Series 1938, No. 10 Issued November 1946

Soil Survey

Fannin County Texas

By
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United States Department of Agriculture

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

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) farmers and others 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) County Surveyed, in which location and extent; physiography, relief, and drainage; climate; water supply; vegetation; organization and population; industries; transportation and markets; and cultural development and improvement are discussed; (2) Agricultural History and Statistics, in which a brief history and the present status of the agriculture are described; (3) Land Uses and Agricultural Methods, in which the present uses of the soils are described, their management requirements discussed, and suggestions made for improvement; and (4) Productivity Ratings, in which is presented the productivity of the soils.

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. The 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 and Crops 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 Uses and Agricultural Methods and Productivity Ratings.

Students and teachers of soil science and allied subjects—including crop production, forestry, 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 and Crops, 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 County Surveyed, Agricultural History and Statistics, Land Uses and Agricultural Methods, Productivity Ratings, and the first part of the section on Soils and Crops of particular value in determining the relations between their special subjects and the soils of the area. Soil scientists and students of soils will find special interest in the section on Morphology and Genesis of Soils.

This publication on the soil survey of Fannin County, Tex., is a cooperative contribution from the—

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SOIL SURVEY OF FANNIN COUNTY, TEXAS

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

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

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AGRICULTURAL development in Fannin County began with the first white settlement in 1838. Immigration was slow until 1873, when the first railroad was built, after which it proceeded rapidly until about 1900, when practically all the best land was cultivated. At first corn, vegetables, wheat, cotton, and hay were the principal crops. Cattle, hogs, and horses were grazed in unfenced forests and prairies. Cattle ranching and self-sufficient farming gave way to raising cotton, the principal crop, following the construction of railways and the introduction of heavier tillage implements and barbed-wire fencing. Livestock raising also is important. Cotton gins are well distributed throughout the county, and the cotton is shipped to eastern and northern cities or to foreign ports. Most of the other crops are fed to farm livestock. Cream-buying stations and poultry and produce houses are in practically all towns with railroad connections; a cheese factory is in the county; onions and cucumbers are grown for sale; and most of the other garden and fruit crops are consumed within the county. 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 Texas Agricultural Experiment Station. The essential features may be summarized as follows.

SUMMARY

The original vegetation of Fannin County consisted of prairie grasses in the extensive treeless sections and oak trees in the forested upland.

The soils are used very largely for cotton farming. In 1939, cropland harvested represented 48.3 percent of the area of the county and cotton occupied 39 percent of the harvested acreage. The only other crops occupying large proportions of cultivated land are corn and oats. Most of the land not in cultivation is used for pasture. Cotton farming dominates the agriculture because of the favorable climate, the abundance of well-suited soils, and economic conditions. To a small extent livestock, livestock products, fruit, and truck crops are produced for sale.

The prevailing soils in the southern half of the county are Houston Black clay and Hunt clay, which are smooth, highly productive, black crumbly clays, underlain by calcareous marls and chalks, and developed under prairie vegetation. These soils are well suited to and almost entirely used for general field crops. Considerable areas of associated, more sloping, less dark, less productive, crumbly clay soils of the Houston, Austin, and Sumter series are more largely used for pasture.

An east-west belt through the north-central part of the county and a smaller strip in the southeastern part are general areas of Crockett, Wilson, and Bonham soils. These are mostly smooth, moderately acid, and moderately productive soils, developed under prairie vegetation from noncalcareous to moderately calcareous clays. The Wilson soils have dark-gray crusty surface soils of silt loam to clay texture, and subsoils of dark-gray compact noncalcareous heavy clay. The Crockett soils are browner and include a much larger proportion of sloping areas. The Bonham soils are browner and have less compact subsoils than the Wilson. All are in general use for cotton farming,

the smoother areas being almost entirely in cultivation and the sloping areas being largely used for pasture.

The northern part of the county is a general area of smooth to sloping light-colored leached sandy originally forested soils, chiefly of the Susquehanna, Bowie, and Chattahoochee series. Their inherent fertility is low. Cotton farming is carried on, and some truck crops and fruit are produced for sale.

The lower terraces of the Red River in the northern part of the county are taken up chiefly by moderately sandy soils of the Bienville, Teller, and Myatt series. These are darker colored, less thoroughly leached, more fertile, and more productive than the Susquehanna and Bowie soils. Most of this land is cultivated and used for growing cotton and corn.

The flood plains of small streams are occupied principally by Trinity clay and Catalpa clay, which are very productive where adequately drained. The flood plains of the Red River are dominantly areas of Yahola and Miller soils. Except for the more sandy types of the Yahola series, these are highly productive and widely used for corn, cotton, and alfalfa.

The soils of the county are grouped according to their natural capability for agricultural use, and the methods used for obtaining the best results on the soils are outlined.

Estimates of yields and productivity ratings show the relation among the soils in terms of relative productivity for the important crops.

The soils of the Gulf Coastal Plain belong to the Red and Yellow Podzolic group and those in the Blackland Prairie area to the Rendzinas and Planosols.

COUNTY SURVEYED

LOCATION AND EXTENT

Fannin County lies in the northeastern part of Texas (fig. 1). It is the fourth county from the northeastern corner of the State in the northern tier adjacent to Oklahoma. It is about 100 miles west of the Texas-Arkansas line and 500 miles north of the Gulf of Mexico. Bonham, the county seat, is centrally situated and is 65 miles northeast of Dallas, Tex. The county is approximately a parallelogram in shape, with an east-west length of 30.3 miles and an average north-south width of 27.7 miles. The northern boundary is the meandering and continually shifting south bank of the Red River, which also forms the State line; and the other boundaries are artificial. The total area of the county is 889 square miles, or 568,960 acres.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Fannin County is a smoothly dissected undulating upland plain with belts of more deeply dissected strongly sloping country along the larger streams. In addition, there are extensive high flats, or river terraces, in the northern part along the Red River. The southern three-fourths of the county lies within the Blackland Prairie (*2*)[2] of Texas, which is a general area of nearly level, fertile, dark-colored, heavy-textured soils. This prairie, which is one of the most productive agricultural sections of the State, is used almost entirely for cotton farming. Physiographically the prairie is a smooth erosional plain,

[2] Italic numbers in parentheses refer to Literature Cited, p. 109.

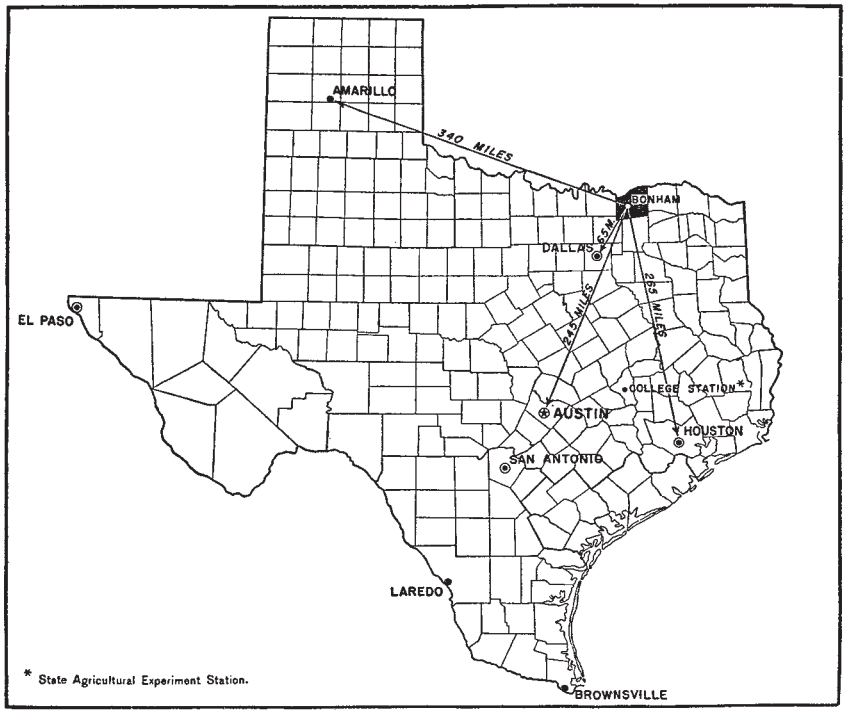

FIGURE 1.—Location of Fannin County in Texas.

most of which is underlain by highly calcareous unconsolidated marine formations. It is generally considered to be part of the interior border of the Gulf Coastal Plain.

The northern one-fourth of the county is a series of flats or river terraces on apparently five distinct levels. The lowest and most northerly of these is the present flood plain of the Red River. The middle three terraces are so recent that little or no regional drainage has developed. They lie from 10 to 100 feet above the level of normal overflow. Although forested with hardwoods in some places, they are said to have been largely treeless prairies originally. These terraces are nearly flat but are generally well drained and have free internal drainage. The highest and most southerly terrace lies about 100 feet above the level of normal overflow and merges almost imperceptibly with the upland plain. This high terrace is very old and is considerably dissected. The central parts—Hawkins, High, and Free Hart Prairies—are flat prairies with a microrelief of low mounds. Water stands on the surface during wet weather. These central poorly drained prairies occupy about one-sixth of the extent of the highest terrace. The rest of the high terrace is undulating to strongly rolling, sandy, forested country and is essentially like the forested main part of the Gulf Coastal Plain, which is known in Texas as the east Texas timber country (*2*). The principal topographic divisions of the county are shown in figure 2.

The prevailing relief is smooth. About 48 percent of the surface is undulating, 22 percent is rolling, 14 percent is a nearly level flood plain, 12 percent is a nearly level upland and river terrace above overflow, and 4 percent is steeply sloping.

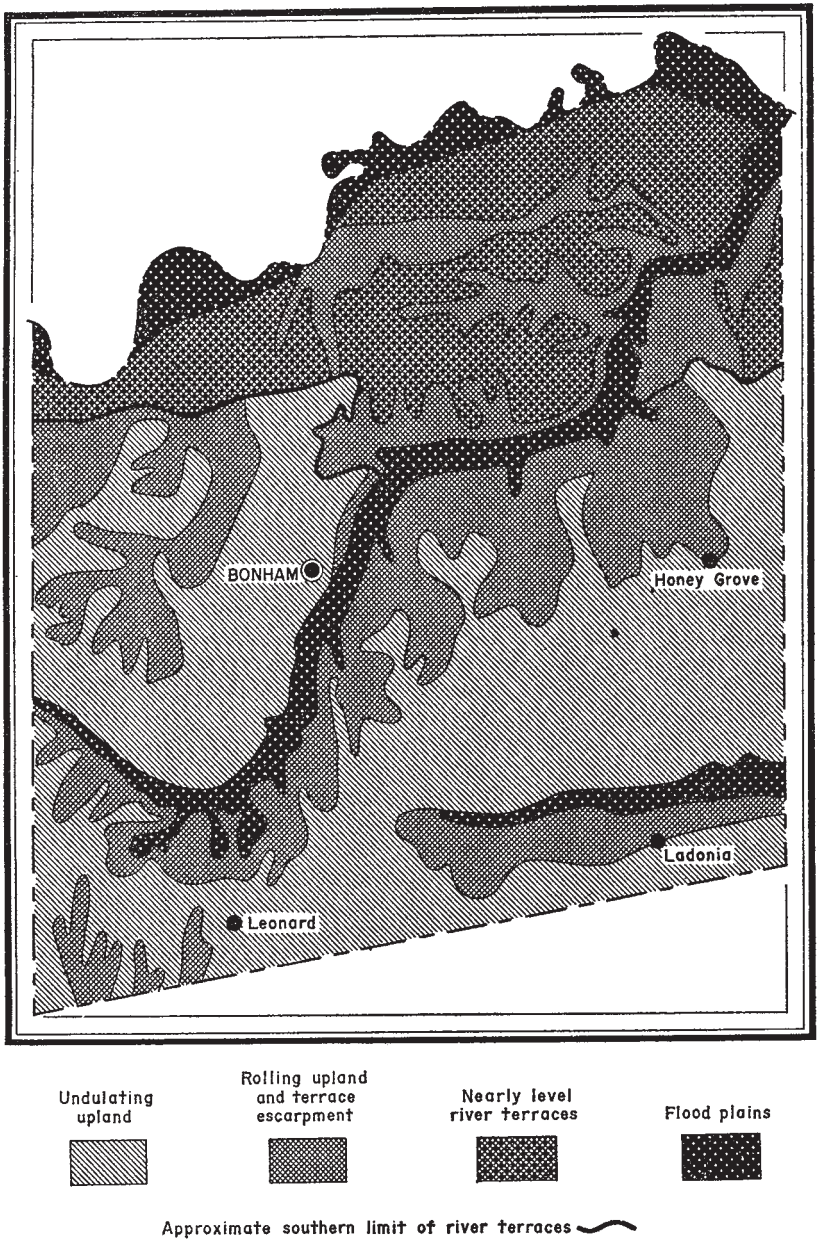

FIGURE 2.—Principal topographic divisions of Fannin County, Tex.

The more strongly sloping surfaces are largely confined to distinct districts, the largest of which is the continuous belt of sloping country extending diagonally across the central part of the county along the southern side of Bois d'Arc Creek. This and the similar belt along the North Sulphur River are the southern sides of the unbalanced drainage basins of the two principal eastward-flowing streams in the county. The western part of the belt along Bois d'Arc Creek is a chalk escarpment. The northern part of the rolling district north of Ector and Savoy is the northeastern end of the East Cross Timbers, a rolling forested country underlain by sandstones and a separate physiographic division of the State. The sloping areas in the southwestern part of the county are valley slopes of southward-flowing tributaries of the Trinity River. These streams rise on the very smooth plain in the vicinity of Trenton and become more deeply entrenched southward with the increasing depth of the chalk below the surface. The sloping areas in the northeastern part of the county are dissected margins of high river terraces and include two smaller areas in the vicinities of Sash and Duplex, where the relief is as strong as any in the county.

The upland plain, which embraces the southern three-fourths of the county, includes some nearly level areas that are slowly though adequately drained. The most extensive of these is the flat south of Honey Grove and Windom. This is part of a general belt of very smooth country underlain by chalk that extends from a point near Trenton past Bailey, Gober, and Honey Grove into Lamar County. Other areas of very smooth upland are northwest of Bonham and east of Savoy.

A rather unusual topographic form, locally known as cove, is associated with the chalk escarpment in the belt of sloping country along the south side of Bois d'Arc Creek. These coves are broad, level-floored, rather steep-walled valleys with constricted outlets. Although most of them lie above backwater overflow from Bois d'Arc Creek and along tributaries that drain very small areas, they are greatly expanded lobes of the Bois d'Arc flood plain. They are naturally poorly drained; a permanent water table lies from 5 to 15 feet below the surface; seeps or wet-weather springs occur around the cove margins at the base of the surrounding chalk escarpment; and the streams heading in them originally had no well-defined channels. The largest of these coves are Foster Valley, the valley of Valley Creek, and Sugar Loaf Bottom. These coves are about 5 miles north and northwest of Leonard.

Because of rapid evaporation, drainage is practically always adequate in this county for crop growth in all areas that are not subject to overflow and that have sufficient slope for water to flow. The seepy areas around the margins of coves are the only sloping areas affected by a high water table.

The surface elevations of the county range between 425 and 750 feet above sea level. The regional slope is southeasterly. The divide between Bois d'Arc Creek and the Trinity River at the Grayson County line, about 4 miles northwest of Trenton, is one of the higher points in the county. According to the topographic maps of the Texas Reclamation Department, the elevation on the flood plain of the Red River at the mouth of Bois d'Arc Creek is 425 feet, and on the flood plain of North Sulphur River at the point where the river leaves the county it is 485 feet. Bench marks of the United States Geological

Survey at Ravenna, Ivanhoe, and Michigan Church give altitudes of 599, 608, and 609 feet, respectively (*8*). The elevations of the Texas & Pacific Railway at Honey Grove, Bonham, and Savoy are 666, 568, and 664 feet, respectively.

CLIMATE

The climate (*3*) is warm-temperate, humid, and continental. The average annual temperature is 64° F., and the mean annual precipitation is 38 inches. The county lies well within the more southerly paths of the high- and low-pressure areas that periodically sweep across the United States, and weather changes are pronounced.

The summers are long, with hot days and warm nights; the winters are short, mild, and characterized by brief cold spells, or northers, alternating with short periods of warm, sunshiny days. During the two hottest months, July and August, the average daily maximum temperature is approximately 93° and the average daily minimum 74°. During the two coldest months, December and January, the average daily maximum is approximately 55° and the average daily minimum 36°. Although the maximum recorded temperature, 112°, is no higher than that recorded in the central part of the Corn Belt, the spells of very hot weather occur throughout a longer season with less relief from intervening cool spells. Although freezing weather is not unusual, it is of short duration. The ground is never frozen to a depth greater than 6 inches nor for periods longer than 2 weeks.

The average date of the latest killing frost is March 29, and the average date of the earliest is November 8, giving an average frost-free season of 224 days. Frost has been recorded as late as May 1 and as early as October 9.

The normal distribution of the annual precipitation is relatively uniform though marked by definite periods of higher and lower rainfall. Rainfall is heaviest in April, May, June, and July, slightly heavier than average in October, and lowest from November to February, inclusive. About 69 percent of the total precipitation falls during the frost-free period.

Rainfall varies greatly from year to year, much more than in the principal corn-producing areas of the central United States. For the year, the mean deviation of the annual precipitation from the average is 8.7 inches, or 22 percent—about one and one-third times as variable as at Springfield, Ill., a representative weather station in the Corn Belt. The mean deviation from monthly averages is greatest during July and August, when it is 1.4 inches, or 79 percent—almost twice as variable as at Springfield. It is least during the period from February to June, inclusive, when it is about 40 percent of the monthly averages.

Occasional torrential rains cause much of the severe soil erosion. A fall of 8.8 inches was recorded at Fort Worth as the maximum precipitation during 24 hours in a 34-year period. Light snows fall during the winter but melt within a few days. Hailstorms occasionally occur but are infrequent and generally not extremely destructive. The rate of evaporation is high, about 55 inches annually from a free water surface (*7*).

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation at Bonham, Tex.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Bonham, Fannin County, Tex.*

[Elevation, 566 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1910)	Total for the wettest year (1905)	Average snowfall
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	44.5	84	−3	2.96	0.54	6.43	0.2
January	43.4	82	−5	2.51	.40	2.25	2.0
February	46.4	92	−5	2.35	1.64	2.62	.6
Winter	44.8	92	−5	7.82	2.58	11.30	2.8
March	54.8	96	15	3.09	2.16	6.71	.5
April	62.9	98	24	4.21	2.09	5.62	0
May	70.7	104	32	4.70	1.44	8.61	0
Spring	62.8	104	15	12.00	5.69	20.94	.5
June	79.6	107	49	3.50	.04	1.56	0
July	83.5	111	52	4.10	(1)	13.91	0
August	83.4	112	52	2.39	2.05	.98	0
Summer	82.2	112	49	9.99	2.09	16.45	0
September	77.2	107	34	2.29	1.24	1.14	0
October	65.3	98	19	3.41	.70	6.44	0
November	54.0	88	14	2.22	.42	3.82	.1
Fall	65.5	107	14	7.92	2.36	11.40	.1
Year	63.8	112	−5	37.73	12.72	60.09	3.4

[1] Trace.

The climate is very favorable for growing cotton, probably more so than for any other major commercial crop. The precipitation is more than adequate for excellent yields of cotton, and the long warm to hot summer season is advantageous to the growth of this crop. Cotton yields are more largely affected by cotton pests and diseases and depletion of fertility than by climate. In general, the lowest yields of cotton are made in wet years, when the vegetal growth is rank and insect damage is severe.

The climate is less favorable for corn than for cotton, although corn is nevertheless the most productive feed and grain crop now available for most farms. Average yields are not more than half of those obtained on equally fertile soils in somewhat cooler and more humid regions. Unfavorable climatic factors are rapid evaporation, variable rainfall, and somewhat inadequate rainfall during late June and July, the period when corn approaches maturity.

Winter grains, sorgos, grain sorghums, peanuts, cowpeas, and such hay grasses as Sudan grass, Johnson grass, and Bermuda grass do well in this climate; the northern hay crops, such as red clover, alsike clover, timothy, and redtop, apparently do not thrive. Fall-sown oats winterkill once in about 5 years; winter wheat practically never winterkills. The climate is somewhat too dry for excellent growth of alfalfa except on soils with exceptionally favorable moisture conditions. The climate is favorable for year-round pasture.

WATER SUPPLY

The water supply is especially unsatisfactory in most of the prairie districts except those underlain at relatively shallow depths by chalk. In most of the prairie districts potable and permanent well water is not generally available within depths practicable for use in farm water-supply systems. The farms in those areas use rain water, which is collected in cisterns and surface tanks. Well water is generally obtainable within practicable depths in most of the originally forested districts and on the river terraces.

VEGETATION

Originally, most of Fannin County was prairie, but a hardwood forest covered the most sandy areas, the flood plains, the rolling areas of thin soils over chalk, and a few areas of smooth, heavy blackland. The vegetation of the prairies differed considerably with the soils. On the heavy blackland soils coarse bunchgrasses, especially prairie beardgrass, locally called little bluestem (*Andropogon scoparius* Michx.); bluejoint turkeyfoot, locally called big bluestem (*A. furcatus* Muhl.); and Indian grass (*Sorghastrum nutans* (L.) Nash) were strongly dominant.[3] On the lighter and more acid soils of the prairies the coarser bunchgrasses were associated with a large number of finer grasses and consequently were much less dominant. Native prairie meadows on the heavy blackland soils produce considerably more hay of superior quality than those on the lighter soils of the prairies. Both types of prairie are excellent range land, the blackland being slightly superior.

The areas of light-colored sandy soils were originally occupied by a slow-growing oak forest. Post oak and blackjack oak are the dominant species in the uncleared areas, together with a small proportion of hickory. Southern red oak is numerous in some places on the sandy forested soils with the more friable subsoils. Within the prairies, small areas of thin, chalky soils support low, small trees of Texas red oak (*Quercus texana* Buckl.) and white oak (*Q. breviloba* (Torr.) Sarg.), the latter commonly known as shin oak. The trees are unsuitable for most commercial purposes but are used for firewood, fence posts, and small rough lumber. Fannin County lies 15 miles west of the western limit of native pine; a few shortleaf pines are native in north-central Lamar County on soils similar to those of northeastern Fannin County. The dominant shrubs are hawthorn, French mulberry, and buckbrush, but none are very abundant.

Grasses are scarce in heavily wooded areas on the sandy soils. In open areas where the forest has been partly or wholly cleared some of the most abundant grasses, in addition to the introduced Bermuda grass (*Cynodon dactylon* (L.) Pers.) are broomsedge (*Andropogon virginicus* L.), beardgrass (*A. divergens* (Hack.) Anderss.), purpletop (*Triodia flava* (L.) Smyth), muhly (*Muhlenbergia capillaris* (Lam.) Trin.), dropseed (*Sporobolus clandestinus* (Spreng.) Hitchc.), panicum (*Panicum rhizomatum* Hitchc. and Chase), and three-awn (*Aristida intermedia* Scrib. and Ball and other species). The grasses

[3] Most of the plants for which scientific names are given were identified by V. L. Cory, range botanist, Texas Agricultural Experiment Station.

do not form a dense sod except in unusually well managed pastures. Partridge-pea (*Cassia fasciculata* Michx.) grows rankly in many idle places, and some wild lespedeza and bur-clover are present in most areas.

The flood plains, other than the sandy areas along the Red River, originally were densely forested with Osage-orange (bois d'arc), ash, water oak, willow oak, elm, hackberry, pecan, and lesser numbers of other trees. Considerable rough lumber is cut from the flood-plain forests, and Osage-orange is especially valued for fence posts. The principal forest growth on the sandy flood plains of the Red River was cottonwood, with lowland hardwoods on the areas of heavier textured soils. Pecan trees grew on the flood plains only in the better drained areas.

The rolling areas of thin blackland soils underlain by chalk supported a shrubby growth of Texas red oak, pecan, Osage-orange, hawthorn, redbud, and some shin oak. The rolling areas of crumbly calcareous soils underlain by very heavy marls were prairie. Some nearly level crumbly blackland soils—much of Houston Black clay, flat phase, and Hunt clay, flat phase—supported hardwood thickets of elm, Osage-orange, ash, and some chestnut oak and Texas red oak. These blackland thickets were confined to areas underlain by chalk and generally to those having a water table within the reach of tree roots.

Most of the native vegetation has been removed in preparing the land for cultivation. Practically all areas of prairie have been cultivated at some time; the post oak-blackjack oak forests have been heavily pastured, cut over, and partly cleared; the flood-plain forests have been cleared or selectively cut out, leaving mostly elm, hackberry, and ash; and practically all the blackland thickets have been cleared.

The two common noxious weeds in cultivated fields are Johnson grass and Bermuda grass, both of which are introduced plants and valuable for meadow and pasture but troublesome in cultivated fields. They are widely distributed throughout the county and, though eradicable and not present in well-tilled fields, are a continual hazard. The other common grasses in cultivated fields are Texas millet (*Panicum texanum* Buckl.), locally known as Colorado or hurrah grass, on the blackland soils, and crabgrass on the others. Field bindweed (*Convolvulus arvensis* L.), locally known as possession vine, grows in small areas in the blackland districts. It is an extremely persistent and detrimental pest and reduces considerably the value of farms where it is present. Snailseed (*Cocculus diversifolius* DC.), locally known as sarsaparilla vine, and sand vine or vine milkweed (*Gonolobus laevis* Michx.), locally known as wild sweetpotato vine, are present in some of the blackland fields. These two vines, though difficult to eradicate, do not reduce productivity or farm values nearly so much as the field bindweed.

ORGANIZATION AND POPULATION

The first settlers came to the section now included in Fannin County in 1836. Immigration continued slowly until 1873, when the first railroad, the Texas & Pacific, was built into the county. After 1873 settlement proceeded rapidly until about 1900, when practically all of the best land was in cultivation. Land was first privately owned in 1835. Considerable areas remained as State domain and were eli-

gible for homesteading or purchase at nominal prices until about 1880. When Fannin County was originally created in 1837 out of part of Red River County, it included the vast little-known northwestern frontier of the Texas Republic and extended westward about 400 miles to the Rio Grande. The county was reduced to its present size in 1846.

The early settlers acquired title to the land either by homesteading or in exchange for land scrip—certificates of right to various areas of public domain that were granted to colonizers, soldiers, railroad promotion companies, and others. The public domain was successively owned and granted to individuals by the Republic of Mexico, the Republic of Texas, and the State of Texas, and never was under the supervision of the United States General Land Office. The land was originally surveyed as separate various-sized tracts by the old Spanish system of surveys in which the vara is the unit of measurement. Legal description of land is by metes and bounds in conjunction with description of part of an original survey, which is designated by the name of the original grantee and by an abstract number.

The early settlers were mostly native whites from the older Southeastern States, some of whom brought Negro slaves. The present population is largely native white. The total population of the county, as reported by the decennial census, rose from 25,501 in 1880 to a peak of 51,793 in 1900 and then fell to 41,064 in 1940. The 1940 population consisted of 36,670 native-born whites, 4,332 Negroes, 61 foreign-born whites, and 1 person of other race. Of the total population 6,349 were classed as urban (residents of places of 2,500 or more), 25,557 as rural-farm, and 9,158 as rural-nonfarm (mostly residents of small towns).

The farm population is rather evenly distributed throughout the county. The largest Negro settlement is a few miles west of Ladonia in the Whatley and Bartley Woods school districts, where much of the land is owned by Negroes. The other principal Negro communities are immediately northeast of Liberty School in the north-central part of the county and on two large plantations in the northeastern corner of the county.

The county seat is Bonham, the largest town and the principal farm market for the central part of the county. The populations of incorporated places, as reported by the census of 1940, are as follows: Bonham, 6,349; Honey Grove, 2,456; Ladonia, 1,279; Leonard, 1,331; Trenton, 634; Ector, 457; Dodd City, 308; Windom, 290; Savoy, 298; and Ravenna, 248. Small country villages are numerous, and few farms are more than 5 miles from a store.

INDUSTRIES

Cotton, the principal farm product, is hauled to cotton gins as bulk seed cotton, is ginned, and is commonly sold within a few days to the ginner or other local cotton buyer. Cotton gins are well distributed throughout the county. Most of the cotton produced in the county is eventually shipped by rail to Houston or Galveston for shipment by water to eastern and northern cities or to foreign ports.

Most of the other crops grown are fed to farm livestock. Fort Worth, 130 miles distant and conveniently reached by either rail or highway, is a primary grain and livestock market. A large flour mill

is located in Sherman in Grayson County, 10 miles west of Fannin County. Cream-buying stations and poultry and produce houses are situated in practically all towns with rail connections; a cheese factory is located in Bonham, but there are no creameries in the county. Onions are marketed principally in Trenton, where they are graded, sacked, and shipped in carlots. Practically all the cucumbers commercially grown are sold under contract to a pickle factory in Sherman. Most of the other garden and fruit crops are consumed within the county.

TRANSPORTATION AND MARKETS

The railways and through highways of Fannin County are adequate to serve practically every agricultural need for transportation facilities to outside markets. The farms farthest from railways and highways are in the northeastern corner of the county.

The county is crossed by four railway lines, and good freight service is available in all directions. Most of the farms are less than 10 miles from a railway shipping point, few are more than 15 miles, and none is more than 20 miles. Bonham is 362 miles by rail from Houston, Tex., the nearest deep-water port.

United States Highway No. 82 passes east and west through the central part of the county and affords excellent all-weather highway connections to outside markets, especially to Dallas and Fort Worth; and No. 69 passes through the southwestern part. A hard-surfaced State highway crosses north and south through the central part of the county, and two other all-weather highways cross parts of the southern half. Most of the public roads are graded dirt roads and are maintained by the county in reasonably good condition, although they become impassable to automobiles during extended periods of wet weather, especially in the blackland districts. Most of the country villages are situated either on highways or on main county roads surfaced with gravel or chalk and passable in all weather. The 1940 census reported that 34.1 percent of the farms were on improved dirt roads, 37.2 percent on unimproved dirt roads, and 23.8 percent on hard-surfaced or gravel roads. The rest were on concrete roads, were on other roads, or were not reported. The all-weather roads have been extended somewhat since that time.

CULTURAL DEVELOPMENT AND IMPROVEMENT

Some of the farm homes have modern conveniences. The country schools, churches, and mail service are generally adequate. Many of the farm residences are unpainted frame houses without modern conveniences, but some of the farms have substantial, attractive, well-maintained, and well-equipped homes. In 1940, according to the census, 63.7 percent of the farms had automobiles, 6.1 percent had motortrucks, 8.2 percent had telephones, and 27.1 percent had electricity. Several electric power distribution lines have been constructed within a quarter of a mile of farm dwellings, and electricity is probably available to 47.1 percent of the farms.

AGRICULTURAL HISTORY AND STATISTICS

Agricultural development of Fannin County commenced with the first white settlement in 1838 and proceeded slowly until the construction of the first railroad into the county in 1873. The earliest agriculture consisted of small self-sufficient frontier farms, most of

which were located in the forested areas, where wood and water were available. Cattle ranches soon occupied the prairies, as the luxuriant and nutritious growth of native grasses provided excellent range. Most of the early settlers selected sloping sandy soils for their small fields. Although the sandy prairies were cultivated at an early date, the heavy prairie soils were not generally cropped until after 1870. The available tillage implements were inadequate to cultivate the heavy soils, and fencing material was unavailable on the prairies. The early settlers cultivated small acreages of corn, vegetables, wheat, and cotton and cut some prairie hay. Cattle, hogs, and horses were grazed in the unfenced forest and prairies. A few small plantations, mainly in the valleys, were worked with Negro slaves prior to the Civil War. The principal agricultural products exported were cattle, which were driven to outside markets, and hides, a relatively nonbulky product. Some cotton and wheat were hauled overland or shipped on flatboats down the Red River to Shreveport and other distant points. An early flour mill in Bonham, known as Peed's Mill, is reported to have been at one time the largest in northern Texas.

Agriculture developed rapidly and cattle ranching and self-sufficient farming gave way to cash-crop cotton farming following the construction of railways and the introduction at about the same time of heavier tillage implements and barbed-wire fencing. After 1873 the prairies were rapidly placed in cultivation. More than 200,000 acres of land were first plowed between 1879 and 1899, and by 1900 crops occupied 58 percent of the county area—more than they have since 1928—and relatively little good land remained out of cultivation. Settlement was completed within 30 years after the railroads reached the county. The census reports more farms, a larger farm population, and a larger total county population in 1900 than in any other census year.

After 1900 the total acreage of crops harvested increased slowly, reaching a maximum about 1920. Some eroded fields, however, were abandoned prior to that time. Soon after the cotton boll weevil first reached the county (about 1905) many of the older sandy fields in the forested sections where the weevil was most destructive were retired from cultivation. Some of the sloping old-field pastures in the sandy prairie sections were abandoned at about the same time, but most of the sloping eroded fields in the heavier blackland sections continued to be cropped until about 1920. Since 1920 the acreage of harvested crops has decreased slowly. Practically all the potentially highly productive land is cultivated, however, except the lower flood plain of Bois d'Arc Creek, which needs some protection from floods before it is suitable for cropping.

The census reports 270,107 acres, or 47.4 percent of the area of the county, as cropland harvested in 1939; 315,693 acres in 1929; and 343,778 acres in 1924. Fairly comparable figures for the earlier census, in which this item is not reported directly, may be obtained by totaling the acreages of all crops reported harvested. To the nearest thousand acres, these totals are as follows: 355,000 acres in 1919, 319,000 in 1909, 317,000 in 1899, 180,000 in 1889, and 113,000 in 1879.

Cotton farming has dominated the agriculture of the county since railroad transportation became available. Cotton occupied 50 percent of the total cropland harvested in 1889, about 50 percent in 1899,

1909, and 1919, 67 percent in 1924, 62 percent in 1929, 42 percent in 1934, and 39 percent in 1939. Considerable wheat was grown prior to 1900 and again during the World War I period, but in recent years it has occupied less than 3 percent of the land in crops. An agricultural economic survey of a nearby representative blackland area, Rockwall County, showed that, for the crop year 1922 (*4*), cotton was the source of 94.4 percent of the farm receipts.

Table 2 gives the number of 500-pound bales of cotton ginned annually from 1914 to 1940, inclusive, as reported by the census.

TABLE 2.—*Number of bales of cotton (500-pound equivalents) ginned in Fannin County, Tex., in stated years*

Year	Number of bales	Year	Number of bales
1914	66,608	1928	63,507
1915	49,853	1929	61,873
1916	74,566	1930	59,339
1917	98,938	1931	95,698
1918	61,947	1932	58,073
1919	72,679	1933	58,430
1920	69,162	1934	35,642
1921	29,002	1935	24,379
1922	55,513	1936	54,898
1923	67,654	1937	73,785
1924	77,292	1938	51,203
1925	79,279	1939	53,328
1926	52,681	1940	62,454
1927	37,046		

Since 1929, cotton has become somewhat less dominant, although it is still by far the major source of farm income, and livestock raising has become more important. The general trend of agriculture may be traced from the acreages of principal crops given in table 3.

TABLE 3.—*Acreages of the principal crops and numbers of peach and pecan trees in Fannin County, Tex., in stated years*

Crop	1879	1889	1899	1909	1919	1924	1929	1934	1939
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Cotton	44,813	94,648	156,065	155,898	189,215	230,438	195,349	122,444	104,587
Corn for grain	48,124	60,515	94,589	121,006	81,578	68,717	76,051	83,044	86,850
Oats threshed	9,698	11,714	28,788	14,750	40,438	17,702	13,740	17,199	18,967
Oats cut and fed unthreshed						6,435	9,852	15,568	6,665
Wheat	7,753	4,849	29,700	5,095	22,259	2,757	3,694	7,101	4,364
Sorghums harvested for grain				17	104	125	463	2,072	748
Sorghums for silage, hay, or fodder					[1] 3,479	3,428	3,551	10,528	8,548
Alfalfa			426	1,913	857	805	754	1,699	3,051
All other tame hay	[2] 1,827	[2] 7,019	2,751	7,053	11,861	9,182	4,767	29,085	19,770
Wild hay			2,498	4,073	3,004	1,998	3,304	[3]	3,681
Peanuts		4	6	288	463	451	2,923	5,664	2,543
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Peaches [4]		67,205	86,214	75,528	41,006	33,274	34,626	32,478	30,438
Pecans [4]							9,558		18,254

[1] Forage.
[2] All hay.
[3] Included with other tame hay.
[4] For the years 1890, 1900, 1910, 1920, 1925, 1930, 1935, and 1940, respectively.

The livestock on farms on April 1, 1940, included 23,878 cattle, 4,537 horses, and 8,547 mules over 3 months old; 15,480 swine over 4 months old; and 1,776 sheep over 6 months old.

According to the census, the total value of all crops, livestock, livestock products, and forest products sold or traded in 1939 was $4,300,178. Cotton lint and seed accounted for 66.6 percent of this total value; all crops other than cotton, 13.5 percent; livestock products, 11.2 percent; livestock, 8.5 percent; and forest products, 0.2 percent. The total value of all farm products used by farm households was $783,329.

Of the 4,638 farms in 1939, field crops were the major source of income on 3,738 farms, dairy products on 129, livestock on 87, poultry on 18, fruit and nuts on 17, and on 618 farms the farm products were used by the farm household.

Expenditures of cash or credit for farm operations are relatively few and small, the principal items being for cotton picking and ginning. During 1939, 2,701 farms, or 58.2 percent of the total number, reported the hire of labor. On these the average expenditure was $189.17. Ginning charges generally equal the proceeds from the sale of the cottonseed. Commercial fertilizers are not used on the major field crops, but a few farmers buy small amounts of mixed fertilizers for special fruit and truck crops. Most farmers buy arsenate poisons for control of the cotton leaf worm in years when infestation is early and severe; practically no farmers use poison for the boll weevil; and only a very few use sulfur dusting for the cotton-flea hopper. Most farmers have inadequate capital and commonly borrow money for current living and operating expenses by mortgaging the livestock, implements, and future cotton crop.

Farm laborers, both Negroes and whites, are plentiful and available at low wages. Commonly the farm family performs all the labor other than cotton picking and, to a less extent, cotton chopping. A few farmers keep Negro families on the farm in exchange for a small monthly wage or hire by the day whenever needed and free house rent. Practically no farms are worked exclusively by labor hired for a cash wage.

Normal labor requirements to the acre on average blackland farms are: 30 man-labor and 33 horse-work hours for cotton, exclusive of picking; 25 man-labor and 32 horse-work hours for corn; 15 man-labor and 22 horse-work hours for oats; and 40 man-labor and 50 horse-work hours for sorgo hay without baling (*5*). In the forested sandy region of northeastern Texas, farming conditions are similar to those in the forested sandy areas of northern Fannin County, and the normal labor requirements to the acre are: 76 man-labor and 40 horse-work hours for cotton, including picking; 36 man-labor and 41 horse-work hours for corn; and 12 man-hours and 23 horse-hours for oats (*1*).

The census of 1940 reports 83.5 percent of the approximate total land area of the county in farms. The average size of farm has increased considerably since 1925, as a result of the introduction of improved farm machinery and labor-saving methods of tillage. In 1940, 26.0 percent of the farms included less than 50 acres, 36.7 percent ranged from 50 to 99 acres in size, and 25.4 percent ranged from 100 to 179 acres. Of the remaining 11.9 percent, 17 farms, all of which included 1,000 acres or more, averaged 1,834.1 acres to the farm.

The percentage of tenancy has been above 60 for the last 35 years and has declined somewhat since 1930. The farms rent for a share

of the crops and for 1-year periods. New leases are made soon after the cotton crop is harvested, generally before the first of February. Change of tenants every year or two is common. About two-thirds of the tenant-operated farms rent for one-fourth of the seed cotton and one-third of the feed crops with the tenant bearing all expenses of farm operation; the rest rent for one-half of all crops with the landlord supplying work animals, feed, seed, and implements. On most farms pasture pays no separate rent, as it goes with the farm rent-free. During past periods of high cotton prices some tenants on good blackland farms paid cash bonuses in addition to the crop shares.

Table 4 gives the number, size, and tenure of farms as reported by the census.

TABLE 4.—*Number, size, and tenure of farms in Fannin County, Tex., in stated years*

Year	Number of farms	Average size	Percentage operated by—		
			Owners	Tenants	Managers
		Acres	*Percent*	*Percent*	*Percent*
1880	3,181	116.0	62.8	37.2	
1890	4,762	77.0	45.9	54.1	
1900	7,202	62.4	35.1	64.8	0.1
1910	6,433	74.3	32.6	67.0	.4
1920	6,338	72.7	34.5	65.4	.1
1930	5,894	78.0	28.7	71.1	.2
1935	5,815	84.6	33.5	66.2	.3
1940	4,638	104.4	39.9	59.7	.4

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 are made, and exposures, such as those in road and railroad cuts, are studied. Each excavation exposes a series of layers, or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil and its content of lime and salts are determined by simple tests.[4] The drainage, both internal and external, and other external features, such as the relief, or lay of the land, are taken into consideration, and the interrelation of the soil and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units, the three principal of which are (1)

[4] 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 reaction of the soil. The presence of lime in the soil is detected by the use of a dilute solution of hydrochloric acid.

series, (2) type, and (3) phase. In some places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a small-scale map but must be mapped as (4) a complex. Some areas of land—such as 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 soil profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage conditions, 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. Austin, Houston, Houston Black, and Wilson are names of important soil series in Fannin County.

Within a soil 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, such as sand, loamy sand, sandy loam, silt loam, clay loam, silty clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Wilson clay and Wilson clay loam are soil types within the Wilson series. 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. In comparisons of the type and phases of that type, to avoid the repetition of their complete names, the type is sometimes referred to as the normal phase.

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

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, 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.

The base map upon which the soil map of Fannin County is superimposed was constructed by plane-table traverse, adjusted, preparatory to publication, to geographic positions established by the Texas Reclamation Department and the United States Geological Survey.

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The channel meanders of Bois d'Arc Creek and the North Sulphur River were copied from topographic maps of the Texas Reclamation Department. The continually shifting channel of the Red River is shown as it existed in the summer of 1936. Land surveys were plotted by adjustment of the original field notes and of available ownership maps to existing property lines. Although the accuracy of the delineation of the land surveys is considerably greater than on any other map, and adequate to permit satisfactory location of a farm from its legal description, the location of a few lines may be as much as 200 feet in error, owing to the many errors in the original surveys, including conflicts, vacancies, and erroneous ties and calls. The survey lines were not established by methods sufficiently accurate for adjustment of disputes concerning property lines.

The lay of the land is indicated by a slope classification. Areas with surface slopes normal and characteristic for the particular soils are designated by the soil name without a qualifying relief phase; areas with surface slopes other than normal for the particular soils are indicated as relief phases. For example, the characteristic relief of Houston Black clay is undulating; accordingly, gently sloping areas of that soil are indicated as Houston Black clay, nearly level areas as Houston Black clay, flat phase, and moderately sloping areas as Houston Black clay, slope phase.

Relief classes are set up with reference to possibilities of land use, and their slope limits vary widely, with major differences in environment and soils. The slope classes recognized in Fannin County, however, have much narrower slope limits than the classes in more northern regions of the United States.

Five grades of slope classifications are defined, as follows:

A. Flat, nearly level to level land on which surface drainage is very slow or lacking and on which detrimental erosion is not likely. All types of farm machinery can be used without difficulty. No significant accelerated erosion is evident in cultivated fields, and erosion proceeds less rapidly under native vegetation than does normal soil development.[5] Surface gradients range from 0 to ½ percent.

B. Undulating, gently sloping land on which surface drainage is free but not rapid and on which any accelerated erosion in cultivated fields can be controlled effectively and cheaply without reducing the proportion of the cultivated area used for intertilled crops to less than one-half of the area in cultivation. All types of machinery can be used with ease. Under native vegetation erosion balances soil development, and the soil layers are of normal thickness and development. Fields are slightly to moderately eroded, but erosion is nowhere so severe that the land is unsuitable for crop production. Slopes range from about ½ to 3 percent in the crumbly soils of the prairies, ½ to 2½ percent in the tight soils of the prairies, and ½ to 4 percent in the light-colored sandy soils.

C. Rolling, moderately sloping land characterized by rapid surface drainage and severe erosion in unprotected cultivated fields. Effective erosion control in cultivated fields is possible but rather expensive and involves terracing, contour tilling, and reducing the area used for

[5] Flat upland surfaces in the humid region are occupied in many places by infertile excessively leached soils with bleached eluviated A horizons and cemented or excessively compact B horizons. Such soils, the ultimate result of insufficient erosion to balance soil development, are not common on flat upland surfaces in Fannin County.

intertilled crops to not more than one-half of the area in cultivation. All types of farm machinery can be used, but difficulty is experienced in using the heavier types. Because of the inconvenient shape of fields, especially of those farmed on the contour, much more labor is required in tillage than on undulating land. Virgin rolling land has considerably thinner soil layers than the less sloping land. All cultivated areas are moderately to severely eroded. Surface slopes range from about 3 to 7 percent in the crumbly soils of the prairies, 2½ to 7 percent in tight soils of the prairies, and 4 to 10 percent in the light-colored sandy soils.

D. Steep, strongly sloping land with very rapid surface drainage, and subject to such severe erosion that effective control is not feasible when used for field crops. Ordinary farm machinery can be used, but difficulty is experienced in using the heavier types. Although sufficient water is absorbed by the soil for a grass cover, the growth is less luxuriant than on smoother surfaces. Erosion is sufficiently rapid under native vegetation to prevent the development of soil layers of normal thickness. Surface slopes range from about 7 to 15 percent on the soils of the prairies. A few small steep areas of light-colored sandy forested soils are included within the rolling phases of those soils.

E. Rough broken or extremely gullied land with excessive drainage. Erosion removes the surface soil as fast or almost as fast as it forms, and desirable pasture grasses cannot maintain themselves. Farm machinery cannot be used, and crop production is practically impossible. Such land has little value for pasture or forestry and is nearly worthless for agriculture.

SOILS AND CROPS[6]

Fannin County lies on the northern margin of the Blackland Prairie of Texas and contains extensive areas of smooth-lying dark prairie soils. The natural fertility of these soils ranges from medium to high. A northwestern arm of the main sandy forested area of the Gulf Coastal Plain, which is known in Texas as the east Texas timber country, extends into the northeastern part of the county. The natural fertility of these forested light-colored sandy soils is low or only fair. The bottoms and lower terraces of the Red River form a belt along the northern side of the county, ranging from 2 to 5 miles wide. Except where the material is very sandy, the overflowed bottoms of the Red River are highly productive, and all but the poorly drained soils of the lower terraces are fertile and well suited to many crops. The remaining soils of the county resemble the soils of other counties lying partly within the Blackland Prairie and partly within the east Texas timber country and support a similar agriculture.

[6] In several places the soil map of Fannin County does not match the soil maps of adjoining areas that were previously surveyed. Three of the adjoining areas—Grayson County, the Paris area, and the Cooper area—were surveyed many years ago when soil distribution was shown in less detail and before many of the soil series and types now recognized were established. With few exceptions the soil map of Fannin County matches the soil maps of Collin and Hunt Counties. In a few places the areas shown as Houston clay in Fannin County join areas shown as Sumter clay in Collin County, as Sumter clay is now restricted to thin severely eroded areas. Likewise, areas shown as Hunt clay in Fannin County join areas shown as Houston Black clay in Collin County. The Hunt series was not established until after Collin County was surveyed, and in that area Hunt clay was included with Houston Black clay. Areas along the boundary of Hunt and Fannin Counties that are shown as Austin clay in Hunt County join areas shown as Austin clay, deep phase, in Fannin County. This difference is due to a recent modification in the definition of the Austin series. The soil shown as Austin clay in Hunt County is smoother and somewhat darker than the soil classed as Austin clay in Fannin County.

Thirty soil series and four miscellaneous land types are shown on the soil map of Fannin County. The Austin series includes soils with dark-brown to grayish-brown calcareous granular friable surface soils, about 12 inches thick, that grade through a transitional layer of a lighter brown material into pale-brown or gray highly calcareous friable permeable subsoils, which are no heavier in texture than the surface soil and are underlain, at a depth ranging from 18 to 40 inches, by chalk or chalky marl. Similar soils that have grayish-brown or dark grayish-brown surface soils and are underlain, at a depth of 18 inches or less, by chalk are separated as shallow phases. Areas with less than 5 inches of soil material over chalk are mapped as chalk outcrop. The profile of the Austin soils is characteristically developed in the clay type and in well-drained prairie areas underlain by very highly calcareous, permeable, and not strongly indurated marine formations. The normal relief is rolling. These soils differ from the Houston soils, with which they were formerly included, in that they are less heavy and plastic, have better internal drainage, and have a well-developed granular structure in the surface layers.

The Bienville series includes soils with brown to light-brown acid surface soils, 12 to 18 inches thick, grading into yellowish-brown or yellow acid friable subsoils. The subsoils are slightly heavier in texture than the surface soils and are underlain by noncalcareous sands and sandy clays of alluvial origin. The profile is characteristically developed in types of medium texture. These soils occur in nearly level well-drained positions on stream terraces situated above overflow. The areas originally were mostly prairie.

The Bonham soils are upland prairie soils with dark grayish-brown noncalcareous crumbly somewhat granular surface soils of medium to medium-heavy texture. Below this is a friable upper subsoil layer, ranging from 6 to 15 inches in thickness, of brown or reddish-brown crumbly clay loam or light clay mottled with brownish red. The lower part of the subsoil is mottled brownish-yellow and gray noncalcareous plastic heavy clay containing spots of dull red. The underlying parent material is yellow and light-gray neutral or calcareous clay of marine origin. The normal relief is undulating, and drainage is free. The Bonham soils are closely related to the Crockett soils but have more permeable subsoils.

The Bowie series includes forested light-colored sandy soils with light-brown or pale-yellow acid sandy surface soils. The subsoils have two distinct horizons, namely, a solid-colored upper part, ranging in thickness from 6 to 15 inches, of yellow friable sandy clay loam or sandy clay, and a mottled lower part of slightly heavier but crumbly yellow sandy clay containing red spots. The underlying parent materials are light-gray noncalcareous sandy clays with red and reddish-yellow spots. The normal relief is undulating, and drainage is free. In Fannin County these soils are mostly confined to dissected very old stream terraces.

The Brewer soil has dark-gray to nearly black noncalcareous surface soil, a dark-gray friable noncalcareous clay loam or clay subsoil, and permeable calcareous clay substrata of alluvial origin. The profile is characteristically developed in types of medium to heavy texture. This soil occurs in some of the lower and less rapidly drained positions on low stream terraces.

The Catalpa soils consist of brown or grayish-brown calcareous alluvium transported by water from areas of heavy calcareous prairie soils. Practically no soil profile has developed.

The Chattahoochee series includes forested light-colored acid sandy soils with subsoils of red or yellowish-red sandy clay or sandy clay loam. These soils occupy stream terraces situated many feet above overflow. The normal relief is gently undulating, and drainage is free.

The Choctaw soils are soils of the upland prairies with brown or dark-brown noncalcareous surface soils, light yellowish-brown friable sandy clay upper subsoils, and mottled yellow and red moderately friable noncalcareous lower subsoils. These soils are underlain by sandstone. The normal relief is gently sloping.

The Crockett series includes upland prairie soils with dark grayish-brown to brown noncalcareous surface soils. The upper subsoil layers are compact noncalcareous clay that is brown or reddish-brown strongly mottled with red and some dark gray. Below the reddish-brown upper subsoil layer, which is from 4 to 18 inches thick, is a lower subsoil layer of yellow and gray noncalcareous compact clay. At a depth ranging from 3 to 5 feet below the surface this layer grades into parent material of yellow or gray slightly to moderately calcareous clay or sandy clay. The normal relief is undulating. External drainage is free; internal drainage is slow.

The Ellis soil is a shallow soil with a yellowish-brown noncalcareous crusty surface soil about 12 inches thick. The subsoil consists of olive-yellow heavy clay, which is underlain, at a depth ranging from 18 to 36 inches, by the parent material of olive-yellow and bluish-gray noncalcareous shaly clay. The normal relief is moderately sloping, and the soil has developed under a prairie vegetation.

The Houston series includes dark-colored calcareous plastic but crumbly clay soil of upland sections of the Blackland Prairie. In Houston clay, which is typically developed on rolling surfaces, the surface soil is dark brown and about 12 to 18 inches thick, the subsoil is brown or brownish yellow, and the substratum is yellow marl.

The Houston Black soils are similar to the Houston soil but are darker, deeper, and generally developed on more nearly level land. In Houston Black clay, which is developed on smooth surfaces, the soil is black or very dark gray to a depth of about 36 inches, where it is underlain transitionally by yellow marl or nearly white chalk.

The Hunt series includes upland prairie soils that have thick surface soils of black noncalcareous extremely plastic but crumbly very heavy clay. This material has a hard, coarse granular structure, and at a depth of about 18 inches it grades into black, dark-gray, or yellowish-brown blocky and slightly less crumbly very heavy clay, underlain, at a depth ranging from 30 to 60 inches, by marl or chalk of marine origin. In general the relief is undulating.

The member of the Ivanhoe series is a poorly drained soil of the prairies developed on old stream terraces. The 8- to 12-inch grayish-brown or gray acid crusty surface soil rests on a noncalcareous compact heavy clay subsoil that is brown or gray mottled with reddish brown. At a depth of about 20 inches the subsoil grades into mottled yellow and gray noncalcareous very compact heavy clay. Below a depth of about 42 inches the material is yellow slightly less compact noncalcareous clay of alluvial origin. The normal relief is nearly level or level.

The Irving series includes soils on stream terraces that have dark-gray or gray noncalcareous crusty surface soils and very compact dark-gray noncalcareous heavy clay subsoils, underlain by substrata of calcareous gray clay. The surface is nearly level to level, and drainage is very slow or wanting.

The member of the Kalmia series is a forested light-colored sandy soil on stream terraces, with a yellow friable subsoil underlain by noncalcareous sands of alluvial origin. Generally the surface is nearly level.

The members of the Kaufman series consist of brown to dark-gray noncalcareous stream sediments, commonly of neutral reaction, having practically no developed soil profile, and occurring normally in rather frequently overflowed flood plains of small streams that drain general areas of Wilson and associated noncalcareous soils of the prairies.

The Kirvin soils, which exist in this area only in intimate association with the Nacogdoches soils in the Nacogdoches-Kirvin complex, are light-colored acid soils developed under forest from unconsolidated sandy clay beds. The thin surface soils are light grayish brown and more or less sandy. They grade through yellow or reddish-yellow sandy material into heavy but permeable subsoils of red clay. The underlying parent material is mottled red, gray, and yellow acid clay.

The member of the Miller series consists of red or reddish-brown calcareous soil materials on the flood plains of streams draining areas of "Red Beds" plains. The deeper soil layers are no more sandy than the surface soils. Practically no soil profile has developed.

The Myatt soils have surface soils of sandy or silty materials that are gray to a depth ranging from 3 to 5 inches and light gray below. The subsoils are mottled light-gray and yellow sandy clay loam. The reaction is acid throughout. These soils occupy slightly depressed poorly drained areas on old stream terraces. Some areas originally were wooded; others were prairies.

The Nacogdoches series includes forested red soils of the uplands. The light-red or red mellow somewhat acid surface soils contain iron concretions and grade into deep-red crumbly clay subsoils, which, in turn, grade into glauconitic sands and sandstones of marine origin. The normal relief is undulating or gently rolling, and drainage is free.

The Ochlockonee soil consists of grayish-brown noncalcareous alluvium derived from areas of light-colored forested Coastal Plain soils. Practically no soil profile is developed other than a slight darkening of the topmost 24 inches of soil material.

The Reinach series includes soils of high flood plains of streams draining areas of "Red Beds" plains. They have reddish-brown slightly granular surface soils, about 18 inches thick, underlain by light-red or light reddish-brown calcareous soil materials that are no less sandy than the surface soils.

The Sumter series includes a shallow eroded brownish-yellow to yellow calcareous soil of the prairies underlain by yellow raw marl at a depth of less than 18 inches. The normal relief is steeply sloping, and the areas are severely eroded.

The Susquehanna series includes light-colored acid soils of forested upland areas having compact subsoils of mottled red, yellow, and gray heavy clay, underlain by gray and yellow noncalcareous clays. The normal relief is rolling, and drainage is free or very rapid.

The Sawyer soil is a forested acid siliceous soil with a light-colored surface layer, pale-yellow subsurface layer, and yellow moderately heavy subsoil, underlain, at a depth ranging from 20 to 30 inches, by dense mottled red and gray clay. Noncalcareous unconsolidated beds of clays and sands are the parent materials.

The Teller series includes soils occupying moderately high terraces of streams draining areas of "Red Beds" plains. They have brown or reddish-brown noncalcareous medium-textured surface soils and red noncalcareous friable subsoils resting on substrata of red alluvial sands and silts. The normal relief is gently undulating, and drainage is slow but free.

The member of the Trinity series consists of black to very dark gray calcareous stream sediments derived from calcareous soils of the prairies. Practically no soil profile has developed.

The Wilson series includes soils of the upland prairies with dark-gray noncalcareous crusty surface soils. The subsoils consist of dark-gray very compact noncalcareous heavy clay underlain by gray or yellow calcareous clays of marine origin. The characteristics of the series are best expressed in the clay loam and silt loam types. The sandy loam in some places has slight brown or reddish-brown mottling in the subsoil, but the mottling is so slight that the color of the mass when mixed is gray rather than brown. Typically, the soils have nearly level to gently rolling relief. Surface drainage is generally free but slow, and internal drainage is very slow.

The members of the Yahola series consist of red or reddish-yellow calcareous alluvium transported by streams draining areas of "Red Beds" plains. Below a depth of 18 inches the layers are sandier than above. Overflows occur periodically. Practically no soil profile has developed.

According to the broader relations among their general characteristics, suitability for agriculture, and geographical association, these soils and land types are placed in 12 groups: (1) Crumbly heavy-textured soils of the smooth prairies, (2) crumbly heavy-textured soils of the rolling prairies, (3) shallow crumbly heavy-textured soils of the prairies, (4) compact (tight) noncalcareous soils of the smooth prairies, (5) medium-textured crumbly noncalcareous soils of the smooth upland prairies, (6) noncalcareous soils of the sloping prairies, (7) well-drained light-colored sandy soils of the smooth uplands and stream terraces, (8) light-colored sandy and clay soils of the sloping uplands, (9) well-drained brown or reddish-brown soils of the stream terraces, (10) slowly drained gray and dark-gray soils of the stream terraces, (11) soils of the flood plains, and (12) miscellaneous land types. Most of these groups, which are discussed under separate headings in this section, occupy separate parts of the county, either exclusively or in association with soils of other groups. This general distribution of prevailing soil associations is shown in figure 3.

The general areas shown as crumbly heavy soils of the smooth prairies are occupied by heavy blackland soils of group 1 with only very small proportions of soils of other groups. The areas indicated as crumbly soils of the rolling prairies are general areas of sloping rather eroded blackland soils of group 2 but include many small bodies of steeply sloping or chalky soils of group 3, which are not separated on the sketch map. Groups 4 and 5 are combined in

FIGURE 3.—General soil areas of Fannin County, Tex.

the sketch map as acid soils of the smooth prairies. Groups 9 and 10 are also combined as brown and gray soils of the river terraces. The more northerly two of the four areas of brown and gray soils of river terraces are parts of the relatively low terraces of the Red River that are occupied by a complex association of the soils of the two groups. The two more southerly areas are the undissected level central part of very high old terraces that are occupied exclusively by poorly drained gray soils of the prairies and form group 10. Only the larger areas of bottom land are delineated in this generalized soil map.

Extensive areas of smooth, moderately to highly productive soils are interspersed with considerable areas of soils poorly suited to cropping, but on the whole the county is productive and extensively farmed. The southern three-fourths, the upland prairie, is part of the Blackland Prairie of Texas and includes two general classes of soils: (1) Black, very fertile, limy or neutral, heavy-textured but crumbly clays, and (2) dark-gray or dark grayish-brown, moderately fertile, acid, somewhat droughty clay loam and sandy loam soils with compact subsoils. This section of smooth prairie is interrupted by flood plains—chiefly the broad bottoms of Bois d'Arc Creek and the North Sulphur River and to a less extent the narrow bottoms of many smaller streams. For the most part the flood plains are occupied by black or brown deep, crumbly, limy bottom-land clays. Although overflows are frequent and drainage is required in some areas for successful crop production, the potential productivity of these soils is very high. The section of the soils of the smooth prairies is also interrupted by several moderately to strongly rolling areas. These are occupied by soils that are closely related to those of the smooth upland but that are less productive, shallower, less dark colored, and liable to severe soil washing where cropped without protection. This more rolling land is also used for general cotton farming, but the proportion of land in cultivation is much smaller than on the smooth upland, and a considerable proportion is used for pasture.

The forested upland of the northeastern part of the county covers an area of about 110 square miles, lying mostly between Ivanhoe, Telephone, and Selfs. This is a sandy, high, old dissected terrace of the Red River. The prevailing soils are essentially the same as those of the east Texas timber country (the forested sandy part of the Gulf Coastal Plain in Texas), and the high terrace may be considered as part of that section. In general, the soils have light-colored acid leached sandy surface soils and variously colored subsoils of friable sandy clay or compact heavy clay. The natural fertility is low, and under prevailing management the yields are very poor. The soils respond readily to soil-improvement practices, however, and when manured or fertilized they produce good yields of general field crops and many fruit and truck crops. These light-colored sandy soils, where in cultivation, are used mainly for cotton and corn; small areas are used for growing sweetpotatoes, cowpeas, peanuts, cucumbers, and tree and bush fruits. The smooth areas, those that are not subject to rapid erosion when cropped, total about 53 square miles and are divided about equally into cropped fields, abandoned fields, and uncleared woodland. The sloping areas, or those that have gradients greater than about 4 percent, erode

severely when cropped without protection, are generally unsuited to the production of common field crops, and are divided about equally between abandoned fields and uncleared woodland.

The flood plain of the Red River is infrequently overflowed and in most places is sufficiently well drained for crops to thrive. It is occupied by reddish calcareous soils that range from fine sand to clay, although medium textures dominate. The sands and loamy sands occur close to the river channel or in the interiors of horseshoe bends and are poorly suited or wholly unfit for field crops. The other soils are very fertile and are extensively cropped to corn, cotton, and some alfalfa. The lower river terraces are occupied by nearly level but adequately drained brown sandy loams. They have friable readily permeable subsoils of sandy loam or sandy clay. These soils are fertile and very responsive to good management and are extensively cropped. In addition to the well-drained brown sandy loams, the lower river terraces include considerable areas of gray, poorly drained soils.

About 92 percent of the county is in farms, between 55 and 60 percent is in cultivation, and about 30 percent—largely abandoned fields and uncleared woodland—is utilized as pasture. Between 10 and 15 percent of the area of the county is uncleared woodland, which is of very low value for timber production other than for firewood and fence posts. No large areas of land are idle, and practically all areas of soils well suited to the common field crops are in cultivation. Considerable areas of soils in the lower part of the flood plain of Bois d'Arc Creek have a very high potential productivity but require drainage before they can be cropped successfully.

The present agriculture consists very largely of the production of cotton as a cash crop and of corn, oats, grain sorghums, hay, and garden vegetables in sufficient quantities for subsistence. Cotton normally occupies about one-half of the land in crops and constitutes the source of about three-fourths of the total farm income. Cotton farming is most dominant in the smooth areas of the Blackland Prairie and least dominant in the areas of light-colored sandy soils and the bottoms of the Red River. The rest of the agricultural income is derived from the sale of livestock products and to some extent from special cash crops, such as onions, peanuts, peaches, cucumbers, and sweetpotatoes.

The prevalent cropping system consists of cotton occasionally alternated with a nonleguminous feed crop, mostly corn. As both of these are intertilled crops, they afford little protection from soil washing and destruction of soil organic matter. Barnyard manure is applied to few fields; commercial fertilizers, green manures, or winter cover crops are practically never used. Crop residues are generally plowed under, however, and only small amounts of plant nutrients are removed from the fields by the dominant crop, cotton. In the following pages the soils [7] of Fannin County are described in detail, and their agricultural importance is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

[7] When a soil type is subdivided into phases, that part of the type that bears no phase name is referred to as the normal phase of the type.

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

Soil	Acres	Per-cent	Soil	Acres	Per-cent
Houston Black clay	64,256	11.3	Bowie fine sandy loam, slope phase	9,856	1.7
Houston Black clay, flat phase	11,008	1.9	Nacogdoches-Kirvin complex	1,088	.2
Houston Black clay, shallow phase	9,280	1.6	Teller fine sandy loam, slope phase	2,048	.4
Hunt clay	29,056	5.1	Susquehanna clay	192	(1)
Hunt clay, flat phase	1,152	.2	Bienville very fine sandy loam	4,992	.9
Austin clay, deep phase	2,624	.5	Bienville fine sandy loam	9,920	1.8
Austin clay, smooth phase	4,736	.8	Bienville loamy fine sand	640	.1
Houston clay	36,800	6.5	Teller very fine sandy loam	960	.2
Houston Black clay, slope phase	1,472	.3	Teller fine sandy loam	1,344	.2
Austin clay	20,928	3.7	Reinach silt loam	2,432	.4
Sumter clay	11,392	2.0	Reinach loamy fine sand	384	.1
Austin clay, steep phase	832	.1	Brewer clay loam	3,008	.5
Austin clay, shallow phase	7,360	1.3	Ivanhoe silt loam	18,944	3.3
Wilson clay loam	16,384	2.9	Irving silt loam	3,840	.7
Wilson clay	21,056	3.7	Irving silt loam, mound phase	7,808	1.4
Wilson-Crockett clays	4,928	.9	Irving clay loam	1,984	.3
Wilson silt loam	3,008	.5	Myatt very fine sandy loam	2,624	.5
Crockett clay loam	14,080	2.5	Myatt fine sandy loam	6,528	1.2
Crockett silt loam	10,816	1.9	Trinity clay	26,560	4.7
Crockett very fine sandy loam	9,600	1.7	Catalpa clay	17,600	3.1
Bonham clay loam	16,192	2.9	Catalpa clay, high-bottom phase	14,400	2.5
Bonham silt loam	8,000	1.4	Catalpa clay loam	1,280	.2
Choctaw fine sandy loam	2,368	.4	Kaufman clay loam	5,504	1.0
Crockett clay loam, rolling phase	15,936	2.8	Kaufman clay loam, high-bottom phase	1,664	.3
Crockett clay loam, steep phase	768	.1	Kaufman loam	2,688	.5
Crockett very fine sandy loam, rolling phase	3,520	.6	Kaufman loam, high-bottom phase	448	.1
Wilson-Crockett clays, rolling phases	960	.2	Ochlockonee fine sandy loam	5,824	1.0
Ellis clay	2,944	.5	Yahola clay	1,216	.2
Bonham clay loam, rolling phase	4,224	.7	Yahola clay loam	2,432	.4
Choctaw fine sandy loam, rolling phase	1,280	.2	Yahola very fine sandy loam	4,224	.7
Susquehanna very fine sandy loam	14,848	2.6	Yahola loamy fine sand	2,112	.4
Sawyer fine sandy loam	1,920	.3	Yahola fine sand	2,304	.4
Bowie fine sandy loam	13,056	2.3	Miller clay	3,328	.6
Chattahoochee fine sandy loam	1,984	.3	Rough broken land	1,216	.2
Kalmia loamy fine sand	1,152	.2	Chalk outcrop	960	.2
Susquehanna fine sandy loam, smooth phase	384	.1	Riverwash	192	(1)
Nacogdoches fine sandy loam	640	.1	Gravel pits	64	(1)
Susquehanna fine sandy loam	16,384	2.9	Total	568,960	100.0
Chattahoochee loamy fine sand, rolling phase	9,024	1.6			

[1] Less than 0.1 percent.

CRUMBLY HEAVY-TEXTURED SOILS OF THE SMOOTH PRAIRIES

Crumbly heavy-textured soils of the smooth prairies include those soils of the Houston Black, Hunt, and Austin series that are developed in gently rolling to nearly level areas. The group is best typified by Houston Black clay. All members of this group are dark, very fertile, crumbly clays of highly calcareous or neutral reaction. They have favorable physical characteristics that enable crops to withstand droughts well. Erosion can be controlled effectively on this smooth land without reducing the proportion used for intertilled crops to less than one-half of the area in cultivation, and none of the land is severely eroded. Practically all of the land is in cultivation. Cotton occupies about 50 percent and corn about 30 percent of the cropped acreage. These are the most productive and the most highly valued upland soils in the county. They are well suited to cotton farming and are used chiefly for that purpose.

These soils constitute the most extensive group of soils in the county, as they occupy about one-fifth of the area of the county, mainly in

the southern half. The soils are developed from very highly calcareous heavy materials, chalks, and marls, and their general distribution coincides with the smooth land surfaces within the outcrop belts of such formations. In most areas the original vegetation was a dense growth of tall bunchgrasses—mainly prairie beardgrass (little bluestem), bluejoint turkeyfoot (big bluestem), Indian grass, and long-leaved dropseed grass. Some of the more nearly level and slowly drained areas underlain by chalk support a few trees, mainly elm, Osage-orange (bois d'arc), and hackberry, an undergrowth of shrubs and climbers, and a moderately dense cover of grass. In undisturbed areas the surface of Houston Black clay and Hunt clay is very uneven; that is, it has a microrelief in which slight ridges or humps, about 1 foot high and from 10 to 15 feet apart, alternate with enclosed depressions or hog wallows. Virgin areas of the Austin soils have even surfaces with practically no microrelief.

Tillage of these extremely heavy textured soils requires much power. They are so sticky that the soil material does not shed well from tillage implements. They warm ready for planting somewhat earlier than the lighter textured soils of the prairies. They are very crumbly and do not crust over to interfere with germinating crops. The Austin soils are the most crumbly and earliest. An excellent seedbed is readily obtained on all these soils, but the plowed layer is too loose for good germination until it is firmed by rains. These soils are very productive but respond more slowly to soil improvement practices than the light-colored sandy soils.

Cotton farming is almost the sole use of these soils, and they support a more prosperous agriculture than any other group of upland soils. Corn is a more important feed crop here than on the other soils of the prairies. Although yields of oats and wheat are very good, these soils, except Austin clay, smooth phase, produce relatively higher yields of corn than of small grains. Oats are grown much less extensively than on the somewhat droughty, tighter soils or on the more erodible rolling soils of the prairies. The commercial production of onions in the county is confined to the deeper soils of this group and to associated well-drained heavy bottom-land soils.

Houston Black clay.—This soil, commonly known as smooth, heavy blackland, is a black, deep, limy, crumbly, highly productive clay soil that occurs in smooth, undulating areas of prairie. It is the characteristic soil of the Texas Blackland Prairie and is one of the most extensive soils of the county and State.

The surface soil is black or nearly black calcareous heavy clay, extremely sticky and plastic when wet but very crumbly when slightly moist. The surface soil continues without apparent change to a depth of about 18 inches, where it grades into slightly less crumbly black or very dark gray calcareous heavy clay. At a depth averaging about 48 inches and ranging from 24 to 60 inches, this subsoil grades through a short transitional layer into the parent material of nearly white chalk, pale-yellow chalky marl, or olive-yellow shaly marl. Where the parent material is chalk or chalky marl the material in the transitional layer is gray or grayish brown and very crumbly, and where the parent material is shaly marl it is yellowish brown and very plastic.

The tilled surface layer in a dry condition is a loose mulch of hard, angular, irregular, brittle fragments about one thirty-second of an inch in diameter. In a slightly moist condition it is a crumbly and porous mass of similar though plastic fragments, and in a wet condition it is an extremely plastic and sticky nearly impervious mass. When plowed in a slightly moist condition the soil pulverizes to coarse crumbs; when plowed in a dry or moderately moist condition it turns up as clods, which crumble with the next thorough wetting and drying; the wet soil is so sticky that it cannot be plowed. The soil will not permanently puddle and does not crust hard enough on drying after a heavy rain to prevent the emergence of germinating plants. Large crevices, as wide as 6 inches, form during dry weather and reach down to the underlying chalk or shaly marl. Although the extensive cracking occasionally injures plant roots, it is beneficial insofar as it allows ready penetration of water into the deeper layers. Whenever the soil is sufficiently wet for the crevices to be closed, the movement of moisture and the absorption of rainfall are very slow.

In virgin areas the immediate surface layer when dry is a loose mass of very fine, hard, angular grains. This loose layer is about 1 inch thick and grades into a porous mass of hard, subangular, loosely bound granules ranging from one-eighth to one-fourth of an inch in diameter. At a depth of about 18 inches the coarsely granular layer grades into more compact almost massive material, which is broken at intervals of from 8 inches to 2 feet by crevices. Although the larger roots tend to follow crevices, especially in the deeper layers, plant roots permeate the soil layers.

The thickness of the black layer varies widely and is related to the microrelief. In smooth areas of virgin prairie the black layer ranges in thickness from 6 inches on the microridges to 54 inches in the hog wallows. In places the layer is lacking on the crests of microridges. Cultivation levels the surface and in smooth areas mixes the material within plow depth to a uniform black or very dark gray. The variation in depth of the black layer is less conspicuous in areas underlain by chalk than in those underlain by shaly marl. In the areas underlain by chalk the transitional layer is gray rather than yellowish brown and contrasts less with the black surface. No observable differences in crop growth are associated with the wavelike variations in the thickness of the black layer or with slight differences in the degree of darkness (between areas with black and areas with very dark gray surface soil) in smooth areas.

The average thickness of the black layer varies with the slope of the surface. It is apparently uniform at about 30 inches in uneroded areas within the range of surface gradient from level to about 3 percent, but it decreases rapidly with increase of slope above 3 percent. A surface gradient of about 5 percent corresponds with an average thickness of 5 inches—the limit in virgin areas between Houston Black clay and Houston clay. The relation of thickness to slope has been altered by accelerated erosion resulting from cropping, and most areas with more than a 3-percent slope are now Houston clay.

Typically, the surface gradient ranges from ½ to 3 percent; areas with surface gradients of less than one-half percent are mapped as a flat phase and those with surface gradients of more than 3 percent

as a slope phase. Areas of Houston Black clay underlain by chalk at a depth of 30 inches or less are designated as a shallow phase. Subrounded chert gravel with a maximum diameter of 3 inches is scattered over the surface of areas indicated by the gravel symbol. This gravel is sufficiently abundant to dull tillage implements rapidly, but otherwise it has no significance.

Houston Black clay is the most extensive soil of the county and occupies broad, uniform areas of undulating upland prairie in the southern half. The soil is slightly to moderately subject to erosion when in intertilled crops, but erosion can be controlled effectively and cheaply without radically altering the cropping system. The most sloping areas—those transitional to Houston clay—have been eroded sufficiently to affect productivity, but none of the areas are very severely eroded or gullied. The soil has free but not rapid surface drainage and practically no underdrainage. Many of the areas are not underlain by a permanent water table, and well water is not generally obtainable except in areas underlain by chalk.

Houston Black clay is one of the most productive soils in the county for cotton, small grains, onions, and native prairie meadow, and it is a good soil for corn, grain, sorghums, sorgo, alfalfa, sweetclover, and pasture. About 85 percent of this land is in cultivation; none of it is in abandoned fields. About 50 percent of the acreage in crops is used for growing cotton, 30 percent for corn, and most of the rest for oats, grain sorghums, and sorgo. Small acreages of alfalfa, onions, and wheat are grown. The average acre yields are from 200 to 225 pounds of lint cotton, 20 to 25 bushels of corn, 25 to 35 bushels of oats, 20 to 30 bushels of grain sorghums, 2 to 3 tons of sorgo hay, 2 to 3 tons of alfalfa hay, 12 to 25 bushels of wheat, and 75 to 125 bushels of onions. Yields vary widely with the season but are relatively uniform from field to field. On some of the better farms acre yields of about 225 pounds of lint cotton and 30 to 35 bushels of corn are produced. The maximum yields occasionally obtained in individual fields are about 1½ bales of cotton, 60 bushels of corn, and 90 bushels of oats to the acre.

Houston Black clay, flat phase.—This phase has essentially the same profile and practically the same use and value as normal Houston Black clay. It differs from the normal phase in occupying very smooth, nearly but not absolutely level, slowly drained areas in which the surface gradient is one-half percent or slightly less. Erosion is not active. Chalk underlies most areas at a depth ranging from 30 to 60 inches. The surface soil is black or nearly black crumbly calcareous heavy clay and continues to a depth of about 18 inches, where it grades into slightly less crumbly nearly black or very dark gray calcareous clay. This material continues to a depth ranging from 30 to 50 inches, where it in turn grades through a short transitional layer of gray chalky clay into chalk or, in a few places, marl.

This soil occupies a few large areas, principally in the vicinity of Honey Grove and Windom, within the general belt of very smooth upland a few miles south of and parallel to Bois d'Arc Creek. Parts of the areas originally were prairie; other parts were blackland occupied by thickets of large hardwood trees and a moderately dense ground cover of grass.

The agronomic relations of this soil are very similar to those of normal Houston Black clay. None of the areas, however, are in need of terracing or contour tillage. Drainage, though adequate for cotton and other crops with late planting dates, is slow, and the soil is slightly too wet early in spring for the best growth of corn and small grains. From 85 to 90 percent of this soil is in cultivation. Cotton occupies between 50 and 60 percent of the cropped acreage, corn 30 to 35 percent, and small grains practically none. Average yields are about the same as those on normal Houston Black clay, the yields of cotton possibly averaging slightly higher and the yields of corn and small grains slightly lower.

Houston Black clay, shallow phase.—This phase differs from normal Houston Black clay in having thinner soil layers and in being underlain by chalk at a depth of less than 30 inches. The surface soil is black or nearly black calcareous crumbly heavy clay, in most places 15 or 20 inches thick. It grades into a 4- to 10-inch transitional layer of gray crumbly clay containing chalk fragments, which rests on chalk at a depth ranging from 18 to 30 inches, or, in a few local areas, at a depth less than 18 inches. The soil has the same tilth, structure, and consistence as normal Houston Black clay. A very few fragments or plates of hard chalk are present on the surface in most fields, but they do not interfere with tillage.

Many areas include spots, too small to map separately, in which the soil is noncalcareous, and in a few places within these inclusions the soil is slightly mottled with reddish brown below a depth of 6 inches. In the areas indicated by gravel symbols, gravel composed of subrounded chert fragments is scattered over the surface but not through the soil. Although this gravel dulls tillage implements rapidly, it is not so abundant as to cause any great difficulty in cultivation.

The largest and most numerous bodies of Houston Black clay, shallow phase, lie between Windom and Cotton Center. Many small bodies occur elsewhere. This soil occupies many gentle knolls surrounded by normal Houston Black clay or Hunt clay. It also occupies transitional zones between areas of Houston Black clay or Hunt clay on the one hand and areas of the Austin soils on the other. This undulating land is freely but not rapidly drained. The surface gradient ranges from ½ to 3 percent. In general, bodies of this soil mark the outcrop of unusually hard layers of chalk and occur along an easterly or northeasterly belt. Originally they were mostly prairie, but some were covered with blackland thickets.

This soil is productive for cotton, small grains, and grain sorghums, but it is somewhat more droughty and less productive, especially for corn, than normal Houston Black clay. In fields including both soils the areas of this shallower soil are made evident in dry weather by earlier wilting of foliage and earlier formation in the soil of dry-weather cracks. About 85 percent of this soil is in cultivation. Cotton occupies about 50 percent of the cropped acreage; most of the rest is planted to oats, corn, grain sorghums, and sorgo. The proportionate acreages of corn are smaller and those of small grains and sorghums are larger than on normal Houston Black clay. The acre yields range from 160 to 200 pounds of lint cotton, 25 to 35 bushels of oats, and 12 to 20 bushels of corn.

Hunt clay.—This soil resembles Houston Black clay but differs from it in containing less lime and in being neutral to slightly acid instead of calcareous. The two soils are not generally differentiated by farmers and are known by the same common name—heavy blackland. So far as is now known, the two are practically identical in productivity, value, utilization, and capabilities of land use.

The surface soil of Hunt clay is black noncalcareous neutral or slightly acid very heavy clay. This is extremely plastic and sticky when wet but very crumbly when slightly moist. It continues without apparent change to a depth of about 18 inches, where the material grades into somewhat more compact and less crumbly black or very dark gray noncalcareous clay. At a depth averaging about 42 inches and ranging from 30 to 54 inches, the very dark layer grades through a transitional layer of gray crumbly calcareous clay into chalk or through yellowish-brown calcareous very heavy clay into olive-yellow nearly impervious shaly marl.

Structure, consistence, apparent content of organic matter, distribution of roots, and the relations of thickness of layers to microrelief and the general slope of Hunt clay are the same as those features of Houston Black clay. In areas transitional to Wilson clay the soil is slightly more crusty and slightly less crumbly than is common. Hunt clay is distinguished from Houston Black clay by the absence of sufficient free carbonates in the surface soil to give visible effervescence upon application of dilute hydrochloric acid to compacted specimens; by the presence, in all soil layers, of small black hard nearly round pellets of iron oxide; and by the general presence on the surface of a very few indurated irregular concretions of calcium carbonate. The soil merges through broad transitions with both Houston Black clay and Wilson clay. It is distinguished from the latter by a black instead of a dark-gray color; natural rupture of the surface crust, on drying after rains, into fragments less than 3 inches in diameter; and the absence of a gray siliceous film on the surface of the crust sufficiently thick to be visible in cross section.

Hunt clay is one of the two very extensive smooth blackland soils in the county. It occupies broad, uniform areas of undulating upland prairie in the southern half of the county and generally occurs between areas of Houston Black clay and Wilson clay. The surface gradient ranges from ½ to 3 percent. A few small nearly level areas with the same profile are designated as a flat phase. The typical soil is slightly to moderately subject to erosion when bare or in intertilled crops, but erosion can be controlled effectively at relatively low expense without greatly reducing the proportion of intertilled crops. In representative long-tilled areas the dark-colored surface layer is not significantly thinner than in virgin areas. In most areas with surface slopes greater than 2 percent, however, erosion has thinned the black layer but nowhere has erosion destroyed the usefulness of the soil for crop production. Surface drainage is free but not rapid, and internal drainage is practically nonexistent. Most areas originally were coarse-grass prairies.

Hunt clay is one of the most productive soils of the county for cotton, small grains, onions, and native prairie meadow, and it is a good soil for corn, grain sorghums, sorgo, alfalfa, sweetclover, and pasture. About 85 percent of the land is in cultivation, and none is

in abandoned fields. About 50 percent of the cropped area is used for growing cotton, 30 percent for corn, and the rest mostly for oats, grain sorghums, sorgo, and small acreages of alfalfa, onions, and wheat. The acre yields over a period of years range from 200 to 225 pounds of lint cotton, 20 to 25 bushels of corn, 25 to 35 bushels of oats, 20 to 30 bushels of grain sorghums, 2 to 3 tons of sorgo, 2 to 3 tons of alfalfa, 12 to 25 bushels of wheat, and 75 to 125 bushels of onions. The maximum acre yields occasionally obtained in individual fields in very favorable years are about 1½ bales of cotton, 60 bushels of corn, and 90 bushels of oats.

Hunt clay, flat phase.—This flat phase has essentially the same profile and nearly the same utilization and value as the normal phase. It differs from that soil in occupying smoother, nearly level, slowly drained areas where erosion is not significant. The surface gradient is one-half percent or slightly less.

The surface soil is black or nearly black noncalcareous heavy clay that is plastic and very sticky when wet but very crumbly when slightly moist. It continues without apparent change to a depth of about 18 inches, where it grades into slightly more compact black or very dark gray clay. This material grades into yellow marl at a depth ranging from 30 to 50 inches.

This flat phase of Hunt clay is much less extensive than the corresponding phase of Houston Black clay and occurs as a few isolated areas 10 miles south of Honey Grove, 1 mile east of Gober, and 1 mile east of Savoy. Parts of areas were prairie and other parts supported blackland thickets.

This soil is one of the most productive in the county for cotton and general field crops. Farmers report that drainage is somewhat too slow for the best growth of corn and that wet conditions early in spring frequently reduce the yields of corn below those on normal Hunt clay. About 90 percent of this soil is in cultivation. Cotton occupies between 50 and 60 percent of the cropped acreage, corn 30 to 35 percent, and sorghums, alfalfa, and oats most of the rest. The yields are about the same as on normal Hunt clay, those of cotton possibly averaging slightly higher and those of corn and small grains slightly lower.

Austin clay, undulating phase.—The surface soil is dark-brown or dark grayish-brown calcareous friable granular clay. This dark-colored layer is 12 to 15 inches thick and grades into light-brown very crumbly highly calcareous clay that gradually becomes lighter colored with depth. Below a depth ranging from 18 to 24 inches the material is grayish-brown or light yellowish-brown highly calcareous clay containing chalky particles. At a depth of about 30 to 40 inches this gives way to impure nearly white chalk or pale-yellow chalky marl. In areas that are transitional to Austin clay, undulating shallow phase, the depth to chalk is less than 30 inches but nowhere less than 18 inches. The soil is distinctly less plastic and heavy than the Houston soils and is characterized by a well-developed granular structure to a depth of about 18 inches. The granules are about one-eighth of an inch in diameter, shaped like dried peas, and coated with a film of very dark brown material. A few of the areas underlain by chalk, especially those in and east of Honey Grove, include small spots in which the surface soil is chocolate brown and noncalcareous and has a harder granular structure than elsewhere.

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This soil phase occurs on many small gently sloping areas of upland prairie, mostly as gentle knolls surrounded by Houston Black clay. The gradient of the surface slope ranges from ½ to 3 percent. Surface drainage is free; internal drainage is moderately free, being more rapid than in the Houston soils. The soil has a fine-crumb tilth and does not crust over after rains or crack deeply during dry weather.

This is one of the most productive soils of the county for small grains and is a very good soil for cotton, corn, and other general field crops. It is slightly earlier but apparently slightly less fertile than Houston Black clay. The soil has excellent physical characteristics and is preferred as sites for gardens and orchards in the general areas of heavy blackland soils. About 85 percent of the area is in cultivation, with cotton occupying about 50 percent of the cropped acreage, oats about 20 percent, corn about 10 percent, and small acreages of wheat, grain sorghums, and sorgo most of the rest. The acre yields over a period of years are about 160 to 200 pounds of lint cotton, 25 to 35 bushels of oats, and 18 to 25 bushels of corn.

Austin clay, undulating shallow phase.—This phase, commonly known as chalky or white-rock land, differs from the rolling phase in having smoother relief and in being shallower. The surface soil is dark grayish-brown very granular very crumbly highly calcareous clay. This dark layer is 10 to 12 inches thick and grades through a 2- to 6-inch transitional layer of light grayish-brown or gray very friable highly calcareous clay into white chalk. Characteristically the depth to chalk is from 15 to 18 inches, but here and there the depth to chalk is considerably less, although nowhere less than 5 inches. A few fragments of chalk are present throughout the soil layers, but they are not sufficiently abundant to interfere with cultivation. The surface soil is light grayish brown or brownish gray in small included areas, especially in the more sloping and eroded areas.

Nine included small bodies, with a total area of about 150 acres, are composed of a related but different soil. In these included areas the surface soil is dark reddish-brown noncalcareous crumbly clay, grading, at a depth of about 12 inches, into brownish-red heavy noncalcareous clay, which overlies chalk at a depth of about 18 inches. The principal bodies of this variation include 18 acres about 1 mile east of Snow Hill School, which is about 6 miles south from Bonham; 35 acres half a mile northeast of Hopewell School, which is 3 miles west of Leonard; 15 acres half a mile east of Hopewell School; 35 acres 1 mile northeast of Nobility; and 20 acres 1½ miles northeast of Nobility. These inclusions are used for the same crops as representative areas of the undulating shallow phase, although they are not commonly selected for gardens.

Subrounded chert fragments are scattered over the surface of certain areas that are indicated as gravelly by the use of symbols on the map. Although these fragments quickly dull tillage implements, they are not sufficiently abundant to affect the productivity of the soil.

The undulating shallow phase occupies many small smooth knolls in association with deeper soils throughout the parts of the upland plain that are underlain by chalk. This belt extends from the southwestern part of the county, near Trenton, to Honey Grove and vi-

cinity. The slope of these knolls ranges from 1 to 3 percent. Surface drainage is free, and internal drainage is moderately rapid. The native vegetation was tall bunchgrasses in most areas; some of the areas were wooded with Texas red oak and other hardwood trees.

Oats and wheat do very well and cotton and grain sorghums do fairly well on this soil. As the soil is shallow over chalk bedrock, corn generally suffers from drought and is not generally grown. About three-fourths of this soil is in cultivation, and it is used mainly for cotton and oats, although there are small acreages of wheat, grain sorghums, and sorgo. Because of the slightly higher elevation and better drainage, many of the areas have been selected as sites for farmsteads. Where available on farms consisting mostly of Houston Black clay or Hunt clay, this soil is commonly chosen for farm gardens and home orchards, as it is early, and many garden crops thrive on it. Peach trees in home orchards appear thrifty wherever they have received reasonable care, and they are reported to produce fair yields of well-flavored fruit. The prevailing yields of general field crops over a period of years are from 125 to 175 pounds of lint cotton, 20 to 35 bushels of oats, 12 to 20 bushels of wheat, and 1 to 2 tons of sorgo forage to the acre.

CRUMBLY HEAVY-TEXTURED SOILS OF THE ROLLING PRAIRIES

The group of crumbly heavy-textured soils of the rolling prairies comprises Houston clay; Houston Black clay, slope phase; and Austin clay, rolling phase. These dark moderately fertile calcareous heavy soils are suitable for the production of general field crops but are subject to severe erosion when cropped without protection. As compared with the crumbly heavy soils of the smooth prairies, their productivity is less and their susceptibility to erosion is greater. Owing to their sloping surfaces and susceptibility to erosion, they are incapable of permanently supporting a type of agriculture that is mainly dependent on intertilled crops, such as cotton and corn. The proportionate area used for field crops is considerably smaller in these crumbly heavy-textured soils of the rolling prairies than in the crumbly heavy-textured soils of the smooth prairies. A considerable proportion of the area of these sloping soils is in abandoned fields, now used for pasture; small areas are in native prairie meadow, native prairie pasture, or woodland pasture. The cropland on these rolling soils is used for the production of cotton, together with considerable oats and corn and some grain sorghums, sorgo for hay, and wheat. Where these soils occur on farms including considerable areas of smoother and deeper soils they are very largely in pasture. The areas that consist very largely of these soils are occupied partly by general farms producing milk and livestock for sale, together with some cotton and small grains as cash crops, partly by livestock farms primarily concerned with the grazing of beef cattle, and partly by farms dependent almost solely on the production of cotton.

Houston clay.—This is a dark-brown or brown moderately sloping crumbly clay soil of the upland prairies. It is commonly known as a blackland soil and differs from Houston Black clay in being less dark, less deep, and characteristically more sloping and eroded.

The 6- to 18-inch surface soil is dark-brown or brown calcareous heavy clay that is plastic and extremely sticky when wet but very crumbly when slightly moist or dry. It grades into brownish-yellow slightly less crumbly highly calcareous heavy clay, which, in turn, at a depth ranging from 24 to 36 inches, grades into the parent material of olive-yellow or yellow and bluish-gray nearly impervious very highly calcareous shaly clay. This is a marl of marine origin and contains a few white lumps of segregated calcium carbonate in its upper part.

The cultivated layer of fields when dry is a loose mass of hard angular brittle grains about one thirty-second of an inch in diameter; when slightly moist it is a crumbly and porous mass of similar though plastic grains; and when wet it is extremely plastic and sticky. When plowed in a slightly moist condition the soil pulverizes to coarse crumbs, and when tilled dry or moderately moist it turns up as clods, which naturally crumble with the next thorough wetting and drying. The soil will not permanently puddle, and it does not form a hard crust on drying after heavy rains. The tilth is excellent. Deep cracks form on drying in the same manner and degree as in Houston Black clay.

In the virgin state the dry surface layer, about 1 inch thick, is a loose mass of very fine hard irregular grains and grades into an underlying porous mass of subangular hard granules that range from one-eighth to one-fourth of an inch in diameter and are loosely bound together by plant roots. At a depth of about 18 inches the coarsely granular layer grades into more compact almost massive material that is broken at intervals ranging from 8 to 24 inches by wide cracks.

The thickness of the dark-colored surface layer varies with the microrelief, the prevailing slope, and the degree of accelerated erosion. In the virgin prairie slight ridges alternate with swales or hog wallows running up and down the slope—a microrelief similar to that of Houston Black clay except that the depressions are elongated and not enclosed. The surface soil is brown on the ridges and black in the depressions, and many of the less eroded fields have slopewise streaks of black soil. Some of the areas north of Hilger are noncalcareous in the upper part of the surface soil.

Houston clay occupies moderate slopes in areas of upland prairie originally covered with a dense growth of coarse bunchgrasses. The areas occur mainly in belts of rolling country along the larger streams. The soil occupies many small and large areas and is one of the more extensive soils of the county. Surface drainage is rapid, but internal drainage is practically lacking. The gradient of the surface ranges from 3 to 7 percent. Moderate sheet erosion and some gullying affect all cultivated areas, but few so severely as to unfit them for crop production.

Houston clay is moderately productive for small grains, hay crops, and pasture. Although on account of erodibility it is unsuited to continual use for intertilled crops, it is fairly productive for cotton, corn, and grain sorghums. From one-third to one-half of the area is in cultivation. . Most of the rest is in abandoned-field pastures, and small proportions are Johnson grass meadows, native prairie meadows, native pastures, or idle land. Cotton occupies about two-

fifths of the cultivated acreage, oats about one-fourth, corn about one-sixth, and grain sorghums and sorgo most of the rest. The yields vary widely with management and severity of erosion, but the soil does not respond so well to applications of barnyard manure or commercial fertilizers as the light-colored sandy soils of the county. Johnson grass and Bermuda grass have invaded many fields. According to farmers' reports, yields equaled those on Houston Black clay during the first few years in cultivation but afterwards dropped much more rapidly than on that soil. The prevailing acre yields over a period of years are from 125 to 165 pounds of lint cotton, 20 to 30 bushels of oats, 12 to 25 bushels of corn, and 1 to 2 tons of sorgo hay.

Most of the pastures are unimproved and weedy and do not contain many desirable forage plants. A few of the abandoned-field pastures have been converted, at no great expense, into grazing land of high carrying capacity by sodding with Bermuda or buffalo grass and mowing to control weeds. Bermuda grass, buffalo grass, sweetclover, and bur-clover are some of the nutritious hay and pasture plants that thrive on this soil.

Houston Black clay, slope phase.—This phase resembles the normal phase but differs from it in being rolling and very susceptible to erosion in unprotected fields. The surface soil is black calcareous heavy clay that is very sticky when wet but very crumbly when slightly moist or dry. It ranges from 6 to 18 inches in thickness and grades into dark-gray or yellowish-brown calcareous generally somewhat less crumbly clay. This material gradually becomes less dark with depth, and at a depth ranging from 36 to 54 inches it is underlain by the parent material of pale-yellow chalky marl or nearly white chalk.

The soil occurs on moderate slopes in sections underlain by chalk. The principal areas are south and southeast of Savoy. The uncleared areas are more or less densely wooded with various hardwoods, mainly Osage-orange, elm, and Texas red oak, but grass is abundant beneath the trees.

This phase is less eroded and more productive than Houston clay but has the same general capabilities of land use. Surface drainage is rapid, and internal drainage is very slow. The surface gradient ranges between 3 and 5 percent. Rapid erosion takes place when the land is used continually for intertilled crops. About three-fourths of the soil is in cultivation; the rest is mostly pasture. Cotton occupies about one-half of the cropped acreage; corn and oats, together with small quantities of sorghums and wheat, occupy the rest. The prevailing acre yields are about 180 to 225 pounds of lint cotton, 25 to 35 bushels of oats, and 20 to 25 bushels of corn.

Austin clay, rolling phase.—This phase is locally referred to as brown loam. It is somewhat similar to Houston clay but is more crumbly, more friable, more permeable, and more freely drained internally. The 12-inch surface soil is brown or dark grayish-brown highly calcareous granular clay. It is underlain by grayish-brown or light-brown very highly calcareous very crumbly clay containing chalky particles. This second layer extends to a depth ranging from

18 to 30 inches, where the parent material of grayish-yellow friable chalky clay is reached. The parent material is a marine sediment.

This soil has a fine-crumb tilth and is not crusty. It is less sticky and plastic when wet than Houston clay. The granular structure, which continues to a depth of about 15 inches, is well defined. The granules are moderately hard, are from one-eighth to one-fourth of an inch in diameter, are shaped like dried peas, and are coated with film of a darker brown material. The color of the material from the surface soil is much darker in broken surfaces than when crushed. In fields where much of the surface soil has been removed by erosion the color of the surface soil is brown or grayish brown.

This phase occupies moderately sloping areas, most of which are within the belt of rolling upland along the south side of Bois d'Arc Creek. It is one of the more extensive soils of the county. The native vegetation in most of the area probably consisted of tall prairie grasses. The small areas of virgin soil remaining, all of which are in unrepresentative situations, are wooded with small hardwoods, mainly Texas red oak, Osage-orange, elm, hackberry, shin oak, and redbud. The soil has rapid surface drainage and moderately free underdrainage. It absorbs water somewhat more readily and warms earlier in spring than Houston clay. The surface gradient ranges from 3 to 7 percent. Cultivated areas are moderately eroded and more or less gullied but not so severely as to be unfit for crop production. Many of the fields are infested with Johnson grass or Bermuda grass.

This phase is productive for small grains, hay, and pasture. Although, on account of erodibility, it is not well suited to nearly continual use for intertilled crops, it is productive for cotton, corn, and grain sorghums where it is well managed. Some farmers report that the least eroded and better managed areas return larger yields of corn than the nearly level areas of Houston Black clay. As the soil has freer internal drainage and is earlier than Houston Black clay, it is inherently better suited for gardens and orchards and is a commonly selected site. Peaches thrive sufficiently well for good home orchards, and pecans are native in many areas. Between one-third and one-half of the total area is in cultivation, about one-tenth is brushy native pasture, and most of the rest is abandoned-field pasture. Cotton occupies about two-fifths of the cropland, small grains (mostly oats) about one-third, and corn about one-sixth. Yields differ widely with management and degree of erosion but are about 150 pounds of lint cotton, 20 to 30 bushels of oats, 15 to 25 bushels of corn, and 1 to 2 tons of sorgo hay to the acre.

SHALLOW CRUMBLY HEAVY-TEXTURED SOILS OF THE PRAIRIES

Sumter clay; Austin clay, steep phase; and Austin clay, rolling shallow phase, make up the group of shallow crumbly heavy-textured soils of the prairies. These soils are too shallow, eroded, or erodible to be generally suitable for the production of field crops. All are calcareous crumbly clays, productive when first tilled, but rapid erosion induced by clean tillage causes rapid deterioration in productivity. They are capable, however, of producing very good pasture crops. These soils occur in small areas associated with smoother and deeper soils, and though partly in cultivation they are mostly used for farm pastures.

Sumter clay.—This soil is commonly referred to locally as eroded yellow clay hills. The soil ranges from 4 to 20 inches in thickness and consists of brownish-yellow highly calcareous crumbly clay. This is underlain transitionally by raw parent material that is either olive-yellow and bluish-gray nearly impervious highly calcareous shaly clay or pale-yellow crumbly chalky clay. The parent materials are marine sediments. In some places there is a thin layer of brown or dark-brown crumbly clay on the surface.

Small areas of this soil occur within the more rolling belts of upland prairie, mostly within areas that are underlain by shaly marl. The native vegetation was originally prairie grasses in the areas underlain by shaly marls. Some Texas red oak and elm trees occur where chalky marls lie beneath the surface.

This soil is generally unsuitable for cropping, and in its present condition it is not valuable for pasture. Productive pastures or permanent meadows can be built up, however, by establishing desirable forage plants. A thin weedy stand of Johnson grass or Bermuda grass now covers most areas. Sweetclover thrives well in a few places where it has become established. Less than one-tenth of the area of this soil is in cultivation; the rest consists of abandoned fields that either are used for pasture or lie idle. The few cultivated areas are used chiefly for growing cotton and probably produce average yields of not more than 80 pounds of lint to the acre. One small field was observed in which the fertility had been partly restored by permitting it to lie idle in Johnson grass for several years. According to the farmer's estimate, this field was producing 150 pounds of lint cotton to the acre.

Austin clay, steep phase.—This phase has essentially the same soil profile as the rolling phase, but is more strongly sloping. The surface soil is brown or dark grayish-brown highly calcareous granular very crumbly clay, from 6 to 12 inches thick. It grades into grayish-brown or light-brown highly calcareous crumbly clay, which at a depth ranging from 18 to 24 inches is underlain by the parent material of pale-yellow crumbly chalky clay.

This soil occupies a few very rapidly drained and strongly sloping areas of upland where the surface gradient ranges from 7 to 15 percent. These areas lie within the rolling belt along the south side of Bois d'Arc Creek, south of the Texas & Pacific Railway. Larger areas lie south of Randolph.

Prairie grasses, together with small hardwood trees, mainly Texas red oak, make up the native vegetation. Less than one-fourth of the area is in cultivation; most of the rest consists of abandoned fields that are either idle or are used as pasture or Johnson grass meadow. The cropland is planted mainly to cotton and oats. Although this soil is fairly productive when well managed, its high erodibility makes it best suited for permanent pasture or meadow. Johnson grass, Bermuda grass, bur-clover, sweetclover, and buffalo grass are desirable forage plants that thrive on this soil. The unproductive pastures can be converted into excellent range at relatively low expense. Yields of field crops differ widely with management and with severity of erosion and average about 100 pounds of lint cotton, 20 bushels of oats, and between ½ and 1½ tons of sorgo or Johnson grass hay to the acre.

Austin clay, rolling shallow phase.—This phase is commonly known as white-rock land or chalky hills. It resembles the undulating shallow phase in some features, but differs in occupying slopes and in being generally more eroded and somewhat shallower. The surface color is lighter than in the undulating shallow phase.

The surface soil, to a depth of 6 to 8 inches, is grayish-brown granular highly calcareous clay that is mealy or very crumbly when dry or moist but somewhat sticky when wet. It grades into a 4- to 10-inch layer of gray or light grayish-brown chalky clay, which rests on chalk at a depth ranging from 5 to 18 inches and averaging about 15 inches. In most areas fragments of white chalk are moderately abundant throughout the soil layers and impart to the fields a grayer appearance than the actual soil color. These chalk fragments are not abundant enough to interfere materially with cultivation.

Many small areas of this soil occupy moderate slopes within the general belt of upland that is underlain by chalk and extends east and west through the central part of the county. One of its characteristic positions is on the crests of slopes above parallel strips of the rolling phase. It is one of the more extensive soils of the county.

The native vegetation consists of mixed prairie grasses and small hardwood trees, principally Texas red oak, shin oak, and redbud. These trees make a very slow growth and are of little value other than for firewood. The surface gradient ranges from 3 to 7 percent. A few included bodies, constituting not more than 10 percent of the total area and located mostly in the vicinity of Sugar Loaf Bottom, are more strongly sloping than representative bodies and have a maximum surface gradient of about 15 percent. Moderate erosion has affected all cultivated areas, but no deep gullies other than natural drainageways have formed.

This rolling shallow phase is fairly productive for small grains but does not produce high yields of cotton or corn. Owing to the combination of erodibility and low fertility, this soil is of marginal suitability for general field crops. About one-third of the area is in cultivation, about one-third is in abandoned fields that are idle or used for pasture, and about one-third is uncleared woodland. Oats with a small acreage of wheat occupy about one-half of the cropland; cotton occupies most of the rest. Grain sorghums and sorgo are occasionally grown. The yields differ widely with the degree of erosion and the state of cultivation. Newly cleared fields produce as much as half a bale of cotton or 40 bushels of oats to the acre, but the productivity decreases rapidly with continued cropping. The prevailing acre yields over a period of years are from 15 to 25 bushels of oats, 8 to 15 bushels of wheat, 75 to 100 pounds of lint cotton, and ½ to 1¼ tons of sorgo or Johnson grass hay. Abandoned fields have in some places a very thin cover of Bermuda grass, Johnson grass, and weeds and afford meager pasturage. The abandoned fields can be converted into excellent pastures.

COMPACT (TIGHT) NONCALCAREOUS SOILS OF THE SMOOTH PRAIRIES

The group of compact (tight) noncalcareous soils of the smooth prairies includes the Wilson and Crockett soils that are developed on undulating and nearly level land. These soils are associated in large

areas in the central-western, southeastern, and central-eastern parts of the county. In general their geographical position is well defined, as they occupy the smooth parts of the outcrop belts of clays containing only small quantities of calcium carbonate. The soils of this group are used almost entirely for general cotton farming, for which they are well suited. This is the second most extensive soil group of the county.

These are dark gray to grayish brown, somewhat acid, more or less droughty soils containing only moderate stores of organic matter and available plant nutrients. General field crops return fair to very good yields, but these soils are somewhat less desirable than the crumbly heavy soils of the smooth prairies. Most of them are somewhat difficult to work. They pack and crust on drying and they do not crumble readily except within a limited range of moisture conditions. Erosion is either insignificant or readily controlled in fields used for intertilled crops most of the time. Drainage generally is sufficient for cotton and other crops planted during warm weather, although these soils have practically no underdrainage. These soils are slightly later than the crumbly blackland soils, such as Houston Black clay. They are somewhat too droughty and, in the more nearly level areas, too cold early in spring for good yields of corn. Oats yield almost as much grain as corn, and with greater surety of a fair crop every year. Land use is similar to that of the crumbly heavy soils of the smooth prairies, except that oats occupy a much larger proportion and corn a smaller proportion of the acreage used for feed crops.

Wilson clay loam.—This soil is locally known as mixed land or gray prairie loam, and in some other parts of Texas it is known as rawhide land. It is a tight gray acid soil of the prairies occurring in nearly level to gently rolling areas. It is productive and suited for cotton, small grains, and sorghums. Almost all of it is in cultivation and used for these crops, although it is chiefly used for general cotton farming. It is regarded by farmers as a desirable soil, although it is less productive and somewhat more difficult to work than the crumbly heavy soils of the smooth prairies.

The surface soil is dark-gray moderately acid clay loam or silty clay loam, averaging about 7 inches and ranging from 3 to 12 inches in thickness. This layer grades through a 1- to 2-inch transitional layer into a very compact subsoil of dark-gray or very dark gray tough and dense very heavy clay. Below a depth of 24 inches the subsoil gradually becomes less dark with depth and grades into gray or mottled yellow and gray noncalcareous very compact clay at a depth of about 48 inches. At a depth of 5 or 6 feet this gives way to the parent material of light gray compact noncalcareous clay mottled with dull yellow. In most places the parent material becomes calcareous at a depth of 6 to 8 feet. The upper part of the parent material contains black friable concretions of iron oxide and a few white lumps of calcium carbonate. A very few black shotlike pellets of iron oxide are present in all soil layers.

Here and there in the more sloping positions the lower part of the subsoil is mottled dark gray and yellow below a depth of about 24 inches. In most of the small areas that are surrounded by larger

areas of Bonham clay loam there is a 2- to 6-inch transitional layer of dark-gray crumbly silty clay between the surface soil and the compact subsoil. Saline spots, locally known as slick spots, which are indicated on the soil map by symbols and described at the end of the section on Morphology and Genesis of Soils, are present in a few areas. These spots are nearly worthless for agriculture, and no practical method of treatment is known.

When dry, clods of the surface soil are very hard, but when moist they crumble under light pressure to fine crumbs. Dry clods of the upper subsoil are extremely hard and consist of indistinct subangular aggregates about one-fourth of an inch in diameter that adhere firmly to one another. The material of the other layers is almost massive when in place. The soil is tight and cloddy but is readily worked into a good seedbed when moisture conditions are optimum. It scours from tillage implements. If the soil is not cultivated after heavy rains, a surface crust forms on drying that prevents crops from coming up.

Wilson clay loam is one of the more extensive soils of the county and occupies large areas of smooth upland prairie in the west-central, central-eastern, and southeastern parts. About 78 percent of the area is undulating or gently rolling with a surface gradient ranging from ½ to 2½ percent. Here, surface drainage is slow but free, and cultivated areas erode unless protected. The other 22 percent is nearly level, having a surface gradient of less than one-half percent, and has very slow surface drainage. The nearly level areas occur at Savoy, 6 miles south of Ector, near Randolph, and near Bonham. The subsoil is so nearly impervious that all areas have practically no internal drainage.

This is a somewhat droughty moderately fertile soil of good productivity for cotton, small grains, and grain sorghums. Although corn is one of the major feed crops, the soil is somewhat too cold early in spring and too droughty at time of maturity for good yields except during unusually favorable seasons. So far as possible, the farmers select bottom land and heavier blackland fields for corn. In addition to being too droughty, this soil is probably generally too acid for alfalfa and sweetclover to thrive. About four-fifths of the land is in cultivation. Cotton occupies about one-half of the cropped acreage, oats about one-fifth, corn one-tenth to one-fifth, and small acreages of grain sorghums, wheat, and sorgo make up the rest. Yields are relatively uniform from field to field. From 150 to 170 pounds of lint cotton, 25 to 35 bushels of oats, 10 to 18 bushels of corn, 12 to 20 bushels of wheat, 15 to 20 bushels of grain sorghums, and 1½ to 2 tons of sorgo hay are obtained from an acre over a period of years. Maximum acre yields of about three-fourths of a bale of cotton, 35 bushels of corn, and 60 bushels of oats are occasionally obtained in individual fields. The growth of crops is not so rank as on Houston Black clay and similar soils. Many farmers have excellent gardens on this soil, and some have a few peach and pear trees. Fruit trees are reported to be short-lived and only moderately productive.

Wilson clay.—This soil is a dark-gray, crusty, slightly droughty clay of the smooth upland prairie. It is intermediate in characteristics between the darker and more crumbly heavy blackland (Houston

Black clay and Hunt clay) and the less dark and more loamy mixed land or gray land (Wilson clay loam). The soil has no specific common name and is generally referred to as crusty blackland or grayish blackland. It is also commonly known in other parts of Texas as rawhide land. It is productive for general field crops, and almost all of it is in cultivation and used for general farming. Farmers consider this a desirable soil, although it is somewhat difficult to work and is somewhat less productive, especially for corn, than such crumbly blackland soils as Houston Black clay.

The plowed soil layer of fields is dark-gray moderately acid crusty clay or light clay. Below plow depth the material is very dark gray extremely tough clay, which continues to a depth ranging from 20 to 40 inches. Below this the subsoil gradually becomes less dark, and at a depth of about 4 feet it grades into gray noncalcareous very compact clay, spotted here and there with light brown. This, in turn, grades into mottled light-gray and olive-yellow very compact noncalcareous clay, the parent material, at a depth of about 5 feet. In most places the parent material becomes calcareous at a depth of 6 to 7 feet. A few white lumps of calcium carbonate and friable rust-black concretions of iron oxide occur in the upper part of the parent material. A few black shotlike pellets of iron oxide are present in all soil layers.

When dry the cultivated surface layer is a loose mass of fine crumbs, underlain by a compact faintly laminated plow sole. If the soil is not disturbed after rains, a crust one-fourth to one-half inch thick forms on the surface. This crust has a surface film, one-fiftieth to one-eighth inch thick, consisting of dark-gray crumblike particles embedded in a hard matrix of gray siliceous material. The lower and thicker part of the crust is a friable, porous mass of crumblike particles. The soil is very cloddy if plowed dry, and the clods do not readily pulverize. When the soil becomes very dry, large cracks appear, but they are smaller and less numerous than in Houston Black clay. In the virgin prairie the 1- to 3-inch surface layer is a gray faintly platy silty clay loam or light clay. This grades into an underlying layer, about 15 inches thick, of compact heavy clay that is massive when wet but when dry is broken into very hard irregular large clods faintly cross-checked into angular fragments about one-eighth inch in diameter. The soil material below a depth of 18 inches is even more compact than the overlying material, almost massive in place, and very slowly pervious to water.

Some of the more sloping areas of Wilson clay contain a few small spots or slopewise streaks of a rather crusty variety of Houston clay. In small areas chalk lies from 3 to 4 feet below the surface. Gravel symbols indicate areas in which subrounded chert fragments are so thickly scattered over the surface that tillage implements dull rapidly, although the gravel apparently does not affect crop growth. The western 80 acres—the part that lies west of the public road—of the area in the southwestern corner of the Chambliss survey, about 2 miles north of Savoy, as well as the northwestern 80 acres of the area situated 1.4 miles northwest of the depot in Savoy, are included areas of an undulating, somewhat more droughty, less fertile soil. This inclusion, which is transitional to Ellis clay, has a surface soil of yellowish-brown,

or dark-gray with a yellow hue, very intractable noncalcareous clay. At a depth ranging from 24 to 36 inches this grades into bluish-gray noncalcareous shaly clay.

Wilson clay occupies large areas of smooth upland prairie within the southern three-fourths of the county. Large representative areas occur in the vicinities of Savoy, Orangeville, and Ladonia, and about 3 miles east of Leonard, and northeast of Honey Grove. About 88 percent of the area is undulating to gently rolling with a surface gradient ranging from ½ to 2½ percent. In this part of the area surface drainage is slow but free, and some erosion occurs where the land is cultivated without protection. The land generally has not eroded severely, and nowhere has it become severely gullied or lost most of the surface soil. Erosion can be controlled effectively and relatively inexpensively. The other 12 percent of the area is nearly level and has a surface gradient of less than one-half percent or slightly less. Here, surface drainage is very slow, and erosion is not a problem even when the land is tilled without protection. These nearly level areas are situated on the east of Savoy, 1 mile east of Ector, and in the vicinity of Randolph.

The soil is productive for cotton, small grains, and sorghums, but it is somewhat too slowly drained and too droughty for high yields of corn, and generally it is too acid for lime-loving legumes. Between 85 and 90 percent of the area is in cultivation. Cotton occupies about 50 percent of the cropped acreage, corn about 15 percent, oats about 25 percent, and grain sorghums and sorgo most of the rest. The prevailing acre yields over a period of years are about 160 to 200 pounds of lint cotton, 12 to 20 bushels of corn, 25 to 35 bushels of oats, 12 to 20 bushels of wheat, 15 to 25 bushels of grain sorghums, and 1½ to 2½ tons of sorgo hay.

Wilson-Crockett clays.—This complex consists of an intermingling of small areas, from 5 to 15 feet in diameter, of Wilson clay and Crockett clay.

Wilson clay has a surface soil of dark-gray to nearly black dense noncalcareous clay that grades into gray heavy waxy noncalcareous clay at a depth of about 12 inches.

The surface soil in spots of Crockett clay is dark grayish-brown acid light clay. At a depth of 4 to 6 inches this grades into a subsoil of mottled dark grayish-brown and reddish-brown dense and tough noncalcareous heavy clay. This material gradually becomes less dark and less red with depth, and at a depth of about 30 inches it grades into mottled gray and dull-yellow noncalcareous tough clay. The parent material of yellow calcareous clay lies at a depth ranging from 3 to 6 feet.

The browner parts of the complex (Crockett clay) occupy indistinct microridges. Although typically the subsoil of the browner areas has the same structure and consistence as the subsoil of Wilson clay, in some areas it is only moderately compact and has a coarse angular nutlike structure to a depth of about 18 inches. A very few of the areas are underlain by chalk at a depth ranging from 3 to 5 feet below the surface. The gravel in areas indicated by gravel symbols consists of subrounded chert fragments thinly scattered over the surface. All of these gravelly areas are in the general sections that are underlain by chalk.

This soil combination occurs in small areas of undulating upland prairie in gradational zones between general areas of crumbly heavy smooth-lying prairie soils and the lighter textured soils of the prairies. Representative bodies occur in the vicinities of Ector, Orangeville, Nobility, Leonard, Gober, and about 6 miles south of Honey Grove. The slope ranges from about ½ to 2½ percent. Surface drainage is free but not rapid, and underdrainage is very slow. Slight to moderately serious erosion takes place on land used for intertilled crops without protection. Most of the areas are moderately eroded, but none is so severely eroded or gullied as to be unfit for crop production.

The utilization, productivity, and crop adaptations of this soil combination are approximately the same as for Wilson clay. No appreciable differences in crop growth are observed between the small areas of Wilson clay and of Crockett clay.

Wilson silt loam.—The 8- to 15-inch surface soil is friable slightly to moderately acid silt loam. In fields it is gray in the plowed layer and dark gray below plow depth, but in virgin areas it is dark gray throughout the layer. The surface soil grades into an upper subsoil of dark-gray slightly to moderately acid compact very heavy clay. This layer continues to a depth of 24 to 30 inches, where it gives way to the gray extremely tough and compact noncalcareous clay lower subsoil. The parent material is reached at a depth of 40 to 50 inches. It consists of mottled light-gray and brownish-yellow nearly impervious compact clay, which is noncalcareous in the upper part but calcareous below a depth ranging from 4 to 6 feet.

Clods of the surface soil are hard when dry but crumble readily to fine crumbs when moist. The undisturbed part of the surface soil is porous and faintly granular; the subsoil is only slightly porous, slowly permeable to moisture, and almost massive in place. The soil is somewhat tight and crusty and is not pulverized readily except within a limited range of moisture content.

In some areas the change from the surface soil to the upper subsoil is abrupt and white material coats the crevices in the base of the surface soil. Such areas have a well-developed claypan. Another inclusion is represented by the small areas of Wilson very fine sandy loam in the southeastern part of the county. The areas associated with areas of Bonham soils have a more crumbly upper subsoil than is characteristic.

Wilson silt loam occupies a few scattered nearly level areas in the upland prairie, the largest bodies lying 6 miles northeast of Honey Grove, 5 miles west of Ladonia, around the heads of tributaries of Timber Creek a few miles northwest of Bonham, and 1 mile northeast of Savoy. The surface gradient is one-half percent or less. Drainage, both surface and internal, is slow but adequate for good growth of crops, and water does not stand for extended periods after rains. None of the areas is materially eroded or subject to erosion. Some areas have received deposits of surface soil material washed from adjacent slopes.

This soil is productive for general field crops and comprises the best land on several successful farms. It is almost entirely in cultivation and is used largely for cotton farming. Cotton occupies about one-half of the cropped acreage. Corn and oats are the prin-

cipal feed crops, and small acreages of grain sorghums and sorgo are also grown. The prevailing acre yields over a period of years are about 125 to 160 pounds of lint cotton, 10 to 18 bushels of corn, 20 to 30 bushels of oats, and 1½ to 2 tons of sorgo hay.

Crockett clay loam.—This soil is closely related to Wilson clay loam but differs from it in having a slightly browner surface soil and a much browner subsoil that is spotted with red in the upper part. It is an acid soil of the smooth prairies and is commonly known as mixed land. Farmers consider it a desirable soil especially for cotton and small grains, though less productive than such crumbly heavy soils as Houston Black clay. They report little difference between yields, crop growth, and workability on this soil and Wilson clay loam.

The surface soil ranges from 5 to 12 inches in thickness and consists of dark-brown or dark grayish-brown slightly to moderately acid clay loam or silty clay loam. This grades shortly into a compact upper subsoil, from 4 to 12 inches thick, of brown or reddish-brown noncalcareous dense, tough, very heavy clay, conspicuously mottled with brownish-red spots. These spots have a maximum diameter of one-fourth inch, and their red color becomes less pronounced with depth. At a depth of about 15 inches the upper subsoil material gives way to mottled brownish-yellow and olive-gray noncalcareous dense tough heavy clay, which becomes slightly less dark and more gray with depth. The change from the subsoil to the underlying parent material is gradual. The parent material, which lies at a depth of about 42 inches, consists of gray and yellow shaly clay. It is slightly less compact than the subsoil and contains friable rusty-black concretions of iron oxide in its upper part. It may or may not be calcareous, but even where not calcareous the reaction is slightly alkaline. This soil has about the same structure, consistence, and tilth as Wilson clay loam.

In the more nearly level areas the upper part of the subsoil contains some dark-gray material, and in general the subsoil is slightly less red than is characteristic of the Crockett soils. The amount of red mottling in the subsoil is variable and apparently is associated with slight variations in microrelief. In a few places, especially near saline spots, the surface soil rests abruptly on the subsoil, which is here a fairly distinct claypan.

Crockett clay loam occupies many large and small areas on the undulating upland prairie in the west-central, central-eastern, and southeastern parts of the county. The soil has free but not rapid surface drainage and practically no underdrainage. The surface gradient ranges from 1 to 2½ percent. Erosion is rapid in unprotected fields, but effective control is feasible without greatly reducing the proportion of intertilled crops. None of the areas is badly gullied or so severely eroded as to be unfit for crop production.

This soil is moderately fertile but somewhat droughty. Cotton, small grains, and grain sorghums return fairly good yields. Although corn is grown occasionally, it does not produce well. Cotton farming is the principal use of the soil, and about four-fifths of the area is in cultivation. Cotton occupies about one-half of the cropped acreage, oats about one-fourth, corn slightly less than oats, and grain

sorghum, wheat, and sorgo nearly all the rest. Over a period of years from 125 to 170 pounds of lint cotton, 25 to 30 bushels of oats, 10 to 15 bushels of corn, 12 to 20 bushels of wheat, and 1½ to 2 tons of sorgo hay to the acre are obtained.

Crockett silt loam.—This soil is similar to Crockett clay loam but differs mainly in having a slightly deeper and less heavy surface soil. It is a smoothly undulating tight loam of the prairies with a compact subsoil of reddish-brown heavy clay. It is commonly known as mixed land or gray prairie loam. It is fairly productive for general field crops and is regarded by farmers as desirable though not the best land.

The 12-inch surface soil is composed of grayish-brown or dark grayish-brown acid silt loam. It grades, through a thin transitional zone not more than 3 inches thick, into a compact upper subsoil material of brown, acid, dense, tough heavy clay, spotted with brownish red. The red coloration gradually decreases with depth, and at a depth of 18 to 24 inches the material grades into mottled brownish-yellow and gray noncalcareous very compact clay. The deep subsoil gradually becomes grayer and lighter colored. The change to the underlying parent material is ill-defined but occurs about 3 feet below the surface. The parent material is mottled or streaked light-gray and dull-yellow neutral to mildly alkaline heavy clay that is nearly impervious though slightly less compact than the subsoil. The upper part of the parent material contains numerous friable rusty-black concretions of iron oxide. In most places the parent material is not calcareous to a depth of 12 feet or more. A few hard pellets of iron oxide are present in all soil layers.

The surface soil under slight pressure crumbles to fine crumbs when it is moist, but it crusts and forms a very hard mass if allowed to dry after rains without cultivation. The soil is crumbly and readily worked within a comparatively small range of moisture content. If tilled when even slightly wet it puddles to a gummy mass that later dries to intractable clods, and if tilled when somewhat dry it turns up very cloddy.

The areas of Crockett silt loam are dotted with somewhat rounded mounds, ranging from 2 to 4 feet in height and from 30 to 50 feet in diameter, which have a much thicker surface soil and a brighter colored subsoil than the places between mounds. In some of the least sloping areas small spots of Wilson silt loam occupy the central parts of the areas between the mounds. The areas north of Bonham and north of Honey Grove grade almost imperceptibly into adjoining more nearly level areas of Ivanhoe silt loam.

Crockett silt loam is developed mainly in two large, broad, very gently undulating areas 5 miles north of Bonham and 7 miles north of Honey Grove. Several smaller areas occur in the southern and central-western parts of the county. The relief is smoothly undulating but is marked by mounds. The range of surface gradient is from ½ to 2½ percent, but nearly all is within the lower half of this range. Surface drainage is slow to free, and underdrainage is very slow or wanting. None of the areas is severely eroded or gullied, and few are subject to moderately rapid erosion.

This soil produces fair yields of general field crops, although it is not especially well suited to corn. Nearly all of it is in cultivation

and is used for cotton farming. Cotton normally occupied one-half or more of the tilled acreage, oats about one-third, and corn, with small acreages of grain sorghums and sorgo, nearly all the rest. The prevailing acre yields over a period of years are about 125 to 165 pounds of lint cotton, 20 to 30 bushels of oats, 10 to 15 bushels of corn, and 1 to 2 tons of sorgo hay.

Crockett very fine sandy loam.—This soil is the well-drained brown rather tight sandy loam of the upland prairies. The 8- to 15-inch surface soil is brown or grayish-brown moderately acid friable very fine sandy loam. It grades through a 1- to 2-inch transitional layer into reddish-brown acid compact very heavy clay strongly mottled with red and, especially in the lower part, with brownish yellow. At a depth ranging from 20 to 24 inches the subsoil gives way to brownish-yellow noncalcareous very tough and compact clay somewhat mottled with gray. At a depth of 3 to 4 feet the lower subsoil grades indistinctly into the parent material of olive-yellow or yellow and gray compact slightly sandy clay. The parent material is noncalcareous in the upper part but is calcareous at a depth ranging from 6 to 15 feet. A few hard black shotlike pellets of iron oxide are present throughout the soil layers. Larger rusty-black friable concretions of iron oxide or films of similar material along cleavage planes occur in the parent material to a depth of 10 feet or more.

When moist the surface soil material crumbles under slight pressure to crumbs and the soil is easily worked. On drying after hard rains it crusts over tightly and interferes with the emergence of germinating plants. In virgin areas the surface soil is porous and faintly granular and the natural cleavage planes are dark brown or slightly darker than the crushed material. Moisture penetrates the upper subsoil material slowly. This material breaks under pressure into irregular very hard clods 1 or 2 inches in diameter and having dark-brown exteriors. The material in the lower horizons is almost massive in place and is very slowly permeable to water.

Many of the areas, such as the one 4 miles north of Bonham, are dotted with sandy mounds approximately 3 feet in height and 50 feet in diameter. These mounds consist of deep brown fine sandy loam or very fine sandy loam, light brown below a depth of 18 inches, and underlain by mottled yellow and red sandy clay at a depth ranging from 18 to 40 inches. The boundaries between areas of Crockett very fine sandy loam and the Susquehanna soils are indefinite, and in some places the zone of transition between the two soils is almost a quarter of a mile wide.

This soil occupies many well-drained areas of undulating prairie within the sandier parts of the upland plain. The largest of these are in the vicinity of Ladonia, north of Honey Grove, 4 to 7 miles north of Bonham, and 3 miles northeast of Savoy. The characteristic native vegetation consists of bunchgrasses, mainly prairie beardgrass and three-awn grasses, with many associated species. Some of the marginal areas were forested with some post oak and blackjack oak trees. The surface slope ranges from ½ to 2½ percent. Typical areas have free surface drainage and very slow underdrainage. Some erosion occurs in places where the soil is tilled without protection, but gullying is nowhere severe. In a few places sheet erosion has removed as much as 6 inches of the surface soil.

Crockett very fine sandy loam is an easily worked somewhat droughty soil that produces fair yields of cotton and other common field crops. Organic matter and available plant nutrients were not abundant originally and have been largely depleted by continued cropping. The prevailing yields are not more than half of those obtained in the few areas recently placed in cultivation. Applications of barnyard manure give large increases in productivity. Small proportions of the areas north of Bonham, mostly areas where the sandy surface soil is thicker than the average, are used for growing peaches, berries, and special truck crops for local sale, and fairly good yields are obtained where fertilizer is applied. The soil seems to be somewhat too droughty, however, to be excellent for tree fruits. About three-fourths of the land is in cultivation, and the rest is largely in abandoned-field pasture. The largest areas used as pasture are west of Ladonia.

Cotton occupies one-half or slightly less of the cropped acreage, corn about one-fourth, oats between one-tenth and one-fifth, and grain sorghums, sorgo, wheat, peanuts, cowpeas, peaches, berries, and special truck crops the rest. Yields vary greatly from field to field, depending on the state of cultivation, but they are generally low. From 80 to 125 pounds of lint cotton, 8 to 15 bushels of corn, 15 to 25 bushels of oats, and ½ to 1½ tons of sorgo hay to the acre are obtained over a period of years. In those few fields where fertility has been maintained or improved, acre yields of as much as 200 pounds of lint cotton, 15 to 20 bushels of corn, and 35 bushels of oats are reported.

MEDIUM-TEXTURED CRUMBLY NONCALCAREOUS SOILS OF THE SMOOTH UPLAND PRAIRIES

Bonham clay loam, Bonham silt loam, and Choctaw fine sandy loam make up the group of medium-textured crumbly noncalcareous soils of the smooth upland prairies. They are dark colored, slightly to moderately acid, and rather friable in the subsoil. Their physical properties are somewhat more favorable for most crops, especially corn and garden and orchard crops, than those of the soils of the well-drained tight soils of the smooth prairies, which differ from this group in having compact subsoils. Most of the land is cultivated and is generally used for cotton farming. Considerable areas in the vicinity of Bonham are used for diversified farming, dairying, and the production of peaches, berries, and vegetables for sale. The soils of the group are productive and well suited to a wide variety of crops.

Bonham clay loam.—This is a dark-brown friable soil, commonly known locally as brown prairie loam or mixed land. It resembles Crockett clay loam in many respects but differs from it in being less crusty, much more friable in the upper subsoil, and more freely drained internally. Farmers regard this as a desirable easily worked soil and consider it much more productive than Crockett clay loam.

The surface soil is dark grayish-brown granular crumbly slightly to moderately acid clay loam or silty clay loam ranging from 8 to 15 inches in thickness. This grades into a 5- to 10-inch friable upper subsoil layer of brown slightly or moderately acid crumbly silty clay or heavy silty clay loam, mottled with brownish-red spots. This

upper subsoil grades, at a depth of 20 or 24 inches, into a more compact lower subsoil of mottled brownish-yellow and gray noncalcareous heavy clay containing spots of dull red. At a depth of 36 to 42 inches the parent material is reached. It consists of gray or light-gray and dull-yellow moderately but not extremely heavy clay and represents an old sea deposit. Soft rusty-black spots of iron oxide are numerous in the upper part, and the material is either calcareous or noncalcareous.

The surface soil material is very friable when moist and crumbles easily. Dry clods are somewhat less hard than those of the surface of Crockett clay loam, and the soil does not crust and pack so readily. The well-defined granular structure of the upper layers reaches to a depth of about 18 inches and consists of a natural aggregation of the soil material into subrounded friable granules about one-eighth inch in diameter and having exteriors of very dark brown. Below the granular layer the undisturbed friable upper subsoil is arranged into friable cubelike fragments that are about three-fourths of an inch in diameter and have gray exteriors and brownish-red centers.

This soil occupies smoothly undulating areas, most of which are large and uniform, on the upland plain. The areas are confined to a general belt, from 3 to 5 miles wide, extending from a point 3 miles northeast of Bonham westward into Grayson County. The large area between Bonham and Ector is the type locality of the Bonham soils. The native vegetation, in the very few areas that have never been plowed or heavily pastured, consists mostly of coarse bunchgrasses, mainly prairie beardgrass and associated species. The slope ranges from about ½ to 3 percent but is about 1 percent throughout most of the area. As a whole the land is very smooth. Both the surface soil and the subsoil are fairly well drained, although underdrainage is slow. Most of the area is not significantly eroded, and none is severely gullied.

Bonham clay loam is fertile, has good physical characteristics, and is productive for all the field crops common in the county. Fairly thrifty alfalfa was observed growing in several small fields. As the acidity of this soil generally approaches the limit tolerated by alfalfa, applications of lime might prove profitable for that crop. About four-fifths of the total area of the soil is in cultivation. Cotton occupies about one-half of the cropped acreage, corn about one-fourth, and oats, grain sorghums, and sorgo most of the rest. The average yields exceed those on Crockett clay loam. Over a period of years the prevailing acre yields are from 150 to 180 pounds of lint cotton, 12 to 20 bushels of corn, 25 to 35 bushels of oats, and 1½ to 2½ tons of sorgo hay. A few fields produce acre yields of 200 pounds of lint cotton or more. The small areas in alfalfa, which are very smooth and probably more fertile than the average, are reported to produce from 2 to 2½ tons of alfalfa hay to the acre annually.

Bonham silt loam.—The 12- to 18-inch surface soil is dark grayish-brown friable neutral to moderately acid slightly granular permeable silt loam grading into silty clay loam in the lower part of the layer. It merges with the upper subsoil, a 6- to 12-inch layer of brown noncalcareous crumbly silty clay loam or light clay mottled with brownish red and some dark gray. The crumbly upper subsoil grades, com-

monly at a depth of 20 to 24 inches, into a more compact lower subsoil of mottled gray and yellow dense noncalcareous heavy clay containing some brownish-red spots. At a depth of about 3 feet below the surface the soil rests on the parent material, a mottled dull-yellow and light-gray noncalcareous clay that is calcareous at a depth ranging from 8 to 15 feet. Films of rusty-black material coat the cleavage planes, and soft concretions of the same material are abundant in the upper part of the parent material. The soil is crumbly and easily tilled. In undisturbed areas the surface soil is well granulated and the upper part of the subsoil has a friable angular nut structure, the nutlike aggregates having gray exteriors and brownish-red centers.

This soil occupies areas of undulating prairie on the upland plain in the central and western parts of the county within the same general belt as Bonham clay loam. A broad, uniform body lies north of Bonham. The slopes are very gentle, ranging from ½ to 2 percent in gradient. Surface and internal drainage are free but not rapid. None of the soil is severely eroded.

This soil is very similar to Bonham clay loam and differs from it chiefly in having a surface soil slightly lighter in texture. It differs from Crockett silt loam in having a less compact subsoil, which causes it to be less droughty. It is easily worked, is moderately fertile, and has favorable physical characteristics. It is moderately productive for all the general crops commonly grown in the county. About four-fifths of the land is in cultivation and is planted chiefly to cotton, which occupies about one-half of the cropped acreage, together with oats and corn as the principal feed crops, and lesser proportions of grain sorghums, sorgo, and wheat. Home gardens and peach and pear trees thrive on this soil. The prevailing acre yields over a period of years are about 150 to 175 pounds of lint cotton, 12 to 20 bushels of corn, 20 to 35 bushels of oats, and 1½ to 2 tons of sorgo hay. Applications of manures and other soil-improvement practices increase yields considerably.

Choctaw fine sandy loam.—This soil has an 8- to 15-inch surface soil of brown or dark-brown slightly acid slightly granular fine sandy loam, which grades into a solid-colored upper subsoil layer, 6 to 15 inches thick, of yellowish-brown slightly acid friable permeable sandy clay loam or sandy clay. This, in turn, at a depth of 20 or 30 inches, grades into a mottled slightly heavier textured lower subsoil layer of brownish-yellow and red noncalcareous friable sandy clay, which gives way, at a depth of 30 to 60 inches, to the parent material of yellow weakly consolidated sandstone. Here and there a few ferruginous sandstone fragments are present on the surface. The soil is friable and easily worked.

Choctaw fine sandy loam occupies gently sloping positions on the upland plain in the west-central part of the county in areas that originally were mostly prairie. It is associated with Crockett very fine sandy loam, from which it differs primarily in having a much less compact subsoil. The largest body is 2 miles east of Ravenna; smaller bodies are in Ector, 3 miles north of Savoy, and 3 miles northeast of Ravenna. The land has a surface gradient ranging between 1 and 3 percent, and it is neither severely eroded nor generally liable to severe erosion. Both internal drainage and surface drainage are free.

This soil contains a moderate amount of organic matter and responds very readily to soil management. Its physical characteristics enable crops to withstand droughts. All the general field crops and many special fruit and vegetable crops do well on it. About three-fourths of the soil is in cultivation and is used mainly for cotton. Corn is the principal feed crop. Small acreages are planted to grain sorghums and sorgo, but practically no small grains are grown. A few small orchards located on this soil appear to be very productive where well managed. Yields of general field crops are variable, depending on management. Cotton yields from 125 to 150 pounds of lint and corn 10 to 18 bushels to the acre under prevailing practice without fertilization.

NONCALCAREOUS SOILS OF THE SLOPING PRAIRIES

Noncalcareous soils of the sloping prairies include the rolling and steep areas of soils of the Crockett, Wilson, Ellis, Bonham, and Choctaw series. It is a group of erodible and more or less severely eroded soils that are naturally of low to moderate productivity for general field crops. Although marginal or below marginal in value for field crops, they are capable of growing fair to very good grass. With proper methods of erosion control, cultivation can be carried on without excessive soil washing; but for the most part the soils are not productive enough to warrant the expenditures for erosion control that are required if the soils are used as cropland. Most of the areas occupy small strips and bodies associated with deeper and more productive soils and they are largely used as small farm pastures.

Crockett clay loam, rolling phase.—This phase differs from normal Crockett clay loam primarily in being more sloping and more severely eroded. All layers are slightly thinner and less dark than those in the normal phase, and in practically all areas the surface soil is much thinner, because of accelerated sheet erosion caused by improper use of the land.

The 2- to 6-inch surface soil consists of dark grayish-brown or brown noncalcareous clay loam or sandy clay loam. The upper subsoil layer of brown noncalcareous compact clay mottled with brownish red is from 3 to 8 inches thick, and at a depth ranging from 8 to 12 inches it grades into the lower subsoil of brownish-yellow noncalcareous very compact and tough clay mottled with some gray. This passes almost imperceptibly, at a depth of about 30 inches, into the parent material of raw yellow and light-gray noncalcareous nearly impervious clay, which is calcareous at a depth ranging from 4 to 8 feet. The surface soil is less than 4 inches thick throughout at least three-fourths of the area, and the subsoil is exposed on the surface here and there. Many of the areas include barren saline spots, which are indicated on the soil map by symbols and described at the end of the section on Morphology and Genesis of Soils.

The slope ranges from 2½ to 7 percent. Surface drainage is rapid and excessive. Gullies have formed in most of the areas, although they are generally not deep or numerous enough to prevent tillage of the land. At least four-fifths of this soil is in abandoned fields and supports a thin cover of weeds, three-awn grasses (locally called needlegrass), and scattered clumps of Bermuda and Johnson grasses.

Some of these abandoned fields lie idle, but most of them are used for pasture and have a carrying capacity estimated at about 1 cow to 10 or 20 acres. The area cultivated at present constitutes not more than 10 percent of the total area and represents the least sloping and least eroded part. Chiefly cotton, oats, grain sorghums, and sorgo are grown on these selected areas, and acre yields of from 50 to 90 pounds of lint cotton, 10 to 15 bushels of oats, and one-half to 1 ton of sorgo hay or forage are obtained. No areas of virgin prairie remain.

Crockett clay loam, steep phase.—This phase includes various soils of the Crockett series on which the slope exceeds about 7 percent and reaches a maximum of about 15 percent. The surface soils consist of a 2- to 6-inch layer of brown noncalcareous clay loam, sandy clay loam, loam, or fine sandy loam, passing into a compact subsoil of mottled brown and brownish-red heavy noncalcareous clay. The subsoil, at a depth ranging from 10 to 20 inches, grades into the parent material of yellow and gray clay and sandy clay. These are noncalcareous in the upper part but become calcareous at a depth ranging from 3 to 5 feet below the surface. Many of the areas include numerous saline spots, which are almost barren of vegetation and are practically worthless for agriculture. Such areas are indicated by symbols on the soil map and are described at the end of the section on Morphology and Genesis of Soils.

This soil occurs 3 miles northeast of Savoy, 1 mile southeast of Anthony, 3 miles west of Ladonia, near Duplex in the central-northern part of the county, and 1 mile west of Allens Chapel northwest of Honey Grove. In places within the areas near Ladonia the subsoil is yellowish-brown rather crumbly somewhat granular clay, underlain by calcareous material at a depth of 2 or 3 feet. The area on the west side of Duplex and most of the areas north of Savoy are underlain by shales interbedded with subsidiary amounts of sandstone and contain places where the upper part of the subsoil is solid red.

The native vegetation is a scrubby growth of post oak and blackjack oak with a moderate ground cover of grasses. Most of the trees have been cut for firewood. The surface is so sloping that insufficient rainfall is absorbed to support a heavy growth of grass, and the land provides only poor to fair pasturage. None of the areas is cultivated, and less than one-fifth ever have been cultivated. The soil is so thin and erodible that it is entirely unsuited for use as cropland.

The saline spots that occur in this soil show as round nearly white patches from 15 to 100 feet in diameter, in most places lying at the bases of slopes or at the heads of small drainageways. These soils evidently contain a considerable quantity of various salts. Analyses of similar spots in other soils of this general region show several different salts to be present. The most abundant salt that is harmful to plants is sodium chloride. These spots occupy less than 1 percent of most areas of the soil. As a rule the soil profile is as follows: A 2- to 4-inch surface layer of light-gray silt loam rests on very dark gray extremely compact dense intractable clay containing soft lumps of salts. This layer ranges from 5 to 10 inches in thickness and grades below into olive-brown or gray very compact clay, which, be-

low a depth of 3 feet, is yellow and less compact. Much of the surface is gullied and eroded.

Crockett very fine sandy loam, rolling phase.—This phase differs from normal Crockett very fine sandy loam primarily in occupying moderately sloping areas and in being generally moderately eroded. All soil layers, especially the surface soil, are somewhat thinner than in the normal phase. The 4- to 8-inch surface soil is composed of brown or grayish-brown acid very fine sandy loam. This grades into a layer, ranging from 5 to 12 inches in thickness, of mottled reddish-brown and yellowish-brown acid compact clay, which forms the upper part of the subsoil and passes into a lower subsoil layer of yellowish-brown or brownish-yellow noncalcareous compact clay slightly mottled with gray. This layer, at a depth ranging from 20 to 36 inches, grades into the parent material of yellow somewhat sandy clay that is calcareous at a depth ranging from 5 to 8 feet. The thickness of the surface soil varies, depending on the sandiness of the parent material and the degree of erosion. Many of the areas, especially those in the southeastern part of the county, contain a few to many saline spots, which are indicated by symbols. Practically nothing will grow on these spots. They are similar to the saline spots on Crockett clay loam, steep phase.

This soil occupies moderately sloping areas associated with Crockett very fine sandy loam in the west-central, east-central, and southeastern parts of the county. The largest areas are a few miles west of Ladonia. In representative places the areas were originally prairie covered with coarse grasses; many areas near the longer streams, however, were thinly wooded with post oak and blackjack oak. The areas have a surface gradient ranging from 2½ to 7 percent and are rapidly and excessively drained. All areas that have been cultivated are severely eroded and somewhat gullied. Many of the areas include a few scattered barren saline spots, which are indicated on the soil map by symbols and described at the end of the section on Morphology and Genesis of Soils.

Two-thirds or more of the area of this soil is in abandoned fields, which are largely used for pasture but are of low value for such use in their present condition. Less than one-tenth of the land is in cultivation, and possibly one-fifth is woodland or native prairie pasture that has never been plowed. Weeds, three-awn grasses, and scattered patches of Bermuda grass make a thin cover in the abandoned fields. The small areas cropped are mostly the smoother and less eroded areas and are devoted to cotton, oats, and small acreages of grain sorghums and sorgo. Cotton yields an average of about 80 pounds of lint or less to the acre, and other crops return correspondingly low yields. The few areas of native prairie pasture probably have a carrying capacity of between 3 and 6 acres for 1 cow, and the abandoned-field pastures between 10 and 20 acres for 1 cow, for the 9-month growing season of pasture grasses.

Wilson-Crockett clays, rolling phases.—This soil combination comprises rolling and moderately to severely eroded areas of Wilson clay intimately associated with very numerous small spots of Crockett clay. Most areas are only moderately productive. Farmers do not regard this as especially desirable land, but it is suitable for crop

production where it is not too severely eroded. The association of intermingled small areas is commonly known as mixed land or "rawhide land."

In the spots of Wilson clay the surface soil is dark-gray noncalcareous crusty and rather intractable clay. Below plow depth the material is very compact dark-gray or very dark gray noncalcareous heavy clay, which reaches with little apparent change to a depth ranging from 18 to 30 inches. Below this is yellowish-brown or olive-brown slightly calcareous compact clay. The parent material of olive-yellow or bluish-gray calcareous shaly clay underlies the soil at a depth of about 3 feet and contains a few concretions of calcium carbonate in its upper part. In spots of Crockett clay the surface soil is brown clay, from 2 to 6 inches thick, grading into reddish-brown or yellowish-brown heavy noncalcareous clay mottled with gray. This gradually changes with depth to light-gray waxy clay slightly mottled with yellow. In this association a few small spots of Houston clay occur as slopewise streaks and occupy the crests of the ridges between the hog wallows of the original surface. A few small areas included on the map have a surface soil consisting of a 2- to 4-inch layer of dark-gray clay loam. Some of the areas include a few barren saline spots, which are indicated on the soil map by symbols and are described at the end of the section on Morphology and Genesis of Soils.

Wilson-Crockett clays, rolling phases, occur in several small rolling areas in the central-western, central, and southwestern parts of the county, generally associated with undulating areas of Wilson soils. The largest area is at Rogers School about 3 miles southwest of Bonham. The area 2 miles west of Bonham and the one 3 miles north of that place represent the phase having inclusions of spots of Houston clay.

Surface drainage is rapid and somewhat excessive, and all areas are subject to erosion in unprotected fields. Moderate gully and sheet erosion have occurred in nearly all areas but generally have not unfitted them entirely for cropland. The surface gradient ranges from 2½ to 7 percent. The native vegetation consisted of coarse and tall bunch grasses; little of this remains, however, as practically all the land has been plowed or heavily pastured.

About one-fourth of the area is in cultivation and devoted to general field crops other than corn. Yields vary greatly from field to field, depending on management and degree of erosion, but on the whole they are not high. Over a period of years the production of cotton lint is about 100 or 125 pounds and of oats 10 to 20 bushels to the acre. The rest of the soil is mostly used for pasture and supports a thin cover of grasses and weeds of rather poor quality. In a few well-managed pastures some nutritious forage plants, such as Bermuda grass, make a good growth.

Ellis clay.—The surface soil ranges from 6 to 12 inches in thickness and consists of neutral to slightly alkaline noncalcareous yellowish-brown very compact heavy clay. It grades through a transitional layer, about 12 inches thick, of olive-yellow noncalcareous or faintly calcareous very compact heavy clay into the parent material of bluish-gray and yellow nearly impervious alkaline noncalcareous shaly clay. The soil is crusty, intractable, and droughty. It differs

from the somewhat similar appearing Houston clay in being noncalcareous, less dark, and much less crumbly.

Ellis clay occupies moderately sloping areas on the upland plain, the largest of which are about 2 miles north of Allens Chapel in the east-central part of the county and in the vicinity of Savoy.

A moderately dense cover of grasses and a brushy growth of small cedar elm trees and thorny shrubs make up the native vegetation. In general the slopes range from 2½ to 7 percent. The gradient of a few included areas exceeds 7 percent. Here the grass cover is extremely thin and the soil layers are less than 15 inches thick over the parent material.

This land is erodible, droughty, and rather infertile. It is as well suited to small grains and cotton as to any common field crops but is not very productive. About one-fifth of the land is in cultivation, about one-half is abandoned-field pasture or is idle, and the rest is native grass pasture. The cropped acreage is used for cotton and small grains, with small areas in grain sorghums, sorgo, and corn. The crop yields range about as follows: 70 to 100 pounds of lint cotton, 10 to 20 bushels of oats, 10 to 15 bushels of grain sorghums, and 5 to 10 bushels of corn to the acre.

Bonham clay loam, rolling phase.—This phase is a sloping, generally moderately eroded and somewhat gullied soil of the prairies with a subsoil of crumbly clay. It differs from normal Bonham clay loam principally in being more sloping and eroded. It differs from Crockett clay loam, rolling phase, in having a redder and much more crumbly subsoil. Where not too severely eroded, it has fair to good productivity for general field crops, but most areas are so severely washed that fertility is low.

The surface soil is dark grayish-brown or brown noncalcareous granular crumbly clay loam. Its thickness ranges from 4 to 12 inches but commonly is about 8 inches in undisturbed situations. The surface soil grades into an upper subsoil layer of brown crumbly light clay or silty clay that contains spots of brownish red and ranges from 5 to 15 inches in thickness. This in turn grades into a lower subsoil layer of brownish-yellow heavy clay mottled with some gray and containing numerous spots of yellowish red. The parent material of mottled gray and dull-yellow moderately heavy clay is reached at a depth of about 3 feet. Friable rusty-black concretions of iron oxide are numerous in the parent material, which is noncalcareous in its upper part but becomes calcareous at a depth ranging from 5 to 7 feet. Here and there erosion has so thinned the surface soil that the subsoil lies within 4 inches of the surface. Some areas include a few barren saline spots, which are indicated on the map by symbols and described at the end of the section on Morphology and Genesis of Soils.

This soil occupies slopes in association with smoother areas of Bonham clay loam and Bonham silt loam. The largest areas are around the heads of Timber and Powder Creeks in the vicinity of Bonham. The gradient of the surface ranges from 3 to 7 percent. Surface drainage is rapid and excessive, and internal drainage is moderately free. All areas are liable to severe erosion when cropped without protection.

About one-fourth of the area is in cultivation; most of the rest is abandoned-field pasture, and small acreages are in prairie meadow

or pasture. The cultivated land is used chiefly for cotton, with small acreages planted to oats, corn, grain sorghums, and sorgo. Cotton yields probably about 100 pounds of lint to the acre, oats about 15 bushels, and sorgo ½ to 1½ tons of hay. The productivity is generally low. Grasses make better pastures than on Crockett clay loam, rolling phase.

Choctaw fine sandy loam, rolling phase.—Areas of Choctaw fine sandy loam that have a slope ranging from 3 to 7 percent are separated as a rolling phase. Moderate sheet erosion and gullying have occurred in practically all areas.

The surface soil is a 4- to 12-inch layer of brown or dark-brown friable acid slightly granular fine sandy loam. This grades into yellowish-brown crumbly sandy clay loam or sandy clay, which, at a depth ranging from 15 to 24 inches, passes into yellow heavier sandy clay with conspicuous red spots. The parent material of yellow weakly consolidated sandstones lies from 2 to 4 feet below the surface. None of the soil material is calcareous.

This soil occupies numerous small areas on the upland plain in the northwestern quarter of the county. Most of these are within a narrow belt extending from a point 2 miles south of Savoy on the Grayson County line past Ector and Ravenna to Duplex. Other bodies are from 4 to 7 miles north and northeast of Savoy.

The characteristic native vegetation is prairie grasses, but in some places the land supports some scattered post oak and blackjack oak trees. The soil has free internal drainage and rapid surface drainage.

This is a very erodible soil, and sheet erosion has greatly reduced its original high inherent productivity. Small areas are fairly fertile, but these are mostly too irregular in shape for convenient fields. About one-tenth of the land is in cultivation, mainly to cotton and corn, with small acreages of grain sorghums, sorgo, peanuts, fruits, and truck crops. Where the surface soil is more than 6 inches thick this soil responds very well to fertilizers and soil improvement. Yields are variable, depending on management, but they are prevailingly low. Over a period of years they probably average 70 to 100 pounds of lint cotton and 6 to 12 bushels of corn to the acre. The soil is not generally suited for the production of cultivated crops.

NEARLY LEVEL LIGHT-COLORED SANDY SOILS OF THE SMOOTH UPLANDS AND OLD STREAM TERRACES

The nearly level light-colored sandy soils of the smooth uplands and old stream terraces comprise members of the Susquehanna, Sawyer, Bowie, Chattahoochee, Kalmia, and Nacogdoches series. Susquehanna very fine sandy loam occupies nearly 15,000 acres and Bowie fine sandy loam slightly more than 13,000 acres; none of the others occupies as much as 2,000 acres. The group comprises leached acid soils that have developed under an oak forest from noncalcareous sands and sandy clays. In undisturbed wooded areas all have a thin surface layer, 2 to 4 inches thick, which is stained brown or grayish-brown by small quantities of organic matter. Below this brown layer the surface soils of all members except the Nacogdoches are pale yellow or light gray with a yellowish tint. The surface soil of the Nacogdoches is pale red below the brown layer, which is somewhat thicker than in the

others. The principal differences between the soils of the group are in the thickness and sandiness of the sandy surface layers and in related differences in the color, texture, and permeability of the subsoils. All except the Nacogdoches and some of the Susquehanna soils occupy high stream terraces and are underlain by parent materials of ancient alluvium.

The soil profiles of these soils reflect the influence of the regional environment on development, even though the parent materials are derived from more youthful formations than the marine formations giving rise to the more rolling forested soils.

The inherent productivity of these smooth, well-drained, light-colored sandy soils is low to fair. Crops return good yields only when the soil is first cropped or when it is fertilized and well managed, and commonly they return very low yields. Fertilizing, manuring, or incorporating organic matter is not a common practice for general field crops. Many areas are abandoned fields that either lie idle or afford only scant pasturage. The soils are especially well suited to many varieties of vegetable and fruit crops and are capable of producing good yields of general field crops under good management. They are representative of the soils that prevail throughout the east Texas timber country.

Susquehanna very fine sandy loam.—This soil is commonly known as "sand with a red clay foundation." The 5-inch surface layer in cultivated areas is light grayish-brown acid very fine sandy loam. It grades into a subsurface layer of strongly acid very fine sandy loam that is pale yellow or light gray with a tint of yellow. At a depth ranging between 5 and 15 inches—generally about 10 inches—the surface soil grades through a 1- to 2-inch transitional layer into the subsoil of mottled red, yellow, and gray dense strongly acid heavy clay. The gray coloration increases and the red coloration decreases with depth, and at a depth of 20 or 30 inches the subsoil changes to light gray mottled with dull yellow. This lower subsoil layer continues without change to a depth of about 4 feet, where it grades into somewhat sandier but compact material. This is the parent material and consists of noncalcareous light-gray and yellow sandy clay and clay comprising old stream terrace formations.

Numerous sandy mounds occupy from one-fiftieth to one-tenth of the area. These have a coarser and much deeper surface soil than places between mounds, and in undisturbed areas they are 2 to 3 feet high.

In the central parts of the mounds the surface soil is pale-yellow light-textured fine sandy loam, from 2 to 3½ feet thick, grading into a subsoil of yellow sandy clay mottled with streaks of light gray and spots of yellowish red. In most places the sandy clay layer ranges from 4 to 10 inches thick and is underlain by heavy plastic clay. In old fields where these mounds have been partly leveled by cultivation their former sites appear as lighter colored spots on which crops make poor growth. Farmers report crop growth on the mounds as very good in new fields or when the land is manured.

Susquehanna very fine sandy loam occupies gently undulating originally forested areas of old terraces of the Red River in the northern part of the county. Some of the larger areas are in the vicinity

of Lamasco. It is the most extensive soil of the smooth light-colored sandy group and occupies some broad areas. The surface gradient ranges from ½ to 4 percent, although only a very small proportion of the land has a slope greater than 2 percent. Surface drainage is slow to free, and internal drainage is rather slow. Except in small areas transitional to Susquehanna fine sandy loam, which is more rolling and has a slope range of 4 to 15 percent, the soil is not materially eroded or subject to erosion.

Inherently the productivity of this soil is rather low, but proper methods of treatment can be used to build it up. Although the subsoil is dense and heavy, crops withstand droughts well (possibly slightly less so than on sandy soils with friable subsoils, such as Bowie fine sandy loam) except in places where the sandy surface soil is less than about 8 inches thick. The soil warms somewhat late in spring and probably is not so well adapted to early truck crops as the associated sandier soils with friable subsoils of sandy clay. Where the soil is continuously cropped without fertilization, as is customary, the productivity decreases somewhat less rapidly than on Bowie fine sandy loam, and the prevailing yields of cotton and peanuts are somewhat higher than on that soil. About two-fifths of the soil is in cultivation, about one-third is uncleared woodland, and the rest is used as pasture. Cotton and corn are the principal crops, each of which occupies about one-third of the total cropped acreage. Most of the rest consists of small acreages of peanuts, cowpeas, oats, grain sorghums, sorgo, and sweetpotatoes. Several small commercial peach orchards are located on this soil and produce good yields of excellent fruit. The acre yields vary widely with management, but in most fields they range from 75 to 100 pounds of lint cotton, 8 to 12 bushels of corn, and 10 to 15 bushels of oats.

Sawyer fine sandy loam.—This soil differs from Susquehanna very fine sandy loam principally in having a sandier and thicker surface soil and a thicker transitional layer of crumbly sandy clay over the subsoil. In addition, sandy mounds are more numerous on this soil than on the Susquehanna soil. Both soils are developed on old stream terraces.

The surface layer of Sawyer fine sandy loam in virgin areas consists of light grayish-brown acid fine sandy loam about 2 inches thick. Where cultivated this layer is 5 to 7 inches thick. It grades into a subsurface layer of pale-yellow strongly acid light fine sandy loam, which reaches to a depth of 14 to 18 inches and in turn grades into a 2- to 5-inch transitional layer of brownish-yellow crumbly sandy clay or sandy clay loam, slightly streaked with light gray. The subsoil proper, which underlies the transitional layer, is dense strongly acid heavy clay, mottled gray, red, and dull yellow. At a depth of 3 to 4 feet it gives way to the somewhat lighter textured parent material of light-gray and yellow noncalcareous heavy sandy clay. The scattered sandy mounds resemble those on Susquehanna very fine sandy loam and constitute from one-tenth to one-fourth of the surface of the soil.

This soil occupies undulating originally forested areas on high old terraces of the Red River Valley in the northern part of the county. In general it occupies transitional areas between Susquehanna very fine sandy loam and Bowie fine sandy loam. The largest area, about

300 acres, is 2 miles east of Ivanhoe. Nearly all of the areas slope 1 to 2 percent but none more than 4 percent. Erosion and gullying generally are insignificant. Surface drainage is rather slow but free.

The productivity and land-use capabilities of this soil are about midway between those of Bowie fine sandy loam and Susquehanna very fine sandy loam. Although its natural fertility is low, this soil is very responsive to management, not at all droughty, and fairly early. Between one-third and one-half of the area is in cultivation and is used mainly for growing cotton and corn, with small areas in peanuts, cowpeas, and fruit and truck crops. The yields are extremely variable, depending on management. Under prevailing practice without fertilization, the acre yields over a period of years are about 70 to 100 pounds of lint cotton and 8 to 12 bushels of corn.

Bowie fine sandy loam.—The surface layer is friable acid fine sandy loam, which is pale grayish brown to a depth of 2 inches in virgin land and 6 to 10 inches where cultivated. This grades into pale-yellow fine sandy loam, which, in turn, at a depth of about 15 inches, grades into the subsoil of friable sandy clay. The subsoil is yellow to a depth of about 24 inches and yellow mottled with red spots below that depth. At a depth of 3 to 3½ feet it is underlain by light-gray noncalcareous rather heavy sandy clay containing numerous red spots surrounded by yellow. At a depth of about 5 feet this material grades into sandier parent material of light-gray noncalcareous sandy clays and sands with spots and streaks of brownish yellow. These are deposits of very old alluvial materials.

Numerous sandy mounds occupy from one-tenth to one-fourth of the surface. They have thicker and sandier surface layers than the typical soil and commonly are from 2 to 3 feet high, somewhat round, and from 30 to 50 feet in diameter. In their central parts the surface soil is pale-yellow light fine sandy loam or loamy fine sand, 3 to 4 feet thick, over a subsoil of yellow sandy clay loam. In some places the texture of the surface soil is very fine sandy loam between mounds.

Bowie fine sandy loam occupies many large and small areas on the forested gently undulating borders of a very high old terrace of the Red River in the central-northern and northeastern parts of the county. The general surface gradient is about 1 percent, but in places near more rolling soils slopes may be as much as 4 percent. The areas of this soil are not significantly eroded or very susceptible to erosion. Surface drainage is slow but free, and internal drainage is free. A thick forest, mainly of oak, with little underbrush or grass, constitutes the native vegetation. The trees are somewhat larger and red oaks are more numerous than in the forest on Susquehanna very fine sandy loam.

Between one-third and one-half of this soil is in cultivation, mainly to cotton and corn. Small acreages of peanuts, cowpeas, fruits, and vegetables are also grown, and some of these products are used locally. Cotton returns from 60 to 100 pounds of lint, and corn 8 to 12 bushels of grain to the acre. Yields are extremely variable from field to field, however, depending on management and the number of years the land has been cropped. Those few farmers who use fertilizers report that they generally obtain more than one-third of a bale of cotton to the acre when fertilizers are used in conjunction with additions of organic

matter. A few farmers specialize in the production of peaches, blackberries, and other fruit for local sale and obtain good yields of high-quality fruit. Many farmers produce and sell small quantities of sweetpotatoes and sorghum sirup.

Chattahoochee fine sandy loam.—This is a light-colored acid sandy forested soil developed on smooth terraces of the Red River Valley. It has a thin surface layer of light grayish-brown friable acid fine sandy loam. In virgin areas this layer is only 1 to 3 inches thick, but in cultivated areas it is 6 to 8 inches thick. It passes into a subsurface layer of fine sandy loam that has practically the same texture but a yellow or light reddish-yellow color. At a depth of 10 to 15 inches it grades into reddish-yellow or yellowish-red acid crumbly fine sandy clay loam. At a depth of about 5 feet the parent material of noncalcareous yellowish-red fine sandy loam (an alluvial deposit) is reached.

Chattahoochee fine sandy loam lies on rather smooth nearly flat to moderately undulating high old stream terraces along the Red River Valley, developed from ancient alluvium. The surface gradient in most places ranges from 1 to 2 percent, but in some small areas it is as much as 4 percent. Areas of this soil are in the northern part of the county, some in the vicinity of Ravenna, and some in the vicinities of Sash and Telephone. The areas near Sash and Telephone are on a very high old dissected stream terrace. Here the soil is associated with Bowie fine sandy loam and is somewhat deeper, slightly more sandy, and therefore looser than the soil on the lower terrace. The uncleared land supports a forest growth of oak trees. Surface drainage and internal drainage are good, and severe erosion is not a problem in most areas.

This soil is inherently of rather low fertility, but it is very responsive to management and produces well when fertilized. Between one-third and one-half of the soil is in cultivation and is used for growing cotton and corn, together with some peanuts, cowpeas, fruits, and vegetables. Yields are extremely variable, depending on management, but are prevailingly very low for general field crops. Most fields produce from 60 to 100 pounds of lint cotton and 8 to 12 bushels of corn to the acre in normal years. When applications of manure or of organic matter and commercial fertilizers are made, high yields are obtained. Some of the orchards and small fields in vegetables receive some manure and produce well, and some of the products are sold on the local markets.

Kalmia loamy fine sand.—This soil is a loose, deep, light-colored sandy soil developed on old stream terraces. In virgin areas the surface soil to a depth of about 3 inches is grayish-brown faintly acid loamy fine sand. This layer is underlain by grayish-yellow slightly to moderately acid loose loamy fine sand, which continues without change to a depth ranging from 3 to 5 feet, where it in turn is underlain by yellow loamy fine sand or fine sandy loam mottled with rusty brown. In cultivated areas the surface soil is light grayish brown to a depth of 5 to 10 inches.

This soil has formed under a forest cover of oak trees from old water-laid sediments and occupies nearly level fairly high terraces of the Red River. The areas are small and occur 1 mile southwest

of Mulberry, 2 miles north of Ravenna, 3 miles northeast and 1 mile north of Telephone, and 2 miles northeast and 1 mile east of Monkstown. The surface gradient is one-half percent or less. Surface drainage is slow, and underdrainage is free.

The natural fertility of this soil is low, and its texture is too sandy for the production of some field crops. Its value for either pasture or forestry is very low. It is, however, one of the most suitable soils in the county for watermelons, peanuts, berries, and vegetables. Less than one-tenth of the area is in cultivation, about one-half is uncleared woodland, and the rest is in abandoned fields, which are either idle or used for pasture. The small part in cultivation is used for cotton, corn, and peanuts. Average yields do not exceed 75 pounds of cotton and 10 bushels of corn to the acre except on new land. Organic matter and some essential plant nutrients are deficient. Where used for the crops to which it is suited, the soil responds well to the use of manures and fertilizers and produces fair yields.

Susquehanna fine sandy loam, smooth phase.—This phase is light colored, forested, sandy, acid throughout, and developed on smoothly undulating uplands. The surface layer in undisturbed areas is grayish-brown fine sandy loam about 2 to 3 inches thick. It grades into yellowish-gray or grayish-yellow fine sandy loam, which continues to the subsoil, which is reached at a depth of 5 to 12 inches. The upper part of the subsoil consists of yellowish-red heavy clay of cuboidal structure and faintly mottled with gray or yellow, but the nearly solid colored layer is only 1 to 3 inches thick, and it gives way to the main subsoil layer of mottled yellow, gray, and red plastic strongly acid heavy clay. With depth the red color decreases and the other colors increase, and at a depth of about 36 inches from the surface the subsoil changes to mottled yellow and gray heavy clay. At a depth of about 40 inches the clay subsoil grades into the parent material, a light-gray or mottled yellow and gray compact calcareous slightly sandy clay. Small sand mounds are scattered over the surface. In places that have been cultivated the color of the surface soil is light grayish brown to a depth of 5 to 8 inches.

Five small bodies of this soil occupy forested undulating to gently rolling areas on the upland plain in association with areas of the darker Crockett soils. The area at Allens Point, north of Honey Grove, is the principal typical body; the five small areas about 5 miles north of Ector have a somewhat crumbly upper subsoil in most places. The gradient of the surface ranges from about 1 to 4 percent. Part of the area near Allens Point is in cultivation and produces 75 to 100 pounds of lint cotton and 8 to 12 bushels of corn to the acre in most years. Some fruits and vegetables grow fairly well. The other areas are in woodland or in abandoned-field pasture that is not improved and not valuable for grazing.

Erosion has thinned the soil in places. Although the soil is not naturally highly productive, it responds well to good management and fertilization where effective measures are used to protect it from erosion.

Nacogdoches fine sandy loam.—The 6- to 12-inch surface soil is light-red slightly acid fine sandy loam. It grades into the subsoil of deep-red noncalcareous permeable crumbly clay. Below a depth of

30 inches the subsoil contains spots of ocher yellow, and at a depth ranging from 36 to 48 inches it rests on partly disintegrated glauconitic sandstone. In wooded areas the topmost 5-inch layer of soil is stained dark with organic matter and is reddish brown. Iron concretions are abundant, and in a few places fragments of sandstone are present in the soil layers. The subsoil has a crumbly subangular fine-nut structure.

Seven areas of this soil, ranging from 25 to 160 acres in size, occur on the upland plain from 2 to 4 miles north or northeast of Savoy. These areas are undulating, ranging from 1 to 4 percent in slope. The native growth is largely post oak. Both surface drainage and internal drainage are free, and the land is slightly eroded. Practically all the soil is in cultivation, mainly in cotton and corn, with small acreages of fruits and vegetables. The acre yields for the generally grown crops are about 100 to 130 pounds of lint cotton and 10 to 15 bushels of corn.

In the parts of northeastern Texas where this very productive early soil occurs in extensive areas, it is highly valued for the production of tomatoes and other vegetable crops. It has excellent physical characteristics, and although not very productive under prevailing farming practice, it produces excellent yields when fertilized. Much of the soil here has been farmed without fertilization or protection from erosion; consequently crop yields are not high.

LIGHT-COLORED SANDY AND CLAY SOILS OF THE SLOPING UPLANDS

Light-colored sandy and clay soils of the sloping uplands comprise Susquehanna fine sandy loam; Chattahoochee loamy fine sand, rolling phase; Bowie fine sandy loam, slope phase; Nacogdoches-Kirvin complex; Teller fine sandy loam, slope phase; and Susquehanna clay. Under natural conditions these soils are forested and have a low fertility. Their slope encourages rapid erosion in cultivated fields unless the land is protected. Most areas are moderately rolling and are not so sloping that the control of erosion is infeasible. Only small areas are steeply sloping. Sheet erosion and more or less gullying have affected all cultivated areas. These soils are generally unsuited to the production of the general field crops, because of the combination of low productivity and erodibility. Where not severely eroded, they are suitable to such fruit and vegetable crops as produce sufficient returns to warrant fertilization and terracing. Some very good sites for fruit orchards are found in locations that provide superior air drainage, thereby tending to reduce losses by late frosts. Although grasses make fair growth where well established, pastures have a relatively low value. The native vegetation consists principally of oak trees that grow slowly and are of little value for lumber.

Susquehanna fine sandy loam.—The surface layer in virgin areas consists of grayish-brown friable fine sandy loam, from 2 to 4 inches thick, which grades into a subsurface layer of pale-yellow fine sandy loam. At a depth ranging from 6 to 12 inches the sandy layer is underlain by the subsoil, which is acid dense heavy clay mottled red, gray, and yellow. The red color decreases and the gray and yellow coloration increases with depth, and below a depth ranging from 20 to 30 inches the material is yellow acid compact clay

mottled with gray. At a depth ranging from 3 to 4 feet below the surface this is underlain by parent material of light-gray and yellow noncalcareous compact sandy clay. In most places the parent materials probably are old alluvium or stream-terrace materials. Most of the areas 5 miles north of Ector, 1 to 3 miles east of Duplex, and at Allens Point are underlain by marine or near-shore sediments of Cretaceous age (*12*).

In fields and areas formerly cropped the surface layer of sandy material has been thinned by erosion. In most fields the sandy layer is from 4 to 8 inches thick and of light grayish-brown color through plow depth, or, in small severely eroded areas where the subsoil is brought up by plowing, reddish yellow. There are local spots where all the surface soil has been washed away and the clay subsoil is exposed. In some places the subsoil differs from the corresponding layer in the typical Susquehanna soil in being yellow or reddish yellow, but these areas are too small to warrant separation on the map.

An acid reaction throughout is characteristic of Susquehanna fine sandy loam. The supply of organic matter is low, and some valuable plant nutrients are deficient. This soil differs from Susquehanna fine sandy loam, smooth phase, chiefly in that it is more sloping, is more severely eroded, and generally does not have small sand mounds over the surface. In the vicinity of Parker Grove School in the northwestern part of the county a few small areas of Susquehanna clay loam are included.

Oak trees, largely post oak and blackjack oak, make up the native vegetation.

This soil is widely distributed on undulating to gently rolling areas in the northern part of the county. At least three-fourths of the soil comprises margins of the very high and dissected terrace that blankets most of the northeastern part of the county. The surface gradient ranges from about 4 to 15 percent, but perhaps five-sixths of the land has a slope of 7 percent or less. Most of the steeper areas are 5 miles north of Ector, in sections surrounding Allens Point and Duplex, on the valley slopes of Sycamore Creek, and within a radius of 2 miles from the lake 10 miles north of Honey Grove.

About one-tenth of the soil is in cultivation, and this portion consists largely of the less sloping areas or small inclusions within fields mostly of smoother soils. One of the largest orchards in the county is located mainly on this soil. The operator reports that, except in places that were very severely eroded prior to establishment of the orchard, the peach trees thrive somewhat better on this soil than on adjacent smoother areas occupied by the smoother and somewhat heavier textured soil, Susquehanna very fine sandy loam. This orchard and other well-managed orchards on Susquehanna fine sandy loam are reported to produce very good yields of peaches of superior quality except in seasons when the fruit is destroyed by late freezes. Pears, blackberries, dewberries, and grapes also appear thrifty and are reported to produce successful crops.

Small areas are used for growing cotton and corn. Yields are very low under prevailing management and probably average not more than 75 pounds of lint cotton and 8 bushels of corn to the acre over a period of years. Newly cleared fields are reported to produce

at least one-third of a bale of cotton and 20 bushels of corn to the acre. About one-third of the area is in abandoned fields in which thin stands of unpalatable grasses and weeds provide sparse forage. The rest is uncleared woodland, most of which is pastured but produces little grazing. The soil responds well to good management, and yields are greatly increased by applications of organic matter, manures, and fertilizers. Much of the soil, however, is so thin or so susceptible to erosion that the expense of improving and protecting it for growing the general farm crops may not be warranted.

Chattahoochee loamy fine sand, rolling phase.—The surface soil is acid nearly loose loamy fine sand ranging from about 15 to 30 inches in thickness. The subsoil is red sandy clay. The upper part of the surface soil, to a depth of about 3 inches in wooded areas and through plow depth in fields, is grayish brown or brownish gray; the lower part of the sandy layer is grayish yellow or yellowish gray. The subsoil of red or yellowish-red acid sandy clay continues to a depth of 4 to 5 feet, where it rests on the parent material of red noncalcareous sand and clay derived from old alluvium. In a few places the loamy fine sand layer is from 3 to 4½ feet in depth. Here the subsoil is red sandy clay loam and is only from 12 to 18 inches thick. In local places the surface soil is fine sandy loam. On the terrace escarpment near Mulberry Store the soil is light-brown loamy fine sand, 8 inches thick, grading into yellowish-brown loamy fine sand, which, at a depth of 40 inches, passes into light-red fine sandy clay loam.

This soil includes the sandiest areas of sloping land in the northern part of the county, where it occupies escarpments of high forested terraces of the Red River and is extensively developed. Some of the larger areas are near Sash and Sowells Bluff Bridge. Where associated with other sloping light-colored sandy soils, it commonly occupies the lower slopes. The slopes range from 4 to 15 percent. Strongly sloping areas, with surface gradients of 10 percent or more, include not more than one-third of the total area and occur largely within a distance of 2 miles from the lake near Sash and along Cottonwood, Sandy, and Sycamore Creeks, which are north of Bonham. The soil erodes severely when cropped without protection. Effective erosion control is feasible in cultivated fields on the moderately sloping areas but not on the strongly sloping land. The areas that are or have been cultivated are eroded and somewhat gullied, and the sandy surface soil is commonly from one-half to two-thirds as deep as in adjoining uncleared areas. Both surface drainage and underdrainage are rapid.

Not more than one-tenth of the land is in cultivation, and between one-third and one-half of it consists of abandoned fields. A large part remains in native oak forest. The small areas in fields are used mainly for growing cotton and corn, together with some peanuts, cowpeas, fruits, and vegetables. Yields are generally very low. Cotton yields from 50 to 75 pounds of lint and corn 6 to 10 bushels to the acre. The few fruit trees observed on this soil were very thrifty, and the soil seems to be excellent for orchards. The abundance of native red oak trees on this soil seems to indicate its suitability for trees requiring favorable moisture conditions.

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Bowie fine sandy loam, slope phase.—The surface soil ranges from 8 to 15 inches in thickness and consists of mellow acid fine sandy loam that is light brown to a depth of 3 or 4 inches and pale yellow or very pale brown below. In fields that have long been cultivated the surface soil, because of erosion, is commonly only 4 to 8 inches thick and is generally pale grayish yellow. The surface soil passes into a crumbly solid-colored upper subsoil layer of yellowish brown, brownish-yellow, or reddish-yellow acid fine sandy clay, ranging from 6 to 10 inches thick and grading into crumbly yellow sandy clay mottled with numerous spots of yellowish red and streaks of light gray. This in turn is underlain at a depth ranging from 30 to 48 inches by a sandier layer of light-gray and yellow noncalcareous sandy clay loam or sandy clay, which is the parent material and is a deposit of ancient water-laid materials.

Although this soil is similar, other than in relief and erodibility, to normal Bowie fine sandy loam, it differs in having thinner soil layers, a slightly redder upper subsoil, and no associated sandy mounds.

This phase occupies most of the slopes adjacent to smooth areas of the normal phase in the northeastern part of the county. Large areas are along Coffeemill and Bois d'Arc Creeks. With the exception of the area about 2 miles east of Monkstown, this soil is confined to the dissected margins of the very old and highest terrace. The range of surface gradient is from about 4 to 8 percent, and all areas are liable to severe erosion in unprotected fields. Most of the areas that have been cultivated are severely eroded by sheet erosion and are also somewhat gullied. The native vegetation is a forest of post oak, blackjack oak, some red oak, and other trees.

About one-tenth of the soil is in cultivation, mostly to cotton and corn. Over a period of years the average acre yields range from 60 to 75 pounds of lint cotton and 6 to 10 bushels of corn in most of the older fields. About one-third of the area is formerly cropped land that is now abandoned and idle or affords scant pasture. The rest is uncleared woodland, most of which is pastured. The soil is well adapted to fruit and truck crops. Under the usual methods of management crop yields are low, but with good management and by using organic matter and fertilizers the yields may be increased. Owing to the rather steep slopes and the consequent rapid runoff of water with resulting erosion, it is probable that much of this soil might better be left as pasture or woodland.

Nacogdoches-Kirvin complex.—This soil complex comprises rolling eroded areas of sandy soils developed from tuffaceous sandstones and shales in the northwestern part of the county. It is an erratic association of several shallow somewhat red soils that are mostly forested and are not well suited to crop production and are only moderately valuable for pasture.

The most extensive soil in the complex is a rather shallow phase of Nacogdoches fine sandy loam. In the undisturbed areas the profile of that soil is as follows: (1) A 4- to 10-inch surface soil layer of friable slightly acid fine sandy loam, the color being brown or reddish brown to a depth of about 5 inches and light reddish brown below, grading into (2) a subsoil of red friable noncalcareous clay, which continues to a depth ranging from 15 to 24 inches and in turn grades into (3) the substratum of red and ocher-yellow noncalcareous crumbly

ferruginous sandstone. Ironstone fragments and concretions are present on the surface and throughout the soil. The Nacogdoches soil occupies possibly two-fifths of the area and occurs in small patches and strips, especially on the crests of knolls and ridges, interspersed between other soils.

The second most extensive soil of the complex is Kirvin fine sandy loam, which has the following profile: (1) A 4- to 10-inch surface soil of slightly acid fine sandy loam, grayish brown in the upper 4 inches and pale yellow below; (2) a 3- to 6-inch upper subsoil of red noncalcareous heavy but brittle clay, grading, at a depth ranging from 10 to 20 inches, into (3) a lower subsoil layer of mottled yellow, gray, and red noncalcareous clay.

In addition, the complex includes small spots of Nacogdoches clay loam, Kirvin clay loam, Susquehanna fine sandy loam, Crockett fine sandy loam, Choctaw fine sandy loam, and other related soils.

The Nacogdoches-Kirvin complex occupies a few areas in the rolling to hilly and mostly forested district 3 to 5 miles north of Savoy and Ector. The areas are moderately to strongly sloping, and the surface gradient ranges from 4 to 15 percent. Most of them are severely eroded and cut by numerous ravines and gullies. The native vegetation is forest—principally small post oak, blackjack oak, hickory, and elm—which has been largely cleared. In some places a dark-brown surface soil indicates a possible prairie development.

None of this soil complex is in cultivation. At least one-third of the area consists of severely eroded and gullied abandoned fields. Most of the complex is used for pasture, and a few areas are idle land. In the areas where the forest has been cleared the cover of grasses and other herbs ranges from very thin in the more eroded places to moderately dense in the less eroded places. In general, pasturage is somewhat more abundant on this soil complex than on the other soils of the sloping light-colored sandy group.

Teller fine sandy loam, slope phase.—The 6- to 15-inch surface soil is light-brown noncalcareous mellow fine sandy loam. This grades into the subsoil of red or yellowish-red crumbly noncalcareous silty or sandy clay loam, which reaches to a depth of several feet, where it is generally underlain by red sand. Some areas included with this soil east of Ragsdale Branch in the northeastern part of the county have a yellowish-brown sandy clay subsoil.

This soil occupies terrace escarpments where the slopes range from 4 to 15 percent but are less than 10 percent in at least two-thirds of the area. It occurs as a nearly continuous strip, 100 to 300 feet wide, bordering the flood plain of the Red River. Most of the largest areas are severely eroded and cut by numerous steep-walled gullies. Practically none of the soil is now in cultivation, and small areas comprise abandoned fields. Some of the areas might be cultivated without excessive erosion if they were properly managed. As the soil is liable to very severe erosion when cropped without protection and generally is the land of lowest suitability for cropland within the farms where it occurs, it is used as pasture. Where stands have become well established the soil supports a moderately dense growth of nutritious grass, mostly Bermuda grass. The soil was originally covered with a forest growth, mostly oak with some elm, cedar, and Osage-orange.

Susquehanna clay.—In virgin forested areas, the surface soil of Susquehanna clay is chocolate-brown very strongly acid clay to a depth of about 3 inches. Below this is red plastic brittle very strongly acid clay, which continues to a depth of 5 or 10 inches, where it grades into mottled light-gray and red very strongly acid very compact heavy clay. With depth the red coloration and the acidity gradually decrease, and at a depth ranging from 2 to 5 feet the material grades into bluish-gray noncalcareous very heavy shale. The areas are gently sloping, the slopes ranging from 1 to 4 percent.

A scrub forest of stunted post oak trees from 10 to 20 feet tall composes the native vegetation. Crops fail almost completely on the small spots included within fields along with more fertile soils. Blackberry bushes thrive, but otherwise the soil shows no indication of suitability for any crop, and it supports practically no grass or other palatable vegetation. A few livestock occasionally browse while on their way across the areas to places where there is some pasturage, but the soil is wasteland and essentially valueless for agriculture. It occupies a few small areas in the west-central part of the county, the largest of which is 1½ miles north of Savoy.

WELL-DRAINED BROWN OR REDDISH-BROWN SOILS OF THE STREAM TERRACES

Bienville very fine sandy loam, Bienville fine sandy loam, Bienville loamy fine sand, Teller very fine sandy loam, Teller fine sandy loam, Reinach silt loam, and Reinach loamy fine sand are well-drained brown and reddish-brown soils of the stream terraces. The physical characteristics of these smooth, fertile, easily worked soils are very favorable for the growth of crops. They are associated on terraces of the Red River, where the Teller soils occupy slight swells on ridges, the Bienville nearly flat but very well drained positions, and the Reinach soils mostly the lowest benches. Most of the associated poorly drained areas are occupied by soils of the Myatt and Irving series. In many areas, especially of the Bienville soils, the native vegetation was largely grass with some trees; but in other areas, especially those of the Teller soils, the native growth was hardwood forest. The forest growth was characterized by a greater abundance of red oak, hickory, dogwood, redbud, and hawthorn than occurred on the lighter colored sandy soils, such as Bowie fine sandy loam.

The soils of this well-drained terrace group, except Reinach loamy fine sand, are regarded by farmers as very desirable land and are almost entirely in cultivation. Most of them are used for cotton farming, but many of the farmers practice a more diversified type of agriculture than is common in upland prairie sections. The soils are especially productive for corn, which is grown on many farms for sale as a secondary cash crop or for feeding to livestock. Small acreages of alfalfa are grown, especially on Reinach silt loam. Most of the farmers do not grow small grains. Such special crops as peanuts, cowpeas, cucumbers, peaches, apples, berries, and sweetpotatoes are grown to some extent on some farms and are marketed locally.

Bienville very fine sandy loam.—The cultivated layer is brown friable rather heavy very fine sandy loam. The surface soil is noncalcareous and commonly slightly acid in reaction. The material below plow depth is dark-brown granular silt loam to a depth of about

15 inches and grades into a subsoil of light-brown or yellowish-brown acid crumbly permeable silty clay loam. The subsoil gradually becomes less dark and slightly heavier with depth, and at a depth of about 24 inches it gives way to a light yellowish-brown acid crumbly silty clay containing in its lower part a few soft black concretions of iron oxide. At a depth of 3½ or 4 feet this grades into dull-yellow noncalcareous fine sandy clay loam.

This soil occurs in nearly level to very gently undulating well-drained areas on some of the lower terraces of the Red River. Most of the areas have a surface gradient of about one-half percent, and none is strongly sloping or severely eroded. The largest areas are in the vicinities of Mulberry and Tulip, in the northwestern and central-northern parts of the county. The area 5 miles northeast of Monkstown, which is surrounded by Brewer and Yahola soils, lies partly within the overflow limit of extreme floods and originally was forested with thrifty oak and other hardwoods. The native vegetation was coarse prairie grasses in the characteristic areas. Underdrainage is free, and drainage is adequate for all common crops to thrive.

This easily worked fertile soil responds very well to management and produces good yields of all the general field crops and many special vegetable and fruit crops. Practically all of the area is in cultivation and used for the production of cotton and corn together with some grain sorghums, sorgo, peanuts, cowpeas, fruit, and vegetables. The largest commercial orchard in the county is located largely on this soil and produces good yields of peaches, apples, and pears except during years of late killing frost. Some orchardists claim that the fruit produced on this soil does not color so well as that grown on sandier soils with heavier subsoils. The prevailing acre yields over a period of years without fertilization are about 140 to 170 pounds of lint cotton, 15 to 25 bushels of corn, about the same quantity of grain sorghums, 1½ to 2½ tons of sorgo hay, and 20 to 30 bushels of oats.

Bienville fine sandy loam.—The surface soil consists of brown slightly acid fine sandy loam, about 12 to 15 inches thick, grading into light-brown or yellowish-brown slightly acid fine sandy loam, which reaches a depth ranging from 18 to 30 inches. The subsoil beneath is light yellowish-brown or brownish-yellow crumbly acid sandy clay or sandy clay loam. Below a depth of 36 inches the subsoil is a heavier sandy clay and contains a few rusty-brown spots about one-fourth of an inch in diameter. At a depth of about 60 inches this grades in turn into dull-yellow noncalcareous sandy clay loam. The underlying beds are of sandy alluvial materials.

This soil occupies nearly level or very gently undulating well-drained positions on the lower terraces of the Red River. In general the surface ranges from level to a slope of about 1 percent, although small strips adjacent to escarpments have surface slopes as steep as 4 percent. Water erosion is nowhere significant, but wind drifts the soil somewhat in a few of the sandier spots. The characteristic native vegetation was coarse bunchgrasses; a few areas, however, apparently were forested with oak and other hardwood trees. This soil is the most extensive of the group and occurs in many good-sized areas on the lower terraces of the Red River, especially in the vicinity of Monkstown.

Favorable characteristics of this soil are the fairly high content of organic matter, ease of tillage, good response to management, and physical properties that aid crops to withstand droughts. It is well suited to cotton, corn, grain sorghums, peanuts, cowpeas, cucumbers, and many other crops. At least three-fourths of the soil is in cultivation, and none of it is in abandoned fields. Cotton returns rather low yields, partly because of the prevalence of the boll weevil and other insects. Yields vary considerably with management, but, where the land is farmed according to prevailing practices without fertilization or other methods of replenishing fertility, they are materially higher than on similarly managed light-colored sandy soils. Cotton occupies between one-third and one-half of the cropped acreage, corn about one-third, and grain sorghums, peanuts, cowpeas, cucumbers, and sweetpotatoes most of the rest. According to local reports the acre yields are about 15 to 20 bushels of corn, 125 to 160 pounds of lint cotton, and 30 to 50 bushels of sweetpotatoes. The fields in sweetpotatoes or other vegetable crops are generally fertilized with barnyard manure or small amounts of mixed commercial fertilizers.

Bienville loamy fine sand.—The surface soil is brown acid loamy fine sand that is dark brown when wet. In old fields the plowed layer is light brown and distinctly less dark than the material below plow depth. The brown surface soil is from 15 to 20 inches thick and grades into pale-yellow loamy fine sand. At a depth ranging from 36 to 48 inches this is underlain by yellow fine sandy loam or fine sandy clay loam, which becomes more sandy below a depth of 5 or 6 feet. The plowed surface soil is very friable and loose.

This soil occupies low flats or terraces along the Red River, mostly in the northeastern part of the county. The largest areas are in the immediate vicinity of Monkstown, and smaller areas are 4 miles north of Monkstown and 3 miles northwest of Telephone. The areas are very gently undulating and for the most part were prairies. The soil is not subject to erosion by water, but wind erosion occurs occasionally in bare fields. After extended rainy periods during cool weather the lower part of the surface soil is waterlogged for several weeks, owing apparently to a rise of the water table to within a few feet of the surface.

This soil produces rather low to moderate yields of most field crops. About one-half is in cultivation, mainly to cotton and corn, with some peanuts and cowpeas. Fairly high yields are obtained after applications of manure. Under prevailing practices without fertilization the acre yields are about 75 to 125 pounds of lint cotton and 8 to 15 bushels of corn.

Teller very fine sandy loam.—The surface soil is 15 or 18 inches thick and consists of brown or reddish-brown slightly acid to neutral very fine sandy loam. It grades into a subsoil of red crumbly permeable noncalcareous clay loam or silty clay that is many feet deep. The soil is somewhat similar to Bienville very fine sandy loam but is slightly better drained and not so dark. Cultivated fields have a distinct red hue.

This soil occupies smooth to very gently undulating well-drained positions on river terraces in the central-northern and northwestern

parts of the county. The largest areas are at Tulip and 3 miles southwest of Mulberry. The soil occurs largely as marginal borders of the first river terrace adjacent to the escarpment leading down to the flood plain. Internal drainage is free. The areas have surface gradients of 1 percent or less and are not liable to severe erosion. The area half a mile south of Anthony in the northwestern part of the county is affected by overwash of local alluvium washed from adjacent higher slopes of Nacogdoches soils.

This is an easily worked fertile soil, responsive to good management and productive for all the common field crops and for vegetables and fruits. About four-fifths of the land is in cultivation, principally to cotton and corn, with small areas in miscellaneous crops, including grain sorghums, peanuts, cowpeas, sorgo, Sudan grass, sweetpotatoes, cucumbers, peaches, and apples. In a large orchard including both this soil and Bienville very fine sandy loam no observable differences in tree growth, coloration of fruit, or productivity are noted. Yields of general field crops apparently are about the same as those on Bienville very fine sandy loam—about 140 to 170 pounds of lint cotton and 15 to 25 bushels of corn to the acre.

Teller fine sandy loam.—The surface soil is fine sandy loam, brown with a slight reddish hue, slightly acid to neutral, from 12 to 18 inches thick. It grades into the subsoil of red friable permeable noncalcareous fine sandy clay loam, which is many feet deep.

This soil occupies smooth to gently undulating well-drained positions on low to medium-high terraces of the Red River, mostly in the northwestern part of the county. The surface gradient ranges from ½ to 4 percent, although nearly all of the area slopes not more than 1 percent. The largest area is 2 miles south of the northwestern corner of the county. This soil is very similar to Teller very fine sandy loam but has a slightly coarser sandy surface soil.

In those few areas that have never been cultivated, the native vegetation is hardwood forest with southern red oak, post oak, blackjack oak, and hickory as the dominant species. These virgin areas generally have a slightly less dark surface soil than is characteristic. Notations of vegetation in field notes of early land surveys indicate that the large typical area 2 miles south of the northwestern corner of the county was a prairie.

This soil is almost entirely in cultivation and used for the production of cotton, corn, peanuts, and small quantities of fruit and vegetables for sale. It is productive for all common field crops and seems to be an excellent soil for garden and orchard crops. Cotton occupies most of the land, and corn most of the rest. Cotton yields 125 to 160 pounds of lint and corn 15 to 20 bushels to the acre.

Reinach silt loam.—The 15-inch surface soil layer is chocolate-brown mellow silt loam. Normally it is about neutral in reaction, although in some places it is calcareous. The plowed soil has a fine-crumb tilth and is readily worked. Below the plowed layer, in which the natural structure has been destroyed by tillage, the material is slightly granular and dark brown on a broken surface and chocolate brown when crushed. The surface soil grades into light-red calcareous mellow silt loam or very fine sandy loam, which continues

without apparent change to a depth ranging from 4 to 8 feet. Below this are red sands erratically interbedded with thin lenses of clay.

The mapped areas include in some places small bodies of Reinach very fine sandy loam and in other places smaller bodies of Reinach clay loam. The area a quarter of a mile southwest of the mouth of Bois d'Arc Creek and the western three areas 1¼ miles northwest of Gossville are bodies of Reinach clay loam. This included soil has a 15-inch surface soil of dark chocolate-brown calcareous or neutral very friable clay loam, underlain by red calcareous silt loam or clay loam.

Reinach silt loam occupies low terraces just above or within the flood plains of the Red River. According to long-time residents, the areas of the soil were flooded in 1908 but have not been inundated at any other time during the last 70 years. The areas of this soil are near the northeastern corner of the county, north of Mulberry in the northwestern part, and north of Tulip. They are nearly level to very gently undulating, with a surface gradient of less than 1 percent, but drainage is free. The shallow water table lies deep enough to allow free underdrainage, but in most places it lies within the reach of alfalfa and tree roots. Residents report that in some of the areas near Mulberry, many cotton and alfalfa plants die, apparently from cotton root rot.

This soil, except for small areas in roads, farmsteads, and the like, is entirely in cultivation. Corn is the most extensively grown crop, with cotton a close second, and together these crops occupy at least four-fifths of the soil. Small acreages are used for alfalfa, grain sorghums, and occasionally some oats. The soil is highly productive, and, as it is early and easily worked, it is regarded by farmers as especially desirable land. Acre yields range from 125 to 250 pounds of lint cotton, 20 to 30 bushels of corn, 2 to 3 tons of alfalfa, and 20 to 30 bushels of oats.

Reinach loamy fine sand.—The surface soil ranges from 10 to 15 inches in thickness and consists of reddish-brown calcareous loamy fine sand. It is very mellow and rather loose, and in spring before fields have a cover of crops the soil drifts in the heavy winds. The surface soil grades into light-red calcareous loose fine sand or loamy fine sand, which reaches to a depth of many feet. In many places the texture of the surface soil approaches a loamy very fine sand. The soil as mapped includes small spots of Reinach fine sandy loam and very fine sandy loam.

This soil occupies small areas with billowy or dunelike surface configuration. Only five areas are mapped, four north of Mulberry and one north of Tulip. The areas were mostly idle abandoned fields supporting a medium dense cover of Johnson grass at the time of the survey. Local residents report that prior to abandonment of the fields the yields were low. The land seems to be too sandy for successful production of cultivated field crops.

SLOWLY DRAINED GRAY AND DARK-GRAY SOILS OF THE STREAM TERRACES

Slowly drained gray and dark-gray soils of the stream terraces are members of the Brewer, Ivanhoe, Myatt, and Irving series. These soils have dark-gray, gray, or grayish-brown acid surface

soils. Brewer clay loam has a permeable dark-gray silty clay subsoil, whereas the other soils are underlain by gray compact subsoils that are more or less mottled with brown shades of yellow and red. In the Myatt soils the subsoil lies 2 to 3 feet below the surface and is a compact though fairly friable sandy clay; in the Ivanhoe and Irving soils it lies within 6 to 15 inches of the surface and is a very heavy clay. The Brewer soil has slow drainage, and the other soils have very slow or no drainage either internally or from the surface. Water saturates the surface soil layers for several weeks after heavy rains in cool seasons, and shallow pools stand on the surface in the lower positions. In some areas drainage can be improved somewhat by constructing shallow open ditches, but many areas are so nearly level and so broad that the fall is insufficient for artificial drainage to be very effective. General field crops are grown in most areas without artificial drainage other than that incidentally afforded by the construction of graded dirt roads; but yields, except those on Brewer clay loam, are low to moderate. Brewer clay loam is a productive soil, in contrast with the other members of this group, which are not well suited to corn, as they are commonly too wet and cold in spring and too droughty late in the season. Oats are the principal feed crop.

These poorly drained gray soils are confined to nearly level and undissected areas on high terraces or flats flanking the Red River. Most of the areas were prairies, but the land supported a considerable growth of hawthorn, redbud, winged elm, and other shrubs and small trees that thrive in wet locations. The two large areas of Ivanhoe silt loam were free of woody vegetation. A few of the areas of Myatt soils were open forests of post oak, blackjack oak, and elm, with considerable grass in interspersed glades.

Most of these poorly drained gray soils are suitable for general field crops but are only moderately productive and are somewhat difficult to work.

Brewer clay loam.—This soil is locally known as black loam. The surface soil, ranging from 12 to 18 inches in thickness, consists of dark-gray or very dark grayish-brown noncalcareous crumbly clay loam. This grades into the subsoil of dark-gray or very dark gray permeable noncalcareous silty clay or light clay, which in turn grades into gray noncalcareous clay loam at a depth of about 36 inches. Here and there the subsoil contains a few inconspicuous spots of brown. An overwash of brown fine sandy loam or loam covers the surface in a few places.

The principal area of this soil extends from Duplex to Elwood along the base of the slopes leading down from High Prairie where hillside streams spread out over the lower flat. Other areas are north of Monkstown and near Anthony. Surface drainage in these nearly level areas is slow, but internal drainage is sufficiently free for successful cultivation of the land. The areas north of Monkstown were overflowed by floodwaters of the Red River during the exceptional flood of 1908. In some places natural drainage is inadequate for the successful production of crops, but most of these places have been drained by ditching.

This is a highly fertile soil. Its physical characteristics and moisture relations are excellent. Nearly all of the land is in cultiva-

tion, mainly to cotton and corn, with some grain sorghums and alfalfa. The prevailing acre yields are about 200 pounds of lint cotton, 25 to 35 bushels of corn, and 2 to 4 tons of alfalfa.

Ivanhoe silt loam.—The surface soil is gray or grayish-brown strongly acid silt loam. It ranges from 10 to 15 inches in thickness and passes into or rests abruptly on the compact subsoil. The upper part of the subsoil is brown or mottled dark-gray and brown strongly acid very dense tough extremely heavy clay containing numerous spots of brownish red. The layer containing distinctly red spots is only from 2 to 5 inches thick, and it is thickest and the spots most deeply red in places where the subsoil lies relatively deep or in places where the surface has a slight but distinct slope. With depth the colors become less dark and the red spots become more yellow and less distinct. From 15 to 20 inches below the surface the subsoil changes to mottled gray and yellowish-brown very dense and tough noncalcareous very heavy clay. At a depth of about 3 feet this in turn grades into indistinctly mottled light-gray and dull-yellow noncalcareous very heavy clay, which, judging from the slight undercutting of ditch walls at this depth, is slightly less compact than the material above. This deepest layer is the parent material and consists of an old stream deposit.

Ivanhoe silt loam is somewhat intractable, as it is crumbly only within a very limited range of moistness and is commonly either too wet or too dry to plow well. On drying after rains a hard surface crust forms, which interferes with the emergence of germinating plants, and adequate stands of many crops are obtained only with difficulty. Below plow depth the material of the surface layer has no definite structure and is permeated by threadlike tubes. The subsoil also has no definite structure; it is a gummy mass when moist, and it cracks to large irregular extremely hard clods of no particular shape on becoming very dry. The fine earth of the parent material is noncalcareous in most places, although the parent material is alkaline and contains a few hard lumps of calcium carbonate. A few black shotlike pellets of iron oxide occur in all the soil layers, and friable concretions of rusty-black iron oxide are numerous in the upper part of the parent material.

Mounds ranging from 3 to 5 feet in height and from 40 to 60 feet in diameter occupy from one-fiftieth to one-fifth of the area. These mounds have a thick surface soil and a more intensely colored subsoil. In undisturbed areas the surface soil on the crests of the mounds ranges from 4 to 5 feet in thickness and consists of silt loam or very fine sandy loam that is brown to a depth of about 18 inches and pale brownish yellow below. The subsoil under the mounds is dull-yellow clay with light-gray streaks and some yellowish-red spots. In cultivated and leveled fields the mound sites are evident as browner spots on which crops make poor growth. Farmers report that when the mounds were first cropped the growth of crops was more vigorous on the mounds than elsewhere. The soil between the mounds has the typical profile of Ivanhoe silt loam. In some areas, especially where the surface soil is somewhat shallower than average, the central parts of the areas between mounds have a subsoil of dark-gray clay and are included spots of Irving silt loam.

This soil occurs principally in two very large and uniform areas, one on Hawkins Prairie and on its extension north of Coffeemill Creek known as High Prairie, in the northeastern-central part of the county, and the other on Free Hart Prairie, about 8 miles north of Honey Grove. These two broad areas are essentially level flats that constitute the undissected parts of a very high and very old river terrace. The central part of Hawkins Prairie in the vicinity of Ivanhoe slopes less than 1 foot to the mile. Surface drainage is very slow, and water stands on the surface in places for a month or longer in very rainy weather. In most areas, however, drainage is adequate for crop production. Numerous examinations indicate that the soil is not underlain by a permanent shallow water table, and, according to well drillers, the ground-water level lies from 40 to 100 feet below the surface in underlying sandy beds. Ivanhoe silt loam occurs also in several smaller areas on lower terraces where it occupies the transitional zones around the margins of areas of Irving silt loam, mound phase, and Irving silt loam. The surface is nearly flat to gently undulating.

Most of Ivanhoe silt loam is used for cotton farming. Oats are the principal feed crop and the secondary cash crop. A few large livestock farms concerned primarily with the grazing of beef cattle are located on this soil, but about three-fifths of it is in cultivation. Cotton normally occupies about one-half of the tilled area, oats about one-fourth, and corn, grain sorghums, sorgo, and wheat the rest. Landowners report that yields, especially of corn, obtained by different tenants vary widely, apparently being greatly affected by the conditions of tilth and slight variations in planting time. Yields of cotton over a period of years range from 75 to 125 pounds of lint an acre and average about 100 pounds. The average yield of corn is about 10 bushels. The maximum yield obtained under prevailing management is about 30 bushels, but near failures because of drought are not uncommon. Oats produce about 20 bushels an acre in most years and an occasional maximum in individual fields of about 60 bushels.

Irving silt loam.—The surface soil is gray acid silt loam, from 7 to 12 inches thick, passing through a very short gradation into the subsoil of dark-gray or very dark gray strongly acid very compact tough heavy clay. Below a depth of about 20 inches this upper subsoil grades into noncalcareous gray neutral or slightly alkaline tough clay. The lighter colored lower subsoil reaches to a depth of 3½ or 4 feet, where it grades into slightly less compact parent material of light-gray noncalcareous nearly impervious clay. This soil has developed from old alluvium on smooth stream terraces.

Irving silt loam is very similar in appearance, and apparently also in suitability for crops, to Ivanhoe silt loam. It is grayer in the surface soil and somewhat darker in the upper subsoil. The subsoil layers, as a rule, are not so brown and the surface soil generally not so thick as the corresponding layers of Ivanhoe silt loam.

Irving silt loam is rather intractable, as the range of moisture in which it can be readily worked is narrow. It dries to a very hard mass unless cultivated after each rain. The soil crumbles readily to fine crumbs when moderately moist, unless puddled by cultivating in a too moist condition. The subsoil is extremely heavy and absorbs

moisture very slowly. It has no well-defined structure but is nearly massive in place. Dry material breaks under pressure into irregular clods.

Some areas of Irving silt loam have a surface soil of light-gray silt loam and a subsoil that is dark gray to a depth of only 12 to 15 inches. Such areas were mostly forested. The largest of these lighter colored areas are 2 miles southeast of Lamasco, 1 and 1½ miles northwest of Ravenna, 1 mile west of the mouth of Timber Creek, and the eastern two-thirds of the area 2 miles southeast of Monkstown.

Irving silt loam occupies nearly level areas having a surface gradient of less than one-half percent. Surface drainage is very deficient, and underdrainage is so slow that water stands on the surface for a long time after rains. The subsoil was found to be hard and dry at a depth of 3 feet in several places that had been covered with water for 2 months, but in cultivated areas the subsoil commonly becomes moist to a depth of many feet during wet winters.

This soil occurs on terraces or benches of the Red River in the northern part of the county. The largest body is 2 miles northwest of Ravenna and is known as the Rainey Flat. The general position of most bodies of this soil is within belts along the interior borders of medium-high terraces, flanked on the north by areas of associated Bienville and Myatt soils and on the south by a gentle rise or slight escarpment to a higher terrace or to the upland plain. Except for the small area at Telephone and the two small areas half a mile south and three-quarters of a mile north of Ivanhoe, all the areas on the highest terrace are forested and light-colored.

About half of this soil is in cultivation. The main areas not in cultivation are the lighter colored soil. The soil is used for cotton farming, with cotton occupying about half of the tilled acreage. About one-third of the fields are used for oats and about one-sixth for corn. The productivity is practically the same as that of Ivanhoe silt loam, and yields commonly obtained are about 75 to 125 pounds of lint cotton, 8 to 15 bushels of corn, and 15 to 25 bushels of oats to the acre.

Irving silt loam, mound phase.—This phase is a complex wherein the dominant areas are of Irving silt loam over which are scattered small sand mounds. The mounds constitute from one-twentieth to one-fourth of the areas. For the most part the soil of this phase is somewhat lighter colored and more poorly drained than the normal phase.

Between the mounds the surface soil is gray very strongly acid silt loam from 6 to 15 inches thick. It passes into an extremely compact subsoil of gray or dark-gray very strongly acid slightly sandy heavy clay. At a depth of about 24 inches the subsoil becomes light-gray extremely compact heavy sandy clay. This is underlain, at a depth ranging from 42 to 48 inches, by the less compact and slightly sandier parent material of light-gray and brownish-gray noncalcareous sandy clays. When dry the subsoil is extremely hard, and when moist it is very firm.

On the mounds the surface soil is strongly acid friable very fine sandy loam that is grayish brown to a depth of about 18 inches and very light brown or pale brownish yellow below. At a depth ranging from 24 to 48 inches it is underlain by a compact subsoil of brownish-

yellow and light-gray heavy sandy clay containing some yellowish-red spots in the upper part. Beneath most of the mounds a thin transitional layer of sandy clay or sandy clay loam lies between the surface soil and the subsoil.

This phase is extensively developed only on the medium-high terraces of the Red River. Most of it is on low flats in the vicinities of Monkstown and Elwood. The few small areas on the highest terrace, those associated with extensive bodies of light-colored sandy soils, are forested with post oak. They have a 4- to 8-inch surface soil of light-gray acid silt loam and a subsoil of dark-gray very heavy clay, grading into light-gray heavy noncalcareous clay at a depth of about 15 inches.

The land is nearly level to slightly depressed. During wet weather water stands between the mounds in most areas. Underdrainage is very slow or wanting. In some places, especially in the vicinity of Monkstown, the water table lies at a shallow depth and rises to within a few feet of the surface after extended rainy periods. Many of the areas are swales shaped like an ox bow, clearly indicating that they are abandoned river channels.

This soil is used for cotton farming, and between one-fourth and one-half is in cultivation. Most areas not in cultivation are slight depressions that are too wet for successful crop production unless artificially drained. Yields are prevailingly low and vary considerably with drainage. Cotton is the principal crop; it normally occupies more than half of the tilled area and in most fields produces from 75 to 100 pounds of lint to the acre. Corn is not generally grown, as soils better suited to corn are available on most farms. Oats are the principal crop other than cotton and in most fields produce from 10 to 20 bushels of grain to the acre.

Irving clay loam.—This soil resembles Wilson clay loam but differs in having a somewhat lighter colored surface soil. It occurs only in poorly drained positions on old stream terraces.

The 4- to 10-inch surface soil consists of gray strongly acid crusty intractable clay loam. This gives way to an upper subsoil layer of dark-gray strongly acid extremely compact tough gummy heavy clay, which reaches to a depth of about 24 inches. The lower subsoil layer is gray neutral to mildly alkaline very compact heavy clay. This is transitional to the parent material, which lies at a depth of about 36 inches and consists of light-gray noncalcareous or slightly calcareous heavy clay. Rusty-black friable concretions of iron oxide, indistinct spots of light brown, and a few hard lumps of calcium carbonate are present in the upper part of the parent material.

Tillage is very difficult, as the soil is commonly too wet or too dry to crumble readily and is frequently too wet to be tilled at the optimum time for planting crops. During most summers the soil becomes so dry that crops deteriorate greatly. The soil bakes to an extremely hard mass unless cultivated before becoming too dry, and adequate stands of many crops are obtained with difficulty.

The land is level or practically level, as slopes do not exceed one-half percent. Surface drainage is very deficient, and underdrainage through the dense subsoil is practically lacking. Nearly everywhere the native vegetation consisted of grass with very little brush or trees. The soil occurs on terraces or benches of the Red River. The

largest bodies of this soil are 1 mile south of Monkstown, 1 mile northeast of Monkstown, and 3 miles northwest of Ravenna. In one area 1 mile northeast of Monkstown a body of Irving clay is included.

About three-fourths of the soil is in cultivation and used for cotton farming. The yields in most fields range from about 100 to 150 pounds of lint, 10 to 15 bushels of corn, and 20 to 30 bushels of oats to the acre.

Myatt very fine sandy loam.—The surface soil consists of strongly acid friable though crusty heavy very fine sandy loam. To a depth ranging from 4 to 7 inches the surface layer is gray or grayish brown, and below this depth it is light-gray very strongly acid somewhat heavier very fine sandy loam with indistinct light-brown splotches. At a depth ranging from 15 to 24 inches the surface soil grades into an upper subsoil layer of light-gray very strongly acid fine sandy clay loam spotted with yellowish brown. This is a transitional layer, ranging from 6 to 12 inches in thickness, its thickness varying with that of the surface soil. The subsoil gradually becomes heavier with depth and slowly changes into light-gray very strongly acid fine sandy clay containing numerous yellow spots. The depth to the fine sandy clay ranges from about 21 to 36 inches and is commonly about 30 inches. This lower subsoil layer continues to a depth of 40 to 50 inches, where it gives way to the somewhat sandier parent material, consisting of yellow and light bluish-gray strongly acid sandy clays. The underlying beds are of sandy alluvial materials.

The surface soil is friable and readily worked throughout a wide range of moisture content. The lower part is permeated by a network of fine tubes and contains numerous pellets of iron oxide. The material of the subsoil layers seems very friable when examined with an auger, but in some places it is firm when moist and is very hard when dry. It seems to be very lightly cemented into an incipient hardpan. The natural breakage is into flat-faced cuboidal fragments with light-gray exteriors and brown or ocher-yellow centers. These fragments are from 2 to 4 inches in diameter in the top of the sandy clay loam layer and gradually decrease in size with depth to about three-fourths of an inch in the middle of the sandy clay layer. Moisture penetrates the substrata freely, and the water table commonly rises to or near the surface during very wet seasons.

More or less numerous sandy mounds with thickened surface soil layers occupy from one-fiftieth to one-tenth of the area. Adjacent to these mounds a few spots of red are common in the subsoil. Here and there the deeper subsoil is gray heavy clay, but this is overlain by a thick layer of crumbly sandy clay. Pellets of iron oxide are rather abundant on the surface and are conspicuous in clean fields that have dried without cultivation.

Myatt very fine sandy loam occupies level or slightly depressed areas, mostly in association with Bienville very fine sandy loam. Surface drainage is absent, and underdrainage is frequently prevented during wet weather by a high water table. Below a depth of about 1 foot the soil remains waterlogged during most of the cool season. The areas are confined to the middle series of river terraces, to those well above overflow but lower and much younger than the old very high dissected terrace represented by Hawkins Prairie.

The native vegetation is either grass with a few scattered trees and shrubs—mainly Osage-orange, honeylocust, winged elm, and hawthorn—or open forest of post oak with some blackjack oak, hickory, and elm. The gray or grayish-brown upper part of the surface soil is somewhat thicker where grass makes up the native vegetation. The largest areas are in the northwestern part of the county. The area just west of Finley School is representative of those areas where the native vegetation consists of forest, and the area half a mile southeast of Mulberry is representative of those developed under grass.

About one-half or two-thirds of the soil is cultivated and used mostly for cotton and to some extent for oats. Better drained soils, which are more suitable for corn, are available on most farms. Where drainage is not deficient, cotton and oats return moderate to high yields. Artificial drainage by tiling probably would be effective, as the deeper layers seem to be sufficiently permeable to allow ready movement of drainage waters. The prevailing yields of lint cotton range from about 75 pounds an acre in the most poorly drained areas cropped to about 160 pounds in fields that have been ditched and are well farmed, and the average over a period of years is probably about 120 pounds. The average yield of oats is probably about 15 bushels an acre.

Myatt fine sandy loam.—This soil differs from Myatt very fine sandy loam in having a thicker and coarser surface soil containing less silt and clay. The surface soil ranges from 20 to 30 inches in thickness and consists of mellow very strongly acid fine sandy loam that is gray or grayish brown to a depth of 8 or 12 inches and light gray spotted with light brown below. The brown spots are distinct only when the material is moist. The surface soil grades through a 3- to 6-inch layer of sandy clay loam into the subsoil of mottled light-gray and brownish-yellow very strongly acid fine sandy clay. At a depth of 42 to 50 inches this rests on the somewhat sandier parent material of noncalcareous sands and sandy clays of alluvial origin. The depth to the parent material is relatively uniform, as the subsoil is thin where the surface soil is unusually thick.

The surface soil, being mellow, can be tilled throughout a wide range of moisture content. The structure and the color distribution are about the same as in Myatt very fine sandy loam. The structural aggregates are from 1 to 3 inches in diameter and when wet are very firm until crushed. An incipent hardpan in the subsoil is slightly more marked than in Myatt very fine sandy loam. Numerous concretions of iron oxide occur on the surface and throughout the soil. They are larger and more friable in the lower depths and form the central cores of many of the brownish-yellow spots in the subsoil. The areas contain many sandy mounds, which occupy from one-twentieth to one-third of the surface and consist mostly of Bienville fine sandy loam or Bienville loamy fine sand.

Large areas of Myatt fine sandy loam occur in the northeastern part of the county on the low terrace of the Red River that extends from Tulip to the flood plain of Bois d'Arc Creek, especially in the vicinity of Monkstown. Small areas occur on slightly higher terraces, but none occurs on the very high and old terraces. The areas in the vicinity of Monkstown represent prairies that were covered with coarse bunchgrasses together with scattered shrubs of hawthorn,

winged elm, and plum. Some of the other areas were forested with post oak, dogwood, redbud, elm, hawthorn, and associated trees and shrubs.

The land is nearly level to slightly depressed. The associated deeper depressions are generally occupied by Irving silt loam, mound phase, and the associated better drained spots by Bienville fine sandy loam. Underdrainage is fairly free unless the water table rises near to the surface, which happens occasionally in very rainy seasons.

This soil is used mostly for cotton farming, and about two-thirds is in cultivation. Cotton and corn are the only crops grown extensively, and the former occupies more than half of the cultivated land. Small acreages are in cowpeas, peanuts, grain sorghums, and sorgo. Farmers consider this soil about as productive as the associated better drained Bienville fine sandy loam, although it is somewhat later and not so suitable for vegetables and fruit. Acre yields range from 100 to 150 pounds of lint cotton and 8 to 15 bushels of corn.

SOILS OF THE FLOOD PLAINS

This group includes all soils of the Trinity, Catalpa, Kaufman, Ochlockonee, Yahola, and Miller series. All these soils are composed of stream sediments or alluvial materials and have little or no development of a soil profile. These soils retain some of the features of soils of the uplands from which the soil materials have been washed. More or less deposition of fresh soil material continues, as it occupies positions that are overflowed at intervals either by floodwaters from the adjacent stream or by local runoff from adjacent hillsides.

Capabilities for land use range from very highly productive for general field crops to entirely unsuitable on account of frequent flooding, deficient drainage, excessive sandiness, or low fertility. In order to bring out the relation of soils and crops, the group may be subdivided on the basis of texture into three subgroups of different fertility. For the sake of simplicity, however, the individual soil types and phases in each series are described together.

The first subgroup includes types and phases having clay surface soils—Trinity clay; Catalpa clay; Catalpa clay, high-bottom phase; Miller clay; and Yahola clay. These are very strong, highly fertile, crumbly soils, which, where adequately drained, are well suited to and highly productive for general field crops, especially for corn and alfalfa. Their value and suitability for cropping differs with the drainage and the frequency and duration of overflows. They are the most fertile or potentially the most productive soils of the county. Considerable areas require protection from the overflow hazard before they will be suitable for crop production. The adequately drained areas are very largely in cultivation and are used for general field crops, especially corn.

The second subgroup of flood-plain soils comprises medium-textured soils—Kaufman clay loam; Kaufman clay loam, high-bottom phase; Kaufman loam; Kaufman loam, high-bottom phase; Catalpa clay loam; Ochlockonee fine sandy loam; Yahola clay loam; and Yahola very fine sandy loam. These flood-plain soils have moderately free to free underdrainage and are situated in positions where overflows either are infrequent or recede quickly. Drainage is nearly everywhere adequate. These soils are highly productive for a wide

variety of general field crops and some special crops; they are largely cultivated and are used mostly for cotton farming. Compared with the bottom-land clay soils, they are somewhat less strong but are somewhat easier to work, as they dry out more rapidly after floods and tillage implements require somewhat less power than on the clay soils.

Yahola fine sand and Yahola loamy fine sand—very sandy soils—constitute a third subgroup of flood-plain soils. The natural fertility is low, and wind-blowing is a problem in cultivated fields. In general, these soils, locally called sand-bar land, are unsuitable for cropland and are used mostly for pasture. Grass grows well except in the most sandy areas.

Trinity clay comprises soil materials transported by streams draining areas principally composed of smooth crumbly heavy very dark soils of the prairies. The Catalpa soils represent materials washed chiefly from sloping crumbly heavy soils of the prairie, especially of the Austin series; the Kaufman soils, materials from acid soils of the prairies; the Ochlockonee soil, material from light-colored forested sandy soils; and the Yahola and Miller soils, materials largely from the "Red Beds" of the western plains.

The areas of Yahola and Miller soils are subject to removal and to accretion or sedimentation of alluvium by the shifting channel of the Red River.

In some places the channel changed as much as a quarter of a mile by cutting and accretion in the 2-year period of 1936–37, but in all places the channel of the river and the areas of soil in its flood plain are indicated on the map as they existed in the early summer of 1936. Comparison of the soil map of Fannin County with the soil map of Bryan County, Okla., made in 1914, the General Land Office maps of Oklahoma made at a somewhat earlier date, and field notes of land surveys in Fannin County, some of which were made as early as 1836, confirms the reports of local residents that the channel continually and rapidly shifts back and forth across the flood plain. This shifting is done mostly by cutting and by sedimentation along old channels but in some places by the cutting of new channels. According to reports, some parts of the channel have shifted gradually more than a mile north and then returned gradually to their original position during the 100 or more years since settlement of the county. The flood plain of the Red River is overflowed once in about 5 to 10 years. The greatest flood of record occurred in 1908.

Straightening the stream channels has greatly improved the drainage throughout very large areas of Trinity clay and Catalpa clay in the flood plains of Bois d'Arc Creek and the North Sulphur River. This work was done by water-improvement districts, which are governmental organizations with taxing power. According to the secretary of one of the drainage districts, the cost of drainage was approximately $28 an acre of land drained in the district, which extends from a point near Randolph to a point north of Dodd City. This straightening of the channel afforded adequate drainage except near the lower end of the straightened channel, where overflows are now worse than before, owing to failure to continue the projected straightening to the mouth of Bois d'Arc Creek. The straightened channels are scouring wider and deeper, so that the protection afforded the land should con-

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tinue to improve. The benefited areas are not entirely protected, as they still overflow occasionally; but the floodwaters recede rapidly and generally do not persist long enough to destroy crops.

Loss or deterioration of crops caused by cotton root rot is exceptional on these bottom-land soils and is confined chiefly to a few patches. Here, according to reports of farmers, insects do much more damage than on the prairie soils of the uplands. This condition is probably due to the ranker vegetal growth and the somewhat later planting time.

Trinity clay.—This soil consists of black, very dark gray, or very dark brown calcareous crumbly very heavy clay, which grades, at a depth of about 6 feet, into gray calcareous nearly impervious clay. The soil consists of stream sediments, most of which have been washed from areas of black calcareous soils of the prairies. The surface soil is extremely sticky and plastic when wet but very crumbly when dry. Although tillage implements require considerable power this soil is readily worked where adequately drained. The tilth is the same as that of Houston Black clay. The soil is very heavy, has little or no underdrainage, and dries out slowly after overflows.

Trinity clay occupies the flood plain of the North Sulphur River, the lower half of the flood plain of Bois d'Arc Creek, and the bottoms of many small streams that drain areas of smooth, heavy soils of the prairies. The areas are practically level, very slowly drained, and subject to overflow in varying degree. In most areas one or more floods occur nearly every year. Internal drainage is very slow.

Where adequately drained, this is one of the most productive soils of the county for general field crops. In most areas along small streams and in the parts of the bottoms of Bois d'Arc Creek and the North Sulphur River where the stream channels have been straightened, the overflows recede quickly enough and drainage is sufficient for excellent yields. At least two-thirds of these better drained areas are in cultivation and are used almost entirely for corn and cotton, although small acreages of grain sorghums, alfalfa, Johnson grass for hay, and oats are also grown. In nearly all of that part of the large area in Bois d'Arc Creek bottoms that lies below the mouth of Sloans Creek, however, the overflows are so prolonged and injurious that the production of crops is not generally successful nor attempted. Two bodies within this lower part of the flood plain—that lying southeast of Bois d'Arc Creek and between the mouths of Wards and Honey Grove Creeks, and that situated within 3 miles of the mouth of Bois d'Arc Creek—are almost entirely in cultivation. These bodies are reported by farmers to be considerably better drained than most of the lower part of the flood plain.

Crop yields vary widely from place to place and from year to year with variations in drainage conditions. Over a period of years in all areas farmed, cotton yields probably about 200 pounds of lint to the acre, and corn 20 to 25 bushels of grain. Yields of 500 pounds or more of cotton lint are not unusual in favorable seasons when insect damage is least, and some of the better drained fields have produced an average of 250 pounds of lint over a period of years. The maximum yield of corn reported from any field during a single year is about 65 bushels. Farmers report about the same or only slightly higher yields of corn than on such soils as Houston Black

clay. The few fields of alfalfa, maintained only in areas with better than average drainage, produce about 3 tons of hay to the acre annually. Grain sorghums are reported to produce about the same amount of grain as does corn and to withstand flooding somewhat better. Johnson grass meadows annually produce from 2 to 4 tons of hay to the acre.

Most of the areas of uncleared woodland are pastured, but most of the pastures are of only low to moderate carrying capacity, owing to the absence of a good stand of grass, caused by shading by trees or the competition of rank-growing, unpalatable weeds. Where freed of competition from trees and weeds, grasses thrive. The forest is largely second growth, in which cedar elm, hackberry, and ash are the dominant trees. The more desirable species, such as Osage-orange and most of the oaks, which produce lumber or building materials, have been largely removed by selective cutting.

Catalpa clay.—The surface soil is brown, dark-brown, or grayish-brown calcareous very crumbly clay. A similar material continues to a depth of many feet. In most places the material below a depth of 3 feet is slightly less dark than that on the surface. The soil consists of soil materials washed mostly from areas of brown calcareous soils of the prairies.

The most characteristic areas in the county are those where the streams carry sediments derived largely from areas of Austin soils and other soils underlain by chalk. Here the soil is less heavy, more permeable, and considerably better drained internally than Trinity clay, probably because of the high content of very fine particles of chalk. The areas in the bottoms of Bois d'Arc Creek and its tributaries, with one exception, are nearly all of this very highly calcareous nature. The exceptional area, situated 5 miles north of Dodd City and surrounding the end of the ditched channel of Bois d'Arc Creek, is an area with a 2- to 4-foot surface layer of brown calcareous clay abruptly underlain by black calcareous clay. The brown alluvium is a very recent overwash that has been deposited since the construction of the straightened channel, a period of approximately 10 years. During this time drainage has become so deficient that all fields have been abandoned, and most of them are covered with a very dense growth of ash saplings.

In areas on streams draining sections occupied principally by Houston clay the soil is yellower and heavier than elsewhere, being of the same consistence as Trinity clay. The largest of such areas border Caney Creek and southward-flowing streams in the southwestern part of the county. In the area that occupies part of the flood plain of Brushy Creek in the northwestern part of the county most of the soil is noncalcareous and neutral or slightly alkaline, as this is an included small area of Kaufman clay. This area is very slowly drained and practically none of it is in cultivation, although a considerable proportion is used for Johnson grass meadow.

Catalpa clay is one of the most productive soils of the county for general field crops, and about two-thirds of it is in cultivation. It is regarded by farmers as very desirable land that is somewhat richer than Houston Black clay but of about equal productivity for cotton and corn, owing to the generally more severe damage by insects, the necessity of somewhat late planting because of slow drainage, and the

occasional loss of a crop from overflow. Occasional replanting is necessitated by overflow, and Johnson grass infestation from seed brought in by floodwaters is a continuous hazard.

Most of the cropland is used for cotton and corn, with smaller acreages used for grain sorghums, alfalfa, oats, Johnson grass for hay, and onions. The average yields are slightly higher than those on Trinity clay, because of the somewhat freer drainage in most places. The prevailing acre yields in most of the fields are from 200 to 250 pounds of lint cotton, 20 to 35 bushels of corn, 25 to 35 bushels of grain sorghums, 2½ to 3½ tons of alfalfa hay, 25 to 50 bushels of oats, and about 100 bushels of onions. Maximum yields occasionally obtained are about 2 bales of cotton, 70 bushels of corn, and 90 bushels of oats.

Native pecan trees are numerous on most of the characteristic areas of Catalpa clay. Nearly all of the areas have moderately free underdrainage and a permanent water table within reach of tree roots. A few small pecan orchards are located on the soil and are reported to be very successful. Most of the areas not in cultivation are woodland pastures. The native forest is characterized by the greater abundance of Osage-orange, pecan, and red oak than in most areas of Trinity clay.

Catalpa clay, high-bottom phase.—This phase consists of areas of Catalpa clay lying on alluvial fans or high bottoms situated at the base of slopes and above the normal level of overflow by floodwaters of the adjacent streams. Runoff from the adjacent slopes flows over the areas after nearly every rain, and as it loses speed at the base of the slopes it deposits the surface soil material washed from the adjacent hillsides. Most of the surface runoff from the adjoining slopes spreads over the land or flows in ill-defined channels, except where ditched, across the areas of Catalpa clay, high-bottom phase.

The surface soil is brown, grayish-brown, or dark-brown crumbly highly calcareous clay several feet thick. In many places the brown surface layer is underlain at a depth ranging from 18 to 48 inches by black or darker brown calcareous clay. In a few places the surface soil is very dark brown or nearly black. The adjacent slopes from which these sediments were washed are occupied principally by Houston clay; Austin clay; Austin clay, shallow phase; and Sumter clay.

Numerous narrow strips of Catalpa clay, high-bottom phase, lie along the margins of nearly all flood plains that are bordered by sloping crumbly heavy soils of the prairies. Most areas are from 100 to 500 feet wide and follow the contour of the valleys. The boundaries between this soil and the adjoining bodies of Trinity clay or normal Catalpa clay are somewhat arbitrary, but generally these are separate areas with a slope that exceeds one-half percent and reaches a maximum of 3 percent. Surface drainage is free. Many of the areas around the margins of the coves of the southwest-central part of the county have a high water table and include seepy spots. Many of these areas have been successfully drained by laying lines of drainage tile in such manner as to intercept the flow of ground water before it reaches the seepy spots.

This is one of the most productive soils in the county for general field crops, and it is suited to some that do not thrive on most soils of the uplands. It is regarded by farmers as very desirable land,

and about two-thirds of it is in cultivation. Corn and cotton are the principal crops, and each occupies nearly one-half of the cultivated area. Small areas are used for grain sorghums, oats, alfalfa, pecan orchards, and onions. The average yields are slightly higher than on most areas of normal Catalpa clay, because of the superior drainage and the absence of the hazard of crop destruction by floods. The crop yields range from about 220 to 250 pounds of lint cotton, 25 to 40 bushels of corn, 25 to 50 bushels of oats, 25 to 35 bushels of grain sorghums, 2½ to 3½ tons of alfalfa hay, and 75 to 150 bushels of marketable onions an acre. Most of the small area not in cultivation is covered with a moderately dense stand of Johnson grass or Bermuda grass and affords very good grazing.

Catalpa clay loam.—This soil consists of brown or dark grayish-brown calcareous friable clay loam or sandy clay loam that continues to a depth of many feet without apparent change other than becoming slightly lighter brown below a depth of about 30 inches. The soil consists of a mixture of soil materials washed from areas of calcareous heavy soils and from lighter noncalcareous soils of the prairies. The areas are small and few. The largest are in the bottoms of Henson Creek southwest of Bonham, and along Jones Creek east of Leonard. Underdrainage is moderately free, floodwaters recede quickly, and drainage is adequate in nearly all areas for successful crop production.

About two-thirds of this soil is in cultivation, although many areas are too small for well-shaped fields. Corn and cotton each occupy about one-half of the cropland and normally produce from 200 to 250 pounds of lint cotton and 25 to 35 bushels of corn to the acre.

Kaufman clay loam.—This soil consists of brown or dark grayish-brown friable clay loam or silty clay loam, which reaches to a depth of many feet without apparent change other than becoming faintly less dark below a depth of about 30 inches. This soil consists of soil materials washed mostly from areas of Wilson, Crockett, and Bonham soils. Layers or lenses of slightly sandier or heavier material are present at various depths, owing to slight stratification. The soil is noncalcareous and in most places is neutral in reaction.

Numerous areas of this soil occupy the flood plains of small streams within the general areas of the lighter and noncalcareous soils of the prairies. Some of the larger areas are along Timber and Little Caney Creeks in the northwest-central part of the county. The overflows along these streams, though rather frequent, are mostly of such short duration that crops are not severely injured. Underdrainage is moderately free, and the soil dries ready for tillage sooner than Trinity clay.

Kaufman clay loam is productive and is highly regarded by farmers, and where it occurs in areas sufficiently large for well-shaped fields it is largely in cultivation. Probably about one-half of the area is cropped, mainly to corn, with considerable cotton and small acreages of grain sorghums, oats, and alfalfa. The high proportion of land in corn is due to the absence locally of other soils suited to this crop. The crop yields are about 20 to 35 bushels of corn and 175 to 200 pounds of lint cotton to the acre.

The native vegetation consisted of various species of hardwood trees, principally ash, hackberry, hickory, pecan, bur oak, water oak, willow

oak, red oak, and redbud. Various climbers and shrubs, such as smilax and buckbrush, are characteristically much more abundant than on Trinity clay. Where the forest has been cleared, many desirable grasses thrive and afford excellent grazing.

Kaufman clay loam, high-bottom phase.—This phase differs from normal Kaufman clay loam in position and drainage. It occupies alluvial fans and gently sloping high bottoms at the base of slopes, most of which are situated along the south side of the flood plain of the North Sulphur River. The areas lie above the level of normal overflows, but they are covered by runoff waters from adjacent hillsides, which deposit materials washed from soils occupying adjacent slopes, principally soils of the Crockett series, and some material from the Houston and Sumter soils.

The surface soil of Kaufman clay loam, high-bottom phase, is dark grayish-brown neutral friable clay loam to a depth of about 30 inches, where it grades into brown neutral clay loam. In many places the material shows some stratification with lenses of sandier or heavier material. In some places the topmost 6- to 12-inch layer is calcareous, but here the deeper layers are generally neutral and noncalcareous. The surface slopes gently and has a gradient ranging between ½ and 3 percent. Drainage is free.

This soil is almost entirely in cultivation and is used mainly for corn and cotton, though small acreages of grain sorghums, alfalfa, and oats are also grown. The acre yields ordinarily range from about 200 to 250 pounds of lint cotton, 25 to 35 bushels of corn, and 2½ to 3½ tons of alfalfa. The soil is easily worked and is one of the most productive in the county.

Kaufman loam.—The surface soil is brown or dark grayish-brown noncalcareous loam. This same soil material reaches to a depth of many feet without apparent change other than slight variations in texture as a result of stratification. The material is a slightly lighter brown below a depth of about 30 inches. The soil represents alluvium washed largely from areas of medium-textured Crockett and Bonham soils. It occupies a few small areas in the narrow flood plains of some small streams, the largest of which border the headwaters of the Middle Sulphur River a few miles west of Ladonia and Timber Creek in the vicinity of Bonham. The overflows of these small streams recede quickly, and, as the soil has free underdrainage, drainage is generally adequate for successful production of all common field crops. Spots of Kaufman silt loam and Kaufman very fine sandy loam that are too small to show separately on the map are included with Kaufman loam.

Kaufman loam occupies small areas surrounded by sloping soils of relatively low productivity, and very little of it is in cultivation. Possibly one-third is in fields planted mainly to corn, which produces from 20 to 35 bushels an acre. Cotton occupies a smaller proportion of the cropland and produces from 150 to 225 pounds of lint, or an average of about 180 pounds. Small acreages are used for growing sorgo (for sirup), sweetpotatoes, and vegetables, all of which thrive on this soil. The uncultivated areas are mostly pastures of Bermuda grass from which the trees have been removed. The small areas that have been mowed to control weeds and otherwise well managed support 1 cow to the acre, without supplemental feeding, during a 9-

month period of best growth of grasses, but in general the areas of this soil that are relatively free of trees range from one-fifth to one-half of that capacity.

Kaufman loam, high-bottom phase.—This phase differs from normal Kaufman loam in relief and position. It occurs on gently sloping alluvial fans or high bottoms along the base of slopes that are occupied by moderately to strongly sloping areas of Crockett soils. The surface soil is grayish-brown or dark grayish-brown friable neutral loam. This either continues to a depth of several feet without apparent change except for a slightly lighter color below a depth of about 30 inches or rests on dark grayish-brown friable noncalcareous clay loam at an undetermined depth. The surface soil is slightly calcareous in places.

This phase occupies a few areas along the southern border of the bottoms of the North Sulphur River northeast of Ladonia. The areas are gently sloping and have surface gradients ranging from ½ to 3 percent. They lie above the level of normal overflow from the North Sulphur River but in some places receive runoff from the adjacent hillsides.

Practically all the soil is in cultivation and used for cotton and corn, together with small acreages of grain sorghums and alfalfa. Cotton yields about 200 pounds of lint, and corn 25 to 35 bushels to the acre.

Ochlockonee fine sandy loam.—The surface soil is grayish-brown or light-brown mellow fine sandy loam of neutral to slightly acid reaction. A similar soil material reaches to a depth of many feet without apparent change other than slight variations in texture resulting from alternate deposition of sandier and heavier materials. The soil consists of alluvium washed from areas of forested light-colored sandy soils. As mapped, the areas include some bodies with a loamy fine sand surface soil, especially along Sycamore and Sandy Creeks. This soil occupies narrow flood plains of small streams in the northern part of the county, the largest of which borders Coffeemill Creek.

This soil constitutes the richest and almost the only fertile land in the forested sandy sections where it occurs, but only about one-third is in cultivation. Corn is the principal crop, but small areas are used for cotton, sorgo for sirup, and other special crops. Acre yields range from 20 to 30 bushels of corn and 150 to 200 pounds of lint cotton.

Yahola clay.—In cultivated areas the surface soil is brownish-red or red crumbly friable calcareous clay. This reaches to a depth of 15 to 24 inches, where it is underlain by lighter textured soil materials, commonly light-red calcareous silt loam or very fine sandy loam. In most wooded areas the 3- to 5-inch surface layer is stained slightly darker to a reddish brown by organic matter. This soil consists of alluvial deposits from overflow waters of the Red River, comprising soil materials transported from "Red Beds" soils and formations in western areas.

The soil occupies rather low positions or slight swales, with sandier Yahola soils occupying the higher positions. It is overflowed whenever the waters of the Red River rise out of the channel, or once every

few years. Surface drainage is almost absent, but underdrainage is free, so that the soil is seldom too wet for crops to grow well. The principal areas are in the northeastern part of the county, and one of the largest is 1½ miles north of Gossville.

About four-fifths of this soil is in cultivation and is used for corn and cotton. Ordinarily the acre yields range from 100 to 400 pounds of lint cotton and 25 to 35 bushels of corn, but yields of cotton average between 125 and 200 pounds, on account of generally severe damage by insects.

Yahola clay loam.—The surface soil is brownish-red or red calcareous friable clay loam or silty clay loam, grading, at a depth ranging from 12 to 30 inches, into sandier substrata that commonly are light-red calcareous very fine sandy loam or silt loam. The soil is commonly known as chocolate loam and occurs in the flood plains of the Red River. It is associated with Miller clay and Yahola clay, which generally occupy slightly lower positions, and Yahola very fine sandy loam, which occupies slightly higher positions. Although the surface is nearly level, drainage is free, as water rapidly penetrates the substrata.

About two-thirds of this soil is in cultivation; the rest largely represents areas that were formed by changes in the channel of the Red River. Corn occupies about one-half of the cultivated land, cotton two-fifths, and alfalfa a small proportion. Corn yields 25 to 35 bushels an acre, cotton 100 to 500 pounds of lint, and alfalfa 2½ to 3½ tons of hay. Yields of cotton vary widely, depending on the severity of damage by insects. Over a period of years the average yield is probably between 175 and 200 pounds of lint.

Yahola very fine sandy loam.—The surface soil is light-red calcareous mellow very fine sandy loam, underlain below a depth of 18 inches in most places by light-red calcareous very fine sandy loam and in some places by yellowish-red loamy fine sand. In the area of about 60 acres adjoining Spies Lake on the south the material below a depth of 18 inches consists of dark-red calcareous silty clay. This is an inclusion of Miller very fine sandy loam, which is not shown separately on the map on account of its small extent.

Yahola very fine sandy loam is the most extensive soil of the Red River flood plains in Fannin County and is commonly known as chocolate loam. Farmers regard it as very desirable land and prize it especially for growing corn. About three-fourths of the soil is in cultivation to corn, cotton, and some alfalfa, which yield respectively from 20 to 30 bushels, 100 to 300 pounds of lint, and 2 to 3 tons of hay to the acre. Yields of cotton are extremely variable, because of the great variation in the ravages of insects from season to season, and they probably average about 160 pounds. Yields of alfalfa are very good but are noticeably lower than on the heavier soils of the Yahola and Miller series.

Yahola loamy fine sand.—The surface soil is light-red calcareous mellow loamy fine sand. In most places the material continues to a depth of many feet without apparent change, but in other places it includes thin interbedded lenses of fine sand or clay below a depth of 2 to 3 feet. The soil occurs in the flood plains of the Red River, espe-

cially in positions adjacent to the river channel or to abandoned channels. The surface is slightly billowy or undulating. Surface drainage is free, and internal drainage is rapid.

Although field crops are produced with fair success on small areas of this soil, in general it is not well suited to such crops, as it is not especially fertile and is so sandy that soil blowing is severe when the land is cultivated. This soil is commonly known as sand-bar land and is used almost entirely as pasture. Most areas support a moderately dense cover of Bermuda grass, which has a high carrying capacity for livestock. Scattered cottonwood trees grow over the areas, but their shade does not greatly interfere with the growth of grass.

Yahola fine sand.—This soil consists of very light red or pale yellowish-red loose calcareous fine sand many feet deep. It occurs on the Red River flood plain, mostly adjacent to the river channel and on the inside of river bends. It is commonly known as sand-bar land and is so loose and sandy that grasses do not make vigorous growth. A scattered growth of cottonwood trees, willows, some Bermuda grass, and various weeds makes up the vegetation. The surface is billowy to dunelike and in some places includes unstable dunes. The soil is entirely unfit for the growth of cultivated crops and has a low value even for pasture.

Miller clay.—The surface soil is chocolate-red calcareous friable clay or silty clay, which shows little change to a depth of at least 3 feet and commonly to a depth of 5 to 6 feet, where it overlies sandier sediments. These underlying materials afford moderately free underdrainage. In some areas the 2- to 6-inch surface layer is stained a darker reddish-brown color by small accumulations of organic matter. This soil is commonly known as chocolate land. The surface is smooth and nearly level to slightly depressed. Some of the depressed areas are too poorly drained for field crops to thrive.

Miller clay is one of the most highly productive soils for corn and alfalfa in the county. Yields of cotton are occasionally very large, but because of the generally severe damage from insects they average no higher than on some other soils. Farmers consider Miller clay as very desirable land, and they report that it warms and dries out sufficiently for cultivation slightly earlier than adjoining areas of Yahola very fine sandy loam. About two-thirds of the soil is in cultivation, and this is used almost entirely for corn, cotton, and some alfalfa. The prevailing acre yields are from 25 to 40 bushels of corn, 100 to 400 pounds of lint cotton, and 2½ to 4 tons of alfalfa, although yields as large as 70 bushels of corn and 2 bales of cotton are occasionally obtained in individual fields. The acre yield of cotton over a period of years is probably between 175 and 200 pounds of lint.

MISCELLANEOUS LAND TYPES

Rough broken land.—This designates areas of steep, broken, or severely gullied land that have practically no soil covering. Wagons or agricultural implements generally cannot cross these areas, and very little vegetation grows on them. The area surrounding the lake at Duplex, which is the only area larger than 20 acres, is an outcrop of shale on an escarpment. This has practically no covering of grass

but supports a few scrub elm trees and shrubs. The areas 2 miles southwest of Mulberry, 4 miles northeast of Mulberry, and 4 miles north of Telephone are abrupt terrace escarpments and outcrops of red alluvial sands. These support a moderately dense growth of oak trees. The areas 3 miles northeast of Ector are underlain by bluish-gray or yellow shales and support a little grass and some scattered shrubs.

Chalk outcrop.—This designation embraces areas where chalk crops out on the surface or underlies not more than 4 inches of gray calcareous clay. Most of the areas are strongly sloping; a few are nearly level. In the nearly level areas the thin soil covering between outcrops of chalk is nearly black. This land cannot be plowed. It supports a very thin covering of grass, a few small Texas red oak trees, and some small shin oak trees. Most of the land is pastured but furnishes very little grazing. The land type occurs only in small areas within the east-west belt underlain by chalk, extending across the central part of the county. The slopes surrounding Sugar Loaf Bottom about 4 miles north of Leonard constitute the largest areas.

Riverwash.—Riverwash comprises areas of loose, continuously shifting river sands that have practically no vegetative covering. The areas are confined to the bed of the Red River and are worthless for agriculture.

Gravel pits.—This term includes excavations and dumps of overburden made in connection with the surface mining of gravel for road building. The areas are essentially worthless for agriculture, although in some places they support a little grass. The principal areas are near Anthony in the northwestern part of the county.

LAND USES AND AGRICULTURAL METHODS

Customs, economic conditions, and favorable climate in Fannin County and surrounding sections largely explain why all land that is sufficiently fertile to be used for field crops is used for cotton farming. Cotton alternates in some fields with corn, oats, sorghums, and minor crops, but the general cropping system is one of nearly continuously intertilled crops grown in no definite rotation and does not include an extensively grown legume. In most fields the cotton stalks and corn stalks are plowed under, but straw from small grains is not generally returned to the fields. The small quantity of available barnyard manure is used mostly on gardens or is allowed to waste. Farmers neither apply commercial fertilizers generally nor practice methods of soil improvement designed to increase the content of organic matter and the availability of plant nutrients, such as plowing under green-manure crops. Many of the fields, but only a small proportion of those requiring such protection, are adequately terraced. This measure of erosion control, however, is being extended rapidly. Most terraced fields are cultivated on the contour; only a few are strip cropped.

The prevailing system of farming does not maintain the fertility of the soil; fertility is decreasing because of accelerated erosion, leaching, and the decomposition of organic matter. These destructive forces follow the replacement of a dense natural vegetative cover by intertilled crops. Such crops afford no protection from soil washing throughout a large part of the year and return less organic matter to

the soil in crop residues than decomposes under the conditions of free aeration and high soil temperatures associated with frequent stirring of the soil by tillage operations and with lessened shading of the soil by plants. The rate of decrease in fertility varies widely with soil conditions; in Fannin County the rate of decrease is closely related to the erodibility of the soil and its texture. It is most rapid on the more sloping surfaces and in the sandiest soils. Increased loss of plant nutrients through leaching apparently is not of major importance in this county except on the lighter textured soils with permeable subsoils, which are inextensive.

Some soils, such as the light-colored sandy soils, are being given over to a type of land use to which they are not naturally suited; full advantage is not being taken of the inherent productive capacity of other soils; and on some soils land use is at the expense of rather rapid dissipation of the land. Fitness of a soil for the prevailing land use—cotton farming—depends on the possibility of restoring the lessened fertility and the determination of the relative net production (after deducting the cost of restoring the fertility) under different types of land use. Decreases in fertility that are due solely to reduction of available plant nutrients generally can be remedied easily by additions of commercial fertilizers and such practices as plowing under green-manure crops, especially legumes. Decreases in fertility and productivity that are due to deterioration of the physical character of the soil, such as loss of a large part of the surface soil by erosion, generally cannot be remedied feasibly. Soils that erode rapidly under present use are naturally unsuited for a type of agriculture strongly dominated by cotton or any other intertilled crop, unless certain systems of rotation are employed and other methods of soil protection are used.

The heavy soils of the prairies apparently present an exception to the general rule that available plant nutrients are readily restored. Fertilizers, especially phosphatic fertilizers, added to these soils tend to revert quickly to unavailable forms (*11*), and many areas are so infested with root rot as to make the growth of legumes not feasible. Although restoration of fertility on the heavy soils of the smooth prairies may be much more difficult and expensive than on sandier soils, it is safe to assume that their fertility can be built up to or above the original state. So far, however, no method of completely avoiding or overcoming the injurious effects of root rot upon cotton and other susceptible crops has been discovered, and the soil characteristics of the crumbly heavy soils of the prairies that favor injury by this disease may unfit them for the prevailing type of agriculture.

Most of the soils of the smooth prairies of the county appear, as a whole, better suited to a modified form of cotton farming than to any other type of agriculture. An increase in the production of feed crops and livestock would distribute labor more evenly throughout the year and produce somewhat larger net returns than the prevailing form of cotton farming (*5*). The rolling areas of soils of the Houston and Austin series are naturally suited to use for broadcast crops, such as small grains and hays, which afford protection from washing. Some cotton and corn can properly be grown on these soils; but, as effective control of erosion is accomplished on them only by terracing in conjunction with strip cropping, cotton farming on these soils should be supplemented by raising many livestock in order to utilize

the large amounts of forage and pasture. Considerable areas that are associated with areas of smoother and deeper soils can be used most profitably as improved pasture.

The better drained areas of the soils of the bottom lands are also suited to cotton, but their superiority for corn and alfalfa and the general severity of damage to cotton from insects cause them to be best suited probably to general farming, with all three as major crops, supplemented with livestock raising.

The forested sandy soils of the northern part of the county are in themselves best suited to the production of special, fruit, and vegetable crops. The advisability of so utilizing them depends on their location with reference to markets and on economic conditions. Smooth areas of these soils are fairly suitable to general field crops but require good management for high productivity.

The extensive soils with sloping surfaces belonging to the Crockett and Sumter series are, for the most part, best suited to pasture. They occur mostly in small areas surrounded by smoother soils and can be largely used as farm pastures. The broader areas are probably best suited to livestock farming.

Table 6 presents the apparent natural capabilities for land use of the soil groups in a summarized tabular form.

TABLE 6.—*Acreage, proportionate extent, and natural capabilities for land use of soil groups of Fannin County, Tex.*

Soil group	Natural capabilities for agricultural use [1]	Acres	Percent of county area
1. Crumbly heavy-textured soils of the smooth prairies.	Cotton and other general field crops except corn, A; corn, A to B; alfalfa, B; onions, A.	122,112	21.4
2. Crumbly heavy-textured soils of the rolling prairies.	General field crops with the fields terraced, strip cropped, and at least one-half in broadcast crops, C; permanent pasture, B; permanent meadow, B.	59,200	10.5
3. Shallow crumbly heavy-textured soils of the prairies.	Permanent pasture, C; permanent meadow, C; small grains, D.	19,584	3.4
4. Compact (tight) noncalcareous soils of the smooth prairies.	General field crops other than corn, B; corn, C; alfalfa in most favorable locations only, C.	79,872	14.1
5. Medium-textured crumbly noncalcareous soils of the smooth upland prairies.	General field crops other than corn, B; corn, B or C; alfalfa, C; tree fruits for local markets, B.	26,560	4.7
6. Noncalcareous soils of the sloping prairies.	Permanent pasture, C; permanent meadow, D; small grains, D.	29,632	5.1
7. Well-drained light-colored sandy soils of the smooth uplands and stream terraces.	Tree and bush fruits, A; vegetables for market, A; general field crops, D; peanuts, A.	33,984	5.9
8. Light-colored sandy and clay soils of the sloping uplands.	Vegetables for market and tree and bush fruits where not severely eroded, A; general field crops, D; farm wood lots, C; permanent pasture, D.	38,592	6.8
9. Well-drained brown or reddish-brown soils of the stream terraces.	General field crops, including corn, B; alfalfa in choice locations, A; vegetables, A.	20,672	3.7
10. Slowly drained gray and dark-gray soils of the stream terraces.	General field crops, C or D; permanent pasture, C.	44,736	7.9
11. Soils of the flood plains:			
Soils of clay texture	General field crops and alfalfa in the better drained locations, A. (Potentially fertile but too poorly drained for field crops in some places.) Johnson grass meadow, A; permanent pasture, A to C; farm wood lots, B.	63,104	11.1
Soils of medium texture	General field crops, A; alfalfa, A or B; permanent pasture, A; farm wood lots, B.	24,064	4.2
Very sandy soils	Permanent pasture, B; farm wood lots, C	4,416	.8
12. Miscellaneous land types	Practically none	2,432	.4

[1] The letters A, B, C, and D, which follow the crops listed as being those to which the group is naturally suited, denote the relative productivity for the crop or crops preceding the letter, A signifying high productivity, B medium-high productivity, C medium productivity, and D medium-low productivity.

Although practices of applying commercial fertilizers or plowing under green crops to add organic matter and increase availability of plant nutrients are not general in Fannin County, a few farmers employ these methods of improving fertility on sandy soils and report success. One farmer reported that in the season following the plowing under of a heavy growth of cane (sorgo) and cowpeas that had been planted in alternate 18-inch rows, he obtained 50 bushels of oats and 200 pounds of lint cotton to the acre in a field of Susquehanna very fine sandy loam, yields that exceeded by one-third any obtained during the previous 5 seasons. He also reported that growth was observably more vigorous in the field thus treated than in adjacent untreated areas for at least 5 seasons afterward, and that the improvement was most marked on the sandy mounds. Here virtual crop failure was converted into the best growth of cotton and corn in the field.

Commercial fertilizers are applied for the most part only in orchards and small fields of market vegetables. The users are unable to state just how much the yields and quality are improved, but they are confident that the practice is profitable. Two farmers report the use of fertilizers for cotton on small fields of Sawyer fine sandy loam, with resulting increases of 100 to 200 pounds of seed cotton to the acre. All of these farmers used a 4–12–4[8] fertilizer at the rate of 100 to 300 pounds an acre.

On soils similar to the smooth well-drained light-colored sandy soils of the northern part of the county, the Texas Agricultural Experiment Station, after careful trials with fertilizer, recommends for cotton an application of 200 to 400 pounds an acre of a 4–6–4 or 4–8–4 fertilizer or a fertilizer supplying similar ratios and quantities of plant food (*10*). On Lufkin fine sandy loam, a soil similar in many respects to the Irving and Ivanhoe soils of Fannin County, 4–12–4 and 0–12–4 mixtures gave the best responses in trials made at College Station. On Houston Black clay and Houston clay at Temple, and on San Saba clay (a soil closely related in many respects to the crumbly heavy-textured soils of the prairies in Fannin County) at Denton, applications of fertilizer resulted in some increases in the yields of cotton, but in general their use was not profitable.

According to farmers, the insects that injure cotton most in Fannin County are the boll weevil, the cotton flea hopper, and the cotton leaf worm. Injury from boll weevil infestation is reported to be most severe on soils within the forested areas and on the soils of the bottom lands where vegetal growth is rank. Injury from the cotton flea hopper is reported to be generally much more severe on such crumbly blackland soils as Houston Black clay than on Wilson clay loam and other tight soils. The cotton leaf worm causes very severe damage in some years, and poisoning for control is common. The commonly greater insect damage on cotton that is thriving than on cotton that is making slow growth partly explains some of the erratic results obtained from soil-improvement practices.

Severe infestation with cotton root rot, as manifested by death of the cotton plant prior to frost and with characteristically injured roots, was observed in many fields only on the crumbly heavy soils of the prairies, although it was reported by farmers on some areas of Reinach soils on the bottom lands in the northwestern part of

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

the county. The amount observed or reported on all other soils in the county, except for a few patches on Wilson clay, was so small as to be insignificant in itself, although important locally on account of the hazard of spreading infestation. Reynolds and Killough (*9*) report considerable control of cotton root rot and significant increases in cotton yields from long rotations with nonsusceptible crops on a soil very similar to the crumbly heavy soils of the smooth prairie in Fannin County. The increases in cotton yields apparently were due largely to less damage by root rot.

Jordan and his associates (*6*) report some control of cotton root rot and considerable increases in yields of cotton resulting from applications of fertilizers to infested areas of several soils of the Blackland Prairie of Texas.

No economical means of overcoming the unfavorable conditions for plant growth on the saline spots on some soils have been devised.

PRODUCTIVITY RATINGS

The average acre yields of the principal crops obtained on each soil in Fannin County under prevailing practices over a period of years are given in table 7.

TABLE 7.—*Estimated average acre yields of the principal crops on each soil in Fannin County, Tex.*[1]

Soil or land type	Crop									
	Cotton lint	Corn	Oats	Grain sorghums	Sorgo hay	Wheat	Alfalfa	Peanuts	Onions	Pasture
	Lb.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Cow-acre-days*[2]
Austin clay, rolling phase	150	17	25	16	1½	12				50
Austin clay, undulating phase	180	20	30	20	2	15				100
Austin clay, rolling shallow phase	80	8	20	10	1	10				30
Austin clay, undulating shallow phase	150	12	27	15	1½	14				90
Austin clay, steep phase	100	13	20	12	1¼					40
Bienville loamy fine sand	100	10						12		20
Bienville fine sandy loam	140	17		14	1½			18		
Bienville very fine sandy loam	160	20	25	18	1¾					
Bonham silt loam	160	17	27	18	1¾	14	2			90
Bonham clay loam	160	17	27	18	1¾	14	2			90
Bonham clay loam, rolling phase	100	12	15	10	1					40
Bowie fine sandy loam	80	10	10	10	¾			15		20
Bowie fine sandy loam, slope phase	70	8						10		20
Brewer clay loam	190	30		30	3		3			
Catalpa clay loam	225	30	30	30	3		3		100	100
Catalpa clay (in areas where flood hazard is slight)[3]	225	30	30	30	3		3		100	100
Catalpa clay (in areas where flood hazard is severe)[3]										30
Catalpa clay, high-bottom phase	225	30	30	30	3		3		100	100
Chalk outcrop										10
Chattahoochee loamy fine sand, rolling phase	60	8						10		15
Chattahoochee fine sandy loam	80	10			¾			15		20
Choctaw fine sandy loam	140	15	20		1¼					
Choctaw fine sandy loam, rolling phase	80	8								30
Crockett very fine sandy loam	100	10	20	12	1¼	10				50
Crockett very fine sandy loam, rolling phase	80	8	12	8	¾					40
Crockett silt loam	140	12	25	16	1½	12				80
Crockett clay loam	150	12	27	18	1¾	14				80
Crockett clay loam, rolling phase	80	6	12	8	¾					40
Crockett clay loam, steep phase										50
Ellis clay	80	8	15	10	1					40

See footnotes at end of table.

TABLE 7.—*Estimated average acre yields of the principal crops on each soil in Fannin County, Tex.*[1]—Continued

Soil or land type	Crop									
	Cotton lint	Corn	Oats	Grain sorghums	Sorgo hay	Wheat	Alfalfa	Peanuts	Onions	Pasture
	Lb.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Bu.*	*Tons*	*Bu.*	*Bu.*	*Cow-acre-days* [2]
Gravel pits										1
Houston clay	150	15	25	16	1½	12				50
Houston Black clay	210	22	30	25	2½	15	2½		100	100
Houston Black clay, flat phase	215	18		25	2½		2½		100	
Houston Black clay, shallow phase	180	15	30	20	2	15				100
Houston Black clay, slope phase	200	22	30	22	2¼	15				100
Hunt clay	210	22	30	25	2½	15	2½		100	100
Hunt clay, flat phase	215	18		25	2½		2½		100	
Irving silt loam	100	10	20	12	1¼	10				50
Irving silt loam, mound phase	80	8	12	10	1					30
Irving clay loam	120	12	25	16	1½	12				50
Ivanhoe silt loam	100	10	20	12	1¼	10				50
Kalmia loamy fine sand	70	8						10		10
Kaufman loam	180	30		30	3		3			100
Kaufman loam, high-bottom phase	200	30		30	3		3			
Kaufman clay loam	180	30		30	3		3			100
Kaufman clay loam, high-bottom phase	225	30	30	30	3		3			100
Miller clay	180	30		30	3		3			100
Myatt fine sandy loam	120	12		12	1¼			15		50
Myatt very fine sandy loam	120	12	15	14	1½					50
Nacogdoches fine sandy loam	120	12			1			15		
Nacogdoches-Kirvin complex										30
Ochlockonee fine sandy loam	160	25		20	2		2¼			100
Reinach loamy fine sand	100	10						12		30
Reinach silt loam	180	25	27	25	2½		2½			
Riverwash										
Rough broken land										5
Sawyer fine sandy loam	80	10			¾			15		20
Sumter clay	80	8	15	10	1					40
Susquehanna fine sandy loam	70	8						10		20
Susquehanna fine sandy loam, smooth phase	80	10			¾			15		20
Susquehanna very fine sandy loam	90	11	12	11	1			15		30
Susquehanna clay										5
Teller fine sandy loam	140	17		16	1½			18		
Teller fine sandy loam, slope phase	80									30
Teller very fine sandy loam	160	20	25	18	1¾					
Trinity clay (in areas where flood hazard is slight)[3]	225	28		30	3		3			100
Trinity clay (in areas where flood hazard is severe)[3]										30
Wilson silt loam	150	15	25	18	1¾	13				90
Wilson clay loam	160	15	27	18	1¾	14				90
Wilson clay	180	15	30	20	2	15	2			90
Wilson-Crockett clays	160	14	27	18	1¾	14				90
Wilson-Crockett clays, rolling phases	100		15	10	1					40
Yahola fine sand										20
Yahola loamy fine sand	80	10								50
Yahola very fine sandy loam	160	25		25	2½		2½			100
Yahola clay loam	180	30		30	3		3			100
Yahola clay	180	30		30	3		3			100

[1] Estimates of average yields to the acre refer to yields obtained in all fields over a period of years. On many soils, especially those of medium and medium sandy textures, much higher yields are obtained when fields are well managed or land is new. Absence of figures indicates that the soil is not commonly used for the given crop.

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

[3] Two ratings are given for these soils in order to show the great variation in productivity with diversity of drainage. The average productivity of all fields on these soils is about two-thirds or three-fourths of the yields obtained in areas where the flood hazard is slight.

The yields in table 7 refer to the productivity of the soils under the prevailing farming practices in Fannin County. Yields may differ from county to county, inasmuch as practices of management and certain minor characteristics of soils may differ from county to county. In Fannin County practically no commercial fertilizer is used.

The estimates of average yields of different crops, especially of crops other than cotton and corn, may be considerably in error. They were made by interpretation of census data, farmers' reports, general observations, and soil characteristics. Probably few of them are within 10 percent of the true value, but they constitute the most nearly accurate information available. The estimates of yields of cotton and corn were adjusted so that the weighted average of the yields on different soils, weighted according to the estimated area of each soil used for cotton or corn, corresponds to the average county yields that are known fairly accurately from census and Agricultural Adjustment Administration data. The average yields refer to those obtained under prevailing farm practices over a period of years. In using them the reader should realize that they are only approximate and that yields differ widely from year to year and with differences in soil management.

In order to compare directly the yields obtained in Fannin County with those obtained for the same crops in other parts of the country, yield figures have been converted in table 8 to indexes based on standard yields of reference. The soil types and phases are listed in the order of their general productivity under prevailing farming practices, the most productive soils being at the head of the table.

The ratings in table 8 compare the productivity of each of the soils for each crop relative to a standard of 100. This standard index represents the approximate average acre yield obtained without 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 is about half as productive for the specified crop as is the soil with the standard index. Soils given amendments, such as lime, commercial fertilizers, and irrigation, and unusually productive soils of small extent, have productivity indexes of more than 100 for some crops.

The natural factors influencing the productivity of land are mainly climate, soil, relief or lay of the land, and management, including the use of amendments. Crop yields over a long period of years furnish the best available summation of the factors contributing to productivity, and they have been used largely as the basis for the productivity indexes in the table. A low index for a particular crop may be due to some local condition of unfavorable relief, drainage, or climate rather than to lack of fertility in the soil. It will be seen from footnote 2 to the table that no rating is given if the crop is not commonly grown on the particular soil.

It should be understood that this productivity rating is not to be interpreted directly into specific land values. It is based on the essentially permanent factors of productivity of the soils and their responsiveness to management, and little attention is given to the more transitory economic conditions of land values.

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TABLE 8.—*Productivity ratings of the soils and land types of Fannin County, Tex. (based on average yields under prevailing management)*

Soil or land type [1]	Crop productivity index [2] for— Cotton (100=400 lbs.)	Corn for grain (100=50 bu.)	Oats (100=50 bu.)	Sorghums for grain (100=40 bu.)	Sorghums for forage (100=4 tons)	Wheat (100=25 bu.)	Alfalfa (100=4 tons)	Peanuts (Spanish) (100=40 bu.)	Onions for market [3]	Vegetables other than onions for market and bush fruits [4]	Tree fruits [5]	Pecans [6]	Pasture (100=100 cow-acre-days) [7]	Farm wood lots [8]
Catalpa clay, high-bottom phase	55	60	60	75	75		75		A	C	C	A	100	
Kaufman clay loam, high-bottom phase	55	60	60	75	75		75			A	C	A	100	
Catalpa clay loam	55	60	60	75	75		75		A	A	E	A	100	
Catalpa clay (in areas where flood hazard is slight) [9]	55	60	60	75	75		75		A	C	E	A	100	A
Trinity clay (in areas where flood hazard is slight) [9]	55	55		75	75		75				E	C	100	A
Brewer clay loam	50	60		75	75		75				E	A		
Kaufman loam, high-bottom phase	50	60		75	75		75			A	E	A		
Houston Black clay	50	45	60	60	60	60	65			D	D	C	100	D
Houston Black clay, flat phase	55	35		60	60		65			D	D	C		
Hunt clay	50	45	60	60	60	60	65			D	D	C	100	D
Hunt clay, flat phase	55	35		60	60		65		A	D	D	C		
Miller clay	45	60		75	75		75				E	A	100	A
Yahola clay	45	60		75	75		75				E	A	100	A
Yahola clay loam	45	60		75	75		75				E	A	100	A
Kaufman clay loam	45	60		75	75		75			A	E	A	100	A
Kaufman loam	45	60		75	75		75			A	E	A	100	A
Houston Black clay, slope phase [10]	50	45	60	55	55	60				D	D	C	100	C
Reinach silt loam	45	50	55	60	60		65			A	D	A		
Austin clay, undulating phase	45	40	60	50	50	60				C	C	C	100	
Houston Black clay, shallow phase	45	30	60	50	50	60				D	E	C	100	
Yahola very fine sandy loam	40	50		60	60		65			A	E	A	100	A
Wilson clay	45	30	60	50	50	60	50			D	E	E	90	E
Ochlockonee fine sandy loam	40	50		50	50		55			A	E	A	100	A
Wilson-Crockett clays	40	30	55	45	45	55				D	E	E	90	E
Bienville very fine sandy loam	40	40	50	45	45					A	A	C		B
Teller very fine sandy loam	40	40	50	45	45					A	A	C		B
Bonham clay loam	40	35	55	45	45	55	50			A	B	C	90	D
Bonham silt loam	40	35	55	45	45	55	50			A	B	C	90	D
Wilson clay loam	40	30	55	45	45	55				D	D	E	90	E

See footnotes at end of table.

TABLE 8.—*Productivity ratings of the soils and land types of Fannin County, Tex. (based on average yields under prevailing management)*—Continued

Soil or land type [1]	Crop productivity index [2] for—													
	Cotton (100=400 lbs.)	Corn for grain (100=50 bu.)	Oats (100=50 bu.)	Sorghums for grain (100=40 bu.)	Sorghums for forage (100=4 tons)	Wheat (100=25 bu.)	Alfalfa (100=4 tons)	Peanuts (Spanish) (100=40 bu.)	Onions for market [3]	Vegetables other than onions for market and bush fruits [4]	Tree fruits [5]	Pecans [6]	Pasture (100=100 cow-acre-days) [7]	Farm wood lots [8]
Austin clay, undulating shallow phase	35	25	55	40	40	55	----	----	----	C	C	C	90	----
Wilson silt loam	35	30	50	45	45	50	----	----	----	D	D	C	90	E
Crockett clay loam	35	25	55	45	45	55	----	----	----	D	D	E	80	E
Crockett silt loam	35	25	50	40	40	50	----	----	----	C	C	E	80	E
Teller fine sandy loam	35	35	----	40	40	----	----	45	----	A	A	C	----	B
Bienville fine sandy loam	35	35	----	35	40	----	----	45	----	A	A	C	----	B
Austin clay, rolling phase [16]	35	35	50	40	40	50	----	----	----	C	C	B	50	C
Houston clay [10]	35	30	50	40	40	50	----	----	----	D	D	E	50	E
Choctaw fine sandy loam	35	30	40	----	30	----	----	----	----	A	A	C	----	----
Irving clay loam	30	25	50	40	40	50	----	----	----	E	E	E	50	E
Myatt very fine sandy loam	30	25	30	35	40	----	----	----	----	E	E	E	50	----
Nacogdoches fine sandy loam	30	25	----	----	25	----	----	40	----	A	----	C	----	C
Myatt fine sandy loam	30	25	----	30	30	----	----	40	----	E	E	----	50	C
Crockett very fine sandy loam	25	20	40	30	30	40	----	----	----	B	B	E	50	E
Ivanhoe silt loam	25	20	40	30	30	40	----	----	----	D	D	E	50	E
Irving silt loam	25	20	40	30	30	40	----	----	----	E	E	E	50	E
Bowie fine sandy loam	20	20	20	25	20	----	----	40	----	A	A	C	20	C
Chattahoochee fine sandy loam	20	20	----	----	20	----	----	40	----	A	A	C	20	C
Sawyer fine sandy loam	20	20	----	----	20	----	----	40	----	A	A	C	20	C
Susquehanna very fine sandy loam	20	20	25	25	25	----	----	40	----	B	B	C	30	C
Susquehanna fine sandy loam, smooth phase	20	20	----	----	20	----	----	40	----	A	A	C	20	C
Bonham clay loam, rolling phase	25	25	30	25	25	----	----	----	----	B	B	C	40	D
Wilson-Crockett clays, rolling phases	25	----	30	25	25	----	----	----	----	E	E	E	40	E
Reinach loamy fine sand	25	20	----	----	----	----	----	30	----	A	D	C	30	A
Bienville loamy fine sand	25	20	----	----	----	----	----	30	----	A	C	C	20	B
Yahola loamy fine sand	20	20	----	----	----	----	----	----	----	----	E	----	50	A
Irving silt loam, mound phase	20	15	25	25	25	----	----	----	----	E	E	E	30	E
Austin clay, steep phase [11]	25	25	40	30	30	----	----	----	----	C	C	C	40	C
Austin clay, rolling shallow phase [10]	20	15	40	25	25	40	----	----	----	D	D	----	30	C

Ellis clay [10]	20	15	30	25	25					E	E	E	40	E
Choctaw fine sandy loam, rolling phase [10]	20	15								A	A	C	30	C
Teller fine sandy loam, slope phase [10]	20									A	A	C	30	C
Sumter clay [11]	20	15	30	25	25					E	E	E	40	E
Crockett very fine sandy loam, rolling phase [10]	15	15	25	20	20					C	C	E	40	E
Crockett clay loam, rolling phase [10]	15	10	25	20	20					E	E	E	40	E
Bowie fine sandy loam, slope phase [10]	17	15						25		A	A	C	20	C
Susquehanna fine sandy loam [10]	17	15						25		A	A	C	20	C
Chattahoochee loamy fine sand, rolling phase [10]	15	15						25		A	A	C	15	C
Nacogdoches-Kirvin complex										A		C	30	C
Kalmia loamy fine sand	17	15						25		B	D		10	C
Crockett clay loam, steep phase [10]										E	E	E	50	C
Catalpa clay (in areas where flood hazard is severe) [9]										E	E	E	30	A
Trinity clay (in areas where flood hazard is severe) [9]										E	E	E	30	A
Yahola fine sand											E	E	20	A
Susquehanna clay										E	E	E	5	C
Chalk outcrop										E	E	E	10	C
Rough broken land										E	E	E	5	C
Riverwash										E	E	E	0	E

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

[2] The soils of Fannin County are given indexes that indicate the approximate average production of each crop in percentage of the standard of reference. The standard represents the approximate average yield obtained without use of amendments on the more extensive and better soil types of the regions in the United States in which the crop is most widely grown. The indexes are largely estimates, as yield data are yet too fragmentary to be complete. Crops for which there is insufficient information to permit the setting up of indexes on a national basis are given alphabetical ratings. In these the most productive soils in the county for a given crop are rated as grade A, the least productive as grade E, and those of intermediate productivity by letters between A and E. Absence of ratings indicates lack of sufficient information to make a rating owing to lack of production of the crop on the soil. This is generally indicative of low suitability of the soil for the crop, or of suitability of the soil to crops of higher economic value.

[3] Onions are produced for sale to outside markets only on the soils of highest productivity. Grade A for onions is equivalent to an average yield of about 100 bushels of marketable onions to the acre.

[4] This is a general rating of productivity for those vegetables and small fruits that are common in farm gardens and are also produced in small quantities for sale, mostly in local markets. The principal products are sweetpotatoes, green peas, green or snap beans, cucumbers, tomatoes, potatoes, turnips, watermelons, cantaloups, sorghum sirup, strawberries, blackberries, and dewberries. Rating A denotes production for sale of all or almost all of these, with high yields and good quality; rating B, production for sale with moderately high yields; rating C, production for home use only, with moderate yields; rating D, production for home use only, with moderate yields, but the soils are later, less productive, more difficult to work, or otherwise generally less suitable for gardens than those of rating C and accordingly not generally used for gardens on farms that embrace soils of higher rating for these crops; rating E, the soil is productive for most vegetables and small fruits only when given exceptional management.

[5] Mostly peaches, some pears, apples, and plums. Rating A denotes production for sale, with high yields and excellent quality; rating B, production for sale, with moderately high yields; rating C, production for home use only, with moderate yields; rating D, production for home use only, with low to moderate yields and generally short life of trees; rating E, the soil is of low suitability and is productive only when given exceptional management.

[6] Pecans are native and highly productive on soils of rating A; when planted and reasonably well managed, they thrive and are moderately productive on soils of rating C; they are unthrifty and short-lived or will not grow on soils of rating E except under unusual circumstances. On a few exceptional areas, underlain by a relatively shallow permanent water table of Houston Black clay, Hunt clay, and Austin clay, undulating shallow phase, (soils that are rated C), pecans are native, thrifty, and highly productive.

[7] For definition of cow-acre-days see table 7, footnote 2.

[8] Flood-plain hardwood species of trees are native and thrifty on soils of rating A. Upland hardwoods, mostly oaks, are native and thrifty or thrive when planted on soils of rating B. Upland species of hardwoods, mostly post oak and blackjack oak (but mainly western red oak and elm on the exceptional forested upland soils of clay texture), are native but of slow growth on soils of rating C. Only the most hardy species thrive when planted on soils of rating D. Even the most hardy species are unthrifty or will not grow on soils of rating E.

[9] Two ratings are given for these soils to show the great difference in productivity with difference in drainage.

[10] Erodible moderately sloping soils that are naturally unsuited to cropping systems in which intertilled crops occupy as much as one-half of the cropland.

[11] Strongly sloping soils that are generally too erodible for use as cropland.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and development acting on the parent soil 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. External climate, although important in its effects on soil development, is less so than internal soil climate, which depends not only on temperature, rainfall, and humidity, but 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.

Fannin County lies across the boundary between the Blackland Prairie of Texas and the main forested body of the Gulf Coastal Plain. The latter section falls within the region of Red and Yellow Podzolic soils. The Blackland Prairie was formerly considered as a southern extension of the great Prairie soils zone, but now its soils are classed as Rendzinas and Planosols rather than true Prairie soils. The boundary between the treeless dark soils and Red and Yellow Podzolic soils passes about east-west through the northeastern part of the county. The southern four-fifths of the county is occupied by dark-colored soils developed under grass, and the northeastern fifth by light-colored soils developed under trees. The boundary closely follows a change in character of prevailing parent materials from argillaceous or highly calcareous to sandy and noncalcareous.

The county lies entirely within the warm-temperate humid zone, wherein the action of soil-forming processes, if sufficiently long continued, presumably results ultimately in the development of Red and Yellow Podzolic soils. It lies, however, within the western and drier part of that climatic zone where the processes of soil development as determined by the climatic environment are more greatly repressed or modified by the character of the parent materials than they are in most places. The influence of parent materials upon soil development is especially marked, inasmuch as a change in vegetation accompanies a change in parent materials. Outcrops of the sandier formations are forested, and those of the argillaceous or highly calcareous rocks are mostly prairie.

The rocks that, in more or less weathered form, constitute the parent materials of the soils of Fannin County are: (1) Unconsolidated or weakly consolidated marine deposits containing little or no sand and ranging in content of calcium carbonate from very high to none (chalks, chalky marls, shaly calcareous marls, noncalcareous shales, and noncalcareous or only moderately calcareous clays and somewhat sandy clays); (2) subsidiary amounts of weakly consolidated sandstones, some of which contain large amounts of volcanic ash and its decomposition products; and (3) extensive deposits of more or less recently placed fresh-water alluvium (*12*). The principal differences in parent rocks that are reflected in soils developed from them consist of differences in content of calcium carbonate, proportions of sand and clay, permeability to moisture, content of incompletely weathered constituents, and length of time since deposition, so far as that period has determined the length of time during which the soils have been

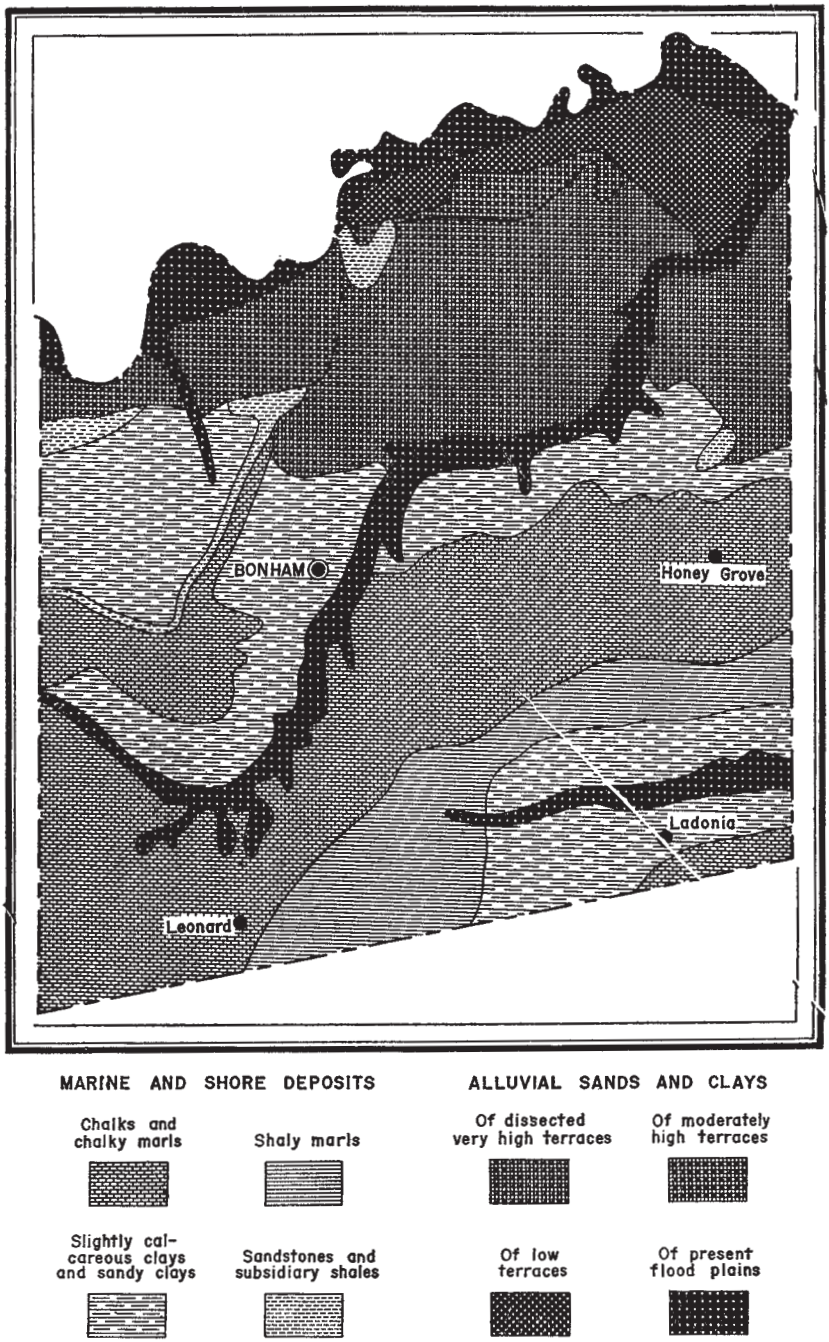

FIGURE 4.—Distribution of soil parent materials in Fannin County, Tex.

subjected to soil development. The general distribution of the various parent materials is shown in figure 4. The soils developed from the various parent materials are listed in table 9.

TABLE 9.—*Soil parent materials, drainage, native vegetation, and resulting soils in Fannin County, Tex.*

MARINE FORMATIONS AND INTERBEDDED SANDSTONES AND SANDS

Parent material	Drainage	Native vegetation	Soil
Chalk	Free but not rapid.	Grasses with a few forested areas.	Houston Black clay. Houston Black clay, flat phase. Houston Black clay, shallow phase. Hunt clay. Wilson clay (in a few forested areas).
	Free	do	Austin clay, undulating phase. Austin clay, undulating shallow phase.
	Rapid	Open hardwood forest with ground cover of grass.	Austin clay, rolling shallow phase. Chalk outcrop (on some of the harder and purer layers).
Chalky marl	Free but not rapid.	Grass with local areas forested.	Houston Black clay. Hunt clay. Hunt clay, flat phase.
	Rapid	Grass or open hardwood forest.	Houston Black clay, slope phase. Austin clay, rolling phase.
	Very rapid	do	Austin clay, steep phase. Sumter clay.
Shaly calcareous marls	Free but not rapid.	Grass	Houston Black clay. Hunt clay.
	Rapid	do	Houston clay.
	Very rapid	do	Sumter clay.
Noncalcareous or moderately calcareous marine clays, shales, and sandy clays.	Slow	do	Wilson clay. Wilson clay loam. Wilson silt loam.
	Free but not rapid.	do	Crockett clay loam. Crockett silt loam. Crockett very fine sandy loam. Bonham clay loam. Wilson clay. Wilson clay loam. Wilson-Crockett clays. Bonham silt loam.
	Free	Trees	Susquehanna clay (in small areas underlain by certain shales).
	Rapid	Grass with scattered trees in a few places.	Crockett very fine sandy loam, rolling phase. Crockett clay loam, rolling phase. Bonham clay loam, rolling phase. Wilson-Crockett clays, rolling phases. Houston clay (in small areas on calcareous clays). Ellis clay (from shales).
	Very rapid	do	Crockett clay loam, steep phase. Sumter clay (in small areas).
Sands and sandstones containing only small quantities of unweathered minerals.	Free to rapid	Grass	Choctaw fine sandy loam. Choctaw fine sandy loam, rolling phase.
		Trees	Susquehanna fine sandy loam, smooth phase. Susquehanna fine sandy loam.
Sands and sandstones containing volcanic ash and decomposition products.	do	do	Nacogdoches fine sandy loam. Nacogdoches-Kirvin complex.

TABLE 9.—*Soil parent materials, drainage, native vegetation, and resulting soils in Fannin County, Tex.*—Continued

ALLUVIUM

Parent material	Drainage	Native vegetation	Soil
Clays and sands of the highest and oldest river terraces.	Wanting or very slow.	Grass	Ivanhoe silt loam. Irving silt loam (in small areas). Irving silt loam, mound phase.
	Free but not rapid.	Trees	Susquehanna very fine sandy loam. Sawyer fine sandy loam. Bowie fine sandy loam. Chattahoochee fine sandy loam.
	Rapid	do	Susquehanna fine sandy loam. Chattahoochee loamy fine sand, rolling phase. Bowie fine sandy loam, slope phase.
Sands and sandy clays of the intermediate river terraces.	Wanting or very slow.	Mostly grass	Myatt very fine sandy loam. Myatt fine sandy loam. Irving silt loam. Irving silt loam, mound phase. Irving clay loam. Ivanhoe silt loam (in small areas).
	Slow but free	Grass	Bienville very fine sandy loam. Bienville fine sandy loam. Bienville loamy fine sand.
	Free to rapid	Grass or trees	Teller very fine sandy loam. Teller fine sandy loam. Teller fine sandy loam, slope phase.
		Trees	Susquehanna very fine sandy loam. Sawyer fine sandy loam. Susquehanna fine sandy loam. Chattahoochee fine sandy loam. Chattahoochee loamy fine sand, rolling phase.
	Slow externally, free internally.	do	Kalmia loamy fine sand.
Alluvium of lowest river terraces above normal overflow.	Slow externally, free to slow internally.	do	Reinach silt loam. Reinach loamy fine sand. Brewer clay loam.
Recent alluvium of the Red River.	Subject to overflow.	do	Miller soils. Yahola soils.
Recent alluvium of local streams draining areas of prairie.	do	do	Trinity soils. Catalpa soils. Kaufman soils.
Recent alluvium of streams draining areas of light-colored soils.	do	do	Ochlockonee fine sandy loam.

The rocks of the group of nonsandy materials of marine origin, considered as to their influence on soil development, apparently consist of various proportions of calcium carbonate, thoroughly weathered clay minerals, and subsidiary amounts of quartz sand. These rocks are themselves relatively thoroughly weathered products; the parent material, the part immediately below the soil proper, does not differ greatly from the underlying material. The only apparent changes below the solum, other than those resulting from stratification, are in color, more or less thorough removal of the carbonates, and some translocation of iron compounds. Immediately below the soil proper the color is somewhat yellower than it is at greater depths, probably indicating some oxidation or hydration. The alteration in color is most pronounced in the bluish-gray marls, which change to olive-yellow within 10 to 20 feet of the surface. In the more highly calcareous rocks the parent material is calcareous, and in the nearly impermeable marls concretions of calcium carbonate are present to a depth ranging from 10 to 20 feet. These segregated masses are not present in the unaltered rock and may constitute a temporary zone of carbonate ac-

cumulation. In smooth areas underlain by more sandy or less calcareous beds the parent material is not calcareous to a depth of many feet. Rusty-brown friable concretions, with a maximum diameter of 1 inch, apparently consisting largely of iron oxide, occur in the C horizons below areas of acid soils of the prairies. So far as could be observed, these segregated masses of iron oxide persist down to the depth where the entire mass becomes calcareous, but they do not occur in the unaltered rocks. They are not confined to layers with an acid or neutral reaction, and they are most abundant in parent materials that consist of alkaline though noncalcareous fine earth containing a very few hard concretions of calcium carbonate.

The belts where the nonsandy marine formations have been exposed to weathering are almost entirely prairies. The prairie vegetation apparently was a climax plant association and the natural type of the environment. For the most part, trees do not thrive or are short-lived when planted on the heavy soils developed from these rocks, owing apparently to the lack of moisture during dry, hot periods of summer. Some of the areas underlain by chalk were forested with Osage-orange, Texas red oak, hackberry, elm, a few other trees, and various shrubs. These forested areas underlain by chalk include both rolling surfaces, where shallow soils have developed, and smooth surfaces, where deep soils have developed. For the most part, the only smooth areas that were forested are those where the water table stands within the reach of tree roots. The soils developed from chalk in these forested areas are dark-colored and for the most part are not observably different from soils developed from chalk under grass. Extensive areas of Hunt clay in smooth forested areas underlain by chalk, together with small areas of Wilson clay, which is nowhere developed on chalk under grass, are also present and indicate that soil development has proceeded somewhat more rapidly in the blackland thickets than in the prairies.

Development of soils underlain by highly calcareous rocks has been strongly modified by the presence of large amounts of calcium carbonate in the parent materials. The abundance of calcium and other bases and the nearly impervious character of the substrata have prevented the thorough removal of these bases from the upper soil layers. The surface soil layers are highly calcareous or (in Hunt clay) neutral to slightly acid. The soils are not eluviated and have no apparent texture profile. The smoother areas of the heaviest soils have a 2- to 4-foot surface layer containing sufficient organic matter to impart a black or very dark gray color. In the more sloping areas, where geological erosion was active, the dark-colored layer is less thick than in the smoother areas and is brown rather than black. The surface horizons of Houston Black clay, Hunt clay, and Houston clay have a coarse, hard, somewhat poorly defined granular structure to a depth of about 18 inches; those of the Austin soils have a well-defined friable medium-granular structure. All these are Rendzina soils, of which Houston Black clay and Hunt clay are the most extensive in Fannin County.

The following profile of Houston Black clay is representative of their general features. This profile was observed 3 miles northwest of Honey Grove, a quarter of a mile west of the northwest corner of the John Bull survey, on an undulating freely but not rapidly drained

upland plain. The area is a prairie meadow of prairie beardgrass, bluejoint turkeyfoot, Indian grass, and associated finer grasses. The surface has a marked microrelief, consisting of alternating elliptical enclosed depressions or hog wallows about 10 feet long and 6 feet wide, and of microknolls, the crests of which are about 12 inches higher than the centers of the depressions. The general gradient of the surface, excluding the microrelief, is about 2 percent. The described profile is in the central part of a microdepression, or hog wallow.

0 to 1½ inches, a loose mass, when dry, of very fine subangular hard grains, about one thirty-second inch in diameter, of black slightly calcareous clay.

1½ to 18 inches, black slightly calcareous crumbly coarsely granular very heavy clay. When very dry the material in this horizon is a porous mass of subangular to rounded hard brittle granules, about half an inch in diameter, which are loosely bound one to another by plant roots. When wet the material is nearly impervious, extremely plastic, and extremely sticky. Earthworm casts are present but not numerous. Plant roots permeate the mass. The interiors of the granules are of the same color as the exteriors. With increasing depth the structure particles become larger and more angular, and the material grades indistinctly into that of the underlying horizon.

18 to 48 inches, black calcareous extremely heavy clay, somewhat more compact and less crumbly than that in the overlying horizon. When wet the material is nearly impervious to water and is extremely plastic and sticky; when very dry it is very hard, though somewhat brittle, and fissured into irregular large clods by crooked nearly vertical contraction crevices 1 to 6 inches wide. Plant roots permeate the material. The material between depths of 3 and 4 feet is faintly less dark than the rest and is grayish black or very dark gray. The material grades into the underlying material.

48 to 60 inches, dark yellowish-brown highly calcareous very heavy clay with an olive hue.

60 to 72 inches, yellowish-brown very highly calcareous very heavy clay with an olive hue, containing a few hard concretions of calcium carbonate.

72 to 90 inches +, the parent materials of olive-yellow very highly calcareous nearly impervious shaly clay containing a few hard concretions of calcium carbonate and thin streaks of bluish gray. The bluish-gray streaks occur medially between horizontal shalelike partings and become thicker with depth. Some of the cleavage planes have a slight film of rusty-black material and a very few friable concretions of ocher-yellow material, perhaps iron oxide.

The very dark layer is much thinner below the intervening ridges than it is in the depressions, and the color is dark brown rather than black. Geologically, the parent material of the described profile is Bonham clay of the Upper Cretaceous period, a marine deposit. As observed elsewhere at greater depths, it is bluish gray and contains no segregated concretions of calcium carbonate.

The Bonham, Crockett, Wilson, and Choctaw soils are well-developed soils formed in slowly to well-drained prairie on parent materials of medium to heavy texture and containing only moderate amounts of alkaline earths. Some authorities class the Wilson soils as Planosols. The Bonham, Choctaw, and Crockett soils are Reddish Prairie soils. Their general characteristics are illustrated by the following profile of Bonham clay loam, as observed 2.3 miles northwest of the court house in Bonham, 0.37 mile south of the northeast corner of the A. Jennings survey, on a smoothly undulating well-drained up-

land surface with a gradient of 1.5 percent. The area is a native prairie meadow of prairie beardgrass and associated grasses.

0 to 12 inches, dark grayish-brown friable granular slightly acid silty clay loam.
12 to 24 inches, brown crumbly slightly acid silty clay. Reddish-brown spots appear in interiors of structure particles, and gray films coat the exteriors. The material has a medium granular structure to a depth of about 18 inches, grading into friable flat-faced cubelike aggregates about three-fourths of an inch in diameter. The transition to the underlying horizon is gradual.
24 to 36 inches, compact slightly acid heavy clay, brownish-yellow slightly mottled with gray, with a hard, fine, cloddy structure. The centers of structure aggregates contain numerous brownish-red spots. A few black hard pitted pellets of iron oxide are present. The change into the underlying material is gradual.
36 to 84 inches +, the parent material of gray heavy noncalcareous clay strongly mottled with brownish yellow. Crumbly rusty-black concretions are numerous and apparently consist largely of iron oxide.

The parent material in the described profile is a marine deposit, the Bonham clay formation of the Upper Cretaceous period. In other places it is calcareous at greater depths.

The terraces of the Red River, which cover the northern part of the county, represent several levels and ages. The soils occupying them constitute a series of stages of development from freshly deposited unaltered material to mature Red and Yellow Podzolic soils.

The highest and oldest terrace, which is greatly dissected, is occupied by mature normal Red and Yellow Podzolic soils wherever normal drainage conditions have been established. This terrace lies about 600 feet above sea level, or 150 to 175 feet above the present river channel, and on the same general level as the upland plain. It consists of three main parts. The first includes the central undissected flats, Hawkins, High, and Free Hart Prairies, where slow drainage or lack of drainage prevents the normal development of soils. Here are broad areas of Ivanhoe silt loam. The second part includes undulating smoothly dissected normally drained borders of sandy forested country where the soils are normal and mature. Bowie fine sandy loam and Susquehanna very fine sandy loam are representative of these soils. The third part includes sloping eroded margins. Rolling areas of the Chattahoochee, Susquehanna, and Bowie soils occupy this land.

The characteristics of the Ivanhoe soils, a series established in Fannin County, are represented by the following typical profile. This soil was observed on Hawkins Prairie, the flat undissected part of a very high old river terrace, 1.5 miles southeast of Ivanhoe, or at the intersection of a line 0.5 mile north with a line 0.4 mile east of the southeast corner of the S. Larkin survey, on a level flat dotted with mounds that occupy about one-twentieth of the surface. The described profile is centrally located between mounds. Surface drainage and for the most part underdrainage are lacking. Water in excess of the quantity absorbed by the soil stands on the surface until removed by evaporation; the permanent water table is more than 50 feet below the surface. All soil horizons become very dry late in summer. The area is a prairie pasture that has never been plowed.

A. 0 to 14 inches, grayish-brown or light grayish-brown moderately acid silt loam, light brown and friable when moist but hard when dry. It contains moderately numerous hard pitted pellets of iron oxide about one thirty-second of an inch in diameter and grades into the underlying horizon through a transitional zone about 1 inch thick. The material has no apparent structure.

B_1. 14 to 17 inches, mottled brownish-red and dark-gray moderately acid very compact heavy clay. The material breaks under pressure to very hard clods of indeterminate size and shape.

B_2. 17 to 24 inches, mottled gray and yellowish-brown slightly acid very compact tough heavy clay.

C_1. 24 to 156 inches, mottled light-gray and brownish-yellow noncalcareous slightly alkaline compact heavy clay. It contains friable rusty-black concretions with a maximum diameter of one-half inch, which apparently consist largely of iron oxide. A very few hard lumps of calcium carbonate are present at various depths, but the fine earth is not calcareous.

C_2. 156 to 180 inches, yellowish-red noncalcareous sandy clay.

The general features of the maturely developed normal soils are illustrated by the following profile of Bowie fine sandy loam, as observed at Bois d'Arc School, 23 miles northeast of Bonham, on a very high old smoothly dissected stream terrace. Surface drainage is free but not rapid, and the surface gradient is 1 percent. The vegetation is a native growth of post oak, blackjack oak, considerable red oak, and a very few hickory trees with very little underbrush. Sand mounds make up about one-eighth of the total area. The described profile is taken at a central point between mounds.

A_0. A 1- to 2-inch layer of loose, dry, broken, partly decayed oak leaves and twigs, which rests abruptly on the mineral soil.

A_1. 0 to 3 inches, grayish-brown slightly acid mellow fine sandy loam.

A_2. 3 to 16 inches, pale-yellow strongly acid mellow light fine sandy loam, which grades into the underlying layer through a 2-inch transitional horizon.

B_1. 16 to 24 inches, yellow friable very strongly acid fine sandy clay.

B_2. 24 to 42 inches, yellow strongly acid friable fine sandy clay containing numerous red spots. The red spots are confined to the interiors of the large indefinite and irregular columns into which the material is naturally separated by dominantly vertical planes of breakage.

B_3. 42 to 66 inches, light-gray slightly acid rather heavy fine sandy clay containing red spots in the interiors of natural aggregates. The color of these spots grades through a transition of yellow into the light gray of the matrix.

C. 66 to 90 inches+, pale-gray noncalcareous fine sandy loam containing yellowish-brown spots.

The next highest terrace of the Red River lies about 50 feet lower, or about 100 feet above the river channel. This is a flat on the north side of Ravenna, which is 2 to 4 miles in width from north to south and extends westward from the vicinity of the State highway into Grayson County. Its elevation above the river channel decreases westward. Narrow valleys of small streams partly dissect the land, but flat constructional surfaces prevail. The northern half of this terrace, the part closest to the flood plain of the Red River, is occupied by Teller soils in the more fully drained positions, the Bienville soils in the nearly level but well-drained positions, and the Myatt soils in the slight depressions or poorly drained flats. The southern half of the terrace is more largely occupied by Irving soils, with considerable Susquehanna very fine sandy loam in the eastern part. The small areas of Chattahoochee fine sandy loam on this terrace are less eluviated than are those on the highest terrace. Most of this terrace was prairie; however, areas of light-colored sandy soils, some of the areas of Teller and Myatt soils, and the sloping margins of the terraces were forested with oak.

The following profile of Myatt very fine sandy loam was observed on this second highest terrace as it appears about 11 miles north of Bon-

ham, 0.9 mile south of Sowells Bluff Bridge, and 0.25 mile west of Finley School. The area is on a level poorly drained stream terrace marked by mounds and occupied by a glady forest of post oak and blackjack oak with numerous shrubs of hawthorn and winged elm and considerable grass in the less shaded places. The typical Myatt profile occurs also in areas originally covered with prairie grasses.

A_1. 0 to 4 inches, gray strongly acid rather silty very fine sandy loam.

A_2. 4 to 20 inches, pale-gray vesicular very strongly acid silty very fine sandy loam containing brown splotches, which are distinct only when the material is wet or moist, and numerous black pellets of iron oxide.

B_1. 20 to 32 inches, light-gray very strongly acid fine sandy clay loam containing numerous spots of yellowish brown. The structural aggregates, about three-fourths of an inch in diameter, are cubelike, have yellowish-brown centers, and are surrounded by films of grayish-white material.

B_2. 32 to 44 inches, light bluish-gray very strongly acid compact fine sandy clay mottled with reddish-yellow spots. The structural aggregates are of the same shape as in the overlying horizon but are larger and less well defined. They are very firm until crushed, even when saturated with water. The horizon is an indistinct hardpan. Masses of the material that have been puddled when wet become stonelike on drying. The layer is nearly impermeable to moisture. Dry material has been reached at a depth of 42 inches in a place where water had stood on the surface for 2 months.

C. 44 to 66 inches+, light-gray moderately acid fine sandy clay loam mottled with some ocher yellow.

A similar intermediate bench on the south side of Elwood is occupied by Bienville, Teller, and Myatt soils and apparently lies slightly lower than the Ravenna terrace.

An extensive lower terrace extends eastward from the vicinity of Tulip past the north side of Elwood to the flood plain of Bois d'Arc Creek. The village of Monkstown is situated toward its eastern end in the part locally known as Blue Prairie. This bench lies from 25 to 50 feet above the present river channel and is the lowest terrace above the flood plain. It is occupied mainly by sandy soils of the Bienville and Myatt series, and before cultivation it was largely covered with beardgrass. In most places the water table lies at a shallow depth and rises to within 2 or 3 feet of the surface after periods of rainy weather.

Slight elevations in the flood plain, which lie above normal overflow but are inundated during extreme floods such as that of 1908, are covered with the Reinach and Brewer soils. The Reinach soils occupy the better drained positions, and the Brewer soil the lower positions where the soils are mostly somewhat heavier textured than the Reinach soils. Little soil development, other than accumulation of organic matter, is evident, and the only differences in texture between the surface soils and the subsoils are due to stratification. The main bodies of this lower terrace are north of Mulberry in the northwestern part of the county, where they comprise the area known as Mulberry Flat, and north of Riverby School in the northeastern part of the county.

Small roundish areas of barren or nearly barren soils characterized by whitish siliceous surface crusts and by dark-colored extremely compact subsoils occur in parts of the county, particularly in areas of acid prairie soils. They are most numerous in some of the Wilson soils near Ladonia and in sloping areas of Crockett soils. These small barren areas are saline spots, commonly known as slick spots, and are indicated on the soil map by symbols, each symbol representing a maxi-

mum area of 2½ acres. As plants do not thrive, and as no feasible method of improvement is known, the saline spots are worthless for agriculture. In general, however, they are so small and few as to have relatively little importance.

Uneroded saline spots have a 2- to 4-inch surface horizon of light-gray noncalcareous silt loam, underlain either transitionally or abruptly by an extremely compact subsoil layer of very dark gray or very dark brown noncalcareous nearly impervious gummy clay. The horizon has no well-defined structure; when moist the material is an amorphous puddled mass, and when dry it is extremely hard and fractures under pressure to clods of indeterminate size and shape. Small pulverulent concretions of white noncalcareous salts are commonly present in this horizon. The very dark horizon is 5 to 10 inches thick and grades below into olive-brown or gray very compact noncalcareous clay. At a depth of about 3 feet this grades to dull-yellow or olive-yellow slightly less compact clay. Vesicles or voids ranging up to one-eighth of an inch in diameter are numerous in the surface horizon.

Nearly all saline spots are severely eroded and have lost the silty surface horizon and more or less of the very dark horizon. In the eroded areas the exposed intractable clay has on the immediate surface the merest film of nearly white very fine sand or silt, which imparts a distinctive appearance to the areas. Most of the saline spots are from 15 to 100 feet in diameter. They occur in situations where saturation of the soil by ground water probably occurs during wet seasons or has occurred in times past. The intractable subsoils are probably caused by the influence of soluble salts, largely of sodium, concentrated in the areas by ground water. The saline spots seem to represent various stages between Solonetz and Soloti, even though the characteristic structure of the subsoil is lacking.

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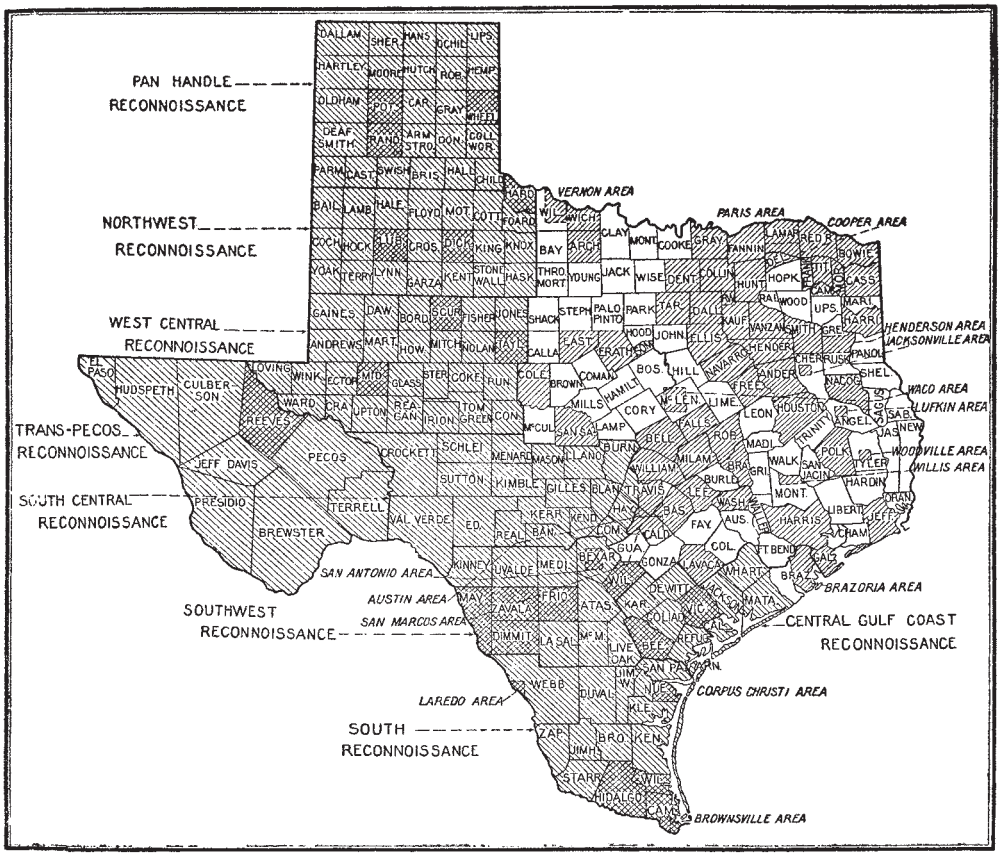

Areas surveyed in Texas shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnoissance surveys shown by northwest-southeast hatching; cross hatching indicates areas covered in both ways.

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