. The till materials now exposed were deposited during the last invasion by the Wisconsin ice sheet, and they consist chiefly of calcareous clay loam containing gravel and some boulders. The texture of the till varies from place to place, however; sandy materials cover the ridges and knolls in morainic sections, and sandy clays occupy the depressed areas. The present depth to carbonates in areas with free but not excessive drainage is about 30 inches.

Alluvial materials comprise deposits on the flood plains of the streams, together with those on fans and terraces bordering the stream bottoms. These deposits range in texture from heavy clay to coarse gravel. Most of the coarser deposits lie on the terraces, and the heavier textured deposits occupy the parts of the flood plains farthest removed from the streams or former stream channels that have acted as settling basins. Most of the alluvium is not calcareous within a depth of 5 feet but is calcareous in some places on the bottoms. The Lamoure soils normally contain carbonates in the surface horizons.

One or more drift sheets older than the late Wisconsin underlie it in Story County, and one, the Kansan, outcrops along stream channels in the southeastern part. Some areas of Lindley loam are thought to have been formed from Kansan till, which is much older than the late Wisconsin, commonly leached of its carbonates, and distinctly acid.

Some of the more extensive soils have been observed in some detail in the field, and descriptions of their profiles are given in the following paragraphs. These descriptions of soil profiles represent the well-drained but not excessively drained Prairie soils, a sandy Prairie soil on the terraces, and one of the imperfectly drained soils of the uplands.

Clarion loam, which occupies a larger acreage in Story County than any other soil, has a profile consisting of a dark-colored surface horizon, a lighter colored yellowish-brown transitional zone, and is underlain by calcareous till. A profile of Clarion loam, observed in a pit dug in a grass-covered lot in the NE¼SE¼ sec. 3, T. 83 N., R. 23 W., is described as follows:

1. 0 to 2½ inches, very dark brown mellow loam that comes out as a root-bound mass. The roots are numerous and fibrous. The small irregular pieces of soil, held in this mass, are very easily crushed into soft crumb-like particles.
2. 2½ to 12 inches, dark grayish-brown friable loam that comes out in large elongated irregular blocks, roughly resembling prisms, held loosely together by numerous grass roots. Under slight pressure these blocks crumble to material with a rather coarse crumb structure. The gray cast disappears in the crumbled friable loam.
3. 12 to 16 inches, a transitional horizon of dark-brown loam differing from the material in the horizon above principally in the absence of the gray color and in the smaller content of grass roots.
4. 16 to 24 inches, a horizon of brown heavy loam or clay loam, showing large irregular dark-brown stains in place. The irregular soil pieces, thus coated, lose this color when compressed and become a brown granular mass when very dry. The material contains a few pebbles with a maximum diameter of one-half inch.
5. 24 to 36 inches, yellowish-brown somewhat gritty clay loam or silty clay loam. Some iron concretions occur in association with rust-brown spots, and a few lime spots appear in the lower part of this horizon.

Some dark-brown material occurs in small isolated spots and along old root channels. A few long grass roots penetrate the horizon. Small stones and pebbles become more numerous with depth.

6. 36 to 60 inches, pale-yellow silty pebbly material flecked and blotched with the light gray of carbonates. A few yellowish-brown mottlings occur in the upper part of this horizon. Some lime pebbles and stones are embedded in the material.

Clarion loam is developed on slopes ranging from 2 to 8 percent. Clarion loam, eroded phase, is developed on rolling relief where the slopes range from 5 to 15 percent, and it has a thinner dark-colored surface horizon than typical Clarion loam. Clarion loam, steep phase, occupies the steeper areas, many of which are partly covered with trees. The slope ranges from 15 to 25 percent. The surface horizon in most places is very thin and in many places is lacking.

Clarion fine sandy loam and Clarion loam occupy similar topographic positions, as do their corresponding phases. The principal difference between the two soils is the higher content of sand in the surface horizon of Clarion fine sandy loam.

Waukesha loam, occurring on the terraces rather than on the uplands, differs from Clarion loam in having a higher percentage of fine sand throughout the solum and in being noncalcareous in the lower layers.

Most of the sandier soils in Story County also belong to the group of Prairie soils, but they generally have brown rather than dark-brown surface horizons, grading through lighter colored layers into sand or gravel. The Dickinson soils occur on the upland on sandy drift or till, and the Buckner and O'Neill soils on fans and terraces. Sarpy fine sandy loam, which occurs in the flood plains of the streams, is in the early stages of development of the soil profile and lacks well-defined horizons.

O'Neill loam is the most extensive of the lighter textured and excessively drained Prairie soils. Following is a description of a profile of this soil, as observed in the NW¼NW¼ sec. 16, T. 82 N., R. 22 W.:

1. 0 to 10 inches, dark-brown to very dark grayish-brown mellow friable loam. The lumps, dug below plow depth, have a strong gray cast, which disappears when the clods are crushed into soft small crumbs. Coarse sand particles, absent from the upper part of the horizon, are numerous in the lower part.
2. 10 to 16 inches, dark-brown to very dark brown gritty heavy loam. When dug, this material comes out in rather small irregular clods, having a very uneven dark-brown color, owing partly to the content of coarse sand. These clods crumble readily to an unevenly granular mass having a fairly uniform brown color.
3. 16 to 24 inches, brown coarse sandy clay loam that seems slightly indurated in place. The irregular clods crumble easily to a very unevenly granular brown-colored mass, after removal.
4. 24 to 38 inches, a yellowish-brown horizon, ranging from fine sand to gravel. Fine sand layers show slight coherence.
5. 38 inches +, pale-yellow incoherent stratified fine sand or gravel.

The imperfectly and poorly drained soils differ from the well-drained Prairie soils in that the profile contains much organic matter in the upper layers and in many places contains carbonates near the surface. The lower part of the profile in poorly drained areas is also marked by a gray, and in places mottled, layer, technically known as a glei horizon. Included in the group of soils with restricted drainage are the members of the Webster, Bremer, Wabash, and Lamoure series. All of these soils occupy level or very nearly flat areas.

Following is a profile description of Webster silty clay loam as observed in a cultivated field in the NW¼NW¼ sec. 15, T. 82 N., R. 24 W.:

1. 0 to 18 inches, black silty clay loam, the topmost 5 inches of which is fairly loose and friable under optimum moisture conditions. The lower part of the horizon comes out in clods that break under considerable pressure into a coarsely granular mass. The material in this horizon cracks badly when very dry. It merges gradually into the material below.
2. 18 to 34 inches, very dark grayish-brown to black silty clay or clay, containing much grit and many glacial pebbles. In place, this material is massive, and, when removed, breaks under considerable pressure into small fragments. When the soil is crushed, the brown color becomes dominant, although gray predominates over the surface of the larger fragments. Some rust-brown iron stains occur in the lower part of this horizon. This material changes abruptly to the material below.
3. 34 to 46 inches, yellowish-gray gritty clay, mottled with rust brown and containing some glacial pebbles and lime pebbles. This material is distinctly less massive in place than the material above but is somewhat plastic when wet.
4. 46 to 60 inches, yellowish-gray clay, becoming more mottled and containing more pebbles and rock fragments with increasing depth.

Webster loam occupies areas intermediate in elevation between Clarion loam and Webster silty clay loam; it is also intermediate in drainage and in depth and blackness of the surface layer. It, therefore, can be considered as transitional between those two soils.

Webster silty clay closely resembles Webster silty clay loam, except in the heavier texture of the upper horizon.

The alluvial soils having restricted drainage, occurring along both the small and large drainage channels, do not differ greatly from the Webster soils in profile characteristics. Small drainageways rise, almost without exception, in areas of Webster soil and later develop well-defined channels and small alluvial plains. The lime content of the alluvial soils varies considerably and is used to determine the separation of the Lamoure and the Wabash soils. The Lamoure soils are highly calcareous throughout the entire solum, whereas the Wabash soils are neutral or slightly acid in the surface layers and generally acid in the subsoil. The soils of both series are naturally imperfectly to poorly drained, are developed in first bottoms, and are subject to annual overflow. Varying quantities of sand, silt, and clay are contained in the alluvial soils.

Members of the Bremer series have restricted drainage and are developed on low terraces adjoining the first bottoms. The soil parent materials were laid down by stream action in the form of level or depressed terraces back from the stream channels. At present, however, these terraces are practically above the level of overflow. The Bremer soils differ from the Webster soils in the position that they occupy, in the character of the soil materials, and in being noncalcareous.

Peat and muck are members of the intrazonal group of Bog and Half-Bog soils, which consist of accumulations of organic matter, partly decomposed under anaerobic conditions, and formed in ponded areas and shallow lakes.

SUMMARY

Story County occupies the geographic center of Iowa. It includes 16 townships and has a total area of 567 square miles, or 362,880 acres. Nevada, the county seat, is near the center of the county on the main line of the Chicago & North Western Railway and on United States Highways Nos. 30 and 65. Iowa State College, including the Iowa Agricultural Experiment Station, is located at Ames in the western part of the county.

The relief of Story County, an area covered by the late Wisconsin glacier, has not been greatly modified since the retreat of the ice sheet. The greater part of the county has a gently undulating to gently rolling land surface.

The Skunk River and its smaller tributaries drain the western part of the county, and a larger tributary, Indian Creek, with its branches, drains the eastern part. Upland drainageways are poorly developed and indistinct.

Elevations range from 830 feet above sea level in the valley of the Skunk River, at the point where the stream leaves the county, to 1,075 feet on a morainic ridge in the northwestern part.

The territory now known as Story County was first opened to white settlers by the treaty with the Indians, known as the Black Hawk Purchase, in 1833. The boundaries of the county were established in 1846, and the first white settlement was made in 1848.

In 1930 the population of the county numbered 31,141 people, of whom 57 percent were classed as rural. The county is well supplied with railroads, and the highway system is well developed. Consolidated and smaller schools, high schools in most of the towns and villages, and the Iowa State College furnish many educational facilities.

The climate is continental and is characterized by comparatively cold winters and warm summers. The mean temperatures are 21.4° and 71.6° F. for the winter and summer, respectively. The mean annual precipitation is 31 inches, of which more than 60 percent falls during spring and summer.

Agriculture is the chief means of livelihood of the people in Story County, and the wealth of the community depends upon the productivity of the soils. According to the Iowa Yearbook of Agriculture, in 1938 about 95.9 percent of the land was in farms and about 72.4 percent of the total farm land was devoted to growing crops. Corn, oats, and hay are the principal crops, and ordinarily about half the cropland is planted to corn. The sale of livestock that has been raised or fattened is the chief source of income on most farms.

Soils of the county are grouped on the basis of natural drainage conditions, as follows: (1) Well-drained soils of the uplands and terraces, (2) imperfectly and poorly drained mineral soils, (3) poorly drained organic soils, and (4) excessively drained soils. Well-drained soils are subdivided on the basis of color into dark-colored and light-colored soils. Groupings made on the basis of natural drainage conditions do not indicate the relative productivities of the soils.

Well-drained soils include the Clarion, Waukesha, Lindley, and Ames series, the members of the latter two series being classed as the light-colored soils of this group.

Imperfectly and poorly drained mineral soils include the Webster soils of the uplands, the Wabash and Lamoure soils of the bottoms, and the Bremer soils of the terraces.

Peat and muck generally occupy low areas on the uplands and comprise the group of poorly drained organic soils.

Excessively drained soils include the Dickinson and Thurman soils of the uplands, the O'Neill and Buckner soils of the terraces, and the Sarpy soils of the bottoms.

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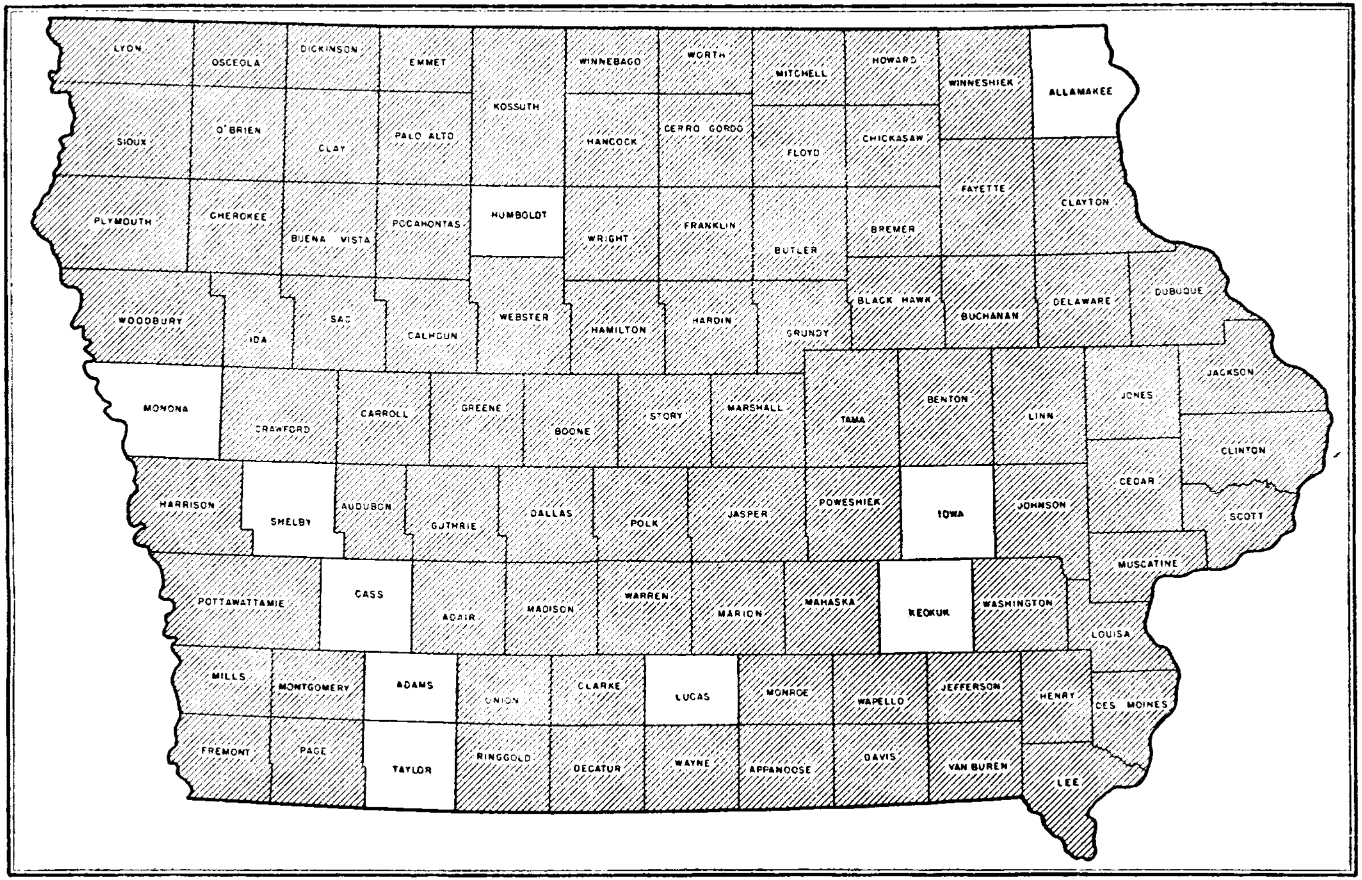

Areas surveyed in Iowa, shown by shading.

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