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Soil Survey

Akron Area Colorado

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Colorado Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils, and Agricultural Engineering
In cooperation with the
COLORADO AGRICULTURAL EXPERIMENT STATION

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SOIL SURVEY OF THE AKRON AREA, COLORADO

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

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THE Akron area, in the northern half of Washington County, Colo., is in the western part of the Great Plains province and includes parts of the High Plains and the Colorado Piedmont sections. Prior to the first settlement, buffalo and antelope roamed the prairies. In the early seventies a few cattlemen grazed their herds during seasons when water and range conditions were most

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

favorable, and in the eighties they began to locate permanently. Some corn and wheat were grown, but cattle furnished the chief source of income until 1920, when much of the arable land was broken for wheat. The irrigating of about 7,000 acres in the northwestern part of the area has utilized the land for sugar beets, alfalfa, corn and other grains, potatoes, melons, and turnips. The present agriculture is gradually adjusting itself to the long stretch of dry years. Since leguminous green-manure crops and fertilizer cannot be relied upon to maintain fertility and insure crop yields, diversified agriculture is proving more satisfactory. To provide a basis for the best agricultural uses of the land a cooperative soil survey was begun in 1938 by the United States Department of Agriculture and the Colorado Agricultural Experiment Station. The essential features may be summarized as follows.

SUMMARY OF THE SURVEY

The Akron area, 95 miles northeast of Denver, in the northeastern part of Colorado, lies along the western border of the High Plains of the Great Plains province. The eastern two-thirds, a plain sloping gently to the east, is cut by moderately shallow valleys partly filled with alluvium. Most of the upland is smooth, with the exception of the north-central, southwestern, and southeastern parts, which are more or less rolling. The greatest fall to the northwest is in the western third of the area, where the South Platte River Valley traverses the northwestern part of the area and slopes to the northeast.

The most extensive soils in the Akron area—well-drained upland soils with smooth to rolling topographic features—are locally known as hard lands. They consist of both weathered Tertiary geologic material and wind-blown loessal deposits and have weathered to depths of a few inches to about 3 feet. Owing to the low precipitation, lime has been leached from depths of only a few inches to about 15. The content of organic matter is about 2 percent. Inasmuch as in this locality alfalfa and sweetclover are not generally successful on hard land unless irrigated, plant nutrients, as nitrates, available phosphates, and potash are on a gradual decline. When dry, these soils are very hard and compact and do not readily absorb water. The better but less extensive soils are dark-colored, friable, easily worked, permeable to plant roots, air, and water, and have been leached to greater depths—approximately 1 to 3 feet. The excessively sandy soils are very low in organic matter and are utilized for grazing.

On the basis of surface and internal drainage conditions, topographic features, available moisture supply or capacity to retain moisture, and suitability for use, the various soils are placed in six groups, according to color and topographic position, as follows:

1. The dark-brown soils of the smooth and undulating uplands are characterized by a dark-brown surface soil, friable to moderately permeable subsoil, high to moderate capacity to absorb and retain moisture, and surface features that are either favorable for retaining local rainfall or for receiving some local runoff from adjoining soils. Owing to their moderate supply of organic matter, permeability to plant roots, and good to fair internal drainage,

these soils are well suited to the commonly grown field crops and especially to corn and sorgo. The Keith, Rago, Goshen, and Haxtun series comprise this group.

2. The brown soils of the smooth and undulating uplands are typical hard-land soils that are characterized by a moderately friable to moderately heavy subsoil, are less permeable to plant roots, especially when moderately dry, are less absorptive and retentive of moisture, and not so well suited to corn as the preceding group. Owing to early maturity of small grains, these soils are better suited to them than to corn; on the sandy-textured soils, however, considerable corn is grown, but they are far less extensive than the loam, silt loam, or clay loam soils. Special tillage methods are highly advantageous in conserving maximum moisture and preventing runoff. The Platner, Weld, Renohill, Colby, and Vona series comprise this group.

3. The brown soils of the rolling uplands are more difficult than the preceding two to till with modern farm implements, and the moisture content in general is lower because of considerable loss of runoff water. They are characterized by a sandy to medium-textured surface soil and moderately friable to moderately heavy subsoil. These soils are used chiefly for grazing, although some small grains and corn are grown; special tillage methods and practices are necessary on sandy-textured types to prevent the wind from injuring young crops and eroding and drifting unprotected soil. The Platner, Weld, Renohill, Colby, and Vona series, and the Weld-Colby complex comprise this group.

4. The brown to dark-brown soils of the narrow bottom lands, alluvial fans, and terraces are utilized to some extent for grazing purposes only; whereas in the South Platte River Valley, where local irrigation and drainage ditches are provided, they produce excellent crops. The Bridgeport, Fort Collins, and Greeley series comprise this group.

5. The brown to grayish-brown soils of the imperfectly drained bottom lands are of minor importance in the Akron area. They are composed mainly of alluvial sediments, with some colluvial wash from the adjoining uplands. The Wann, Laurel, and Las Animas series comprise this group.

6. The miscellaneous soils and land types are generally unsuited to cultivated crops and are, therefore, utilized primarily for grazing purposes. The Blakeland, Valentine, McKenzie, Platner, Canyon, and Stoneham series together with the Platner-Canyon complex and miscellaneous land types comprise this group.

In the sections on Land Use and Agricultural Methods and Estimated Yields and Productivity Ratings, the use suitability of the soils and agricultural methods are discussed, and estimated crop yields and productivity indexes are presented. In the section on Morphology and Genesis of Soils the factors of soil formation are presented, and profile descriptions of representative soils are given.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

The Akron area, in the northern half of Washington County in northeastern Colorado (fig. 1), is almost square and comprises 1,296 square miles, or 829,440 acres. Akron, the county seat, near

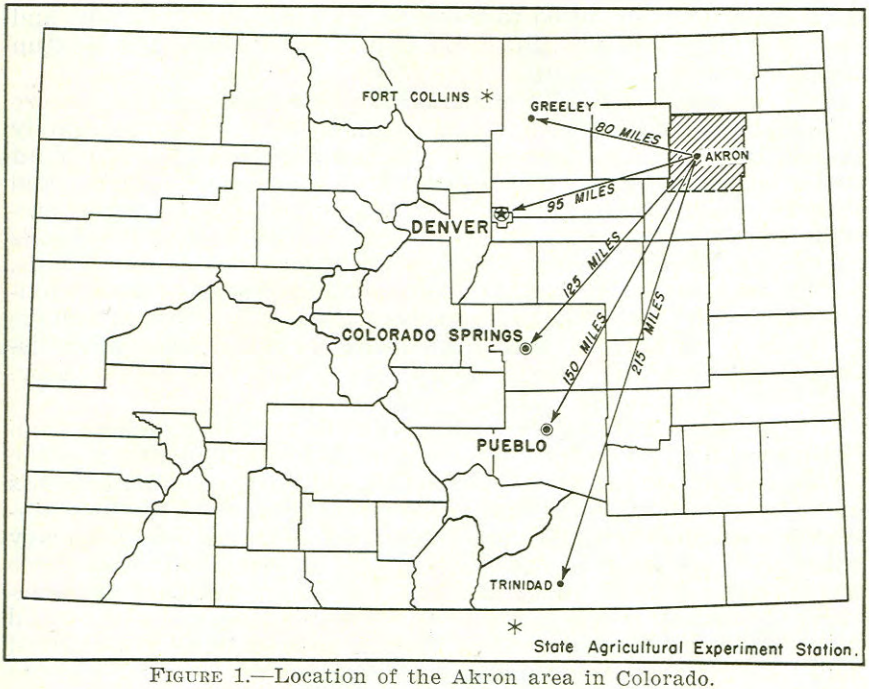

FIGURE 1.—Location of the Akron area in Colorado.

the center of the area is 95 miles northeast of Denver and 150 northeast of Pueblo.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Situated in the western part of the Great Plains province, the Akron area includes parts of the High Plains and the Colorado Piedmont sections (*4*).[2] Its general surface aspect is that of a nearly flat, moderately dissected plain modified in numerous places by extensive areas of hummocky or dunelike sand hills and large tracts of hard land[3] in which streams are entrenched to variable but commonly shallow depths.

In the eastern two-thirds of the area the High Plains section slopes gently to the eastward, whereas in the western one-third the slope of the Colorado Piedmont section is to the north and west and the slope gradient is more pronounced than to the east. The divide separating these areas is nearly imperceptible except locally, as in vicinity of Fremont Butte. According to the geological map of Colorado[4] the divide is formed by the White River geological formation of Tertiary age.

East of the divide the formations are also of Tertiary age but belong to the Ogallala group chiefly, except in the extreme northeastern part, where they belong to the Arikaree group. West of the divide the bedrock is composed of sandstone and shale members of the Pierre formation of Upper Cretaceous age. The bedrock over a large part of the area is mantled to varying depths by

[2] Italic numbers in parentheses refer to Literature Cited, p. 80.
[3] "Hard land" is a term used widely on the Great Plains to cover land on which soils are of silty and clayey texture, as opposed to sandy land.
[4] U. S. Geol. Survey. GEOLOGICAL MAP OF COLORADO. 1935.

loessal deposits and sands that have been shifted and assorted by the wind and drifted into low hummocks and dunelike ridges. The loess varies from less than 2 to 30 feet thick, and in places where it is thinnest it has become mixed with soil material weathered from the underlying formations. Comparatively large bodies of sand hills are in the northwestern and in the southeastern parts of the area. South of Otis, the sand is considerably coarser than elsewhere and is firm in places or somewhat compact because of the small content of clay, which is generally lacking in such soils.

Alluvial lands, including the low stream terraces and flood plains, occupy only a small part of the area. The terrace bordering the South Platte River attains a width of approximately 3 miles, but its total acreage is small because of the short distance the river flows through the area. The top of this terrace is 15 to 25 feet above the adjoining bottom land. Most of the terraces are lower, one-fourth to one-half mile wide, and border intermittent streams only.

The highest elevation in the area, roughly 4,700 feet, is at the top of Fremont Butte; the lowest, 4,090 feet, is on the South Platte River near Messex in the northwestern corner—a maximum elevation range of about 600 feet. Locally the drainageways are 25 to 125 feet below the crests of the ridges and the slopes are commonly not more than 1 mile long. Slopes leading to the major streams are 2 to 6 miles long and are steepest near the divides and adjacent to the terraces of the South Platte River. Elevations (5) at several towns along the Chicago, Burlington & Quincy Railroad that give an average cross section of the relief from west to east across the area are as follows: Pinneo, 4,376 feet; Akron, 4,669; Platner, 4,443; and Hyde, 4,232 feet.

The area is drained mostly by small intermittent streams that head near the low divide in the western part. They are more deeply entrenched near their sources and some of them are still being extended by active headward erosion that exposes the underlying bedrock in places along the more prominent parts of the divide. The channels of streams flowing eastward broaden and become ill-defined in the east-central part of the area and the water carried in most of them collects in intermittent lakes or spreads and sinks into the ground on flats surrounded by rolling sand hills. A small section in the northeast corner of the area is drained by Rock Creek, a tributary of the Republican River. Drainage to the north and west is through small tributaries directly into the South Platte River.

The broad interstream divides, particularly in the northeastern part, are characterized by numerous small depressions, only a few feet to as much as 30 feet below the level of the surrounding land. There storm water collects to form intermittent lakes that persist over varying but commonly short periods.

CLIMATE

The chief climatic hazards to crop production are cycles of abnormally low rainfall, unfavorable distribution of precipitation, high winds, rapid evaporation, and danger of injury from hail. These hazards, however, are not sufficiently grave to prevent successful agriculture over a period of years if the farmer is industrious, thrifty, and a good manager and if he relies on practical

diversified farming methods and the most approved tillage practices.

The climate, although continental, is very different from many inland localities. Because of the high altitude, the atmospheric pressure and relative humidity are low and the air is highly exhilarating during all seasons. During the hottest days of midsummer the heat does not seem oppressive, because of the low humidity and moderate to strong breezes. Summer nights are invariably cool. During the winter months, the air, even if the thermometer reads —20° F., does not feel so cold as along the Arkansas or Missouri Valleys even if the temperature there is only a few degrees below zero. During any season when the days are moderately calm and bright it is not unusual, at vantage points, to see clearly the snow-capped mountain peaks some 150 to 200 miles distant.

The average yearly precipitation recorded by the Weather Bureau at Akron is 17.18 inches. This is 2 to 3 inches more than records show at either Fort Collins or Greeley to the west, or at Sterling 40 miles north. To the south and southwest in this general locality, the average precipitation decreases, but to the northeast it increases, as is shown by crop yields even within the Akron area. Of the average rainfall, 6.10 inches falls during March, April, and May, and 6.76 inches during June, July, and August. Ordinarily, this is sufficient to mature the principal grain crops—wheat, barley, and corn—provided it is favorably distributed, absorbed in the soil, and not permitted to run off.

In years immediately preceding the survey, however, the supply of subsoil moisture became so depleted by long drought that the average quantity of water retained in the subsoil was below normal and the soil became dry and hard to depths of 6 to 14 feet or more. A small-grain crop, after receiving an average of 8.34 inches of rain during March, April, May, and June should mature satisfactorily, provided the rainfall is distributed favorably; otherwise, the yield is often reduced, not only because of rapid surface evaporation but because the available subsoil moisture is exhausted when the wheat is far advanced. Good summer fallowing increases the depth to which subsoil moisture penetrates and lengthens the period during which crop roots can obtain moisture from the subsoil. If no showers fall after small grains have headed, a few extra days of available subsoil moisture may determine the difference between profit and loss after the crop is harvested.

Corn requires an ever-increasing moisture supply until it matures. In this locality the crop usually attains promising proportions up to the tasseling and silking stage, because more than half the annual precipitation falls during May, June, July, and the first 2 weeks of August. Thereafter, the prevailing long, windy days of maximum summer heat increase the moisture needs of the long spreading roots and leaves, and unless a good rain comes at about the tasseling stage, the available subsoil moisture is soon exhausted and the crop rapidly deteriorates. This fact is very obvious, especially on the hard-land soils in this general locality.

Figure 2 shows a marked decline of rainfall during the last two-thirds of August. The chart shows an average of 1.06 inches

during the first third of the month; whereas only 0.35 inches, or about one-third as much, falls during the last third. It is noted further that small grains receive considerably more moisture during the early spring growing period, especially from April 10 to June 20, than late in June, when the grain is in the critical dough stage. The shortage of moisture is not so pronounced, however, as that late in August. These data, taken over a period of 31

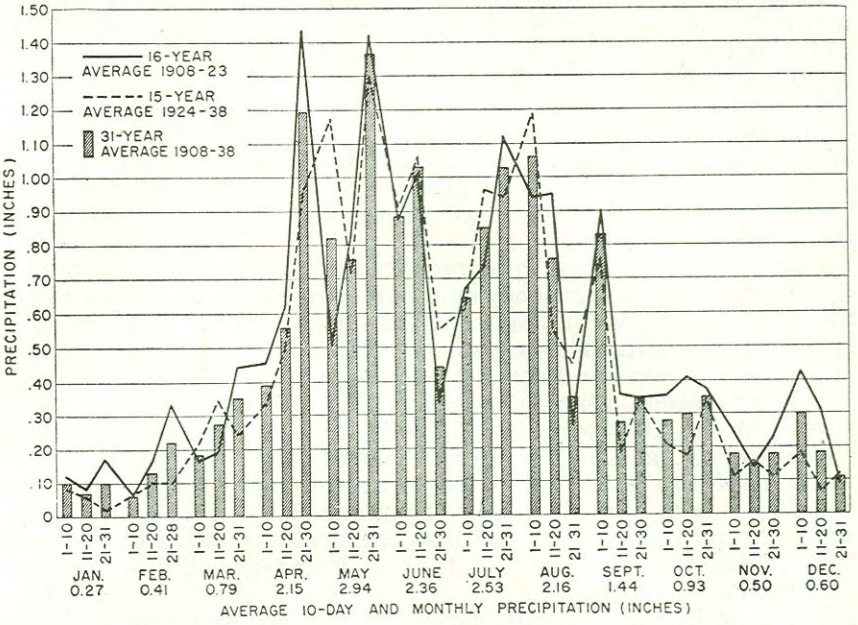

FIGURE 2.—Average precipitation by 10-day periods for the 31 years, 1908-38, at the United States Dry Land Field Station, 4 miles east of Akron, Colo. (From Circular 700, U. S. Dept. of Agr. (*1*).)

years, are significant in that the climatic factor has a marked influence on yields of two important crops grown in this locality.

One of the most serious crop hazards other than that of low or unfavorably distributed precipitation is the injury brought about by high winds. Early in spring or when the soil may be dry or loose, small grains are sometimes blown out, cut off, or covered up by wind-blown sand, especially on sandy soils. Most of the land is smooth, treeless, and impossible to protect from strong winds. Even during the winter months, winter wheat is sometimes injured by blowing sand when the soil is abnormally dry and not covered by snow. Moreover, a good snowfall may be almost entirely blown off smooth-surfaced fields, especially on north slopes, and the much needed moisture lost. Sometimes listed corn is so badly cut or so deeply covered by blowing sand that replanting is necessary. Yields of small-grain crops are sometimes greatly reduced by the drying effects of strong, hot winds from the south or southwest that pass over the field during the dough stage of the crops. High winds occasionally thresh out some of the grain or break off the heads and stems before the crop can be harvested.

According to the past records at the United States Dry Land

Field Station at Akron, the average wind velocity at 2 feet above ground level for the 28-year period 1912-39 was 6.2 miles an hour. The maximum average during March, April, and May was 7.3, 7.9, and 7.4 miles an hour, respectively, where the vegetative cover was very thin. Occasionally the wind velocity rises to as much as 20 miles or more an hour for a 24-hour average. An average velocity above 8 or 10 miles an hour for more than a 24-hour period ordinarily starts soil drifting, especially on dry sandy-textured soils that are unprotected by proper tillage. When the soil blowing once begins it is difficult to check even at a much lower average wind velocity.

In some instances dust storms may be severe but do little injury to local crops, depending on the time of year and the dryness of surface soil. In this locality dust storms are less severe than on the more sandy-textured soils to the south, but when they do occur, crops are damaged, and barren dry fields are eroded by the wind.

Hail is a crop hazard to be reckoned with in summer. Many of the electric storms produce some hail with the local showers, but the area is usually confined to small strips varying from ½ to 2 or 3 miles in width. The crops most affected are wheat, rye, barley, and oats, but corn and sorghum occasionally are badly damaged.

During recent years maximum seasonal temperatures have risen. In the 26 years 1908-33, only 39 days had temperatures above 100° F. at the Dry Land Field Station; whereas in the 6 years 1934-39, 74 days had temperatures above 100°, or nearly double the former record in less than one-fourth the time. At the same station the average seasonal evaporation—April to September, inclusive—from a 6-foot tank over the period 1908-39 was 44.3 inches.

Weather Bureau records show that the average length of the frost-free season is 151 days. Frosts have been recorded as early as September 9 and as late as June 5. Crop growth is remarkably rapid, and several crops mature in considerably less time than in some regions where the growing season is longer.

The climatic conditions permit more successful dry farming than can be carried on farther south where the rainfall is about the same, but the growth of corn on the heavy-textured soils is very uncertain. Cherries, plums, apples, pears, peaches, and other orchard fruits are not generally grown except in the irrigated South Platte River Valley and on a few farmsteads equipped with windmill irrigation.

The normal monthly, seasonal, and annual temperature and precipitation data at the United States Weather Bureau Station at Akron are given in table 1.

WATER SUPPLY

An abundance of good well water is available in all parts of the area, varying at depths of 40 to 200 feet. In places, flowing wells are obtained at a depth of 60 to 230 feet, and in the southern part a number of these wells are 180 to 230 feet deep. There are no springs and no permanent streams except the South Platte River. Water for livestock is obtained from wells, except where watering ponds have been formed by damming drainageways or where a limited use is made of the supply in the intermittent lakes. Water

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Akron, Washington County, Colo.*
(Elevation, 4,650 feet)

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
December	27.9	69	−28	0.59	0.57	0.32	5.3
January	24.9	66	−23	.23	.40	1.10	2.8
February	28.5	71	−22	.44	1.10	1.68	5.5
Winter	27.1	71	−28	1.26	2.07	3.10	13.6
March	36.4	80	−16	.96	.90	1.50	6.1
April	45.2	88	− 3	2.52	.06	5.19	4.6
May	56.6	92	21	2.62	.57	4.13	.2
Spring	46.1	92	−16	6.10	1.53	10.82	10.9
June	67.0	101	31	2.24	.67	3.75	.2
July	74.1	102	41	2.51	1.83	1.10	0
August	71.1	99	39	2.01	.50	3.51	0
Summer	70.7	102	31	6.76	3.00	8.36	.2
September	63.6	95	25	1.49	1.04	1.76	.1
October	50.5	90	− 5	1.00	.06	.48	3.6
November	36.0	81	− 9	.57	.43	.15	5.2
Fall	50.0	95	− 9	3.06	1.53	2.39	8.9
Year	48.5	[2]102	[3]−28	17.18	[4]8.13	[5]24.67	33.6

[1]U. S. Weather Bureau data, 1891-1942.
[2]In July 1919.
[3]In December 1919.
[4]In 1894.
[5]In 1915.

for irrigation purposes is diverted from the South Platte River in Morgan County and stored in a reservoir near Messex. The reservoir is used as a recreation area, chiefly by local residents.

VEGETATION

The vegetation consists almost entirely of native grasses, weeds, and flowering plants. On the smooth heavy-textured soils, commonly called hard lands, the vegetation is dominantly short grasses —chiefly blue grama and buffalo—in contrast with bluestem, bunchgrass, and other tall grasses in more easterly parts of the plains region. Wheatgrasses are common in depressed situations where supplemental moisture accumulates. Squirreltail and saltgrass predominate in low poorly drained bottom lands that contain some alkali salts. Pricklypear cactus is the most common noxious plant associated with blue grama and buffalo grass on the hard lands. Sand sage, wild sage, porcupine or needlegrass, blow-out grass, bush morning-glory, sandgrass, skeletonweed, and yucca are the dominant grasses and plants on the sandy soils and dune sand. Red three-awn grass and false buffalo grass are among the first to make their appearance on areas of abandoned soils. On the sandy soils a wide variety of annual grasses and weeds come in at different seasons of the year. The more troublesome weed pests in cultivated fields are Russian-thistle, pigweed, ragweed, lambsquarters, wild mustard, ticklegrass, cocklebur, and bindweed.

The principal native trees, willow and cottonwood, are confined mostly to the bottom lands of the South Platte River. Small groves or scattered trees grow naturally in widely separated spots where moisture conditions are favorable. Trees planted in towns and on farmsteads grow slowly and are short-lived unless they occupy favorable sites or are given special care. Those most commonly

planted are Chinese elm, ash, cottonwood, willow, honeylocust, western yellow pine, spruce, and Russian-olive. For landscaping purposes Persian lilac, spiraea, Siberian pea-shrub, and tamarisk are the shrubs that seem to be best suited to this locality.

ORGANIZATION AND POPULATION

The first settlers in the area were cattlemen who arrived about 1884. Prior to this date cattle were grazed on the open range by ranchmen living elsewhere. Washington County was formed in 1887 from part of Weld County, and Akron was established as the county seat. In 1903, additional tracts belonging to Adams and Arapahoe Counties were added to form the present county boundaries.

The early settlers were mainly from Kansas, Nebraska, Iowa, and Missouri. Most of them were American-born, chiefly of German, Swedish, and Swiss descent. Akron, the largest town in the area, according to the Federal census, had a population of 1,417 in 1940.

TRANSPORTATION AND MARKETS

The Chicago, Burlington & Quincy Railroad, crossing the area near the center, and the Union Pacific Railroad in the northwestern corner furnish rapid transportation to nearly all the large cities and chief marketing centers east and west. Akron, Platner, Otis, and Messex are the principal shipping points and trade centers. Akron is a division point for the Chicago, Burlington & Quincy Railroad, and roundhouse and shop facilities are maintained here. Kansas City, Mo., Omaha, Nebr., and Denver, Colo., are the chief outside markets for grain and livestock. Parts of the area are as much as 25 miles from a railroad, but this is not a serious handicap to marketing, as most farmers have trucks for hauling and no farm is more than 8 miles from a hard-surfaced road. About 150 miles of State and Federal-aid highways, about half of which are of bituminous or concrete construction, serve nearly all communities. The county roads are of earth construction, and the more important ones are kept in good repair. An aviation field is located 2 miles southeast of Akron.

CULTURAL DEVELOPMENT AND IMPROVEMENT

The public grade and high school systems are well developed and include consolidated schools in the more thickly populated communities. There are about 60 rural schools, all provided with bus transportation. Churches are well distributed throughout the area.

Most of the farms and ranches are fairly well improved. Nearly all the houses are of wood construction with four to six rooms. The barns and other outbuildings are usually large enough to store the grain and feed and to shelter the livestock. Fences are mainly of barbed wire. Few of the farmhouses and buildings have received a coat of paint in the past 10 years (1933-43), and the farms in general are in a run-down condition.

Windmills are commonly used for pumping water. A few of the homes have modern conveniences and are lighted with electricity produced by home-generating plants. Rural electrification had not reached the area at the time of this survey. Radios are in

common use, and the northern two-thirds of the area is well supplied with telephones. Rural mail delivery extends to most parts.

AGRICULTURE

Prior to the first settlement in the part of the county now included in the Akron area, buffalo and antelope roamed the prairies in countless numbers. In the early seventies a few cattlemen began grazing their herds during seasons when water and range conditions were most favorable. In the early eighties several cattlemen had located permanently and by 1888 several hundred had arrived, owing to a few exceptionally favorable years. In the few droughty years following 1888, some of the more needy settlers resorted to picking up bleached buffalo bones and hauling them to the nearest railroad station as a source of livelihood. In the nineties most of the years were favorable and fairly steady agricultural progress was made, which continued through the greater part of the next decade.

Some corn, oats, and wheat were grown between 1900 and 1910, but the cattle that grazed on the open prairie furnished the chief source of income. Lack of equipment, droughty years, and ravages of grasshoppers greatly curtailed the production of cash crops. The next decade, 1910-20, was the period of greatest expansion. High prices during World War I caused thousands of acres of arable land to be broken for wheat. Much of this land was marginal for cultivated crops and should not have been broken. Nevertheless, there was healthy increase in population, and prosperity continued for a number of years, owing to favorable crop years and to good prices of farm products.

According to the census of 1920, the population of Washington County had increased from 6,002 in 1910 to 11,208 in 1920. The fact that the railroad and towns of the county lie within the Akron area, the population there was considerably more than half of that for the entire county. Several years after the war, droughty years again became more frequent, the price of farm commodities declined, and many who did not have a reasonable acreage of grazing land upon which cattle could be raised were forced to vacate. The decline in population continued from its peak in 1920 to 8,336 in 1940. The lengthy cycle of abnormally dry years, or rather the several years of unfavorable distribution of rainfall for growing crops, and the unbalanced relation between the low prices received for farm commodities and those paid for necessary farm machinery and equipment were largely responsible for the decline. Moreover, continued high taxes and difficulty in obtaining extended credit forced some to vacate. At present the agriculture of this locality is undergoing a period of readjustment to a more diversified type.

Some changes have been made in the kinds of crops grown, as in any other newly settled locality, but corn and wheat have always been the most important. In the early days a few patches of peanuts, buckwheat, and flax were grown, but unfavorable returns caused them to be discontinued. After the first diversion ditch was built along the South Platte River in 1889, which was followed by others, some 7,000 acres of land in the northwestern part of the area was made available for intensified irrigation. The land has been utilized mainly for sugar beets and alfalfa, with some corn, wheat, oats, barley, potatoes, melons, and turnips. Crop

yields in this limited part of the Akron area are far higher and more consistent than those obtained in any other part.

CROPS

As the Akron area includes slightly more than half of Washington County, the census data, which are for the county, are not representative of all of the crops grown in the Akron area only. It is estimated that about two-thirds of all the wheat, oats, rye, and barley acreage and possibly three-fourths of the corn acreage are confined to the Akron area. The figures for potatoes, beets, and alfalfa are representative, inasmuch as these crops are confined mainly to the irrigated valley of the South Platte River within the Akron area. The comparative acreages of crops grown in Washington County during several decades are shown in table 2.

TABLE 2.—*Acreage of principal crops in Washington County, Colo., in stated years*

Crop	1889	1899	1909	1919	1929	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Wheat	118	368	11,458	160,466	109,939	58,194
Corn:						
Harvested for grain	11,128	1,178	20,307	57,331	116,226	34,563
Cut for silage	.....	.....	.....	.....	141	4,442
Hogged, grazed, or cut for fodder	.....	.....	.....	16,646	17,387	15,096
Oats:						
Threshed	290	263	5,989	2,863	3,676	735
Cut and fed unthreshed	.....	.....	.....	.....	655	1,205
Rye	210	54	608	12,925	5,184	1,499
Barley	14	115	1,977	14,933	54,609	39,474
Sorghums:						38,002
Harvested for grain	.....	.....	.....	.....	160	3,543
Cut for silage, hay, or fodder	.....	.....	.....	23,747	17,901	34,459
All hay	8,015	11,840	19,197	25,960	28,867	11,747
Alfalfa	.....	1,051	1,559	4,203	3,541	1,340
Small grain hay	.....	576	1,417	6,389	5,754	5,620
Other tame hay	.....	299	2,102	6,022	9,421	1,269
Wild hay	.....	9,914	14,119	9,346	10,151	3,518
Dry beans	.....	2	91	465	14,670	378
Potatoes	692	11	786	485	397	15
Sugar beets	.....	.....	584	1,479	1,396	1,330

Prior to 1900, as shown in table 2, the land in oats, wheat, rye, and barley was less than 400 acres each. By 1909 the acreage of various crops had increased considerably, that of wheat being 30 times greater. From 1909 to 1919, the decade of greatest expansion, the acreage of most crops had made pronounced increases, that of wheat being about 450 times greater than in 1900. By 1929, the acreage of corn, oats, barley, and edible beans had continued to make some increases, whereas the acreage in most other crops had decreased. Owing to the recent cycle of dry years, the acreage of all crops, with the exception of forage crops and oats cut and fed unthreshed, declined from 1929 to 1939.

According to census data of Washington County, the harvested area of all crops in 1939 was 207,888 acres, as compared with 376,171 acres in 1929. Other grains and roughages were correspondingly short. The chief crops of corn, wheat, and barley harvested for grain in 1939 totaled 132,231 acres, as compared with 280,774 acres in 1929; furthermore, the total number of bushels harvested in 1939 was about a fourth of the total harvested in 1929. The foregoing gives some idea as to the severity of the recent cycle of dry years.

The average acre yields of the important crops over a 30-year

period, 1909 to 1938, at the United States Dry Land Field Station, 4 miles east of Akron are shown in table 3 (*1*). Inasmuch as this station is near the center of the Akron area and on Rago silt loam, a typical hard-land soil, the results of the various crops under various tillage methods over a 30-year period are fairly representative of crop yields to be expected under good management on this particular soil.

Yields in table 3 were averages of experimental plots under varied tillage practices and probably would check closely with the same practices on this soil for the Akron area. Proso, or hog millet, was not grown regularly each year, but when grown was usually seeded on fallow or Sudan grass stubble. The yields shown, therefore, are higher than for the average of various tillage methods for the area. Also the averages of oats and barley are considered rather high because fallow plots are usually averaged with other tillage methods for these crops.

TABLE 3.—*Annual and average yields per acre of crops grown by periods for the 30 years 1909-38*

Year	Grain					Forage and grain yields		Stover or straw	
	Winter wheat	Spring wheat	Oats	Barley	Corn	Corn	Sorgo	Corn	Barley
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1909	14.1	13.8	19.4	19.8	24.9	4,570	7,950	2,827	1,561
1910	14.1	9.2	13.3	12.0	10.9	2,241	3,620	1,478	978
1911	4.1	3.7	4.0	6.1	3.2	1,367	1,300	1,143	538
1912	33.8	19.7	42.3	30.8	30.9	4,535	6,100	2,372	2,098
1913	7.4	3.9	6.6	6.3	3.9	1,607	1,400	1,334	601
1914	25.5	16.6	42.2	37.8	11.3	2,730	3,560	1,939	1,830
1915	21.8	27.3	64.3	55.0	29.2	3,564	5,860	1,520	2,523
1916	13.7	7.1	11.3	11.0	1.1	915	550	838	701
1917	6.6	13.2	26.2	26.4	15.2	2,765	2,350	1,701	966
1918	5.3	1.1	1.4	4.3	12.4	3,076	3,200	2,208	562
1919	15.0	6.3	16.9	18.3	4.5	1,620	2,150	1,305	1,010
1920	14.2	18.7	44.2	32.1	35.6	4,356	6,270	1,864	1,376
1921	12.3	2.1	13.1	14.1	6.3	1,223	1,560	782	756
1922	.6	6.9	15.9	11.7	11.2	2,545	4,860	1,761	1,039
1923	3.2	4.6	14.4	18.6	17.8	3,464	4,910	2,218	1,662
15-year average	12.8	10.3	22.4	20.3	14.6	2,705	3,709	1,686	1,214
1924	3.9	.5	5.8	4.1	1.8	1,220	700	1,094	382
1925	6.5	3.4	6.7	5.1	.8	766	770	710	643
1926	1.3	.3	.11	2.3	8.5	2,485	3,348	1,890	716
1927	16.3	11.2	33.7	32.0	8.2	1,474	3,370	900	2,416
1928	11.7	11.0	33.6	34.1	8.3	2,294	3,060	1,713	1,774
1929	4.0	1.7	1.6	1.4	13.7	2,281	3,920	1,322	700
1930	12.3	1.6	6.0	10.9	20.9	3,262	6,850	1,799	620
1931	7.3	1.0	7.2	9.1	.4	602	1,280	574	324
1932	2.2	3.6	13.0	7.5	4.2	1,694	1,870	1,400	340
1933	1.0	1.0	7.8	6.8	4.8	1,793	2,080	1,457	559
1934	1.9	.4	.2	1.5	.2	484	310	470	568
1935	6.2	11.2	38.2	46.8	10.7	2,444	2,810	1,695	2,721
1936	17.0	4.7	19.8	16.9	3.6	1,544	2,200	1,292	1,214
1937	11.0	3.8	13.0	11.2	1.2	885	1,170	801	774
1938	12.2	5.8	28.7	24.2	1.3	854	1,130	763	1,769
15-year average	7.7	4.1	14.4	14.3	5.9	1,605	2,325	1,192	1,040
Percentage of loss	40	60	36	30	60	41	37	29	14
30-year average	10.2	7.2	18.4	17.3	10.2	2,155	3,107	1,439	1,127

LIVESTOCK AND LIVESTOCK PRODUCTS

Raising beef cattle, especially the larger herds, is confined to the more rolling and to the excessively sandy parts of the area. Some are raised locally, others are bought, pastured, and marketed at opportune times, often in summer or early fall. Grade Hereford and Shorthorn cattle are most commonly raised, but a few farmers

own highbred Aberdeen Angus. In 1940 the Federal census reported 32,391 cattle over 3 months old on April 1, valued at $1,272,255. Although purebred dairy cattle, chiefly Holstein-Friesian, are kept on a few farms, the bulk of the dairy products are produced from dual-purpose cows. Dairy products sold from the 16,062 cows and heifers reported in the 1940 census brought $189,375 in 1939. Most of the products, especially cream, are shipped to the larger marketing centers.

Hogs are raised by some farmers, especially by those owning beef or dairy cattle. Duroc-Jersey, Poland China, Chester White, and Hampshire are the leading breeds, and some purebred herds are kept. Most of the hogs are raised, fattened, and shipped to Denver or other markets, and some are butchered for home consumption. The census of 1940 lists 5,211 hogs and pigs over 4 months old on April 1, valued at $42,667.

Sheep ranches are confined mainly to the more rolling northern and southwestern parts of the area. Some sheep are raised and others are bought on the market to be pastured locally and sold at the most advantageous time. The census of 1940 reports 24,857 sheep over 6 months old on April 1, valued at $135,658. Because of the thin grass cover brought about by the dry years during the last decade, sheep are far less numerous than formerly.

Raising horses and mules formerly reached considerable proportions but has gradually declined since 1920. Most of the horses are either Percherons or of mixed breed. The census of 1940 lists 8,068 horses and 270 mules over 3 months old on April 1, valued at $339,435 and $15,600, respectively.

Chickens are raised by most farmers, and there are many flocks of several hundred White Leghorns, Rhode Island Reds, Plymouth Rocks, or mixed breeds. Some turkeys and in favorable places a few geese and ducks are raised. The 1940 census reports the value of poultry raised and eggs produced in 1939 at $267,754.

The value of all crops harvested, according to the 1940 census, was $682,834 and of all livestock and livestock products, $2,519,795.

LAND USE

The types of farming in any locality are usually determined by the crops that can be produced most advantageously on the local soils. In this area the smooth hard and semihard soils are utilized very largely in producing cash grain crops. Other crops are grown and fed to livestock in the form of grain, hay, roughage, or silage, and the net income realized is from the sale either of livestock or of livestock products. Farmers who own considerable nonarable grazing land or excessively sandy land ordinarily raise livestock in conjunction either with or without some cash grain crop and with the growing of corn and forage crops. Many farmers who own only good plow land practice diversified farming, and their cash income is obtained from the sale either of grain, poultry, and livestock or of their products. At the present time this is the most successful type of agriculture in this locality.

This trend in agriculture has been brought about by the recent long cycle of comparatively dry years and the prevailing low prices of grain, especially in 1931 and 1932, which forced a number of wheat growers to reduce their wheat acreage and diversify their crops. Most of the following years have been more or less

droughty, and the prices of wheat on the farm have not been sufficiently high to insure a reasonable yearly income by relying on wheat alone. Consequently, more farmers now own a number of dual-purpose cows, raise calves, and sell milk or milk products, poultry and poultry products, and some cattle each year. Poultry raising and dairying greatly increased during the decade 1930-40, and more hogs are now raised by many of the more successful farmers. This diversified trend in agriculture is having a balancing effect and is much safer through a period of years than depending on cash income derived chiefly from wheat.

Lack of available pasture has forced many farmers to continue raising cultivated crops. It usually takes about 15 years for idle land to revert to a fair stand of native grasses, but by the use of newer methods of seeding a stand can be obtained in as little as 2 years if moisture conditions are favorable. Farmers cannot afford to let the land remain idle very long, because not only is insufficient cropland left to insure a fair income but also a considerable tract of grazing land is required for a farmer to succeed in the livestock business. This overcrowded condition of the more suitable cropping land, under restricted rainfall conditions, was brought about during World War I, when the influx of population was greatest and the prices of farm commodities were abnormally high, and at the same time when a cycle of good crop years prevailed. The breaking up of thousands of acres of virgin grassland at that time has left many farmers with insufficient grass to depend upon cattle for cash income. A gradual shift, therefore, has been under way by which less small grain is grown and a greater acreage is used for sorghums for both grain and forage, especially the latter, in order that more livestock may be raised.

The present condition of agriculture, although not the best, is gradually adjusting itself to the long stretch of dry years. Inasmuch as leguminous green-manure crops and fertilizers cannot be relied upon to maintain fertility and insure crop yields, diversified agriculture is proving more satisfactory.

TYPE OF FARMS

The 1940 census reported 1,439 farms in Washington County, or 314 less than in 1930. The size of farms in the county ranges from 3 to more than 1,000 acres, but the greater number contain more than 1,000 acres. The average size of 904.3 acres is high for the Akron area, as it embraces the more thickly settled northern half of the county. In 1939 improved land in farms, including plowable and other arable land suitable for crops, represented 77.2 percent of the county, or 698.2 acres per farm. Of the idle and cultivated land confined strictly to the Akron area about 7 percent was idle at the time of the survey. The fact that a large body of dune sand covers the northwestern part and another lies south of Otis accounts for the low percentage of land under cultivation within the area.

Of the improved farm land in the county in 1939, 207,888 acres was in harvested crops; 213,572 in crops failed to mature; 89,957 in idle or fallow cropland; and 493,249 in plowable pasture.

FARM TENURE

Owners operated 55.3 percent, tenants 44.5 percent, and managers 0.2 percent of the farms in 1940; whereas in 1920, owners

operated 81.4 percent, tenants 18.2 percent, and managers 0.4 percent. Recent years of prevailing low prices and low crop yields have made it necessary for a large number of farmers either to sell, move to other localities, or go on relief, with the result that the percentage of owner-operators decreased and the percentage of tenants increased. The proportion of tenant farmers, however, has increased steadily since 1890, when only 3.6 percent of the farms were rented.

In this locality the crop-share system is the most common form of land rental. On improved land the tenant furnishes all seed, labor, and machinery and delivers one-third of the corn or small-grain crop to the owner. On unimproved land the tenant delivers one-fourth of the crop. Cash rents for grazing lands vary according to the forage produced.

FARM INVESTMENTS AND EXPENDITURES

The selling price of individual farms ranges widely, depending on the character of the soil, surface features, drainage, improvements, and location with regard to railroads or highways. Much of the plow land at the time of the survey, which was broken during abnormally dry seasons, could be bought for $10 to $15 an acre and in more isolated places as low as $3. During cycles of good crop years, prices more than doubled and many dry-land farms were valued at $30 to $40 an acre or more. Irrigated land in the valley of the South Platte River commands the highest and most consistent price of any within the Akron area. The 1940 census reports the total value of land and buildings in Washington County at $7,337,381, an average of $5,099 per farm and $5.64 per acre.

Labor is difficult to obtain. Farmers usually employ white labor; but in the South Platte River Valley, some farmers contract with Mexican families to raise and top the sugar beet crop. In recent years, the daily wage for assisting in harvesting small grain was $2.00 to $2.50 a day. Ordinarily monthly wages range from $25 to $35, with board and lodging. Of the 1,439 farms in Washington County, 534 hired labor in 1939 at a cost of $129,083.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their characteristics, particularly in regard to the growth of various crops, grasses, and trees. The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings made, and highway or railroad cuts and other exposures studied. Each excavation exposes a series of layers, or horizons, termed collectively the soil profile. Each horizon, as well as the underlying parent material, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stones are noted. The chemical reaction of the soil and its content of lime and salts are determined by simple tests.[5] Other features taken into consideration are the drainage, both

[5] 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, alkalinity; and lower values, acidity. Indicator solutions are used to determine the chemical reaction. The presence of lime is detected by the use of a dilute solution of hydrochloric acid.

internal and external, the relief, or lay of the land, and the interrelations of soil and vegetation.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaption of the land to the production of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the principal three of which are (1) series, (2) type, and (3) phase. In some places two or more of the three may be in such intimate or mixed pattern that they cannot be clearly separated on a small-scale map but must be mapped as (4) a complex. Some areas of land—badlands, dune sand, riverwash, and rough stony land—that have no true soil are called (5) miscellaneous land types.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Haxtun, Platner, Keith, Weld, and Rago are names of important soil series in the Akron area.

Within a series are one or more types, defined according to the texture of the upper part of the soil. Thus, the class name of this texture—sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, or clay—is added to the series designation to give a complete name to the soil type. Except for the texture of the surface soil, these 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 unit to which agronomic data are definitely related. Haxtun fine sandy loam and Haxtun sandy loam are soil types within the Haxtun series.

A soil phase is a variation within the type, differing from it in some minor feature, generally external, that may be of special practical significance. For example, with the normal range of relief of a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Differences in relief, stoniness, and degree of accelerated erosion may be shown as phases. Even though no important differences may be apparent in the soil profile 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 instances the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, some soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil profile or in the growth of native plants. Platner loam, rolling phase, is an example of a phase in the Platner series.

An example of a soil complex is found in Weld-Colby silt loams, rolling phases, in which the soils are so intimately associated that they cannot be separated on a map of the scale used.

The soil surveyor makes a map of the county or area, showing

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the location of each of the soil types, phases, complexes, 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

The soils included in the Akron area lie near the western border of the Great Plains. Differences in the weathered products of the various soil-forming materials, mode of distribution, drainage, and surface relief have given rise to many distinct soil characteristics that have greatly influenced the suitability of the soils for various crops grown in this locality. The erratic climatic conditions from year to year or over a period of years have made the common agricultural practices more or less hazardous.

The climatic environment during past ages has produced a general but variable grass cover over practically the entire area. The smooth silty and clayey soils of mild relief, locally referred to as hard lands, have medium- to heavy-textured subsoils. The grass cover, through long decay of grass roots, has produced brown and dark grayish-brown soils with a fair to moderate content of organic matter. The intensity of darkness and the depth to which the dark color has penetrated depend on surface relief, drainage, location in regard to the surrounding runoff, and the length of time the soils have been unmolested by either wind or water erosion. Ordinarily on the excessively sandy soils the grass cover is less abundant and the organic matter is less conspicuous, except in low situations that collect considerable runoff water. Many depressions scattered over the broad upland divides collect water during rainy periods and thus form intermittent lakes. Such areas, which are variably distributed on several of the hard-land soils, have extremely heavy dark surface soils and deep heavy subsoils. Excessively sandy soils with rolling relief are much lighter in color, owing to the less abundant grass cover, the lighter accumulation of organic matter, and the effects of erosion.

Ordinarily the soils having the highest content of organic matter are most valuable for raising the common crops. The only exception in this area is on certain undrained soils that receive more or less surface runoff during the heavy rains and thus form temporary lakes. Most of the soils in the area are low in organic matter, probably not exceeding 2 percent, but the lower lying soils with deep dark subsoils probably contain considerably more. The presence of organic matter in liberal quantities has several beneficial effects. It assists the soil in absorbing the sun's heat and in maintaining a uniform temperature; it greatly increases the water-holding capacity and rate of absorption; and makes the soil more retentive of moisture, thereby insuring considerable protection against crop failure during droughts. The porous condition of soils containing organic matter facilitates root penetration and the free movement of air and water, which assists in making available plant nutrients in the raw vegetal and mineral constituents of the soils.

Practically all the region was formerly mantled with loess, a light yellowish-gray floury and limy silt similar to that which covers most of southern Nebraska. The loess in the north-central and southwestern parts of the Akron area, where the relief is

rolling, is thicker—20 to 30 feet in places—than in parts of central, eastern, and southern extremities, where the relief is mild and the loess is thin and more or less mixed with underlying formations. Numerous local areas are practically devoid of loess. No doubt most of the original mantle was blown over these smoother parts or thinned more or less by erosion. At any rate loess has contributed to or is the material on which the more extensive hard-land soils have developed. Soils developed from this material have smooth or undulating relief and a moderately to fairly deep dark-brown surface soil; whereas those having a rolling surface have a grayish-brown surface soil and a grayish-yellow subsoil.

Under the prevailing dry climate, the annual average precipitation of 17.18 inches has not been sufficient to remove the lime carbonate in any of the hard-land soils to any considerable depth. Ordinarily the leaching of lime is confined to a depth of a few inches to 15 or 20 inches. In places along rolling slopes lime carbonate occurs at the surface, and everywhere there is an abundance for the needs of the common crops grown. Also the supply of phosphorus, potash, and nitrogen is generally sufficient for present crop needs, but the continued planting of the land to wheat and corn may eventually result in such a marked deficiency of the available forms of these plant nutrients that crop yields will prove more or less unprofitable. A shift to tame grasses, or preferably to wild, on fields of low fertility has proved beneficial in making available the plant nutrients necessary for various cultivated crops. Proper crop rotations are always beneficial.

During dry periods, some of the hard-land soils become exceedingly hard and intractable—a condition that greatly retards the movement through the soil of air, water, and especially crop roots. Figure 2 shows that the rainfall during the critical dough-stage of wheat and the tasseling stage of corn is decidedly lower than at other times during the growing season. Some hard-land soils do not ordinarily permit more than two-thirds of the annual rainfall to penetrate the soil; and the long windy days of high evaporation during the growing season so reduce the supply of stored water that it is no wonder that farming some hard-land soils is an exceedingly hazardous task. Moreover, some soils have such a compact subsoil that the capillary rise of moisture is greatly retarded and deep-rooted crops, as corn, cannot be depended upon to produce satisfactory yields, even when there is a good supply of subsoil moisture in spring.

Many of the soils of the Akron area are friable and easily penetrated by roots, air, and water. Such soils have a high moisture-holding capacity, but some of these cannot always absorb rainfall as rapidly as it falls. The excessively sandy soils absorb practically all the rainfall, but those having a sandy surface soil and a moderately heavy subsoil do not, so that, during some seasons the corn crop is partly washed out, especially on slopes, and replanting becomes necessary.

Owing to the long cycle of dry years, farmers are more and more turning to a diversified farming system. Inasmuch as many do not own sufficient land to permit large-scale livestock raising, it is apparent that it is very desirable to raise some poultry, dairy

cows, and possibly a few brood sows to supplement the chief cash crop, wheat. Those owning large tracts of grazing land continue year after year to raise cattle or sheep for market. This, as a rule, is the most dependable farming practice in dry-land localities not overpopulated. At present comparatively few farmers depend on small-grain crops alone.

On the basis of their agricultural suitability, the soils are utilized either for grazing purposes or for the cultivation of intertilled crops. The loose dark sandy-textured ones occurring in most parts of the country are planted to corn. Many of these, because of low-lying position, collect considerable runoff, and all are highly absorptive of moisture and have a very loose to moderately friable subsoil. Such soil conditions are especially suitable for corn production on the Great Plains. Greeley soils of terraces and high first bottoms, Las Animas and Wann soils of the first bottoms, Bridgeport and Goshen soils on the alluvial fans and slopes, and Haxtun and Keith soils of the uplands fall into this group. Some small grains are grown on these soils, but corn is better suited to them; and the desire of most farmers to raise some corn for livestock feed makes this a more favored crop.

Wheat and barley are more generally confined to the medium and heavier textured upland soils that are not so well suited to successful corn production and are better suited to small grains. The early maturity of small grains gives them a better chance than corn to mature before the severe droughts of summer set in. The Platner, Weld, Renohill, and Colby soils are well suited to small grains. Considerable corn, however, is grown on the Weld soils, because they have characteristics favorable not only to small grains but fairly favorable to corn.

Irrigated land in the valley of the South Platte River is utilized chiefly for sugar beets and alfalfa, especially on the Fort Collins and Wann soils. Other crops, including corn, wheat, barley, and potatoes, produce high yields, but the profits ordinarily are not so consistently high as those derived from sugar beets and alfalfa. Most of the farmers, however, grow some of these crops for use in raising and fattening hogs and feeding sheep or cattle late in fall.

Practically all the rolling, light-colored excessively sandy lands, including the Valentine soils and large bodies of dune sand, are chiefly in pasture, but a small percentage of the former having favorable surface features are planted to rye, corn, or sorgo, or in places are kept in native grasses that are cut for hay. Such soils are utilized in connection with raising livestock.

Inasmuch as the soils differ greatly in productivity and crop suitability, they may be arranged in groups, each of which includes soils that are similar in their soil characteristics and fairly consistent in their capability for use and are used for some particular crop or crops more extensively than soils of some other group. In this area six soil groups, based on regional soil characteristics, surface and internal drainage conditions, and topographic features, which may decidedly affect their crop adaptability for use under the prevailing climate, are as follows: (1) Dark-brown soils of smooth and undulating uplands, (2) brown soils of smooth and undulating uplands, (3) brown soils of rolling uplands, (4) brown to dark-brown soils of narrow bottom

lands, alluvial fans, and terraces, (5) brown to grayish-brown soils of imperfectly drained bottom lands, and (6) miscellaneous soils and land types.

This grouping does not necessarily imply that the soils of any one group are equally productive or that the farming practices are precisely the same. Any grouping would include soil types with certain differences that might affect agricultural usage to a certain extent. Even the farming systems and crops grown may vary on the different soils of a group or on the same soil in different parts of the area, depending on the requirements of certain farmers. Also some local differences in quantity and distribution of rainfall would have some bearing on the crop adaptability or capability for use within a group. Over a long period of years, however, the soils of each group have certain crop suitabilities that affect the agriculture to a greater or lesser extent.

DARK-BROWN SOILS OF THE SMOOTH AND UNDULATING UPLANDS

Considering the wide variation in climatic conditions over a long period of years, the dark-brown soils of the smooth and undulating uplands are among the most desirable of the Akron area. Because of their capacity to absorb and retain rainfall, their moderately high organic-matter content, their favorable position for the accumulation of more or less surplus runoff, and their smooth, nearly level to gently sloping surface features, these soils are well suited to corn and forage crops, even during cycles of abnormally low rainfall. These crops contribute to livestock farming, which, in the long run, is the most dependable source of income in most dry-land areas. Moreover, most of these soils occur in close association with the excessively sandy soils, which are suitable only for grazing, and the production of grains on the moderately sandy soils provides supplemental feed for livestock pastured on the silty soils.

These soils are members of the Keith, Rago, Haxtun, and Goshen series. Keith soils are derived from loessal deposits and have a deep, dark grayish-brown silty surface soil underlain by light grayish-yellow floury silt similar to the material underlying the Colby and Weld soils. Rago soils occupy smooth, nearly level or slightly concave upland situations. The 16- to 24-inch surface layer is dark brown to dark grayish brown. Haxtun soils are immaturely developed from aeolian and colluvial deposits in nearly level to slightly sloping depressed situations throughout the sandy soils of the uplands. They consist largely of sand but contain enough silt and clay to give them moderate coherence and a dark color. Goshen soils occur in swales or elongated depressed situations along intermittent drainageways having no entrenched channel and in low-lying places resembling former shallow lake beds. They are mapped also in places along low terraces bordering entrenched drainage courses. The surface soil is dark grayish-brown silty to clay loam, underlain by either a silty or moderately heavy dark deep subsoil apparently modified by both colluvial and alluvial deposits. This group comprises the following: Keith silt loam and very fine sandy loam; Rago silt loam and very fine sandy loam; Haxtun fine sandy loam, loamy sand, and sandy loam; and Goshen loam, sandy loam, and clay loam.

BROWN SOILS OF THE SMOOTH AND UNDULATING UPLANDS

The brown soils of the smooth and undulating uplands are the most inclusive of the several soil groups. Most of them are commonly referred to as hard land. The subsoil is moderately heavy, and under drought conditions often becomes extremely hard and impermeable to plant roots. The several crops commonly grown in this locality are more adversely affected by long droughts on these soils than on most of those of other groups. In spite of this, they are responsive to good management, especially to the summer-fallow practice, and are not in so much danger of being severely blown or drifted as are the soils of the next group. Practically all these soils are suitable for the use of heavy farming implements, but more power is necessary in plowing some of the heavy-textured members. Although the supply of organic matter is fair to good, it is not so abundant as in the soils of the first group.

These soils are members of the Weld, Platner, Renohill, Colby, and Vona series. Platner loam is characterized by a brown moderately friable surface soil overlying a heavy brown subsoil containing varying quantities of coarse sand, silt, clay, and pebbly material. Derived from grayish-yellow fine silty wind-deposited loess, the Weld and Colby soils occupy gently sloping to rolling situations. The 8- to 16-inch surface soil of the Weld is brown and the 3- to 8-inch surface layer of the Colby is light brown. Although in both soils the surface soil is friable, the subsoil of the Weld is moderately heavy to heavy and that of the Colby is very silty and friable. The Vona soils have a brown surface soil and a very friable loamy subsoil containing a low percentage of clay and pebbly material. The Renohill soils have a grayish-brown friable surface soil underlain by a light-brown or light brownish-yellow subsoil composed largely of Cretaceous shale having a comparatively high percent of silt, some clay, and a small percentage of very fine sand. This group comprises the following: Weld silt loam and its undulating phase, silty clay loam, very fine sandy loam and its undulating phase; Platner loam and its undulating phase, the fine sandy loam and its undulating phase, the sandy loam and its undulating phase; Renohill clay loam and its undulating phase; Colby silt loam and very fine sandy loam, deep phase; and Vona loamy fine sand.

BROWN SOILS OF THE ROLLING UPLANDS

The use capability of the brown soils of the rolling uplands is somewhat restricted by their rolling surface. They resemble the brown soils of the smooth and undulating uplands in many respects, but because of greater slope they are not so well suited to large farm machinery. On the fine-textured types, particularly, more of the rainfall runs off instead of being absorbed. The soils are members of the Weld, Platner, Renohill, Colby, and Vona series and include the following types: Weld-Colby silt loams, rolling phases; the rolling phase of Weld very fine sandy loam; the rolling phases of Platner loam, fine sandy loam, and sandy loam; Renohill clay loam; the rolling phases of Colby silt loam and very fine sandy loam; and the rolling phase of Vona loamy fine sand.

BROWN TO DARK-BROWN SOILS OF THE NARROW BOTTOM LANDS, ALLUVIAL FANS, AND TERRACES

The brown to dark-brown soils of the narrow bottom lands, alluvial fans, and terraces include all the well-drained alluvial

soils, whether on first bottoms, alluvial fans, or river terraces. These soils are members of the Bridgeport, Fort Collins, and Greeley series. The Bridgeport soils occur on narrow strips of local alluvium along upland drains and on alluvial slopes bordering the first bottoms; the Fort Collins on river benches or terraces; and the Greeley on smooth low terraces and first bottoms of the nonirrigated uplands and on terraces in the irrigated valley of the South Platte River.

The Bridgeport soils are along the intermittent streams of the nonirrigated uplands and consist of alluvial wash mainly from the rolling Colby soils. The surface soil and subsoil are brownish yellow and fairly uniform from the surface downward. The Fort Collins soils occur chiefly in the irrigated valley of the South Platte River. They have a brown friable to moderately heavy surface soil with a grayish-brown to olive-gray moderately heavy subsoil. The surface soil is much darker than that of the Bridgeport soils, and the subsoil is considerably heavier. Developed from alluvial deposits washed from Tertiary geologic formations, the Greeley soils occur principally on high first bottoms and low terraces bordering intermittent small streams and drainage courses, but areas are found on terraces in the irrigated valley of the South Platte River. The surface soil is somewhat deeper than that of the Platner soils of the uplands, and the moderately heavy subsoil contains varying quantities of coarse sand, clay, and pebbly material. This group comprises the following: Bridgeport fine sandy loam, silt loam, and silty clay loam and its sloping phase; Fort Collins loam and clay loam; and Greeley fine sandy loam and sandy loam.

BROWN TO GRAYISH-BROWN SOILS OF THE IMPERFECTLY DRAINED BOTTOM LANDS

The brown to grayish-brown soils of the imperfectly drained bottom lands are of minor importance in the Akron area. This group comprises the following types of the Laurel, Wann, and Las Animas series: Laurel and Wann clay loams and Las Animas loamy sand and sandy loam. These soils are composed mainly of alluvial sediments, with some colluvial wash from the adjoining uplands in places. Most of the Las Animas and Wann soils in the South Platte River bottoms are good productive soils that have been drained successfully and well supplied with irrigation water. The Las Animas along Camp Creek in the west-central part are in pasture only, because they are imperfectly drained, are susceptible to blowing when broken, have a slight to moderate alkali content, are low in organic matter, and are inaccessible to irrigation water. Very little, if any, improvement could be made on their present use.

Las Animas sandy loam has a loose sandy grayish-brown surface soil and a moderately heavy sandy clay subsoil, whereas Las Animas loamy sand has a slightly darker grayish-brown surface soil and a more friable subsoil. Surface and internal drainage conditions in the South Platte River valley are better in Las Animas loamy sand than in the sandy loam. The Wann soil is darker colored because of a higher organic-matter content than either the Laurel or Las Animas soils. With adequate surface drainage, Wann clay loam apparently is the most productive of the group. All these soils have limy subsoils.

MISCELLANEOUS SOILS AND LAND TYPES

The miscellaneous soils and land types—15 in number—vary greatly in their respective characteristics. They are too steep, rocky, sandy, shallow, severely dissected, or inadequately drained to permit general cultivation. Their productivity is low and when cultivated the crop yields are uncertain. Their capability for use, therefore, is limited almost entirely to grazing. This group comprises the following: Blakeland loamy sand and its level phase; Valentine sand and its level phase; McKenzie clay and loam; Platner-Canyon complex and Platner loam, shallow phase; riverwash; dune sand (stabilized); badlands; Canyon gravelly loam and its undulating phase; Stoneham gravelly loam; and rough stony land (Travesilla soil material).

Blakeland loamy sand has smooth gently sloping to rolling surface features in contrast with the sharply rolling irregular relief of the dune sand. It contains more coarse sand than dunes and enough clay particles to give the material a fair degree of coherence and stability. Without a protective cover of native grass, this soil is subject to surface drifting, but not to the extent of forming deep blow-outs, which are common in dune-sand areas. Valentine sand differs from dune sand in having less rough surface features and a browner colored surface soil and is smooth enough to permit the operation of farm implements or haying machinery. The surface soil of Valentine sand, level phase, is grayish brown and deep, and the subsoil is a loose slightly coherent sandy material free of lime, representing wind-blown material closely associated with dune sand and Blakeland loamy sand. McKenzie clay occupies the deeper basinlike intermittent lake beds, whereas McKenzie loam occupies small shallow depressed areas or intermittent lakes, some of which are cultivated during dry years. Platner loam, shallow phase, is underlain at a depth of 16 to 36 inches by material essentially the same as that of the Canyon soil. Riverwash consists of low variable deposits of soil materials subject to very frequent overflow and to shifting from place to place by floodwater. Badlands consist of sharply dissected, rough, barren, eroded land showing several underlying rock and clay formations. Canyon gravelly loam, characterized by moderately thin to thick beds of granitic gravel and partly disintegrated limestone, occurs on the narrow brows of the high upland flats or divides. Stoneham gravelly loam occurs chiefly along small drainageways of the uplands and contains small granitic pebbles and clay in both surface soil and subsoil. Rough stony land has gently sloping to rolling topographic features with a moderate to thick covering of sandstone boulders.

DESCRIPTIONS OF SOIL UNITS

In the following pages the various soils of the different groups are described in detail and their agricultural importance is discussed. Their location and distribution are shown on the accompanying soil map, and their acreage and proportionate extent are given in table 4.

Badlands—Steep, hilly, severely eroded, and dissected land make up this land type, and the greater part of it is barren. Several geologic formations, including Brule clay, Chadron clay, and one

TABLE 4.—*Acreage and proportionate extent of the soils mapped in the Akron area, Colo.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Badlands	1,728	0.2	Platner fine sandy loam	11,264	1.3
Blakeland loamy sand	42,752	5.1	Rolling phase	1,216	.1
Level phase	5,120	.6	Undulating phase	3,840	.5
Bridgeport fine sandy loam	2,368	.3	Platner loam	148,416	17.9
Bridgeport silt loam	1,600	.2	Rolling phase	5,056	.6
Bridgeport silty clay loam	3,072	.4	Shallow phase	2,624	.3
Sloping phase	896	.1	Undulating phase	23,680	2.8
Canyon gravelly loam	1,024	.1	Platner sandy loam	54,336	6.6
Undulating phase	2,112	.3	Rolling phase	3,648	.4
Colby silt loam	1,984	.2	Undulating phase	24,384	2.9
Rolling phase	19,712	2.4	Rago silt loam	44,032	5.3
Colby very fine sandy loam:[1]			Rago very fine sandy loam	5,632	.7
Deep phase	4,224	.5	Renohill clay loam	4,608	.6
Rolling phase	8,192	1.0	Undulating phase	2,624	.3
Dune sand (stabilized)	86,208	10.4	Riverwash	768	.1
Fort Collins clay loam	4,736	.6	Rough stony land (Travesilla soil material)	960	.1
Fort Collins loam	2,368	.3	Stoneham gravelly loam	2,560	.3
Goshen clay loam	1,408	.2	Valentine sand	48,064	5.8
Goshen loam	29,632	3.6	Level phase	16,896	2.0
Goshen sandy loam	2,304	.3	Vona loamy fine sand	1,600	.2
Greeley fine sandy loam	1,600	.2	Rolling phase	448	.1
Greeley sandy loam	6,208	.7	Wann clay loam	1,472	.2
Haxtun fine sandy loam	1,280	.2	Weld-Colby silt loams, rolling phases	6,400	.8
Haxtun loamy sand	42,944	5.2	Weld silt loam	47,296	5.7
Haxtun sandy loam	2,880	.3	Undulating phase	19,712	2.4
Keith silt loam	15,360	1.8	Weld silty clay loam	5,440	.7
Keith very fine sandy loam	2,816	.3	Weld very fine sandy loam	13,824	1.7
Las Animas loamy sand	1,216	.1	Rolling phase	5,632	.7
Las Animas sandy loam	4,160	.5	Undulating phase	10,880	1.3
Laurel clay loam	1,088	.1			
McKenzie clay	4,096	.5	Total	829,440	100.0
McKenzie loam	1,472	.2			
Platner-Canyon complex	5,568	.7			

[1]Type not mapped.

of the sandy clay beds of the Laramie or Fox Hills formations are exposed. Numerous deep gullies and eroded slopes expose several colors of clays, shales, and sands, and in many places, a scattering of boulders, rock ledges, and gravelly material. The principal areas in the total of 2.7 square miles are 8 miles northwest of Akron in the vicinity of Fremont Butte and 2 to 6 miles southeast of Rago.

Owing to very rapid runoff on the barren steep slopes, most of the areas are slowly enlarging by headward erosion. Such areas have little agricultural use except for the very limited value for grazing and, in places, for providing sites for impounding water for livestock. Except for a few scattered small well-grassed patches—mainly of grama grass—the grazing value and carrying capacity are about the same as those of dune sand.

A few small areas of rough broken land (Colby soil material) are included with this land type because the combined areas are too small to be mapped separately. These areas lie 2 to 4 miles east and southeast of Rago and in the northern part in secs. 6 and 1, T. 5 N., Rs. 51 and 52 W., respectively, and also in secs. 13 and 25, T. 3 N., R. 53 W. Most of these areas are deeply cut by erosion, which has left steep banks extending into the smooth upland of grayish-yellow silty Colby soil material, or are partly filled former gullies.

Blakeland loamy sand.—Closely associated with dune sand and with Valentine sand, this type is more resistant to drifting than either when cultivated, because of the higher percentage of coarser sand grains and the higher but still small clay content. Along exposed road cuts the soil material remains in a vertical

position, and, when dry, it is difficult to penetrate with digging tools. Apparently this material has been deposited by wind.

The total area is 66.8 square miles. The largest areas lie southeast of Otis and smaller ones occur in widely separated areas in the north-central and west-central parts. The surface features, although rolling (4 to 12 percent), are moderately smooth and even. Practically all the soil is used for pasture, for which use it is best suited.

The 4- to 6-inch brown loamy sand surface soil grades into brown or rust-brown loamy sand, which, at a depth of 14 to 16 inches, is slightly lighter brown, fairly uniform, moderately compact in place when dry, and slightly sticky and gritty when wet. Below an average depth of 24 inches the clay content is very low and the color is a uniform pale grayish brown. The porous consistence and the rapid internal drainage have caused most of the lime carbonate to be leached away, but traces of it were observed at a depth of 5 or 6 feet in a few places.

Because of its low content of organic matter, its susceptibility to blowing and drifting, and its general droughty nature this soil ordinarily cannot be cultivated successfully. Where the land is cultivated, corn and sorgo are best adapted, but rye and barley do fairly well during seasons of higher than average rainfall. The grass cover is more evenly distributed and contains a higher percentage of buffalo, grama, and sandgrasses than on areas of dune sand or Valentine sand. Yucca is common. Ordinarily 25 to 35 acres will support one animal unit through the grazing season. Well water is available at depths of 80 to 210 feet.

This type includes a few widely scattered areas in the north-central and west-central parts, the slope gradients of which range from 2 to 5 percent. In these places the surface soil is somewhat thicker and darker and does not blow quite so easily when cultivated. Though heavy machinery can be used in cultivating the land, it is much better not to break the sod because of wind-erosion hazard. About 15 percent of this soil is cultivated, and the rest provides pasture about equal in carrying capacity to that of the more strongly sloping areas of Blakeland loamy sand.

Blakeland loamy sand, level phase.—Closely associated with rolling areas of the type, Valentine sand, and dune sand, this phase covers a total area of 8 square miles, mostly in the southeastern, northwestern, north-central, west-central, and southwestern parts. The soil differs only slightly from the main type, but the surface soil in most places is slightly thicker and darker, indicating a somewhat higher content of organic matter. In general, both units are rather low in organic matter. The soil is moderately coherent and is not so easily blown or drifted as Valentine sand and dune sand.

This soil can be cultivated with heavy machinery, is easily tilled, and warms up readily. It absorbs moisture rapidly but does not retain a very large supply. Severe drifting or blowing of the surface soil is the chief hazard in cultivating. About 10 to 15 percent of this soil is or has been cultivated, and about half of the several fields is lying idle. The crops best suited are corn and sorgo, generally occupying about two-thirds of the cultivated land. Some barley and rye are grown successfully during seasons of ample

rainfall. This soil is probably best suited to pasture. The vegetative cover, although thin, is thicker than on areas of Valentine sand and dune sand. Its carrying capacity is slightly higher than that of the typical soil.

Bridgeport fine sandy loam.—Occupying either first bottom positions or slightly sloping colluvial deposits from the adjoining rolling Colby soils, this soil material consists mainly of loessal sediments from the Colby soils, but some places include material washed from Tertiary deposits. Most of the 3.7 square miles mapped is in the north-central and northwestern parts of the county. Good surface and internal drainage, high capacity to absorb and retain moisture, and ease of root penetration make this a good soil for cultivated crops. Runoff water from higher land supplements the water supply available for plants. Some of the lower areas are subject to temporary overflow.

The 6- to 10-inch surface soil consists of grayish-brown friable fine sandy loam, grading into slightly lighter colored fine sandy loam subsoil. At a depth of 20 to 30 inches the subsoil grades into grayish-yellow or very light brownish-yellow fine sandy loam that continues downward several feet. Below the slightly darker colored surface soil, the underlying soil material is remarkably uniform in texture, structure, and consistence. Lime carbonate is abundant below a depth of 10 or 12 inches but is less noticeable in the surface soil. In some places there is very little change in color from the surface downward. As mapped, it includes some areas of very fine sandy loam.

Corn is the most important crop, followed by sorgo, wheat, barley, and oats. Approximately 30 percent of the soil is cultivated. Uncultivated areas afford good pasture of grama and buffalo grasses and about 20 acres will support one animal unit.

Bridgeport silt loam.—For the most part this soil is derived from colluvial and alluvial deposits washed from the higher Colby soils and deposited in fan-shaped areas at the foot of the slopes adjacent to the watercourse. This 2.5 square miles occurs along the intermittent drainage courses, chiefly in the north-central, northwestern, and southwestern parts. The land surface is smooth and has a slope of only 1 to 1½ percent. The soil, however, has good surface and internal drainage. It is permeable to moisture and plant roots and is well suited to cultivated crops in most places.

The 6-to 8-inch surface soil consists of grayish-brown friable silt loam, darkened very slightly with organic matter in places not recently overflowed. This rests on light-gray to light brownish yellow silt loam that is remarkably uniform to depths of several feet. The soil is limy at or near the surface and throughout the subsoil and is friable throughout, but in places the lower subsoil varies slightly in texture.

The 65 percent of the cultivated soil is used chiefly for corn. Some wheat, barley, and sorgo are grown, though small grains usually occupy less than a third of the cultivated acreage. Most of the uncultivated areas are more susceptible to overflow and remain in grass. This soil is valuable to farmers who own large acreages of the adjoining rolling upland soils that are used chiefly for grazing purposes.

Bridgeport silty clay loam.—Although moderately friable, this soil is considerably heavier and not so easily handled as the silt loam. It has been formed from alluvial fan deposits derived from Colby and Renohill soils and from shales of the badlands. The soil occurs along intermittent streams in the southwestern and northwestern parts of the area, totaling 4.8 square miles. Surface drainage in most places is fairly good, but internal drainage is slow.

The 6- to 8-inch surface soil, consisting of gray or light brownish-gray silty clay loam, is underlain by a slightly lighter colored fairly uniform silty clay loam or clay loam subsoil, which shows slight variations in color and texture in places owing to different overflow stages in the past.

As this soil in most places is very susceptible to overflow, approximately 65 percent has been left in native grasses, to which use it is probably best suited. Corn and sorgo are the chief cultivated crops. The acreage in small grains is small. Ordinarily the yields of the several crops are lower than those produced on the silt loam and fine sandy loam.

A long narrow area lying in secs. 27 and 34, T. 5 N., R. 53 W., consists of a brown clay loam surface soil containing a slight admixture of sand, presumably brought in by the wind from adjoining areas. This area is not adequately drained and is in grass pasture, but it is too inextensive to be shown on the map as a separate type.

Bridgeport silty clay loam, sloping phase.—This phase is confined to narrow undulating to sharp slopes bordering intermittent drainage courses, which, for the most part, contain light-colored sediments from either the loessal uplands or badlands. These areas lie northwest of Akron and northwest and southwest of Rago. The total area is 1.4 square miles. The slope varies from 3 to 8 percent in most places. These areas are utilized almost entirely for grazing, but in some places cultivated fields extend down the slopes to the main drainage courses. The soil material is more or less variable in texture, owing to frequent overflow deposits along the small drainageways.

The areas in the north-central part include small bands of Greeley fine sandy loam on the upper slopes and Bridgeport material on the lower levels. The mapped areas, however, show the quantity of uncultivable land bordering the smooth cultivable bottom land that affects the value of the adjoining farm land.

Canyon gravelly loam.—Many of the upper beds of partly leached limestone fragments, mostly northwest of Akron, are underlain by irregular pockets of Tertiary pebbles and coarse sand that are used to some extent in surfacing county roads. The total area is 1.6 square miles. The relief ranges from rolling to steeply sloping or precipitous. This type is used almost entirely for grazing, but for this purpose it is inferior to the undulating phase.

Canyon gravelly loam, undulating phase.—A total area of 3.3 square miles is mapped, mostly in the central part, 4 to 13 miles northeast of Akron, but some is in the south-central part. This phase is confined chiefly to long narrow belts along the bluffs at the edges of the uplands and in isolated areas on the upland flats. The slope varies from 2 to 5 percent.

It is developed from material of Ogallala formation, and the surface soil on the immediate ridge crests consists of grayish-brown or light-brown gravelly loam 4 to 8 inches thick, which grades rather abruptly into a very light-gray or nearly white mixture of coarse granitic sand and gravel interbedded with white partly leached limestone fragments. About midway down the narrow slope most of the suface soil has been removed by erosion, exposing considerable light-gray gravel and limestone fragments; the soil on the lower part of the narrow slope has a thicker surface soil that is variable in color and texture.

This extremely droughty soil is unsuited to cultivation. Probably less than 3 percent of the acreage is or has been cultivated. Owing to rapid runoff, impermeability to water and plant roots, and to difficulty in cultivating, practically all the land is used for grazing. It supports a scanty growth of grama and buffalo grasses, and sandgrass, needlegrass, and bunchgrass on the more sandy places. Broomweed is common on all the exposed gravelly and rocky areas. In grazing, 20 to 35 acres are required to support one animal unit.

Colby silt loam.—This soil occurs chiefly on small narrow flat-topped ridges or on gently sloping areas adjoining those of the rolling phase. The areas, totaling 3.1 square miles, are small and widely scattered. The soil differs very little from the rolling phase, but the surface is more favorable for cultivation and the losses incurred from surface runoff and erosional waste are slight. Most of this type is used for pasture land along with larger areas of the rolling phase.

Colby silt loam, rolling phase.—An immaturely developed phase derived from wind-deposited silt or loess. The 30.8 square miles is confined largely to the north-central, west-central, southwestern, and northeastern parts. It occupies rolling to moderately hilly land, the slopes of which vary from 5 to 12 percent.

The surface soil consists of a 2- to 4-inch light-brown or grayish-brown silt loam, underlain by slightly heavier light-brown silty clay loam that grades abruptly at a depth of 4 to 8 inches into pale grayish-yellow limy silt. Below a depth of 18 to 20 inches the content of very fine sand is more noticeable and the material is remarkably uniform to a depth of 6 to 20 feet or more. On a few of the sharper narrow ridge tops, the loess is exposed. The soil differs from Keith silt loam in its much thinner and lighter colored surface soil and from the Weld by the absence of the brown moderately heavy subsoil. The content of organic matter is low.

The rolling surface is dissected more or less by numerous small drains leading down from the higher upland divides and flats. Consequently, much of the land is undesirable for cultivated fields. Surface drainage is rapid, and unless great care is taken in cultivation, the loss of the surface soil by erosion is rapid and gullies soon become conspicuous. In general, this soil is more rolling and less suitable for cultivation in the southwestern than in the north-central part.

About 20 percent of the soil is or has been cultivated. In recent years nearly a fourth of the cultivated land has been lying idle.

Corn and sorgo are the leading crops, and some of the soil is used for wheat and barley. In seeding small grains, the surface is left too smooth to absorb all the rainfall and hence erosion is very active. By the listing method, along the contour of the slope, practically all the water is absorbed and fairly good yields of corn and sorgo are produced, notwithstanding the very low organic-matter content. This is especially true in the northeastern and northern parts of the area, where a higher average precipitation prevails than in the southwestern part. Fairly high yields are produced occasionally, but during very dry years some crops fail.

Although practically all the rolling phase could be cultivated, apparently its most practicable use over an extended period under the low rainfall is for grazing, especially in the southwestern part. A good cover of grama and buffalo grasses exists on virgin land and, if not overgrazed, provides excellent pasture. Many of the pastures, however, have become thickly infested with cactus, which covers as much as 60 percent of some fields. In most places water for livestock can be obtained at a depth of 50 to 180 feet. The carrying capacity of pastures varies from 20 to 30 acres for each animal unit during the grazing season.

Colby very fine sandy loam, deep phase.—Associated with other Colby soils, this phase has been formed from wind-blown deposits of very fine sand on the uplands under conditions of good but not excessive surface and internal drainage. A total area of 6.6 square miles is mapped, chiefly in the southwestern, north-central, central, and northeastern parts.

The surface has a slope gradient of 2 to 5 percent and is easily accessible to modern farming implements. Both surface and internal drainage are good. Because of the friable permeable character of the soil from the surface downward, it is easily penetrated by moisture, plant roots, and air. When the sod is broken and the binder of grass roots has disappeared, the plow soil is susceptible to blowing and drifting; hence row crops, as corn and sorgo, are listed in order to check wind movement of the soil.

The 5- or 6-inch surface layer consists of brown very fine sandy loam grading into light-brown very fine sandy loam at a depth of 12 to 16 inches. The upper subsoil is pale yellowish-brown friable very fine sandy loam high in lime carbonate, grading at a depth of 20 to 24 inches into a deeper subsoil of pale-yellow or grayish-yellow very fine sand containing considerable silt. With increase in depth the material is a remarkably uniform mixture of silt and very fine sand.

Approximately 75 percent of this soil is cultivated. Corn and sorgo probably occupy about 70 percent of the acreage, and barley, wheat, rye, and proso most of the rest. The uncultivated areas provide a fair pasture of grama, buffalo, and numerous other grasses. About 25 acres will furnish pasture for one animal unit during the grazing season.

The phase includes about 2¾ square miles of smooth nearly level land, the slope of which does not exceed 2 percent. In these places the content of organic matter is slightly higher, owing to the slightly deeper surface soil. This soil absorbs water readily, retains it well, and is easily penetrated by plant roots. It is a

good soil for cultivated crops but requires precautionary measures to prevent excessive wind erosion and drifting. Corn, sorgo, barley, or rye are the best-suited crops.

Colby very fine sandy loam, rolling phase.—Immaturely developed from very fine sand and silt laid down in the past by strong winds from the northwest, this phase occurs on rolling moderately hilly terrain in widely separated places. The relief is rolling (5 to 10 or 12 percent), and the land has been dissected by numerous small intermittent streams that extend up to the brow of the smooth upland. Although heavy farming machinery can be operated on many of the smoother rolling slopes, the plowed soil is susceptible to blowing and drifting, and special tillage methods are necessary to prevent excess wind and water erosion. In seeding small grains the surface is left too smooth to hold and absorb all the rainfall, but most of it can be conserved in seeding corn by listing along nearly level contours of the slopes. The friable and permeable subsoil absorbs water rapidly but does not retain very much of it.

The 2- to 6-inch light-brown very fine sandy loam surface soil in most places grades into light grayish-yellow limy very fine sandy loam that is slightly compact when dry but very friable when moist. In most places, at a depth of 20 to 24 inches, the material contains a higher percentage of very fine sand. The underlying 6- to 30-feet of material is remarkably uniform in color, texture, structure, and consistence. Where exposed along deep cuts the material remains indefinitely in an upright position. The total area of 12.8 square miles is in the southwestern, west-central, central, north-central, and northeastern parts of the area.

Only about 10 percent of the soil is cultivated. Probably about a third of this acreage is lying temporarily idle and a few fields are gradually reverting to native grasses. Of late years corn and sorgo have occupied most of the cultivated acreage, but some wheat, rye, and barley are grown. The percentage in different crops fluctuates widely, depending on moisture conditions. Because of the blow hazard the practice of leaving fields in summer fallow is much more risky than on the smoother hard-land soils. Apparently the most practicable use of this soil is for grazing, inasmuch as the grass cover consists largely of grama and buffalo grasses and niggerwool or threadleaf sedge. About 20 to 30 acres are necessary for each animal unit during the grazing season to prevent an overgrazed condition. Water for livestock is readily obtained in wells along the lower drainage courses. The phase includes some areas where the surface soil is deeper and the land surface is somewhat more suitable for cultivation.

A few small areas of fine sandy loam and sandy loam are combined on the map with this soil, owing to their small extent. Apparently these places have been covered locally by sandy windblown material from adjoining fields. The content of organic matter is lower than on other upland soils.

Dune sand (stabilized).—In past years, extensive areas of dune sand were deposited by very strong winds blowing from the northwest, and probably much of it originated in the South Platte River Valley. The material, which is identical with extensive areas in

the southern, western, and northern parts of the Great Plains region, consists largely of light-brown or light grayish-brown loose incoherent sand of medium fineness. In some places finer sand predominates, and in others adjoining Blakeland loamy sand a considerable part of the sand grains are noticeably coarser. In many low situations the topmost material to a depth of 2 to 6 inches has a slightly darker tint, owing to a slight admixture of organic matter, whereas most of the material occupying the higher irregular hillocks has little, if any, variation from the surface downward. The several chemical constituents necessary for the vigorous growth of plants are very scarce. No free carbonate of lime is in evidence from the surface downward.

A total of 134.7 square miles occurs in the west-central, northwestern, north-central, and southeastern parts. The relief is a succession of mild to sharply rolling hillocks rising to heights of 10 to 60 feet or more above the depressions, especially in places where the sand has shifted recently. In some areas, particularly south of Otis, the hillocks are less abrupt and have moderately smooth rolling surfaces. No delineation of slopes was made. This land type as now recognized is highly susceptible to drifting if overgrazed. The sharply rolling barren dunes occupy a relatively small part of the total acreage.

Less than 2 percent of this land type is cultivated. A few irregular, widely scattered fields are planted to corn or rye, but yields are not only low but undependable. Probably the hazard of excessive drifting will always necessitate utilization primarily for grazing. In the low situations, a good supply of water for stock usually is available at a depth of 10 to 180 feet. The porous consistence of this material permits all the rainfall to be absorbed. Native vegetation consists largely of porcupine grass or needlegrass, sage, sandgrass, and numerous flowering plants and weeds. The cover, however, is sparse, and many of the plants are not palatable for livestock. About a section of land is required during summer to pasture 12 to 16 animal units, depending upon the rainfall. Some farmers who have access to large holdings pasture certain parts and hold others in reserve.

Fort Collins clay loam.—Although formed from overflow sediments in the past, areas of this type are too high to be covered by floodwater under the prevailing precipitation. Moreover, the stage of development of the soil profile indicates that no overflow sediments have been deposited in comparatively recent times. The soil occupies smooth terraces along the larger streams in the west-central and northwestern parts. The total area is 7.4 square miles, 6 of which lie in the irrigated river valley and about half of the rest is cultivated. Surface drainage, although somewhat slow, is ample under dry-land and irrigation conditions. Although internal drainage is also rather slow, cultivated crops seldom show any signs of being adversely affected. Most of the areas have a slope of approximately 1 percent and nowhere exceed 2 percent. The surface is sufficiently smooth to be very easily irrigated.

The 6- to 9-inch surface soil of brown, dark-brown, or grayish-brown clay loam grades into slightly lighter grayish-brown heavier clay loam subsoil extending downward to a depth of 30 or 40 inches. In places, the material has a light olive-gray cast.

The underlying material is more or less sandy, usually with a fine sandy loam or a sandy loam texture, interbedded with alternate heavier layers of clay loam. When dry, the upper subsoil has an ill-defined prismatic structure. In the South Platte River Valley the quantity of clay in the subsoil varies from place to place and in some of the more nearly flat situations the plow soil is a heavy clay loam. The subsoil, although plastic when wet, is permeable enough for deep-rooted crops, as alfalfa, to make a luxuriant growth. The growth of alfalfa is favored by liberal quantities of lime carbonate below a depth of 10 to 12 inches. Apparently the soil contains a moderate quantity of organic matter.

Under irrigation the crops grown consist in order of their importance, mainly of sugar beets, alfalfa, corn, barley, wheat, and oats. The dry-land areas are planted chiefly to small grains and corn, but the yields are much lower and compare favorably with those produced on Weld and Rago silt loams.

This soil is easily kept in a fertile condition under irrigation inasmuch as rotations are practicable. Alfalfa can be grown 2 or 3 years, followed by sugar beets 1 year, corn 1 year, and barley 1 year in regular rotation. Moreover, manure can be applied without risk of burning the crop. It is applied preferably before the corn is planted.

Fort Collins loam.—Practically all this soil is moderately smooth, but the gradient varies from about 1 to 1½ percent in most places. Occupying terrace positions, usually at slightly higher levels than the associated Fort Collins clay loam, this soil is confined chiefly to the irrigated river valley and to a few small dry land areas in the southwestern part. The total area is 3.7 square miles.

The 6- to 10-inch light-brown loam or sandy loam surface soil grades into light-brown friable clay loam and, at an average depth of 16 inches, into grayish-brown clay loam. The lower subsoil at an average depth of 24 inches consists of light-gray limy clay loam, gradually merging into light-brown sand or sandy loam at a depth of 36 to 40 inches.

About 82 percent of this soil is cultivated. Most of the uncultivated areas lie in the southwestern part 1 mile northeast and 2 miles east of Antelope Valley School. Apparently the content of organic matter is lower than that of Fort Collins clay loam, but owing to good surface and internal drainage the soil is well suited to alfalfa, corn, potatoes, and sugar beets. The acreages in beans, barley, wheat, and oats are small. The yields compare favorably with those produced on the clay loam, but the soil is more easily worked, warms up more readily, and is well suited to many truck crops, as potatoes, tomatoes, and melons, as well as to general field crops.

Along the border line of the terrace and first bottom east of the South Platte River is a small strip of uncultivated Fort Collins loam, averaging about 150 feet in width, that has a 5- to 8-percent slope. It is included with the loam only because the total area was too small to be separated on the map.

Goshen clay loam.—Closely associated with Goshen loam, this type occurs in low-lying situations or flats bordering very shallow

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drainageways, some of which have no continuous entrenched channels. The total area of 2.2 square miles is located in the eastern and northeastern parts of the area. Surface drainage is slow because the surface is nearly flat; internal drainage is fair to good in most places but is rather slow following heavy rains.

This soil consists of dark-brown to dark grayish-brown deep clay loam modified with varying quantities of colluvial and alluvial soil materials. It has a massive or fine-crumb structure in most places; but some of the lowest imperfectly drained places show, when dry, a rather coarsely prismatic structure at depths of 8 to 15 inches. The underlying soil material is brown to dark grayish-brown clay loam grading at a depth of 3 to 5 feet to gray or light olive-gray clay or clay loam. Ordinarily a few small granitic pebbles and coarse sand are scattered thinly over the surface and through the subsoil and, in local places, are fairly abundant at depths of 3 or 4 feet. Though lime occurs ordinarily at a depth of 20 to 30 inches, the soil material in many spots is very dark grayish-brown or almost black and moderately friable, indicating a buried surface soil.

Approximately 50 percent of this soil is cultivated, chiefly for corn, sorgo, wheat, barley, and proso, and the rest is in pasture. Average yields are about the same as those estimated for the loam, but some of these areas are more or less susceptible to overflow for short periods and are not very dependable for cultivated crops.

Goshen loam.—In the north-central part of the area the soil has formed largely from material washed from adjoining loessal deposits and is dark fine-textured loamy material containing very little coarse sediment; whereas in other parts, larger percentages of coarser sands and clay materials are in evidence. The total area of 46.3 square miles occurs in the northeastern, north-central, eastern, and south-central parts. It is principally in elongated depressions—long narrow belts subject to temporary overflow—or on broad flats resembling old temporary lake beds that have been subjected to periodic overflow of short duration. Owing to the slight slope (not exceeding 2 percent), drainage channels are either shallow and unconnected or are entirely absent. The most noticeable characteristic of this type is the deep accumulation of dark-colored soil material. It has been modified by varying quantities of both colluvium and alluvium, derived from loessal and Tertiary soil materials of the adjoining uplands.

Ordinarily in the larger flats this soil consists of dark grayish-brown loam or heavy loam surface soil grading at 8 to 12 inches into friable clay loam. At depths of 18 to 24 inches the material is either a dark-brown or a very dark grayish-brown to almost black clay loam, the latter a buried soil. At a depth of 30 to 48 inches the lower subsoil grades into moderately friable gray or brownish-gray clay loam or sandy clay soil material. In many places there is a certain quantity of coarse sand and pebbly material at depths of 3 or 4 feet; in others the dark soil material extends to depths of 5 feet or more. Apparently this soil type is moderately well supplied with organic matter and plant nutrients.

Owing to the smooth surface and fair surface and internal drainage, all the mapped areas can be cultivated; but probably

not more than 70 percent of it is in crops; the rest provides pasture for livestock. All the principal crops—corn, wheat, oats, barley, proso, and sorghums—do well under good farming practices. Ordinarily the corn covers approximately 50 percent of the cultivated parts, and smaller and variable acreages of wheat, barley, oats, and proso are grown. Relatively high yields have been reported for these crops, but in years of drought yields are low.

The uncultivated areas are used for grazing only. Many of the smaller narrow belts along drainage courses in the northeastern, north-central, and southwestern parts border rolling phases of other soils and are not cultivated. Such areas provide excellent pasture, consisting chiefly of western wheat, buffalo, and grama grasses. These soils contain more silt and fine sand than most areas of Goshen loam on larger cultivated flats. All the grassed pastures are strong grazing soils, unsurpassed by any other in the area. Water for livestock is obtainable at depths of 40 to 200 feet in most places.

Mapped with this type are a few small areas of slightly different soils that occur on terraces, mainly in the northeastern part. Some of these are not so dark or thick as the typical soil and consist of brown to dark-brown loam, grading at 6 to 12 inches into brown moderately heavy clay loam and at 20 to 24 inches, into gray or light-gray friable limy material similar to that beneath the Platner soils. Such areas are really terrace phases of the Platner soils, but are of too small extent to be separated on the map.

Another local area bordering the large intermittent lake 16 miles northeast of Akron includes a number of small depressed spots of hard soils that apparently contain traces of alkali salts. These are indicated on the map by solonetz symbols. Because of the small extent, this area also is included with Goshen loam. Imperfect surface and internal drainage makes this area less desirable for cultivated crops than the more typical areas.

Goshen sandy loam.—This is a minor soil (3.6 square miles) in the Akron area, with several areas 2 or 3 miles northwest and 2 miles southwest of Otis and in widely separated places in the northeastern and western parts. It occurs in swales or in low-lying situations that receive runoff waters. Consequently, the soil material consists of either alluvial or colluvial sediments, or both, derived largely from local Tertiary soil materials.

Like Goshen loam this soil is unusually deep and dark-colored. The surface is dark-brown to dark grayish-brown fine sandy loam grading into loamy material at a depth of 8 to 20 inches. Though more or less variation in color and clay content is common below this depth, the color as a rule is slightly to considerably darker, indicating a buried soil that varies in texture from loam and sandy loam to clay loam. Below depths of 3 or 4 feet grayish-brown calcareous clay loam usually exists, but in places the darker color extends downward to 5 feet or more.

Owing to the smooth and nearly level surface, the high moisture-absorbing and retaining capacity, and the moderately high organic-matter content, this soil usually is planted to corn and produces good yields. Approximately 90 percent is cultivated and the rest, although cultivable, is in pasture. Yields are practically

the same as on Goshen loam. During dry periods this soil is susceptible to blowing and a cover crop or precautionary tillage methods are necessary to prevent wind erosion.

Greeley fine sandy loam.—The combined areas of this soil total 2.5 square miles. Most of it is confined to the high first bottoms along the smaller dry-land drainage courses in the north-central, east-central, and southwestern parts of the area. Like Greeley sandy loam, the soil material consists of alluvial deposits washed mainly from Tertiary deposits, but the alluvium has been deposited farther downstream where the gradient is lower and water movement is slower during overflow periods.

The brown very friable fine sandy loam surface soil varies from a few to 20 inches in thickness and represents soil material deposited mainly during the last 3 decades or after considerable land had been cultivated. Below, the color is slightly darker and a little heavier and at a depth of 2½ to 3½ feet grades into brown to light-brown fine sandy loam or loamy fine sand. Small to moderate quantities of lime carbonate are well mixed through the soil, either from the surface or near the surface downward. In sections 14 and 23, 9 miles northeast of Otis, the soil material is very fine sandy loam to a depth of 1 to 4 feet and the stream channel has almost disappeared because of the low gradient.

The land is smooth, with a slight slope downstream sufficient to insure good surface drainage. Plant roots, moisture, and air easily penetrate the subsoil, owing to the friable, permeable condition. Less than 10 percent of the total combined area is cultivated, mainly because of the overflow hazard. Good corn yields are produced during moderately dry seasons if the crop is not injured by overflow water. Probably the best use of the greater part of this soil is for grazing.

Greeley sandy loam.—Although confined mainly to the low terraces and high first bottoms that border intermittent small streams and drainage courses, a few areas are in the irrigated South Platte River Valley. Widely separated areas are in all parts of the county except the southeastern and west-central parts. The combined areas total 9.7 square miles, of which a little more than 1½ square miles is in the irrigated river valley. Many of the areas are subject to overflows of short duration, following heavy local showers or general rains.

Inasmuch as the alluvial materials have been deposited mainly by rushing water currents, varying quantities of pebbles are scattered through the soil profile. Where the gravel is abundant the deposits are shown on the soil map by gravel symbols. In places, especially along Sand Creek near Platner, the stream channel is shallow, 50 to 100 feet or more in width, and contains vast quantities of coarse sand and water-worn granitic pebbles. Large quantities have been used for road-building materials. All the smaller streams become dry after short periods following heavy rains.

The surface soil consists of brown friable sandy loam containing a noticeable quantity of coarse sand grains and a few scattered pebbles. Ordinarily this grades into slightly heavier, and in many places, slightly darker colored sandy loam that becomes rather

compact during dry periods but is very friable when moist. Below a depth of 2 to 3 feet the soil material is somewhat lighter in color and texture, and below 40 inches it is light-brown coarse sandy loam or loamy sand, containing considerable lime and a higher percentage of coarse sand and pebbly material. Ordinarily the soil adjoining the inner bends of drainage courses is more sandy and pebbly than elsewhere.

The relief is smooth to slightly sloping, and heavy machinery can be used. Most of the narrow bottom-land areas, because of numerous channel bends, small intervening acreage, gentle slope, and susceptibility to overflow, are not cultivated. Some of the larger areas, where cultivated, are occasionally inundated for a few hours following heavy local rains, but this hazard has not been very great in recent years. In fact, a light overflow may prove an asset rather than a liability, depending upon the stage of development and kind of crop grown.

Approximately 25 percent of this soil is cultivated along the dry land of small stream valleys, and about 90 percent is cultivated in the irrigated river valley. Ordinarily more than 75 percent of the cultivated area is used for corn, which is listed to prevent destructive blowing of the soil early in spring. Yields of unirrigated corn vary from 10 to 25 bushels an acre. Most of the small areas in the valley under irrigation produce excellent yields of corn, alfalfa, sugar beets, and potatoes, comparable with those produced on the irrigated Fort Collins loam. The uncultivated areas afford fair pasture but possibly not quite so good as the grassed areas of Bridgeport fine sandy loam.

Haxtun fine sandy loam.—Of the 2 square miles mapped, the more important areas are in the northeastern and eastern parts, and several areas lie 6 to 10 miles northwest of Akron. The soil is immaturely developed and occupies nearly level or very slightly sloping depressions modified by the gradual accumulation of colluvial soil material. Both surface and internal drainage conditions are good.

At a depth of 20 to 30 inches, the surface soil of dark grayish-brown mellow moderately coherent fine sandy loam grades into a subsoil of either brown or dark-brown loamy fine sand or fine sandy loam. This, at a depth of 45 to 55 inches, grades into light grayish-brown limy fine sandy loam, considerably heavier than the overlying soil material. In places some variations in the intensity of the dark color and in the depth to the grayish underlying limy soil material are noticeable. In a number of places the texture of the surface soil is very fine sandy loam, but the areas are not large enough to justify separation on the soil map.

The level surface, liberal content of organic matter, high moisture-absorbing and retaining capacity, and permeability to plant roots make this soil well suited to corn and sorghum crops, which are most commonly grown. Barley, wheat, oats, and proso also do well, but some risk is taken in planting this soil to small grains, because of the blowing and drifting hazard. With sufficient moisture and good crop management practices, this soil is very productive of small grains but more dependable, probably, for corn and sorgo. Ordinarily yields average higher than those produced

on Haxtun loamy sand. About 95 percent of this soil is cultivated, and the rest is tillable although used for pasture.

Haxtun loamy sand.—Developed mainly from reworked Tertiary rock materials and occurring in low-lying flats or elongated depressions that have been modified by wind action and by the accumulation of colluvial soil material, this soil readily absorbs and holds rain and runoff water. The underlying water table is consistently higher than that in most soils of the area. A heavy grass cover during a long period has given rise to a very dark deep soil containing a liberal supply of organic matter.

The total of 67.1 square miles occurs in close proximity to the Valentine soils and to areas of dune sand, chiefly in the northwestern and southeastern parts of the area. Because of the loose loamy nature of the soil, internal drainage is excellent except in a few areas lying 8 to 10 miles south of Otis, which are sometimes inundated for short periods because surface runoff collects against adjoining dune-sand areas. These areas are shown with intermittent lake symbols.

The surface soil, consisting of very loose dark grayish-brown loamy sand, grades at a depth of 20 to 30 inches into a dark grayish-brown friable clay loam subsoil, and this in turn grades into a substratum of gray or pale yellowish-gray highly calcareous loamy sand at a depth of 32 to 38 inches. With increase in depth the soil material gradually merges into friable grayish-brown loamy soil containing a moderate quantity of clay. In places the surface soil is not so dark colored as described and the subsoil has a comparatively small percentage of clay and a slight lime content, which is noticeable at depths of 4½ to 5 or 6 feet.

Approximately 55 percent of the total area is cultivated, and the rest supports a thick dependable stand of native grasses, chiefly bluestem, buffalo, and western wheatgrass. Most of the grassed fields are in the southeastern part. The soils are better suited to corn and sorghums than to most other crops, but barley, oats, rye, and proso also do well. Orchard crops—cherries, apples, and plums—are grown successfully by some farmers to supply home needs, but windmill irrigation is advisable to make such crops dependable. Relatively high yields have been reported in certain years, but averages are not high, owing to the fact that at least a third of the years are unfavorable for cultivated crops.

Haxtun sandy loam.—Of comparatively small extent (4.5 square miles), the more important areas are in the northeastern and central parts, mainly northeast of Akron, and others are widely separated. The soil occurs on rather broad flats or in slightly depressed situations and also on gentle bordering slopes, which seem to have a more abundant supply of moisture than most upland soils.

This type differs from Haxtun loamy sand mainly in that the subsoil and, in many places, the surface soil contain a higher percentage of clay, but not enough to impart a stiff or heavy consistence. The dark-brown to dark grayish-brown friable sandy loam surface soil grades at a depth of 20 to 24 inches into a dark grayish-brown clay subsoil, usually slightly darker than the surface layer. The 36- to 50-inch subsoil gradually merges into light-

gray calcareous silty clay loam or clay loam soil material, usually containing a small quantity of coarse sand and pebbles.

During the past, the thick stand of native grasses caused the formation of a dark and deep soil that absorbs and retains moisture well. These characteristics are very favorable for the development of forage crops, as corn and sorghums. Like other Haxtun soils, the sandy surface material is more or less susceptible to wind erosion, thus making the production of small grains more or less hazardous. Some farmers obtain fair yields of potatoes planted for home use in small patches. A few farmers who have an ample supply of windmill water grow small patches of truck and orchard crops successfully.

Approximately 95 percent of this soil is cultivated, and the rest supports an excellent stand of native grasses. This type is about equal to Haxtun fine sandy loam in cropping value and averages better than Haxtun loamy sand.

Keith silt loam.—This excellent upland soil, with a total area of 24 square miles, occurs in widely separated places from the northeastern and central to the southwestern parts of the area. This soil has been developed from very fine wind-deposited dust and loess, which has been deposited on the smooth to nearly level parts of the upland. Many of the mapped areas occur in slightly lower situations than the bordering soil, thus favoring an excellent grass cover prior to cultivation. This grass vegetation has caused the formation of a very dark and deep soil.

The 20- to 36-inch surface soil consists of dark grayish-brown silt loam, grading into light-gray or grayish-yellow floury silt similar to that underlying the Colby and Weld soils. The high percentage of silt and the low clay content of both the surface soil and subsoil make this soil highly absorptive and retentive of moisture and permeable to air and to crop roots. It is well supplied with nitrogen, phosphorus, potassium, lime, humus, and other plant nutrients, thus providing a high degree of fertility for plant growth. Moisture supply is the chief controlling factor in the growth of plants suited to the prevailing climate.

Probably 95 percent or more of this soil is cultivated, and the rest is in native pasture. The smooth to nearly level surface features and good surface and internal drainage permit the use of any type of modern farm machinery. Ordinarily the soil does not blow or drift unless the ground has been left dry and open by improper tillage methods or by other unwise management practices.

If beans are grown it is considered good practice to plant alternate strips of beans and corn or sorghum cane; the strips, usually about 3 or 4 rods in width, check the loss of surface soil and help protect the crop from strong winds. Ordinarily, wheat and other small-grain crops are not so susceptible to injury from soil blowing. Sometimes overgrazing by cattle or sheep in wheat or cornstalk fields has a tendency to cause some soil movement by the wind. The soil, however, is far less susceptible to injury from soil blowing than are the more sandy soils of this area. Farmers living in adjacent areas of very sandy soils or other soils unsuited to tillage utilize this soil largely for growing feed crops, as corn and sorghums; whereas those not having access to grazing land usually plant such areas to wheat. Acre yields of various crops

have wide ranges, depending largely upon weather conditions. High yields are harvested during exceptionally favorable crop years, whereas during extremely dry years some crops are failures.

Keith very fine sandy loam.—Formed from loessal deposits, areas of this soil are near the more extensive Colby and Weld soils. Most of it lies somewhat lower than the adjoining soils, and its dark color has resulted from the decay of the heavy stand of prairie grasses, especially of the roots. The dark, loose, friable soil has a moderately high organic-matter content and sufficient plant nutrients for cultivated crops. It differs from Keith silt loam mainly in its higher percentage of very fine sand and its lower content of silt and clay. The comparatively small areas, principally in the northeastern part of the area, aggregate 4.4 square miles. The land is smooth, with less than 2 percent gradient, making it favorable for the use of any type of farm machinery. Excellent surface and internal drainage permit the growing of any of the common crops.

The 8- to 12-inch surface soil consists of dark grayish-brown loose friable fine sandy loam, having a massive to fine-crumb structure. The upper grayish-brown slightly heavier silt loam subsoil, which is very friable, grades at a depth of 20 to 22 inches into gray loose silt with a slight brownish tinge, and at an average depth of 26 inches into light grayish-yellow silt or parent loess.

About 95 percent of the soil is cultivated. Owing to its slightly higher very fine sand content, it is more susceptible to wind erosion than the silt loam. All the common crops of the upland are grown successfully. A high percentage of the land is used for corn and sorgo, partly because these crops are well adapted and partly because most of the areas occur near the larger areas of very sandy grazing lands where coarse grain crops are needed for feeding cattle and other livestock. The acreage in small-grain crops is variable from year to year. Crop yields average about the same as on the silt loam, but corn probably averages slightly more.

The uncultivated fields are used for grazing and during the summer grazing season provide excellent pasture, which is comparable to grassed areas of Goshen loam.

Las Animas loamy sand.—The total of 1.9 square miles, formed mainly from sandy overflow deposits washed largely from sandy Tertiary beds, is confined to the irrigated South Platte River Valley in the northwestern part. For the most part, surface drainage is good, but internal drainage is more or less imperfect, owing to the high water table. A large part of this soil varies from 4 to 6 feet above the normal water level of the South Platte River and hence is susceptible to inundation during high stages of overflow. South of the river the soil forms slight ridgelike areas, and lower intervening strips are imperfectly drained.

The 12- to 15-inch surface soil consists of grayish-brown to dark grayish-brown loamy sand, grading into similar but more coherent material. At a depth of 2 to 3 feet the soil material contains some lime carbonate and a higher percentage of clay, averaging a sandy loam texture. Below a depth of 3½ or 4 feet the light-gray highly calcareous sandy clay soil material contains an abundance of small mica flakes. A narrow belt west of the railroad and southwest of

Messex, which borders the upland, has a slight slope and is modified to some extent by very recent alluvial deposits, which are brown or grayish-brown and very incoherent and susceptible to drifting. In this place the lower subsoil is not so dark as that of the typical soil and contains less clay and lime.

Owing to considerable seepage from the drainage canal along the eastern border of the bottom land and to imperfect surface and internal drainage, the cultivated areas are used mainly for pasture and hay land, whereas practically all this soil north of the river—approximately three-fourths of the total area—is cultivated. Corn and alfalfa are the chief crops grown, but some of the nearly level fields are planted to sugar beets. The yields average lower than on the higher terrace soils of the Fort Collins loam and clay loam. Cultivated areas are subject to wind erosion.

Las Animas sandy loam.—The principal areas of the 6.5 square miles mapped are along Camp Creek in the west-central part and in the vicinity of Prewitt Reservoir in the northwestern part. Because of seepage, a few places bordering Prewitt Reservoir are inclined to be wet and marshy. Occupying low poorly drained flats, the mapped areas are temporarily subject to partial overflow or standing water during wet seasons and are modified to some extent by deposits of wind-blown sand from adjoining areas of Valentine sand. Much of the soil has a slight, and in places, moderate accumulation of alkali salts as well as considerable lime carbonate.

The brown to grayish-brown loose sandy loam surface soil grades at a depth of 8 to 10 inches into light-brown or light grayish-brown sandy loam. The 18- to 22-inch subsoil of heavy sandy loam or sandy clay usually is still lighter in color below a depth of 36 inches. This soil is calcareous from the surface downward, with the exception of a few places bordering Valentine sand, where the topmost soil to a depth of 6 to 10 inches is neutral. Rust-brown iron stains are present nearly everywhere in the lower subsoil.

Saltgrass is the dominant grass cover, but some western wheat, grama, and sand grasses occur along the border line of upland soil types. The great expense necessary to drain this soil properly, its susceptibility to drifting when broken, its low organic-matter content, and its undependability when cultivated have necessitated use of the soil for pasture. To prevent an overgrazed condition, ordinarily 20 acres or more are required to pasture one animal unit through the grazing season.

Laurel clay loam.—The total of 1.7 square miles occurs associated with Las Animas sandy loam and Valentine sand in a few small areas along Camp Creek in the west-central part and in the northwestern part of the area, mainly west and southwest of Prewitt Reservoir. This soil occupies the lowest parts of the low imperfectly drained flats; hence, the accumulation of alkali salts is slight to moderate and, in local spots, strong.

The grayish-brown clay loam surface soil grades at a depth of 4 to 7 inches into light-brown moderately heavy clay loam, which when dry is extremely hard and compact. Below 18 to 20 inches the light-brown to yellowish-brown heavy clay loam is slightly splotched with light gray and brown and in places very decidedly

splotched and marked more or less with rust-brown stains. In a few places the lower subsoil grades into more friable soil material, but as a rule the heavy material continues to a depth of several feet. The soil is limy either at the surface or several inches below it, and substrata are limy to depths of several feet.

The natural cover consists largely of saltgrass, with occasional small patches of wheatgrass and a scattering of gumweeds. It is doubtful whether any of this soil can be drained and cultivated economically because of difficulty in providing adequate surface and internal drainage. Moreover, the soil is low in organic matter and would not be dependable for crops during some years. Its use therefore is restricted chiefly to grazing.

McKenzie clay.—The total of 6.4 square miles consists of shallow to moderately basinlike depressions, mainly in the north-central, northeastern, east-central, and southwestern parts. The larger bodies are deeper and receive runoff from a much greater expanse of the surrounding land.

Since there is no outlet for surplus rainfall, surface drainage is impossible and internal drainage is exceedingly slow because of the very heavy, dense, and thick accumulation of fine-textured soil material. After heavy rains and especially during years of maximum rainfall, water accumulates in these areas to a depth of 4 to 10 feet. In reality they are intermittent lakes, inasmuch as on some areas the water periodically remains for 1 to 2 or 3 years or more. During abnormally dry cycles they dry up completely and later revert either to a rank growth of such weeds as cocklebur, pigweed, and smartweed, or, in places, to wheat, buffalo, and grama grasses. At the time of the survey the largest single area, 16 miles northeast of Akron, supported a good stand of these grasses.

The dark-gray to almost black heavy clay surface soil grades at a depth of 8 to 10 inches into brownish-gray clay subsoil. This gradually merges into dark-brown to dark grayish-brown heavy clay at depths of 3½ to 5 feet. Lime carbonate is noted at a depth of 4 to 6 feet where the texture is not so heavy and the color gradually becomes lighter brownish gray with depth. The depth to lime carbonate, as well as the color and texture of the lower subsoil, is variable in widely separated areas.

Practically all this soil is used either for grazing or for water reservoirs for livestock. Because of susceptibility to water accumulation, it is not dependable for grazing on many of the mapped areas. During dry cycles many areas can be grazed, but during good crop years most of them are covered with 2 to 10 feet of water.

McKenzie loam.—Many of the mapped areas contain less than 1 acre, varying from 100 to 300 feet in diameter and 2 to 5 feet below the surrounding gently sloping land. The total of 2.3 square miles occurs in small scattered areas associated with all the extensive hard-land soils. The more numerous bodies are northeast, east, southeast, and southwest of both Akron and Otis. They occupy small depressed areas with no outlets; hence are really intermittent shallow ponds.

Because of the heavy subsoil, internal drainage is slow. After heavy rains water accumulates but usually disappears within 2

to 5 weeks. During years of extreme drought many areas lying within cultivated fields have been cultivated very successfully, but most of them are undependable, as one moderately heavy rain may destroy a promising crop.

The surface soil is dominantly a gray or dark-gray loam, but in places includes silty clay loam or clay loam that grades into dark-gray clay loam at depths of 5 to 8 inches. Below a depth of 2 or 3 feet, the soil material is brownish gray and in many places is noticeably lighter in texture with more or less lime in evidence at a depth averaging about 3 feet. Because of wind and water erosion on higher land, these low areas are gradually filling up and becoming lighter in texture, especially in cultivated fields. In fact, some of the small areas in fields have become almost filled and are regularly planted.

Probably 25 or 30 percent of the mapped areas are cultivated periodically and the rest are used when convenient either for pasture or for hayfields. Grama, western wheat, and buffalo grasses are most common, but some areas support only saltgrass. Other places, receiving more runoff, are barren most of the time, while still others may have a seasonal growth of sedge, pigweed, smartweed, biennial ragweed, and gumweed.

Platner-Canyon complex.—The principal areas of the total of 8.7 square miles are in the central and south-central parts, usually adjoining areas of either Platner loam or Canyon gravelly loam, undulating phase. This complex occupies smooth gently sloping land along the higher upland divides similar to that occupied by Canyon gravelly loam, undulating phase. Internal drainage is either rapid or restricted, but in either case a very droughty condition prevails during dry weather. Moreover, most of the areas have a slope of 2 to 5 percent, which induces considerable surface runoff following rains. A few areas too small to show separately have rolling relief.

The 5- to 8-inch brown moderately heavy loam surface soil grades into a brown clay loam containing some coarse sand and small pebbles. Beneath this, at a depth of 12 to 15 inches, is a light-brown clay loam containing some coarse sand and pebbles and a scattering of small white pebbles. At a depth of 16 to 20 inches the subsoil grades into light brownish-gray or gray clay loam containing either remnants of leached or partly leached limestone pebbles or very compact white calcareous rock identical with the corresponding material of Canyon gravelly loam, undulating phase. A few of the included mapped areas, however, grade into small local spots of granitic gravelly material. In general, the areas shown on the map include both Platner and Canyon soils that could not be satisfactorily separated.

Approximately 20 to 25 percent of this complex is cultivated and planted chiefly to wheat, barley, and sorgo. Crop yields are lower than those obtained on Platner loam, and the best use is for grazing. The soils support a good uniform grass cover identical with that of other hard-land soils, but more care is necessary to prevent overgrazing. If livestock were grazed on this soil only, approximately 30 acres would be required for one animal unit through the grazing season.

Platner fine sandy loam.—A total of 17.6 square miles is widely distributed over the area. The land is smooth with a slope not exceeding 2 percent. The soil absorbs water rapidly and retains it fairly well; the subsoil is not heavy enough to prevent fairly good internal drainage or to restrict root development, except during very dry seasons. The soil material seems to have been deposited largely by high winds, the deposits conforming to the general northwest to southeast wind movements.

The brown friable fine sandy loam surface soil grades at a depth of 9 to 12 inches into brown friable fine sandy clay or clay loam subsoil that is very hard and compact when dry but moderately friable when moist. With increase in depth the soil merges into light-brown fine sandy clay, and at a depth of 20 to 24 inches into very light-brown to yellowish-brown fine sandy clay containing considerable limy material. Below a depth of 34 to 38 inches this grades into light-gray or pale yellowish-gray light-textured clay loam or fine sandy loam containing considerable lime carbonate and less clay. Judging from the brown color of the surface soil, the content of organic matter is rather low but there is somewhat more of it in local spots.

About 80 percent of this soil is cultivated. Corn and sorgo are more dependable than small grains. Susceptibility to blowing and drifting makes precautionary measures necessary in cultivated fields. When planted to corn or sorgo, the fields usually are listed to conserve the greatest quantity of moisture and to check blowing and drifting. The native sod affords fair grazing—usually 40 acres will support two animal units during the grazing season.

Platner fine sandy loam, rolling phase.—A total of 1.9 square miles is mapped bordering small upland streams and drainageways, mainly within 2 miles south and west of Hillside School in the southwestern part, 3 miles northwest and southwest of Pleasant Hill School in the north-central part, 1 mile northwest of Fremont Butte in the west-central part, and in a few other small widely separated areas.

This phase differs from Vona loamy fine sand in that the subsoil contains a higher percentage of clay and, therefore, does not absorb rainfall so readily. Except for the rolling relief, this soil is practically the same as the undulating phase. After being broken and cultivated two or three seasons the soil blows and drifts very easily and is subject to more or less water erosion. Only about 20 percent of it is cultivated, and the rest is used as pasture, to which use it is best suited.

Platner fine sandy loam, undulating phase.—The small areas of this phase, aggregating 6 square miles, are widely scattered. It differs from the type mainly in having a slope of 2 to 5 percent. The soil absorbs water rapidly and retains it fairly well and is permeable to roots. It warms up rapidly in spring and is well suited to corn and sorgo.

The profile is almost identical with that in the type. In places the surface soil is slightly lighter brown and not quite so thick, indicating a slightly lower content of organic matter.

Because of its susceptibility to drifting, care is necessary in the cultivation of this phase. Some barley, rye, proso, and wheat are

grown, but the total acreage used for these crops during late years probably did not exceed one-third of the cultivated areas. Approximately 70 percent of the soil is cultivated. The acreage of the several crops grown is subject to considerable fluctuation, owing to climatic cycles that are either favorable or unfavorable to small-grain crops. Crop yields are about the same as on Platner sandy loam. The uncultivated areas support a fair grass cover, used primarily as pasture for livestock. Water is available at a depth of 80 to 180 feet.

Platner loam.—A typical hard-land soil and the most extensive (231.9 square miles) arable soil type mapped, being widely distributed in the central, northeastern, east-central, southeastern and south-central parts. It occupies the larger hard-land flats where the gradient does not exceed 2 percent and is derived chiefly from Tertiary sands, clays, water-worn granitic pebbles, intermixed in many places, especially in the subsoil, with varying quantities of fine silt of loessal origin.

Surface drainage is fair to good and internal drainage is slow, owing to the moderately heavy subsoil. During droughty periods the subsoil often becomes so hard and compact that root penetration is almost completely checked. For this reason corn is more adversely affected than other crops by prolonged droughts. Small grains can easily fail unless ample subsoil moisture is available, but they are usually harvested before summer droughts curtail the yields greatly.

One outstanding characteristic of the landscape in many places is the presence of gravelly mounds varying from 8 to 12 feet in diameter, 8 to 18 inches in height, and 6 to 12 rods apart, presumably formed by pocket gophers or badgers. In many cultivated fields the surface has a somewhat spotted appearance because of the mixing, by cultivation, of the lighter colored spots of gravelly soil material. Another characteristic, usually confined to idle fields, is the presence of blunt cone-shaped anthills, consisting largely of coarse sand and varying from 6 to 10 inches in height, 18 to 30 inches in diameter, and 3 to 6 rods apart, occupied chiefly by large red ants. These are conspicuous because each is surrounded by a circular barren spot 6 to 8 feet in diameter.

The 6- to 10-inch brown to grayish-brown friable moderately light to moderately heavy loam surface soil ordinarily grades rather abruptly into a dark-brown heavy or moderately heavy clay loam subsoil. Much of this subsoil is massive and blocky but in many small areas it has a distinct prismatic structure (pl. 1). At a depth of 12 to 16 inches the subsoil merges into light-gray or yellowish-gray clay loam—the lime zone—with little or no structural development. In most places other than in small depressed situations the parent material, consisting of either light-brown sandy clay or loamy material, with considerable silt, has not been weathered below an average depth of 30 inches.

A noticeable quantity of coarse sand grains and scattered granitic pebbles occur on the surface and throughout the profile to lower substratum level. In places, layers of gravelly sandy clay, varying in the quantity of sand, clay, and gravel, occur at a depth of 2½ to 5 feet. The principal variation in this soil type, however, is in the thickness and color of the subsoil layer corresponding

to the slight rises and dips that are common over many places on the broad flats. The more pronounced small depressions of 75 to 125 feet in diameter, which do not have surface drainage, are shown on the soil map by depression symbols; and small irregular hard barren spots, 6 to 10 feet in diameter in places, are shown on the map by solonetz symbols. Ordinarily these occur in low-lying situations surrounded by saltgrass and apparently contain some traces of alkali. Also a few lightly scattered gravel symbols are shown on the soil map to indicate a thicker-than-average distribution of gravel but not thick enough to be mapped as Platner gravelly loam.

In general, the several crops grown are more adversely affected by drought because penetration by plant roots is more restricted than in most subsoils within the area, less rain water is absorbed, and the subsoil is generally in a drier condition. In using this soil, therefore, especially during drought cycles, it is good practice to keep a large acreage in summer fallow by using a lister or damming lister to conserve precipitation. Moreover this soil is far less susceptible than sandy soils to blowing or drifting when left without vegetative cover.

Approximately 80 percent of this soil is cultivated. In the northeastern part of the area the yields are considerably higher than in the southern and southwestern parts, owing to a higher and more favorable seasonal distribution of rainfall. Between 90 and 95 percent of this soil is cultivated in the northern and northeastern parts, whereas only 65 to 70 percent is cultivated in the large areas dominated by it in the south-central part. In general, most of the soil in the northeastern part contains a higher percentage of fine sand grains in the surface soil than most of the loam in the south-central part. This variation of the loam texture is slightly more favorable for crops, because tilth is easier to maintain and the absorption rate of the soil is slightly greater.

Wheat, barley, sorgo, corn, oats, proso, and beans are the principal crops grown. In very favorable crop years the acreage in corn is greater than in average years. Bean planting was almost entirely suspended during recent drought years because of the blow hazard. The percentage of idle or temporarily idle fields has been greater owing to the years of low precipitation. Yields of corn have been lower and more failures have resulted than heretofore. Probably the planting of small grains and sorgo followed by summer fallow is as practicable as any method, especially during drought cycles. In favorable crop years good corn yields have been reported, but in dry years crop failure may occur.

Practically all soil in native sod is utilized for grazing purposes. The grass cover consists largely of grama, buffalo, wheat, three-awn, and numerous other grasses and herbaceous plants of less importance. The grazing capacity ordinarily ranges from 18 to 25 acres for each animal unit during the grazing season, but recently about 30 acres has been required in some places to prevent overgrazing. Well water is available at a depth of 80 to 220 feet. Some farmers construct small dams or ponds along small drainage courses to supplement the water supply.

The surface soil has a clay loam texture in places, especially in deeply plowed fields, but the agricultural significance is slight.

A few of these areas, however, 4 to 7 miles northwest of Akron in secs. 20, 21, 26, 27, 28, and 35, T. 3 N., R. 53 W., lie in a rather low-lying flat that drains to the northwest. In this variation the surface soil is darker than the type and the subsoil is darker, heavier, and of more prismatic structure. Surface and internal drainage are inadequate. Owing to the small extent of this variation, the areas are included with Platner loam.

Several areas east and northeast of Otis consist of 6- to 10-inch brown loamy surface soil underlain by very dark grayish-brown friable, loamy material, apparently a buried former surface soil. As the surface features do not indicate their presence and their outline is irregular, such variations are included with Platner loam. Another variation occurs on a few flat ridges, as the one in secs. 26, 27, 31, 32, and 33, T. 1 S., R. 50 W. The surface soil is not so thick as the type and is underlain by brown prismatic clay loam that grades into loamy material fairly high in silt and similar to Weld silty clay loam, but the surface soil and subsoil contain a scattering of coarse sand and small granitic pebbles.

Platner loam, rolling phase.—Closely associated with other Platner soils in a total area of 7.9 square miles, this phase is confined chiefly to rolling areas bordering small upland drainageways widely separated throughout the hard land, where the slope gradient varies from 5 to 10 percent.

This phase is much like the type, except that the brown loam surface soil and the brown clay loam subsoil layers overlying the lighter colored lime carbonate zone do not average so thick, because of the more rapid rate of surface runoff and consequent shallower depth to which leaching has progressed. The average moisture content is lower, and crops are more adversely affected by droughty periods. The grass cover is not so uniformly distributed and its grazing capacity is somewhat lower and less dependable, especially during continued seasons of low rainfall. In most places the percentage of small pebbles scattered over the surface and throughout the subsoil is higher.

Probably less than 20 percent of this phase is cultivated. Owing to slow absorption of water, rapid runoff, and droughtiness of the soil, the cultivated crops are less dependable than on any of the other Platner soils with the exception of Platner loam, shallow phase. Contour listing for both corn and fallow land is necessary to conserve as much water as possible. Even this precaution does not prevent some soil waste by erosion. The seeding of small grains by the ordinary drill eventually results in accelerated erosional wastage. Therefore, unless great care is exercised, cultivated fields rapidly decline in productivity. Apparently the most dependable use of this soil is for grazing.

Platner loam, shallow phase.—Most of the areas occupy the higher flat upland divides or knolls bordered with sloping narrow belts of Canyon gravelly loam, undulating phase, or Platner-Canyon complex in the south-central, central, and northeastern parts. A total of 4.1 square miles is mapped. The soil is similar to Canyon gravelly loam, undulating phase, but the surface is flat and gives the impression of being better suited to cultivated crops than is actually the case.

Approximately 50 percent of the phase is cultivated and planted chiefly to wheat, barley, and sorgo. Most of the cultivated areas are in the northeastern part. Crop yields are lower than on the typical soil. The yielding capacity probably is about the same for Weld silty clay loam, which occupies similar situations on moderately high flats.

Because of the droughty nature of this soil, its best use is for grazing. The carrying capacity is the same as for the Platner-Canyon complex.

Platner loam, undulating phase.—This phase differs from the type mainly in that the surface is gently undulating—2 to 5 percent slopes—instead of nearly level. The soil characteristics are practically the same, but the land surface is somewhat more irregular and marked by slight dips and depressions. Surface runoff is more rapid, and more care is necessary to conserve the maximum quantity of moisture. In many places the brown surface soil grades into a brown or dark-brown clay subsoil overlying limy light-gray or yellowish-gray clay loam at shallower depths than in the type. The content of clay, coarse sand, and pebbly material in the two soils differs very little.

Distributed in all parts of the county, except in the more sandy localities in the northwestern and southeastern parts, most of this phase, totaling 37 square miles, is confined to narrow strips or belts rather than to broad stretches.

About 55 to 60 percent of the soil is cultivated, and the crops and management practices are much the same as on the type. All this soil is cultivable, but crop yields probably average a little lower than on the type. Though grass cover and its density are practically the same, areas of this soil, owing to the higher rate of surface runoff, probably reach an overgrazed condition sooner than the more nearly flat areas of the normal loam.

Platner sandy loam.—Most of the areas of this fairly extensive and widely distributed soil, totaling 84.9 square miles, border sandy-textured soils of the Weld and Valentine series and Platner loam. For the most part the soil material is derived from Tertiary geologic formations. The surface is moderately smooth—less than 2 percent slope—but small local mounds and sags are common in places. Surface drainage is adequate, but internal drainage is often more or less retarded, especially after hard rains following periods of drought. Ordinarily most of the rainfall is readily absorbed.

The 10- to 15-inch surface soil consists of brown to grayish-brown friable sandy loam and grades into a subsoil of brown clay loam, which is very hard and intractable when dry but sticky and gritty when wet. Below a depth of 22 to 30 inches the soil material is light-brown friable clay loam, high in lime carbonate, and grades into yellowish-brown limy clay loam at a depth of 36 to 40 inches. The underlying soil material is extremely variable, consisting of yellowish-brown sand or loamy sand, with a fairly high percentage of silty material in places and considerable pebbly material in the lower subsoil. During droughts the subsoil becomes hard and compact and more or less impermeable to plant roots.

Approximately 75 percent of this soil is cultivated, and the grassed areas are used primarily for pasture. The natural cover consists largely of grama, buffalo, needle, and bunch grasses. The grazing capacity is about the same as that of Platner loam. The crops best adapted are corn, sorgo, and barley; but during favorable years of sufficient subsoil moisture, wheat, rye, and proso or hog millet are grown successfully. Because of the blowing and drifting hazard, corn and sorgo are listed. This practice is considered best if the land is prepared for summer fallow. During recent years, approximately three-fourths of the cultivated areas were planted to corn and sorghums.

South and southeast of Antelope Valley School in the extreme southwestern part, a few areas are included in which the lower soil is very friable and closely approaches that of Vona loamy fine sand. Such areas, however, are ordinarily somewhat more susceptible to blowing and drifting than most of the sandy loam.

Platner sandy loam, rolling phase.—The surface soil in most places is thinner than that of the undulating phase, and apparently the organic-matter content is lower. The brown or light-brown clay loam subsoil, high in lime, grades into lighter textured material with increase in depth. In most places, the lower part of the slopes bordering small drainageways have darker and deeper surface soils.

Most of this rolling phase is in the southwestern, central, northeastern, and eastern parts, bordering intermittent upland streams or small tributaries, and in several isolated places throughout the uplands. The total area is 5.7 square miles. Although the relief is rolling, 5 to 10 percent gradient, the surface is smooth enough to permit the use of modern machinery, but with some difficulty. Cultivated areas are highly susceptible to blowing and drifting, and it is almost impossible to prevent runoff and sheet erosion.

Less than 25 percent of this soil is cultivated. Corn and sorgo are probably more dependable than other crops, especially when they are listed on nearly level contour lines around the slope in order to conserve as much rainfall as possible. At best, yields are lower than those obtained on the type soil. The use of this soil for grazing seems most practicable. In grazing value it compares favorably with the more extensive areas of Platner sandy loam and Platner loam.

Platner sandy loam, undulating phase.—Ordinarily the surface soil is not so deep as that of the type and grades into lighter colored limy material at shallower depths. The brown sandy loam surface soil grades at a depth of 8 to 12 inches into a brown clay loam subsoil, which becomes light-brown limy clay loam at a depth of 18 to 24 inches. The lower subsoil consists of yellowish-brown sandy clay or loamy sand. In secs. 9, 10, 14, 15, 16, and 18, T. 3 N., R. 51 W., this layer is more friable and lies deeper than elsewhere. In these areas more rain water is absorbed and the soil is better suited to corn than the soil included in many of the mapped areas.

Like Platner loam, this phase is widely distributed over the hard lands of the area and totals 38.1 square miles. The slopes are gentle, varying from 2 to 5 percent, and the land is easily

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farmed with modern heavy machinery. Considerable care is necessary, however, in cultivating this soil, because, in most places, it is more susceptible to drifting and to runoff of rainfall than the more nearly level typical soil.

The use capability varies little from that mentioned for the loam type, but the percentage of the soil under cultivation is not so high and probably the average yields are slightly lower.

Rago silt loam.—Confined mainly to the central, north-central, northeastern, east-central, south-central, and southwestern parts of the area on a total of 68.8 square miles, this soil occupies many of the broader and higher upland flats in close association with the Weld soils, but it is darker and deeper and most of it is more productive. In most places the slope averages about 1 percent and nowhere does it exceed 2 percent.

This soil always has a very smooth surface. Although surface and internal drainage are rather slow, the subsoil is not heavy enough to cause any ill effects upon cultivated crops. In places some of the mapped areas receive some runoff from Weld silt loam, which lies at slightly higher levels. The organic-matter content, although not high, apparently is higher than in Weld and Platner soils. The soil is fairly permeable to plant roots, and crops are not so adversely affected during severe droughts as on Platner loam.

The grayish-brown to dark grayish-brown friable silt loam surface soil grades at a depth of 4 to 8 inches into a brown to dark-brown clay loam subsoil, which is moderately friable when moist, but, upon drying, contracts into prismatic aggregates locally referred to as joint clay. This layer is 12 to 20 inches or more thick, the lower part lighter in color and in texture than the upper. It merges downward into pale grayish-yellow silt, the lime-carbonate layer, several inches thick, and then into the unaltered parent loess that extends downward to 4 to 20 feet or more (pl. 2, *A*). In some of the older deeply plowed fields the texture of the plow soil varies from a heavy silt loam to silty clay loam, because of the mixing, through cultivation, of some of the underlying clay loam subsoil material with the surface soil.

Some of the older fields contain scattered granitic pebbles in the plow soil only, which have been brought up from depths of 5 to 8 feet by pocket gophers, badgers, or other burrowing animals. The distribution of gravel is not general on this soil, inasmuch as the original silt in most places is too deep for burrowing animals to bring up such material from the underlying gravel beds. Some gravel occurs on the land owned by the United States Dry Land Field Station east of Akron and on several other fields 6 to 12 miles southeast of Akron. In a few other places, about 12 miles southeast of Akron and 6 miles east-southeast of Otis, a few pebbles are scattered where the soil borders Platner loam. In such places soils are difficult to delineate because of the necessity of making many deep borings.

About 75 to 80 percent of the type is cultivated. Probably wheat occupies about 50 percent of the area in crops, followed by barley, corn, sorgo, proso, oats, and beans in order of importance. The acreage in sorgo has increased rapidly in recent years. Fairly high yields have been reported for these crops during exceptional

years, but during poor seasons some crops have practically failed. Several large areas in the southwestern part receive less rainfall than those in the northeastern part, so that yields are lower and more of the land is unbroken.

Results of extended experiments at the Dry Land Field Station east of Akron show that average crop yields, especially of wheat and barley, can be greatly increased by certain tillage methods. The uncultivated fields are used for grazing, mainly for beef and dairy cattle. Most of the grassed fields are in the southwestern part of the Akron area, and 20 to 30 acres are required for one animal unit during the grazing season to prevent overgrazing.

Rago very fine sandy loam.—The comparatively small and widely separated individual areas occupy smooth flats averaging a little more than 1 percent in gradient, nowhere exceeding 2 percent. The total of 8.8 square miles is mainly in the southwestern, northeastern, west-central, east-central, and north-central parts. Like Rago silt loam, this is a deep, productive soil. In some places its productivity approaches closely that of Keith very fine sandy loam.

This type has the same dark color, moderately friable deep subsoil, and grayish-yellow limy parent loess in the lower subsoil as in Rago silt loam, but the surface soil has a coarser texture. Apparently the organic-matter content is higher than that contained in typical Weld and Platner soils. Owing to the very fine sandy loam texture, this soil has a rather high water-absorbing capacity and retains moisture well in the subsoil. Furthermore, it warms up readily and is easily worked, making it a desirable soil for cultivated crops. If the fields are left in a bare condition, however, precautionary tillage methods are necessary to prevent young crops from being injured by soil blowing.

About 90 percent of this soil is under cultivation. The land use, crop adaptability, and yields average about the same as on Rago silt loam, but corn probably is slightly better suited, inasmuch as most of the soil areas are in the northeastern part of the area, which is favored by a slightly higher average rainfall.

Renohill clay loam.—Erosion in places has made the soil fairly shallow, but the low hills are smooth with very few gullies. This soil type, developed on the oldest of the several geologic formations within the Akron area, occupies 7.2 square miles in the northwestern, west-central, and southwestern parts, the larger areas in the general locality of Fremont Butte northwest of Akron. Surface drainage is rapid, and internal drainage rather slow. Owing to the rolling surface (5 to 10 percent) and erosion, the soil is fairly shallow and the subsoil cannot absorb as much rainfall as the more nearly level upland soils.

The 3- to 6-inch surface soil consists of either light-brown silty clay loam or clay loam that merges gradually into slightly heavier friable grayish-brown to grayish-yellow clay loam subsoil, which upon drying has a fairly distinct to ill-defined prismatic structure within short distances. The material is more or less splotched with gray, yellow, and brown. Below depths of 18 to 20 inches the lower subsoil is more or less massive or cloddy to blocky, grading into greenish-yellow or olive-gray clay loam with thin ill-defined shale layers at a depth of 30 to 36 inches. Along the boundary

line between it and the higher lying Colby soils, this type closely resembles them to a depth of 10 to 15 inches, and a fairly well-developed lime carbonate layer has accumulated apparently because the surface soil consists partly of loessal material. In most places, however, the boundary line between Renohill and Colby soils is fairly distinct.

In several spots there is a noticeable quantity of rounded waterworn gravel 1 to 2½ inches in diameter, strewn over the surface and through the upper subsoil. These spots are indicated on the soil map by gravel symbols.

About 20 percent of this soil is cultivated, but it is not very desirable for cultivated crops. It is fairly responsive to good tillage practices, although some difficulty is experienced in operating heavy farm machinery. Considerable erosion is evident under the best tillage practices. Because of extensive areas of nearby grazing lands, corn and sorgo are the most desirable crops. Moreover, by listing corn with the contour of the long slopes, most of the rainfall is retained and the subsoil seems to be fairly retentive of moisture. Sorgo apparently is the most dependable crop, and some small grains are grown, chiefly wheat and barley. Probably the most practicable use of this soil over a long period is for grazing. The grass cover compares favorably with that of other hard-land soils and has about the same carrying capacity. Well water is obtained at a depth of 60 to 100 feet.

A few small areas of a very fine sandy loam surface soil underlain by shaly material, 15 to 18 inches below the surface, too inextensive to be mapped separately, are included with this soil.

Renohill clay loam, undulating phase.—The 4.1 square miles of this phase is confined mainly to the northwestern part, chiefly north and northwest of Akron. Its more gentle slope (2 to 5 percent) makes it better suited to cultivated crops than the type, but it is not highly productive. The general soil characteristics and crop adaptations differ very slightly from those of the type, but the yields of various crops probably average somewhat higher, because of the more favorable slope that retards rapid surface runoff. About 50 percent of the soil is cultivated, and the rest is grazed. Its value for grazing is about the same as that of the Weld and Colby soils.

Riverwash.—This land type, comprising 1.2 square miles, occurs mainly in areas bordering the South Platte River in the northwestern part. The mapped areas consist of numerous sand flats, small islands, and sand bars bordering the main channel of the river. The surface is irregular, uneven, and inclined to be moderately hummocky in places, caused by obstructions of trees, logs, and brush during various stages of overflow. As the soil material lies only 2 to 4 feet above the main river channel, the areas are subject to frequent inundation.

The native vegetation consists mainly of a scattered growth of willow and cottonwood trees, various shrubs, and a scant growth of grasses and weeds. A few fields along the edges farthest from the river are cultivated, but the soil is low in organic matter and is highly susceptible to drifting during dry windy weather. Its only practical use is for grazing.

Rough stony land (Travesilla soil material).—Numerous small ridges and other small narrow patches with sandstone outcrops make up this miscellaneous land type. Such areas are nonarable and are used for grazing only. Most of its 1.5 square miles is 8 to 10 miles southwest and 3 to 9 miles northwest of Akron. The slope varies from 2 to as much as 15 percent in places.

The protruding sandstone boulders and, in a few places, ledge outcrops are grayish-brown to brown on the surface, with a somewhat gray interior. The sand is neutral to slightly calcareous. Most of the boulders and slabs vary from 2 to 4 feet in diameter and from 4 to 8 feet in length and are very irregular and variable in shape and size. The rock material is usually too soft or too irregular in cleavage to be worked into building stone.

A moderately to fairly good stand of grama grass exists between the scattered boulders, but in places very little grass can grow, as the land is steep and closely covered with rocks. In grazing value, this land type is probably slightly better than dune sand and about equal to Blakeland loamy sand.

For the most part the soil material between the rocks closely resembles Blakeland loamy sand, but the sand grains are not so coarse, and below depths of 30 to 40 inches there is a slight lime carbonate accumulation. In a few places the soil material resembles that of the Renohill soils, with shale soil material at shallow depths. Other soil variations were noted in mapping, but, owing to the small extent of the combined rocky areas, the differing areas were included in this land type. Moreover, no attempt was made to indicate different classes of slopes.

Stoneham gravelly loam.—The larger areas of the 4 square miles covered by this type are in the northeastern, east-central, and south-central parts, and most of them border small drainageways with rolling slopes. The relief varies from nearly level to rolling, but the slope gradient has little if any agricultural significance, because land use is limited almost entirely to grazing. Most of the soil has good internal drainage and it is nearly everywhere subject to drought if cultivated.

The 8- to 10-inch brown gravelly loam surface soil grades into a brown gravelly clay loam subsoil, which in turn, grades into light-brown gravelly clay loam at 16 to 18 inches. The lower subsoil, beginning at a depth of about 20 inches, is variable, but ordinarily the gravel and sand content increase as the clay content decreases. In places, gravel pockets containing an abundance of limy material extend downward several feet; in others there is only a moderate quantity of gravel and considerable sand, or vice versa. In a few places the deeper subsoil contains light-gray calcareous gravel identical with that underlying the Canyon soils. Some of the underlying gravelly material is used in road building. Most of the gravel consists of waterworn granitic material of Tertiary age, in which individual pebbles range from about one-fourth to three-fourths of an inch in diameter.

All areas regardless of slope, are very droughty and unsuited to cultivated crops. About 95 percent of this soil is used for pasture, and care is necesary to prevent overgrazing. It supports a fair cover, largely of grama and buffalo grasses, and has about the same grazing value as Platner loam, shallow phase.

Valentine sand.—The total of 75.1 square miles is in the west-central, northwestern, north-central, and southeastern parts, closely associated with areas of dune sand and Blakeland loamy sand. It occurs in the broad intervening relatively low areas, which over a considerable distance have slopes up to 3 percent. Local relief varies from 3 to 6 feet and creates a more or less hummocky appearance. The higher spots are more sharply defined than the intervening low areas. Apparently this material was laid down by strong winds blowing toward the southeast. The material is so unstable after the original grass cover has been broken that cultivation results in severe wind erosion unless great care is taken.

The surface material consists of grayish-brown to light-brown sand containing a slight admixture of organic matter and grading at a depth of 4 to 12 inches into slightly lighter brown to grayish-brown medium sand. Below a depth of 20 to 24 inches, similar-colored medium sand continues for several feet. The material falls apart into single sand grains and is very incoherent. In some places at a depth of 20 to 30 inches the soil is slightly coherent, owing to the very small percentage of clay particles. All free carbonate of lime has been leached to indefinite depths.

Approximately 5 percent of this soil is either cultivated or lying idle. Fair crops of corn, sorgo, barley, and rye are produced for 2 or 3 years after the sod is broken, but thereafter the yields decline. More than half the cultivated land is planted to corn.

Because of very low organic-matter content, danger of wind erosion, and uncertainty of obtaining a paying crop, this soil is used primarily for grazing. A few of the smoother areas are used in producing hay, but neither yield nor quality is high. An ample supply of good water can be obtained in most places at a depth of 20 to 150 feet. Many farmers use this type for pasturing milk cows and work animals, but many areas adjoining extensive dune sand areas are pastured only to range cattle. Depending on the quantity of rainfall, 25 to 35 acres of land is necessary to pasture one animal unit during the grazing season. The most common grasses are sand, wheat, and needle grasses, and big and little bluestem. Most of the original bluestem has been killed by overgrazing and severe droughts.

A few included variations not consistent with this soil type but of insufficient area to establish a separate type follow: In secs. 4, 5, and 21, T. 5 N., R. 52 W., and secs. 2, 15, 16, 21, and 22, T. 5 N., R. 54 W., are small areas containing carbonate of lime below depths of 15 to 30 inches. These areas, however, do not have any agricultural significance in this locality. In secs. 2, 3, 6, 7, 15, 16, 21, 28, 29, and 33, T. 5 N., R. 54 W., the soil in several areas consists of fine sand, closely approaching a loamy fine sand. All these variations show very little organic matter and are equally as susceptible to drifting as Valentine sand.

Valentine sand, level phase.—Most of this level phase is in the north-central, west-central, northwestern, and southeastern parts, bordering areas of Valentine sand, Blakeland loamy sand, Haxtun soils, and dune sand. The total of 26.4 square miles occupies low-lying nearly flat land similar to the Haxtun soils; it is not so dark, however, though darker than the type.

The 15- to 20-inch surface soil consists of loose grayish-brown sand, grading into slightly lighter grayish-brown sand subsoil, and this into light grayish-brown sand at a depth of 30 to 36 inches. In places, the lower layers have a slight clay content, but owing to the porous, highly absorptive nature of the soil, all traces of lime have been leached away, if any ever existed. This soil absorbs rainfall readily and is slightly more retentive of moisture than the type. It is permeable only to plant roots. Apparently the content of organic matter is slightly higher than in the type. If the sod is broken the organic matter rapidly declines, and after two or three crop seasons the plow soil is very unstable and as it is easily drifted, cultivation becomes increasingly hazardous. Occasionally some fields become so bumpy and uneven after severe windstorms that soils must be leveled or the fields abandoned.

Approximately 10 to 15 percent of this soil has at some time been cultivated, and about half this acreage is lying idle. Rye, barley, corn, and sorgo produce fair yields the first 2 or 3 years, but thereafter the yields decline. Probably about 70 percent of the present cultivated acreage is used for corn and sorgo. During certain seasons when the rainfall is favorably distributed, good yields of barley and rye are obtained. Yields average lower on this soil than on the Haxtun soils but higher than on the type. In general this soil is best used for grazing. It has a higher grazing value than the normal type or dune sand but a slightly lower value than other sandy soils in the area.

Vona loamy fine sand.—This soil apparently has been formed largely from wind-blown soil-forming materials, containing a comparatively high percentage of fine sand and lower percentages of very fine sand, silt, and clay. Most of its 2.5 square miles lies about 3 miles west, southwest, and northwest of Pleasant Hill School and the north-central part, and a few small scattered areas are in the northwestern and southwestern parts. It differs from Platner fine sandy loam in the lower percentage of clay in the subsoil, which accounts for the very friable loamy condition of this layer in contrast with the moderately heavy subsoil of the sandy Platner soils.

The 6- to 10-inch brown loamy fine sand surface soil grades into light-brown loamy fine sand, which in turn passes into a yellowish-brown loamy fine sand subsoil at an average depth of about 20 inches. The subsoil ordinarily consists of either fine sand or loamy fine sand with a moderate to fairly abundant supply of lime carbonate below a depth of 20 to 30 inches. This soil is similar to Valentine sand, but the sand is finer and the lower subsoil contains considerable lime, whereas in the Valentine, lime carbonate rarely occurs.

The land is smooth with slight to gentle slopes, most of which have a gradient of 2 to 5 percent. A few small areas of less than 2 percent slope are included. Inasmuch as this soil is susceptible to blowing and drifting, cultivated fields usually are listed and planted to corn or sorgo.

Approximately 25 percent of the area is cultivated, and the rest is used as pasture. Crop yields average slightly higher than on Blakeland loamy sand and about the same as on Platner fine

sandy loam, undulating phase. In places, the boundary lines between this and the Platner soil are more or less arbitrary.

Vona loamy fine sand, rolling phase.—This phase is of small extent (0.7 square mile), the main areas lying in the north-central part of the area. In texture, color, and structure it differs very little from the type, but the rolling relief is not favorable for cultivation of fields because of the wind-erosion hazard. Nevertheless, the soil can be farmed. Most of the areas are in native pasture, to which use the soil is probably best suited.

Wann clay loam.—A nearly level dark-gray clay loam containing a relatively high percentage of sand. The 2.3 square miles is confined to the first bottoms in the river valley near Messex and Balzac. The deposited alluvium is washed mainly from Tertiary formations. As it lies only about 5 or 6 feet above river level, surface and internal drainage are imperfect. Several small ditches provide ample drainage for most areas near Messex. The soil does not warm up so readily in spring as the adjoining areas of Las Animas loamy sand, owing to heavier texture and imperfect drainage.

To depths of 8 to 24 inches the soil material is slightly heavier than clay loam and contains some lime carbonate and a scattering of granitic pebbles. It grades into gray friable clay loam in which rust-brown stains, spots, and splotches are common; at a depth of 34 to 38 inches, into brown or grayish-brown coarse sand and gravel material; and finally, into rust-brown loose coarse sand and gravel. This soil is limy from near the surface downward.

The chief crops grown are sugar beets, alfalfa, and corn. The yields are somewhat lower than on the Fort Collins soils but are slightly higher than on Las Animas loamy sand. About 50 percent of the total area is cultivated.

South of the South Platte River, east and southeast of Balzac, a variation is included that was considered too small to justify separate mapping. As the area is low-lying, poorly drained, and fed by seepage water, it is unfit for cultivation. The dark-gray surface soil grades at 16 inches into light-gray clay loam with considerable rust-brown and olive-gray coloring. In turn, this grades into grayish-brown coarse sand containing only slight traces of lime carbonate in the lower part. The soil is in native grass and is used primarily for hay and late fall pasture, whereas practically all the Wann soil near Messex is cultivated.

Weld-Colby silt loams, rolling phases.—This complex occurs in association with typical Weld silt loam and its undulating phase in a total of 10 square miles. These areas usually border small drainage courses and intermittent lakes, but fairly large areas southwest of Elba are on rolling relief. Fifty percent or more of this complex consists of typical Weld silt loam or soils that are only slightly thinner over the underlying limy parent material than the Weld soils on nearly level to undulating relief.

The 4- or 5-inch surface layer of brown silt loam and the heavy subsoil layer of brown silty clay loam, clay loam, or clay of the Weld soils are underlain at depths of 8 to 15 inches by the characteristic grayish-yellow silty loess. These layers differ very

little from those of the undulating phase, but in most places adjacent to small drains there is a thicker accumulation of colluvial surface soil and a more friable subsoil overlying the parent loess. Areas of these thicker soils too small to be shown separately on the map of the scale used are included with Goshen loam.

Under virgin conditions, the Colby and Colbylike soils of this complex have a 2- to 5-inch surface soil of grayish-brown silt loam and a brown to grayish-brown silt loam subsoil that merges with the underlying calcareous material at a depth of 4 to 8 inches. Under cultivation the surface soil and subsoil become mixed; any difference in subsoil color is largely destroyed, and enough of the calcareous subsoil is incorporated with the plowed layer to make it calcareous to the surface.

This complex is not well suited to cultivated crops owing to lower average quantity of subsoil moisture, difficulty in conserving moisture in the cultivated soil, and apparent lower organic-matter content. More power is required and more difficulty experienced in operating farm machinery. Ordinarily the best practice in cultivated fields is to list with the contour of the slopes in order to conserve precipitation and at the same time reduce erosional wastage. Less than 20 percent of the total area is cultivated. Although yields of various crops are considerably lower than on Weld silt loam and its undulating phase, fair yields are obtained with good tillage methods. Probably the safest long-time utilization of this phase is to leave unbroken fields for grazing purposes only, inasmuch as a few of the fields are lying idle and gradually reverting to the original sod cover.

Weld silt loam.—This hard-land soil occupies both large and small areas in all parts of the area except in the northwestern and most of the southeastern parts. The combined areas total 73.9 square miles. Although the slope does not exceed 2 percent, the surface in general is smoother than on most areas of Platner loam. The original soil material consisted of fine silty wind-blown loess, but, owing to the smooth relief, this type has reached the stage of normal soil development consistent with the climatic environment and native vegetation. Practically all the mapped areas occur on the higher parts of the hard lands and gradually slope into the lower and more extensive flats of Platner loam or into undulating or rolling phases of the Weld soil types. In the general area lying 2 to 8 miles east, northeast, and southeast of Otis, most of the mapped areas include scattered depressions and surround small areas of McKenzie loam and clay. Such soil areas also occur in the southwestern part of the area and northeast and southeast of Akron.

Surface drainage is good, but internal drainage is rather slow. Ordinarily the subsoil absorbs moisture fairly well, but much of the water from sudden showers runs off unless the soil is left in a roughly plowed condition to facilitate infiltration. Under optimum moisture conditions, the subsoil is fairly permeable to plant roots and moisture, but is much less permeable to plant roots after it has become dry during droughty periods.

The 3½- to 6-inch light-brown or light grayish-brown silt loam surface soil is underlain rather abruptly by brown fairly heavy clay subsoil which, upon drying, contracts to form vertical pris-

matic aggregates, locally referred to as joint clay (pl. 2, *B*). At a depth of 8 to 12 inches the lower subsoil merges into light-brown clay loam and then, within 2 or 3 inches, into pale grayish-yellow loose floury silt, high in lime—the unaltered parent loess. In a number of older fields the plow soil has become somewhat heavier in places and varies from a heavy silt loam to silty clay loam, due to the mixing through cultivation of some of the heavier underlying clay material. Furthermore, some of the older fields contain scattered granitic pebbles in places in the plow soil only, which were brought up by burrowing animals from the substratum 5 to 8 feet below. Ordinarily, however, the mantle of loess is too deep for burrowing animals to bring up pebbles and gravel. Along the margin of areas of this type and Platner loam a slight scattering of pebbles and coarse sand exists, but the silty material is dominant to depths of not less than 4½ feet. In places, however, the underlying materials are so mixed that considerable deep boring is necessary to establish the boundary line between Platner and Weld soils.

Approximately 85 percent of this soil is cultivated. Of the small grains, wheat, barley, and proso probably are the most dependable. Formerly, considerable corn was grown, but during recent years the acreage has decreased and the acreage of sorgo has increased. The cultivated crops in recent years include wheat, barley, sorgo, corn, oats, proso, and beans in approximately their order of importance. The acreage and percentage in various crops, however, fluctuates widely, depending upon the length and severity of droughts. Under the most approved tillage practices conducted at the United States Dry Land Field Station and by farmers relying on summer fallow, or during exceptionally favorable crop years, yields of all crops have been fairly high (see table 3). A higher average precipitation in the northeastern part results in consistently higher yields than in the southwestern part.

During recent years more land has been left in summer fallow than formerly. Over a period of years, this practice has proved more dependable than growing a crop every year in the hope that rainfall will be sufficient to produce paying yields without previous summer fallowing. If damming listers are used, practically all the local rainfall during the fallow season is absorbed in the subsoil, making the chances much better for a paying yield the following season.

The various fields in native sod provide excellent pasture. The grass cover consists mainly of grama and buffalo grasses, a small percentage of wheatgrass, and numerous other grasses and herbaceous plants of less importance. About 20 or 25 acres is necessary to pasture one animal unit through the summer during favorable seasons, but 25 to 30 acres is required to prevent overgrazing during dry years. Sufficient water for livestock can be obtained in most places at a depth of 80 to 200 feet.

Weld silt loam, undulating phase.—The total of 30.8 square miles is distributed in the same general parts of the area as the type, but this phase embodies smaller or narrower soil areas and the slopes vary from 2 to 5 percent instead of less than 2 percent. Surface drainage is fairly rapid, and much of the rain water runs off instead of soaking into the subsoil.

Essentially this phase is the same as that of the type, except that the surface has a more distinct brown color and the brown clayey subsoil does not average quite so thick in many places. Ordinarily the grayish-yellow parent loess material underlies the surface and upper subsoil layers at a depth of 8 to 13 inches. As with the normal type, some of the surface soil in older fields has become somewhat heavier in texture through years of cultivation, hence the texture varies from a heavy silt loam to a silty clay loam.

For dependable crop yields, the soil requires special tillage methods for conserving water. Approximately 65 percent is under cultivation, and the various crop yields are slightly lower than on the type, because of the generally smaller quantity of subsoil moisture and the apparent slightly lower content of organic matter. Although the kinds of grass and the density of growth are practically the same on both soils, areas of this phase are overgrazed more easily than is the type.

In part of the south half of sec. 6, T. 4 N., R. 51 W., the soil is really silty clay loam in the native sod condition, but owing to its small extent it is included on the map with this phase.

Weld silty clay loam.—This soil, heaviest and most slowly drained of the Weld series, is confined to the higher nearly flat upland divides, most of which lie about 6 to 14 miles northeast of Akron and 4 to 11 miles north and northwest of Otis. The total area is 8.5 square miles. In most places the slope is negligible—less than 1 percent, and nowhere exceeding 2 percent.

Surface and internal drainage are somewhat restricted by the prevailing nearly flat surface and heavy subsoil. Small barren depressed spots are common on the more nearly flat places and are shown on the soil map by solonetz symbols. Water accumulates after heavy showers and remains in such places for several days. The subsoil is less permeable to crop roots, moisture, and air than other Weld soils.

The surface soil consists of brown to grayish-brown moderately friable silty clay loam or clay loam, ordinarily 4 to 5½ inches thick. This layer grades rather abruptly into the dark grayish-brown subsoil, which is very plastic when wet and upon drying contracts into short vertical prismatic aggregates locally referred to as joint clay. At a depth of 15 to 20 inches the material grades into light-gray to grayish-yellow loam or silt loam—the lime carbonate horizon—containing a noticeable mixture of scattered sand and gravel with the dominant silt material. With increase in depth the material varies in the percentage of silt and sand grains, but at depths of 3½ to 4 feet the content of coarse sand and scattered white gravel usually increases; or fragments of more massive material occur similar to that underlying the Canyon soils.

A number of places bordering these soil areas are occupied by narrow belts either of Canyon gravelly loam or of Platner loam, shallow phase, which accounts for the presence of scattered sand and gravel in the lower subsoil. This soil type is intermediate in character between the typical Weld soils and Platner loam but for the most part has characteristics similar to the Weld soils. In a few places, as in section 24 about 5 miles east-northeast

of Otis, the surface soil consists of very fine sandy loam. These areas and a few other similar small scattered areas are included with this soil, owing to their small total area.

About 60 percent of the soil is cultivated. The fact that several old cultivated fields are now lying idle is mute evidence that the soil appears to be more suitable for cultivated crops than it actually is. Practically all the cultivated areas are planted to wheat, barley, or sorgo. Crop yields are lower than on other Weld soils and average lower than on Platner loam, especially during droughty years.

Sorghums succeed better than most other crops. Corn is very uncertain and is poorly adapted to this soil. Apparently the most practicable land use is for grazing or for planting limited acreages of sorghum for forage. In most places, well water can be obtained at a depth of 150 to 200 feet.

Weld very fine sandy loam.—Like Weld silt loam this soil is developed on the hard lands in widely separated places, mainly in the northeastern, east-central, north-central, central, and southwestern parts of the area, totaling 21.6 square miles. The areas are rather narrow, elongated, and fairly small. The surface is very smooth, the slope not exceeding 2 percent. The soil is closely associated with areas of the silt loam that occupy the higher parts of the uplands.

The 5- to 8-inch surface soil is brown to grayish-brown very fine sandy loam grading into brown moderately heavy clay loam, which when moist, is fairly friable, but when dry contracts into vertical prismatic aggregates similar to those of the subsoil of the silt loam. With increase in depth, the clay loam grades into lighter brown shades underlain, at a depth of 12 to 16 inches, by grayish-yellow limy floury silt containing a relatively higher percentage of very fine sand grains than the underlying loessal material of the silt loam. The soil is free from pebbles. Ordinarily the surface soil and subsoil are more absorptive and retentive of moisture than the silt loam, and crops withstand drought periods better. Although some surface runoff is common after hard rains, the soil has not undergone much erosion in old cultivated fields. The content of organic matter, although not high, apparently is equally as high as that of the silt loam, if not higher. Considerable care is necessary when the soil is left bare to prevent wind erosion of the surface soil and at the same time to encourage the absorption and retention of as much rainfall as possible. The soil is easily worked and is responsive to good tillage practices.

Approximately 85 percent is cultivated. Corn, wheat, barley, and sorgo are the crops most commonly grown, and they probably occupy about 75 percent of the total crop acreage. Proso, oats, rye, and beans are grown occasionally, but the acreages vary from year to year. Yields of corn are somewhat higher, especially during dry years, than on the silt loam because of its greater capacity to absorb local rains. Ordinarily the yields of small grains differ very little from those produced on the silt loam, but corn and sorgo average higher. The fields in native sod provide good pasture. The grass cover and carrying capacity differ very little from those of the silt loam.

Weld very fine sandy loam, rolling phase—Except for the rolling topographic features, this rolling phase is almost identical with that of the undulating phase, although the surface soil is a trifle lighter brown in color and the underlying loess occurs at slightly shallower depths, except along the lower slopes bordering small drainage courses. The soil occurs chiefly in the northeastern, southwestern, central, north-central, and east-central parts. The total area is 8.8 square miles.

Approximately 30 percent of the area is cultivated and planted chiefly to corn. In tilling this soil the cultivated fields cannot be expected to endure for very many years, unless precautionary practices are followed to prevent blow hazard, excess surface runoff, and consequent erosion. Even when the land is listed and cultivated with the contours of the slope, the yields ordinarily average lower than on the type and its undulating phase. Some difficulty is experienced in operating heavy farm machinery and especially in trying to prevent erosional waste of the plow soil. The cultivated fields therefore should be confined to long smooth rolling slopes not dissected by small field drains. Apparently the best use of most parts of the mapped areas is for grazing, especially for any great length of time. Its grazing value and carrying capacity is about the same as for other Weld soils.

Weld very fine sandy loam, undulating phase.—Essentially, this phase is much like the type. For the most part it occupies rather long narrow belts, mainly in the northeastern, north-central, east-central, southwestern, and central parts of the areas, in a total of 17 square miles. The slope varies from 2 to 5 percent. Surface features are smooth and permit easy operation of various kinds of farming implements.

The brown to light-brown surface soil grades at a depth of 5 to 8 inches into subsoil of heavy brown clay loam, which when dry has a vertical prismatic structure. The 10- to 14-inch subsoil is underlain by the grayish-yellow limy loessal material identical with that underlying the type. The soil is fairly absorptive and retentive of moisture and is moderately permeable to plant roots, but the surface soil apparently is a trifle lower in organic matter than is that of the type.

The crop yields are probably little lower than on the typical soil, but more care is necessary in tillage in order to prevent excessive runoff of rain water and injury to fallow fields and young crops by wind and water erosion. Approximately 75 percent of the land is in cultivation, and its crop suitability differs very little from that of the type.

LAND USE AND AGRICULTURAL METHODS

The net income of any farmer, other than that derived from outside sources, depends very largely on his management ability. Every farmer should strive to utilize the farm or land at his disposal to best advantage and at the same time not allow it to decline in value or productiveness. To this end good judgment is required, and a knowledge of soils, machinery, crops, and livestock is necessary. Moreover, the importance cannot be overemphasized of conserving the maximum quantity of precipitation in the subsoil, insofar as is practicable within the bounds of economy.

Under the prevailing annual precipitation of 17.18 inches (*1*), rainfall is sufficient in occasional years to produce an excellent crop of both small grains and corn, but it is unusual for both crops to make good average yields in the same season, especially on the hard-land soils. Cycles of years in which the average yearly precipitation is above normal, or at least favorably distributed, alternating with years below normal, some of which may be unfavorably distributed, can be expected in this and almost any other dry-land locality. The prevailing climatic conditions are understood by the older settlers, but it takes time for farmers who migrate to this locality during good crop years to adjust themselves to the most dependable land use and agricultural methods. Most of the hard-land soils are inherently fertile, and many of them have a high potential capacity for producing good yields. The controlling factor, however, is not the quantity of yearly precipitation but its seasonal distribution, whether favorable or unfavorable for the several adapted crops, especially wheat and corn.

Under a well-managed cropping system in the Corn Belt States, to maintain a sufficient supply of organic matter and to keep the soil in good tilth, approximately a fourth of the cultivated land would be planted to legumes. In this locality, where leguminous crops—alfalfa and sweetclover—do not succeed unless irrigated, it is difficult to maintain an ample supply of organic matter, especially on the sandy hard-land soils. Inasmuch as the climate is too dry to permit the use of commercial fertilizer with any degree of success when the soils have declined greatly in productiveness, other means of supplying ample plant nutrients, mainly humus, nitrates, and phosphates, will be necessary. Therefore cultivated fields that are droughty because of heavy surface or subsoil texture, gravelly subsoil, too steep slopes, or other causes can best be used as grazing land. Should this be disadvantageous, drought-resistant crops, especially sorghums, are best suited. Much of the inferior cropland is reverting to native grassland—as it should—but the overcrowded condition on certain soils that are poorly suited to cropping prevents much of the land from being put to its best agricultural use.

The cropping and land management practices in this area are similar to those in other counties in northeastern Colorado. Prior to World War I, a large percentage of the farmers relied upon grazing cattle as their chief source of income and grew considerable quantities of corn for feed. During and after the war the high prices of wheat caused many farmers to break up much of the heavy hard-land soils—Platner, Colby, Weld, Rago, Keith, and Goshen—and to rely largely for their income on wheat. During the drought decade 1930-40 a more diversified agricultural trend developed. Under this system more feed crops, especially sorghums, are produced and more poultry, hogs, and dairy cattle are raised. Less dependence is placed on wheat as a cash crop. This diversification is having the wholesome effect of making the income more sure than when all is staked on wheat.

Perhaps some farmers will continue to grow wheat as their chief cash crop, but the trend on these soils is to diversify and keep a larger acreage in summer fallow. Others who own or

have access to large holdings of grazing land—Valentine soils, dune sand, and other miscellaneous soils and land types—will, no doubt, continue to raise cattle as their chief source of income, inasmuch as on these land types grazing is their most practicable use (pl. 3, *A*). The small part of the Akron area within the South Platte River Valley (about 13 square miles) has been favored with irrigation, and the farmers have depended largely on sure crops of alfalfa, sugar beets, corn, wheat, oats, barley, and potatoes. Some do considerable feeding and fattening of cattle and sheep late in fall. The land use and management problems of the farmers within the valley are far less acute than of those living on the hard lands.

Corn is and always has been an important crop in the area. The acreage, however, has fluctuated greatly, owing both to economic and climatic conditions. No doubt the crop will always be grown on soils to which it is well adapted, inasmuch as cattle will be produced on lands suited to no other purpose than grazing. In the locality having grazing lands that are unsuited to cultivation, regardless of rainfall, the better upland soils for corn are dark-colored, sandy-textured, and have a deep friable subsoil, very permeable to air, water, and plant roots, and are highly absorptive of rain. They include soils of the Goshen, Keith, and Haxtun series of the uplands and of the Bridgeport and Fort Collins series of the bottoms and terraces. Considerable corn is grown also on the sandy-textured Weld and Colby soils in the northeastern part. If corn is grown on the heavier textured hard lands, especially on Platner and Weld soils, the yields usually are unsatisfactory during exceptionally dry cycles, even on summer-fallow land, but during seasons when the precipitation is high and favorably distributed fair to excellent yields are produced on practically all the hard-land soil types regardless of texture. Such seasons, however, are in the minority.

The tillage methods for corn are much the same throughout this area. Practically all the corn is listed during the latter part of May with a 2- or 3-row lister-planter, team- or tractor-drawn, at the rate of 4 to 6 pounds an acre. Farmers having barnyard manure usually apply a light top dressing prior to listing. Two or three cultivations usually are sufficient, the first applied lightly and the last two just enough to level rows. According to experiments conducted at the Dry Land Field Station, the most efficient spacing of corn for silage production is 12 to 18 inches in 44-inch rows. The highest 12-year average yield—1924 to 1935, inclusive—was 13.3 bushels an acre for 24-inch spacing in 44-inch rows. These data apply mainly to the heavier hard-land soil types of the Platner, Weld, and Goshen series. The spacing of corn on the sandy-textured soils of the Weld, Keith, Goshen, and Haxtun series, as observed in the survey, was 12 to 20 inches in the row, with the listed rows varying from 36 to 44 inches apart. Inasmuch as these soils are the most dependable for corn production, owing to the fact that barnyard manure can be applied successfully, they will no doubt continue to be used primarily for corn (pl. 3, *B*).

The harvesting of corn is similar to that practiced in other semiarid regions. The crops on the larger fields are cut with the

corn binder and shocked. Some farmers having pit silos cut the crop for silage; whereas, others may husk and store the grain. In many places where corn has not matured because of extreme drought, cattle are allowed to browse on the crop late in fall and in winter. Occasionally a small acreage is hogged off, provided the corn is of a flint variety. As a rule, the crop is fed locally in the form of silage, fodder, whole grain, or ground grain mixed with other ground grains. Most of the corn is of early-maturing varieties—Yellow Dent and Minnesota 13—but a small percentage of Blue Flower (dwarf flint variety), Northwestern Dent, Calico, and local strains of white corn are grown.

The preparation of land for wheat is more variable than for corn. Owing to the recent cycle of years of extremely low average annual precipitation, more land is being summer-fallowed than formerly. Land for wheat is either plowed 4 to 8 inches deep or is listed following a small grain crop, and early in fall is harrowed or disked preparatory to seeding, provided the subsoil moisture supply is sufficient. If not, many farmers leave the land over winter in a rough condition for summer fallow or to be planted to corn or sorghums in spring. If summer-fallowed, the land is worked in spring with either a lister, disk, duckfoot cultivator, or damming lister to lessen the runoff (pl. 4, *A*) and to facilitate the accumulation of the maximum quantity of subsoil moisture. On sandy-textured soils the lister is the better implement to use, because when fields are listed crossway of the general wind movement, the plow soil is less susceptible to wind erosion and drifting. If the precipitation is so low during the fallow season that no appreciable quantity of subsoil moisture has accumulated, the prospects for a paying wheat crop are still remote, but such seasons in this locality rarely occur.

Hard winter wheat is seeded with the standard press drill, either team- or tractor-drawn, at the rate of 2 to 3 pecks an acre, usually between September 10 and 20.

During spring seasons of ample subsoil moisture some spring wheat is seeded, ordinarily from March 15 to April 5, at the rate of 4 pecks an acre. The varieties best suited are Komar and Ceres, according to results at the Dry Land Field Station. A few farmers use the lister drill; but this implement has not proved entirely satisfactory in some localities. It has the advantage possibly of conserving more snow that otherwise might be blown off, but if the precipitation is too low to insure a paying wheat yield generally, its use is not advantageous. Its best use is on moderately heavy-textured soils—Colby, Rago, and Platner.

Wheat is harvested during the latter part of June with either the binder, header, or combine. If the binder is used, the wheat is threshed from the shock because very few farmers go to the trouble of stacking. After threshing a large part of the wheat crop, especially that produced by tenant farmers, is trucked to the nearest elevator and sold immediately; whereas some of the larger landowners store their grain with a view of selling it at a more opportune time. Formerly, large acreages of wheat were grown on the same land several years in succession, and this practice is still followed on some farms even though it has proved more or less disadvantageous, especially during cycles of abnormally dry years.

Some very striking and highly significant experiments have been conducted at the Dry Land Field Station, showing acre yields of the best-adapted wheat and barley varieties under the tillage methods best suited to this locality. Table 5 shows that during 14 years of alternated summer-fallow plots the yearly yields of the several wheat varieties approximately double those that follow corn with the exception of 2 years. In 1930, a good year, favorable moisture distribution caused practically equal yields; also in 1934, a failure resulted on both types of tillage preparation with little difference in yields. It is significant, however, that during the 14 years, only four low yields resulted under summer fallow; whereas there were eight low yields following corn. The 10 good years under summer fallow averaged approximately twice the good or poor yields following corn with the exception of 1930, a good year, and 1934, a poor year, on both types of tillage preparation. These experiments were conducted on smooth very slightly sloping Rago silt loam. Although this type of soil is not very extensive within the Akron area, wheat yields compare favorably with those produced on Goshen clay loam, Keith silt loam and very fine sandy loam, and Weld silt loam and very fine sandy loam. Platner loam covers a much wider area, but average wheat yields are lower, owing to less favorable soil characteristics under low rainfall.

The tillage methods common in many wheat-growing sections are very undependable and hazardous in the Akron area. Experiments at the Dry Land Field Station for a 14-year period on Rago silt loam show that winter wheat under continual disking and occasional plowing averaged 5.2 bushels; whereas under the early-fall plowing method the yields averaged 4 bushels, and under late-fall plowing, only 3.4 bushels. These results show the folly of attempting to grow wheat continually by methods common in eastern Kansas, Nebraska, and Iowa and other localities receiving much greater average annual precipitation. During experiments in the 30-year period 1909-38 with early fall-listed, early fall-plowed, and late fall-plowed land, yields averaged 7.4, 7.1, and 6.2, respectively, whereas under fallow the same term average was 16.3 bushels.

A climatic characteristic that should not be overlooked is that in this general locality the wheat crop receives lower average precipitation at the critical pollinating and dough stage than earlier or later. The deficiency is even more pronounced for corn, beginning with and immediately following the tasseling and silking stage. These bimonthly periods, the last 2 weeks of June for wheat and the last 2 weeks of August for corn, in which the maximum rainfall is needed, unfortunately have a marked decrease in precipitation at the Dry Land Field Station (see fig. 2, p. 7).

These observations are substantiated by experiment station records at both the Fort Hays and the Colby Branch Stations in Kansas. At Colby, 125 miles by air southeast of Akron, the biweekly records over the 26-year period 1914-39 show an average of 1.54 inches of precipitation for the first half and 0.90 inches for the second half of June. Those at Hays, Kans., 215 miles southeast of Akron, over a like period, show an average of 2.06

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TABLE 5.—*Plot experiments conducted for wheat and barley yields at the Dry Land Field Station, Akron, Colo., in the 14 years 1925-38*

WHEAT YIELD—BUSHELS PER ACRE—SUMMER FALLOW

	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	Avg.
Blackhull	6.3	2.7	18.2	45.0	13.2	19.6	16.2	17.7	11.3	3.9	27.1	30.6	19.7	30.4	18.7
Kanred	2.4	1.9	....	48.2	14.4	19.5	14.8	14.8	8.8	1.9	25.1	31.8	22.2	25.7	17.8
Kharkof	5.0	2.2	21.5	4.9	13.6	24.2	16.2	10.2	6.5	2.6	26.0	27.4	21.3	30.1	18.3
Tenmorg	....	....	27.3	48.6	13.8	20.2	14.7	16.3	8.6	2.9	26.5	34.5	21.2	28.7	21.9
Nebt. No. 60	....	....	....	47.0	11.7	19.8	13.9	12.0	6.4	2.5	25.4	27.2	20.6	....	18.7
Early Blackhull	....	....	....	....	....	24.6	12.3	18.3	10.3	3.9	27.2	34.9	17.5	29.6	19.8
Cheyenne	....	....	....	....	....	....	17.2	13.2	6.0	3.0	27.9	32.3	21.7	28.0	18.7
Total average	....	....	....	....	....	....	....	....	....	....	....	....	....	....	19.1

WHEAT YIELD—BUSHELS PER ACRE—FOLLOWING CORN

Blackhull	3.9	1.5	13.9	24.1	6.2	19.4	4.1	1.3	....	3.2	8.9	14.0	8.5	14.7	7.8
Kanred	2.2	.7	11.9	25.1	4.0	20.6	2.8	1.2	....	2.5	13.0	10.4	6.8	15.4	8.3
Kharkof	4.3	1.1	13.7	23.4	3.6	19.0	4.4	1.1	....	3.3	6.4	10.8	6.1	15.8	8.1
Tenmorg	....	....	17.7	21.3	4.2	21.3	3.8	1.2	....	3.5	9.2	15.2	9.1	14.2	10.1
Nebt. No. 60	....	....	....	31.1	3.4	16.1	5.0	1.2	....	2.8	7.6	11.5	5.0	....	8.4
Early Blackhull	....	....	....	....	....	19.6	2.5	1.3	....	3.5	11.8	15.6	5.0	17.6	8.5
Cheyenne	....	....	....	....	....	....	3.4	1.3	....	3.7	9.6	13.2	7.0	16.7	6.9
Total average	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8.3

BARLEY YIELD—BUSHELS PER ACRE—FOLLOWING CORN

Club Mariout	8.4	0.4	22.3	35.4	6.3	19.6	3.3	4.1	5.7	....	39.8	19.7	7.8	20.9	13.5
Vance (Smyrna)	7.3	.9	18.7	34.3	4.2	11.2	.9	2.7	4.9	....	35.7	12.9	8.2	25.3	11.9
Coast	8.9	.9	18.9	39.7	4.5	11.5	3.1	4.2	3.1	....	33.1	14.7	7.7	21.8	12.3
Total average	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12.5

inches for the first half and 1.71 inches for the last half of June, and 1.94 inches for the first half and 1.05 inches for the last half of August. This climatic peculiarity is undoubtedly one of the most outstanding reasons that so many promising wheat and corn yields during many seasons have been greatly curtailed or have been failures. This is especially true on the extensive Platner soil types in the Akron area.

Barley is one of the most certain crops for feed purposes grown on the hard lands. Results at the Dry Land Field Station show little difference between fall listing and spring plowing of stubbleland in preparation of the seedbed. The crop does well on a seedbed prepared by disking or harrowing corn stubbleland. A higher yield is obtained on summer-fallow land and may be a justifiable practice; however, it frequently produces good yields without fallowing. Ordinarily barley is drilled from March 15 to April 5 at the rate of 4 to 5 pecks an acre. Binders and combines are used in harvesting. Approximately half the barley is sold and the rest is fed to livestock. The varieties that have proved most successful on hard lands since 1928 include Club Mariout, Vance (Smyrna), Spartan, and Flynn.

Of recent years the acreage in oats and rye has been small in comparison with that in wheat. Rye, however, because of its early maturity and adaptability to excessively sandy soils, as Valentine sand and Blakeland loamy sand, fits into the farming practice on some farms better than wheat. Oats are grown largely for feeding young animals and work teams on the farm. The common varieties of oats are Kanota and Brunker, and those of rye are Rosen and the common winter variety. Oats are usually grown as a nurse crop for sweetclover, but in this locality the climate

is too dry to depend upon sweetclover or alfalfa except in the irrigated river valley. Seeding may be done as late as April 10 at about the same rate as for barley.

Proso, or hog millet, locally called Hershey, is grown successfully in the Akron area by many farmers. It is most commonly grown on the hard-land soils, chiefly types of the Platner, Weld, Rago, Keith, and Goshen series. According to experiments at the Dry Land Field Station, it should be sown with a grain drill —8-inch spacing—immediately after a rain, preferably from June 15 to July 1, at the rate of 35 pounds an acre. It is cut with either header or binder and later combined from windrows or cured shocks, or headed small piles are hauled to a thresher. Of the varieties tested at the station, Turghai, Red Russia, and Yellow Manitoba, are most successful, in the order named. Yields of all varieties over a 7-year period averaged 15.1 bushels on land following summer fallow and 8.4 bushels on Sudan grass stubble. Not only is proso a good catch crop, but the grain when finely ground and mixed with corn or barley provides an excellent ration for livestock. In feeding value it is 90 to 100 percent as good as corn. Some dairymen utilize the crop for summer pasture; but foxtail millet will outyield the hog millet for pasture or hay.

In earlier years beans were an important cash crop. The cultivation of beans, however, leaves the soil in an open, loose condition, very susceptible to severe wind erosion and soil drifting. This hazard has greatly decreased the production of beans as a money crop, but a few farmers still grow them on a limited scale. Of late years the crop usually has been grown with alternate strips of either corn or sorgo listed crosswise of the general wind movement. The strips vary from 2 to 6 rods in width. The wind hazard is great, and the crop, when young, can easily be injured severely if not destroyed by wind-driven soil, especially on sandy soil types. To safeguard such fields it is necessary to list the land in fall. Great Northern and Pinto are the principal bean varieties, and the latter is usually preferred. Beans are grown to best advantage on the Keith, Weld, Rago, and Goshen soils, and especially during cycles of maximum precipitation.

In view of the erratic climatic conditions in this locality sorghums are rapidly gaining in favor. Their peculiar ability to remain dormant during hot dry midsummer periods, to resume vigorous growth after the first rain late in summer or early fall, and then to produce fair to good yields is a desirable characteristic. In this locality sorghum is the surest crop for large quantities of roughage for feeding livestock. During favorable years any surplus tonnage may be stacked or carried over as a safeguard in the event of a following extremely dry year or two. Like other crops, if planted on the heavy-textured hard lands—mainly Platner loam and Weld and Rago silt loams—sorghum grows best after the land has been fallowed or following row crops (pl. 4, *B* and *C*). On these soils, according to experiments made, the yield from fallow land was almost a third greater than from stubble land during the 13-year period 1925-37. Crop yields usually are higher on the sandy types of the Rago, Weld, Keith, Haxtun, Bridgeport, and Fort Collins soils.

Ordinarily sorghums are seeded with the lister on land that is

as free as possible of annual weeds, from May 25 to June 8 at the rate of about 5 to 10 pounds an acre, depending upon the type, size, and vitality of seed, condition of seedbed, and stand desired. Sudan grass, the earliest of the sorghums, may be seeded up to June 20 at the rate of 30 to 40 pounds an acre. According to experiments, the most efficient spacing for forage sorghums is 3 to 5 inches apart in 44-inch rows. Either sandy-textured soils or fallowed heavy-textured hard-land soils are suitable. Two or three shallow cultivations usually are sufficient. If seed is drilled at 8-inch spacing, 30 to 40 pounds an acre is required, but experiments show that the yield of forage sorghums in rows is about 25 percent greater than from drill plantings. Inasmuch as kernel smut is prevalent in this locality, seed should be treated chemically prior to planting. At the Fort Hays Branch Station, Hays, Kans., experiments show that dust treatments, particularly with New Improved Ceresan or copper carbonate, improve field stands appreciably (*8*). The crop is cut with the row binder and later shocked, but if intended for the silo it is left until mature. In the case of grain sorghums, the heads are cut by hand and piled for drying or the combine is used if the grain is thoroughly dry. The crop is fed locally, mainly as roughage for livestock or in the form of whole or ground grain for poultry and livestock. For most types of fattening, the grain has about 90 percent the value of grade 1 corn (*6*).

According to experiments at the Dry Land Field Station the best adapted varieties of early grain sorghums or milos include the Sooner, Colby, and Pigmy, which can be harvested with the combine. The best dual-purpose sorghums include the Improved Coes and Highland varieties. Recommended forage varieties are the Leoti and Fremont, but Black and Red Amber and Orange still are commonly grown. Some Sudan grass is grown for either hay or summer pasture.

In the Akron area alfalfa is grown successfully only in a small section in the irrigated river valley. It is seeded with a drill in July or August at the rate of 8 or 10 pounds an acre and is covered ½ to 1 inch deep (*7*). A uniform, well-worked seedbed as free as possible of noxious weeds is important. Ordinarily three cuttings are produced, which are stacked in the field and later fed locally or sold to dry-land farmers. Adapted varieties include Meeker, Baltic, Grimm, and Hardistan.

Sugar beets also are grown in the small area of the river valley. They are an important cash crop, but their production entails many complications relating to labor, yields, and cost of production in relation to price obtained. They are grown mainly on the Fort Collins and Wann soils.

As no definite or generally recognized system of crop rotation is practiced, crop yields have decreased somewhat below those obtained when the soils were newly broken. Nitrogen and especially organic matter are decreasing, partly because of wind and water erosion and partly because soil-building legumes do not succeed and so cannot be used for maintaining and increasing the fertility of hard lands or general upland soils. Inasmuch as the use of commercial fertilizers and the growing of legumes are not practical, the maintenance of ample quantities of organic

matter will, no doubt, become an increasingly difficult problem.

Many farmers do nothing to eliminate or keep insect pests, plant diseases, and noxious weeds under control, whereas others go to considerable expense to check their inroads. The hessian fly and the grasshopper cause considerable damage in some years, but their habits are sufficiently well known for most farmers to take proper measures to prevent serious damage. Of the crop plants, several are susceptible to kernel smuts. These can be controlled by killing the spore on the seed with chemical solutions or dust treatments (*3*).

The more common weeds are bindweed, Russian-thistle, cocklebur, biennial ragweed, prairie sunflower, bull nettle, sandbur, buffalo-bur, green foxtail or pigeongrass, three kinds of pigweeds, and numerous others of less importance. Their control depends largely on the individual farmer and his willingness to eliminate them at first sight. Only a few patches of field bindweed were noticed during the survey, but since it spreads rapidly and causes great damage, every effort should be made to eradicate it before the land becomes generally infested. The application of sodium chlorate solution to small patches when first observed, either by spraying or by working the chemical into the soil at the rate of about 6 pounds per square rod is very effective (*9*). Otherwise, if the spread becomes general, clean cultivation is the most practicable method of control.

From time to time some livestock die from eating poisonous weeds, as the dwarf milkweed *(Asclepias pumila)* and a few seleniferous plants—*Astragalus racemosus, A. bisulcatus,* and *A. pectinatus* (*2*). Because of the danger of prussic acid poisoning it is dangerous to pasture livestock on second growth from harvested sorghums before the stubble has completely dried.

ESTIMATED YIELDS AND PRODUCTIVITY RATINGS

In table 6 the soils of the Akron area are listed alphabetically and estimated average acre yields of the principal crops under common management practices are given for each soil type or mapping unit for two generalized conditions of climate.

The figures in columns A are estimates of the average yields of the better two-thirds of the years, whereas those in columns B are estimates of the average yields over a period that includes both the better and the poorer years. Common management practices as considered here do not include the use of commercial fertilizers, or of all the latest improved crop varieties, intensive measures of erosion control, or of all the approved methods of tillage and plant-residue management. Management practices generally followed by most farmers include the return of manure to the land, the listing of corn, the diversification of close-growing crops with intertilled crops, the use of strip-cropping to some extent to reduce the hazard of soil blowing, the use of some summer fallow, and the incorporation of stubble.

The principal factors affecting the productivity of land are climate, soil (this includes the many physical, chemical, and biological characteristics), and management, including the use of amendments. No one of these operates separately from the others, although some one may dominate. Those listed may be grouped

simply as the soil factor and the management factor. Slope, drainage, and most of the aspects of climate may be considered characteristics of a given soil type, since the soil type occupies specific geographic areas characterized by a given range of slope and climatic conditions. Crop yields over a long period of years furnish the best available evidence of productivity and therefore are used where available.

In this area, climatic conditions, especially those relating to precipitation and its distribution, are very pronounced in their effect upon crop production. Ordinarily sufficient rainfall is available but its distribution is not consistent or favorable for either small grains or corn as shown on the precipitation chart (fig. 2). Moreover, the rainfall in the southern part, especially in the southwestern part, is slightly lower than at the Dry Land Field Station and is considerably lower than in the northeastern part, as shown by yearly crop yields and from statements of numerous old settlers living in the area. Soils of the same types consistently produce a higher yield in the northeastern than in the southwestern part.

The estimates in table 6 are based primarily on interviews with farmers, the county agricultural agent, members of the Experiment Station and Agricultural College, and particularly with the members of the staff of the United States Dry Land Field Station, 4 miles east of Akron. Because of its central location the results over the 30-year period 1909-38 are fairly representative of average yields on Rago silt loam for the area, inasmuch as the results of many tillage and cropping practices are averages that give a fair average of yields under the different cultural methods commonly practiced. The average yields of oats and barley at the station were considered rather high because several plots were under fallow; therefore the 30-year average for these crops was estimated at a lower level on Rago silt loam than shown in table 3.

It is strongly emphasized that the figures in table 6 are estimates of yields for generalized conditions of climate. They cannot be expected to apply directly to any specific tract of land for any particular year, because of great climatic fluctuations from year to year and also because management practices may differ slightly from farm to farm. The soil units shown on the map also may vary somewhat from place to place.

The low yields of this area do not indicate that the soils are infertile but instead reflect the low and irregular moisture supply of the prevailing climatic environment. Practically all the soils contain sufficient plant nutrients to insure higher yields under a higher or a more favorable distribution of rainfall. During exceptionally favorable seasons the principal crops may produce at least a half more to double the number of bushels indicated in the table for the average of the better two-thirds of the years, whereas in extremely droughty years crops may fail entirely on some soils, especially if the best management practices are not followed.

In view of the erratic yearly yields, due to variable weather, extremes in yearly temperatures, quantity and distribution of rainfall, and presence of grasshoppers or other insects, and of black-stem rust or other diseases, it should be understood that yields in any year may differ greatly from the average. Such

crops as proso and field beans are not so generally grown; therefore the estimates are perhaps less reliable, although they do show relatively the productivity of the soil types for these crops. Because of the small quantity of rye grown it is not included in the table; however, the soils usually cropped to rye are the sandy loams to loamy sands. Grain sorghums and sorgo have about the same adaptability as corn and can be expected to give best results on the soil types best suited to growing corn.

In order to compare directly the yields obtained in the Akron area with those obtained in other parts of the country, yield figures have been converted in table 7 to indexes based on standard yields. The soils are listed in the approximate order of their general productivity under column A, the most productive at the head of the table.

The rating compares the productivity of each of the soils 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 more extensive and better soil types of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil to which it is given is about half as productive for the specified crop as one with the standard index. The standard yield for each crop is given at the head of its column. Soils given amendments of lime and commercial fertilizers, irrigated soils, and unusually productive soils of small extent, may have productivity indexes of more than 100 for some or all crops.

Six classes are indicated in the column General Productivity. The order of placement of the soils in the classes of general productivity has been based largely on personal judgment of the relative suitability of the soils combined with a percentage weighting of its crop indexes in the A column according to the relative acreage and value of the individual crops.[6] No weighting was assigned to oats, grass, or grain sorghums.

Since it is difficult to measure mathematically either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soils for particular crops, too much significance should not be given to the precise order in which each soil is listed.

In the column on Remarks of table 7, the general use suitability of the soils is indicated together with the more important characteristics or conditions that determine the relative suitability of each group.

Economic considerations play no part in determining the crop productivity indexes. They cannot be interpreted, therefore, into land values except in a very general way. Distance to market and other costs of production, relative prices of farm products, and other factors influence the value of land. It is important to realize that productivity, as measured by yields, is not the only consideration that determines the relative worth of a soil for growing crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained are examples of

[6] Because of the relatively small acreage of each, the relative percentage weightings assigned to the crop indexes are:

Wheat	40	Sorgo	20
Barley	25	Corn	15

TABLE 6.—*Estimated average per acre yield of the more important crops on the soils of the Akron area, Colorado*

[Figures in columns A and B represent estimated average yields that may be expected under the prevailing soil-management practices; the yields in columns A are estimated average yields of the better two-thirds of the years only; those in columns B are estimated average yields for all years, which range from years of crop failure to those with bumper yields. These figures are offered only as estimates of judgment, because yield data are scarce and unsatisfactory, largely because climatic conditions vary widely from year to year and from one part of the area to another.]

Soil	Wheat		Oats		Barley		Corn		Proso		Beans		Sugar beets	Alfalfa	Sorgo[1]	Grain sorghum[1]	Remarks	
																	Use	Grazing capacity (per animal unit per season)
	A	B	A	B	A	B	A	B	A	B	A	B	B	B				
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Bu.*		*Acres*
Badlands	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	....	Grazing	30–50
Blakeland loamy sand	8	5.5	16	11	13.5	9.5	9	6	....	....	....	....	....	....	1–2.5	8–16	15 percent in crops	25–35
Level phase	8.5	6	17.5	12	14	10	9	6	....	....	....	....	....	....	1–2.5	9–18	.....do.....	22–32
Bridgeport fine sandy loam	14.5	10	23	16	22	15.5	17	12	15	9	14	7	....	....	2–3.5	12–24	Grazing; 30 percent cultivated.	18–25
Bridgeport silt loam	15.5	11	25	17.5	22	15.5	16	11	15	9	14	7	....	....	2–3.5	11–22	Grazing; 35 percent cultivated.	18–25
Bridgeport silty clay loam	15	10.5	24	17	21	14.5	14.5	10	15	9	13	6	....	....	1.5–3	10–20	Largely in crops	18–25
Sloping phase	15	10	24	17	21	14	14	10	15	9	12	6	....	....	1.51–3	10–20	.....do.....	18–25
Canyon gravelly loam	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	....	Grazing	20–40
Undulating phase	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	....	.....do.....	20–35
Colby silt loam	12	8.5	20	14	20	14	12	9	13	7	11	5	....	....	1.5–2.5	9–18	.....do.....	20–25
Rolling phase	11	7.5	18	12.5	15.5	11	12	9	11	6	10	5	....	....	1.5–2.5	9–18	Grazing: 20 percent cultivated.	20–30
Colby very fine sandy loam:																		
Deep phase	12.5	8.5	21	14	19	13	15	11	13	7	13	5	....	....	1.5–2.5	10–20	75 percent in crops	20–30
Rolling phase	11	7	17	10	15.5	10.5	12	10	11	6	10	5	....	....	1.5–2.5	9–18	Grazing	20–30
Dune sand (stabilized)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	....	.....do.....	30–40
Fort Collins clay loam—irrigated	....	28	....	55	....	52	....	47	....	....	....	....	15	4	.....	.....	Largely in crops	.....
Fort Collins loam—irrigated	....	26	....	52	....	48	....	50	....	....	....	....	14.5	4	.....	.....	.....do.....	.....
Goshen clay loam	14	10	24	17	21	15	15	10.5	15	9	11	5	....	....	1.5–2.5	10–22	50 percent in crops	15–25
Goshen loam	14	10	24	17	21	15	15	11	15	9	11	5	....	....	2–3	12–24	65 percent in crops	15–25
Goshen sandy loam	12.5	8.5	21	14.5	18	12.5	15.5	10	14	8	13	6	....	....	2–3	12–24	90 percent in crops	15–25
Greely fine sandy loam	13	9	21	14	18	12	14	10	14	8	10	5	....	....	1.5–2.5	12–24	Grazing	15–25
Greeley sandy loam	12.5	8.5	21	14	18	12	18	12.5	14	8	10	5	....	....	1.5–2.5	12–24	Grazing; 25 percent used for crops, largely corn.	20–30
Haxtun fine sandy loam	12	8	21	14.5	18	12.5	17	12	14	8	14	7	....	....	2–3.5	12–24	Nearly all in crops	.....

Haxtun loamy sand	11	7.5	20	14	17.5	12	16	11	11	6	10	5	....	....	2-3	10-20	Slightly more than half in crops.	18-25
Haxtun sandy loam	11.5	8	21	14.5	18.5	13	18	12.5	12	7	13	6	....	....	2-3.5	11-22	Nearly all in crops.	.....
Keith silt loam	17	12	27	19	23	16	15.5	10.5	16	10	14	7	....	....	2-3.5	12-24	.....do.....	.....
Keith very fine sandy loam	17	12	27	19	23	16	16	11	15	9	14	7	....	....	2-3.5	12-24	.....do.....	.....
Las Animas loamy sand—irrigated	....	20	....	32	....	30	....	37	....	....	....	....	....	....	.....	.....	75 percent in crops	.....
Las Animas sandy loam	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	Grazing	15-25
Laurel clay loam	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....do.....	15-20
McKenzie clay	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....do.....	20-60
McKenzie loam	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	Grazing; 25 percent in crops.	15-20
Platner fine sandy loam	11	7.5	21	14.5	19	13	14	10	13	7	11	5	....	....	1.25-2.25	10-20	80 percent in crops	18-30
Rolling phase	9.5	6.5	19	13	16.5	11.5	12.5	8.5	12	6	....	....	....	....	1.25-2.25	9-18	20 percent in crops	20-35
Undulating phase	10.5	7	20	14	18	12.5	13.5	9	13	7	11	5	....	....	1.25-2.25	10-20	70 percent in crops	18-30
Platner loam	12	8	20	14	18	12	11.5	8	13	7	9	4	....	....	1-2	9-18	80 percent in crops	18-30
Rolling phase	10	6	17	10	15.5	10	10.5	7	10	6	8	4	....	....	1-2	9-18	20 percent in crops	20-35
Shallow phase	10	6	17	10	15	10	10	7	11	6	8	4	....	....	1-2	8-16	50 percent in crops	18-30
Undulating phase	11	7.5	19	13	17	11.5	11	7.5	12	8	9	4	....	....	1-2	9-18	60 percent in crops	18-30
Platner sandy loam	11	7.5	19	13	17	12	14	10	12	7	10	5	....	....	1.25-2.25	8-20	75 percent in crops	18-30
Rolling phase	9.5	6.5	17	10	15	10.5	12.5	8.5	10	6	....	....	....	....	1-2	8-18	25 percent in crops	20-30
Undulating phase	10.5	7	17.5	12	16.5	11.5	13.5	9	12	7	11	5	....	....	1.25-2.25	9-18	60 percent in crops	18-30
Platner-Canyon complex	11	8	19	13	17	12	11	7	11	7	8	4	....	....	1-2	8-16	25 percent in crops	25-30
Rago silt loam	14	10	24	17	21	15	13	9	14	9	15	7	....	....	1-2.5	8-18	75 percent in crops	20-30
Rago very fine sandy loam	14	10	24	17	21	15	14	10	14	9	15	7	....	....	1.5-3	10-20	90 percent in crops	20-30
Renohill clay loam	10	6	17.5	12	15.5	11	10.5	6	....	....	....	....	....	....	1-2	8-16	20 percent in crops	20-30
Undulating phase	12	8.5	22	15.5	19	13	11	7.5	....	....	....	....	....	....	1-2	8-16	50 percent in crops	20-30
Riverwash	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	Grazing; idle	.....
Rough stony land (Travesilla soil material)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	Grazing	30-35
Stoneham gravelly loam	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....do.....	25-35
Valentine sand	8.5	5.5	15	10	13	9	8	5	....	....	....	....	....	....	1-2	7-15	Grazing; 5 percent in crops.	25-35
Level phase	8.5	6.5	16	11	14	10	10	6	....	....	....	....	....	....	1-2	7-15	.....do.....	22-30
Vona loamy fine sand	11.5	8	22	15.5	18	12	14	10	....	....	....	....	....	....	1.5-2.5	10-20	25 percent in crops	20-30
Rolling phase	11	7.5	17.5	12	16	11	14	9	....	....	....	....	....	....	1.5-2.5	8-16	Largely grazing	22-30
Wann clay loam—irrigated	....	26	....	44	....	40	....	40	....	....	....	....	14	3.5	.....	.....	50 percent in crops	[2]12-18
Weld-Colby silt loams, rolling phases	11	7.5	19	13	16	12	12	8.5	12	8	13	5	....	....	1-2	8-16	20 percent in crops	20-30
Weld silt loam	13	9.5	23	16	20	14	12	8.5	14	9	15	7	....	....	1-2.5	8-18	85 percent in crops	20-30
Undulating phase	12	8.5	22	15.5	19	13	11.5	8	13	7	15	6	....	....	1-2.5	8-18	65 percent in crops	20-30
Weld silty clay loam	9	6	18	12.5	15.5	10.5	9	5.5	14	8	12	5	....	....	1-2	8-16	60 percent in crops	20-30
Weld very fine sandy loam	13	9	23	16	20	14	14	10	14	9	15	6	....	....	1.5-3	10-20	85 percent in crops	20-30
Rolling phase	11	7.5	19.5	13	17	12	12	8	13	7	14	6	....	....	1.5-2.7	9-18	30 percent in crops	20-30
Undulating phase	11.5	8	22	15.5	19	13	13	9	14	9	15	6	....	....	1.5-3	10-20	75 percent in crops	20-30

[1]Information for sorgo and grain sorgum was insufficient to report other than a range of yields.
[2]Estimate refers to land not irrigated.

considerations other than productivity that influence the general suitability of a soil for agricultural use. In turn, steepness of slope, presence or absence of stone, resistance to tillage offered by the soil because of its consistence or structure, and the size and shape of areas are characteristics of soils that affect the relative ease with which they can be tilled. Likewise, inherent fertility and susceptibility to erosion are characteristics that influence ease of maintaining soil productivity at a given level. Productivity, as measured by yields, is influenced to some degree by all these and other factors, as moisture-holding capacity and permeability to roots and water, and so they are not factors to be considered entirely separate from productivity. On the other hand, schemes of land classification to designate the relative suitability of land for agricultural use must give some recognition to such factors.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on the parent material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The Akron area lies near the western edge of the Great Plains region. It is in a transition belt between the Brown and the Chestnut soil zones. The most extensive have profiles common to the Brown soils, but soils in many of the lower flats or depressed situations receive runoff water from higher levels and have the dark-brown or dark grayish-brown surface layers and the fairly deep dark-colored subsoils common to the Chestnut soils. Lime carbonate has been leached to greater depths in the depressions than on the higher ground. In parts of the area, chiefly in the northeastern part, some of the soils of the higher flats have developed these characteristics without the aid of surplus runoff water. This is probably because the precipitation is greater than in the southwestern part.

A large part of the area was formerly mantled with loess, a light-gray or pale grayish-yellow calcareous silt similar to that which covers most of southern Nebraska. This material was later thinned to a certain extent by erosion over considerable stretches, and the thinner original deposits were intermixed more or less with the underlying sandy and gravelly Tertiary materials. The present mantle varies in thickness from a few feet to as much as 20 or more. Extensive deposits of dune sand were accumulated in the northwestern and southeastern parts. Prior to the loessal depositions a large part of the area consisted of a moderately smooth undulating plain formed chiefly of materials of Tertiary age. Most of these materials consisted of granitic pebbles, sands,

and clays washed eastward by streams from the Rocky Mountains and deposited as a sheet or apron on the plains. At present the exposed Tertiary deposits are more or less consolidated and occur along low knolls and ridges of the higher parts of the upland flats, especially in the proximity of Fremont Butte. The uppermost bedrocks include the Ogallala, Brule, and Chadron formations from the surface downward. The Sidney bed, a light-brown to reddish brown loosely indurated sand-gravel layer of the Ogallala, has apparently contributed much of the material from which the Platner soils have developed. Loess mixed to a greater or less extent with Pleistocene sands and gravels has also contributed material to these soils.

The Ash Hollow bed, a light-gray limy shaly sandstone of the Ogallala, is the material on which the shallow Canyon soil is developing. Although the sandy soils of this locality are derived largely from local Tertiary materials, the excessively sandy soils—Valentine, Haxtun, Vona, and dune sand—have been derived largely from more recent sands blown from the northwest, apparently from the river valley or from exposures of the sandy members of the Ogallala.

Assuming that several recent decades have been fairly representative of climatic conditions of the past ages, the soils have developed under an average precipitation of approximately 17 inches and an average annual temperature of about 48° F. Grass is the chief native vegetation, and the character of the stand has been influenced mainly by the climate, degree of slope, and texture and other properties of the parent materials. One outstanding characteristic of a few of the well-drained soils of the broad, smooth upland divides is their hard compacted condition. This is attributed mainly to the general low precipitation of the region and to the consequent low accumulation of organic matter. The relatively high percentage of moderately coarse sand grains and pebbly material intermixed with clay also helps to cause the soil material to become extremely hard and compact when it dries. This condition is most pronounced in the Platner loam but is also quite noticeable in the Weld and Rago soils. Other soils having lighter surface and subsoil textures are not so adversely affected.

Under the prevailing rainfall the carbonates have been leached to a depth of 2 inches to 5 feet. The smooth hard-land soils of the uplands, including the Platner, Weld, Rago, Keith, and Goshen, and the Fort Collins and Greeley of the terraces have been leached to a depth of 10 to 22 inches. The less strongly developed soils, the Colby, Renohill, and Canyon, contain lime at or near the surface or at depths of 8 to 12 inches. Most of the alluvial soils, including members of the Bridgeport, Laurel, Las Animas, and Wann series, contain carbonate of lime at the surface or within a depth of 12 to 15 inches, but the carbonates may be as low as 20 inches in places on the Las Animas. The Haxtun and McKenzie soils have been leached in places to a depth of 2 to 5 feet.

The degree to which the factors of climate and vegetation have acted on the parent soil material is influenced by the relief and drainage conditions under which the soils have developed. Although the differences in elevation are not great, some of the soils,

TABLE 7.—*Estimated productivity ratings of the soils of the Akron area, Colorado*

[Indexes in columns A refer to estimated average yields of the better years; in columns B to estimated yields for all years. These indexes indicate the approximate average production of each crop in percentage of a standard of reference. This standard represents the approximate average yield obtained without the use of amendments on the more extensive and better soil types of those regions of the United States in which the crop is most widely grown. Indexes are based on estimates of yields, as specific yield data are very limited.]

Soil[2]	Crop productivity index for—																	Remarks
	Wheat (100= 25 bu.)		Oats (100= 50 bu.)		Barley (100= 40 bu.)		Corn (100= 50 bu.)		Proso (millet) (100= 20 bu.)		Beans (pints) (100= 25 bu.)		Sugar beets (100= 12 tons)	Alfalfa (100= 4 tons)	Sorgo[3] (100= 4 tons)	Grain sorghums[3] (100= 40 bu.)	Grazing[3] (100=100 cow-acre-days)[4]	
	A	B	A	B	A	B	A	B	A	B	A	B	B	B				
VERY HIGH GENERAL PRODUCTIVITY[1]—WEIGHTED AVERAGE OF INDEXES ABOVE 90																		
Fort Collins clay loam	..	112	..	110	..	130	..	94	..	..	..	..	125	100	.....	.....	.....	These soils constitute the irrigated land along the South Platte River in northwestern Washington County.
Fort Collins loam	..	104	..	104	..	120	..	100	..	..	..	..	120	100	.....	.....	.....	
Wann clay loam	..	104	..	88	..	100	..	80	..	..	..	..	117	87	.....	.....	9–14[5]	
MODERATELY HIGH GENERAL PRODUCTIVITY[1]—WEIGHTED AVERAGE OF INDEXES 60–75																		
Las Animas loamy sand	..	80	..	64	..	75	..	74	..	..	..	..	...	...	.....	.....	.....	The Las Animas soil is irrigated; the Keith soils are agriculturally very important in the High Plains of eastern Colorado and western Kansas and Nebraska, because of both their extent and high general productivity under dry-land farming conditions.
Keith very fine sandy loam	68	48	54	38	57	40	32	22	75	45	56	28	...	...	50–87	30–60	.....	
Keith silt loam	68	48	54	38	57	40	31	21	80	50	56	28	...	...	50–87	30–60	.....	
MEDIUM GENERAL PRODUCTIVITY[1]—WEIGHTED AVERAGE OF INDEXES 40–59																		
Bridgeport silt loam	62	44	50	35	55	39	32	22	75	45	56	28	...	...	50–87	28–55	7– 9	
Bridgeport fine sandy loam	58	40	46	32	55	39	34	24	75	45	56	28	...	...	50–87	30–60	7– 9	
Bridgeport silty clay loam	60	42	48	34	52	36	29	20	75	45	52	24	...	...	37–75	25–50	7– 9	
Sloping phase	60	40	48	34	52	35	28	20	75	45	48	24	...	...	37–75	25–50	7– 9	
Goshen loam	56	40	48	34	52	37	30	22	75	45	44	20	...	...	50–75	30–60	7–11	
Goshen clay loam	56	40	48	34	52	37	30	21	75	45	44	20	...	...	37–62	25–55	7–11	
Rago very fine sandy loam	56	40	48	34	52	37	28	20	70	45	60	28	...	...	37–75	25–50	6– 9	
Rago silt loam	56	40	48	34	52	37	26	18	70	45	60	28	...	...	25–62	20–45	6– 9	
Weld very fine sandy loam	52	36	46	32	50	35	28	20	70	45	60	24	...	...	37–75	25–50	6– 9	
Haxtun fine sandy loam	48	32	42	29	45	31	34	24	70	40	56	28	...	...	50–87	30–60	.....	
Haxtun sandy loam	46	32	42	29	46	32	36	25	60	35	52	24	...	...	50–87	28–55	.....	
Weld silt loam	52	38	46	32	50	35	24	17	70	45	60	28	...	...	25–62	20–45	6– 9	
Goshen sandy loam	50	34	42	29	45	31	31	20	70	40	52	24	...	...	50–75	30–60	7–11	
Greeley sandy loam	50	34	42	28	45	30	36	25	70	40	40	20	...	...	37–62	30–60	6– 9	
Weld silt loam, undulating phase	48	34	44	31	47	32	23	16	65	35	60	24	...	...	25–62	20–45	6– 9	Although only of medium productivity, these soils constitute most of the farming land in the Akron area, and lend themselves to the production of a number of crops that makes for greater diversification and stability in the
Greeley fine sandy loam	52	36	42	28	45	30	28	20	70	40	40	20	...	...	37–62	30–60	7–11	
Colby very fine sandy loam, deep phase	50	34	42	28	47	37	30	20	65	35	52	20	...	...	37–62	25–50	6– 9	
Weld very fine sandy loam, undulating phase	46	32	44	31	47	32	26	18	70	45	60	24	...	...	37–75	25–50	6– 9	
Haxtun loamy sand	44	30	40	28	44	30	32	22	55	30	40	20	...	...	50–75	25–50	7– 9	
Colby silt loam	48	34	40	28	50	35	24	18	60	35	44	20	...	...	37–62	22–45	7– 9	

Renohill clay loam, undulating phase	48	34	44	31	47	32	22	15	..	..	..	..	...	...	25–50	20–40	6– 9	agriculture. Hard lands are better suited to small grains, whereas the sandy loams are relatively well suited to corn and sorghums.
Vona loamy fine sand	46	32	44	31	45	30	28	20	..	..	..	..	...	...	37–62	25–50	6– 9	
Weld very fine sandy loam, rolling phase	44	30	39	26	42	30	24	16	65	35	56	24	...	...	37–67	22–45	6– 9	
Platner fine sandy loam	44	30	42	29	47	32	28	20	65	35	44	20	...	...	31–56	25–50	6– 9	
Weld-Colby silt loams, rolling phases	44	30	38	26	40	30	24	17	60	40	52	20	...	...	25–50	20–40	6– 9	
Platner loam	48	32	40	28	45	30	23	16	65	35	36	16	...	...	25–50	22–45	6– 9	
Vona loamy fine sand, rolling phase	44	30	35	24	40	27	28	18	..	..	..	..	...	...	37–62	20–40	6– 8	
Platner sandy loam	44	30	38	26	42	30	28	20	60	35	40	20	...	...	31–56	20–50	6– 9	
Platner fine sandy loam, undulating phase	42	28	40	28	45	31	27	18	65	35	44	20	...	...	31–56	25–50	6– 9	
Colby very fine sandy loam, rolling phase	44	28	34	20	39	28	23	17	55	30	40	20	...	...	37–62	22–45	6– 9	
Colby silt loam, rolling phase	44	30	36	25	39	28	24	18	55	30	40	20	...	...	37–62	22–45	6– 9	
Platner sandy loam, undulating phase	42	28	35	24	41	29	27	18	60	35	44	20	...	...	31–56	22–45	6– 9	
MODERATELY LOW GENERAL PRODUCTIVITY[1]—WEIGHTED AVERAGE OF INDEXES 25-39																		
Platner loam, undulating phase	44	30	38	26	42	29	22	15	60	40	36	16	...	...	25–50	22–45	6– 9	
Platner-Canyon complex	44	32	38	26	42	30	22	14	55	35	32	16	...	...	25–50	20–40	6– 7	
Renohill clay loam	40	24	35	24	39	27	21	12	..	..	..	..	...	...	25–50	20–40	6– 9	
Platner fine sandy loam, rolling phase	38	26	38	26	41	29	25	17	60	30	..	..	...	...	31–56	22–45	5– 9	These soils are not generally well suited to the production of crops. Shallowness, rolling topography, droughtiness, and heaviness limit their use and productivity for crop production.
Platner loam, rolling phase	40	24	34	20	39	25	21	14	50	30	32	16	...	...	25–50	22–45	5– 9	
Weld silty clay loam	36	24	36	25	39	26	18	11	70	40	48	20	...	...	25–50	20–40	6– 9	
Platner loam, shallow phase	40	24	34	20	37	25	20	14	55	30	32	16	...	...	25–50	20–40	6– 9	
Platner sandy loam, rolling phase	38	26	34	20	37	26	25	17	50	30	..	..	...	...	25–50	20–45	6– 9	
Blakeland loamy sand, level phase	34	24	35	24	35	25	18	12	..	..	..	..	...	...	25–62	22–45	6– 8	
Blakeland loamy sand	32	22	32	22	34	23	18	12	..	..	..	..	...	...	25–62	20–40	6– 7	
Valentine sand, level phase	34	26	32	22	35	25	20	12	..	..	..	..	...	...	25–50	17–37	6– 8	
Valentine sand	34	22	30	20	32	22	16	10	..	..	..	..	...	...	25–50	17–37	6– 7	
LOW GENERAL PRODUCTIVITY[1]—WEIGHTED AVERAGE OF INDEXES 10–24																		
Laurel clay loam	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	9–14	These soils are limited to grazing largely by imperfect and poor drainage conditions.
Las Animas sandy loam	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	7–11	
McKenzie loam	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	9–11	
VERY LOW GENERAL PRODUCTIVITY[1]—WEIGHTED AVERAGE OF INDEXES 0–9																		
Canyon gravelly loam, undulating phase	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	5– 9	Varying widely in characteristics, these soils are of very low productivity for the common crops. They range from sand to clay and in relief from breaks or badlands to riverwash, which is barely above the surface of the South Platte River.
Stoneham gravelly loam	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	6– 7	
Canyon gravelly loam	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	4– 9	
Rough stony land (Travesilla soil material)	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	5– 6	
Badlands	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	3– 6	
Dune sand (stabilized)	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	4– 6	
McKenzie clay	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	2– 9	
Riverwash	..	..	..	..	..	..	..	..	..	..	..	..	...	...	.....	.....	.....	

[1]A simple grouping on the basis of general productivity under the conditions stated for column A.

[2]Soils are listed in the approximate order of their general productivity under prevailing management practices and according to the production of the average better years (column A), except for the irrigated soils. Where no index is given the crop is not commonly grown.

[3]The estimated production of sorgo and grain sorghums and the grazing capacity are given as an estimated range, because of limited information.

[4]The grazing season varies, but it is estimated to be about 170 days. The term "cow-acre-days" is used to express the carrying capacity or grazing value of pasture or range and. It represents the number of days that 1 animal unit can be supported on 1 acre without injury to the range or pasture, or the product of the number of animal units an acre multiplied by the number of days of grazing. The animal unit is a means of measuring the feed requirements of livestock. It is the equivalent of a mature cow, steer, or horse, 5 hogs, or 7 sheep or goats. On semiarid grazing land the ratio is more properly 3 to 5 mature sheep to each cow. For example, a soil that requires 17 acres to provide grazing for 1 cow for a season of 170 days rates 10 cow-acre-days.

[5]Estimate refers to unirrigated land used for grazing.

including certain types of the Renohill, Canyon, Weld, and Colby series, have rolling to rather steep surface features, and the excess runoff water has been unfavorable for accumulation of organic matter or deep weathering. Where erosion, although mild, has also been an important contributing factor, soils are less strongly developed. On the broad upland flats or divides, normal erosion is slight and the soils have attained the maximum development possible under the prevailing climate and native vegetation. The Rago soils, which occur on upland flats, especially on level land around heads of intermittent streams, have strongly developed profiles. They may be classified as Planosols. Following is a description of a profile of Rago silt loam, a soil developed from loess taken about 1,900 feet north of the southwest corner of sec. 1, T. 4 N., R. 51 W.:

1. 0 to 6 inches, grayish-brown to dark grayish-brown massive to slightly platy friable silt loam, slightly compact in place.
2. 6 to 22 inches, brown moderately friable prismatic clay loam, the prisms averaging about ¾-inch in horizontal dimension, and 3 to 5 inches in perpendicular; the lower part of layer slightly lighter in color and texture, with ill-defined prisms.
3. 22 to 26 inches, light-brown or grayish-brown friable massive silt loam, the lower part merging into lighter colored silt.
4. 26 to 48 inches, pale grayish-yellow floury limy silt.

Closely associated with the Rago soils are the Weld, which ordinarily occur at slightly higher levels under good surface drainage. These are less strongly developed Planosols than the Rago, and the subsoil layer is somewhat heavier and not so thick. Following is a description of Weld silt loam taken in a sod pasture 50 feet from the road about 700 feet east of the half line on the south side of sec. 17, T. 4 N., R. 50 W.:

1. 0 to 3½ inches, brown or light-brown friable massive to platy silt loam, containing a rather high percentage of very fine sand.
2. 3½ to 11 inches, brown heavy clay loam with well-defined prismatic breakage, the vertical prisms varying from ½ to 1 inch in diameter and from 2 to 5 inches in length.
3. 11 to 14 inches, light-brown heavy clay having a somewhat blocky structure with ill-defined prismatic breakage.
4. 14 to 22 inches, light-gray heavy highly calcareous silt loam. This is the horizon of maximum lime carbonate accumulation.
5. 22 to 48 inches, pale grayish-yellow loose, floury, limy, very uniform silt loam, the unaltered parent loess. This material extends downward 5 to 20 feet.

Keith silt loam belongs to the Chestnut group of soils. It has a dark grayish-brown friable silt loam surface soil with a massive to fine-crumb structure. The upper subsoil is grayish-brown very friable silt loam with imperfect prismatic structure. This soil is also underlain by calcareous loess, in most places at depths of 20 to 28 inches.

The Colby soils are shallow Brown soils developed from loess. They occupy the rolling land chiefly in the northeastern and southwestern parts of the area. The topmost layer, 1 to 4 inches thick, consists of either light-brown or grayish-brown friable silt loam or very fine sandy loam having a massive to slightly platy structure. The next layer, 4 to 6 inches thick, contains sufficient clay to form the characteristic prismatic structure, which is less pronounced than in the subsoil of the Weld and Rago soils.

This soil is underlain by the same kind of grayish-yellow silt that underlies the Weld, Rago, and Keith soils.

At comparatively lower levels Platner soils of the broad extensive flats of the uplands are derived from Tertiary geologic material intermixed with varying quantities of wind-blown loess. In general, the surface features are not so smooth as those of soils developed entirely from loess, owing to the slight rises and dips and the small depressions with many intermittent lakes over the general landscape where these soils are common. Some of the upland divides, however, are fairly smooth over broad stretches. Platner soils have also developed on gentle to rolling slopes, but the areas are not extensive. Owing to considerable local variation of the surface features on the extensive flats, the soil profile is quite variable in short distances. As a rule the better developed profiles consist of friable brown loam, 6 to 10 inches thick, having a massive, and in places, ill-defined platy structure. When dry the material is hard and compact and breaks into irregular blocks 6 to 10 inches in diameter, with vertical cracks between them. The upper part of the subsoil makes contact with the surface layer abruptly or very imperceptibly, depending on the quantity of silt, clay, and sand in the material. The structure may be either massive or prismatic, and the color varies from light brown to moderately dark brown. This layer is about 15 inches thick and merges downward into light-gray or light-brown limy clay loam of little or no structural development. The unweathered or only slightly modified parent material usually lies at a depth of 25 to 30 inches (see pl. 1). The entire solum contains scattered granitic pebbles and rather coarse sand grains. The principal variations in color, thickness, structural development, and variability of parent material are attributed largely to the variability of the surface features. As mapped, the Platner soils range in character from strongly developed Planosols, with profiles similar to those of Rago, to Brown soils. Typically, they are Planosols.

Other upland soils, mainly of the Goshen and Haxtun series, occupy both narrow and wide depressions that have received considerable runoff water from the adjoining higher upland soils. The Haxtun soils consist largely of sandy colluvial-alluvial Tertiary materials and have dark deep friable surface and subsoil layers; the Goshen soils have a dark deep surface layer and a considerably heavier subsoil, with the exception of some of the narrow colluvial areas that receive runoff from adjoining loessal soils, mainly Weld silt loam and very fine sandy loam. Both the Goshen and Haxtun soils appear to be immaturely developed. The Fort Collins and Renohill soils belong to the Brown soils group but are only fairly well developed. The Greeley, Vona, and Valentine soils owe their lack of textural profile development to their sandy character. The Bridgeport, Laurel, Las Animas, and Wann soils have been developing from recent alluvial and alluvial-colluvial deposits for too short a time to develop much of a textural profile. The McKenzie soils are Solonetz soils of small basins.

Mechanical analyses of samples of certain soils in the Akron area are given in table 8.

TABLE 8.—*Mechanical analyses of samples of certain soils in the Akron area, Colo.*

Soil type and sample number	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	Inches	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
Goshen loam:								
491212	0–7	4.0	8.4	7.8	11.8	20.7	31.8	15.5
491213	7–20	4.0	10.0	7.4	11.0	14.5	31.8	21.3
491214	20–28	1.2	4.6	4.3	7.3	11.7	38.1	32.8
491215	28–38	1.0	3.5	4.1	7.1	13.7	38.3	32.3
491216	38–50	8.1	15.2	16.8	19.8	13.8	13.1	13.2
Weld silty clay loam:								
491242	0–4½	1.4	4.9	4.0	7.2	15.0	51.9	15.6
491243	4½–20	.7	4.3	4.4	7.7	12.8	36.3	33.8
491244	20–30	.6	1.4	1.6	5.6	17.3	49.5	24.0
491245	30–40	2.6	8.8	7.9	14.8	23.5	22.4	20.0
Rago very fine sandy loam:								
491289	0–6	.2	1.0	1.1	8.8	50.1	23.3	15.5
491290	6–20	0	.6	.9	6.5	40.1	24.5	27.4
491291	20–34	0	.3	.4	2.9	43.2	31.8	21.4
491292	34–48	0	.4	.9	9.0	57.4	17.5	14.8
Colby very fine sandy loam, rolling phase:								
4912113	0–5	.3	2.7	3.6	15.8	39.6	22.4	15.6
4912114	5–20	.2	2.0	2.1	9.7	43.8	26.2	16.0
4912115	20–48	0	.8	1.0	6.7	49.8	26.5	15.2
Platner fine sandy loam:								
4912122	0–10	.3	4.3	9.2	22.1	22.5	28.3	13.3
4912123	10–36	0	4.2	8.5	20.3	19.3	25.1	22.6
4912124	36–48	.2	7.6	12.6	28.5	21.8	14.4	14.9

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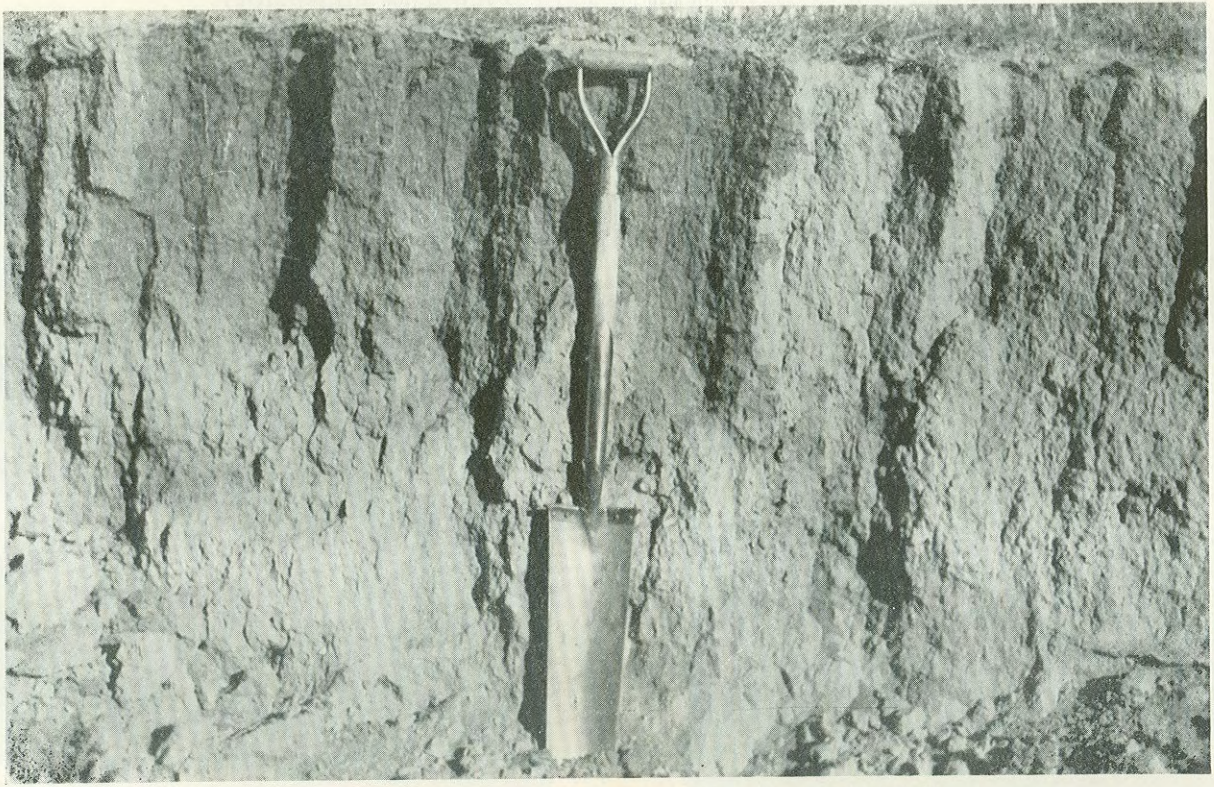

Characteristic profile of Platner loam, a typical hard-land soil.

Characteristic soil profile of (*A*) Weld silt loam and (*B*) Rago silt loam.

A, Grazing scene on sandy lands (Blakeland loamy sand); *B*, typical cornfield on Haxtun fine sandy loam in 1938, a dry crop year.

A, Damming-lister method of conserving runoff on Weld silt loam; *B*, a good average crop of sorgo that is to be expected during dry-cycle years on Platner loam; *C*, typical field of sorgo growing on smooth-upland or hard-land soils.

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS PROVIDE a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) General Nature of the Area, in which location and extent, physiography, relief, drainage, climate, water supply, vegetation, organization and population, transportation and markets, and cultural development and improvement are discussed; (2) Agriculture, in which a brief history and the present status of the agriculture are described; (3) Land Use and Agricultural Methods, in which the present uses of the soils are described, and suggestions made for improvement; and (4) Estimated Yields and Productivity Ratings, in which is presented the productivity of the soils, which are grouped according to their relative physical suitability for agricultural use, and their management requirements are discussed.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Land Use and Agricultural Methods and Estimated Yields and Productivity Ratings.

Students and teachers of soil science and allied subjects—including crop production, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on General Nature of the Area, Agriculture, Land Use and Agricultural Methods, Estimated Yields and Productivity Ratings, and the first part of the section on Soils of particular value in determining the relation between their special subjects and the soils of the area.

This publication on the soil survey of the Akron area, Colo., is a cooperative contribution from the—

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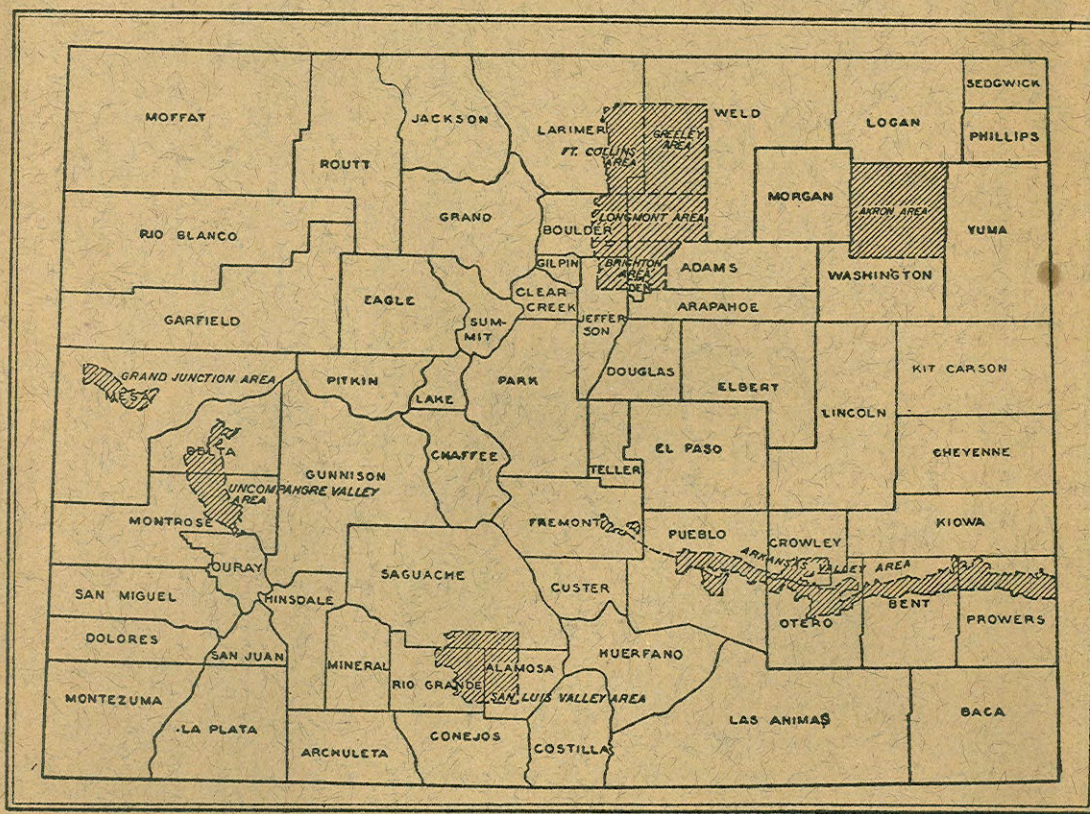

Areas surveyed in Colorado shown by shading.

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