LACIE-00408
JSC-09853

LARGE AREA CROP INVENTORY EXPERIMENT (LACIE)

7.9-10132
CR-158141

NASA NOAA USDA

INTENSIVE TEST SITE ASSESSMENT REPORT

(E79-10132) LARGE AREA CROP INVENTORY EXPERIMENT (LACIE). INTENSIVE TEST SITE ASSESSMENT REPORT (Lockheed Electronics Co.) 388 p HC A17/MF A01 CSCL 02C
N79-18397
Unclas
G3/43 00132

National Aeronautics and Space Administration

LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

August, 1975

INTENSIVE TEST SITE

ASSESSMENT REPORT

REVIEWED BY:

T. M. McPherson
LACIE-DAPTS

APPROVED BY:

J. L. Dragg
LACIE-
Applications Evaluation System

Acknowledgement

The research and compilation of the data in this report was performed by the following LEC Regional Analysis personnel:

W. J. Daley	Senior Scientist
D. P. McGuigan	Scientist
L. D. Pearl	Scientist
C. R. Reed	Associate Scientist
M. C. Swope	Associate Scientist
M. R. Villanueva	Senior Scientist

This work was performed under NASA contract NAS 9-12200.

CONTENTS

Note: For the reader's convenience, each numbered section contains its own table of contents, table of tables, and table of figures.

CONTENTS

TABLES

TABLE		Page
I-27	CROP CALENDARS FOR THE SOUTHWEST CROP REPORTING DISTRICT OF KANSAS (FINNEY AND MORTON COUNTIES).	1-76
I-28	CROP CALENDARS FOR THE CENTRAL CROP REPORTING DISTRICT OF KANSAS (SALINE, RICE AND ELLIS COUNTIES).	1-76
I-29	USUAL PLANTING AND HARVESTING DATES FOR OTHER CROPS IN KANSAS	1-77
I-30	DISTRIBUTION OF WINTER WHEAT VARIETIES. . . .	1-78

FIGURES

INTENSIVE TEST SITE ASSESSMENT REPORT

KANSAS

SECTION ONE

.0 KANSAS INTENSIVE TEST SITES

1.1 REGIONAL DESCRIPTION

Five Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the state of Kansas. These test sites are located in Finney, Morton, Saline, Rice and Ellis counties (fig. 1-1).

1.1.1 Location

TABLE I-1.- COUNTY SIZE AND LOCATION OF THE LACIE INTENSIVE TEST SITES IN KANSAS

County	Sq. miles	Total acres	N. Lat.	W. Long.	Test site size, miles
Finney	1302	833,280	38°04.2′	101°01′	5x6
Morton	725	464,000	37°16.0′	101°54.0′	5x6
Saline	720	460,800	38°51.8′	97°28.4′	3x3
Rice	725	464,000	38°17.0′	98°12.7′	3x3
Ellis	900	576,000	38°50.1′	99°13.0′	3x3

The test sites in Finney and Morton counties are in the southwestern crop reporting district of Kansas and are representative of the subhumid areas of the high plains. Annual precipitation averages 18 to 20 inches. This region on the high plains is characterized by unpredictable precipitation from year to year. The other three test sites in Kansas are found within the central crop reporting district and reflect an increase in precipitation from west to east.

KANSAS

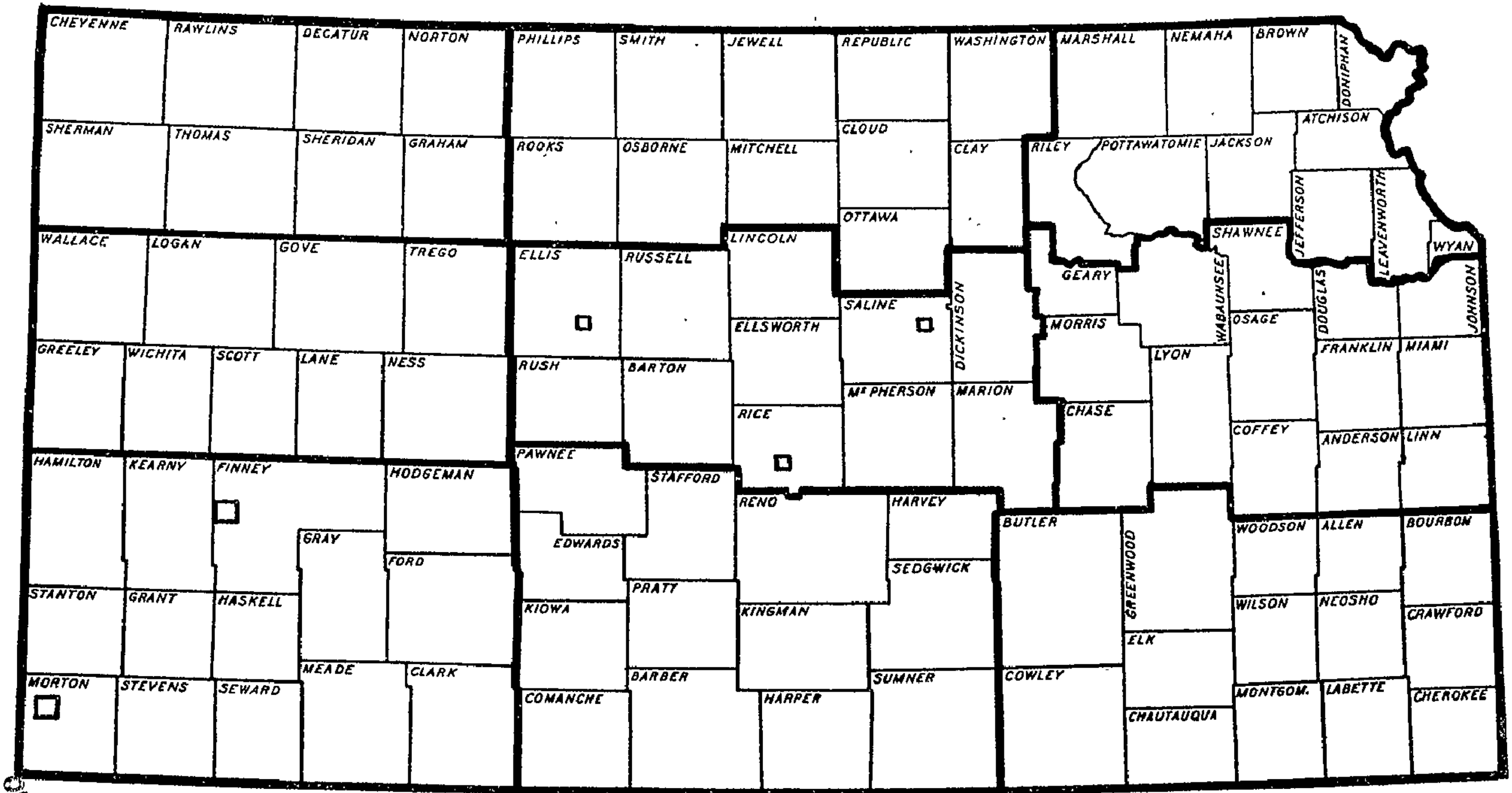


Figure 1-1. – Location of the five LACIE Intensive Test Sites in Kansas.

1.1.2 Physiography

1.1.2.1 Finney County. Finney County consists of five distinct physiographic areas. These are the High Plains tableland, in which the test site is located, the Scott-Finney depression, the drainage basin of the Pawnee River, the valley of the Arkansas River, and the Sandhills.

The High Plains tableland is in the northwestern and northcentral parts of the county. The test site is located one mile east of the Kearney County line with the Scott-Finney depression to the northeast and the Arkansas River to the south. The altitude of the test site is about 3000 feet. The High Plains tableland consists of windblown deposits classified as Permian loess, from the early Wisconsian age. The loess, approximately 10 to 30 feet thick, is over calcareous silt, sand and gravel of the Ogallala formation of the tertiary age. The material that makes up the Ogallala formation was deposited by widely shifting streams that originated in the Rocky Mountains.

A common feature of the High Plains tableland is the shallow undrained basins that hold water after rains. These form temporary lakes. Short tributaries lead into some of the depressions; otherwise the area has no defined drainage pattern.

1.1.2.2 Morton County. Morton County is a part of the Southern High Plains section of the Great Plains physiographic province. About 85 percent of the county consists of upland plains and rolling-to-hilly sandy land; the rest is stream flood plains and intermediate slopes. Large areas on the upland are comparatively flat and featureless. In detail, however, most parts of the flat upland are more or less uneven and consist of broad gentle swells or hills and shallow depressions.

The sandhills have hilly and rolling topography. The sandy areas consist of sand dunes that differ in size and age. The larger dunes are 20 feet high or more. The landscape of the county is illustrated in figure 1-2.

The Cimarron River passes through the central part of the county. Here, the river is an intermittent stream that flows only when there is heavy rainfall upstream. The

MORTON COUNTY, KANSAS

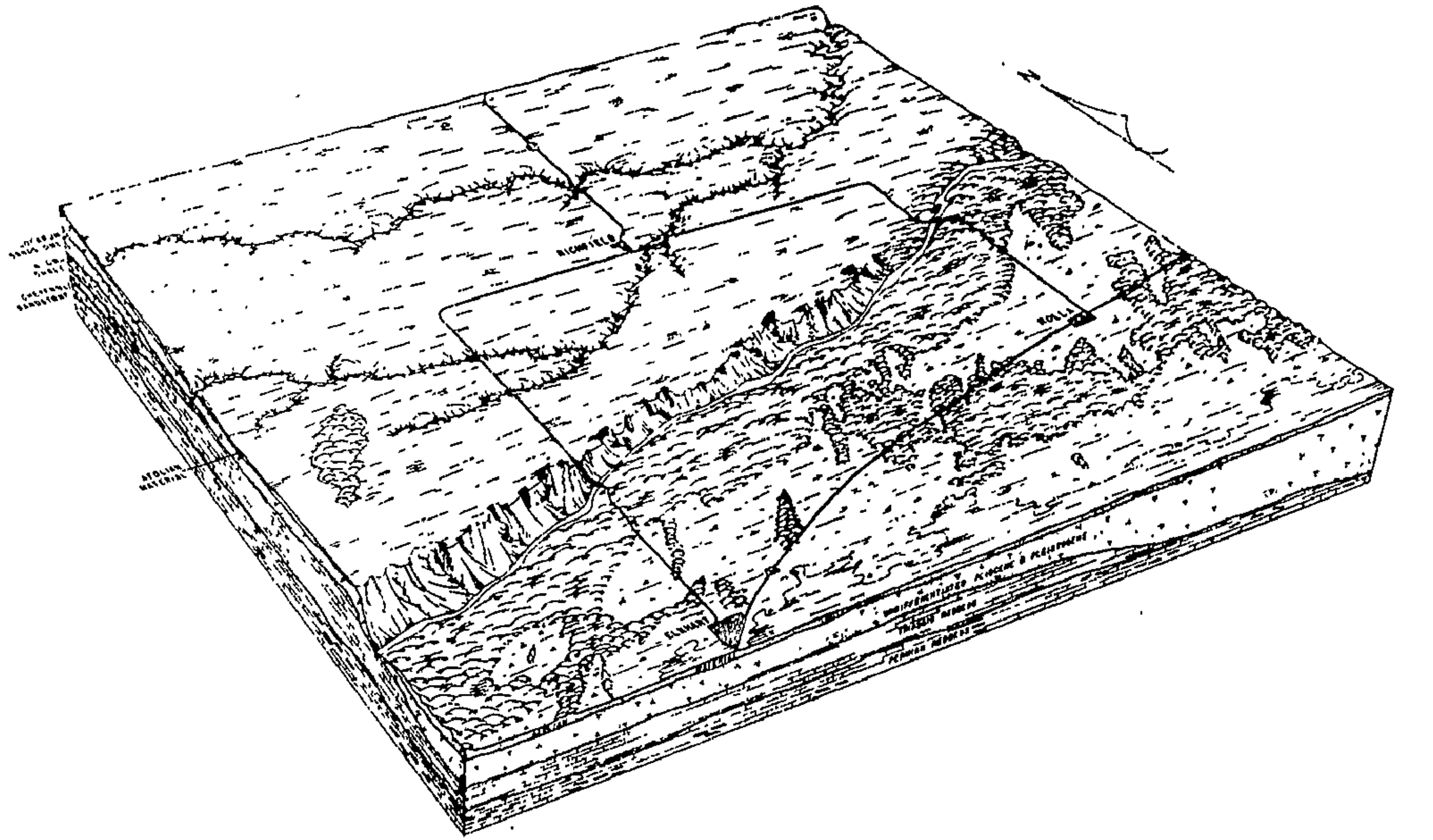


Figure 1-2. – Landscape of Morton County, Kansas.

floodplain is small and only a few feet higher than the bottom of the river channel. Sandhills occur on the southern side of the Cimarron River, and a sloping-to-steep valley wall, consisting of less sandy materials, occurs on the northern side. The North Fork of the Cimarron River, also an intermittent stream, passes through the northern part of the county.

The elevation of the upland ranges from about 3,700 feet above sea level in the southwestern part of the county to 3,150 feet on the eastern county line. The lowest point is in the northeastern corner of the county, on the North Forth of the Cimarron River. In general, the county slopes to the east-northeast about 15 feet per mile.

The Cimarron River is more than 100 feet below the upland areas, and the North Fork of the Cimarron River is more than 50 feet below the Cimarron River.

About 50 percent of the county is drained by the Cimarron River and its tributaries; the rest has no exterior drainage. Rain that falls on flat upland and sandhills drains into temporary ponds or small, shallow lakes; then it evaporates or percolates downward. Stream dissection in this county is in the stage known as topographic youth.

1.1.2.3 Saline County. Saline County lies partly within Great Plains Province and partly within the Central Lowland Province of the Interior Lowland region. The boundary between the two provinces roughly divides the county into halves.

The western half of the county lies within an eroded zone along the eastern edge of the High Plains. It consists of steeply rolling hills and ridges separated by relatively narrow and deep stream valleys. Upland areas are remnants of an alluvial plain that once spread from the mountains in the west to the Central Lowland. Progressing eastward toward the more maturely dissected central part of the county, the ridges are lower and partially dissected into low mesa-like hills with cone-shaped bases and rounded tops. Elevations in this part of the county range from 1,680 feet near the western county line to 1,280 feet near the terraces along the Smoky Hill River in the central part of the county.

The eastern part of the county lies within the smoother, gently rolling Central Lowland Province. The test site is located in this plain of low relief and hills east of the Smoky Hill River. The confluence of the Saline River and the Smoky Hill River is located near the western boundary of the test site. The hills east of the Smoky Hill River are composed of wind-deposited materials from the valley floor. The divide between the Smoky Hill River and Gypsum Creek consists of erosion remnants similar to those in the western part of the county. Elevations in the eastern part of the county range from 1,520 feet in the southcentral part to 1,200 feet in the northeastern part.

The county is drained by three large rivers and four major intermittent streams. The Smoky Hill River is the largest stream. It enters from the south, flows north to the vicinity of Salina, and then follows an easterly course until it leaves the county. The Saline River enters the county from the north and flows south-eastward until, east of Salina, it empties into the Smoky Hill River. The Solomon River flows across the northeastern corner of the county line. Broad, gently sloping terraces border these rivers. In addition to the rivers, three intermittent streams - Mulberry, Spring, and Dry Creeks - and their tributaries drain the western part of the county. These streams rise in the steeply rolling areas and flow east and northeast to the Saline River. The southeastern and eastern parts of the county are drained by Gypsum Creek and its tributaries, another intermittent stream which flows northward to the Smoky Hill River. Since this stream receives runoff from a large area, it sometimes reaches flood stage. When this occurs, farmlands along the length of the valley are subject to flooding.

1.1.2.4 Rice County. Rice County lies within an eroded zone along the eastern edge of the High Plains within the Great Plains Province. Refer to the description of the western part Saline County, Kansas for a physiographic description. The approximate elevations in Rice County are 1660 to 1800 feet.

The Arkansas River, Cow Creek, and the Little Arkansas drain the surface area of Rice County. The Arkansas River cuts through the southwestern corner, and Cow Creek meanders from the northwestern corner through the Intensive Test Site to the southeastern corner. The Little Arkansas flows along the eastern section. All three bodies of water flow in a southeasterly direction.

1.1.2.5 Ellis County. Ellis County lies within the Great Plains Province. This county lies within the eroded zone along the eastern edge of the High Plains. See description of the western part of Saline County, Kansas for a physiographic description. The elevations in Ellis County are about 1,500 to 2,500 feet.

The county is drained by the Saline and Smoky Hill Rivers and Big Creek. Big Creek cuts through the southwestern corner of the test site. All three flow eastward. The Saline River enters the county from the northwest corner and meanders along the northern boundary of the county. The Smoky Hill River enters from the southwestern part of the county and skirts the southern boundary. Big Creek enters from the middle of the western boundary of the county and flows southeasterly through the middle of the county until it takes a more easterly course out of the county on the eastern boundary.

1.1.3 Climate

Because of its location in the Great Plains, Kansas has a distinct continental type of climate. About half the time, the annual precipitation is similar to semiarid regions. The rest of the time, it is similar to dry subhumid regions.

To a great extent, the amount of rainfall depends on the supply of moisture from the Gulf of Mexico. The Rocky Mountains to the west prevent an inflow of moist air from the Pacific Ocean. Most of the precipitation falls during the warm season. The summers are warm, and the winters are cold but not intolerable. The abundant sunshine and the constant movement of the wind are probably the two most noticeable characteristics of the climate. Marked and significant differences in daily temperature occur in the colder part of the year.

1.1.3.1 Finney County. The climate of Finney County is continental as can be seen from the fluctuations in daily, seasonal, and annual temperature and precipitation that occur within a short period. There are also longer climatic trends. At times, there are longer than average periods of low rainfall and high temperatures. Again, there may be longer than average periods of favorable temperature and precipitation.

Temperatures vary widely in this county over a 24-hour period. The days are warm and the nights are cool. The average (mean) maximum temperature is about 29° higher than the average minimum for the year. The range between absolute monthly extremes, however, increases from 69° F in July (the difference between the maximum extreme of 113° F and the minimum extreme of 44° F) to 120° F in March (the difference between the maximum extreme of 98° F and the minimum extreme of -22° F).

Winter temperatures sometimes linger in this county, and occasionally spring temperatures arrive early. The highest temperature recorded for March, 98° F, was on a date only 8 days later than the one on which the lowest temperature on record occurred! Another fact that emphasizes the wide range in temperature is that a temperature of 100° F or higher has been recorded almost 2 weeks earlier in spring than the date of the last freezing temperature of 32° or lower. Similarly, the date of the first freeze in fall is 5 days earlier than the date on which a temperature of 100° F or higher occurred. At Garden City, the highest temperature on record is 113° F, which occurred on July 13, 1934. The coldest temperature on record is -32° F, which occurred on February 12, 1899.

Temperatures during the cold season are less extreme in this county than those during the warm season. In no month has the average minimum temperature been below zero, but the average minimum was 10° F or lower in six Januarys and four Februarys. In this county the lowest average minimum temperature for any month on record was 44° F for February 1899. January 1912 had the greatest number of days when the temperature was zero or lower. That period had a total of 13 such days, and January 1930 and February 1899 were next with 12 days each. The average monthly temperatures at Garden City, Kansas are shown in table I-2.

TABLE I-2. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT GARDEN CITY, FINNEY COUNTY, KANSAS.

Month	Temperature average, °F	Precipitation average, inches
December	32.8	0.58
January	30.9	0.40
February	34.6	0.75
Winter	32.8	1.73
March	42.8	1.06
April	53.7	1.94
May	63.5	2.64
Spring	53.3	5.64
June	73.6	3.01
July	78.9	2.61
August	77.9	2.29
Summer	76.8	7.91
September	69.4	1.75
October	56.7	1.31
November	42.4	0.74
Fall	56.2	3.80
Year	54.8	19.08

[a]Averages for period 1898-1962.

The average amount of monthly precipitation increases from 0.40 inch in January to 3.01 inches in June. After June, the average amount of monthly precipitation decreases. There is a marked increase in the amount of precipitation received from February through April; then an even more rapid decline in precipitation from the first week in August through September. During the latter part of June and extending through much of July, the probability of receiving a weekly total of less than 2 inches decreases sharply.

The rapid decline in the probability of receiving an adequate supply of rainfall during July, and during the early part of August is a definite limitation on the production of crops. That is the period when the weather is the hottest and when crops require the most moisture.

The intensity, or rate of fall, of rains is a governing factor in planning engineering projects, such as the design of culverts, the capacity of dams, and the capacity and type of waterways. Heavy downpours usually come in summer. A 30-minute rain of 0.9 inch or more, for example, will occur practically every year, but a 30-minute deluge of 2.7 inches will occur only once in a century. Again, a total of 1.9 inches of rainfall is received during a 24-hour period once every year. In contrast, a total of 5.3 inches or more is received during a 24-hour period only once in 50 years, and a total of 5.9 inches is received during a 24-hour period only once in a hundred years.

Wet and dry years differ, not only in the amount of rainfall received but also in the distribution of rainfall. Figure I-3 shows that in 1915, 1923, and 1951, for example, the total amount of rainfall was 2 inches or more for each month from April through September. Also, in 1923 the wettest year of record at Garden City, October, with 3.29 inches of rainfall, was the seventh consecutive month in which 2 inches or more of rainfall was recorded. In contrast, during the years of 1893 and 1934, not a single month had as much as 2 inches of rainfall. In 1923, the wettest year on record at Garden City, more than five times as much rain fell as in 1956, the driest year on record.

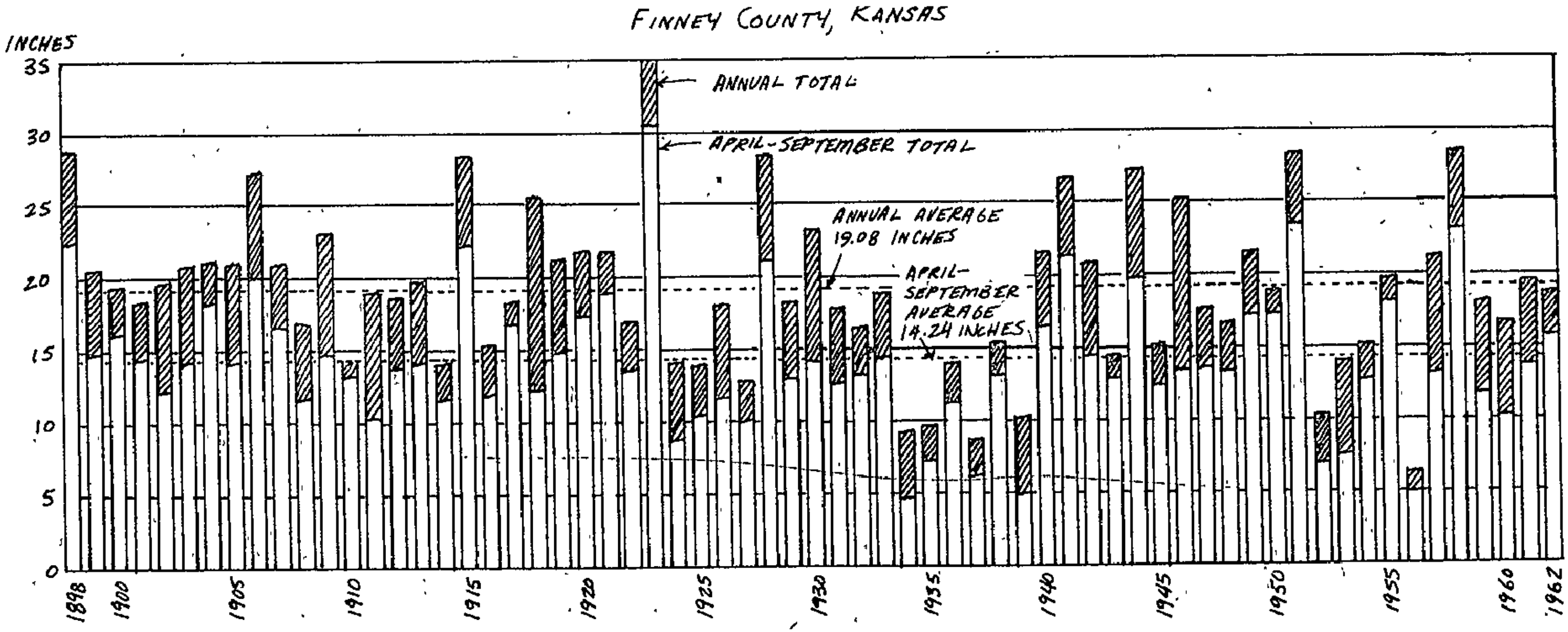


Figure 1-3. - Annual and April to September precipitation at Garden City, Kansas from 1898 to 1962.

The periods of high and of low precipitation in summer are fairly obvious. From 1898 through 1910, the amount of precipitation received in summer was approximately normal. From 1924 through 1939, most of the summers had below normal rainfall. Then, rainfall was more favorable for 12 consecutive summers following 1940. These 12 years were followed by 10 more years of favorable and of less favorable rainfall. During the years 1952 through 1962, rainfall was below average during most summers.

Figure 1-3 shows that in about one summer in eight, 20 inches or more of rainfall are received, and that in about one summer in eight, less than 10 inches of rainfall are received. Summer periods of favorable rainfalls have been fairly evenly distributed throughout the 65 years when records were kept.

Snowfall is a most unreliable weather factor in this area. It cannot be counted on to supply moisture. Yet, there may be enough snow to be hazardous to livestock and to traffic on the highways. The average amount of snowfall received each year is about 19 inches. Less than 10 inches has been received in 14 of 60 years; however 30 inches or more have been received in 8 out of 60 years.

The beneficial effects of snow are determined largely by the extent of the accompanying winds. Much of the time, high winds blow the snow from the fields. As a result, moisture that would have been obtained from the melted snow is lost. The rare occasions when several inches of snow fall at a time when there is no wind, and the temperature is a few degrees below freezing are a boon to wheat.

The least amount of snow received during an entire winter was 2.5 inches in 1895-1896. The most was 51.7 inches in 1902-1903. The greatest amount for any 1 month, 34 inches, fell in February 1903.

On the average, the first day in winter with 1 inch of snowfall is December 2. January and February each have an average 5 days of snow depth 1 inch or more. From December through March, the average depth of snow during days when there is snow cover is about 3.8 inches.

Occasionally, violent hailstorms, severe windstorms, tornadoes, dust storms, and blizzards occur in this county.

Most of these are of relatively short duration. The dust storms and blizzards may last for 24 hours or more, but their effects last longer. Railroads and highways have been left impassable by drifted snow. Each strong wind raises some dust. The major dust storms, however, occur after long periods of deficient rainfall and little or no vegetative cover.

Tornadoes occur about once a year in this county. Any one point in the county is likely to be subjected to hailstorms and windstorms about four times each year. Such storms are generally local, and the resulting damage is spotty and variable. May and June are the most likely months for the occurrence of hail. Thunderstorm squalls and shifts in wind direction produce the highest wind gusts. These gusts reach 75 to 80 miles per hour.

1.1.3.2 Morton County. Morton County, at the extreme southwestern corner of Kansas, has a semiarid, but invigorating continental climate. Because it is west of the general flow of moist air from the gulf and 200 miles east of the Rocky Mountains, (the barrier to moisture from the Pacific) this area has scant and scattered annual precipitation.

The relatively dry air and many hours of sunshine cause a large daily range in temperature. The open and unobstructed plains permit the invasion of cold, northern air and favor wide ranges in seasonal and annual temperatures. Periods of greater precipitation and cooler weather, lasting for several years, contrast with intervening periods of little rainfall and excessive heat.

Fall and spring often bring quick, noticeable changes in weather. In fall each succeeding cold snap is a little more severe, and the sunshine of summer gives way to low clouds and light, low-falling rain or snow. In spring the cold spells wane, and showers increase until in summer they become intense thunderstorms accompanied by severe winds, lightning, and hail.

Morton County is not subject to the great extremes of summer and winter temperatures as are some other parts of the state. The range in monthly mean temperatures was from

84.4° F in July 1934 to 21° F in January 1930. Generally, severely cold weather is rare and of short duration. The coldest 2-month period was January-February 1929, when means were 30.8° F and 28° F, respectively.

There are few days in any winter during which the temperature fails to rise above the freezing mark and few times that it remains below zero all day. In the coldest month on record, January 1930, there were only 12 days when the maximum temperature was below freezing; 9 of these days were consecutive. During this same month, subzero temperatures occurred on 9 nights; 5 of these were consecutive. A minimum temperature of zero, or lower, occurs almost every winter. Zero temperatures have occurred as early as November 2 (1951) and as late as March 19 (1923).

Warm weather is common much of the year because of the prevalent sunshine, but extremely hot weather is exceptional. Several years have had no 100° F temperatures. In only one-third of the summers recorded has the maximum temperature risen to 100° F, or higher, in each of the 3 summer months. Only twice in the 33 years on record in Elkhart has there been a temperature of 100° F in 4 successive summer months. In the exceptionally hot year of 1934, the temperature held at 100° F, or higher, for 34 days. Temperatures of 100° F have occurred as early as May 17 (1927) and as late as September 21 (1926).

Table I-3 gives the average monthly, seasonal, and annual temperature and precipitation, based on records of the U.S. Weather Bureau at Elkhart, Kansas.

Deficient and uncertain precipitation is the main concern in crop production in the county. At Elkhart, rainfall increases from a minimum in January to a maximum in July. In January the total precipitation is more than 1 inch in less than 1 year in 10; whereas in July the precipitation exceeds 1 inch 8 years in 10.

The annual precipitation and the precipitation during the growing season (March through September), based on records of the U.S. Weather Bureau at Richfield, Kansas, are shown in figure 1-4. The annual precipitation has averaged 16.77 inches at Richfield for the period (1891-1960). The growing season average (March through September) is 13.15 inches.

TABLE I-3.— AVERAGE[a] MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT ELKHART, MORTON COUNTY, KANSAS

Month	Temperature average, °F	Precipitation average, inches
December	35.2	0.67
January	33.4	0.40
February	37.1	0.66
Winter	35.2	1.73
March	43.9	0.82
April	54.4	1.53
May	63.5	2.27
Spring	53.9	4.62
June	73.2	2.14
July	76.9	2.66
August	77.3	2.17
Summer	75.8	6.97
September	69.5	1.56
October	57.6	1.27
November	43.7	0.62
Fall	56.9	3.45
Year	55.5	16.77

[a]Averages for period 1925-1960

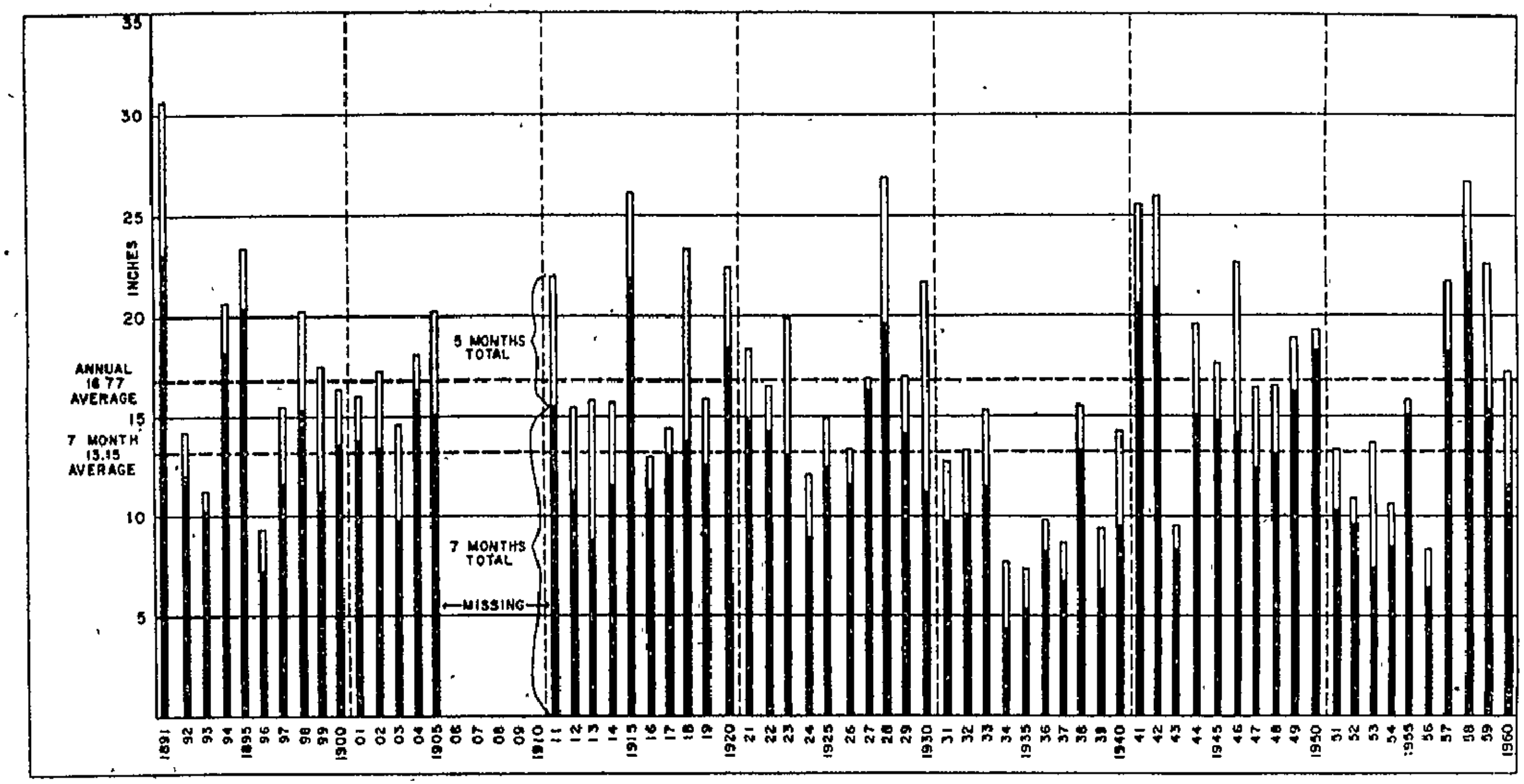


Figure 1-4. – Annual and crop season precipitation at Richfield, Kansas. The black, or lower part of each bar, shows the amount of precipitation during the growing season, March through September.

Two very noticeable dry periods are apparent in figure 1-4. In the 10 year period from 1931-40, no year or growing season received less than half the average. The 6 dry years of the early 1950's were not as deficient nor as prolonged as those of the thirties; there were only four consecutive below-average growing seasons. Over the years, five periods of three consecutive growing seasons with above-average precipitation are shown, but there is only one period of four consecutive seasons with above-average precipitation.

A comparison of the grain sorghum yield data of the U.S. Department of Agriculture, Statistical Reporting Service, with the average summer precipitation at Richfield shows that when the precipitation was 10 inches, the yield was 7.8 bushels per acre; when it was 15 to 22 inches, the corresponding yield was 18.1 bushels per acre. Figure 1-4 shows that only 20 summers of the 65 years on record at Richfield had 15 or more inches of rain. Thus in two out of three years, there is not enough rain to produce yields of grain sorghum averaging more than 18 bushels per acre. If high yields of grain sorghum are to be obtained in Morton County, rainfall should be supplemented by an improvement of plants, cultural practices, and, where possible, irrigation.

Dry periods of 30 consecutive days or more, in which there is less than 0.25 inch of rain, occur almost every year from April 1 to September 30, inclusive. Dry periods have lasted more than 50 consecutive days on several occasions, 1902, 1914, and particularly in the years of the 1930's and 1950's.

Table I-3 shows that monthly precipitation averages slightly over 2 inches from May through August, but when these monthly averages are broken down into weekly values, it is evident that the best chance of receiving rain is during the latter part of May through the early days of August. There is a noticeable peak in the probability curves the last of May, especially in the smaller rainfall totals. The larger weekly amounts of 1 inch to 2 inches are most likely to occur during the middle or last of July.

Heavy rains in 24 hours are not frequent enough to be of great concern, but they should be considered in planning roads or similar constructions. Rains of 2.00 inches or more in 24 hours have been recorded from April through

October. For example, about once each year 0.8 inch of rain may be expected to fall within 30 minutes, and once in 100 years a total of 2.6 inches is likely to fall in 30 minutes. During a 3-hour period, 1.4 inches is probable each year, 2.7 inches once in 10 years, and 4.1 inches once in a century. On September 15, 1923, the greatest 24-hour of rainfall on the Elkhart record was 6.12 inches.

The seasonal snowfall varies greatly. One-eighth of the winters on record had less than 10 inches of snow, which was not enough to furnish 1 inch of moisture. Six of the winter seasons had 30 inches, or more. The least amount of snow, 1.5 inches, fell during 1934-35. Most of the time little benefit is derived from snow, which is blown from the fields by high winds.

The freeze-free period in Morton County averages about 180 days. The valleys and lower lying ground may have a damaging freeze a few days later in spring or earlier in fall than the higher elevations. The crops that are commonly grown are seldom damaged by freezing, because the growing season is generally long enough to permit maturity.

Dust storms that can last several hours are a menace during long droughts. Occasional heavy snows and high winds result in blizzards, some of which are exceptionally severe.

Thunderstorms occur mostly from May through August and at times are accompanied by damaging winds. The average number of thunderstorms is approximately 50 per year. Hailstones of pea-to-marble size driven by high winds, have preharvested a grain crop in a few minutes. On rarer occasions, hailstones the size of golf balls have killed small animals and bruised and cut the backs of cattle.

Tornadoes are another adversity, but generally they are not so long nor so frequent as in the eastern and more humid parts of Kansas.

The wind blows almost constantly, and generally from the north or south. Breezes and the low humidity make the summer heat less oppressive. The winter cold is more penetrating, however, because of the wind.

Clear days predominate in Morton County. The sun shines approximately 70 percent of the time that it is above the horizon.

1.1.3.3 Saline County. Saline County has a subhumid continental type of climate that is characterized by hot summers and moderately cold winters. Table I-4 shows the average monthly, seasonal, and annual temperature and precipitation at Salina. Temperature extremes vary from 118° F to -31° F. The average annual temperature, based on a 54-year record, is 56° F. Daily temperature changes are often abrupt and sometimes relatively great. The growing season at Salina is 174 days. The average date of the last killing frost in spring is April 23, and that of the first killing frost in autumn is October 14. The latest and earliest dates of killing frost during the 40 years on record were May 27 and September 13, respectively.

The average precipitation at Salina, based on a 69-year record is 27.17 inches. Nearly 70 percent of this amount falls during the frost-free period. However, the seasonal and monthly distribution of precipitation are both very variable. The decrease in precipitation during the latter part of the growing season and the relatively high rates of evaporation at this time of year cause periods of drought that are injurious to crops.

1.1.3.4 Rice County. Rice County has a subhumid continental type of climate similar to that of Saline County. Table I-5 shows the average monthly, seasonal, and annual temperature and precipitation at Ellsworth which is approximately 35 miles north of the center of the study area. Meteorological data for Ellsworth in Ellsworth County has been cited as there is no meteorological station in Rice County. Ellsworth County is immediately adjacent to Rice County on the north.

The adjacent counties to the east and west presented too much variation to cite them as examples. In Ellsworth the annual average precipitation, based on a 25-year record is 25.66 inches and the annual average temperature, based on a 25-year period is 56.2° F. The growing season is 186 days. The last killing frost is usually April 18 and the first killing frost is October 21. From 65-70 percent of the precipitation falls during the frost-free period.

The annual average precipitation in McPherson County, east of Rice County, is 4.04 inches greater than Barton County to the west of Rice County. The amount of precipitation definitely decreases from east to west.

TABLE I-4.– AVERAGE[a] MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT SALINA, SALINE COUNTY, KANSAS

Month	Temperature average, °F	Precipitation average, inches
December	32.9	0.79
January	30.1	0.67
February	33.9	1.00
Winter	32.3	2.46
March	44.4	1.37
April	55.6	2.52
May	64.8	3.90
Spring	54.9	7.79
June	75.0	4.53
July	80.8	3.25
August	80.0	3.26
Summer	78.6	11.04
September	71.1	2.74
October	59.1	1.97
November	44.4	1.17
Fall	58.2	5.88
Year	56.0	27.17

[a]Temperature averages for period 1898-1952. Precipitation averages for period 1883-1952.

TABLE I-5.— AVERAGE[a] MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT ELLSWORTH, ELLSWORTH COUNTY, KANSAS

Month	Temperature average, °F	Precipitation average, inches
December	33.5	.90
January	30.5	.72
February	34.6	1.00
Winter	32.9	2.62
March	42.9	1.56
April	55.3	2.44
May	64.7	3.96
Spring	54.3	7.96
June	76.3	3.55
July	82.2	2.79
August	80.8	3.21
Summer	79.8	9.55
September	71.1	2.86
October	59.1	1.55
November	43.1	1.12
Fall	57.8	5.33
Year	56.2	25.46

[a]Averages for period 1931-1955. Ellsworth is adjacent to Rice County on the north. Meteorological data for Rice County, Kansas is not available.

1.1.3.5 Ellis County. Ellis County has a subhumid continental type of climate that is like that of Saline County. Table I-6 shows the average monthly, seasonal, and annual temperature and precipitation at Hays which is about 6 miles northwest from the center of the test site. The annual average temperature, based on a 25-year record, is 54.7° F. The growing season at Hays is 167 days. The average date of the last killing frost in spring is April 30, and that of the first killing frost in autumn is October 14.

The average precipitation at Hays, based on a 25-year record, is 22.9 inches. Over 70 percent of this amount falls between May and the middle of October the freeze-free period. The distance of 100 miles between Hays and Salina to the east shows a marked difference of 4.2 inches of precipitation. This is typical of the increasing aridity as one moves from east to west across the High Plains.

1.1.4 Soils

The Intensive Test Sites located in Saline, Rice, and Ellis Counties are on soils in the order Mollisol. The Intensive Test Sites located in Finney and Morton counties also possess soils of the Mollisol order but both have large areas of Alfisols (Morton) and Entisols (Finney) resulting from alluvial-type soil formations. The Great Plains region of the United States is characterized by the soil order Mollisol. This soil order is found as far south as central Texas and as far north as the prairie provinces of Canada. The soil order Mollisol is soil that has nearly black friable organic-rich surface horizons high in bases formed mostly in subhumid and semiarid warm to cold climates. The soil order Alfisol is found in the southern two-thirds of Morton County. These soils are medium to high in bases (base saturation at pH 8.2), and have gray to brown surface horizon and subsurface horizons of clay accumulation. They are usually moist, but during the warm season of the year they are dry part of the time. The soil order Entisol, found in the southern third of Finney County, is soil that has no pedogenic horizon. (See table I-7 for a description of the soils found in the five Kansas Counties and figs. I-5, 6, 7, 8 and 9 for county soil maps.)

TABLE I-6.— AVERAGE[a] MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT HAYS, ELLIS COUNTY, KANSAS

Month	Temperature average, °F	Precipitation average, inches
December	32.2	0.60
January	29.6	0.46
February	33.6	0.68
Winter	31.8	1.74
March	41.5	1.14
April	53.6	2.13
May	63.0	3.78
Spring	52.7	7.05
June	74.2	4.27
July	80.6	2.55
August	78.9	2.92
Summer	77.9	9.74
September	70.0	2.21
October	57.6	1.22
November	41.7	0.94
Fall	56.4	4.37
Year	54.7	22.90

[a]Averages for period 1931-1955.

TABLE I-7.- KANSAS COUNTY SOIL TYPES

Classification	Description
ALFISOLS	Soils that are medium to high in bases, base saturation at pH 8.2, and have gray to brown surface horizon and subsurface horizons of clay accumulation; usually moist but during the warm season of the year, some are dry part of the time.
Ustalfs	Alfisols that are in temperate to tropical regions. Soils mostly reddish brown; during the warm season of the year, they are intermittently dry for long periods; used for range, small grain and irrigated crops.
Haplustalfs	(formerly reddish chestnut and reddish brown soils.) Ustalfs that have a subsurface horizon of clay accumulation that is relatively thin or is brownish.
A9-2	Haplustalfs plus Calciustolls and Argiustolls, gently sloping.
ARIDISOLS	Soils that have pedogenic horizons and are low in organic matter and are never moist as long as 3 consecutive months.
Argids	Aridisols that have a horizon in which clay has accumulated with or without alkali (sodium); used for mostly range and some irrigated crops.
Haplargids	(formerly Sierozem, Desert, Red Desert and some Brown soils.) Argids that have a loamy horizon of clay accumulation with or without alkali (sodium).
D2-11	Haplargids plus Torriorthents, Argiustolls, and Torripsamments, gently sloping.

TABLE I-7.- KANSAS COUNTY SOIL TYPES - Continued

Classification	Description
ENTISOLS	Soils that have no pedogenic horizons.
Orthents	Loamy or clayey Entisols that have a regular decrease in organic matter content with depth; used for range or irrigated crops in dry regions and for general farming in humid regions.
Ustorthents	(shallow; formerly Lithosols.) Ustorthents that are shallower than 20 inches to bedrock.
E6-3	Ustorthents (shallow) plus Ustorthents, moderately sloping.
Psamments	Entisols that have textures of loamy fine sand or coarser; used for range, wild hay, and some hardy vegetables in Alaska, woodland and small grains where warm and moist, pasture and citrus in Florida, and range and irrigated crops where warm and dry.
Ustipsamments	Psamments that contain easily weatherable minerals; during the warm season of the year, they are intermittently dry for long periods.
E12-1	Ustipsamments, moderately sloping.
MOLLISOLS	Soils that have nearly black friable organic-rich surface horizons high in bases; formed mostly in subhumid and semiarid warm to cold climates.
Udolls	Mollisols of temperate climates. Udolls are usually moist and have no horizon in which either calcium carbonate or gypsum has accumulated; used for corn, small grains, and soybeans.

TABLE I-7.- KANSAS COUNTY SOIL TYPES - Continued

Classification	Description
MOLLISOLS - Continued	
Argiudolls	(formerly Brunizems and reddish prairie soils.) Udolls that have a subsurface horizon in which clay has accumulated.
M6-5	Argiudolls plus Argiustolls, Argiaquolls, and Ustipsamments, gently sloping.
Halpludolls	(formerly Brunizems and some Regosols, brown forest, and alluvial soils.) Udolls that have horizons from which some materials have been removed or altered but have no subsurface horizon of clay accumulation.
M7-3	Hapludolls plus Argiudolls, gently sloping.
Hapludolls	(shallow: formerly Lithosols.) Hapludolls that are shallower than 20 inches to bedrock.
M8-1	Hapludolls (shallow) plus Argiustolls and Argiudolls moderately sloping.
Ustolls	Mollisols that are mostly in semiarid regions. During the warm season of the year, these soils are intermittently dry for a long period or have subsurface horizons in which salts or carbonates have accumulated; used for wheat or small grains and some irrigated crops.
Argiustolls	(formerly Chernozem, Chestnut, and some Brown soils.) Ustolls that have a subsurface horizon of clay accumulation that is relatively thin or is brownish.

TABLE I-7.- KANSAS COUNTY SOIL TYPES - Concluded

Classification	Description
MOLLISOLS - Continued	
M9-1	Argiustolls, gently sloping.
M9-2	Argiustolls plus Calciustolls and Paleustolls, gently sloping.
M9-18	Argiustolls plus Usorthents, gently sloping.

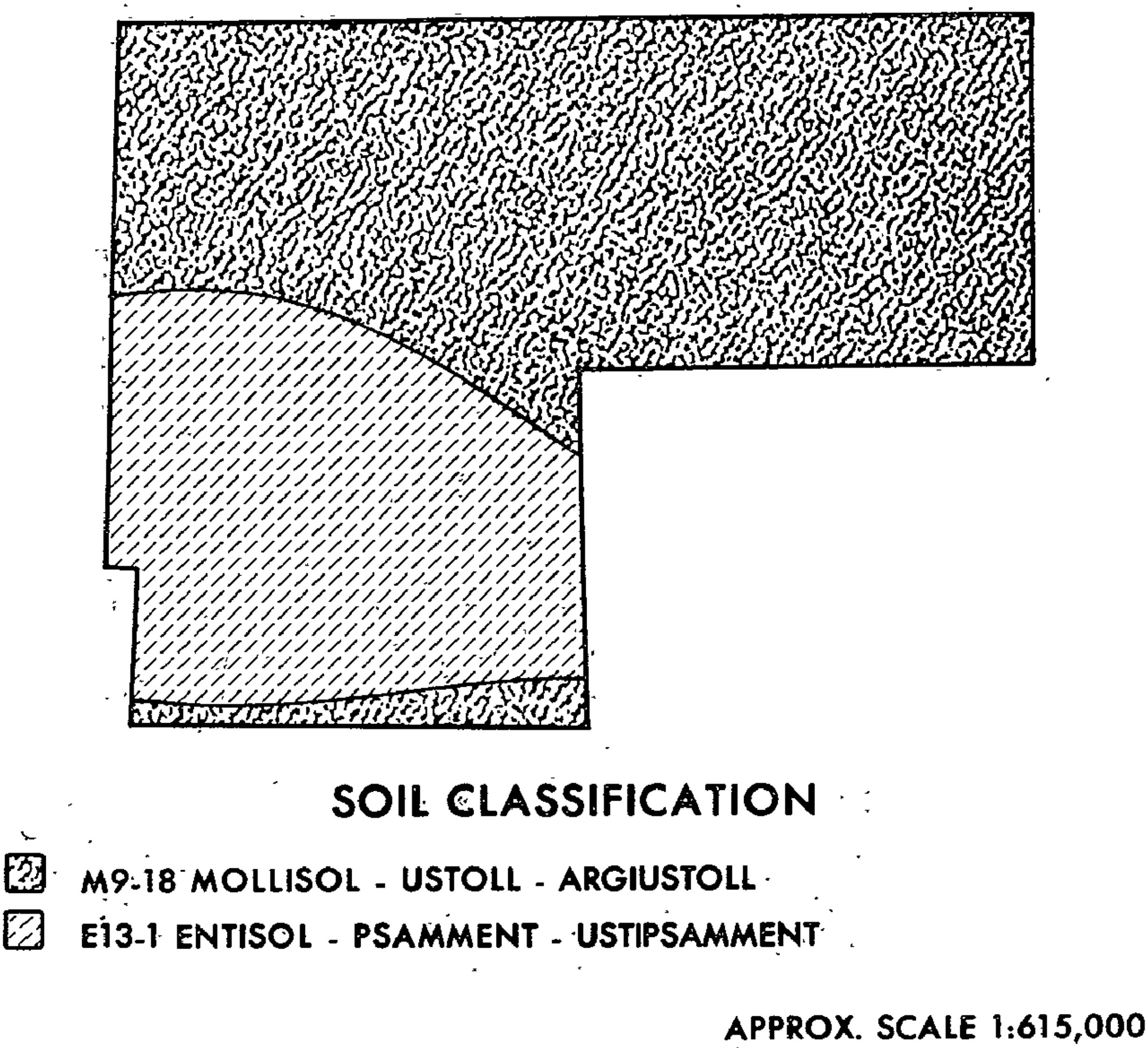
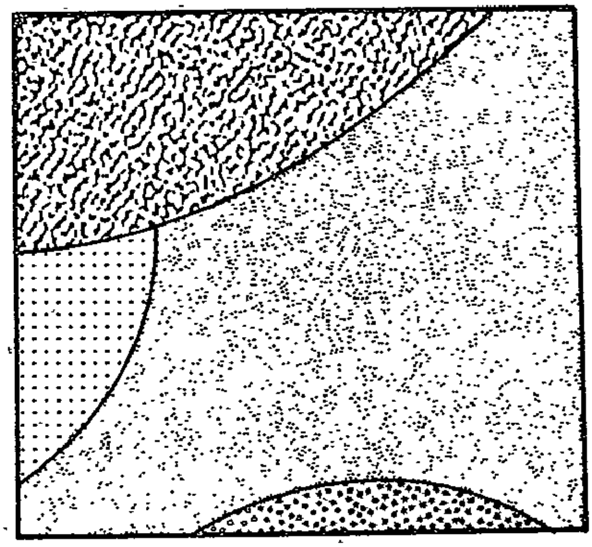


Figure 1-5. — Soil classification map of Finney County, Kansas.



SOIL CLASSIFICATION

- A9-2 ALFISOL - USTALF - HAPLUSTALF
- M9-18 MOLLISOL - USTOLL - ARGIUSTOLL
- D2-11 ARIDISOL - ARGID - HAPLARGID
- M9-9 MOLLISOL - USTOLL - ARGIUSTOLL

APPROX. SCALE 1:615,000

Figure 1-6. – Soil classification map of Morton County, Kansas.

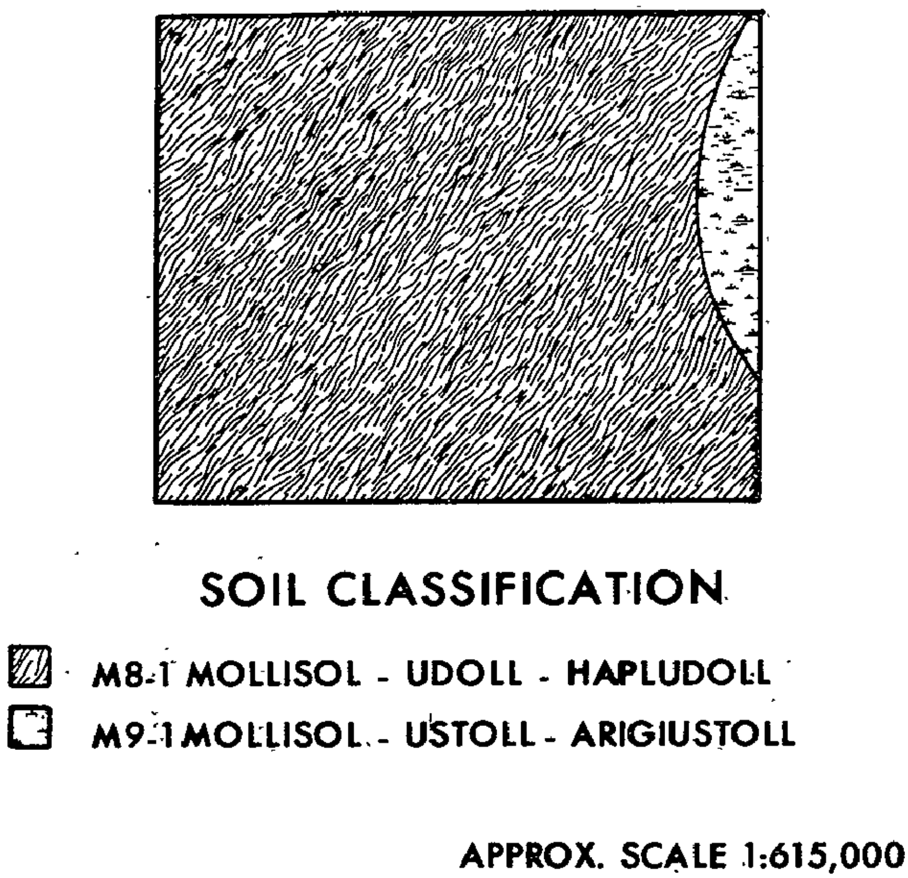


Figure 1-7. — Soil classification map of Saline County, Kansas.

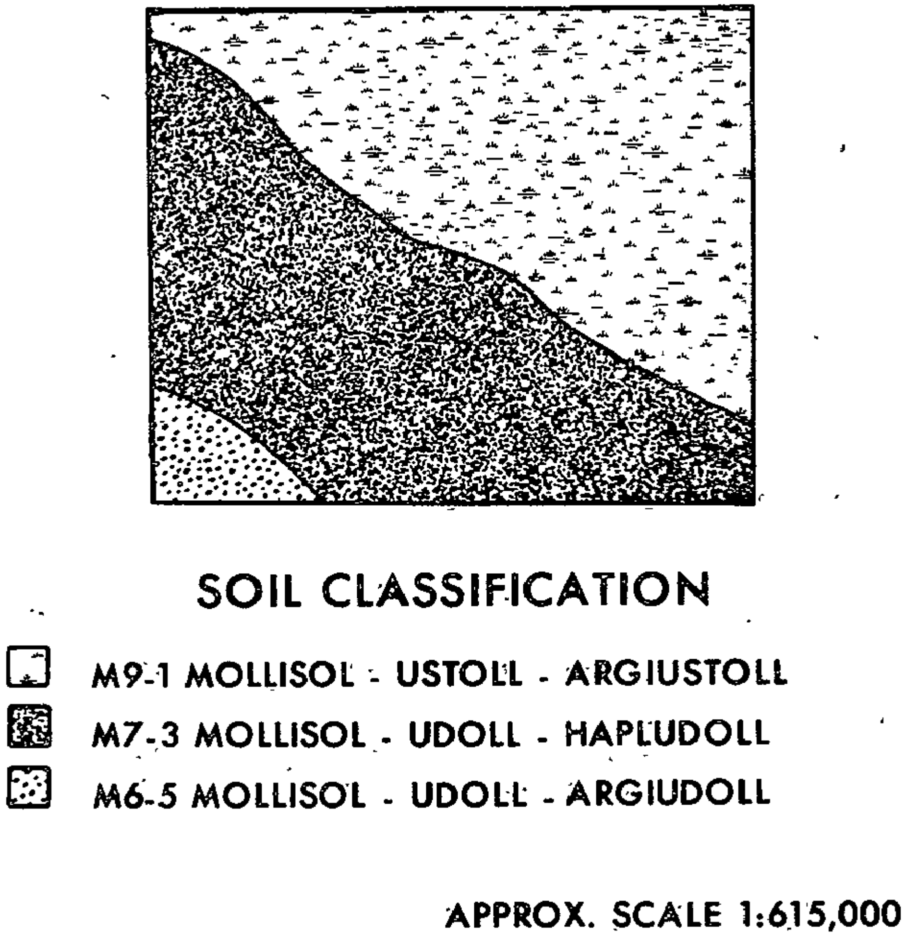


Figure 1-8. — Soil classification map of Rice County, Kansas.

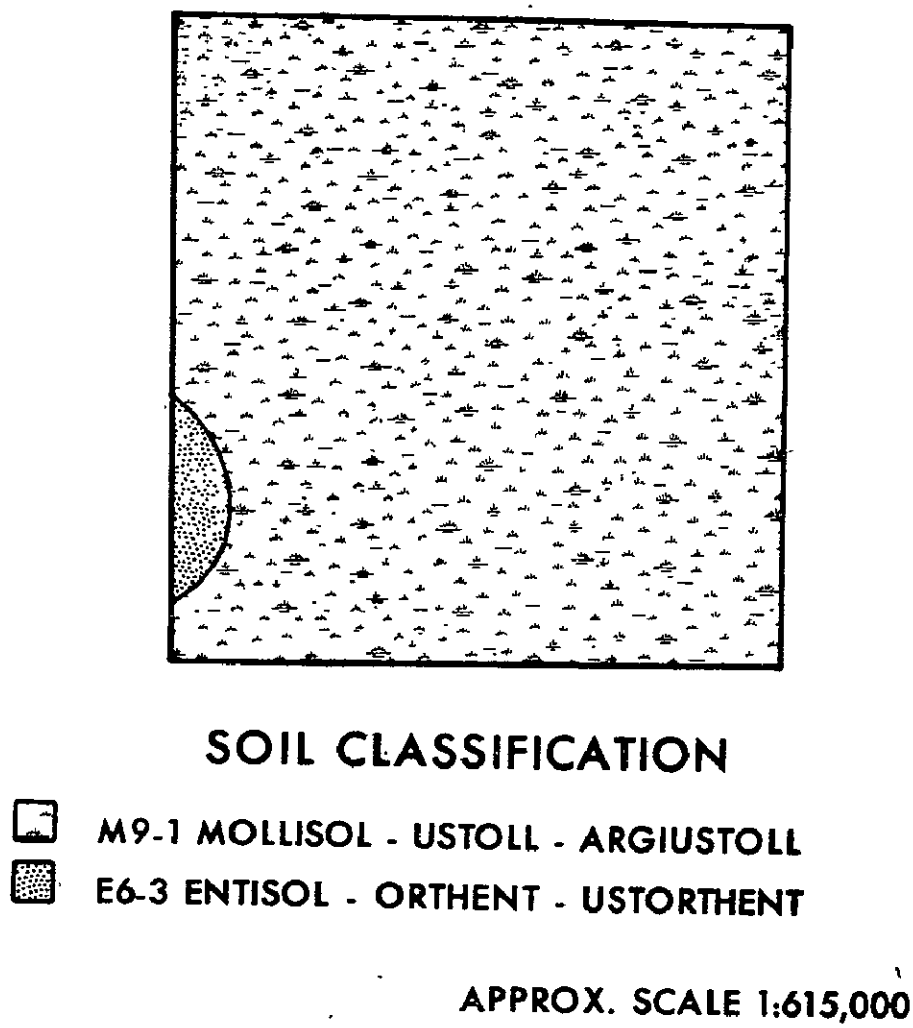


Figure 1-9. — Soil classification map of Ellis County, Kansas.

Soil map transparencies are available at a scale of approximately 1:24,000. These transparencies can be used to overlay the test site on USDA/ASCS 1:24,000 black-and-white photography. These transparencies were reduced to fit the 8½- by 11-inch format of this report.

1.1.4.1 Finney County. Finney County soils are predominantly of the Mollisol order, Ustolls suborder, and Argiustolls great group. The southern half of Finney County is of the Entisol order, Psamments suborder and Ustipsamments great group.

Test Site Soils

The test site in Finney County has two major soil series represented. These are the Richfield and Ulysses series. The Richfield-Ulysses Association accounts for 53.5 percent of the soil series within Finney County. The Richfield Series occupies 33.5 percent and Ulysses 20 percent. The Intensive Test Site in Finney county appears to be predominantly of the Richfield series approximately 60 percent with Ulysses series at about 40 percent. See table I-8 for symbols of soil series and figure I-10 for the Intensive Test Site soil classification.

Richfield-Ulysses Association
[Loamy soils of the High Plains tableland]

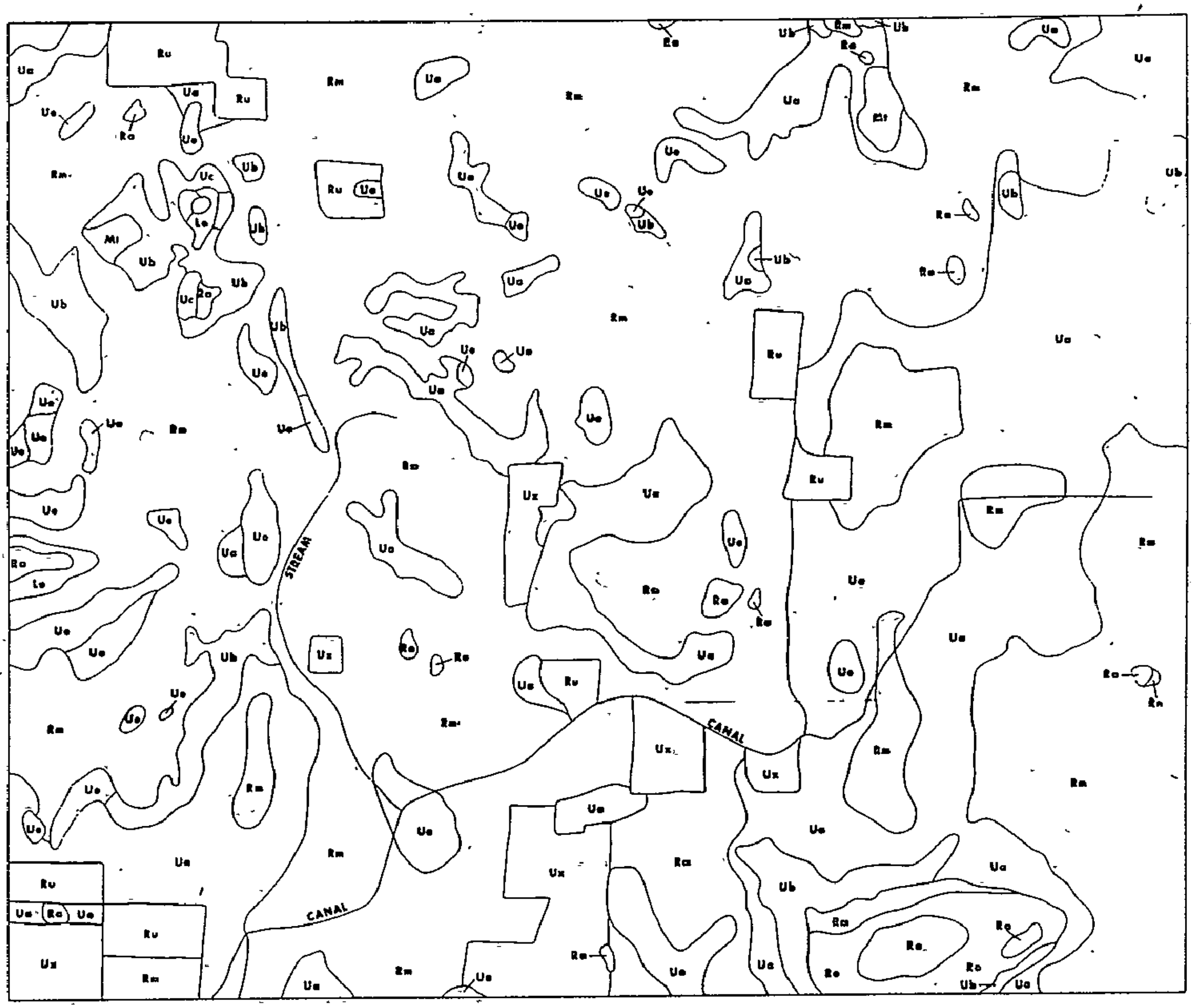
This association occupies the broad High Plains tableland north of the valley of the Arkansas River and west of the drainage area of the Pawnee River. Northwest of Garden City, the tableland slopes gently eastward toward the Scott-Finney depression, which divides the association. The area of the association east of the Scott-Finney depression is much more rolling than that to the west.

The association lacks a well-defined drainage pattern, but depressions dot the landscape and collect runoff from the surrounding slopes. Also, a few entrenched drainageways extend into the association from Kearny County to the west. These drainageways gradually become more shallow as they extend farther into the county; they eventually disappear on the western slope of the Scott-Finney depression.

Nearly level and gently sloping, deep, permeable, loamy Richfield and Ulysses soils are dominant in the association. The Richfield and Ulysses soils are well-drained and fertile, and they formed in thick deposits of silty loess.

TABLE I-8.– SYMBOLS FOR THE INTENSIVE TEST SITE SOIL SERIES MAP - FINNEY COUNTY, KANSAS

Symbol	Name
	Richfield series
Rm	Richfield silt loam, 0 to 1 percent slopes
Rn	Richfield silt loam, 0 to 3 percent slopes
Ro	Richfield silt loam, saline
Ru	Richfield and Ulysses complex, bench leveled
	Ulysses Series
Ua	Ulysses silt loam, 0 to 1 percent slopes
Ub	Ulysses silt loam, 0 to 3 percent slopes
Uc	Ulysses silt loam, 3 to 5 percent slopes
Ue	Ulysses-Colby silt loams 1 to 3 percent slopes, eroded
Ux	Ulysses and Richfield soils, silted 0 to 1 percent slopes



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD, JSC/NASA,
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 1-10. – Finney County, Kansas, LACIE Intensive Test Site soil classification map.

Sandy Manter and Otero soils occupy a small acreage in the association, and small areas of Keith soils occur with them. Randall soils occupy the bottoms of depressions. The Randall soils are ponded after rains.

Practically all of this association is cultivated. The Richfield and Ulysses soils are well suited to the dryland and irrigated crops commonly grown in the county, and they are used mainly for wheat and sorghum. The chief problems where cultivated crops are grown are conserving moisture and controlling erosion. Wind erosion is the major hazard in nearly level areas, but both wind erosion and water erosion are hazards on the sloping soils.

Richfield Series

The Richfield series are the deep, nearly level and gently sloping, loamy soils of the upland. These soils are fertile. They are well-drained and have high moisture-holding capacity. The native vegetation was grass.

In most places the surface layer is dark grayish-brown silt loam about 6 inches thick. Its structure is granular. This layer is easily worked, but it pulverizes if tillage is excessive, and a crust forms after rains. A plowpan is likely to form if tillage is always at the same depth. The transitional layer between the surface layer and the subsoil is about 4 inches thick.

The subsoil has subangular blocky structure and is generally dark grayish-brown silty clay loam about 12 inches thick. It is hard when dry and firm when moist, but it is permeable to moisture and roots. It is noncalcareous, but there is a layer of accumulated lime just below the subsoil. The substratum is light-colored, calcareous, silty loess.

The thickness of the surface layer ranges from 5 to 10 inches, that of the transitional layer between the surface layer and the subsoil ranges from 2 to 6 inches, and that of the subsoil ranges from 8 to 14 inches. Depth to calcareous material ranges from 12 to 20 inches.

The Richfield soils have a less clayey, less compact subsoil than the Spearville soils, and they are more clayey and have a more strongly defined subsoil horizon than the Ulysses soils. The Richfield soils have a more clayey subsoil than the Keith soils. The lower part of their subsoil is less clayey than that of the Harney soils.

Richfield silt loam, 0 to 1 percent slopes (Rm). This nearly level soil is in the uplands. It has a thicker profile than the more sloping Richfield soils. Depth to calcareous material ranges from 15 to 20 inches.

In the northwestern part of the county, areas of Ulysses silt loam and Keith loam are mapped with this soil. In the central and eastern parts, small areas of Harney silt loam and of Spearville silty clay loam are mapped with it. The Ulysses soil makes up about 10 percent of the acreage, and the Keith soil, about 5 percent.

This Richfield soil is well suited to wheat and grain sorghum. Conserving moisture and controlling wind erosion are the major problems in managing it. Keeping plant residue on the surface will conserve moisture and provide protection from erosion. Contour farming, stripcropping, and terracing are other good practices.

Richfield silt loam, 1 to 3 percent slopes (Rn). This gently sloping soil is in the uplands, mainly in the area drained by the Pawnee River. The profile is thinner than that of Richfield silt loam, 0 to 1 percent slopes. Depth to calcareous material ranges from 12 to 16 inches. Mapped with this soil are small areas of Ulysses silt loam. The Ulysses soil occupies as much as 10 percent of the acreage.

This Richfield soil is well suited to wheat and grain sorghum. Conserving moisture and controlling water and wind erosion are problems in managing it. Terraces, contour farming, and good management of plant residue will help to control runoff and erosion. Contour stripcropping is also a good practice.

Richfield silt loam, saline (0 to 1 percent slopes) (Ro). This nearly level soil is in the Scott-Finney depression. It is slightly to moderately saline at depths ranging from 16 inches to more than 5 feet. This soil contains an accumulation of white crystalline salts (calcium sulfate) in the substratum, generally in the same zone as the soluble salts. Profiles of buried soils underlie this soil in many places. In some areas this soil is calcareous to the surface, and in other areas it is noncalcareous to a depth of as much as 18 inches.

Mapped with this soil are small spots of Drummond silt loam that are generally less than 50 feet in diameter. The Drummond soil makes up about 12 percent of the acreage. Another 8 percent is saline Ulysses silt loam.

Wheat and grain sorghum are the principal crops grown on this saline Richfield soil. The growth of crops is uneven, because of variability in the degree of salinity and in the location of the concentration of soluble salts in the profile. The closer the salts are to the surface, the more the growth of crops is retarded. The growth of crops is especially variable where the supply of moisture is low.

Conserving moisture and controlling wind erosion are additional problems in managing this soil. Good management of plant residue is important. Contour farming, strip-cropping, and terracing are also desirable practices.

Richfield and Ulysses complexes, bench leveled (0 to 1 percent slopes) (Ru). These complexes consist of areas of Richfield, Ulysses, Colby, and Keith soils that have been leveled for irrigation. As a result of cutting and filling, the soils are so intermingled that they cannot be mapped separately. Not every area contains soils of all these series. Every area, however, contains some Richfield or Ulysses soils, or both, in combination with Colby or Keith soils. In some areas soils of both the Colby and Keith series occur. The areas indicated on the soil map as Richfield and Ulysses complexes, bench leveled, are those in the county at the end of 1960. Since 1960, many other areas have been bench leveled, but they are not shown on the soil map as a part of this mapping unit.

Leveling has affected the soils in several ways. In areas where some soil material has been removed, the subsoil is exposed at the surface. The kind of soil material that is now cultivated depends on the depth to which soil material has been removed and on the characteristics of the original soil. The Colby soils are mainly in areas where soil material from the Richfield, Ulysses, and Keith soils has been removed to a considerable depth. Where there are fill areas, the soil material is stratified. Texture, color, and reaction are affected by the various sources of the fill material and the mixing of that material. In some areas where the layer of fill material is as thick as 20 inches, the soil series to which the soils belong cannot be identified.

Much of the leveling has been done in areas where the soils originally had a slope of less than 1 percent. Cuts of as much as 5 feet have been made in small areas that had an original slope of more than 1 percent, however, so that fields could be squared. The difference in elevation between the benches is generally about 1 to 2 feet.

A few areas of undulating Ulysses loam have been leveled. Originally, these areas had slopes of between 0 to 3 percent. A few small areas of Manter fine sandy loam have also been leveled along with some of the Keith and Ulysses soils, and a few depressions where Randall clay occurs have been filled. In these areas that were formerly depressions, the slowly permeable layer of clay below the fill material restricts the movement of water and air. Crops grown on such areas are damaged if the soil is saturated for too long after a rain, because of the lack of adequate subsurface drainage.

In some places leveling has exposed light-colored, calcareous material that is low in fertility. The growth of crops is generally reduced on these highly calcareous areas for at least several years after the areas are leveled. Iron chlorosis commonly affects young sorghum plants grown on them. Where residue from crops or animals worked into the soils in cut areas, it helps to improve the fertility and structure of the soils.

All of the acreages of these complexes are irrigated. The soils are suited to sorghum, wheat, sugar beets, alfalfa, and other irrigated crops.

Ulysses Series

The Ulysses series consists of deep, loamy, well-drained, nearly level to sloping soils of the upland. These soils are fertile, and they have high moisture-holding capacity. The native vegetation was grass.

In most places the surface layer is dark grayish-brown silt loam about 6 inches thick. It has granular structure. It is easily worked, but if tillage is excessive, the soil material pulverizes and a crust forms after rains. When dry, the soil material blows easily.

The subsoil is generally dark grayish-brown, friable silt loam or light silty clay loam. It is easily penetrated by moisture and roots. Below the subsoil is light-colored, calcareous, silty loess.

The thickness of the surface layer ranges from 4 to 8 inches. Where the Ulysses soils occur with more sandy soils, the texture of the surface layer is loam and the texture of the subsoil is loam or light clay loam. The subsoil of the Ulysses soils is poorly defined, and its structure ranges from granular to subangular blocky. Its reaction ranges from calcareous at the surface to noncalcareous at a depth of 15 inches.

The Ulysses soils are less clayey than the Richfield soils, and they have a more poorly defined subsoil than the Richfield and Keith soils. They are not dark colored to so great a depth as are the Keith soils. The Ulysses soils are darker colored and less calcareous than the Colby soils, and their subsoil is more strongly defined.

Ulysses silt loam, 0 to 1 percent slopes (Ua). This is a nearly level soil of the uplands. It is generally more clayey and less calcareous than the sloping Ulysses soils. Small areas of Richfield and Keith soils were included in mapping. About 10 percent of the acreage is Richfield silt loam, and about 5 percent is Keith loam.

This Ulysses soil is well suited to wheat and grain sorghum, but conserving moisture and controlling wind erosion are problems. Keeping plant residue on the surface will provide protection from erosion and conserve moisture. Contour farming, stripcropping, and terracing are also desirable practices.

Ulysses silt loam, 1 to 3 percent slopes (Ub). This soil is on weakly convex slopes. In much of the acreage, it is calcareous to the surface.

Where this soil occurs with more sandy soils, areas of Manter fine sandy loam make up as much as 5 percent of the acreage. Small areas of Richfield silt loam and a small acreage of Keith loam were also included in mapping. The Richfield soil makes up about 12 percent of the acreage.

This Ulysses soil is well suited to wheat and grain sorghum, but conserving moisture and controlling erosion by wind and water are problems. Terraces, contour farming, and good management of plant residue are essential. Stripcropping is also a good practice.

Ulysses silt loam, 3 to 5 percent slopes (Uc). This soil is on weakly convex slopes, mainly within the drainage area of the Pawnee River. Much of it is calcareous to the surface. Mapped with it are small areas of Richfield and Mansic soils and a small acreage of Mansker soils. About 7 percent of the acreage is Richfield silt loam, and about 5 percent is Mansic clay loam.

Wheat and grain sorghum are the main crops grown on this Ulysses soil. Conserving moisture and controlling erosion by wind and water are the principal management problems. Terraces, contour farming, and good management of plant residue are essential, and stripcropping is a good practice.

Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue). This complex of Ulysses and Colby soils is on weakly convex slopes. Ulysses silt loam makes up 50 to 65 percent of the acreage, and Colby silt loam makes up 25 to 40 percent. About 10 percent of the acreage is Richfield silt loam.

The areas of Colby silt loam were formerly Ulysses silt loam, but erosion stripped away the dark-colored, original surface layer and exposed the lighter colored, more calcareous subsoil. The Colby soil of this complex is generally on the tops or crests of slopes, where the effects of erosion have been more pronounced than on the lower parts of the slopes.

The soils of this complex are well suited to wheat and grain sorghum. Careful management will conserve moisture and control erosion by wind and water. Terracing, contour farming, and good management of crop residue are essential, and stripcropping is a desirable practice.

Ulysses and Richfield oils, silted, 0 to 1 percent slopes (Ux). The soils of this mapping unit are on the tableland north and northwest of Garden City, in an area where the soils are generally irrigated. The mapping unit consists of Ulysses and Richfield soils that have received deposits of silt and clay from irrigation water taken from the Arkansas River.

These soils have a more clayey, compact, calcareous surface layer than the normal Ulysses and Richfield soils. Their surface layer is silty clay loam or light silty clay and is 5 to 12 inches thick. The thickest deposits of silt and clay are generally at the lower end of the irrigation run. At that place the water is ponded, and the silt and clay are allowed to settle.

The Ulysses subsoil is like the one in the profile described for the Ulysses series, and the Richfield subsoil is like the one in the profile described for the Richfield series. The deposits of silt and clay mask the original Ulysses and Richfield profiles to such an extent that it was not practical to separate these soils on the soil map. A few small areas of silted Keith soils are included in the mapping unit.

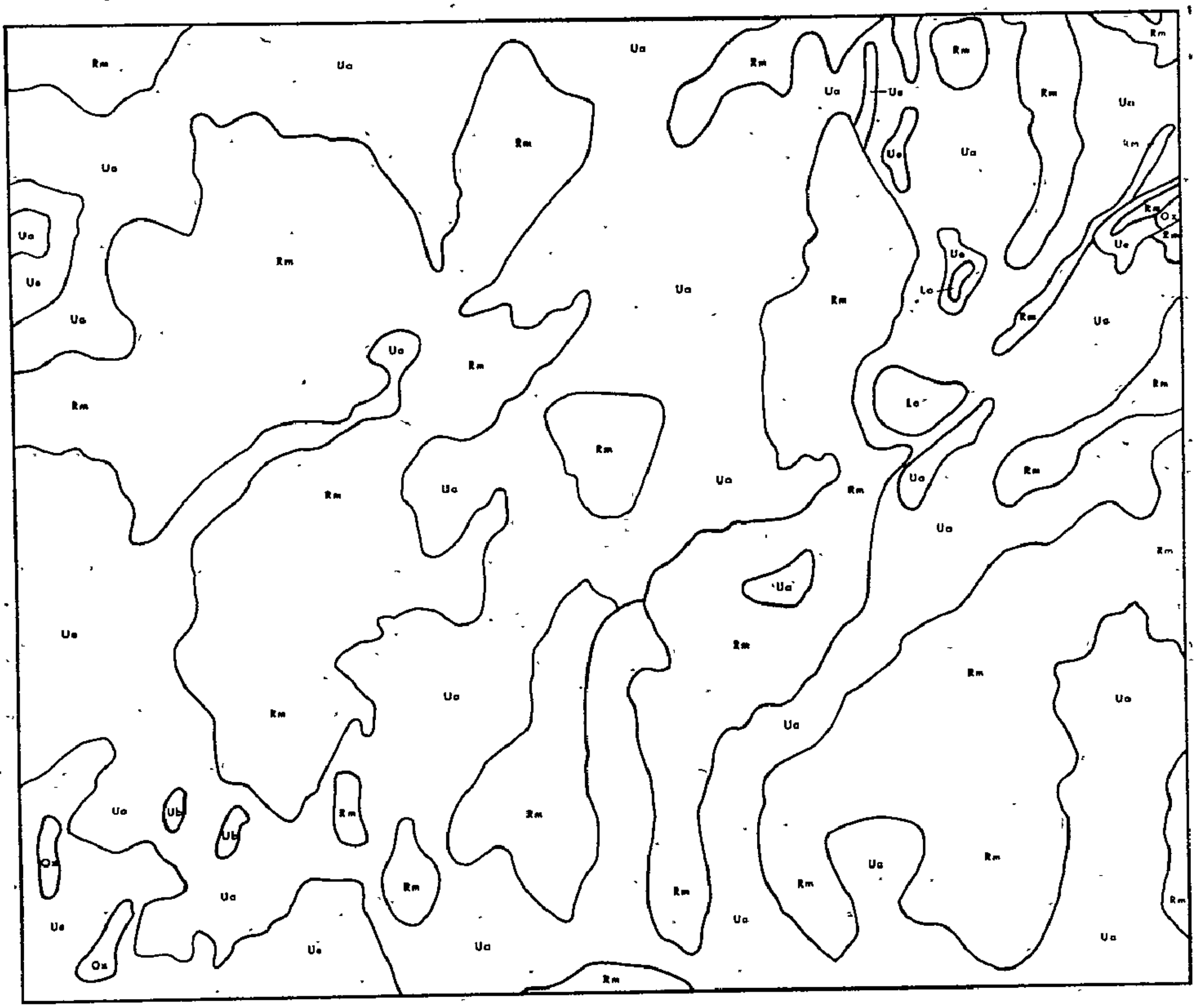
These Ulysses and Richfield soils are suited to all the crops commonly grown in this area. Their clayey surface layer is difficult to work when either too wet or too dry. Careful management is required to maintain the favorable structure and tilth of the surface layer.

1.1.4.2 Morton County. Morton County soils are of the Alfisol, Mollisol and Aridisol orders; Ustolls, Ustalf and Argid suborders; Argiustolls and Haplargid and Haplustalf great groups. See Finney County, Kansas, soils section for an explanation of the Richfield and Ulysses soil series that are found in the Intensive Test Site in Morton County, Kansas. See figure I-11 for the Intensive Test Site soil classification map.

1.1.4.3 Saline county. Saline County soils are of the Mollisol order, Udoll and Ustoll suborder, and Hapludoll and Arguistoll great groups. See figure I-12 for the Intensive Test Site soil classification map.

Test Site Soils

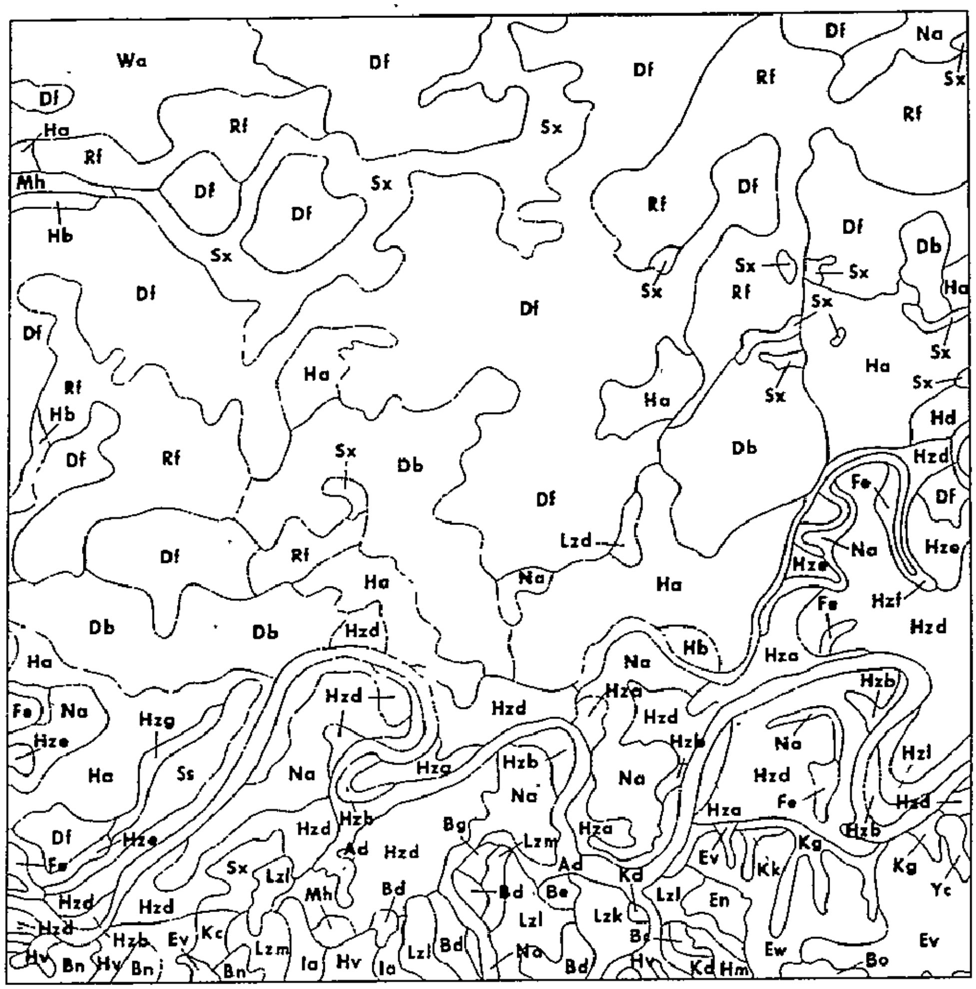
The test site in Saline County has a highly diverse number of soil series. Detroit and Humbarger series are the dominant series within the study area. There are also significant amounts of Roxbury, Sutphen, and Wabash series found within the test site. The Smoky Hill River runs through the bottom half of the test site which is surrounded by a highly complex series of soils. Some of the



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD JSC/NASA
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 1-11. - Morton County, Kansas LACIE Intensive Test Site soil classification map.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 1-12. – Saline County, Kansas LACIE Intensive Test Site soil classification map.

major contributing series will be discussed below. For a description of each of the soil series found within the test site refer to the Soil Survey Saline County, Kansas 1959 USDA Soil Conservation Service.

Detroit Silt Loams

Detroit silt loams are deep, friable, moderately fine textured soils on terraces. They occur throughout the county, but their greatest extent is in the valley along the Saline, Solomon, and Smoky Hill Rivers and along Gypsum Creek. They usually are on broad, low terraces that are midway between present stream channels and bordering uplands. They have developed in moderately fine textured alluvial materials that are usually greater than 5 feet in thickness but are not highly stratified. In some areas these soils overlie brighter colored materials that have a higher content of fine and very fine sand and are much more highly stratified.

These are well-drained soils. In most areas surface runoff is medium to slow. After heavy rainfall, water may stand for short periods. However, permeability is moderately rapid, and under-drainage is free. These soils have a large water-storing capacity, and much of the water stored is available to growing plants.

These are among the most productive soils in the county. They are resistant to erosion and are easily tilled within a wide range of soil moisture content if they are properly managed. Included with these soils are a few areas that are slightly lighter colored but otherwise similar.

<u>Detroit silt loam, 0 to 2 percent slopes (Db)</u>. This mapping unit has profile characteristics similar to those described for Detroit silt loams.

Detroit Silty Clay Loams

Detroit silty clay loams are deep soils characterized by friable, moderately fine textured surface layers and upper subsoils and lower subsoils that consist of fine-textured less permeable materials. Although they occur throughout the county, these soils generally occupy the nearly level to slightly concave upland margins of terraces along the Saline, Solomon, and Smoky Hill Rivers. They have developed in friable, fine to moderately fine textured, calcareous alluvium. In most places the parent materials are thicker than 5 feet. They do not show much stratification but tend to be uniformly silty throughout.

These are moderately well drained soils. In most areas runoff is slow to very slow, and ponding may occur after heavy rains. The surface layer and upper subsoil have moderately slow permeability, but the lower subsoil is only slowly permeable. Under-drainage is slow and water tables sometimes develop. These soils have a large water-storing capacity, but much of the moisture stored in the fine-textured lower subsoil is not readily available to plants.

Detroit silty clay loams are moderately productive and suited to most crops grown in the county. Field trials do not show any serious deficiency of plant nutrients, but supplemental nitrogen promotes the growth of crops when the spring season is cold and wet. Both the surface soil and upper subsoil have a moderately resistant structure that makes tillage farily easy. The use of conventional machinery, however, is limited to a narrow range of soil moisture content. When exposed, the lower subsoil is hard to work and turns up as hard resistant clods that are difficult to work down to a good seedbed. The soils puddle easily if tilled when wet and are extremely hard to work when dry. Some lighter colored soil areas are included that are otherwise similar to Detroit silty clay loams.

Detroit silty clay loam, 0 to 2 percent slopes (Df). The profile characteristics for this mapping unit are the same as those described for uneroded Detroit silty clay loams.

Hall Silt Loams

These deep, friable, terrace soils occur throughout most of the river valleys in the county. They have developed in calcareous alluvial materials that are somewhat older than present flood plain deposits and are subject to less frequent overflow.

Hall silt loams are well-drained. In most areas surface runoff is slow, though rapid enough to prevent ponding after rains. Permeability is moderately rapid to rapid, and underdrainage is free. High water tables generally do not occur in these soils. The water-storing capacity of these soils is large, and most of the water is available to plants.

These soils are very productive and suited to all crops grown in the county. They possess good qualities of tilth and can be tilled throughout a wide range of soil moisture content.

Hall silt loam, 0 to 2 percent slopes (Ha). This soil differs from the phase on 0 to 2 percent slopes mainly in occurring as long, narrow, irregular-shaped areas along shallow drainageways. In these positions, they are difficult to manage as a separate unit.

Humbarger Loams

These deep, light-colored soils of the bottom lands have developed in friable, calcareous, stratified silty alluvium. The alluvial materials, usually more than 7 feet thick, overlie other alluvial deposits or buried soils. The Humbarger soils occur on the nearly level to very gently undulating convex surfaces of recent flood plains and low terraces. Many areas are on natural levees along present and abandoned stream channels. The greatest acreages are in the valley of the Saline and Smoky Hill Rivers in the vicinity of Salina.

Humbarger loams are well-drained. In most areas, surface runoff is slow. However, runoff is sufficiently rapid to prevent ponding. Permeability is moderate to rapid, and underdrainage is free except in those few areas underlain by fine-textured alluvial materials. Their water-storing capacity is moderate, and most of the water stored is available to plants. High water tables generally do not occur.

Humbarger loams are fertile, possess good qualitites of tilth, and are suited to most crops grown in the area. They are usually deficient in nitrogen, unless a legume crop has been grown in the crop rotation. They are easily tilled throughout a fairly wide range of moisture content. They are only moderately resistant to erosion and are particularly susceptible to wind erosion if poorly managed.

Humbarger loam, 0 to 2 percent slopes (Hza). The profile of this soil is the same as that described for uneroded Humbarger loams.

Humbarger loam, 2 to 6 percent slopes (Hzb). This mapping unit has the same profile characteristics as those described for uneroded Humbarger loams. It occurs on moderately undulating convex slopes along the sides of drainage channels and on natural levees adjacent to river channels. In some areas it occurs as long, narrow, irregular-shaped bodies that are difficult to manage as separate units.

Humbarger loam, 2 to 6 percent slopes, eroded (Hzc). This soil differs from uneroded Humbarger loam soils in having lost 2 to 3 inches of the surface layer. The soil is less fertile and contains less organic matter than the uneroded Humbarger loam on slopes of 2 to 6 percent. In many areas it occurs in long, narrow, irregular-shaped areas along shallow drainageways.

Humbarger Silt Loams

These deep,light-colored soils of the bottom lands have developed in friable, calcareous, stratified silty alluvium. The alluvium usually is more than 5 feet thick; it overlies other alluvial deposits and, in some areas, buried soils. Although Humbarger silt loams are present throughout the county, their greatest acreage is on the flood plains along the Smoky Hill, Saline, and Solomon Rivers.

Humbarger silt loams are well-drained. Surface runoff is very slow in most areas, but the soils are rarely ponded. Permeability is moderate to moderately rapid, and underdrainage is free, except in a few areas where fine-textured alluvial materials underlie these soils at depths of 5 feet or more. The water-storing capacity of these soils is large, and most of the water stored is available to plants. High water tables generally do not develop.

Humbarger silt loams are productive and suited to all crops grown in the county. They are subject to occasional stream overflow, but damage to crops usually is small. The soils are easily tilled throughout a fairly wide range of moisture content, but they are moderately susceptible to wind erosion if managed improperly.

Humbarger silt loam, 0 to 2 percent slopes (Hzd). The profile of this mapping unit is the same as that described for uneroded Humbarger silt loams.

Humbarger silt loam, 2 to 6 percent slopes (Hze). The profile characteristics for this soil are similar to those described for uneroded Humbarger silt loams. The soil frequently occurs as long, narrow, irregularly shaped areas that are difficult to manage separately.

Humbarger silt loam, 2 to 6 percent slopes, eroded (Hzf). The profile of this mapping unit is similar to that described for uneroded Humbarger silt loams, but 4 to 5 inches of the surface layer have been removed by erosion. This soil frquently occurs along the sides of drainage channels that have cut into areas of Humbarger loam soils. In these positions the narrow soil bodies are difficult to manage separately. In some parts of the county this soil occurs in gently sloping areas on natural levees.

Humbarger silt loam, 2 to 6 percent slopes, severely eroded (Hzg). This soil differs from uneroded Humbarger silt loams in having lost 7 inches or more of its surface layer. It is lower in fertility and organic-matter content than the uneroded Humbarger silt loam on comparable slopes and is more susceptible to erosion. It often occurs as irregular-shaped areas along stream channels and the sides of shallow drainageways.

Roxbury Silty Clay Loams

These deep, friable soils occur principally on the terraces along the Smoky Hill River in the central part of the county. In most areas they occupy nearly level to slightly concave surfaces. Where they occur adjacent to drainage channels, slopes are slightly steeper. The parent materials normally are 4 to 6 feet in thickness and consist of calcareous, silty clay loam alluvium. They are underlain by other alluvial deposits, generally of finer texture.

Roxbury silty clay loams are moderately well-drained. In most areas, surface runoff is very slow and temporary ponding may occur. Permeability is moderately slow, and underdrainage is restricted by the finer textured alluvial beds that underlie these soils. Although water tables are often present, they seldom are high enough to affect the growth of crops. Most of the moisture stored in these soils is available to plants.

Because of their poor tilth, Roxbury silt loams can be tilled only within a very narrow range of soil moisture content. If heavy equipment is used on these soils when they are wet, tillage pans will form. These soils are best suited to crops that can withstand wetness for short periods of time, but they are productive of most crops commonly grown.

Roxbury silty clay loam, 0 to 2 percent slopes (Rf). The profile of this mapping unit is the same as that described for uneroded Roxbury silty clay loams.

Sutphen Silty Clay

This deep, friable soil occurs on the low terraces and flood plains of the major rivers in the county. The parent materials are calcareous alluvial deposits of silty clay texture that overlie strata of coarser textured, friable, silty alluvium at depths of 8 or 10 feet. These materials are of recent age and generally overlie older alluvial deposits.

This is an imperfectly drained soil. In most areas surface runoff is very slow and ponding occurs following heavy rains. Both permeability and underdrainage are slow. High water tables are present at times. The soil is subject to flooding from stream overflow and to accumulation of runoff from adjacent upland slopes. Because of its fine texture, much of the water stored in this soil is slowly available to plants.

Sutphen silty clay has fair tilth and is easily tilled, even though its texture is fine. However, tillage is limited to a narrow range of moisture content. The use of heavy equipment should be avoided when the soil is wet.

The soil is moderately productive and best suited to crops that are tolerant of short periods of wetness and poor aeration. Since the soil warms slowly in spring, topdressings of nitrogen fertilizers are needed to increase the supply of available nitrogen at that time. Only one unit was mapped in the county.

Sutphen silty clay, 0 to 2 percent slopes (Sx). The profile of this mapping unit is the same as that described for Sutphen silty clay.

Wabash Silty Clay Loam

This deep, friable, alluvial soil occurs on the low terraces and flood plains along the Solomon River and along Gypsum Creek. It has developed in neutral to slightly alkaline, fine-textured alluvium of recent age. The parent material generally is more than 6 feet thick.

Wabash silty clay loam is an imperfectly drained soil. Surface runoff is slow in most areas, and water stands on the surface following rains. However, surface drainage is rapid enough to prevent serious crop loss from ponding. Permeability and under-drainage are moderately slow. The water-storing capacity of the soil is large, but some of the moisture stored in the fine-textured subsoil is not available to plants. Water tables may be present during periods of excessive rainfall. The soil also is subject to occasional stream overflow.

Wabash silty clay loam is a moderately productive soil. Because it is imperfectly drained, it is best suited to crops that can withstand a wet, poorly aerated soil for periods of time. Tillage also is limited to a narrow range of soil-moisture content. The soil usually is deficient in available nitrogen in the spring when cold, wet weather prevails. Only one unit was mapped.

<u>Wabash silty clay loam, 0 to 2 percent slopes (Wa)</u>. The profile of this mapping unit is that described for Wabash silty clay loam.

1.1.4.4 <u>Rice County</u>. Rice County soils are of the Mollisol order, Udoll and Ustoll suborders and Hapludoll, Arguidoll, and Argiustoll great groups. A soil survey from which the detailed Intensive Test Site soil maps were prepared does not exist for Rice County.

1.1.4.5 <u>Ellis County</u>. Ellis County soils are of the Mollisol and Entisol orders, Ustoll and Orthent suborders and Argiustoll and Ustorthent great groups. A soil survey from which the detailed intensive test site soil maps were prepared does not exist for Ellis County.

1.2 PRINCIPAL CROP PRODUCTION

1.2.1 State and County

The principal crops in Kansas are wheat, sorghum, and corn.

Kansas produces more than one-fourth of all the hard winter wheat in the United States. Kansas produces about one-fifth of all the wheat grown in the United States. Approximately one-half of all the cropland in the state is devoted to wheat production. This includes the acreage being fallowed for wheat.

Other crops produced include oats, barley, soybeans and sugar beets. Hay ranks third in acreage after wheat. The major portion of Kansas wheat is grown in the central and western parts of the state.

The major producing counties of barley are in the south central crop reporting district of Kansas which coincide with many of the major wheat producing counties. Sorghum and corn are distributed over the state with the main areas of production in the northeast and southwest respectively. Soybeans and oats are concentrated in the eastern third of the state.

1.2.1.1 <u>Finney County</u>. Wheat and grain sorghum are the major dryland crops grown in the county. Only a minor acreage is used for small grains other than wheat. Wheat has averaged 61.5 percent of the acreage of the principal crops listed in table I-9 over the years stated. Sorghum has averaged 20.5 percent over these same years. Together they account for almost over 80 percent of the area in the major crops within Finney County. See table I-10 for land use in Finney County.

1.2.1.2 <u>Morton County</u>. The agriculture of Morton County is based on production of wheat and grain sorghum as cash crops. This county is one of the leading producers of grain sorghum in the state.

Wheat and grain sorghum, the major crops grown, are better suited to dryland agriculture and the climate of this

TABLE I-9.– ANNUAL CROP PRODUCTION IN FINNEY COUNTY, KANSAS FROM 1970 TO 1973

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Wheat	195	192	199	210	181	189	188	207	32.9	36.6	38.3	34.9	bushel
Irrigated	27	29	25	9					41.0	37	44	50	bushel
Nonirrigated	168	163	174	181									
Sorghum	73	74	60	57	72.3	72.5	57	56.4	68.5	69.2	81.8	69	bushel
Grain					69	65	52	54.7					
Silage								.6				10.5	ton
Forage								1.1				1.9	ton
Corn	45	45	45	67	44.55	44.55	44.1	66	103	120	131.9	119.2	bushel
Grain					31.5	29.9	40.3	49.9					
Silage								16				19	ton
Alfalfa					23.3	23.8	25.5	30.1	3.7	4.1	4.6	4.3	ton
Rye	8.2	10	7.9	3.6	3.28	2	.4	1.06	18	16	15	15	bushel
Barley	.7	.4	.7	1	.6	.36	.64	.95	30	25	37	35	bushel
Oats	.6	.6	.3	.1	.3	.18	.06	.05	35	35	44	35	bushel
Soybeans	.29	.65	.4	1	.25	.64	.39	.99	33	28	34	30	bushel

TABLE I-10.– LAND IN FARMS[a] ACCORDING TO USE IN FINNEY COUNTY, KANSAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvest cropland	495	290,480	507	253,810
Cropland used only for pasture or grazing	119	15,971	119	15,078
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	38	3,181	82	9,844
Cropland on which all crops failed	54	4,601	99	11,246
Cropland in cultivated summer fallow	423	204,309	454	193,392
Cropland idle	130	18,524	83	13,715
Total cropland	503	537,066	(NA)	497,085
Woodland pastured	3	161	--	--
Woodland not pastured	3	91	4	132
Total woodland	4	252	4	132
Improved pastureland and rangeland	35	7,373	44	18,290
Pastureland and rangeland not improved	185	206,119	(NA)	211,185
Total pastureland and rangeland (other than cropland and woodland pasture)	206	213,492	236	229,475
All other land	304	12,966	432	14,109
Irrigated land	296	133,934	289	103,149
Total pastureland (all types)	264	229,624	(NA)	244,553

[a]Farms with sales of $2,500.00 and over.

county than any other known crops. On the silty and loamy soils, these crops are usually grown in a crop-fallow system. During the fallow period, weeds are controlled so that moisture is conserved for use by the crop that follows. Grain sorghum is usually grown continually on the sandy soils. A small acreage of broomcorn is also grown on the sandy soils. See table I-12 for land use in Morton County.

Over the average of 1970-1973 wheat occupied an average of 48 percent of the acreage of the major crops shown in table I-11. Sorghum accounted for 46 percent over the same period. Together they account for 94 percent of the acreage for the major crops.

1.2.1.3 Saline County. The acreages of principal crops in stated years are shown in table I-13. Wheat is the chief crop in Saline County. In the period 1970-1973, wheat accounted for an average of 72 percent of the acreage in principal crops and 90.8 percent of the acreage in small grains. Sorghum and hay crops, in nearly equal proportion, made up 28.1 percent of the acreage in principal crops. Corn, alfalfa for seed, and soybeans were grown on most of the remaining acreage in crops. See table I-14 for land use in Saline County.

Wheat. This most important cash crop, is grown on most soils, but the areas of intensive production are the alluvial soils of river valleys and on the deeper loess soils in the central and eastern parts of the county.

Wheat of the winter varieties is grown. The best yields are usually obtained by plowing the land as soon as possible after the last crop is removed. Early plantings, between September 25 and October 10, assure better root development and reduce winter killing. The crop is harvested almost entirely by combines and sold at local elevators soon after harvest. In recent years a percentage of the crop has been stored on the farms.

Corn. The acreage planted in corn has decreased steadily during the last 24 years. Today very little corn is grown for grain; the greater part of the crop is used for feeding livestock. The crop is grown almost entirely on the soils in stream valleys. Since prolonged periods of hot, dry weather during the tasseling stage often prevent pollination,

TABLE I-11.— ANNUAL CROP PRODUCTION IN MORTON COUNTY, KANSAS FROM 1970 TO 1973

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Wheat	90	91	93	106	77	78	59	105	26.2	25.7	18.7	24.5	bushel
Irrigated	6	11	12	14					31	26	47	23	bushel
Nonirrigated	84	80	81	92									
Sorghum	81	96	88	89	78.6	94.1	87.1	88.1	51.2	42.3	49.1	46.5	bushel
Grain					71	91	80	82.8					bushel
Silage								.9				8.6	ton
Forage								4.4				2.5	ton
Corn	4.2	5.7	6.9	17	4.1	5.59	6.8	16.8	100	105	120	124.5	bushel
Grain					3.3	3.7	6.1	16					
Silage								.78				16	ton
Alfalfa					.4	1.2	.5	.5	3.8	3.5	4.3	3.6	ton
Rye	1.7	3.5	2.8	1.6	.43	.7	.08	.4	16	15	15	18	bushel
Barley	.9	.3	.9	.8	.68	.27	.83	.79	25	45	37	40	bushel
Oats	.2	.1	.2	.3	.1	.03	.05	.09	35	30	48	30	bushel
Soybeans[a]													bushel

[a]Not significant.

TABLE I-12.- LAND IN FARMS[a] ACCORDING TO USE IN MORTON COUNTY, KANSAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	216	153,062	201	114,369
Cropland used only for pasture or grazing	90	16,608	49	7,524
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	81	21,276	89	25,684
Cropland on which all crops failed	52	12,350	108	29,185
Cropland in cultivated summer fallow	166	93,022	151	91,936
Cropland idle	61	16,504	65	17,508
Total cropland	219	312,822	(NA)	296,206
Woodland pastured	1	80	--	--
Woodland not pastured	1	10	--	--
Total woodland	1	90	--	--
Improved pastureland and rangeland	21	12,292	15	2,776
Pastureland and rangeland not improved	78	41,998	(NA)	33,247
Total pastureland and rangeland (other than cropland and woodland pasture)	91	54,290	71	36,023
All other land	117	5,029	115	3,226
Irrigated land	91	45,231	58	21,158
Total pastureland (all types)	141	70,978	(NA)	43,547

[a]Farms with sales of $2,500.00 and over.

TABLE I-13.— ANNUAL CROP PRODUCTION IN SALINE COUNTY, KANSAS FROM 1970 TO 1973

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Wheat	115	108	122	128	113	88	116	124	32	34	30.4	37.1	bushel
Irrigated	0	0	0	0									
Nonirrigated	115	108	122	128									
Sorghum	31	40	32	47	30.4	38.8	31.4	46.1	33.3	46	57.5	51.2	bushel
Grain					24	33	20	41.4					
Silage								3.3				11.5	ton
Forage								1.4				4.5	ton
Corn	3	4	4	5	2.94	3.86	3.96	4.9	40	60	69.4	78.2	bushel
Grain					1.3	1.2	2	2.3					
Silage								2.5				15	ton
Alfalfa					17.1	17.4	16.6	15.7	2.6	2.9	3.6	3.1	ton
Rye	.9	1.1	.5	.8	.06	.06	.08	.4	22	17	23	23	bushel
Barley	2.4	2.1	.7	.5	2.28	1.79	.64	.45	34	39	42	38	bushel
Oats	2.3	2	1.3	1.3	2.23	1.6	.78	1.12	N/A	38	38	45	bushel
Soybeans	2.3	.9	.9	1.3	2	.86	.89	1.3	12	11	28	25	bushel

TABLE I-14.– LAND IN FARMS[a] ACCORDING TO USE IN SALINE COUNTY, KANSAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvest cropland	641	171,975	697	178,967
Cropland used only for pasture or grazing	269	37,532	172	24,336
Cropland in cover crops, legumes, and soil improvement grasses, not harvested or pastured	176	6,242	260	9,924
Cropland on which all crops failed	20	522	108	2,514
Cropland in cultivated summer fallow	442	37,580	489	25,738
Cropland idle	193	12,821	177	7,187
Total cropland	642	266,672	(NA)	248,666
Woodland pastured	34	815	17	403
Woodland not pastured	80	2,001	59	1,256
Total woodland	111	2,816	72	1,659
Improved pastureland and rangeland	52	9,991	32	5,353
Pastureland and rangeland not improved	282	108,883	(NA)	164,689
Total pastureland and rangeland (other than cropland and woodland pasture)	323	118,874	501	170,042
All other land	510	18,945	669	16,803
Irrigated land	48	2,636	63	3,710
Total pastureland (all types)	510	157,221	(NA)	194,781

[a]Farms with sales of $2,500.00 and over.

plantings are staggered over several weeks and hybrid varieties differing in time of maturity are usually grown in the same field. Production of corn is confined almost entirely to the deep, friable, fertile soils of the stream valleys.

Sorghum. Sorghum ranks second to wheat in total acreage. Much of the crop is used for forage, but the demand for sorghum grain for commercial use and as livestock feed is increasing. The crop is hardy and grows on soils where the fertility is seriously depleted. For this reason the crop is grown on badly eroded and shallow soil areas following wheat. The planting date is usually between May 25 and June 20.

Alfalfa. Alfalfa is grown for hay, seed, and dehydrated alfalfa, principally in the river valleys. On upland soils yields are poorer and it is often difficult to maintain the stand. Alfalfa is a soil-building crop; its deep roots penetrate the heavy subsoils and claypans and bring plant nutrients nearer to the surface layer. When used for green manure, alfalfa increases the supply of available nitrogen. For best growth, many of the soils in the county require applications of phosphorus fertilizer when alfalfa is grown. The soils developing on sandstone and shale parent materials also require additions of lime.

In preparing the seedbed for alfalfa, the soil usually is plowed in the spring and left fallow until late in August to increase the supply of moisture. The planting date is between August 15 and September 5. Fertile bottomland soils are sometimes plowed following wheat harvest and, if kept free of weeds during the intervening period, are planted in alfalfa in August.

Sweetclover. Sweetclover is used as a soil-building crop in the uplands where alfalfa is not as well suited to the soils. If properly inoculated, it adds more nitrogen to the soil during its short period of growth than any other crop. It can be grown more easily than alfalfa on shallow, rocky, and claypan soils and is more tolerant of poorly drained and droughty soils.

Sweetclover is seeded between March 1 and April 15 in the spring or between August 10 and August 31 in the fall. On sandy soils the crop is often sown in sorghum cover or sorghum stubble. The seed is sown with press-wheel drill, and the soil is packed afterward to firm the seedbed. On clean-tilled sandy soils, sweetclover is often seeded in wide-spaced rows of oats. The ground is packed before planting the sweetclover and oats.

Oats. Oats are seeded in the spring, often as a replacement crop where stands of wheat are poor or where wheat has been winter killed. For this reason, the acreage planted fluctuates from year to year. The crop is not suited to some of the imperfectly and poorly drained heavy clay soils in the county. Oats feed heavily on soil nitrogen but tend to lodge when the supply of nitrogen is excessive. The crop should not be grown immediately after turning under a green-manure crop on soils that are normally high in available nitrogen. Since the crop does not feed so heavily on phosphorous as wheat, it is a good second-year crop on a field where a legume has been turned under. The best seeding time is between March 1 and March 15.

Barley. Both winter and spring barley are grown in the county. Winter barley is planted about the same time as wheat on summer-fallowed land. Spring-sown barley, like oats, is used a replacement crop for wheat that failed, but barley is easily damaged by hot humid weather in the spring and early in summer. Barley is not as well suited to poorly drained soils as wheat and is less tolerant of nitrogen and phosphorous deficiencies. It is sensitive to moderate degrees of acidity but is tolerant of moderate accumulations of alkali and soluble salts. Barley is generally planted in summer-fallowed land between September 20 and October 10. Spring barley is generally planted between March 5 and March 25.

1.2.1.4 Rice County. Wheat and grain sorghums are the major dryland crops cultivated in Rice County. On a 4-year average (1970-1973) wheat acreage has accounted for 68 percent of the principal crop acreage. Sorghum has averaged 28.5 percent for the same period. Together they account for 97 percent of the acreage sown for the principal crops listed in table I-15. See the principal crops section on Saline County for a description of crops found in the central crop reporting district. See table I-16 for land use in Rice County.

TABLE I-15.— ANNUAL CROP PRODUCTION IN RICE COUNTY, KANSAS FROM 1970 TO 1973

Crop	Planted acres (1000) 1970	1971	1972	1973	Harvested acres (1000) 1970	1971	1972	1973	Yield per harvested acre 1970	1971	1972	1973	Unit
Wheat	148	138	146	156	113	88	116	124	32	34	30.4	37.1	bushel
Irrigated	0	0	0	0									
Nonirrigated	148	138	146	156									
Sorghum	54	62	54	78	30.4	38.8	31.4	46.1	40.2	46	42.8	57.7	bushel
Grain					45	55	47	72.5					
Silage								3.1				1.6	ton
Forage								.8				3.8	ton
Corn	3	3	3.1	5	2.94	2.92	3.07	4.9	65	85	1089	85.6	bushel
Grain					1.3	1.2	.46	3.5					
Silage								1.3				16	ton
Alfalfa					13.8	15.2	14.5	15.9	2.3	3.3	3.5	3.9	ton
Rye	2.4	3.6	2.6	3.1	.12	.18	.65	.47	18	13	25	19	bushel
Barley	1.2	.8	.6	.5	.96	.68	.55	.45	26	45	42	41	bushel
Oats	.7	.3	.4	.2	.56	.21	.27	.13	N/A	32	43	40	bushel
Soybeans	1.2	.35	.3	.2	1.1	.33	.25	.2	10	15	25	21	bushel

TABLE I-16.— LAND IN FARMS[a] ACCORDING TO USE IN RICE COUNTY, KANSAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	670	230,148	718	229,435
Cropland used only for pasture or grazing	295	28,781	262	14,880
Cropland in cover crops, legumes, and soil improvement grasses, not harvested or pastured	147	6,383	201	10,724
Cropland on which all crops failed	13	1,261	74	2,521
Cropland in cultivated summer fallow	579	87,704	641	78,041
Cropland idle	193	13,836	119	5,510
Total cropland	676	368,113	(NA)	341,111
Woodland pastured	33	1,172	7	156
Woodland not pastured	73	1,389	51	761
Total woodland	95	2,561	58	917
Improved pastureland and rangeland	61	9,841	65	4,509
Pastureland and rangeland not improved	317	72,096	(NA)	94,067
Total pastureland and rangeland (other than cropland and woodland pasture)	365	81,937	554	98,576
All other land	543	12,537	672	14,371
Irrigated land	44	5,077	38	3,131
Total pastureland (all types)	568	111,890	(NA)	113,612

[a]Farms with sales of $2,500.00 and over.

1.2.1.5 Ellis County. Wheat and sorghum are the major dryland crops grown in Ellis County. Wheat has averaged 75 percent of the acreage of the principal crops listed in table I-17 over the period of 1970 through 1973. Over this same period sorghum has averaged 22 percent of the acreage of the principal crops. See the principal crops section on Saline County for a description of the crops found in the central crop reporting district. See table I-18 for land use in Ellis County.

1.2.2 CROPPING SYSTEMS

The test sites in the southwest and central CRD's of Kansas reflect changes in farming practices due to the lack of available water in the west to adequate moisture in the east where soil fertility is the important aspect of farming. The data for these counties will illustrate the dominant types of farming.

The following farming practices for western Kansas are representative of the study areas in Finney and Morton County. The farming practices for the central part of Kansas are likewise representative of the study areas in Saline, Rice and Ellis county. See tables I-19 through I-23.

1.2.2.1 METHODS USED IN WESTERN KANSAS.

Seedbed preparation. In western Kansas where rainfall is limited, methods of seedbed preparation which will aid in storing and conserving soil moisture must be used. Summer fallow is the most successful method of accomplishing this. Summer fallow is the practice of handling the soil from one harvest through the next summer period and until seeding time, in such a manner that the moisture which falls penetrates the soil and nothing grows during that period to use the moisture. Good summer fallow is one in which the soil is kept free of plant growth and the soil surface is kept in an open, cloddy condition to permit rapid penetration of moisture. The surface is kept cloddy to let the rain penetrate and to prevent soil blowing. The first tillage is started in spring as soon as weeds begin to grow. This usually means before the end of May.

TABLE I-17.– ANNUAL CROP PRODUCTION IN ELLIS COUNTY, KANSAS FROM 1970 TO 1973

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Wheat	120	119	125	120	113	108	112	117	28.6	27.9	29.8	36.6	bushel
Irrigated	1	1	1	0					40	36	45	40	bushel
Nonirrigated	119	118	124	119									bushel
Sorghum	34	44	35	32	33	43.6	34.7	31.4	25.4	41.6	45.8	49.4	bushel
Grain					15	27	22	18.2					bushel
Silage								2.6				8	ton
Forage								10.6				3.4	ton
Corn	3	3	3.3	5	2.94	2.91	3.27	4.9	89	90	108.8	96.8	bushel
Grain					.7	1.9	.83	3.3					bushel
Silage								1.5				17	ton
Alfalfa					6.3	6.6	7.2	8.3	2.3	2.6	3	3.3	ton
Rye	.6	.4	.6	1.3	.04	.02	1.2	.23	20	20	25	20	bushel
Barley	.3	.1	.2	.1	.29	.08	.19	.09	28	34	33	36	bushel
Oats	.7	.3	.9	.1	.48	.21	.36	.09	37	33	32	40	bushel
Soybeans[a]													bushel

[a]Not significant.

TABLE I-18.— LAND IN FARMS[a] ACCORDING TO USE IN ELLIS COUNTY, KANSAS

Use	1969		1965	
	Farms	Acres	Farms	Acres
Harvested cropland	666	153,048	657	162,159
Cropland used only for pasture or grazing	235	36,614	153	10,170
Cropland in cover crops, legumes, and soil improvement grasses, not harvested or pastured	75	4,289	83	3,213
Cropland on which all crops failed	11	679	121	5,073
Cropland in cultivated summer fallow	535	88,890	617	84,208
Cropland idle	314	38,097	143	9,542
Total cropland	673	321,717	(NA)	274,365
Woodland pastured	15	903	8	210
Woodland not pastured	17	872	12	139
Total woodland	30	1,775	19	349
Improved pastureland and rangeland	112	24,630	25	6,071
Pastureland and rangeland not improved	378	158,853	(NA)	227,067
Total pastureland and rangeland (other than cropland and woodland pasture)	473	183,483	641	233,138
All other land	499	18,677	592	10,440
Irrigated land	52	5,632	47	3,924
Total pastureland (all types)	621	221,000	(NA)	243,518

[a]Farms with sales of $2,500.00 and over.

TABLE I-19.– AREA PLANTED AS PERCENT OF TOTAL CROPLAND[a] IN FINNEY COUNTY, KANSAS (1967)

Crop	Percent, %
Wheat	47.1
Fallow	31
Sorghum	14
Corn	b
Alfalfa	b
Rye	b
Barley	b
Oats	b
Soybeans	b

[a]Total cropland - 535,060 acres.
[b]Not significant, less than 1 percent.

TABLE I-20.– AREA PLANTED AS PERCENT OF TOTAL CROPLAND[a] IN MORTON COUNTY, KANSAS (1967)

Crop	Percent, %
Wheat	37
Fallow	24
Sorghum	37
Corn	b
Alfalfa	b
Rye	b
Barley	b
Oats	b
Soybeans	b

[a]Total cropland - 317,341 acres.
[b]Not significant, less than 1 percent.

TABLE I-21.– AREA PLANTED AS PERCENT OF TOTAL CROPLAND[a] IN SALINE COUNTY, KANSAS (1967)

Crop	Percent, %
Wheat	63
Fallow	10
Sorghum	9
Corn	1
Alfalfa	7
Rye	b
Barley	b
Oats	1
Soybeans	1
Other	8

[a]Total cropland - 254,250 acres.

[b]Not significant, less than 1 percent, can be considered with other.

TABLE I-22.– AREA PLANTED AS PERCENT OF TOTAL CROPLAND[a] IN RICE COUNTY, KANSAS (1967)

Crop	Percent, %
Wheat	58
Fallow	17
Sorghum	14
Corn	b
Alfalfa	4
Rye	b
Barley	b
Oats	b
Soybeans	b
Other	7

[a]Total cropland - 331, 758 acres.

[b]Not significant, less than 1 percent, can be considered with other.

TABLE I-23.—AREA PLANTED AS PERCENT OF TOTAL CROPLAND[a] IN ELLIS COUNTY, KANSAS (1967)

Crop	Percent, %
Wheat	54
Fallow	28
Sorghum	12
Corn	1
Alfalfa	2
Rye	b
Barley	b
Oats	b
Soybeans	b

[a]Total cropland - 305,416 acres.
[b]Not significant, less than 1 percent.

Stubble mulch tillage. The stubble mulch tillage method of fallowing is recommended in western Kansas. The main purpose of this system of farming is to keep enough residue anchored on the surface of the soil to protect both the crop and the soil from wind and water erosion.

1.2.2.2 Methods used in central and eastern Kansas. In this section of the state, the development of nitrates is more important than the conservation of moisture. Cultivation of the soil well in advance of seeding hastens the decay of organic matter, thus liberating the nitrogen and making it available to the plants and nitrates. In order to help provide the wheat plants with an adequate supply of nitrates the soil must be plowed immediately after harvest. Early seedbed preparation is necessary for highest yields.

Crop rotation. A crop rotation of fallow, wheat and sorghum is an excellent practice in western Kansas. When the sorghum stubble is to be fallowed for wheat, the stubble is left standing through the winter. Sorghum generally does not produce enough residue to necessitate purposely burying a portion during the fallow period.

Irrigation. Maximum use must be made of the limited supply of water available for crops, especially in southwestern Kansas. Wheat will use approximately 24 inches of water throughout its growing season. In these areas soils are irrigated in the fall for wheat before planting to produce maximum yields. The fields are, with normal rainfall, irrigated to a depth of 6 feet; in dry years, an extra irrigation at the boot stage is required to produce such yields.

Research at Garden City Branch Experiment Station has shown that irrigation during early spring growth (March and April) is harmful. Such irrigation has encouraged excessive growth and lodging, but no increase in yields.

Sometimes wheat is planted early for maximum pasturing; in this case, the soils may not have been wetted to 6 feet. Irrigation may then be necessary during the winter to build up subsoil supplies.

In irrigating wheat, the need for nitrogen fertilization must be given careful consideration. A minimum of 40 to 60 pounds of actual nitrogen should be applied.

Pasturing wheat. Winter wheat is the most widely used temporary pasture crop in Kansas. Wheat can be grazed without apparent injury to the grain crops, provided it is not grazed severely over an extended peiod of time, or too late in the spring.

Pasturing does not begin in the fall until the plants have become firmly rooted. Grazing is discontinued just before the plants begin to grow erect in preparation for jointing. See tables I-24, I-25, I-26.

1.2.3 Cropping Calendars

Cropping calendars for the small grains and other principal crops are presented in tables I-27, I-28, and I-29. For the small grains the crop calendar data are presented at the crop reporting district level and are representative for the respective counties. For the other crops data are presented at the state level.

1.2.4 Wheat Varieties

Adapted wheat varieties are selected for those areas that will produce the grain quality demanded by the trade. Table I-30 shows the distribution of these varieties within the test site counties.

TABLE I-24.- WHEAT PRODUCTION ON IRRIGATED, SUMMER FALLOWED AND CONTINUOUS CROPPED DRYLAND, KANSAS 1972

[1000 acres]

County	Fallowed summer 1971	Fallowed summer 1972	Irrigated	Continuous cropped dryland
Finney	177	160	25	14
Morton	85	76	12	5
Saline	36	28	—	94
Ellis	99	96	1	28
Rice	61	59	—	87

TABLE I-25.– NUMBER OF FARMS AND ACRES HARVESTED

[COUNTY DATA - 1972]

County	Number of farms	Total acres harvested
Finney	611	320,840
Morton	251	155,960
Saline	878	179,350
Ellis	890	169,920
Rice	814	216,290

TABLE I-26.– NUMBER, AVERAGE SIZE, AND RANGES OF FIELDS WITHIN THE KANSAS TEST SITES

County	Test site size, miles	No. of fields	Avg. field size, acres	Range field size, acres
Finney	5×6	400–420	45	2–160
Morton	5×6	220–250	80	10–160
Saline	3×3	150–170	30	5–120
Rice	3×3	150–170	40	5–140
Ellis	3×3	150–170	40	5–140

TABLE I-27.- CROP CALENDARS FOR THE SOUTHWEST CROP REPORTING DISTRICT OF KANSAS (FINNEY AND MORTON COUNTIES)

Seedbed preparation			Full coverage			Heading, flowering			Post-Harvest operations		
Start	Mid-pt.	End	Start	Mid-pt.	End	Start	Mid-pt.	End	Start	Mid-pt.	End
Winter Wheat											
Aug 15	Sept 10	Sept 20	Dec 10	Dec 20	Mar 20	May 10	May 20	June 01	Jun 25	July 10	July 25
Grain Sorghum											
Apr 01	Jun 01	Jun 20	Jun 15	Jun 25	July 10	July 20	Aug 10	Aug 30	Sept 25	Oct 20	Nov 30
Barley											
Aug 15	Sept 10	Sept 20	Dec 10	Dec 20	Mar 20	May 05	May 15	May 25	Jun 20	Jul 05	Jul 20
Rye											
Aug 15	Sept 10	Sept 20	Dec 10	Dec 20	Mar 20	May 01	May 15	May 25	Jun 20	Jul 05	Jul 20
Oats											
Mar 01	Mar 10	Mar 20	May 10	May 15	May 25	Jun 10	Jun 15	Jun 25	Jun 25	Jul 05	Jul 15

TABLE I-28.- CROP CALENDARS FOR THE CENTRAL CROP REPORTING DISTRICT OF KANSAS (SALINE, RICE AND ELLIS COUNTIES)

Seedbed preparation			Full coverage			Heading, flowering			Post-Harvest operations		
Start	Mid-pt.	End	Start	Mid-pt.	End	Start	Mid-pt.	End	Start	Mid-pt.	End
Winter Wheat											
Aug 20	Sept 25	Oct 10	Dec 20	Jan 15	Mar 10	May 05	May 15	May 25	Jun 20	Jul 05	Jul 20
Grain Sorghum											
Mar 01	Mar 10	Mar 20	May 10	May 15	May 25	Jun 05	Jun 15	Jun 25	Jun 25	Jul 01	Jul 10
Barley											
Aug 20	Sept 25	Oct 10	Dec 20	Jan 15	Mar 10	May 01	May 10	May 20	Jun 15	Jul 01	Jul 15
Rye											
Aug 20	Sept 25	Oct 10	Dec 20	Jan 15	Mar 10	Apr 25	May 10	May 20	Jun 15	Jul 01	Jul 15
Oats											
Mar 01	Mar 10	Mar 20	May 10	May 15	May 25	Jun 05	Jun 15	Jun 25	Jun 25	Jul 01	Jul 10

TABLE I-29.– USUAL PLANTING AND HARVESTING DATES FOR OTHER CROPS IN KANSAS

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Beans, dry	May 20-July 1	Aug. 25	Sept. 1-Oct. 10	Oct. 20
Corn:				
Grain	Apr. 15-June 20	Sept. 15	Oct. 10-Nov. 15	Dec. 5
Silage	Apr. 20-June 20	Aug. 25	Sept. 1-Oct. 1	Oct. 10
Forage	Apr. 20-June 20	Sept. 20	Oct. 1-Oct. 1	Oct. 10
Hay:				
Alfalfa		May 10		Oct. 30
Clo-tim		May 25		Aug. 20
Lespedeza		Aug. 5		Sept. 10
Wild		July 15		Sept. 1
Popcorn	May 5-June 1	Oct. 10	Oct. 15-Nov. 10	Nov. 15
Soybeans	May 10-July 5	Sept. 20	Oct. 1-Nov. 5	Nov. 20
Sugarbeets	Apr. 5-May 5	Sept. 20	Oct. 1-Nov. 10	Nov. 25
Seed Crops:				
Alfalfa		Aug. 5	Aug. 20-Sept. 20	Oct. 5
Red clover		Aug. 1	Aug. 15-Sept. 15	Oct. 1
Sweetclover		July 1	July 10-Aug. 5	Aug. 20
Lespedeza		Oct. 1	Oct. 10-Nov. 15	Dec. 1

TABLE I-30.— DISTRIBUTION OF WINTER WHEAT VARIETIES

[Percent variety by county]

County	Scout	Triumph	Eagle	Parker	Satanta	Centurk	Gage
Finney	55	2	10	-	12	1	-
Morton	73	-	2	-	6	16	-
Saline	17	8	13	46	8	1	-
Ellis	66	3	20	2	2	-	-
Rice	44	15	5	10	7	7	4

County	Bison	Apache	Wichita	Sturdy	Kaw	Shawnee	Kiowa
Finney	18	-	-	-	2	-	-
Morton	-	-	3	-	-	-	-
Saline	-	-	-	-	1	2	-
Ellis	2	-	2	4	2	-	1
Rice	1	2	-	2	-	2	-

INTENSIVE TEST SITE ASSESSMENT REPORT

TEXAS

SECTION TWO

CONTENTS

TABLES

FIGURES

2.0 INTENSIVE TEST SITES - TEXAS

2.1 REGIONAL DESCRIPTION

Three Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the state of Texas. The test sites are located in Randall, Deaf Smith and Oldham counties (figure 2-1).

TABLE II-1.— COUNTY SIZE AND LOCATION OF THE LACIE INTENSIVE TEST SITES IN TEXAS

County	Sq. Miles	Total acres	N. Lat.	W. Long.	Test sites size, miles
Randall	920	588,800	35°08.6'	102°04.6'	3x3
Deaf Smith	1,500	964,480	34°52.2'	102°23.8'	3x3
Oldham	1,478	945,920	35°15.0'	102°32.0'	3x3

These sites belong to the I-N or Northern High Plains crop reporting district.

2.1.1 Location

The test site for Randall County is located in the northern part of the county.

In Deaf Smith County, the test site is located in the southeast part of the county just north of the city of Hereford. The area is nearly level except in some areas where it is modified by creeks and playas.

The Oldham County test site is located near the south-central part of the county, about 6 miles west of the city of Vega. A large playa lake is located north of the test site.

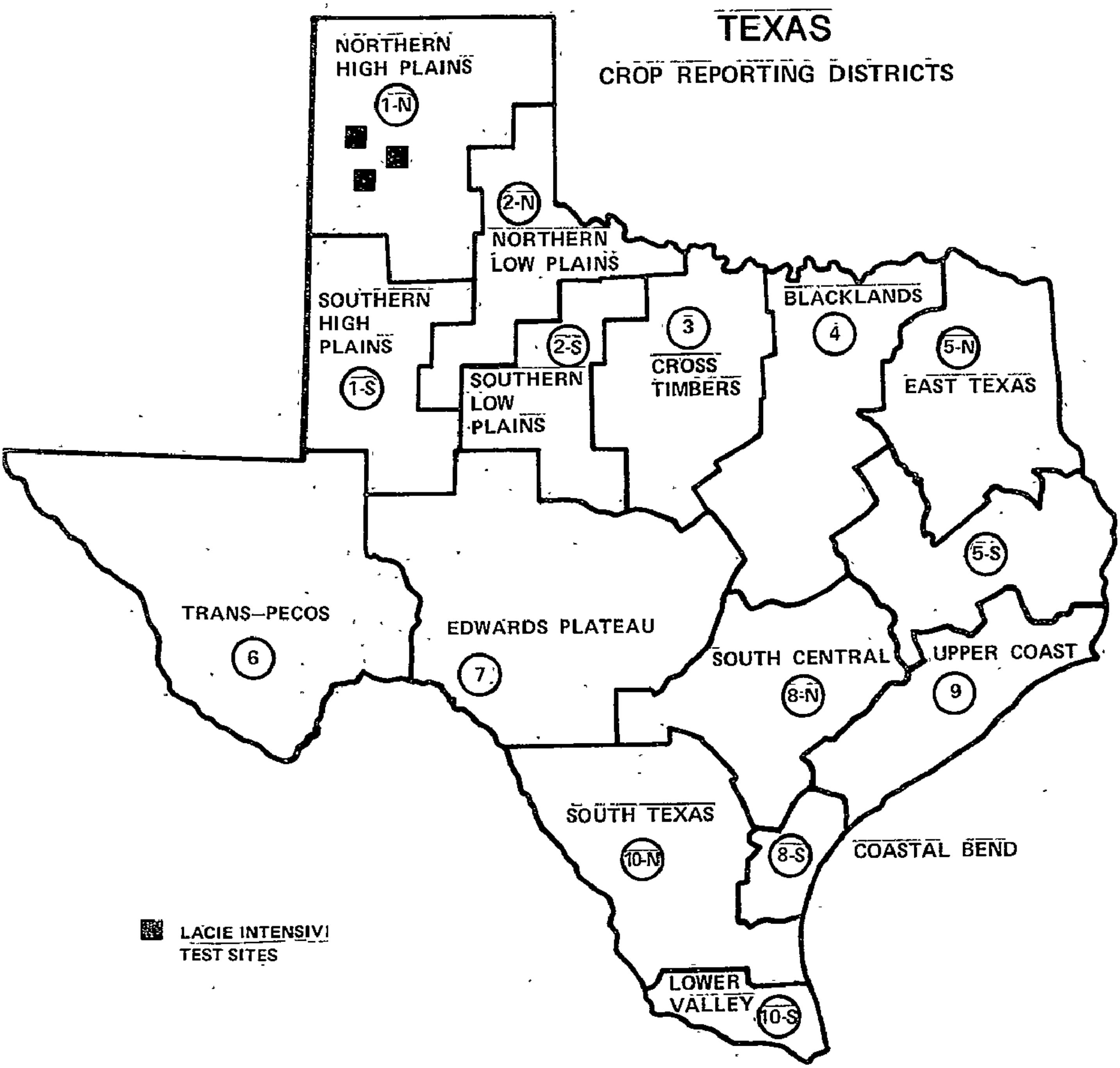


Figure 2-1. — Location of the three LACIE Intensive Test Sites in Texas.

2.1.2 Physiography

The North Plains, where the test sites are located, has primarily wheat and grain sorghum farming, but there is also significant ranching and petroleum developments. The flat, nearly level surface of very large areas has few streams of any dissection to cause local relief. However, several major rivers originate in the High Plains or cross the area. The largest is the Canadian River which has cut a deep valley across the Panhandle section. Playas, small intermittent lakes scattered through the area, lie up to 20 feet below the surrounding flat plains. They receive most of the runoff, with less than 10 percent of this water percolating back to the aquifer.

2.1.2.1 Randall County. Randall County is in the south-central part of the Texas Panhandle under District I-N or Northern High Plains crop reporting district (figure 2-1).

About 85 percent of Randall County consists of smooth areas of the High Plains, and about 15 percent is rough land of the canyons and valleys of the Palo Duro Creek and its tributaries that drain into the Prairie Dog Town fork of the Red River. This drainage system bisects the county and flows in an easterly direction.

The High Plains part of the county is marked by a prominent escarpment where it borders the Palo Duro Canyon and its tributary canyons. Elevation of the High Plains ranges from 3460 to 3890 ft. Except where pitted by playas, the surface is remarkably smooth. These playas range from a few square yards to 9 square miles in size and from a few inches to more than 50 feet in depth. The average grade of the High Plains is about 10 feet per mile to the east.

The land is nearly level in the northern part of the county, gently sloping and featureless plain dotted by three saucer-shaped depressions or playa lakes. These playas catch most of the runoff from heavy rains and also irrigation tail water, from which there is no definite outlet. When a small playa fills, any additional water must drain into another larger playa or into playas at lower elevations.

2.1.2.2 Deaf Smith County. Deaf Smith County is in the western part of the Panhandle of Texas (fig. 2-1). It belongs to District I-N or northern High Plains crop reporting district.

Elevations range from about 4,450 feet on the western edge of the county to about 3,650 feet along Tierra Blanca Creek. Most of the county (95 percent) is on a smooth tableland of the High Plains, tilted to the east at an average grade of about 10 feet per mile. Except for a few low rivers and many playas, or depressions, the main surface is smooth. Runoff water flows into the playas from the nearly level areas. These playas are disc-shaped and consist of a central basin in which runoff is held, a higher, nearly level bench or terrace, and an outer rim that slopes to the main surface.

2.1.2.3 Oldham County. Oldham County is in the western part of the Panhandle of Texas (fig. 2-1). It belongs to District I-N or the northern High Plains crop reporting district.

Elevations range from 3,200 to 4,200 feet. The physical feature is generally level, broken by the Canadian River and its tributaries and by playas or depressions. These playas consist of a central basin in which runoff is held, a higher, nearly level bench or terrace, and a rim that slopes to the main surface.

2.1.3 Climate

The weather in Texas is highly variable. Ten climatic subdivisions result from the size, differences in elevation, and other factors. Maritime, continental and mountain types of climate are all found in Texas. The continental type is the most prevalent over the state. This is characterized by rapid changes in temperature, marked extremes, and large temperature ranges both daily and annually. The northern Panhandle Plains is characterized by a semi-arid climate.

Rainfall in Texas is not evenly distributed over the state and varies greatly from year to year. The number of days with measurable precipitation follows the general trend of rainfall totals, so that seasonal frequencies are lowest where amounts are lowest. Rains occur most frequently in the springtime as a result of squall line thunderstorms, showing a peak in April and May. A secondary peak in rainfall frequency and amount appears during the fall when tropical disturbances move inland. Mean annual precipitation in the northern High Plains ranges from 16 to 20 inches.

Temperatures in the northern half of the state during the winter are quite changeable from day to day, because of the frequent northers which move through the area. In summer, the temperature contrast from north to south is less marked with the daily highs in the nineties.

2.1.3.1 Randall County. The climate of Randall County is cool temperate. Rainfall occurs most frequently in thunderstorms rather than in general rains. This kind of rainfall is spotty and partly accounts for the extreme variability in precipitation. Table II-2 shows the average rainfall and temperature data for Canyon, Texas which is about 12 miles southeast of the test site.

Rainfall is greatest during May, June, and July and three-fourths of the average annual rain falls during the 6-month period, May through October. Dry spells of several weeks or more are common, and there are monthly periods without measurable rain. These periods have occurred in all months except April, May, July, and August.

During winter, frequent cold fronts block the moisture from the Gulf of Mexico and precipitation is limited. Precipitation in winter usually falls as rain or snow, but sometimes the rain and snow are mixed. Snowfalls are generally light, and the snow remains on the ground for only a short time. Heavy snow falls infrequently when moisture from the Gulf is carried into low pressure centers over the Texas Panhandle. Because much of the snow is driven by the wind into high drifts, distribution of moisture is uneven when the snow melts.

C-2

TABLE II-2. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT CANYON, RANDALL COUNTY, TEXAS

Month	Temperature average, °F	Precipitation average, inches
December	40.4	0.80
January	38.3	0.58
February	42.9	0.51
Winter	40.5	1.89
March	48.1	0.76
April	57.7	1.39
May	66.7	3.19
Spring	57.5	5.34
June	75.4	2.91
July	77.7	2.85
August	77.2	2.22
Summer	76.8	7.98
September	70.9	1.75
October	60.5	1.98
November	46.6	0.59
Fall	59.3	4.32
Year	58.5	19.53

[a]Averages for period 1934-1963.

Like rainfall, temperature in Randall County is extremely variable, especially from November through April. Cold fronts from the northern part of the Rocky Mountains and the Plains states sweep across the plains of the Panhandle at speeds of 20 to 40 miles per hour. Temperature commonly drops 50 to 60 degrees within 12 hours. Cold spells seldom last more than 2 or 3 days before southwesterly winds from the high plateaus in New Mexico cause rapid warming. Also, temperature falls a great deal from the maximum in the afternoon to the minimum early in the morning. This is because the dry air, high elevation, and usually clear skies permit warming by the sun during the day and cooling at night.

July has the highest daily maximum temperature, but the maximum temperature recorded was 107° F in June 1953. The wind and low humidity prevent the high day time temperatures from being uncomfortable. The county receives about 72 percent of the possible sunshine.

The average speed of the wind is fairly high because the surface of the county offers little resistance to the wind. The strong continuous winds that normally are most frequent in March and April cause soil erosion and duststorms. The prevailing winds are usually southerly from May through September and southwesterly during the rest of the year. Winds, in short gusts, are strongest during intense thunderstorms.

Hail may accompany almost any thunderstorms, but damaging hailstorms are fairly infrequent and cover only small areas. Hail is most frequent late in spring and early in summer.

Humidity averages about 72 percent at 6:00 a.m. and only about 38 percent at 6:00 p.m. Most cloudiness occurs in the period January through May.

The average length of the freeze-free period is 200 days but the length of this period varies considerably from year to year. Between the last occurrence of a 28° F temperature in spring and the first occurrence in fall, the average number of days is 215. April 15 is the average date of the last 32° F temperature in spring. On the average, one year out of every five will have a 32° F temperature after April 23. The average date of the first freeze in fall is November 1. On an average of one year out of every five, a freeze will occur before October 16. Because of differences in elevation and uneven terrain, these average dates vary locally within the county.

Average annual lake evaporation is approximately 66 inches. Of this, 45 inches evaporates in the period May through October.

2.1.3.2 Deaf Smith County. Deaf Smith County has a semiarid, continental climate with an average annual rainfall of about 18 inches. However, this amount fluctuates greatly from year to year, ranging from a low of 8 inches to a high of 40 inches. Most of the precipitation comes in summer and much of it is in hard showers of short duration. The winter months are mostly dry and windy, with occasional snows. Temperatures throughout the year range from slightly above 0° F in winter to about 100° F in summer. In summer, temperatures generally reach the middle 90's during the day and are in the 60's during the night. A summary of data on climate is shown in table II-3 for Hereford, a city about 3 miles south of the test site.

Monthly and annual rainfall is characterized by extreme variability. Rainfall occurs more frequently in thunderstorms than in general rains. This spotty, shower-type rainfall accounts for the extreme variability in amounts. Maximum rainfall occurs during the months of May, June, and July and 78 percent of the average annual rainfall occurs in the 6-month period, May through October. Little benefit is derived from much of the precipitation during exceptionally wet months or years because the precipitation comes in heavy thundershowers and much of the moisture is lost in excessive runoff that causes erosion.

During the winter months, the area is cut off from the moisture in the Gulf of Mexico by frequent cold fronts and precipitation is rather limited. Precipitation in winter falls as rain or snow, or sometimes as rain and snow

TABLE II-3. – AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT HEREFORD, DEAF SMITH COUNTY, TEXAS

Month	Temperature average, °F	Precipitation average, inches
December	39.0	0.69
January	36.3	0.58
February	40.7	0.50
Winter	38.7	1.77
March	46.4	0.64
April	55.8	1.15
May	65.2	2.82
Spring	55.8	4.61
June	74.5	2.50
July	77.6	2.73
August	76.7	2.12
Summer	76.3	7.35
September	69.6	1.67
October	59.3	2.15
November	45.3	0.49
Fall	58.1	4.31
Year	57.2	18.04

[a]Averages for period 1937-1962.

mixed. Snowfalls are generally light, and the snow remains on the ground for only a short time. A few times in winter over a long period, snow has been heavy when moisture from the Gulf is carried northward into low pressure centers over the Texas Panhandle.

Temperature, like rainfall, shows extreme variability, especially from November through April, or during the colder 6 months of the year. Cold fronts from the northern Rocky Mountains and Plains states sweep across the plains of the Panhandle at speeds of as much as 40 miles per hour. Drops in temperature of 50° to 60° F within a 12-hour period are common in Deaf Smith County. Strong southwesterly winds blow in from the high New Mexico plateaus and cause rapid rises in temperature. Large fluctuations in temperature are often noted from day to day during the latter part of fall and in winter and spring. Relatively severe cold fronts may follow several weeks of mild weather and push rapidly southward late in spring. These cold fronts have a disastrous effect on new spring vegetation. A weather pattern of this kind discourages the growing of fruit trees in the area and also penalizes farmers who plant tender crops too early.

Because the dry air, high elevation, and usually clear skies result in much solar radiation, there is a large range between the maximum temperature during the afternoon and the minimum temperature during the early morning. This daily range averages about 28° F. Days are hot in summer and have low humidity. Nights in summer are relatively cool with the minimum temperature in the low sixties.

Average speeds of wind are rather high in Deaf Smith County because the high, level terrain offers little resistance to the wind. The average hourly windspeed is about 12 miles per hour. The direction of the prevailing winds ranges from south to southwest.

Humidity in this county is low compared to that of central and eastern Texas. The highest humidity occurs early in the morning, and the lowest occurs during the warmest part of the afternoon. In summer, the readings at 6 a.m. may be expected to average about 77 percent, but readings at 6 p.m. average about 40 percent.

Hail may accompany almost any thunderstorm, but damaging hailstorms are infrequent and cover only small areas. Hail is most frequent late in spring and early in summer. The growing season is fairly short. There are 185 days between the average date of the last occurrence of 32° F in spring and the average date of the first occurrence of 32° F in fall. The average date of the last freeze in spring is April 20. On the average, one year out of every five will have a freezing temperature after May 8. The average date of the first freeze in fall is October 22. In one year out of every five, on the average, a freeze will occur before October 12, and in one year in every twenty before October 2. The average number of days between the last occurrence of 28° F in spring and the first occurrence of 28° F in fall is 210 days.

Sunshine is abundant year around. Evaporation is high, as is expected in a semiarid region. Average annual lake evaporation is approximately 67 inches. Evaporation from a Weather Bureau 48-inch pan is approximately 98 inches, of which 68 percent evaporates during the period May through October.

2.1.3.3 Oldham County. A detailed climatic description for Oldham County is not available. However, because of its location it can be assumed that the climate of this county is similar to those of Randall and Deaf Smith Counties. The average temperatures range from 56.9° F to 58.5° F and the average annual precipitations range from 18.04 inches to 19.53 inches for the three counties. The average precipitation and temperature are presented in table II-4 for Vega, a city about 6 miles east of the test site.

2.1.4 Soils

The test sites in Texas are on soils in the orders Mollisol and Alfisol and suborders Ustoll and Ustalf. These are soils that have nearly black surface horizons high in organic matter and bases. They are sometimes dry, sometimes moist and have long periods without enough water for plant growth. The mean soil temperature is about 47° F or higher and there is usually some accumulation of calcium carbonate in the lower part of the profile.

TABLE II-4. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT VEGA, OLDHAM COUNTY, TEXAS

Month	Temperature average, °F	Precipitation average, inches
December	38.3	0.81
January	36.2	0.67
February	39.9	0.55
Winter	38.1	2.03
March	46.1	0.81
April	55.7	1.46
May	64.1	2.97
Spring	55.3	5.24
June	74.1	2.42
July	78.3	2.34
August	76.9	3.01
Summer	76.4	7.77
September	69.4	1.80
October	58.8	1.50
November	45.5	0.75
Fall	57.9	4.05
Year	56.9	19.09

[a]Averages for period 1931-1955.

The soils in the sites on both Randall and Deaf Smith counties are represented by the great groups Calciustoll and Arguistoll which are generally described as level-undulating, i.e., more than 70 percent of the area has slope gradients of 0-8 percent. They are of the clay and fine-loamy types of soil.

In Oldham County, the site has Calciustoll, Argiustoll, and Haplustalf great groups. The latter great groups are described as shallow loamy, fine loamy and undulating hilly, i.e., more than 70 percent of the area has slope gradients of 3-8 percent (see table II-5 and figures 2-2, 2-3, and 2-4 for a description of the soils found in these counties).

Soil map transparencies are available at a scale of approximately 1:24,000. These transparencies can be used to overlay the test site on USDA/ASCS 1:24,000 black and white photography. These transparencies were reduced to fit the 8½- by 11-inch format of this report.

A more specific and detailed description of soil is presented for each of the test sites in later discussions.

2.1.4.1 Randall County. The general soils map of Randall County is shown in figure 2-2. The test site is located northeast of the county. Randall County soils are of the Mollisol order, Ustoll suborder, and Argiustoll great group.

A detailed soils map for the test site is shown in figure 2-5 and a description in table II-6.

Pullman Association

Pullman soils have a dark grayish-brown, neutral clay loam surface layer about 6 inches thick. The upper part of the subsoil is dark grayish-brown to brown, very firm clay about 46 inches thick. Soil reaction (pH) ranges from neutral at the top of this layer to alkaline at the bottom. The lower part of the subsoil is reddish-brown heavy clay loam. At a depth of 62 inches is pink clay loam that contains many concretions of lime.

TABLE II-5. — DESCRIPTION OF THE THREE TEXAS COUNTY SOILS

Classification	Description
MOLLISOLS	Soils that have nearly black friable organic rich surface horizons high in bases formed mostly in subhumid and semiarid warm to cold climates.
Ustolls	Mollisols that are mostly in semiarid regions. During the warm season of the year, these soils are intermittently dry for a long period or have subsurface horizons in which salts or carbonates have accumulated: used for wheat or small grains and some irrigated crops.
Argiustolls (formerly Chernozem, Chestnut, and some Brown soils)	Ustolls that have a subsurface horizon of clay accumulation that is relatively thin or brownish.
M9-2	Argiustolls plus Calciustolls and Paleustolls, gently sloping.
M9-15	Argiustolls plus Paleustolls and Ustorthents, gently sloping.
Calciustolls (formerly Calcisols)	Ustolls that are calcareous throughout and have either an indurated (petrocalcic) horizon cemented by carbonates or a horizon in which carbonate or gypsum has accumulated.
M10-1	Calciustolls plus Haplustolls, Arguistolls, and Ustochrepts (shallow), gently or moderately sloping.
ALFISOLS	Soils that are medium to high in bases (base saturation at pH 8.2) and have gray to brown surface horizon and subsurface horizons of clay accumulation; usually moist but during the warm season of the year some are dry part of the time.
Ustalf-Alfisols	That are in temperate to tropical regions. Soils mostly reddish brown; during the warm season of the year, they are intermittently dry for long periods; used for range, small grain and irrigated crops.
Haplustalf	(formerly reddish chestnut and reddish brown soils). Ustalfs that have a subsurface horizon of clay accumulation that is relatively thin or is brownish.
A9-2	Haplustalfs plus Calciustolls and Argiustolls, gently sloping.
A9-5	Haplustalfs plus Ustipsamment, gently sloping.

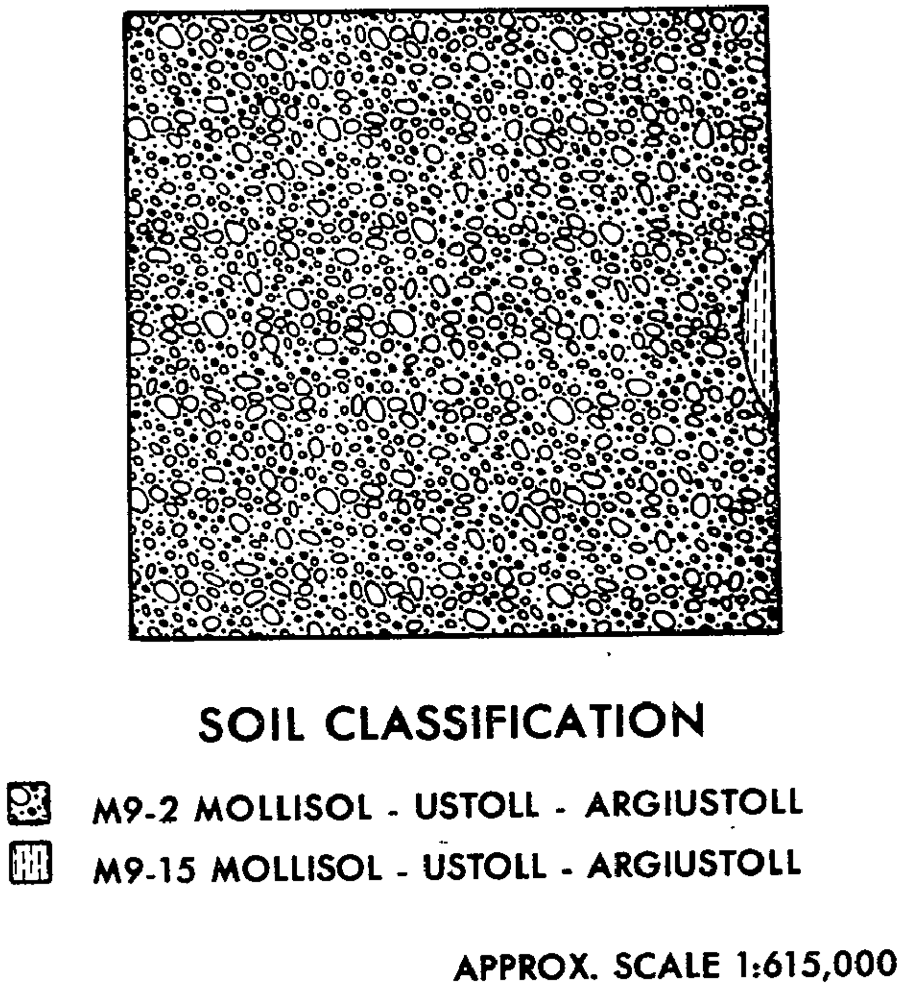
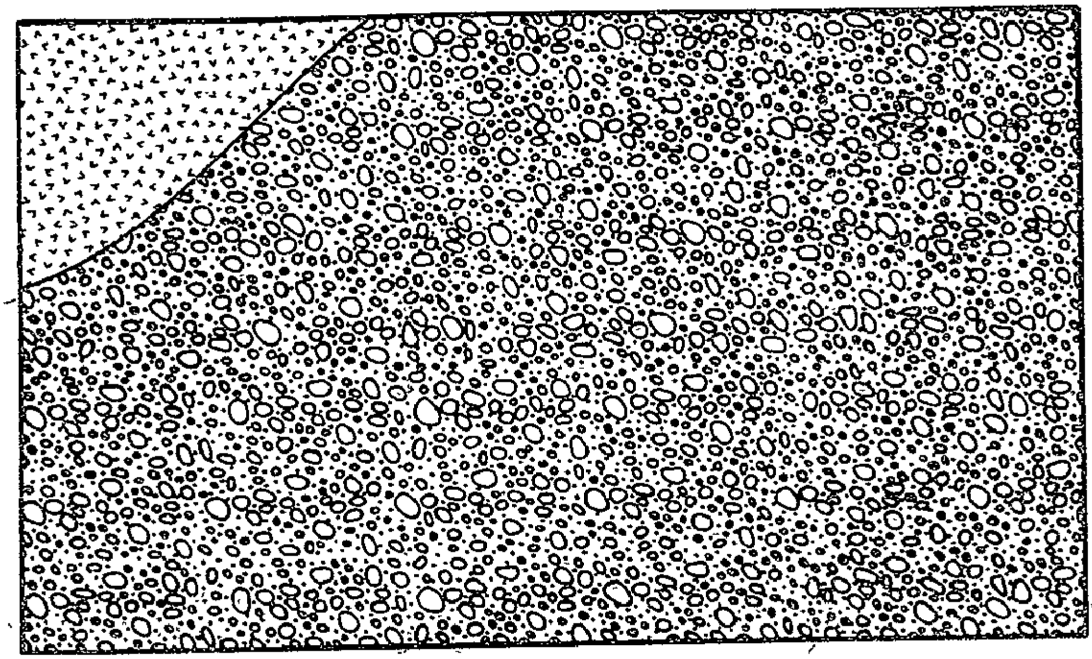


Figure 2-2. — Soil classification map of Randall County, Texas.



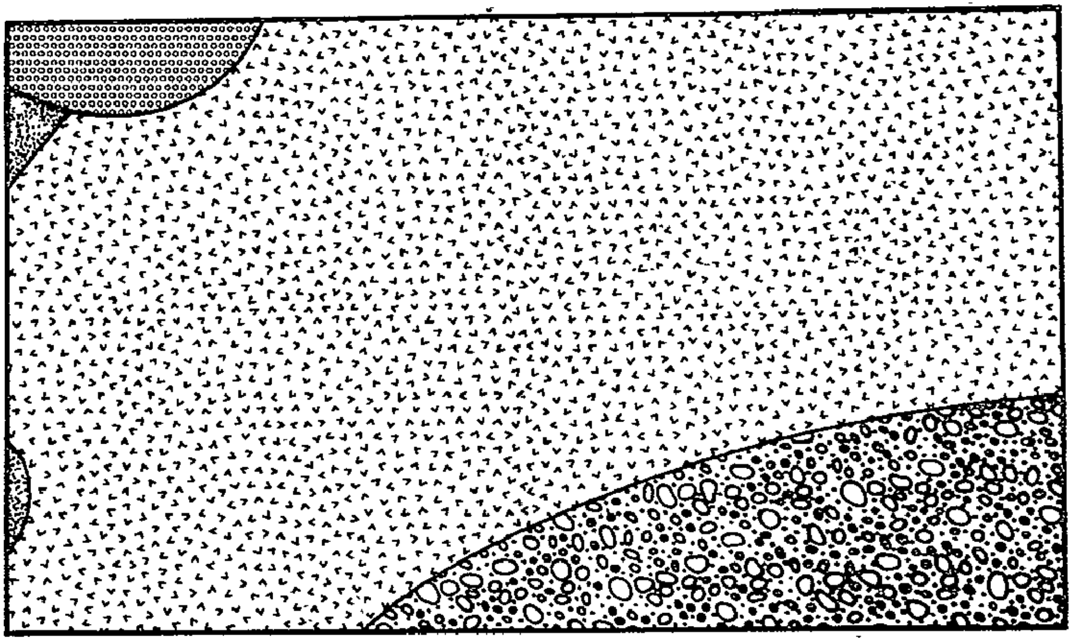
SOIL CLASSIFICATION

M9-2 MOLLISOL - USTOLL - ARGIUSTOLL

M10-1 MOLLISOL - USTOLL - CALCIUSTOLL

APPROX. SCALE 1:615,000

Figure 2-3. — Soil classification map of Deaf Smith County, Texas.

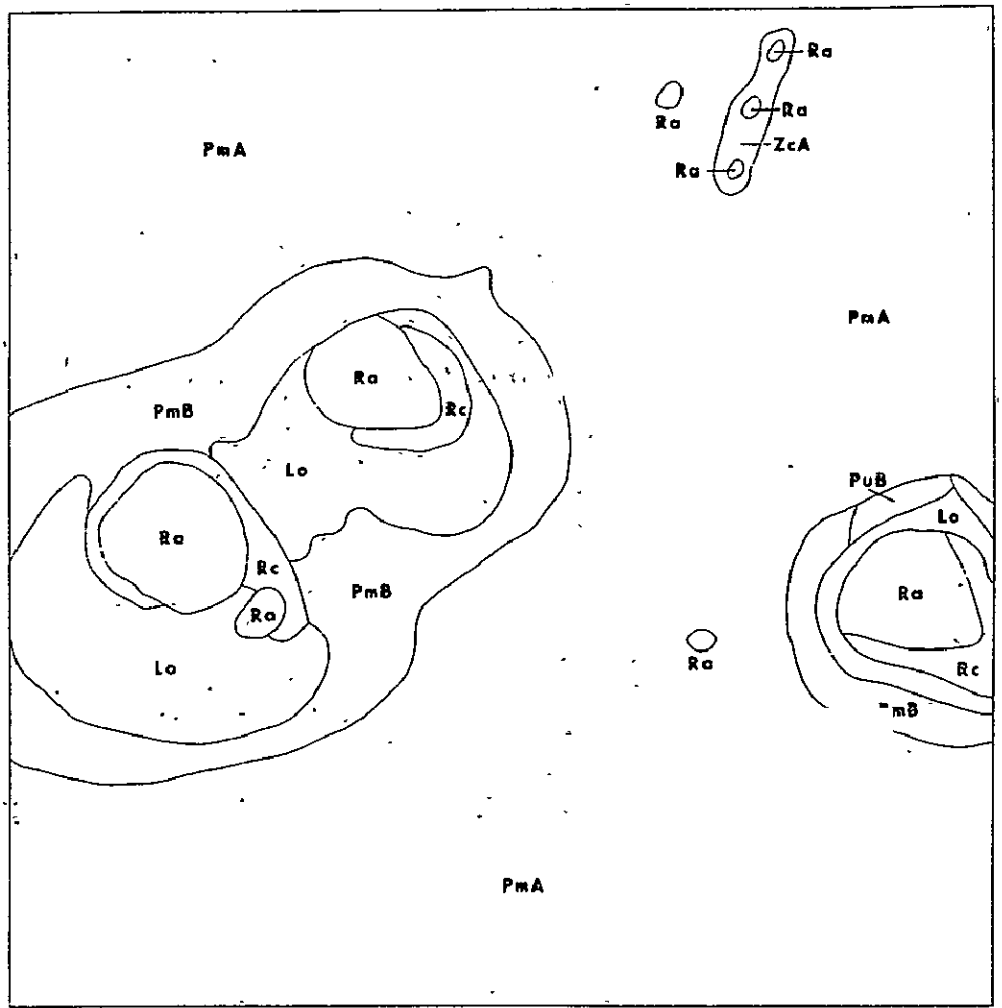


SOIL CLASSIFICATION

- M10-1 MOLLISOL - USTOLL - CALCIUSTOLL
- M9-2 MOLLISOL - USTOLL - ARGIUSTOLL
- A9-2 ALFISOL - USTALF - HAPLUSTALF
- A9-5 ALFISOL - USTALF - HAPLUSTALF

APPROX. SCALE 1:615,000

Figure 2-4. — Soil classification map of Oldham County, Texas



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 2-5. – Randall County, Texas LACIE Intensive Test Site soil classification map.

TABLE II-6.– RANDALL COUNTY SOIL DESCRIPTIONS

Symbol	Name
Lo	Lofton clay loam
PmA	Pullman clay loam, 0 to 1 percent slopes
PmB	Pullman clay loam, 1 to 3 percent slopes
PuB	Pullman clay loam, moderately shallow, 1 to 3 percent slopes
Rc	Roscoe clay
ZcA	Zita clay loam, 0 to 1 percent slopes

Pullman soils are generally well drained, but they are slowly permeable when moist and very slowly permeable when dry.

Minor soils in the Pullman association are found near the playa lakes. The Randall and Lofton soils are the most extensive. Randall soils are poorly drained and are on the floor of the playas, a few feet below the Roscoe, Lofton, and Zita soils. The Ulysses, Mansker, and Drake soils occupy the more sloping upper rim of the playas.

Pullman Series

Pullman clay loam, 0 to 1 percent slopes (PmA)

This is the most extensive soil in the test site sloping eastward at a gradient of mostly less than 0.3 percent. The surface layer is neutral, dark grayish-brown, friable clay loam about 6 inches thick. The middle layer is brown compact clay, generally neutral and is the least permeable layer in the subsoil. This droughty Pullman soil takes in water slowly but has high available water capacity. Its natural fertility is also high. If properly managed and moisture is optimum, crops grow well. This soil is easily worked within a moderate range of moisture content. Excessive tillage, however, destroys the desirable structure, powders the soil, and makes it susceptible to blowing. A plowsole tends to form if this soil is tilled when too wet or if repeatedly tilled at the same depth.

Pullman clay loam, 1 to 3 percent slopes (PmB).

This soil occurs in bands that surround the larger playas and on the weaker side slopes or draws. The surface layer is neutral, dark grayish-brown, friable clay loam about 5 inches thick. This droughty Pullman soil takes in water slowly, but its fertility and available water capacity are high. It can be worked throughout a moderate range of moisture content. When the moisture content is favorable and the soil is properly managed, crops grow well under dry farming. Crop growth is good to excellent under irrigation and good management. Parts of the acreage is cultivated and the rest is used as native short-grass range.

Pullman clay loam, 1 to 3 percent slopes, eroded (PmB_2)

This eroded soil is on ridges and at heads of small draws in cultivated fields from which water drains into the playas and draws. Most slopes are about 3 percent, but in some included areas slopes are as much as 4 percent. About half of the surface layer has been removed, mainly by sheet erosion. In some areas tillage has made the surface layer more clayey by mixing into it some of the upper part of the clay subsoil. The surface layer, therefore, crusts more easily and slows the rate of water intake. Droughtiness and susceptibility to erosion increase. This soil has moderate to moderately high available moisture capacity and fertility.

Pullman clay loam, moderately shallow, 1 to 3 percent slopes (PuB)

This soil occurs in a small area around the eastern playa. Most slopes are 2.5 percent and may range up to 4 percent. The surface is plane or convex. Because of slope and lack of cover, about 2 inches of the surface layer has been removed by sheet erosion. The subsoil is similar to that of Pullman clay loam but it is thinner and slightly more permeable. The surface layer is neutral, grayish-brown clay loam. This droughty Pullman soil takes water slowly, but its fertility and available moisture capacity are high. Crops grow well if management is good and the moisture content optimum. This soil is easily worked throughout a moderate range of moisture content.

Randall Series

Randall clay (Ra)

This poorly drained soil occurs on floors of playas. It may be level, but may have slopes of as much as 2 percent on the outer rims. The surface of these rims is concave.

The topmost layer is gray to dark-grey, heavy and blocky soil material. This layer is generally clay but the topmost 2 to 5 inches is clay to fine sandy loam in recent windblown or waterlain deposits. Some faint mottles occur in the lower part of the surface layer and in the substratum. The substratum is light gray, massive clay stratified with clay loam and loam at depths of more than 80 inches. This soil is very slowly permeable when wet. When it is dry, deep shrinkage cracks occur in a geometric pattern and extend downward to the substratum. This soil is fertile, but water penetrates very slowly and is regularly ponded ranging from a few days to months. It is generally not suitable for cultivation. When the ponded water dries up, this soil becomes susceptible to blowing.

Roscoe Series

Roscoe clay (Rc)

This soil occurs on loam benches in the playas. Areas of Roscoe clay are crescent shaped or in concentric bands surrounding the bottom Randall clay of the playas. The surface layer is dark gray, calcareous clay that ranges from about 15 to 30 inches in thickness. Below the surface layer is very sticky, calcareous, slowly permeable, blocky clay about 20 inches thick. It is underlain by calcareous, light gray silty clay. Roscoe clay is deep and fertile, but droughty and slowly permeable in the subsoil. Because of its relatively less occurrence, this type of soil is of minor importance in the test site.

Lofton Series

Lofton clay loam (Lo)

This soil occurs on smooth upper playa benches and slight depressions within broad areas of the Pullman soils. It is important for farming because it receives extra runoff water from the surrounding, higher lying soils. Slopes are mostly less than 0.5 percent, but may range up to 2 percent. The surface is weakly concave or plain. The surface layer is dark grayish-brown, neutral clay loam about 8 inches thick. Structure is moderate to strong granular under native grass, but in cultivated areas it is weak, fine, granular and the surface is cloddy. The subsoil is slowly permeable. Capacity for holding available moisture and plant nutrients is high. Except in the driest years, dryland crops grow well if managed properly.

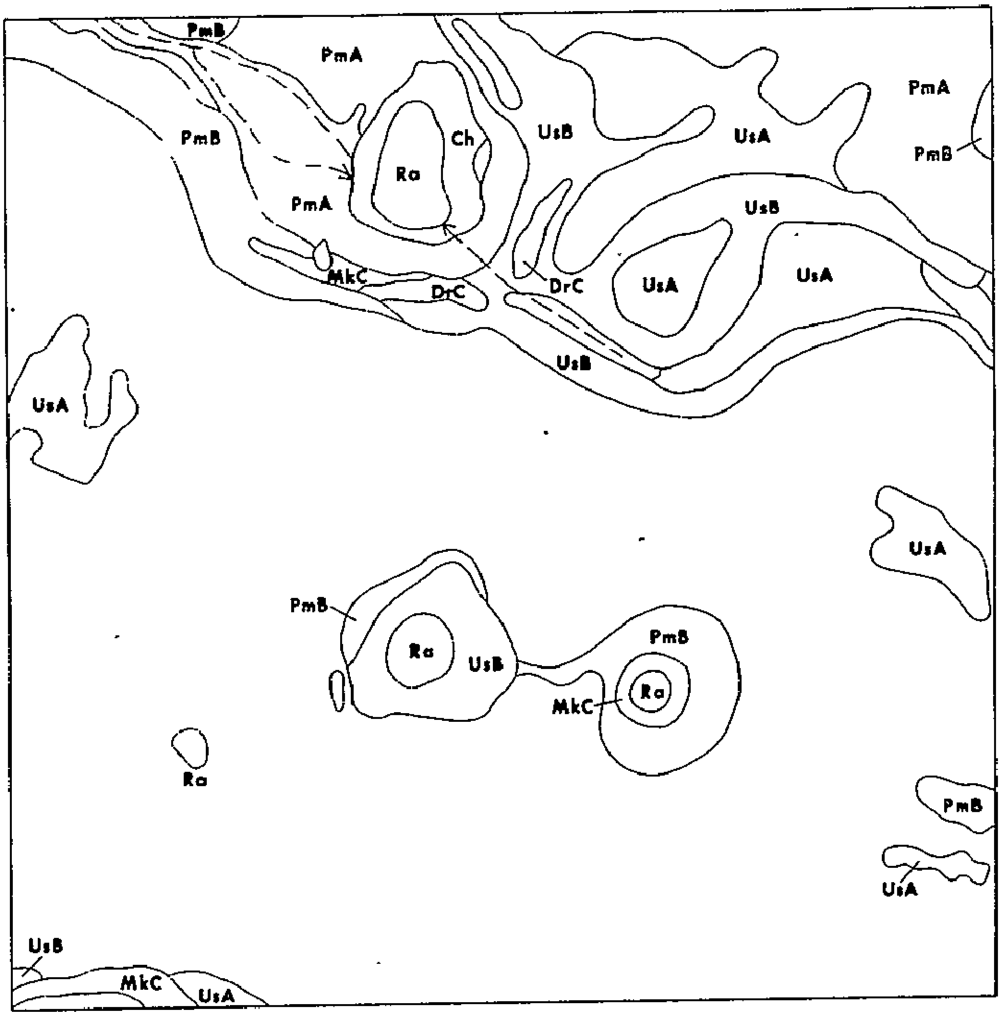
Zita Series

Zita clay loam, 0 to 1 percent slopes (ZcA)

This soil is of minor importance in the test site because of its very small occurrence. It is found on a slightly concave area on the northeastern corner of the site. The surface layer is neutral, dark brown to dark grayish-brown, very friable clay loam. The subsoil is brown moderately permeable, calcareous clay loam. Much of the surface layer and subsoil is made up of warm casts, and a large amount of organic matter has been uniformly distributed by plants and soil organisms. This friable Zita soil is well drained, easy to till and has high natural fertility, but is susceptible to soil blowing.

2.1.4.2 Deaf Smith County. Deaf Smith County soils are of the Mollisol order, Ustoll suborder and Calciustoll and Argiustoll great groups (fig. 2-4.).

The test site in Deaf Smith County lies on two major soil associations, namely Ulysses-Pullman and Pullman associations (see fig. 2-6 and table II-7). They are both nearly level to gently sloping on smooth upland plains. Soils of the Ulysses-Pullman association are moderately deep or deep over soft caliche while those of the Pullman association are deep dark-grayish brown loamy. Ulysses-Pullman association covers about 24 percent of the county. Ulysses soils make up about 70 percent of the association; Pullman soils, 20 percent; and minor soils, the remaining 10 percent. The dark-colored Pullman soils generally occur as irregularly shaped areas within larger areas of the limy, light colored Ulysses soils.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 2-6. – Deaf Smith County, Texas LACIE Intensive Test Site soil classification map.

TABLE II-7.— DEAF SMITH COUNTY SOIL DESCRIPTIONS

Symbol	Name
Cl	Church clay.
DrC	Drake soils, 3 to 5 percent slopes.
MkC	Mansker clay loam, 3 to 5 percent slopes.
PmA	Pullman clay loam, 0 to 1 percent slopes.
PmB	Pullman clay loam, 1 to 3 percent slopes.
Ra	Randall clay.
UsA	Ulysses clay loam, 0 to 1 percent slopes.
UsB	Ulysses clay loam, 1 to 3 percent slopes.

Pullman association covers 63 percent of the county. It is extensive and contains most of the dry farmed and irrigated cropland in the county.

Most of the soils within the test site are of the Pullman clay loam type, 0 to 1 percent slopes (PmA). For a detailed description of this soil type see discussion for Randall County.

Various other soil types occur around the playas and along the creek running across the northern section of the test site. Among these are Pullman clay loam, 1 to 3 percent slopes (PmB) and Randall clay (Ra) both of which have been described under Randall County. Other soil types present in the Deaf Smith County test site are as follows:

Ulysses Series

Ulysses clay loam, 0 to 1 percent slopes (UsA)

This type of soil occurs on the nearly level high plains and is surrounded by large areas of the Pullman soils. The surface layer of this soil is brown, grayish-brown or dark grayish-brown. This soil is friable, granular, and easy to work. It has moderate fertility and is moderately well suited to cultivation, but it blows readily where the surface is not protected. About half of this soil is cultivated and the rest is range.

Ulysses clay loam, 1 to 3 percent slopes (UsB)

This soil occurs around playa basins and along draws and creeks. A few areas are on low rises or ridges adjoining Pullman clay loam. It has the same physical features as UsA.

Mansker Series

Mansker clay loam, 3 to 5 percent slopes (MkC)

This soil is found around the playas and along streams. It is dark colored, dark grayish to reddish-brown or dark brown, granular clay loam. This soil is in range and is of minor importance in the test site area.

Church Series

Church clay (Ch)

This is a dark, limey soil on broad level benches of the playa basins. It is found only around the big playa on the north-central part of the test site. Although it is also suited for cultivation, it is likely to be utilized as range in the test site because of the nature of its occurrence.

Drake Series

Drake soils, 3 to 5 percent slopes (DrC)

These are grayish-brown, limey clay loam soils that occur in two small areas on the southeastern slope of the large playa basin. They are moderately low in natural fertility and contain high amounts of lime. Most of these soils are in range.

Olton Series

Olton clay loam, 0 to 1 percent slopes (OcA)

These soils are found in a small spot east of the test site. They are deep, dark-brown, loamy soils that are slowly permeable. They have moderately high natural fertility and moderate to high water-holding capacity.

Olton clay loam, 1 to 3 percent slopes (OcB)

These soils are found in a small area northeast of the test site occupying an area adjoining draws and the large playa. Other physical features are similar with those of the OcA.

2.1.4.3 Oldham County. Oldham County soils are of the Mollisol and Alfisol orders, Ustoll and Ustalf suborders and Argiustolls-Calciustolls and Haplustalf great groups (fig. 2-4).

The test site in Oldham County is situated on soils belonging to Pullman Association. These soils are loamy, deep, nearly level to gently sloping having a dark grayish-brown surface layer and a compact clayey subsoil. Prominent features are lacking, except for a few low rises and many round, disc-shaped depressions. These depressions, which are generally Randall clay at the bottom, catch most of the water running off the Pullman soils, and the rest runs into the drainage ways and creeks that cut the plain.

The dark grayish-brown surface layer is noncalcareous clay loam about 6 inches thick. It has weak granular structure and generally good tilth. It is easily worked throughout a wide range of moisture content, but tends to crust after hard rains. The crusted surface is susceptible to soil blowing if it is bare. The surface layer is naturally fertile. The Pullman soils are slowly permeable. Almost all of the acreage of these soils is well suited to irrigation, mainly because slopes are smooth and nearly level. They are somewhat droughty, but in wet years are well suited to dry-farmed wheat and grain sorghum.

An updated soil survey for Oldham County does not exist; therefore a detailed soil series map for this county could not be prepared.

2.2 PRINCIPAL CROP PRODUCTION

2.2.1 State

The principal crops grown in Texas are cotton, grain sorghum, rice, and wheat, and exist in that order on the basis of production value. Other crops of less importance include rye, barley, corn, oats and some oilseed crops. More than half of the state's wheat acreage is found on the High Plains and approximately half of this is irrigated. Practically all wheat harvested for grain is used in some phase of the milling industry. Planting wheat solely for grazing has become important in the main Texas wheat-producing areas. This is because irrigation water on the High Plains permits production of good amounts of forage from August through May. Also, high beef prices, low wheat prices during previous years, and relatively poor grain production response to high soil moisture and soil fertility levels have influenced many farmers to utilize their wheat for grazing instead of grain. Current developments in the wheat market, however, have modified this trend.

Rye, barley and oats are also grown mainly in the same general area where wheat is produced. These crops are used mainly for winter grazing and only small acreage is harvested for grain.

2.2.1.1 Randall County. Soils in Randall county are generally suitable for cultivation except around the big playas, but the use is limited mainly by low rainfall. The major crops are dryland and irrigated winter wheat and grain sorghum. Some areas around the playas are utilized for pasture. In a few areas of the county, barley, oats and corn and, in the southern part, cotton are grown. Minor acreages are seeded to rye primarily as a cover crop and for grazing during the fall, winter, and early spring. Farming is generally mechanized.

Table II-8 shows yearly crop production in Randall county from 1970 to 1973. There is a wide year-to-year variation in acreages planted and harvested for each crop. This trend was exhibited also by crops grown under irrigated

TABLE II-8.– ANNUAL CROP PRODUCTION IN RANDALL COUNTY, TEXAS (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Upland cotton	1.85		1.75		1.43		1.5		213.0		267.0		lb
Wheat	114.0	112.0	164.0	152.0	60.3	33.0	72.0	131.0	23.7	29.2	20.7	32.4	bu
Oats	0.95	1.2	0.8	0.6	0.32	0.1	0.3	0.1	22.5	31.0	48.0	53.0	bu
Barley	1.4	2.0	0.8	1.5	0.86	1.7	0.45	1.4	26.4	14.1	18.7	33.1	bu
Rye	6.1		0.2	5.3	0.7	0.2	a	0.2	13.4	12.0	a	21.0	bu
Sorghum	63.7		72.5										
Grain					51.2		59.0		71.3		69.9		bu
Silage					0.55		2.2		9.96		6.8		ton
Hay					1.97		2.8		1.71		1.4		ton
Corn	9.2		5.2										
Grain					3.0		0.5		110.3		117.0		bu
Silage					5.5		4.7		13.76		22.1		ton
Soybeans	2.2		a		2.0				18.0				bu
Sugarbeets	0.95		1.3		0.9		1.15		18.9		20.6		ton
Other hay					3.9		1.3		2.54		1.77		ton

[a]Not significant.

conditions (table II-9). This suggests that moisture may not be the only factor considered for harvesting for grain. Other factors that can affect cropping operation include frost damage, pest occurrence, hail damage, and market situations both for wheat and for beef industry.

Land use in Randall county for 1964 and 1969 is shown in table II-10. Wheat acreage was 66.5 percent of total cropland. This is more than twice as much as the area planted to sorghum. Wheat and sorghum, the two major crops in the county, are grown in about 96 percent of the total cropland. Small acreage is also used for other hay crops like alfalfa, but the area is of minor importance and the yearly acreage is inconsistent (table II-11).

2.2.1.2 Deaf Smith County. The principal crops in the county are grain sorghum, wheat, alfalfa, vegetables and sugar-beets. Wheat is the major crop in most irrigated dryland cropping systems. Table II-12 shows the yearly crop production in Deaf Smith County from 1970 to 1973. There is a wide year-to-year variation in area planted and area harvested for each crop, with the exception of wheat. Wheat acreage planted and harvested showed an increasing trend with the largest increase, almost 100 percent, in harvested acreage in 1973. This trend was also exhibited by crops under irrigation (table II-13).

Land use in Deaf Smith County for 1964 and 1969 is shown in table II-14. Almost one-half of the total cropland is planted to wheat. Wheat and sorghum, the second main crop, occupy close to 80 percent of the total cropland (see table II-15). Acreages devoted to hay crops, like alfalfa and others except corn and sorghum, are not included because of their minor importance and inconsistent yearly production.

2.2.1.3 Oldham County. The principal crops in the county are wheat and grain sorghum. Oats, barley, rye, and hay other than sorghum are also produced in the county at a limited extent. Table II-16 shows the annual crop production in Oldham County from 1970 to 1973. Wheat acreage increased from 40,600 in 1970 to 58,200 in 1972, but declined to 53,200 in 1973. Sorghum acreage, on the other hand, decreased from 19,100 in 1970 to 12,100 in 1972.

TABLE II-9.– ANNUAL PRODUCTION OF IRRIGATED AND UNIRRIGATED CROPS IN RANDALL COUNTY, TEXAS (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
IRRIGATED													
Upland cotton			1.35		1.43		1.3		213.0		262.0		lbs
Wheat		42.0	41.0	41.0	20.5	27.2	27.0	37.0	39.3	34.1	31.1	42.2	bu
Grain sorghum			31.5		35.1		29.6		94.7		96.2		bu
UNIRRIGATED													
Wheat		70.0	123.0	111.0	39.8	5.8	45.0	94.0	15.6	6.2	14.4		bu
Grain			41.0		16.1		29.4		20.2		43.4		bu

TABLE II-10.— LAND IN FARMS[a] ACCORDING TO USE IN RANDALL COUNTY, TEXAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	417	139,515	352	148,288
Cropland used only for pasture or grazing	253	48,039	161	36,321
Cropland in cover crops, legumes and soil-improvement grasses, not harvested or pastured	45	5,878	40	8,105
Cropland on which all crops failed	99	13,575	89	17,334
Cropland in cultivated summer fallow	287	91,842	293	73,183
Cropland idle	90	15,694	53	9,604
Total cropland	458	314,543	(NA)	282,835
Woodland pastured	5	1,117	2	2,217
Woodland not pastured	6	1,803	—	—
Total woodland	458	314,543	(NA)	282,835
Improved pastureland and rangeland	77	33,197	31	6,695
Pastureland and rangeland not improved	250	169,236	(NA)	231,141
Total pastureland and rangeland (other than cropland and woodland pasture)	306	202,433	288	237,836
All other land	315	25,937	317	4,983
Irrigated land	268	81,133	235	76,620
Total pastureland (all types)	410	251,589	(NA)	266,374

[a]Farms with sales of $2500 and over.

TABLE II-11. — AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN RANDALL COUNTY, TEXAS (1972)

Crop	Percent, %
Upland cotton	0.7
Wheat	66.5
Oats	0.3
Barley	0.3
Rye	0.1
Sorghum	29.4
Corn	2.1
Soybeans	—
Sugarbeets	0.5

TABLE II-12.- ANNUAL CROP PRODUCTION IN DEAF SMITH COUNTY, TEXAS (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Upland Cotton	6.8		6.3		5.6		3.8		402.0		329.0		lb
Wheat	111.7	130.0	151.0	201.0	69.6	55.0	71.0	136.0	32.7	27.9	26.5	32.9	bu
Oats	2.0	1.7	1.1	3.1	0.22	0.45		0.4	58.2	37.8		55.0	bu
Barley	3.5	2.0	1.6	1.5	2.5	1.0	1.0	1.4	55.0	35.0	50.5	41.6	bu
Rye	10.1			3.4	2.0	0.65	1.9	1.3	19.7	18.0	26.3	25.2	bu
Sorghums	103.0		79.5										
Grain					91.6		67.6		102.0		100.5		bu
Silage					0.7				14.97				ton
Hay					1.95		2.8		1.83		1.9		ton
Corn	14.4		26.0										
Grain					4.0		9.2		111.5		144.0		bu
Silage					9.2		16.3		18.7		18.9		ton
Soybeans	5.6		1.1		5.4		0.9		31.7		18.9		bu
Sugarbeets	13.7		10.0		13.1		9.25		19.3		23.4		ton
Alfalfa							5.4				4.39		ton
Other Hay crops					6.4		2.9		2.69		2.03		ton
All vegetables					12.3		8.4						

TABLE II-13.— ANNUAL PRODUCTION OF IRRIGATED AND UNIRRIGATED CROPS IN DEAF SMITH COUNTY, TEXAS (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
IRRIGATED:													
Upland Cotton			5.9		5.2		3.6		420.0		331.0		lb
Wheat	39.7	54.6	60.0	95.0	39.7	35.4	29.0	60.0	45.4	38.2	47.2	41.2	bu
Grain Sorghum			63.0		79.2		58.0		115.1		110.9		bu
UNIRRIGATED:													
Upland Cotton					0.4				170.0				lb
Wheat	29.9	75.4	91.0	106.0	29.9	19.6	42.0	76.0	15.9	9.3	12.2	26.4	bu
Grain Sorghum			16.5		12.4		9.6		18.2		28.1		bu

TABLE II-14.— LAND IN FARMS[a] ACCORDING TO USE IN DEAF SMITH COUNTY, TEXAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	610	252,960	515	234,735
Cropland used only for pasture or grazing	284	56,705	153	23,478
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	67	10,606	73	18,371
Cropland on which all crops failed	152	20,439	97	34,518
Cropland in cultivated summer fallow	443	148,189	449	111,252
Cropland idle	140	31,417	56	6,556
Total cropland	633	520,316	(NA)	428,910
Woodland pastured	3	408	-	-
Woodland not pastured	1	167	1	16
Total woodland	4	575	1	16
Improved pastureland and rangeland	78	32,520	80	8,814
Pastureland and rangeland not improved	261	287,913	(NA)	349,333
Total pastureland and rangeland (other than cropland and woodland pasture)	320	320,433	329	358,147
All other land	416	40,371	483	6,963
Irrigated land	515	235,408	476	218,557
Total pastureland (all types)	456	377,546	(NA)	381,625

[a]Farms with sales of $2500 and over.

TABLE II-15. — AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN DEAF SMITH COUNTY, TEXAS (1972)

Crops	Percent, %
Upland cotton	2.2
Wheat	53.0
Oats	0.4
Barley	0.6
Rye	0.0
Sorghum	27.9
Corn	9.1
Soybeans	0.4
Sugarbeets	3.5
Vegetables	2.9

TABLE II-16.— ANNUAL CROP PRODUCTION IN OLDHAM COUNTY, TEXAS (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
Wheat	40.0	50.0	58.2	53.2	31.6	23.0	21.6	33.2	23.9	10.9	18.2	27.3	bu
Oats	1.6	0.5	0.5	0.5	0.14	0.1	0.2	0.2	10.0	32.0	42.5	48.5	bu
Barley				0.7				0.4				48.0	
Rye	4.3			0.6	0.65				11.2				bu
Sorghum	19.1		12.1										
Grain					14.4		10.6		71.2		79.7		bu
Silage													
Hay					0.37		0.6		1.3		2.3		ton
Other Hay					1.8				2.2				ton

Wheat and sorghum are both produced under dryland and irrigated conditions. Production of these crops are shown in table II-17 under both farming systems. Yields of wheat increased three times or more with irrigation while those of sorghum increased by as much as five times.

Land use in Oldham County for 1964 and 1969 is presented in table II-18. In 1970, about 62 percent of the total cropland was devoted to wheat. This was more than twice as much as the acreage planted to sorghum. Wheat acreage increased to 82.2 percent of total cropland in 1972 and only 17.1 percent was planted to sorghum. The pattern of cropland use appears to have been greatly influenced by the wheat market during recent years (table II-19).

2.2.1.4 Wheat by counties. As in most counties in Texas, wheat in Randall County is also grown under summer fallow and under continuous cropping. Table II-20 shows wheat produced under summer fallow and continuous cropping. Overall, the yields from summer fallow did not show any considerable advantage over continuous cropping. This has been corroborated by Leonard and Martin (1963) for the Panhandle of Texas. In this general location, precipitation during the season seems to be more important than cropping practices in influencing wheat yield under dryland conditions.

In Deaf Smith County, during 1970 and 1972, wheat was grown on 48.5 and 64.8 percent, respectively, of the total area planted to cereal crops. In 1970, less acreage was harvested for wheat than for grain sorghum while in 1972, the acreage harvested for wheat was only slightly more than that for grain sorghum. Areas planted to oats, rye and barley were insignificant.

Wheat is grown also under summer fallow and continuous cropping in Deaf Smith County. Table II-20 shows acreage of wheat on land under summer fallow and on land under continuous cropping. Wheat yield was slightly higher on summer fallow than under continuous cropping. However, in 1973 the difference in yield between the two cropping systems was very small.

TABLE II-17.— ANNUAL PRODUCTION OF IRRIGATED AND UNIRRIGATED CROPS IN OLDHAM COUNTY, TEXAS (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per Hectare				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
IRRIGATED:													
Wheat		7.5	10.2	5.2	8.1	1.7	5.6	4.2	43.3	30.9	38.8	41.2	bu
Grain Sorghum			5.4		8.6		5.3		107.0		127.5		bu
UNIRRIGATED:													
Wheat		42.5	48.0	48.0	23.5	21.3	16.0	29.0	17.1	9.3	11.1	25.3	bu
Grain Sorghum			6.7		5.8		5.3		18.3		31.8		bu

TABLE II-18.— LAND IN FARMS[a] ACCORDING TO USE IN OLDHAM COUNTY, TEXAS

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested Cropland	99	39,149	88	34,989
Cropland used only for pasture or grazing	83	24,556	39	10,752
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	36	9,844	21	10,113
Cropland on which all crops failed	25	6,630	45	11,730
Cropland in cultivated summer fallow	83	36,444	72	22,583
Cropland idle				
Total cropland	117	122,072	(NA)	92,000
Woodland pastured	1	179	--	--
Woodland not pastured	--	--	--	--
Total woodland	1	179	--	--
Improved pastureland and rangeland	21	57,844	7	2,203
Pastureland and rangeland not improved	79	683,795	(NA)	503,281
Total pastureland and rangeland (other than cropland and woodland pasture)	90	741,639	83	505,484
All other land	86	7,565	75	17,751
Irrigated land	52	20,717	41	15,971
Total pastureland (all types)	119	766,374	(NA)	516,236

[a]Farms with sales of $2500 and over.

TABLE II-19. – AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN OLDHAM COUNTY, TEXAS (1972)

Crop	Percent, %
Wheat	82.2
Oats	0.7
Rye	--
Sorghum	17.1

TABLE II-20.– WHEAT PRODUCTION ON IRRIGATED, SUMMER FALLOWED AND CONTINUOUS CROPPED DRYLAND, TEXAS 1973

(1000 ACRES)

County	Fallowed summer, 1972	Fallowed summer, 1973	Irrigated	Continuous cropped dryland
Randall	44	41	35	76
Deaf Smith	35	95	34	72
Oldham	26	5.2	35	76

Winter wheat is the major crop in Oldham County being grown on about three-fourths of the total cropland in the county. The other small grain crops grown in the county are oats and rye whose acreage is insignificant.

The major wheat varieties grown in Oldham County belong to the hard red winter type.

2.2.2 Cropping Systems

With reference to wheat growing, various cropping practices are employed with the primary aim of attaining more favorable moisture condition for crop production. Wheat is either grown continuously, on summer fallow, or in rotation with other crops.

A winter wheat-sorghum-fallow rotation has aided in the stabilization of crop production in the Texas Panhandle where soil is heavy and rainfall is low. A flexible cropping system is needed on the soils of the High Plains used for dryfarmed crops. Wheat and sorghums are the major dryfarmed crops because moisture is low and the growing season is relatively short. Farmers often use a cropping system that provides a fallow period after harvest of a crop so that moisture is stored in the subsoil for use by the next crop. Fallowing is most effective on Pullman clay loam and other droughty soils in the county. Suitable cropping systems that provide fallow are: (1) continuous wheat with occasional fallow; (2) wheat-grain sorghum with occasional fallow; or (3) wheat-fallow-wheat. Stubble-mulch tillage with the aid of sweep is practiced extensively on both dryfarmed and irrigated soils. This practice helps control soil blowing and water erosion by increasing the rate of water intake.

Under irrigation, crop residues (stalks and straw) are left on the surface. Following harvest, the residues are usually gone over with a shredder and tandem disc. This cover is maintained until the seedbed is prepared for pre-irrigation and planting. Furrow irrigation is the method most commonly used. Water is pumped from the irrigation wells into open ditches or underground pipelines. These ditches or pipelines convey the water to the high end of the fields, where it is turned into the furrows. Some of the more sloping areas are leveled and irrigated by the graded-border and graded-furrow methods. Essentially the same cropping systems as those used for dryland can be used under irrigation. On irrigated soils, however, a better soil-improving and fertility program is needed because the crops generally grown are high yielding and quickly deplete the soil of plant nutrients.

The rotation pattern not only considers the beneficial effects of this practice on the farming operation as a whole, but also considers the market situation for each of the crops. The beef market affects the cropping system to a certain extent because small grain crops are utilized for winter grazing. It is a common practice in Texas and other states to graze wheat during the fall as soon as the young plants have been established. If managed properly this does not affect yield performance of the crops, and in some cases can even result in higher production. The extent of winter grazing also depends upon the market situation of the beef industry. If there is a promising outlook for beef, grazing of some of the wheat crops is extended and is not harvested for grain. Grazing time usually covers the period from October to April. In case of unfavorable weather in the spring, particularly under drought situations, and eventual crop failure, the wheat crop is grazed completely and/or plowed under and the land prepared for a fall crop such as sorghum rather than risk failure of a grain crop. Crop damage may also result from severe frost.

Table II-21 represents the number of farms and acres harvested on the test sites. The number of fields, average size and ranges of field sizes are shown in table II-22.

2.2.3 Cropping Calendars

Table II-23 and II-24 present cropping calendars for the various crops that are grown in the northern High Plains. In the absence of information on crops that are exclusively grown in the test site, the calendar is provided on the crop reporting district level. There is a wide range in planting dates because this operation is mainly dependent upon soil moisture. However, the average peak of operation (10 to 95 percent) lies very closely within the same period for a

TABLE II-21. — NUMBER OF FARMS AND ACRES HARVESTED IN THE INTENSIVE TEST SITES (COUNTY DATA) 1969

County	Number of farms	Total acres harvested
Randall	486	142,409
Deaf Smith	639	254,304
Oldham	107	39,665

TABLE II-22. — NUMBER, AVERAGE SIZE, AND RANGES OF FIELDS WITHIN THE TEXAS TEST SITES

County	Test site size, miles	No. of fields	Avg. field size, acres	Range in field size, acres
Randall	3x3	90-105	60	5-320
Deaf Smith	3x3	160-175	35	7.5-160
Oldham	3x3	55-65	105	10-320

given crop. In some cases, seeding is delayed because of army worm infestation during September and October.

Under normal conditions, most of the wheat is seeded in September and is established by late October to early November. Depending upon winter conditions, the plants may come out of the dormant stage in late February based on the cropping calendar presented in table II-23. See table II-24 for additional crop calendar information.

Extremes of sowing average from August 15 to November 15 and vary according to the availability of soil moisture. Harvesting is usually completed by the middle of July.

2.2.4 Wheat Varieties

Adapted wheat varieties are selected for certain areas which will produce grain quality demanded by the trade. These varieties are given in table II-25 to show the distribution of these varieties within the test site counties.

TABLE II-23.– CROPPING CALENDARS FOR THE PRINCIPAL CROPS GROWN IN THE NORTHERN HIGH PLAINS DISTRICT OF TEXAS.

Crop	Seedbed preparation			Full coverage			Heading			Post-harvest operation		
	Start	Mid-Pt.	End	Start	Mid-Pt.	End	Start	Mid-Pt.	End	Start	Mid-Pt.	End
Winter Wheat	July 31	Aug. 15	Oct. 15	Feb. 15	Mar. 15	Apr. 15	Apr. 5	Apr. 25	May 15	June 15	June 30	July 31
Barley	July 31	Aug. 15	Oct. 15	Feb. 15	Mar. 15	Apr. 15	Apr. 5	Apr. 30	June 1	June 15	June 30	July 31
Oats	July 31	Aug. 20	Oct. 1	Mar. 1	Apr. 1	May 1	Apr. 1	Apr. 25	May 10	June 1	June 30	July 31
Rye	July 31	Aug. 15	Oct. 15	Feb. 15	Mar. 15	Apr. 15	Apr. 5	Apr. 30	June 1	June 15	June 30	July 31
Grain Sorghum	Mar. 15	Apr. 30	May 31	June 20	July 20	Aug. 15	July 31	Aug. 20	Sept. 15	Sept. 15	Oct 25	Dec. 1

TABLE II-24.— TEXAS: USUAL PLANTING AND HARVESTING DATES BY CROPS

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Broomcorn	Mar. 1-Apr. 15	June 25	July 1-July 15	July 30
Corn:				
Grain	Mar. 1-May 30	July 20	Sept.25-Oct. 10	Nov. 1
Silage	Mar. 1-May 30	July 5	July 20-Sept. 5	Sept. 30
Forage	Mar. 1-May 30	July 5	July 20-Sept. 5	Sept. 30
Cotton	Mar. 5-June 20	Aug. 1	Nov. 1-Dec. 1	Dec. 20
Flaxseed	Nov. 5-Dec. 5	May 1	May 15-May 25	June 5
Hay:				
Alfalfa		Apr. 15		Sept. 20
Other		May 10		Sept. 25
Peanuts for nuts	Mar. 31-July 20	Aug. 15	Oct. 15-Nov. 15	Dec. 15
Popcorn	Mar. 15-Apr. 15	July 15	July 20-Aug. 1	Aug. 15
Rice	Mar. 20-June 5	July 30	Aug. 20-Sept. 1	Nov. 10
Sorghum:				
Silage	Mar. 1-July 1	June 15	June 30-Sept. 1	Sept. 30
Soybeans	May 1-July 15	Oct. 1	Oct. 25-Nov. 5	Nov. 30
Sugarbeets	Mar. 15-Apr. 20	Oct. 1	Oct. 15-Nov. 15	Dec. 10
SEED CROPS:				
Alfalfa		Aug. 15	Aug. 20-Sept. 1	Sept. 15
Sweetclover		July 1	July 10-July 20	July 30
Hairy vetch		June 1	June 5-June 20	June 30

TABLE II-25.– DISTRIBUTION OF WINTER WHEAT VARIETIES BY PERCENT

County \ Variety	Tascosa	Concho	Sturdy	Triumph	Wichita	Others[a]
Randall	12.1	14.4	6.2	9.0	19.3	39.0
Deaf Smith	38.3	29.4	14.9	5.4	--	12
Oldham	12	75	4.2	--	--	8.8

[a]Includes varieties reported less than 0.1 percent of the total acreage planted.

INTENSIVE TEST SITE ASSESSMENT REPORT

NORTH DAKOTA

SECTION THREE

CONTENTS

TABLES

Figures

Figure | Page

3.0 NORTH DAKOTA INTENSIVE TEST SITES

3.1 REGIONAL DESCRIPTION

Three Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the state of North Dakota. These test sites are located in Burke, Divide and Williams Counties.

TABLE III-1. – COUNTY SIZE AND LOCATION OF THE LACIE INTENSIVE TEST SITES IN NORTH DAKOTA

County	Sq. miles	Total acres	N. Lat.	W. Long.	Test site size, miles
Burke	1,118.7	715,968	48° 53.2'	102° 10.0'	5x6
Divide	1,299.7	831,808	48° 53.6'	103° 10.9'	2x10
Williams	2,064.2	1,321,088	48° 19.2'	103° 24.7'	5x6

The test sites in Divide, Burke, and Williams counties are all in the northwestern crop reporting district of North Dakota and are representative of the cool temperate semiarid areas of the northern Great Plains where annual precipitation averages 14 to 16 inches (fig. 3-1).

3.1.1 Location

The Burke County test site is located to the west of upper Des Lacs Lake, about 6 miles west of Renville County line and about 4 miles north of the Ward County line. The altitude for the area in the test site is about 1900 feet.

The test site for Divide County is located in the northeast part of the county about 8 miles west of the Burke County line and about 4 miles south of the Saskatchewan Province, Canadian border, with an altitude of about 1900 feet.

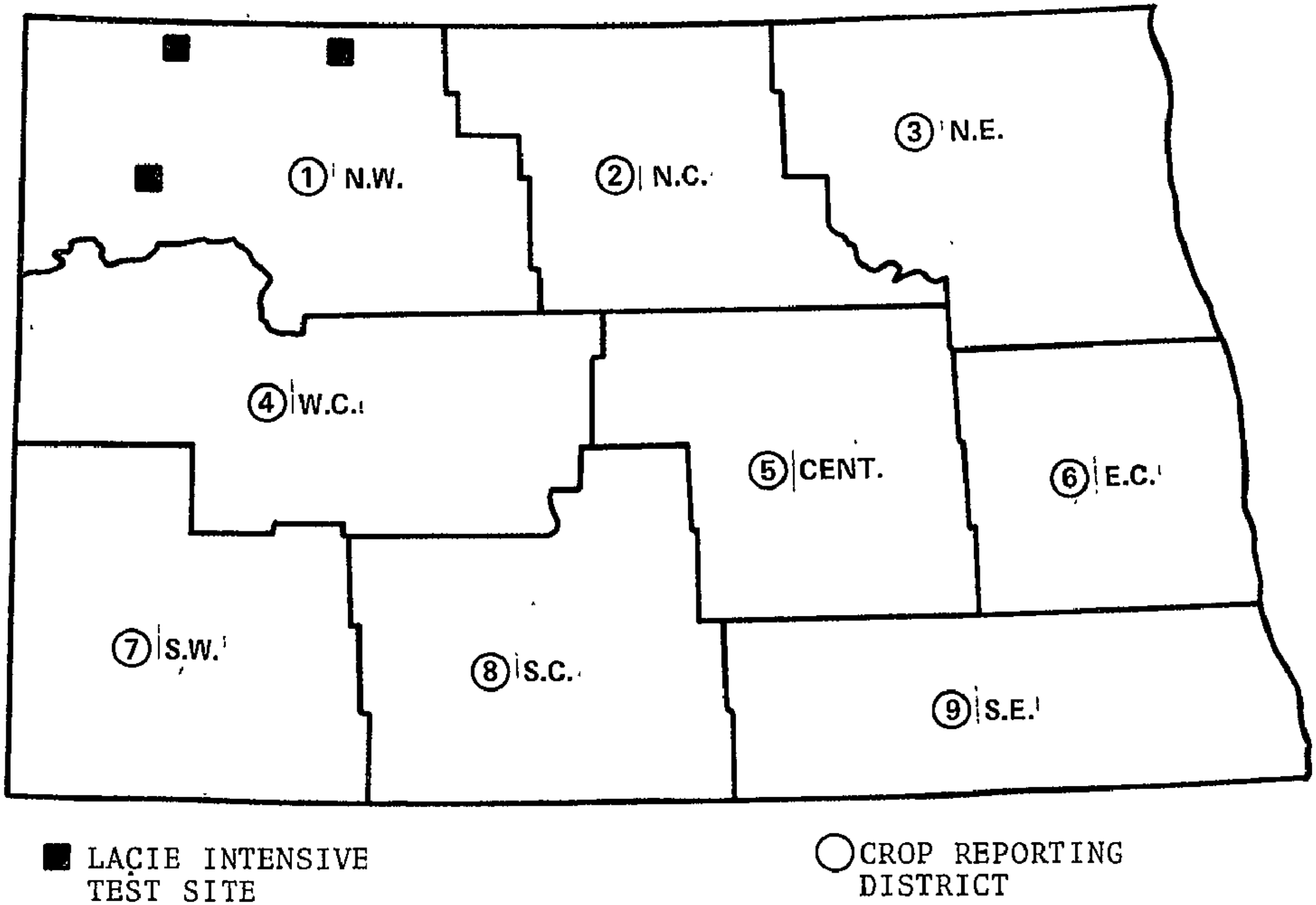


Figure 3-1. — Locations of the three Intensive Test Sites in North Dakota.

The Williams County test site is located about 11 miles east of the Little Muddy Creek in approximately the center of Williams County at an altitude of about 2300 feet.

3.1.2 Physiography

3.1.2.1 Burke County. Burke County lies partially in the Missouri Coteau, which is located in south of a line running through the county from the Northwest corner to the southeast corner in the till plain of the Drift Prairie, with the Intensive Test Site in the till plain of the Drift Prairie. The general slope of the Drift Prairie is to the south and east, with an undulating to steep surface.

Stream systems are poorly developed in the Drift Prairie; most of the runoff drains into the numerous closed depressions where it percolates to a ground water table or evaporates. Most of the existing streams occupy channels which carried water from the melting glaciers. Des Lacs, one of these streams, occupies a large, glacial meltwater valley and is grossly underfit in relation to the size of the valley into which it flows.

The cutting of deep, steep-sided coulees back from the glacial stream valleys is the principal development of drainage in the 10-12 thousand years since the last glaciation. The valleys of the post-glacial period have been modified by the deposition of alluvium, the meandering of the present streams on the wide valley bottoms, and the deposition of alluvial fans at the coulee mouths.

The till plain is an undulating plain with low rounded knolls, numerous closed depressions, and a few widely spaced streams with the dominant relief less than 25 feet.

3.1.2.2 Divide County. Two-thirds of Divide County consists of the plateau known as the Couteau du Missouri on the eastern edge of the Missouri Plateau. The surface is gently rolling, irregular, and dotted with old lake beds, intermittent lakes, and numerous permanent small lakes that are a result of glaciation of this region of the United States. In southwestern Divide County there are sandy, gravelly outwash areas.

The other one-third of Divide County in the northeastern section where the Intensive Test Site is located, is part of the till plain of the Drift Prairie. (See physiography pertaining to the till plain of the Drift Prairie under Burke County.)

3.1.2.3 Williams County. The major portion of Williams County lies in the glaciated area of the Missouri Plateau with a drift mantle and an undulating to steep surface.

Stream drainage in the area east of the Missouri River is weakly developed. The Little Muddy Creek, a very small stream, is the tributary in Williams County extending 40-60 miles north of the Missouri River. There are few other tributaries. The area between the headwaters of the tributaries of the Missouri and the eastern edge of the plateau is without a system of stream channels. Except for the slope at the eastern edge, all runoff within the area collects in numerous closed depressions and small lakes.

Drainage of this area was greatly altered by glaciation. Prior to glaciation, the Missouri River flowed northeast through Divide County and the Yellowstone River, which is now the southern boundary of Williams County, flowed north through the present valley of Little Muddy Creek. With their northward flow blocked by the ice sheet, these rivers were diverted to the south and east.

Much of Williams County is mantled with glacial drift. This region between the Missouri River and the Missouri Coteau, of which Williams County is a part, is an undulating to rolling plain which has been called the Missouri Slope. In northern Williams County and along the Little Muddy Creek there are sandy and gravelly outwash areas. These were deposited near the base of the westward slopes of the Missouri Coteau by glacial meltwaters flowing toward the Missouri River.

3.1.3 Climate

The climate of North Dakota is typically continental with long cold winters, short warm summers, large diurnal ranges in temperature, frequent strong winds, and limited, as well as uncertain and highly variable, precipitation.

The region experiences large fluctuations in climate as a result of successive inundations by moist, dry, cold, and hot air masses. Sudden temperature changes, extreme cold, severe gales, driving snows and blizzards in the winter and thunderstorms at other seasons of the year, are fairly common. Tornadoes are rare. In the summer there are long spells of hot, dry weather with southerly winds. Irregular weather changes are very frequent; the winter cold is often tempered by warm "chinook" winds.

The fluctuations of the climate create serious climatic risks for agriculture. The uncertainity of precipitation, the ever-present danger of drought, temperature extremes, unseasonal frosts (which may affect the length of the growing season), and high wind velocities are among the major crop hazards of the northern Great Plains.

In spring and autumn, an advance of polar air may cause killing frost, resulting in great crop damage. Equally serious is the hazard presented by the hot, dry winds of summer which are, at times, experienced in all parts of the Great Plains. The hazards of frost, hot winds, and hail are great. Hail storms are common during the summer.

In some years, the amount and seasonal distribution of precipitation is entirely adequate for successful agriculture. In other years, the precipitation is too meager for crop production.

The normally high winds and recurring droughts are a constant threat to this region because they bring the possibility of crop failures, dust storms, and land damages by wind erosion. The drought hazard is greatest in winter and least in late spring and early summer. Drought periods of 35 or more consecutive days may be expected annually and a drought period has occasionally lasted for as long as 90 days.

3.1.3.1 <u>Burke County</u>. A detailed climatic description is not available. However, it can be assumed that the climate is similar to Williams County because of its location. Burke County has a semiarid continental climate with an average annual rainfall of about 15 inches. However, this amount fluctuates from year to year. A summary of climatic data for Portal, a city about 20 miles northwest of the test site, is shown in table III-2.

TABLE III-2. – AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT PORTAL, BURKE COUNTY, NORTH DAKOTA

Month	Temperature average, °F	Precipitation average, inches
December	11.8	.44
January	4.1	.43
February	8.2	.44
Winter	8.0	1.31
March	19.4	.67
April	39.5	.83
May	52.7	1.88
Spring	37.2	3.38
June	60.7	3.78
July	68.2	2.10
August	65.3	2.27
Summer	64.7	8.15
September	55.1	1.24
October	43.3	.75
November	24.5	.47
Fall	40.9	2.46
Year	37.7	15.30

[a]Averages for period 1931-1960.

Maximum rainfall occurs in the months of June, July, and August and 79 percent of the average annual rainfall occurs in the period from April through September.

For Bowbells, a station about 8 miles southwest of the test site, the average latest freezing temperature in spring occurs at the end of April and the earliest in autumn occurs in mid-September. Between the last occurrence of a 28° F temperature in spring and the first occurrence in fall, the average number of days is 131. April 30 is the average date of the last 32° F temperature in spring. The average date of the first freeze in fall is September 10. Other climatic data are not available.

3.1.3.2 Divide County. A detailed climatic description is not available for Divide County. However, because of its location, it can be assumed that the climate for all three counties is similar. The average annual precipitation ranges from 13.75 inches to 15.30 inches and the average annual temperature ranges from 37.7° to 41.3°. The average precipitation and temperature are presented in table III-3 for Crosby, a city 5 miles from the test site.

3.1.3.3 Williams County. All climatic data is for Williston, North Dakota where the meteorological station is located. The climate at Williston is similar to that of the test site area.

Owing partly to the distance from large bodies of water and partly to the barrier imposed by the Rocky Mountains to the west, Williston is semiarid; the average annual rainfall is about 14 inches. Table III-4 shows the average rainfall and temperature data for Williston, North Dakota, located about 18 miles southwest of the test site.

The amount of rain occurring during the growing period is the most important climatic element for agricultural interest in the vicinity of Williston. Generally, considerably more precipitation occurs in the spring and summer months than in winter, (only about one-half inch of monthly precipitation occurs from November to February) but the rainfall is just adequate for successful farming operations in normal years. Summer precipitation is in the form of thunderstorms. In the winter, cold waves and occasional blizzard conditions occur. Cold waves result when extremely

TABLE III-3. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT CROSBY, DIVIDE COUNTY, NORTH DAKOTA

Month	Temperature average, °F	Precipitation average, inches
December	13.8	.41
January	6.0	.36
February	10.3	.34
Winter	10.0	1.11
March	21.5	.62
April	39.7	.79
May	52.9	1.64
Spring	38.0	3.00
June	60.7	3.29
July	68.5	2.13
August	65.7	1.85
Summer	64.9	7.27
September	55.0	1.09
October	44.0	.83
November	25.8	.40
Fall	41.6	2.30
Year	38.7	13.75

[a]Averages for period 1931-1955.

TABLE III-4. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT WILLISTON, WILLIAMS COUNTY, NORTH DAKOTA

Month	Temperature average, °F	Precipitation average, inches
December	15.7	.54
January	10.0	.49
February	13.5	.46
Winter	13.0	1.40
March	26.5	.75
April	42.9	1.07
May	54.6	1.66
Spring	41.3	3.40
June	63.0	3.59
July	70.9	2.13
August	68.1	1.41
Summer	67.3	7.10
September	57.2	1.21
October	45.5	.77
November	28.3	.58
Fall	43.6	2.50
Year	41.3	14.66

[a]Averages for period 1921-1950.

cold air advances southward from northwestern Canada. In blizzard conditions, the advancing cold wave is accompanied by winds of gale force and the air is filled with fine, wind-driven snow. There is considerably less than an average amount of snowfall here for such places so far north in the United States. Although snow has been observed every month, except July and August, there is usually very little after April and until November. Accumulated winter snow remains unmelted on the ground until about March. The average annual snowfall is 36 inches. Ice crystals, which rarely yield more than a trace of precipitation, are common in the cold months. Great temperature extremes are encountered such as cold winters and warm summer days. In winter, temperatures below zero are common and a low of -50° has been recorded. When temperatures are lowest, with dry air and little or no wind, the weather is fine and invigorating. At the other extreme, temperatures of about 100° with low humidity have been reached in all months from May to September. July has the highest daily maximum temperature. The area receives about 61 percent of possible sunshine.

The average speed of the wind is fairly high, averaging 10.1 miles per hour, because the land surface offers little resistance. The prevailing winds are usually southeasterly from April through July, and southwesterly from August through December, with winds in January, February and March being westerly, northeasterly, and northwesterly respectively.

Humidity averages about 81 percent at 6:00 a.m. and only about 55 percent at 6:00 p.m.

The growing season averages 131 days, but it has ranged from 94 to 172 days. On the average, the latest freezing temperature in spring occurs in mid-May and the earliest in autumn occurs in late September. Between the last occurrence of a 28° F temperature in spring and the first occurrence in fall, the average number of days is 151. April 14 is the average date of the last 32° F temperature in spring. The average date of the first freeze in fall is September 23. These average dates will vary locally within the county.

3.1.4 Soils

The Intensive Test Sites located in Divide and Burke counties are on soils in the order Mollisol. The Intensive Test Site located in Williams County is on soils of the Mollisol and Entisol orders that result from alluvial-type soil formations. The Mollisol soil has nearly black friable, organic, rich surface horizons high in bases and is formed mostly in subhumid and semiarid warm to cold climates. The soil order Entisol, found in the southern third of Williams County, has no pedogenic horizons. (See table III-5 and figs. 3-2, 3-3, and 3-4 for a description of the soil types found in the three counties of interest.)

Soil map transparencies are available at a scale of approximately 1:24,000. These transparencies can be used to overlay the test site or USDA/ASCS 1:24,000 black and white photography. These transparencies were reduced to fit the 8½- by 11-inch format of this report.

3.1.4.1 Burke County. Burke County soils are of the Mollisol order, Boroll suborder, and Argiboroll plus Haploboroll great groups. (See fig. 3-5 for soils of Intensive Test Sites.)

Williams Association

This association occurs on undulating to rolling landscapes west of the Missouri Coteau on both sides of the Missouri River. Surface drainage is partially developed and considerable surface runoff drains into the depressions. Slopes are complex and range from 2 to 12 percent with the most common range from 2 to 8 percent.

The Williams soils occur on the well-drained plane and convex side slopes and broad, slightly convex crests of knolls and ridges. The Williams soils are well-drained Chestnut soils developed from calcareous, loam glacial till. Surface soil colors are very dark brown to very dark grayish brown. They have a granular structure, are very friable, and have an A1 layer 3 to 6 inches thick.

Other soils in the association are the Bowbells, Zahl, Tetonka, and Oahe. Tetonka soils are in the shallow depressions, Oahe are medium textured, well-drained soils with a gravel substratum at moderate depth. They occur on

TABLE III-5. — DESCRIPTIONS OF THE THREE

NORTH DAKOTA COUNTY SOILS

Classification	Description
ENTISOLS	Soils that have no pedogenic horizons.
Orthent	Loamy or clayey Entisols that have regular decrease in organic matter content with depth.
Ustorthent (formerly Regosols)	Orthents that are intermittently dry for long periods during the warm season of the year.
E5-3	Ustorthents plus Haploborolls, moderately sloping or steep.
MOLLISOLS	
Boroll	Mollisols of cool and cold regions. Most Borolls have a black horizon.
Arigiboroll (formerly Chernozems)	Borolls of cool regions. They have a subsurface horizon in which clay has accumulated.
Haploboroll (formerly Chernozems)	Borolls of cool regions. They have no horizon of clay accumulation.
M3-4	Argiborolls plus Haploborolls, gently sloping.
M3-8	Argiborolls plus Natriborolls and Haploborolls, gently sloping.
M5-3	Haploborolls plus Argiborolls, moderately sloping.

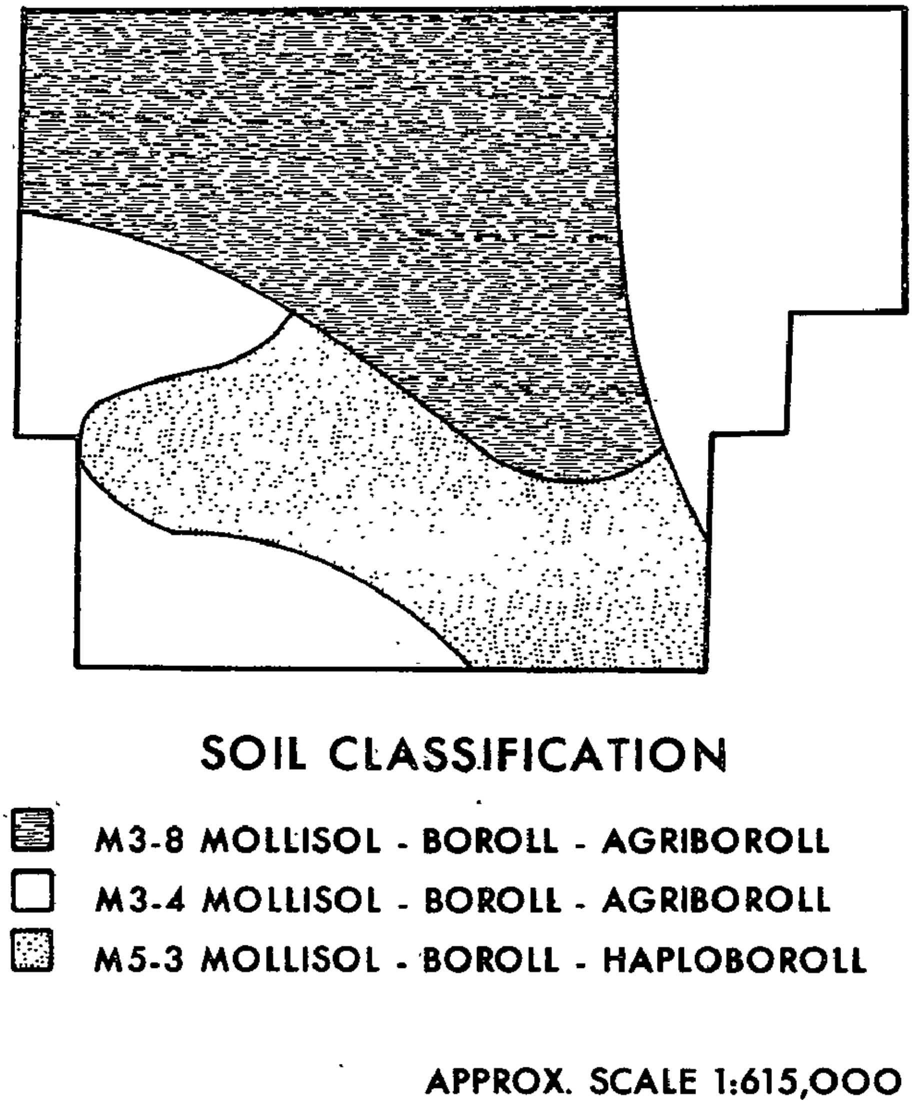


Figure 3-2. — Soil classification map of Burke County, North Dakota

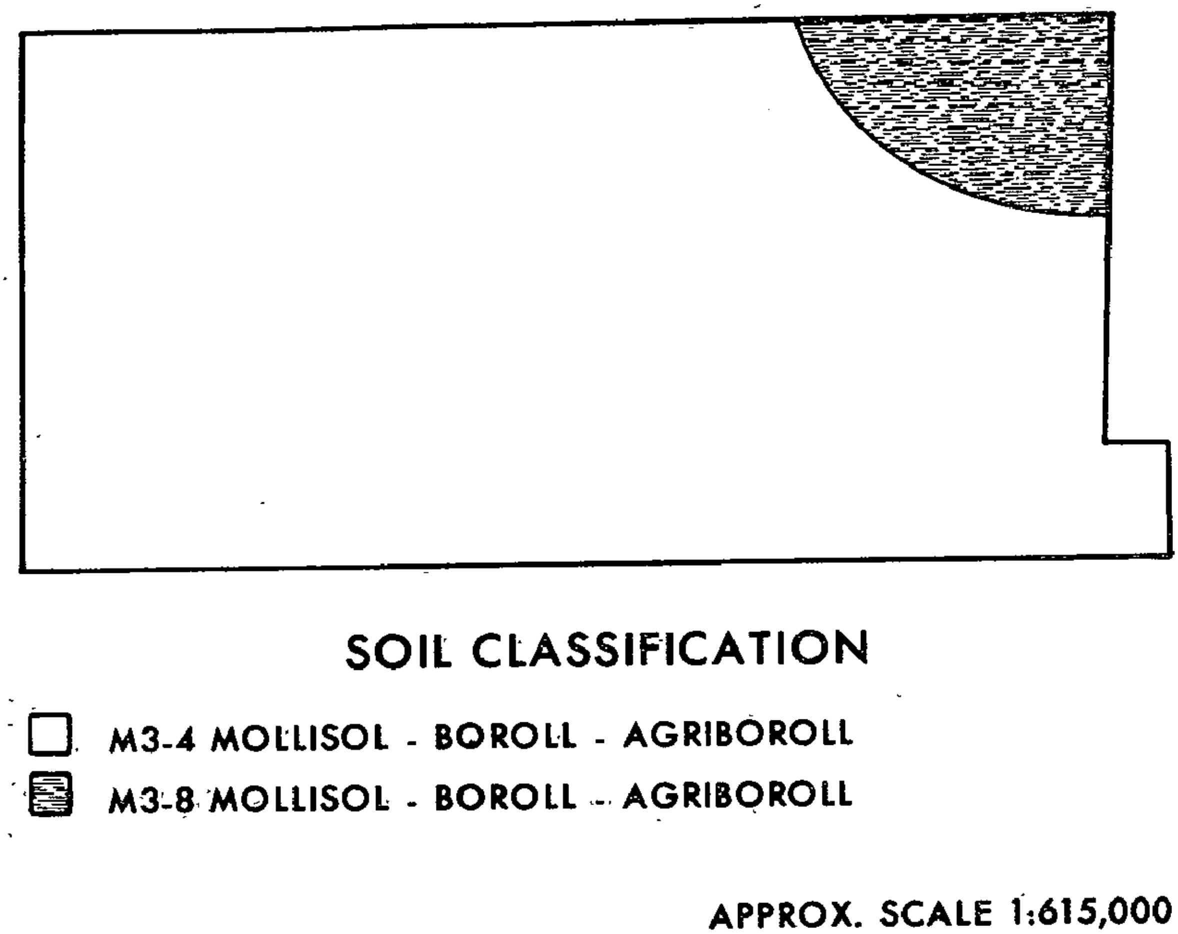
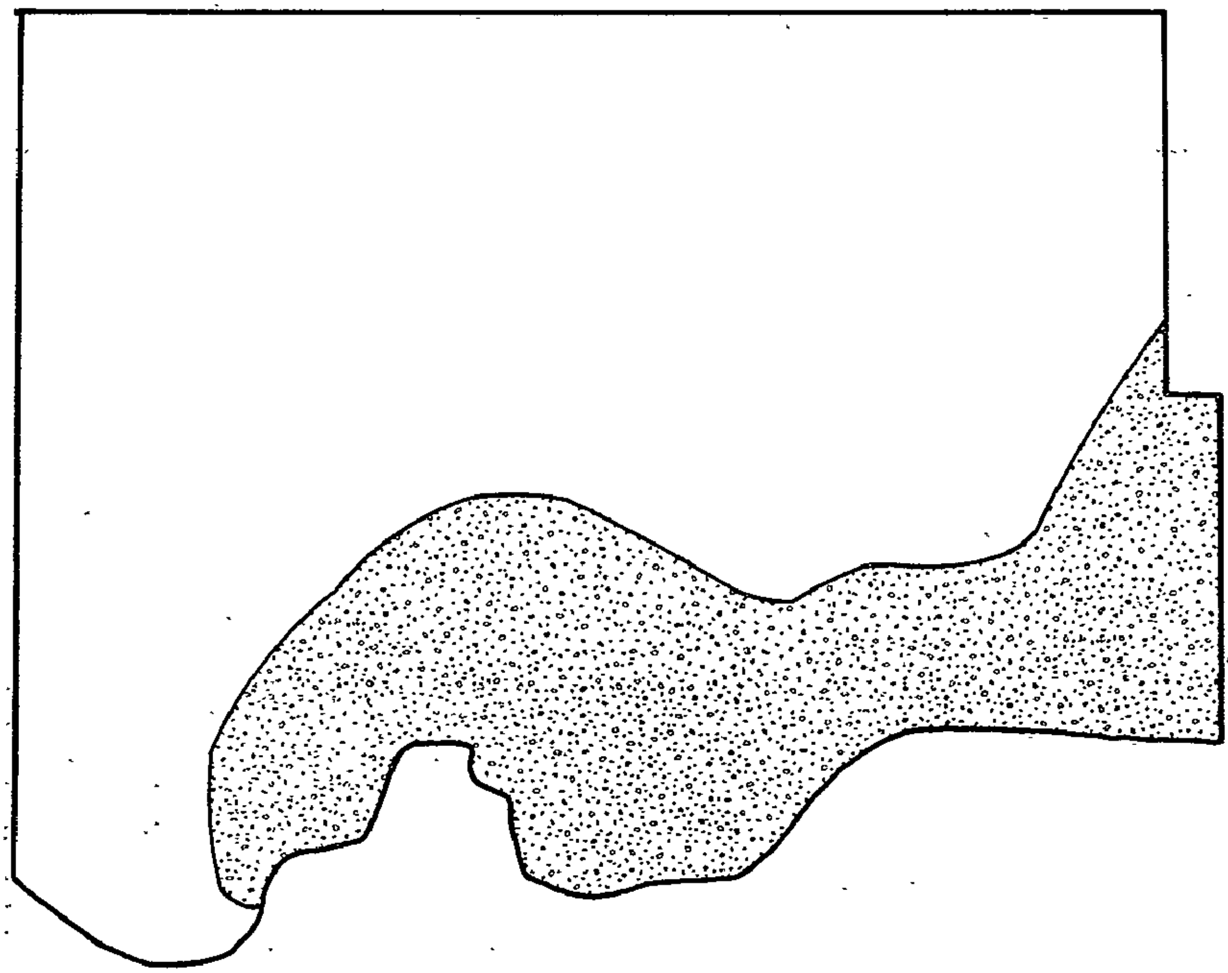


Figure 3-3. — Soil classification map of Divide County, North Dakota.



SOIL CLASSIFICATION

- ☐ M3-4 MOLLISOL - BOROLL - AGRIBOROLL
- ⛆ E5-3 ENTISOL - ORTHENT - TORRIORTHENT

APPROX. SCALE 1:615,000

Figure 3-4. — Soil classification map of Williams County, North Dakota

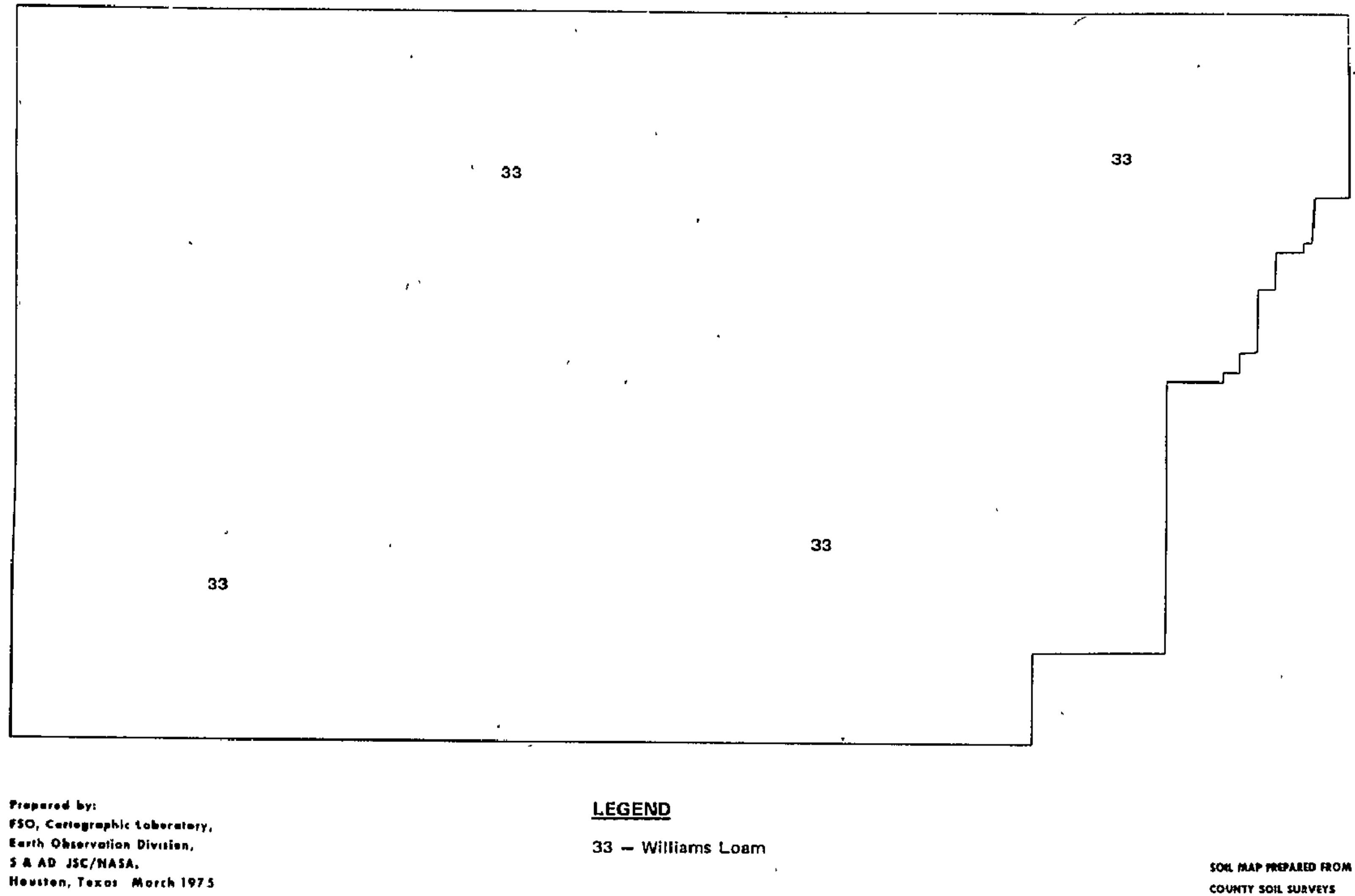


Figure 3-5. – Burke County, North Dakota LACIE Intensive Test Site soil classification map.

small areas of outwash and stream terraces. Zahl soils are on the steeper, convex crests of knolls and ridges. They have a thick, very dark gray surface layer and a very dark grayish-brown subsoil. The soils are very productive.

The dominant land use is cropland.' Moderate susceptibility to water erosion is the principal limitation.

3.1.4.2 Divide County. Divide County soils are of the Mollisol order, Boroll suborder, and Argiborolls great group. The test site has three soil types. (See fig. 3-6 for soils of the Intensive Test Site.)

Cresbard — Cavour Association

This association occurs on nearly level to gently undulating till plain. Drainage is weakly developed adjacent to streams with depressions common in other parts of the areas. Slopes are usually less than 3 percent. Cresbard soils are imperfectly drained. They have a moderately thick black A1 horizon, a gray A2 horizon, and a clay loam B2 horizon with prismatic and strong blocky soil structure. They are in nearly level to gently sloping positions. Cavour soils occur on the lower, level areas and in complex with the Cresbard on the gentle slopes. They have thin A1 and A2 horizons and a dense, dispersed B2 horizon with strong columnar structure. The B2 horizon is very slowly permeable. Cavour soils are formed from calcareous loam glacial till. They are a very dark gray loam with moderate granular structure, friable and neutral, with an A1 layer 4 to 8 inches thick.

Tetonka soils occupy the shallow depressions. Svea soils are also in this unit on the concave side slopes and foot slopes of low knolls.

These soils are used for cropland and pasture. Areas dominated by the Cavour soils are usually pastures. Wetness and intermittent ponding hinder farming operations. Cavour soils have poor tilth when cultivated.

Williams — Cresbard Association

The Williams — Cresbard Association has a landscape of low relief with gentle convex slopes and common shallow depressions. Weakly entrenched intermittent streams cross the area but most of the surface runoff flows into depressions.

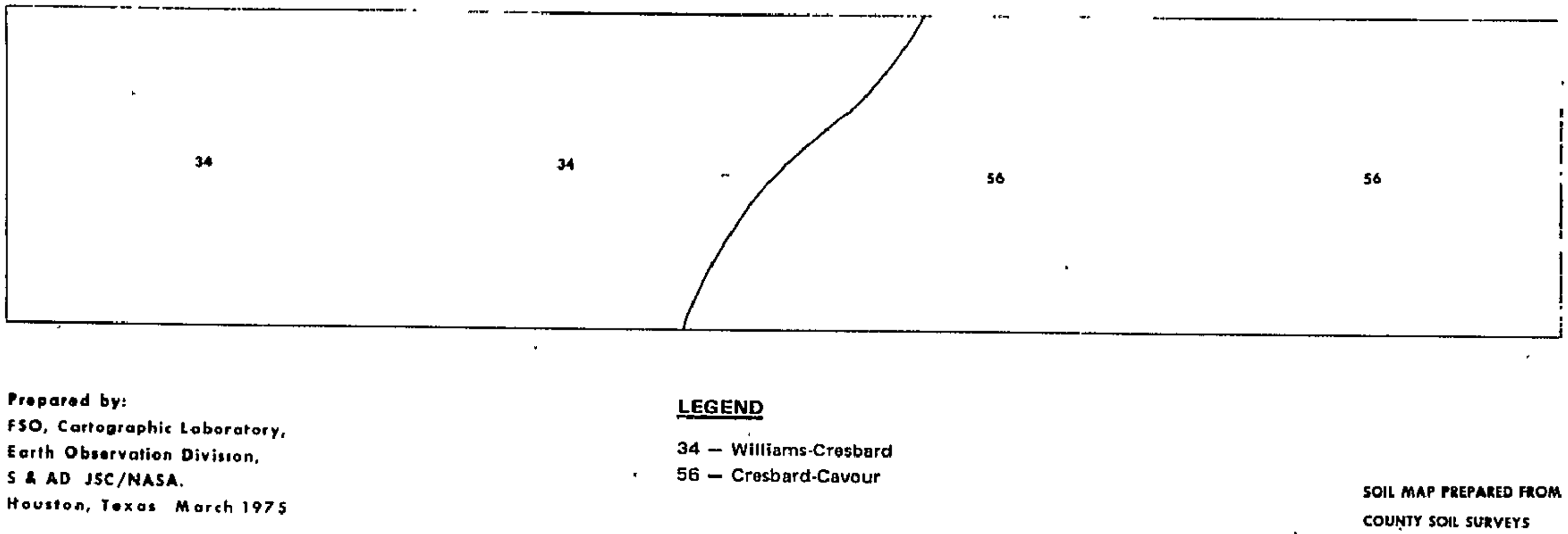


Figure 3-6. — Divide County, North Dakota LACIE Intensive Test Site soil classification map.

The Williams soils occur on the well-drained convex and plane slopes of the low knolls and ridges. Williams soils have loam surface layers and clay loam subsoils. The Cresbard soils are dominant on the plane and slightly concave positions between the knolls. They have friable loam A1 and A2 horizons and a clay loam B horizon with strong, blocky structure.

Other soils in the area are the Tetonka, Cavour, and Oahe. The poorly-drained Tetonka soils are in the depressions. The poorly-drained Cavour has a dense, very slowly permeable B horizon that disperses and crusts when brought to the surface by tillage. The Oahe soils are on the terraces of the intermittent streams. They are well-drained and have a gravel substratum at moderate depths.

The principal land use of this association is cropland. Ponding of the Tetonka soils and the poor tilth of the Cavour soils are the main limitations.

Williams – Zahl Association

This association occurs on rolling to hilly topography with numerous depressions. Surface drainage is poorly developed. Much of the runoff flows into depressions. Slopes range from 0 to 15 percent with dominant slopes of 6 to 12 percent.

The Williams soils are on well-drained plane and convex side slopes of knolls and ridges. They also occur on the gently sloping convex, crests of broadtopped knolls and ridges. The Zahl soils are on the convex crests and the steep upper side slopes of hills and ridges. The Zahl soils are excessively-drained Regosols developed from calcareous loam glacial till. They are very dark brown loam with moderate granular structure, friable, and slightly calcareous with an A1 layer 4 to 8 inches thick.

Other soils in the association are the Oahe, Sioux, and Parshall. They are on nearly level to undulating local outwash areas. Oahe soils are medium and moderately coarse textured. They are well-drained Chestnut soils developed from medium and moderately coarse textured outwash 12 to 30 inches thick over gravel and coarse sand. The excessively-drained Sioux soils are black in color, developed from medium to moderately coarse textured outwash, and underlain by gravel and coarse sand at shallow depth. Parshall soils are well-drained, very dark brown sandy loams. Tetonka soils are very dark gray to black silt loam found in shallow, intermittently ponded depressions. They are poorly-drained Planosols formed from local alluvium less than 20 inches thick, underlain by calcareous loam glacial till. The soils are used as pasture and cropland, depending upon the slope. Pasture is the dominant land use on slopes steeper than 9 percent. Moderate susceptibility to water erosion is the main limitation in this association. Oahe soils have limited water-holding capacity and are somewhat dry. Parshall soils are susceptible to wind erosion.

3.1.4.3 Williams County. In the northern part of Williams County, soils are of the Mollisol order, Boroll suborder, and Argiboroll great group, and the Entisol order, Orthent suborder and Torriorthent great group. The test site has two soil types. (See fig. 3-7 for Intensive Test Site soils.)

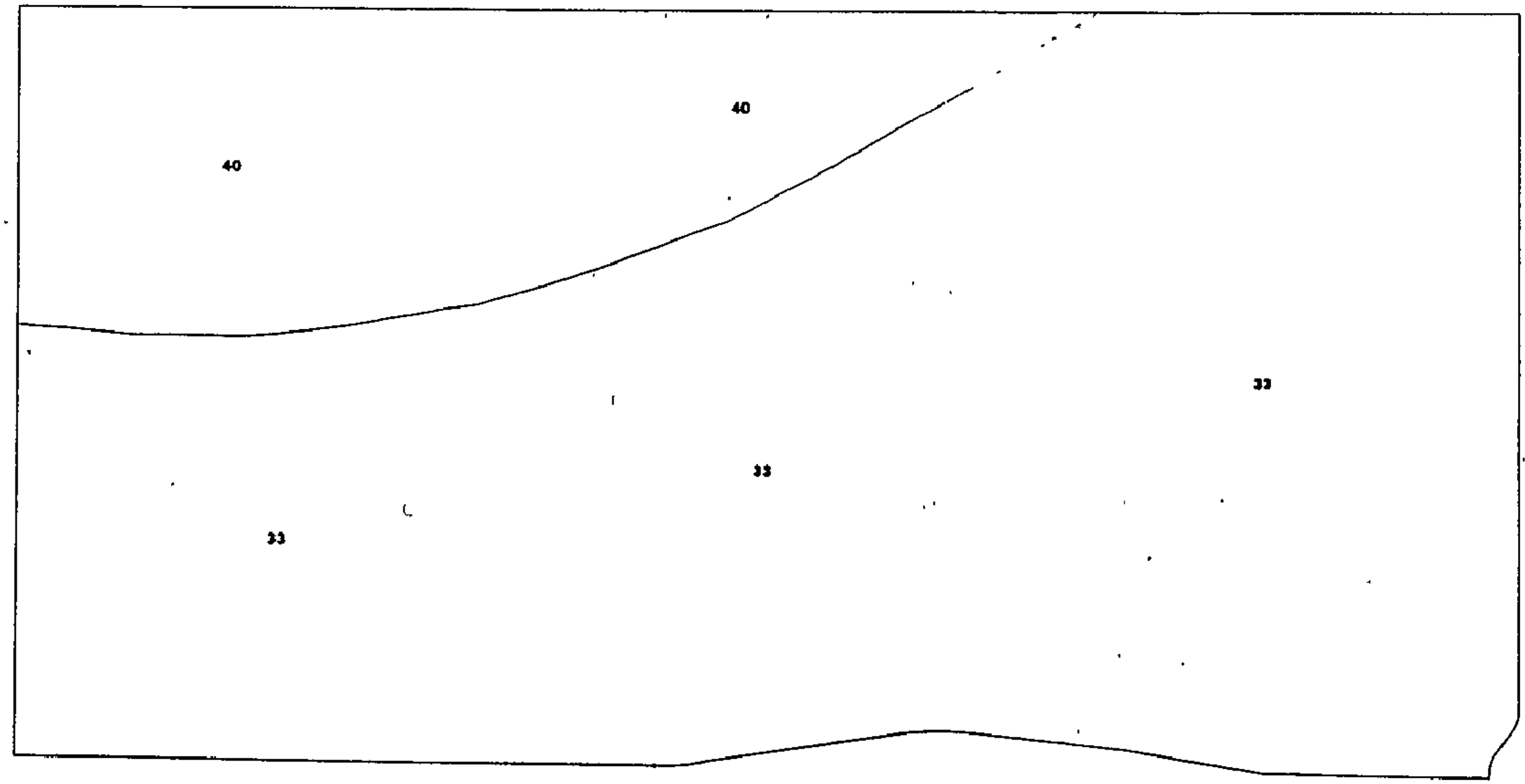
Williams Association

See soils - Burke County.

Williams — Zahl Association

See soils - Divide County.

A more detailed breakdown of the soils in the Intensive Test Sites is not available at this time because soil surveys for Burke, Williams, and Divide counties are not available.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

LEGEND

33 — Williams Loam
40 — Williams-Zahl Loam

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 3-7. — Williams County, North Dakota LACIE Intensive Test Site soil classification map.

3.2 PRINCIPAL CROP PRODUCTION

3.2.1 State

The principal crops in North Dakota are wheat, barley, oats, rye, flaxseed and alfalfa. The state is part of the major hard red spring and durum wheat region of the United States. In 1972, North Dakota ranked first in durum wheat and other spring wheat production. Spring wheat accounts for about 50 percent of the cash value of North Dakota crops.

Other crops produced include corn for grain, sugar beets, potatoes, soybeans, dry edible beans, sunflowers and millet for grain. The major portion of wheat is grown in the northwest, west-central and eastern parts of North Dakota. The major barley producing counties are in the eastern part of the state. Oats are distributed over the state with the main areas of production in the north-central and southeastern parts of the state.

3.2.1.1 Burke County. Wheat is the leading crop in the county with barley, oats, alfalfa, flaxseed, and rye being principal crops. In recent years there has been a small amount of corn grown but this acreage has been steadily decreasing. The major change in crop acreage has been a decrease in flaxseed and rye acreage, and an increase in wheat acreage. In 1972, 73.5 percent of grain crop acreage was in wheat. This includes both durum and other varieties of spring wheat. There are no farms reporting irrigated wheat acreages.

Wheat crop acreage is divided between hard red spring wheat and durum wheat with about three-fourths of the acreage in hard red spring wheat. Winter wheat is also grown but the acreage is negligible in Burke County (table III-6).

Wheat in Burke County is grown on summer fallow and continuous cropping. Under summer fallow, there is a considerable increase in yield per acre. Continuous cropping acreage is very slight compared to summer fallow.

The soils in the test site of Burke County are used dominantly for cropland. They are very productive, with the principal limitation being that they are moderately susceptible to water erosion. Cultivation is limited by the variability of rainfall (see table III-7).

TABLE III-6. — ANNUAL CROP PRODUCTION IN BURKE COUNTY (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
All Wheat	136.4	186.1	154.0	191.0	134.3	181.1	152.5	188.5	24.6	32.0	30.4	30.4	bu
Spring Wheat	114.0	143.0	112.0	124.0	112.5	139.0	111.0	123.0	23.5	31.5	27.5	29.5	bu
Durum Wheat	22.3	43.0	42.0	67.0	21.8	42.0	41.5	65.5	30.5	33.5	29.5	32.0	bu
Winter Wheat	100.0	100.0			0	100.0			0	25.0			bu
Barley	18.5	18.5	24.0	22.0	18.0	18.0	23.5	21.0	38.0	41.0	36.0	40.0	bu
Oats	39.0	15.0	20.0	18.0	38.0	14.0	18.0	17.0	54.0	54.0	53.5	53.0	bu
Rye	5.0	3.0	1.5	1.2	4.5	3.0	1.5	1.1	29.0	28.0	28.0	27.0	bu
Flaxseed	11.5	4.0	2.0	4.5	10.0	3.5	2.0	4.5	11.5	9.0	13.0	13.0	bu
Potatoes	0.04	0.04			0.4	0.4			70.0	60.0			cwt
All Hay					41.0	38.0	29.0	37.0	1.19	1.26	1.26	1.32	tons

TABLE III-7. — AREA HARVESTED AS PERCENT OF TOTAL CROPLAND[a] IN BURKE COUNTY IN 1969

Crop	Percent, %
Wheat	29.3
Winter Wheat	0.02
Barley	4.1
Oats	6.2
Rye	0.93
Potatoes	0.008
Hay (all)	5.6
Others	53.8

[a]Total cropland was 493, 730 acres.

Farms in Burke County are large with the majority covering from 260 to 1,999 acres (see table III-8).

3.2.1.2 Divide County. In Divide County, 94.5 percent of the land area is farmland. Land usage is divided between cropland, grazing land, woodland, and all other land (table III-9).

The soils in Divide County generally fall into two categories; those suitable for cultivation, and those more suitable for grazing. Cultivation is limited because of variable rainfall, natural hazards, soils with poor drainage, intermittent ponding, and poor tilth when cultivated. The major crops are spring wheat, including durum wheat, oats, and barley. Other crops grown are alfalfa, rye, flaxseed, and corn. Wheat is the crop with the most acreage and importance. In 1972, wheat accounted for 80 percent of all principal crop acreage sown. Both hard red spring wheat and durum wheat are grown. A limited acreage of winter wheat has been planted in past years (see table III-10).

Acreage planted to summer fallow has a considerably higher yield per acre than continuous cropped land. Wheat acreage in continuous cropping is very slight compared to summer fallow.

Since 1970, there has been a significant decrease in planted rye acreage and a decrease in flaxseed because of the market situation for wheat (see table III-11).

The amount of irrigated land in Divide County is slight. Farms are very large, the majority covering from 260 to 1,999 acres.

3.2.1.3 Williams County. About 97.3 percent of the land area is farmland. Land usage is divided between cropland, grazing, woodland, and all other land (see table III-12).

Soils in the test site of Williams County are suitable for cropland and pasture. The Williams Association soil is a very productive soil with the only principal limitation being that they are moderately susceptible to water erosion. Parshall soils have limited water capacity and are somewhat dry. The major crop is wheat which covers 71.4 percent of the grain crop acreage. Other principal crops, in order of

TABLE III-8. — LAND IN FARMS[a] ACCORDING TO USE IN BURKE COUNTY

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	631	237,955	612	224,228
Cropland used only for pasture or grazing	148	21,174	125	10,611
Cropland in cover crops, legumes and soil-improvement grasses, not harvested or pastured	58	6,577	107	14,276
Cropland on which all crops failed	16	774	48	2,565
Cropland in cultivated summer fallow	594	199,332	593	154,718
Cropland idle	161	13,728	71	9,249
Total cropland	634	479,540	N/A	415,647
Woodland pastured	5	112	3	245
Woodland not pastured	12	1,347	2	85
Total woodland	17	1,459	5	330
Improved pastureland and rangeland	48	12,551	23	1,526
Pastureland and rangeland not improved	312	96,072	N/A	125,945
Total pastureland and rangeland (other than cropland and woodland pasture)	343	108,623	406	127,471
All other land	527	47,187	598	53,724
Irrigated land	-	-	-	-
Total pastureland (all types)	423	129,909	N/A	138,327

[a]Farms with sales of $2500 and over.

TABLE III-9. – LAND IN FARMS[a] ACCORDING TO USE IN DIVIDE COUNTY

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	643	262,999	612	233,442
Cropland used only for pasture or grazing	164	24,358	140	9,294
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	72	13,350	155	32,473
Cropland on which all crops failed	7	241	65	6,254
Cropland in cultivated summer fallow	616	238,856	604	205,546
Cropland idle	102	15,073	39	3,289
Total cropland	647	554,877	N/A	490,298
Woodland pastured	7	1,138	1	80
Woodland not pastured	5	350	5	55
Total woodland	12	1,488	6	135
Improved pastureland and rangeland	47	15,460	50	3,749
Pastureland and rangeland not improved	393	134,619	N/A	141,391
Total pastureland and rangeland (other than cropland and woodland pasture)	425	150,079	500	145,140
All other land	517	53,562	593	61,604
Irrigated land	7	998	-	-
Total pastureland (all types)	472	175,575	N/A	154,514

[a]Farms with sales of $2500 and over.

TABLE III-10. — ANNUAL CROP PRODUCTION IN DIVIDE COUNTY (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
All Wheat	179.2	186.1	208.0	244.0	176.8	181.1	206.0	241.0	25.4	32.0	28.0	30.3	bu
Spring Wheat	115.9	124.0	95.0	93.0	114.5	119.0	94.0	92.0	23.5	27.0	29.5	27.5	bu
Durum Wheat	63.1	115.0	113.0	151.0	62.2	113.0	112.0	149.0	29.0	31.5	32.0	32.0	bu
Winter Wheat	.2	—	—	—	.1	—	—	—	26.0	—	—	—	bu
Barley	23.5	14.5	20.0	18.0	23.0	14.0	19.5	17.5	44.0	39.0	41.0	40.0	bu
Oats	35.0	13.0	21.0	69.0	32.0	12.0	18.0	16.0	54.0	48.0	59.0	43.0	bu
Rye	2.5	2.5	0.5	0.3	2.5	2.5	0.5	0.3	20.0	27.0	28.0	27.0	bu
Flaxseed	6.0	1.5	0.5	1.0	5.5	1.0	0.5	1.0	13.0	8.5	12.0	11.5	bu
Potatoes	0.08	0.04			0.07	0.04			60.0	60.0			cwt
All Hay					31.0	34.0	36.0	45.0	1.2	1.24	1.38	1.32	tons
All Corn	0.4	0.2	0.1		0.4	0.2	0.1						various

TABLE III-11. — AREA HARVESTED AS PERCENT OF TOTAL CROPLAND[a] IN DIVIDE COUNTY IN 1969

Crop	Percent, %
Wheat	32.9
Barley	3.1
Oats	4.6
Rye	0.47
Potatoes	0.0008
Hay (all)	4.4
Others	54.52

[a]Total cropland was 573,936 acres.

TABLE III-12. — LAND IN FARMS[a] ACCORDING TO USE IN WILLIAMS COUNTY

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	993	381,846	979	356,437
Cropland used only for pasture or grazing	221	38,604	146	9,847
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	94	12,502	193	38,868
Cropland on which all crops failed	26	3,664	72	3,005
Cropland in cultivated summer fallow	936	364,827	943	307,361
Cropland idle	147	21,194	70	9,619
Total cropland	1,000	822,637	N/A	725,137
Woodland pastured	19	8,331	18	2,908
Woodland not pastured	14	1,941	15	768
Total woodland	33	10,272	31	3,676
Improved pastureland and rangeland	105	42,995	53	6,820
Pastureland and rangeland not improved	633	313,614	N/A	419,232
Total pastureland and rangeland (other than cropland and woodland pasture)	697	356,609	833	426,052
All other land	764	57,794	954	58,272
Irrigated land	77	13,024	73	12,099
Total pastureland (all types)	801	403,544	N/A	438,807

[a]Farms with sales of $2500 and over.

importance, are oats, barley, alfalfa, sugar beets, corn, rye, and flaxseed. In the past few years, there has been a significant decrease in rye and flaxseed acreage and an increase in barley and wheat acreage. Both hard red spring wheat and durum wheat are grown in Williams County and a slight amount of winter wheat is also grown. But, most of the wheat is grown on summer fallow with a slight amount grown on continuous cropping (see tables III-13 and III-14). The majority of farms range from 260 acres to over 2,000 acres. In 1969, in Williams County, there were 35 farms reporting a total of 1,986 acres of irrigated wheat.

3.2.2 Cropping Systems

With reference to wheat growing, various cropping practices are employed with the primary aim of developing a farming system that will give the farmer the ability to survive the unfavorable periods of low production and take maximum advantage of favorable years of production conditions. Wheat and barley are either grown continuously or on summer fallow (most acreage goes to summer fallow). Some wheat acreage in Williams County is irrigated, but this is a negligible amount of approximately 1,876 acres in 1969.

Climatic conditions suggested a need for early maturing, drought-resistant crops as well as a need for field practices conducive to the conservation of soil moisture. There are various methods used: summer fallowing, stubble-mulching, and biennial cropping of wheat.

3.2.2.1 Summer fallow. Under the fallow system, one-half of the cropland is planted in any given year while the other half is worked fallow to control weeds and insure that the annual precipitation, of that year is conserved and retained as soil moisture for the next year's crop. Even fallowing will not help to produce much of a crop during years of drought. This suggests the importance of supplementary irrigation.

3.2.2.2 Stubble-mulching. After the crop is harvested, the crop residues are gone over with a shredder and tandem disk and left in the land to help control soil blowing and water erosion by increasing the rate of water intake.

TABLE III-13. – ANNUAL CROP PRODUCTION IN WILLIAMS COUNTY (1970 TO 1973)

Crop	Planted acres (1000)				Harvested acres (1000)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
All Wheat	256.8	328.0	288.1	322.1	306.3	245.1	152.5	317.8	20.8	26.4	28.0	26.9	bu
Spring Wheat	216.5	212.5	215.0	202.0	212.5	245.0	214.0	200.0	20.0	26.0	28.0	26.5	bu
Durum Wheat	39.2	62.0	70.0	116.0	38.6	60.5	69.0	114.0	25.0	28.0	34.0	27.5	bu
Winter Wheat	1.1	1.0	3.1	4.1	0.8	0.8	2.3	3.8	29.5	26.0	33.0	26.0	bu
Barley	23.5	16.5	36.0	42.0	23.0	15.0	35.5	40.5	35.0	41.0	48.0	36.0	bu
Oats	65.0	24.0	38.0	38.0	60.0	19.0	32.0	33.0	51.0	49.0	68.0	46.0	bu
Rye	10.5	7.0	1.0	0.6	10.0	6.5	1.0	0.5	24.0	31.0	30.0	25.0	bu
Flaxseed	5.5	1.0	0.5	1.0	5.5	1.0	0.3	1.0	14.5	8.5	12.0	12.0	bu
Potatoes	0.15	0.15	0	0	0.14	0.14	0	0	70.0	70.0	0	0	cwt
All Hay					46.0	43.0	54.0	63.0	1.49	1.38	1.53	1.32	tons
All Corn	2.3	2.1	2.1	0	2.2	2.0	2.1	0	—	—	—	—	various
Sugar Beets			2.72	31.0			2.72	3.1			14.70	19.20	tons

TABLE III-14. — AREA HARVESTED AS PERCENT OF TOTAL CROPLAND[a] IN WILLIAMS COUNTY IN 1969

Crop	Percent, %
Wheat	32.1
Barley	2.67
Oats	4.2
Rye	0.9
Potatoes	0.0005
Hay (all)	4.8
Corn (all)	0.02
Others	55.3

[a]Total cropland was 844,893 acres.

3.2.2.3 Shelterbelts. Shelterbelts are planted in order to deter wind, reduce runoff, and trap drifting snow so that the melting snow can help recharge the soil moisture.

3.2.2.4 Irrigation. Most of the cropland is under dry-farming but interest in irrigated farming has been on the increase. Irrigation has been integrated into the existing dryland farms. It is generally recommended that irrigated land be used in connection with livestock enterprises on the farm. Irrigated land is used for growing additional cash crops. The principal irrigated crops are alfalfa, corn, dry beans, potatoes, sugar beets, barley, and oats. Small grains are not usually grown as a principal cash crop, with irrigation, but are grown to provide livestock feed.

A cropping pattern that works well with irrigation is one that combines three uses:

1. One-third of the land in alfalfa or grass

2. One-third involved in intertilled crops to provide control over weeds

3. One-third in small grains or another close growing crop.

Yields on irrigated land over a period of years tend to average about two times the yield of dryland farms. But irrigation yields, like dryland yields, fluctuate from year to year. (See table III-15 for field size information.)

3.2.3 Cropping Calendars

Crop calendars for the small grains are presented in tables III-16 and III-17 for the principal crops of North Dakota. For the small grains, the crop calendar data are presented at the crop reporting district level and are representative of the respective counties. For the other crops, data are presented at the state level.

3.2.4 Wheat Varieties

Table III-18 contains the distribution statistics for durum and hard red spring wheat varieties for the three North Dakota test sites.

TABLE III-15. — NUMBER, AVERAGE SIZE, AND RANGES OF FIELDS WITHIN THE NORTH DAKOTA TEST SITES

County	Test site size, miles	No. of fields	Average field size, acres	Range in field size, acres
Burke	5 x 6	210-230	55	5-160
Divide	2 x 10	NA	NA	NA
Williams	5 x 6	240-310	40	5-160

TABLE III-16. – CROPPING CALENDAR FOR THE NORTHWEST CROP REPORTING DISTRICT OF NORTH DAKOTA (BURKE, DIVIDE, AND WILLIAMS COUNTIES)

CROP	Seedbed preparation			Full coverage			Heading, flowering			Post-harvest operations		
	Start	Mid-point	End	Start	Mid-point	End	Start	Mid-point	End	Start	Mid-point	End
Winter Wheat	Jul 5	Aug 5	Sep 5	Apr 13	Apr 19	Apr 25	May 30	Jun 13	Jun 27	Jun 28	Jul 5	Aug 5
Durum Wheat	Apr 20	Apr 30	May 15	May 20	May 27	Jun 3	Jun 22	Jul 5	Jul 20	Jul 25	Aug 10	Nov 10
Spring Wheat	Apr 20	Apr 30	May 15	May 18	May 25	Jun 1	Jun 23	Jul 5	Jul 18	Sep 25	Oct 15	Nov 15
Rye	Jun 25	Jul 25	Aug 25	Apr 9	Apr 16	Apr 22	May 27	Jun 10	Jun 24	Aug 30	Sep 15	Nov 15
Oats	May 1	May 11	May 25	May 23	May 30	Jun 6	Jun 25	Jul 8	Jul 23	Sep 10	Sep 25	Nov 15
Barley	Apr 29	May 9	May 25	May 20	May 27	Jun 6	Jun 22	Jul 7	Jul 19	Jul 24	Aug 10	Nov 10

TABLE III-17. – NORTH DAKOTA: USUAL PLANTING AND HARVESTING DATES BY CROP

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Beans, dry	May 10-Jun. 10	Sept. 1	Sept. 15-Oct. 5	Oct. 15
Corn:				
Grain	May 15-Jun. 20	Oct. 5	Oct. 10-Oct. 25	Nov. 5
Silage	May 15-Jun. 20	Sept. 5	Sept. 10-Sept. 20	Sept. 25
Forage	May 15-Jun. 20	Sept. 5	Sept. 10-Sept. 25	Oct. 1
Flaxseed	May 5-Jun. 20	Aug. 20	Sept. 1-Sept. 25	Oct. 15
Hay:				
Alfalfa		Jun. 20		Sept. 25
Wild		Jun. 25		Oct. 15
Millet	Jun. 20-Jul. 20	Sept. 25	Oct. 1-Oct. 15	Oct. 20
Peas, dry	Apr. 25-Jun. 1	Aug. 20	Oct. 25-Sept. 1	Sept. 10
Sorghum, silage	May 25-Jun. 20	Aug. 25	Sept. 1-Sept. 15	Sept. 20
Soybeans	May 20-Jun. 10	Sept. 25	Oct. 5-Oct. 20	Oct. 25
Sugarbeets	May 10-Jun. 5	Sept. 20	Sept. 25-Oct. 25	Nov. 1
Seed crops:				
Alfalfa		Oct. 5	Oct. 10-Oct. 15	Oct. 30
Sweetclover		Aug. 20	Aug. 25-Sept. 5	Sept. 20
Kentucky bluegrass		Jun. 25	Jul. 1-Jul. 5	Jul. 5
Crested wheatgrass		Aug. 5	Aug. 20-Sept. 1	Sept. 5

TABLE III-18. — DISTRIBUTION OF WHEAT VARIETIES FOR THE THREE INTENSIVE TEST SITES IN NORTH DAKOTA

County	Variety by percent for durum				
	Leeds	Wells	Rolette	Hercules	Misc.
Burke	20	49	7	22.9	1.1
Divide	61	29.8	7	0.1	2.1
Williams	36	53.2	5	0.6	5.2
	Variety by percent for hard red spring wheat				
	Waldron	Lark	a	Chris	Misc.
Burke	38	0.5	5	40	16.5
Divide	52	0	0	22	26
Williams	42	0	0	5.8	52.2

[a]World seeds 1809.

INTENSIVE TEST SITE ASSESSMENT REPORT

MONTANA

SECTION FOUR

CONTENTS

TABLES

Table		Page

FIGURES

4.0 MONTANA INTENSIVE TEST SITES

4.1 REGIONAL DESCRIPTION

Four Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the State of Montana. These test sites are located in the north-central region of the state within Glacier, Toole, Liberty, and Hill counties (fig. 4-1).

TABLE IV-1.- COUNTY SIZE AND LOCATION OF THE LACIE INTENSIVE TEST SITES IN MONTANA

County	Sq. Mi.	Total acres	N. Lat.	W. Long.	Test site size, miles
Glacier	2964.1	1,897,024	48° 37'	112° 33'	2 × 10
Hill	2926.9	1,873,216	48° 42'	109° 55'	2 × 6
Liberty	1438.5	920,640	48° 44'	110° 51'	2 × 10
Toole	1949.8	1,247,872	48° 53'	111° 46'	2 × 10

Montana covers 147,138 square miles. It is the fourth largest state in the Union, measuring 280 miles from north to south and 550 miles from east to west. The state is a vast area with many variations in elevations, climate, vegetation, geology and soils.

4.1.1 Location

The four test sites are situated within the Piedmont physiographic region and therefore, physiography and climate will be discussed collectively.

4.1.2 Physiography

Montana is divided into three physiographic areas (fig. 4-2) The Montane area comprises the mountains and valleys of the western part of the state. Here the elevation, climate,

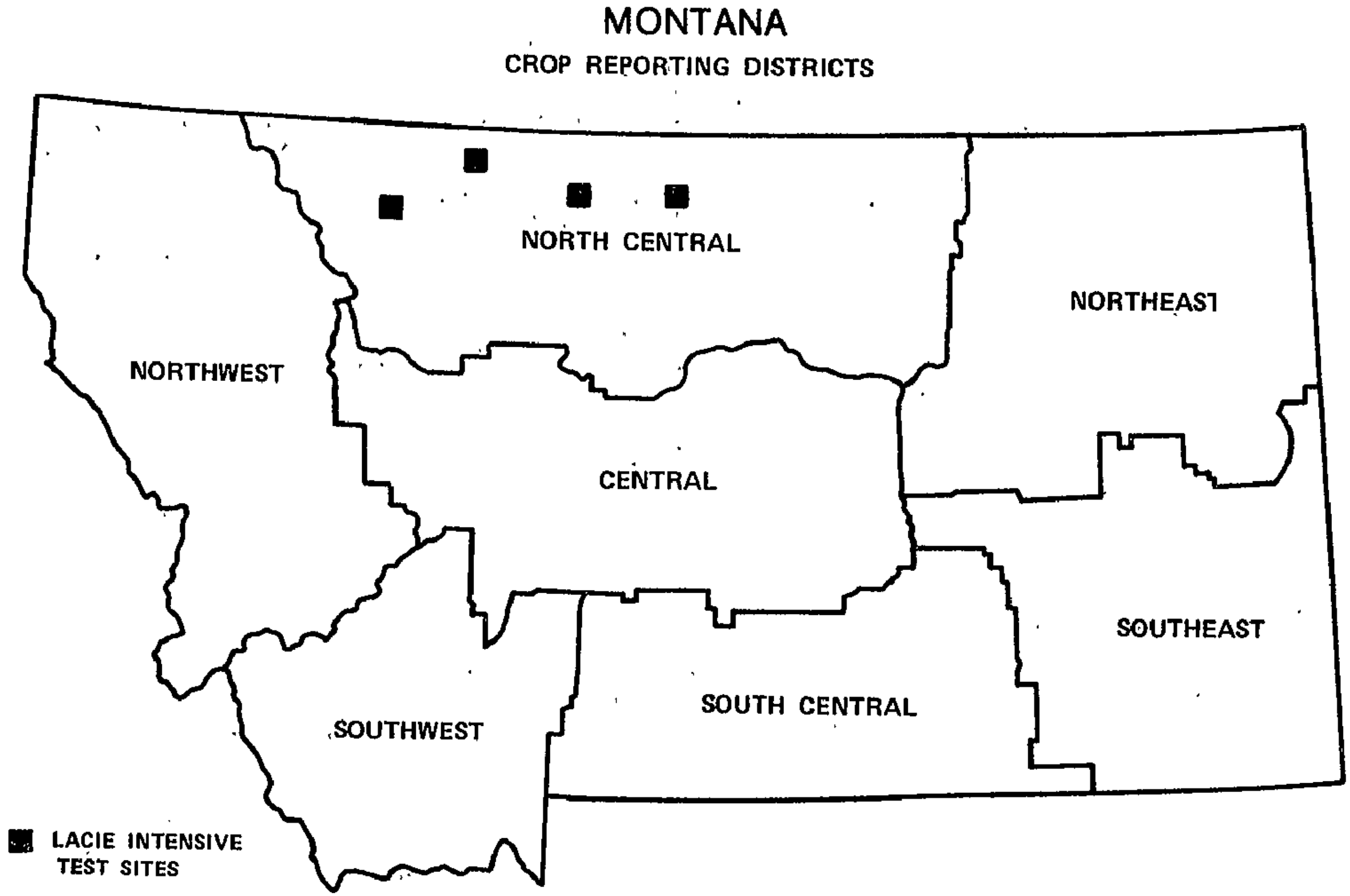


Figure 4-1. — Location of the four Intensive Test Sites in Montana.

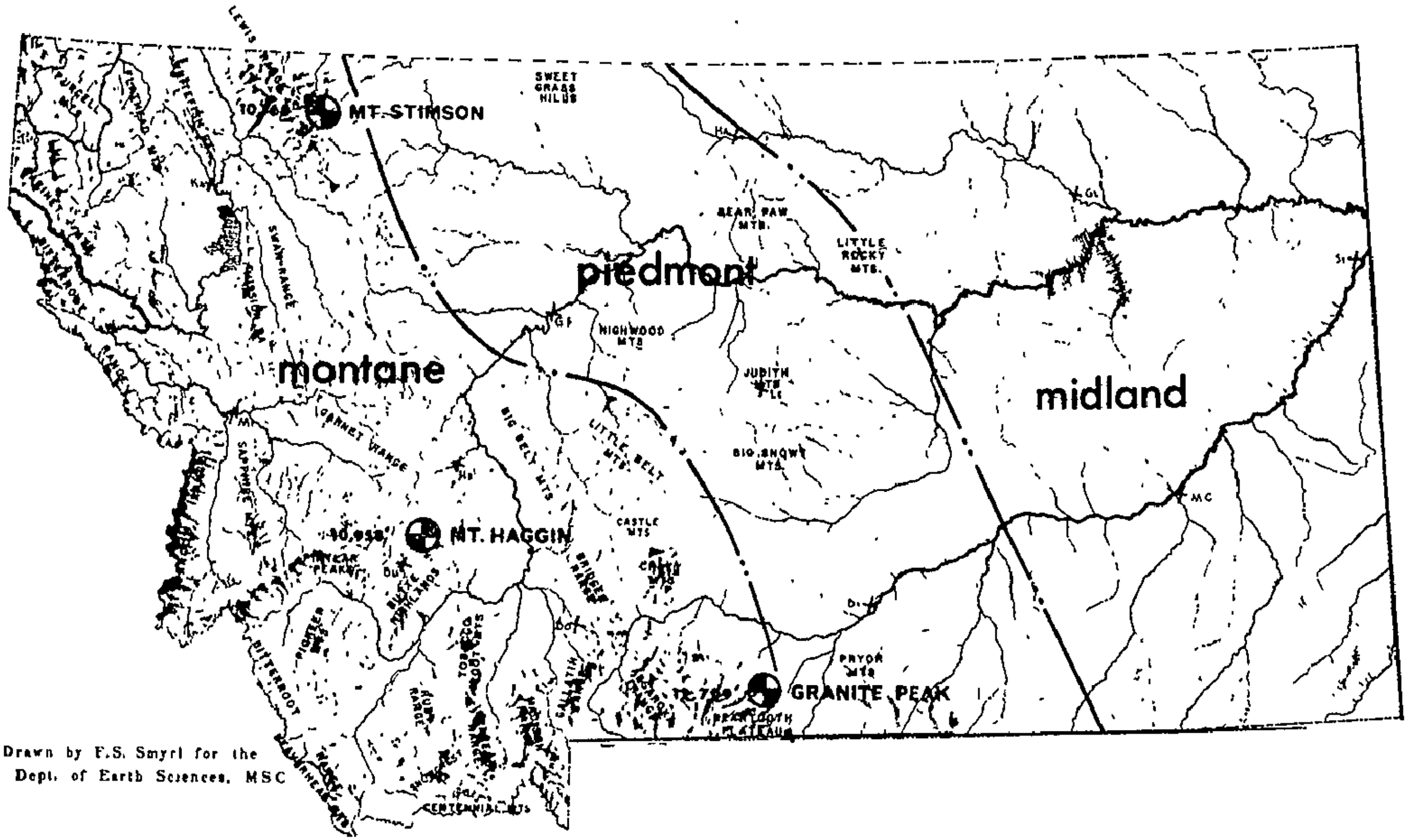


Figure 4-2. — Physiographic overlay and elevation of key peaks.

vegetation, and soils change abruptly over short distances. The Piedmont area along the eastern edge of the Rocky Mountains includes some of the lesser mountain ranges. The Midland area, relatively flat lands in the eastern part of the state, is an extension of the plains of the interior of the continent.

The northern plains of Montana, of which Hill, Liberty, Toole, and Glacier counties are a part, occupy an area of the great continental slope, known as the Great Plains, which stretches from the foothills of the Rocky Mountains toward the Mississippi Valley. The area includes a narrow strip across the western part of the Great Plains, with the exception of several comparatively small mountainous areas. The surface relief is for the most part characterized by smooth tabular divides separated by stream valleys. Although the smooth, uneroded, treeless upland appears almost flat, it has a slight general inclination toward the east. The average slope is almost 8 feet to the mile. The larger streams of the area, for example the Milk River, flow in a general easterly direction and are bordered by comparatively narrow alluvial plains and by wider valley slopes which range from gently rolling hills on the outer edge to rugged breaks near the streams. In places where the rock was less resistant to erosion or the slopes were steeper, badly deserted areas and badlands have been produced. The smaller streams for the most part have narrow valleys and cut abruptly in the plain.

The monotony of the plain with its apparently level surface is relieved by several highlands that cannot, strictly speaking, be called a part of the Great Plains. The most conspicuous of these are the isolated mountain groups that rise abruptly above the general level of the plain. The Bearpaw Mountains in southern Hill County and the Sweetgrass Hills in northern Liberty and Toole counties are examples of these conspicuous highland areas.

The Bearpaw Mountains are of volcanic origin, and the igneous exposures consist largely of ancient trap rocks. The mountains range in elevation from about 5,000 feet to over 7,000 feet above sea level.

The Sweetgrass Hills comprise an isolated group of igneous buttes lying from 75 to 90 miles east of the main range of the Rocky Mountains. These buttes rise from 1,500 to 2,000 feet above the glaciated plains and cover approximately a township.

4.1.3 Climate

The climate of Montana is highly variable over relatively short distances. This variability is related in part to the abrupt changes in elevation in mountain areas.

The Continental Divide forms a natural boundary between the principal climatic areas of the state. East of the Divide the climate is characterized by generally less precipitation and greater temperature extremes; hotter in summer and colder in winter. Maritime influences account for the more uniform temperatures as well as more uniform and increased precipitation west of the Divide. However, some intermountain valleys west of the Divide are among the driest places in Montana. East of the Divide, the greater proportion of the long-term average annual precipitation occurs during the period April through September, with May, June, and July being the wettest months. Montana has a true continental climate in the eastern or Midland and Piedmont regions and a maritime-modified climate in the western Montana region.

4.1.3.1 Test sites. The climate of the four-county region under study is characterized by moderately low rainfall, dry atmosphere, hot summers, cold winters, and a large number of days of sunshine.

The period of high temperatures in the summer are not long in duration, usually lasting only a few days, and are not oppressive because of the low humidity. The extreme cold waves are not generally accompanied by high winds. Extremely high and very low temperatures are somewhat common in the area. In some valleys along the foothills of the mountains, the winter temperatures are modified by the warm chinook winds.

Precipitation, especially during the growing season, is not only one of the most important factors to be considered in estimating the agricultural possibilities of this area, but it is the most variable factor as well. The summer rains usually occur as showers, and a particular locality may be passed by for several years and have crop failure. At the same time, unusually large crops may be grown in other parts of the same county. The amount of soil moisture available for plants varies in different regions with the rate of evaporation from the surface and the capacity of the soil to hold its moisture.

The average frost-free period ranges from 116 to 140 days. Killing frosts can occur, however, in every month of the year. The growing season on the high plateau region is probably a week or 10 days shorter than in certain river valleys.

The area is swept at times by strong winds, usually from the west or northwest. These winds are very brisk and continuous during the spring and do considerable damage to early-seeded crops on the lighter soils. During the summer, winds occasionally blow from the southwest and during dry seasons crop losses may occur. Chinook type winds, which occur during the winter months, can prevent the accumulation of snow in the region.

A large part of the precipitation during the fall, winter, and early spring is in the form of snow. The strong winter winds remove the snow from the greater part of the smooth land surfaces and collect it in drifts, usually in depressions. Owing to the melting of the drifted snow, a much larger quantity of water is absorbed by the soil in such places. Hailstorms occur locally during the summer and add to the hazards of farming, yet these hailstorms are no more frequent than in many other parts of the Great Plains.

Tables IV-2, IV-3, IV-4, and IV-5 show representative monthly temperatures and precipitation for stations in the four counties under study. The following is a narrative summary of the weather station at Havre, Montana in Hill County prepared by the National Oceanic and Atmospheric Agency (NOAA).

Havre, Montana, is located in a level valley formed by the Milk River, which courses through the city from west to east. Most of Havre lies on the south side of the river. On the north side, hills rise abruptly to above 200 feet above the valley floor. The landmass north to the Canadian border is gently rolling and increases slightly in elevation. During winter months, frequent invasions of cold polar continental air move down across these rolling plains, bringing snow and subzero temperatures.

TABLE IV-2. – AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT CUT BANK, GLACIER COUNTY, MONTANA

Month	Temperature average, °F	Precipitation average, inches
December	22.4	0.34
January	17.5	0.38
February	19.9	0.36
Winter	19.9	1.08
March	26.6	0.48
April	40.1	0.74
May	50.3	1.73
Spring	39.0	2.95
June	56.7	2.87
July	65.3	1.31
August	62.8	1.15
Summer	61.6	5.31
September	53.2	1.20
October	43.9	0.55
November	30.2	0.32
Fall	42.4	2.07
Year	40.7	11.41

[a] Averages for period 1931-1955.

TABLE IV-3. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT HARVE, HILL COUNTY, MONTANA

Month	Temperature average, °F	Precipitation average, inches
December	20.4	0.56
January	16.2	0.46
February	18.9	0.39
Winter	18.5	1.41
March	30.3	0.70
April	45.1	0.90
May	55.7	1.48
Spring	43.7	3.08
June	62.9	2.98
July	71.3	1.47
August	68.0	1.06
Summer	67.4	5.51
September	57.0	1.15
October	46.8	0.68
November	30.9	0.48
Fall	44.9	2.31
Year	43.6	12.31

[a]Averages for period 1931-1955.

TABLE IV-4. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT DUNKIRK 14 NNE, LIBERTY COUNTY, MONTANA

Month	Temperature average, °F	Precipitation average, inches
December	20.3	0.47
January	15.5	0.36
February	19.4	0.41
Winter	18.4	1.24
March	27.3	0.54
April	41.0	0.82
May	51.5	1.56
Spring	39.9	2.92
June	58.1	2.69
July	66.7	1.43
August	64.1	1.25
Summer	62.9	5.37
September	54.0	1.08
October	43.8	0.58
November	28.9	0.35
Fall	42.2	2.01
Year	40.9	11.54

[a]Averages for period 1931-1955.

TABLE IV-5. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT CHESTER, TOOLE COUNTY, MONTANA

Month	Temperature average, °F	Precipitation average, inches
December	20.0	0.32
January	14.0	0.45
February	17.0	0.26
Winter	17.0	1.03
March	26.5	0.29
April	42.5	0.62
May	53.0	1.54
Spring	40.6	2.45
June	59.5	2.66
July	67.0	1.17
August	64.5	1.19
Summer	63.6	5.02
September	54.0	1.02
October	44.5	0.41
November	29.5	0.31
Fall	42.6	1.74
Year	41.0	10.20

[a]Averages for period 1940-1967.

The Bearpaw Mountains extend from 15 to 30 miles south of Havre. Most of the peaks are from 4,000 to 5,000 feet above sea level and several are above 6,000 feet. The highest is Old Baldy, 6,906 feet above sea level.

Winters are cold in the Havre area, but snow cover is seldom more than a few inches and usually some ground is bare. Spells of mild weather do occur at least a few times each winter, arriving with sometimes fresh to strong southwest to west foehn winds, locally referred to as "Chinooks". During winter months, rain rarely falls; the winter precipitation that does occur is almost always in the form of snow. The transition from winter to spring conditions is fairly rapid in the usual year, but cold snaps and snow can occur as late as early May or as early as September.

Summers are characterized by warm, but seldom hot (95°F or warmer) weather. Daytime warmest readings usually run from the eighties to the mid-nineties most of July and August, but summer relative humidities are seldom as high as 50 percent during afternoon hours. Summertime night temperatures are rarely oppressively warm. Most spring and summer precipitation falls as showers, but occasionally steady rains lasting several hours are observed in May and June and again in September. Thunderstorms occur on an average of about 1 day in 5 or 6, June through August. About half of the total annual rainfall falls during May, June, and July, when it is needed most. When rainfall is short during these months, crops may be poor and may average only 4 to 5 bushels or less to the acre, whereas normally average production is close to 20 bushels of grain per acre.

Fall seasons are characterized by much clear weather, although cold snaps of a day or two, with some snow, can occur as early as mid-September. The first wintry weather each year generally arrives several weeks before the date of the winter solstice. The average date of the last 32°F minimum temperature in the spring is May 9; the first in the fall is September 23. The average length of the season between freezes is 138 days.

4.1.4 Soils

Much of Montana, including the four LACIE test sites, is covered with sedimentary rocks. These are predominantly sandstone, siltstone, and shale. Generally, shale weathers to clayey soils and sandstone weathers to sandy soils. Impurities in the rocks, such as lime and salts more soluble than lime, are at least partially leached away. Iron as an impurity will usually remain for longer periods.

Montana east of the Rocky Mountains and north of the Missouri River is covered by material deposited by glaciers. This material, called continental glacial till, was moved by the ice to its present location. It is a mixture of sand, silt, clay, gravel, cobbles, and stones. These materials, deposited as the ice moved over the landscape, are compacted to varying degrees depending on the texture of the glacial till and the thickness of the ice. The textures of soils formed from the glacial till are related to the texture of the till at the time of deposition.

The major kinds of soils in Montana are many and varied. Generally, Mollisols and Entisols are predominant over most of the state (see table IV-6). A breakdown as to the actual type of soils and their particular characteristics within the LACIE area of interest is discussed in the next section of this report. See table IV-6 and figures 4-3, 4-4, 4-5 and 4-6 for a description of soil orders.

Soil map transparencies are available at a scale of approximately 1:24,000. These transparencies can be used to overlay the test site on USDA/ASCS 1:24,000 black and white photography. These transparencies were reduced to fit the 8½ by 11 inch format of this report.

4.1.4.1 Glacier County. Glacier County soils are of the Mollisol, Alfisol and Inceptisol orders, Borolf and Ochert suborders, and Argiboroll, Cryoboralf and Cryochrept great groups. (See fig. 4-7.)

Turner Series

The predominant soil in the Glacier County test site is the dark grayish-brown Turner series. This soil series encompasses almost 80 percent of the site, the exception being the northwestern quarter. These soils are developed

TABLE IV-6. — DESCRIPTIONS OF THE FOUR MONTANA COUNTY SOILS

Classification	Description
ALFISOL	Soils that are medium to high in base (base saturation at pH 8.2) and have gray to brown surface horizon and subsurface horizons of clay accumulation. These soils are usually moist but, during the warm season of the year, some are dry part of the time.
Boralf	Alfisols of cool to cold regions; used for woodland, pasture, and some small grain.
Cryoboralf[a]	Boralfs of cold regions.
A3-1	Cryoboralfs plus Cryorthols, steep.
ENTISOLS	Soils that have no pedogenic horizons.
Orthents	Loamy or clayey Entisols that have a regular decrease in organic matter content with depth; used for range or irrigated crops in dry regions and for general farming in humid regions.
Ustorthents[b]	Ustorthents that are shallower than 20 inches to bedrock.
E6-2	Ustorthents (shallow) plus Haploborolls and Agriborolls, steep.

[a]Formerly Gray Wooded.

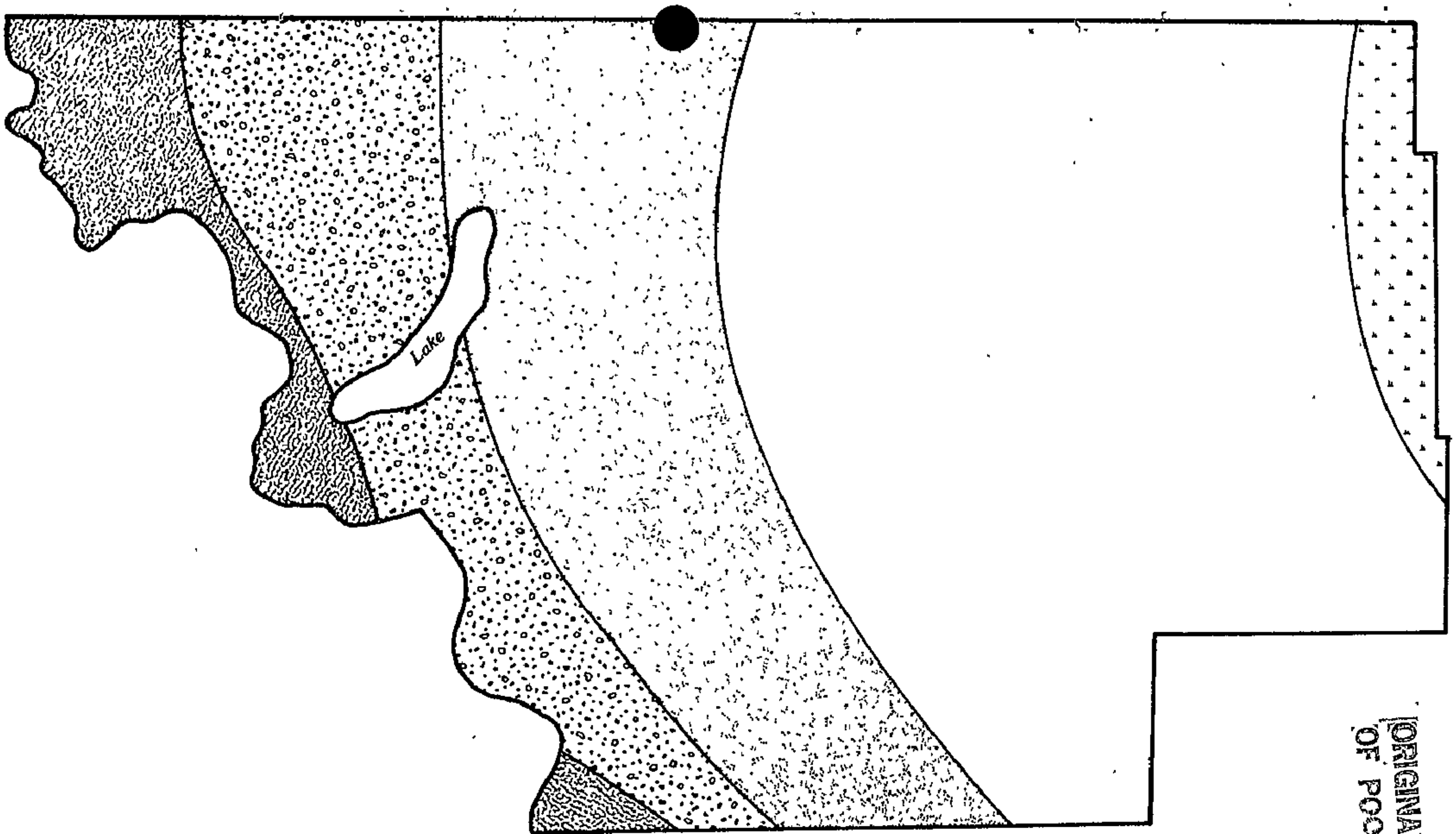
[b]Shallow, formerly Lithosols

TABLE IV-6. — DESCRIPTION OF THE FOUR MONTANA COUNTY SOILS - Concluded

Classification	Description
INCEPTISOLS	Soils that have weakly differentiated horizons; materials in the soil have been altered or removed, but have not accumulated. These soils are usually moist but, during the warm season of year, some are dry part of the time.
Ochrept	Inceptisols that have formed in materials with crystalline clay minerals, have light-colored surface horizons, and have altered subsurface horizons that have lost mineral materials; used for woodland and range in Alaska and northwestern United States, pasture, wheat, sorghum, and hay in Oklahoma and Kansas, and pasture, silage, corn, small grain, and hay in northeastern United States.
Cryochrept[a]	Ochrepts of cold regions.
17-2	Cryochrepts plus Rockland, Cryumbrepts and Cryandepts, steep.
MOLLISOLS	Soils that have nearly black friable organic-rich surface horizons high in bases; formed mostly in subhumid and semiarid warm to cold climates.
Borolls	Mollisols of cool and cold regions. Most Borolls have a black surface horizon; used for small grain, hay, and pasture in north-central states and ranges, woodland, and some small grain in western states.
Argiboroll[b]	Borolls of cool regions. They have a subsurface horizon in which clay has accumulated.
M3-1	Argiborolls, moderately sloping.
M3-4	Argiborolls plus Haploborolls, gently sloping.
M3-7	Argiborolls plus Haploborolls, Natrargids and Calciborolls, gently sloping.

[a]Formerly Subarctic Brown Forest Soils.

[b]Formerly Chernozems.



SOIL CLASSIFICATION

- M3-4 MOLLISOL - BOROLL - AGRIBOROLL
- M3-1 MOLLISOL - BOROLL - AGRIBOROLL
- A3-1 ALFISOL - BORALF - CRYOBORALF
- I7-2 INCEPTISOL - OCHREPT - CRYOCHREPT
- M3-7 MOLLISOL - BOROLL - AGRIBOROLL

APPROX. SCALE 1:615,000

Figure 4-3. — Soil classification map of Glacier County, Montana.

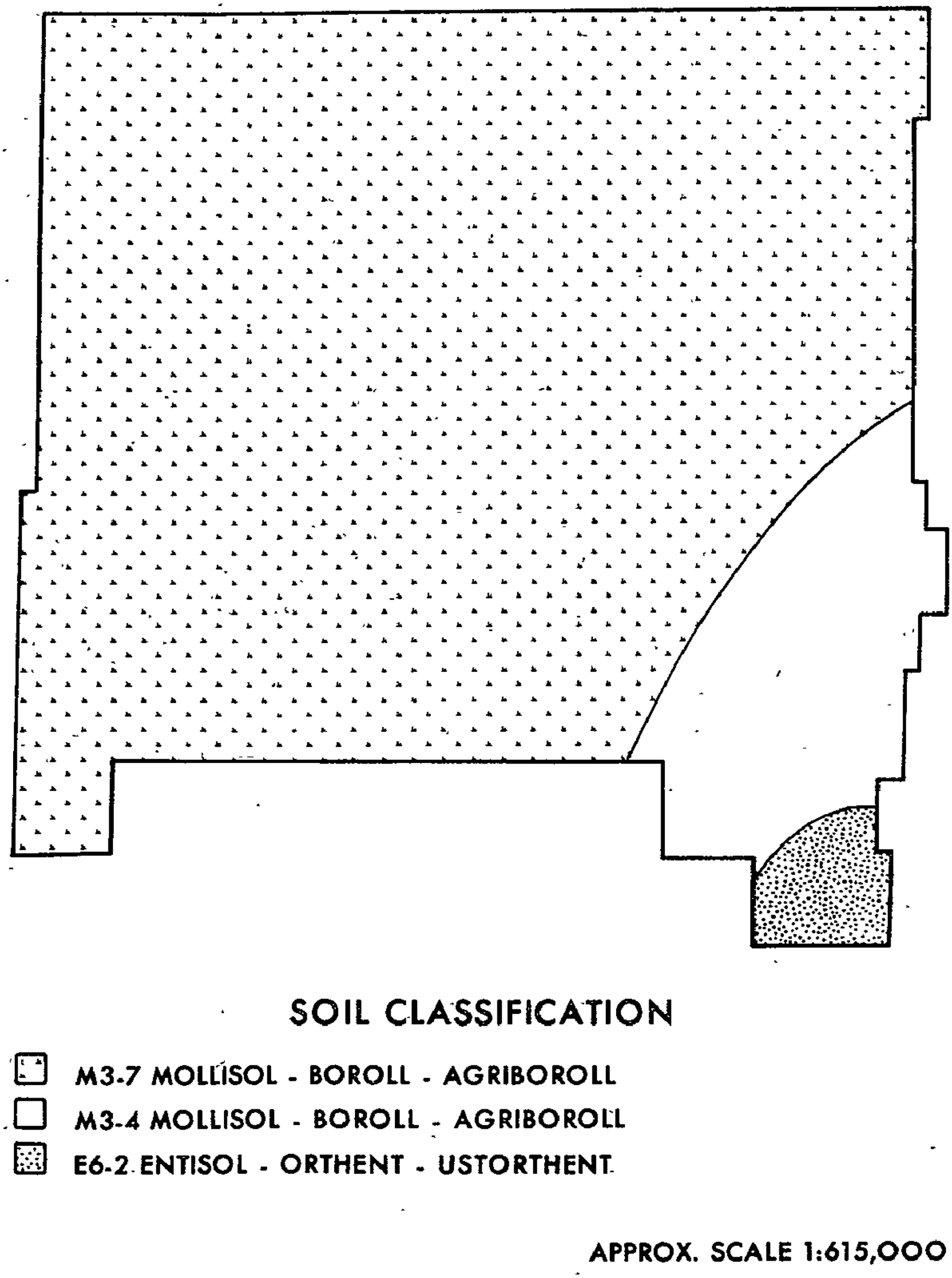


Figure 4-4. — Soil classification map of Hill County, Montana.

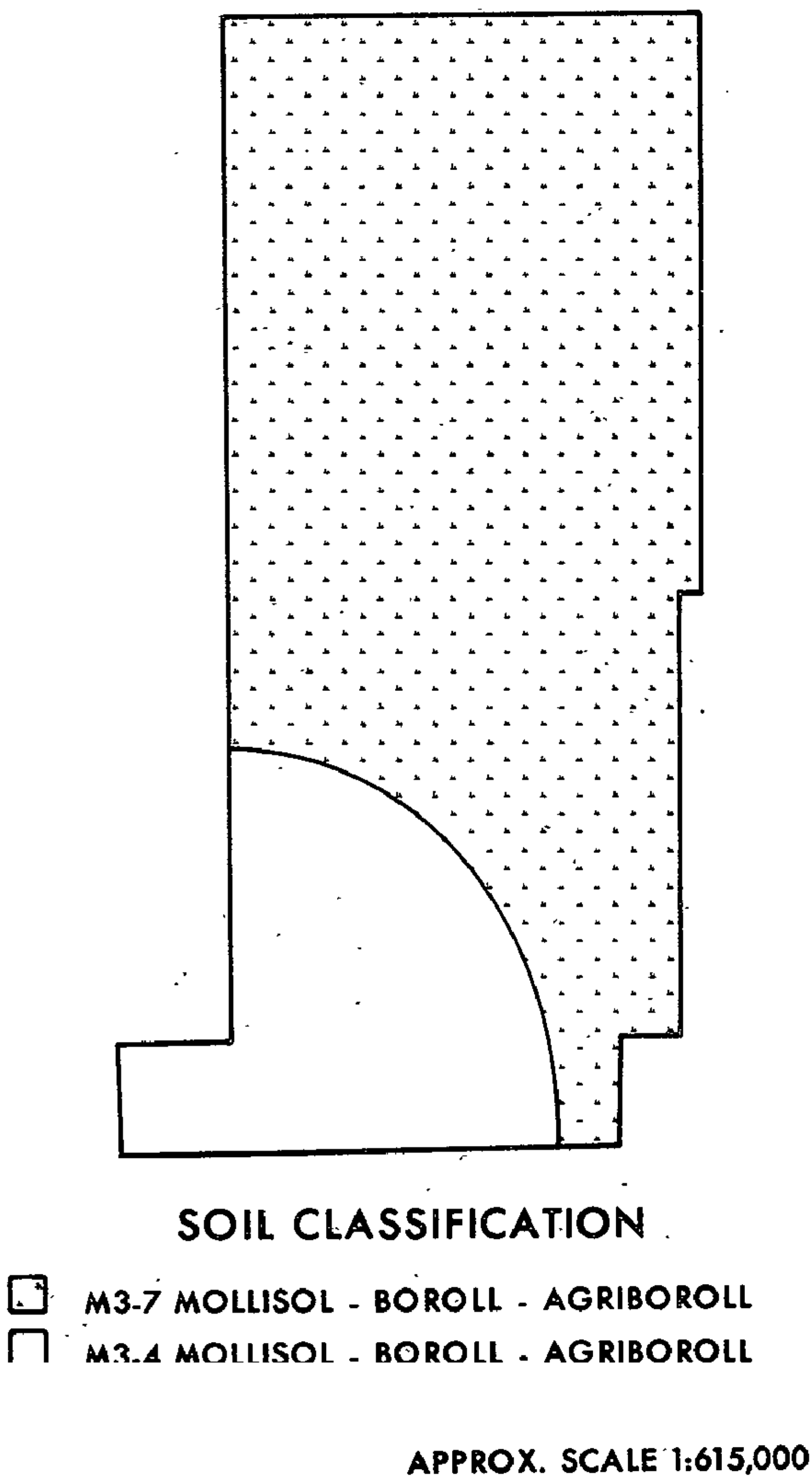
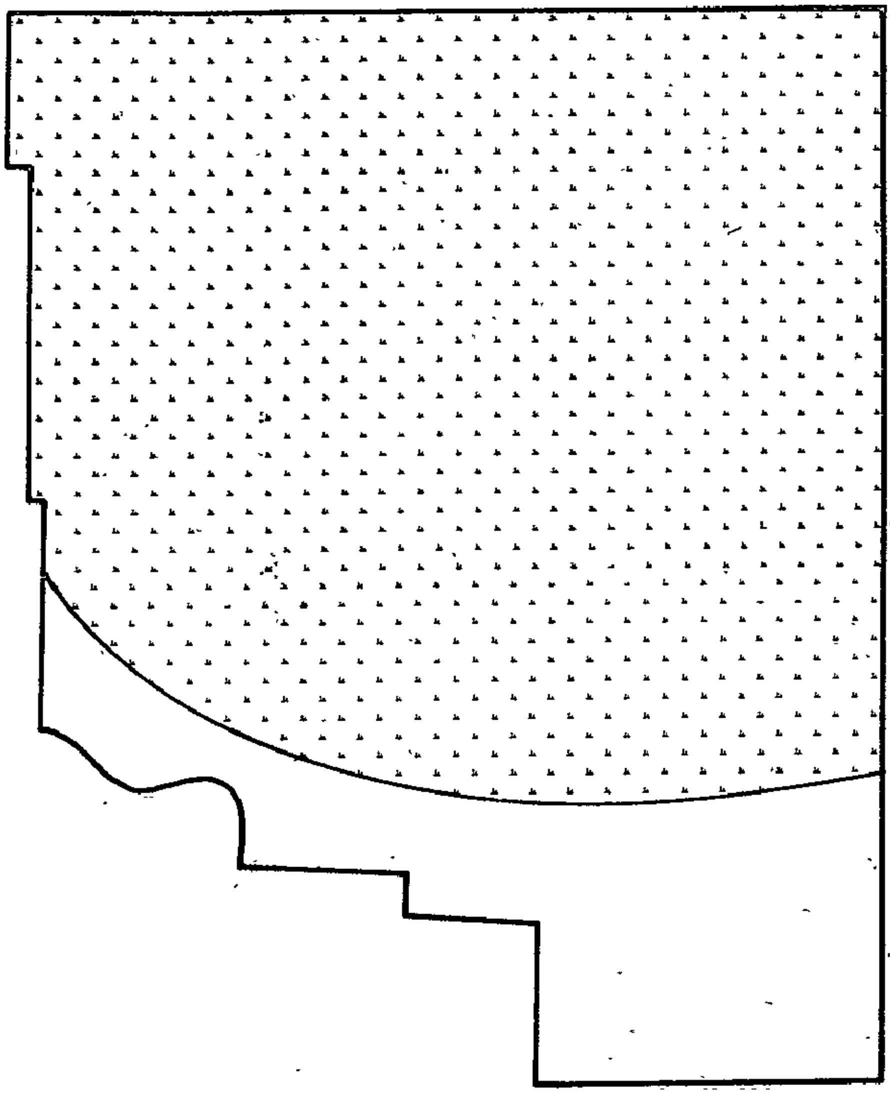


Figure 4-5. — Soil classification map of Liberty County, Montana.

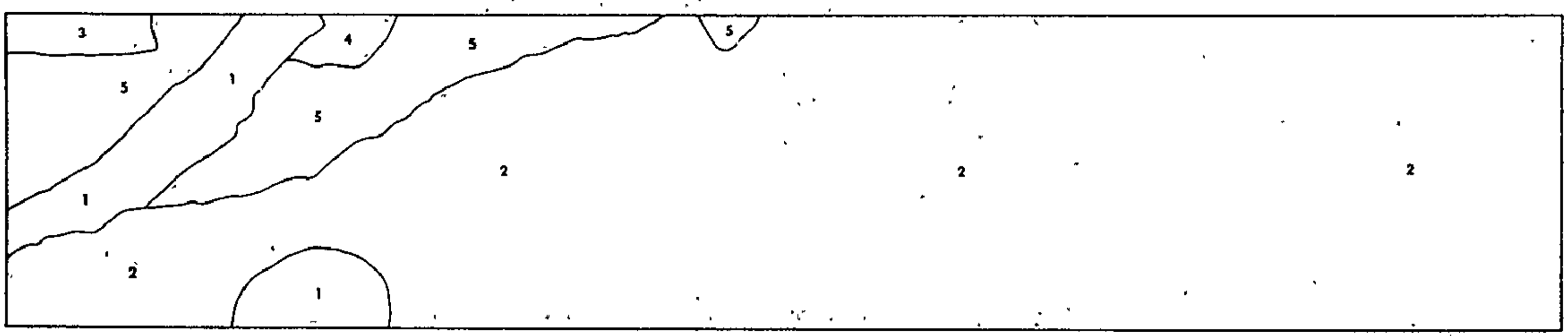


SOIL CLASSIFICATION

- M3-7 MOLLISOL - BOROLL - AGRIBOROLL
- M3-4 MOLLISOL - BOROLL - AGRIBOROLL

APPROX. SCALE 1:615,000

Figure 4-6. — Soil classification map of Toole County, Montana.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

LEGEND

1 — Alluvial Soils
2 — Turner Fine Sandy Loams
3 — Buffalo Loams
4 — Scobey Sandy Loams
5 — Beaverton Gravelly Loams

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 4-7. — Glacier County, Montana LACIE Intensive Test Site soil classification map.

over gravelly benches. The soils within the site are sandy in texture. The surface soils, ranging from 5 to 7 inches in thickness, consist of grayish-brown or dark grayish-brown fine sandy loam or loam. The subsoils are heavy, rather compact, and have a light brown or grayish-brown color.

Beaverton Series

The second predominant soil within the Glacier County test site is the Beaverton series. It encompasses approximately 13 to 15 percent of the northwest quadrant of the site. The surface soil consists of a grayish-brown or dark grayish-brown loose mulchlike silty or sandy material. It is underlain to a depth of 6 to 8 inches by a firm dark grayish-brown layer which in many places is slightly columnar. These soils have developed over alluvial deposits, and they occur on high well-drained terraces in comparitively small disconnected areas. They have fair surface drainage, but under irrigation, the lower-lying land in many places becomes seeped.

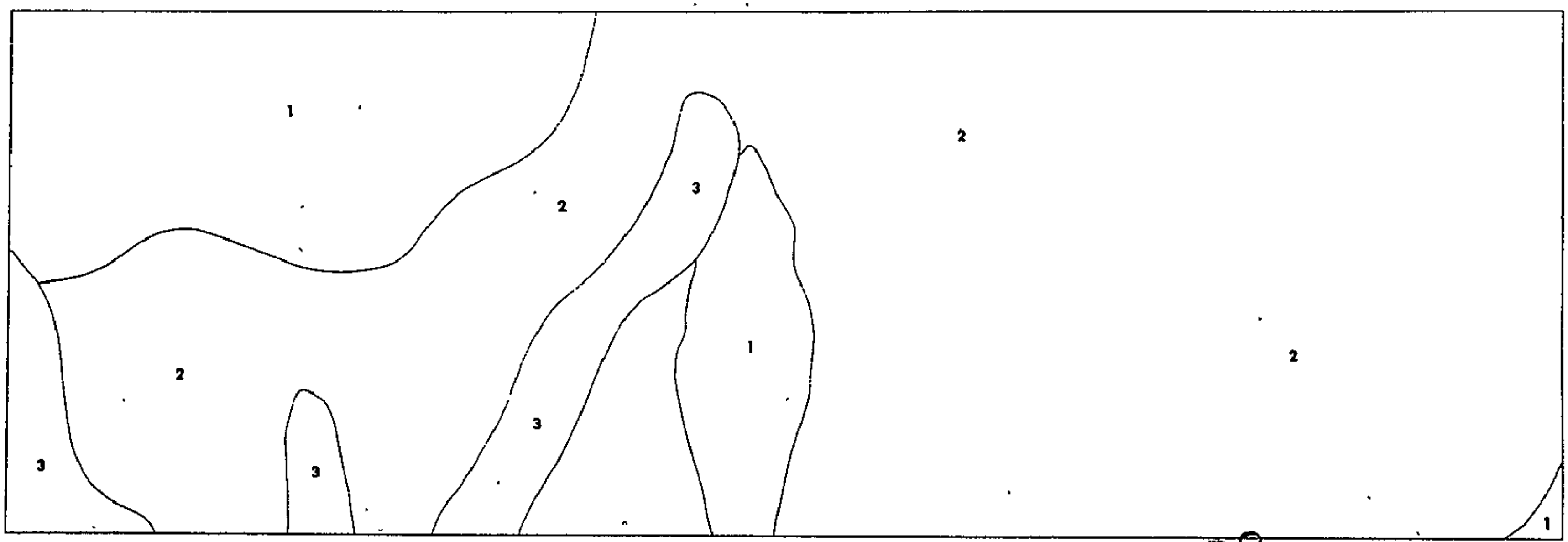
Buffalo Series

Besides alluvial soils, the last major soil with the Glacier county test site is the Buffalo series. Situated in the extreme northwest corner of the site, these soils are dark-brown loams ranging in thickness from 9 to 14 inches. The surface soils are underlain by gravel, mainly quartzite. Gravel is scattered over the surface and through the soil. Over the greater part of the area of these soils the bedrock of sandstone or slate lies within 30 inches of the surface, and exposures of the rock occur in the more eroded areas.

4.1.4.2 Hill County. Hill County soils are of the Mollisol and Entisol order, Boroll and Orthent suborders, and Argiboroll and Ustorthent great groups. (See fig. 4-8.)

Scobey Series

Comprising over 60 percent of the Hill County test site region are the soils of the Scobey series, the most extensive soils in northern Montana. The surface layer is a 1- or 2-inch



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

LEGEND

1 — Phillips Loams
2 — Scobey Loams
3 — Bainville Loams

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 4-8. — Hill County, Montana LACIE Intensive Test Site soil classification map.

layer of dark grayish-brown silt loam or very fine sandy loam which, unless held together by grass roots, is loose and powdery and forms a surface mulch. This is underlain by a layer, ranging from 5 to 8 inches in thickness, of dark grayish-brown loam which is firm in position and in places has a well-marked columnar structure. When plowed, the material breaks up into small firm clods. Boulders are scattered on the surface and through the soil.

Scobey soils have a surface relief, texture, and structure that render these soils suitable for farming on a large scale. The soils are regularly maintained in a mellow condition and hold the seasonal supply of moisture fairly well. Wind blowing also gives more trouble on the sandier areas of these soils.

Phillips Series

The second most prominent soil in the Hill County test site is the Phillips series. Phillips soils are widely known for the desolate appearance of the landscape where they occur. These soils are characterized by numerous depressed bare spots which are locally known as "slick spots," "blowouts," or "scab land." The bare spots cover from 20 to 60 percent of the area. The spots range in size from a few feet to 30 feet and they lie from 3 to 10 inches below the general level of the region.

The surface layer of the Phillips soils is a loose silty mulch from 1 to 5 inches thick. It is underlain by a grayish-brown or dark grayish-brown loam or sandy loam. At an average depth of about 9 inches, the material is a rich brown or rather dark brown, tough heavy claypan which is the distinguishing characteristic of these soils. A strong concentration of lime and gypsum occurs immediately below the claypan.

The bare spots occur where the loose upper two layers are removed by the wind and the compact brown clay layer is exposed. They normally support little vegetation. The location of the slick spots usually show up in grainfields a number of years after the land has been broken out. In dry seasons, the grains on the bare spots have a stunted growth and are the first to show signs of firing.

Barnville Series

Barnville soils, which encompass a small area in the southwestern quadrant of the test site, have a loose, shallow, light grayish-brown sandy mulch on the surface. The humus-bearing layers are brown or dark grayish-brown, slightly columnar loams, or silt loams, from 4 to 6 inches thick. In segments of sandstone, some gravel occur in all layers above the sandstone from which these soils are developed. The more level areas of this soil are considered marginal farming land and the more rolling areas can be utilized only for grazing.

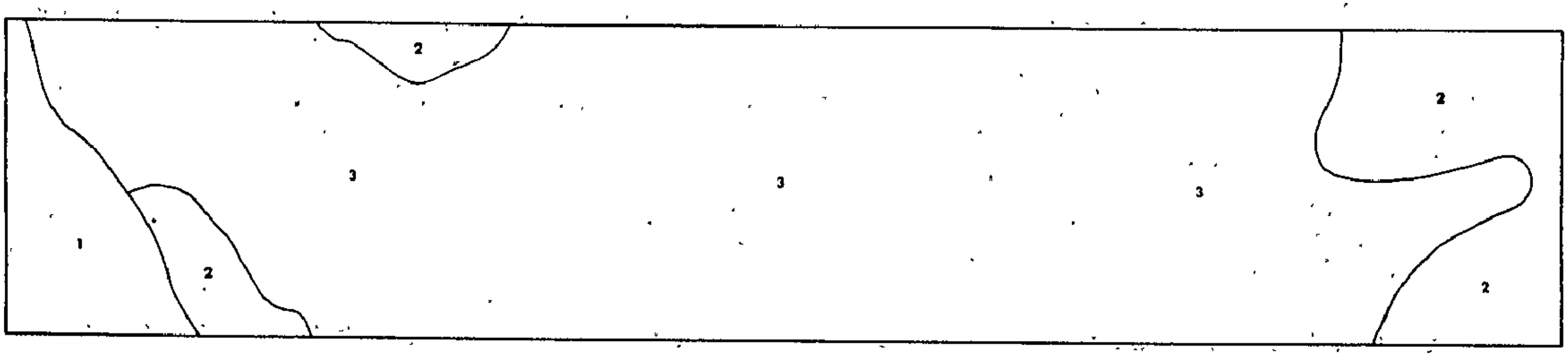
4.1.4.3 Liberty County. The soils in Liberty County are of the Mollisol order, Boroll suborder, and Argiboroll great group. (See fig. 4-9.)

Joplin Series

The predominant soils of the Liberty County test site are the Joplin soils. They encompass over five percent of the test area. These soils occur on the glaciated upland. The surface soils are a grayish-brown color. In unplowed soil, a loose floury grayish-brown mulch is well developed, but in the plowed soil this is mixed with the layer below. The lower part of the 6- to 8-inch surface soil is brown or grayish-brown loam which is fine but not compact. Under the plow, the material in this layer breaks into small clods. Below this the soil material becomes lighter in color and more friable. Gravel and boulders are scattered over the surface of these soils or embedded in the soil at all depths, but they are not sufficiently abundant to seriously interfere with cultivation and, in places, the soils are almost stone-free. These soils have a fair water-holding capacity.

In some of the Joplin soils, especially those in the extreme western portion of the site, the upper two layers contain silt and very fine sand in sufficient quantity to give the surface soil a smooth silt loam texture.

The Phillips soils described elsewhere in this text cover portions of the western area as well as the extreme eastern portion of the site.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

LEGEND

1 — Joplin Silt Loam
2 — Phillips Loams
3 — Joplin Loams

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 4-9. — Liberty County, Montana LACIE Intensive Test Site soil classification map.

4.1.4.4 Toole County. The soils in Toole County are of the Mollisol order, Boroll suborder, and Argiboroll great group. (See fig. 4-10.)

Many of the soils which are situated in the Toole County test site have been described elsewhere in the text. The Phillips soils cover a small area in the west-central and north-central regions of the site. Soils of the Joplin series cover a majority of the western third of the site. Soils of the Scobey series encompass the west-central portion of the site. Alluvial soils are scattered throughout the western portion of the site.

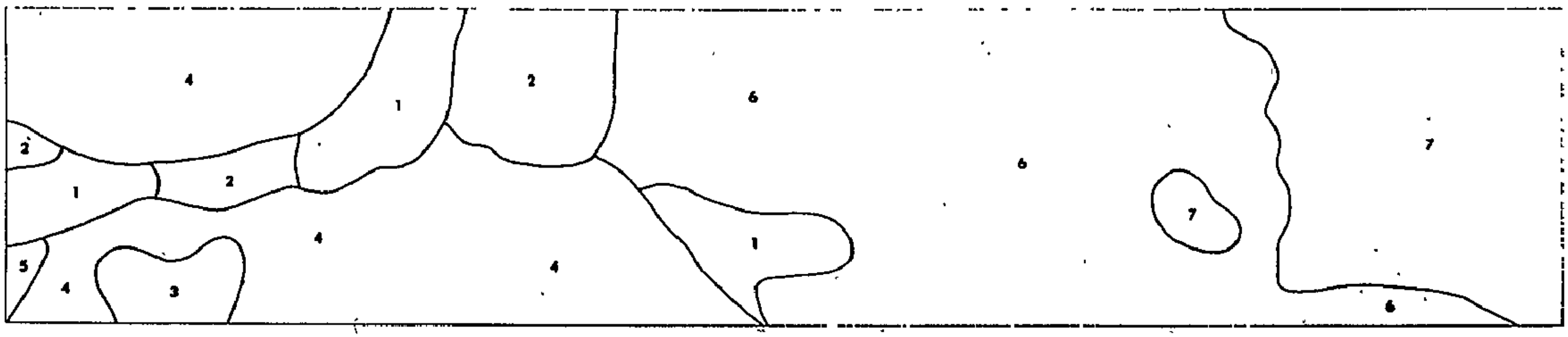
Williams Series

The soils of the Williams series, which cover the eastern quarter of the site, are the darkest colored upland soils in Montana and, when wet, appear almost black. The color is caused by a large content of black organic matter. The topmost 2 or 3 inches of the soil, in cultivated land, is loose and mellow. The lower part of the dark surface soil is firmer than the upper part and in places is slightly compact. Rock fragments, gravel, and boulders may occur at any depth in these soils and are, at certain locations, scattered over the surface.

4.2 PRINCIPAL CROP PRODUCTION

4.2.1 State

Most of Montana, except for the mountainous western portions of the state, contains large areas of farmland. Barley, oats, and spring wheat are predominantly grown in the north-central and northeast portions of the state. Winter wheat is grown mostly in the north, south-central, and east-central portions of the state. Flaxseed is predominantly grown in the northeast portion, while sugarbeets are grown in the southeast and east-central regions of the state. Hay is grown throughout Montana.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

LEGEND

1 — Alluvial Soils
2 — Phillips Loams
3 — Joplin Stony Loams
4 — Joplin Loams

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 4-10. — Toole County, Montana LACIE Intensive Test Site soil classification map.

4.2.1.1 Glacier County. The principal crops grown in Glacier County include barley, wheat, and hay. Table IV-7 shows acreage planted and harvested and yield for the principal crops for the years 1971, 1972, and 1973.

Fluctuations in crop acreages can be detected in table IV-7. Normally, as barley acreage increases, wheat acreage decreases and vice versa. Little acreage of the planted crops are under irrigation. Barley is the major small grain crop in Glacier County. In 1972, Glacier County was the number one county in Montana in barley production. Spring wheat is the second ranking grain crop in this county.

Land usage for Glacier County is shown in table IV-8. Average farm size is over 4,500 acres in the county. Of the 1,897,024 acres in the county, approximately 80 percent of this acreage is land in farms according to the 1969 Census of Agriculture (table IV-9).

4.2.1.2 Hill County. The principal crops grown in Hill County include wheat, barley, oats, and rye. Table IV-10 shows acreage planted and harvested and yield of the principal crops for the years 1971, 1972, and 1973.[1]

In 1972, Hill County ranked high in agricultural production of grains in Montana and in total wheat production, it was third. The county was second in winter wheat production, fourth in spring wheat production, and sixth in total barley production.

Land utilization for Hill County is shown in table IV-11. Average farm size is 2,410 acres in the county. Of the 1,873,216 acres in the county, approximately 99 percent is land in farms according to the 1969 Census of Agriculture (table IV-12).

---

[1]Statistical acreage figures for rye and hay are not available for 1972 and 1973.

TABLE IV-7. – ANNUAL CROP PRODUCTION IN GLACIER COUNTY, MONTANA (1971 to 1973)

Crop	Planted acres (1000)			Harvested acres (1000)			Yield per acre, bushels		
	1971	1972	1973	1971	1972	1973	1971	1972	1973
Winter Wheat	9.8	21.0	15.0	9.6	16.0	13.0	31.0	36.1	25.1
Spring Wheat	55.0	37.0	38.0	53.4	36.0	38.0	28.1	37.1	18.1
Total Wheat	64.8	58.0	53.0	64.1	52.6	51.5	28.4	36.8	19.9
Barley	96.0	111.0	128.8	94.0	106.5	127.5	35.2	54.1	26.2
Oats	4.4	3.3	4.9	2.9	1.9	3.4	46.2	30.9	25.6
Rye	-	-	-	-	-	-	-	-	-
Hay	-	-	-	[a]26.2	N/A	N/A	-	-	-

[a]Tons

TABLE IV-8. — LAND IN FARMS[a] ACCORDING TO USE IN GLACIER COUNTY, MONTANA

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	254	174,761	283	183,667
Cropland used only for pasture or grazing	57	10,113	39	20,566
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	12	826	32	5,315
Cropland on which all crops failed	3	1,243	32	2,403
Cropland in cultivated summer fallow	190	154,967	189	140,313
Cropland idle	27	9,510	25	14,174
Total cropland	263	351,420	-	365,438
Woodland pastured	5	3,178	5	1,515
Woodland not pastured	1	2,029	2	5,918
Total woodland	5	5,207	6	7,433
Improved pastureland and rangeland	23	9,560	40	8,214
Pastureland and rangeland not improved	195	407,842	-	767,354
Total pastureland and rangeland (other than cropland and woodland pasture)	203	417,402	242	775,568
All other land	141	9,615	269	15,187
Irrigated land	54	12,344	70	12,713
Total pastureland (all types)	227	430,693	-	797,649

[a] Farms with sales of $2500 and over.

TABLE IV-9. — AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN GLACIER COUNTY, MONTANA (1969)

Crop	Percent, %
Wheat	15.08
Hay	7.43
Other Small Grains	27.11
Other Crops	50.38

TABLE IV-10. — ANNUAL CROP PRODUCTION IN HILL COUNTY, MONTANA

Crop	Planted acres (1000)			Harvested acres (1000)			Yield per acre, bushels		
	1971	1972	1973	1971	1972	1973	1971	1972	1973
Winter Wheat	218.0	254.0	298.0	210.0	197.0	285.0	26.7	20.0	22.6
Spring Wheat	227.0	184.0	153.0	219.0	178.0	140.0	21.1	20.0	14.0
Total Wheat	446.5	439.3	452.1	431.2	376.2	435.0	23.8	20.0	19.6
Barley	102.2	93.8	97.0	101.0	92.4	94.6	31.0	30.1	20.2
Oats	16.4	31.7	27.1	3.7	3.0	N/A	30.7	33.0	22.0
Rye	2.2	-	-	0.8	N/A	N/A	36.0	-	-
Flaxseed	0.1	N/A	N/A	0.1	N/A	N/A	N/A	N/A	N/A
Hay[a]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a]In 1971 29.4 tons of hay were harvested.

TABLE IV-11. — LAND IN FARMS[a] ACCORDING TO USE IN HILL COUNTY. MONTANA

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	666	494,279	692	466,272
Cropland used only for pasture or grazing	103	20,641	65	15,402
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	47	9,158	130	17,971
Cropland on which all crops failed	48	17,214	63	19,373
Cropland in cultivated summer fallow	598	514,864	663	515,856
Cropland idle	111	19,467	125	15,037
Total cropland	675	1,075,623	-	1,049,911
Woodland pastured	6	632	7	1,116
Woodland not pastured	4	1,650	2	85
Total woodland	9	2,282	9	1,201
Improved pastureland and rangeland	81	34,487	117	20,764
Pastureland and rangeland not improved	411	579,840	-	580,396
Total pastureland and rangeland (other than cropland and woodland pasture)	434	614,327	466	601,160
All other land	417	614,327	659	44,454
Irrigated land	57	27,696	42	3,275
Total pastureland (all types)	476	635,600	-	617,678

[a]Farms with sales of $2500 and over.

TABLE IV-12. — AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN HILL COUNTY, MONTANA (1969)

Crop	Percent, %
Wheat	32.68
Hay	2.87
Other small grains	10.54
Other crops	53.91

4.2.1.3 Liberty County. The principal crops grown in Liberty County include wheat, barley, oats, and hay. Table IV-13 displays acreage, planted and harvested, and yields of the principal crops for the years 1971, 1972, and 1973.

Liberty County ranked seventh in Montana in total wheat production in 1972. As table IV-13 shows, spring and winter wheat acreage have fluctuated greatly since 1971. In 1972, Liberty County ranked seventh in the state in spring wheat production and eleventh in the state in barley production.

Land utilization for Liberty County is shown in table IV-14. Average farm size is over 2,900 acres in the county. Of the 920,640 acres in the county, approximately 97 percent of this acreage is land in farms according to the 1969 Census of Agriculture (table IV-15).

4.2.1.4 Toole County. Toole County was the third leading county in Montana in barley production in 1972. It ranks sixth in the state in spring wheat production and tenth in total wheat production.

The principal crops grown in Toole County include wheat, barley, and hay. Table IV-16 shows acreage, production, and yields of the principal crops for the years 1971, 1972, and 1973.

Land utilization for Toole County is shown in table IV-17. Average farm size is over 2950 acres in the county. Of the 1,247,872 acres in the county, approximately 97 percent of this acreage is land in farms according to the 1969 Census of Agriculture (table IV-18).

4.2.2 Cropping Systems

In view of Montana's surface and climatic features, stripcropping and terracing are practiced in the state. These are primarily geared toward soil and water conservation. The soils of the north-central and northeast parts of the state produce good crops without extensive irrigation. In fact, only 17 percent of the total harvested cropland in 1971 was under irrigation. Crop rotation is not practiced extensively in the state.

TABLE IV-13. — ANNUAL CROP PRODUCTION IN LIBERTY COUNTY, MONTANA (1971 TO 1973)

Crop	Planted acres (1000)			Harvested acres (1000)			Yield per harvested acre			Unit
	1971	1972	1973	1971	1972	1973	1971	1972	1973	bu
Winter Wheat	70	70	99	67.6	53	95.5	27.5	26	20	bu
Spring Wheat	132	127	76	128.3	123	73	23	21	10	bu
Total Wheat	203.7	197.6	175.5	197.3	176.5	159.5	24.5	22.5	15.4	bu
Barley	72	79.2	88.5	70	75	85.1	35	30	14.3	bu
Oats	2.4	5.4	4.2	1.6	1.8	1.3	42	33	26.6	bu
Rye	—	—	—	—	—	—	NA	NA	NA	bu
Hay				10.8	NA	NA	NA	NA	NA	ton

TABLE IV-14. – LAND IN FARMS[a] ACCORDING TO USE IN LIBERTY COUNTY, MONTANA

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	279	243,612	299	254,855
Cropland used only for pasture or grazing	41	9,410	28	2,879
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	56	4,245	78	9,088
Cropland on which all crops failed	7	2,197	29	4,309
Cropland in cultivated summer fallow	273	275,398	291	269,854
Cropland idle	33	5,659	56	7,660
Total cropland	281	540,621	---	548,645
Woodland pastured	---	---	---	---
Woodland not pastured	1	120	2	40
Total woodland	1	120	2	40
Improved pastureland and rangeland	33	29,435	22	11,643
Pastureland and rangeland not improved	153	289,566	---	351,079
Total pastureland and rangeland (other than cropland and woodland pasture)	178	319,001	202	362,722
All other land	205	26,462	282	17,283
Irrigated land	19	2,274	14	1,271
Total pastureland (all types)	192	328,411	---	365,601

[a]Farms with sales of $2500.00 or more.

TABLE IV-15. — AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN LIBERTY COUNTY, MONTANA (1969)

Crop	Percent %
Wheat	27.98
Hay	2.28
Other small grains	14.8
Other crops	54.94

TABLE IV-16. — ANNUAL CROP PRODUCTION IN TOOLE COUNTY, MONTANA
(1971 TO 1973)

Crop	Planted acres (1000)			Harvested acres (1000)			Yield per harvested acre			Unit
	1971	1972	1973	1971	1972	1973	1971	1972	1973	bu
Winter Wheat	43	34	35	37.3	30	34	29	23.2	16.2	bu
Spring Wheat	150	124	105	145.6	121	94	23	21.5	11.0	bu
Total Wheat	193	158.2	140.2	183.2	151.2	128.2	24.2	21.8	12.4	bu
Barley	116.5	130.5	162.4	116	126	157.7	34	37.0	19.0	bu
Oats	2.6	5.3	5.6	1.8	2.1	2.8	41	47.0	26.0	bu
Rye	1	—	—	.8	NA	NA	40	—	—	bu
Flaxseed	.3	NA	NA	.2	NA	NA	NA	NA	NA	bu
Hay				14.5	NA	NA	NA	NA	NA	tons

TABLE IV-17. — LAND IN FARMS[a] ACCORDING TO USE IN TOOLE COUNTY, MONTANA

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	353	302,807	380	296,411
Cropland used only for pasture or grazing	52	11,908	33	12,162
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	34	2,762	98	14,361
Cropland on which all crops failed	6	1,491	44	8,203
Cropland in cultivated summer fallow	326	310,603	367	302,776
Cropland idle	49	5,858	47	7,002
Total cropland	356	635,429	---	640,915
Woodland pastured	6	4,074	1	200
Woodland not pastured	2	760	---	---
Total woodland	8	4,834	1	200
Improved pastureland and rangeland	38	19,623	43	6,341
Pastureland and rangeland not improved	243	495,566	---	455,563
Total pastureland and rangeland (other than cropland and woodland pasture)	264	515,189	268	461,904
All other land	249	27,129	350	36,947
Irrigated land	31	4,113	21	2,147
Total pastureland (all types)	283	531,171	---	474,266

[a]Farms with sales of $2500 and over.

TABLE IV-18. — AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN TOOLE COUNTY, MONTANA (1969)

Crop	Percent, %
Wheat	23.18
Hay	2.14
Other small grains	23.17
Other crops	51.51

4.2.3 Cropping Calendars

Tables IV-19 and IV-20 display crop calendars for the principal crops in Hill County. These crop calendars can also be used for the other three counties where test sites are located.

4.2.4 Wheat Varieties

In table IV-21, distribution of both winter and spring wheat varieties in the Montana LACIE test sites is listed by the percentage of varieties found in each county.

TABLE IV-19. — CROPPING CALENDAR - PRINCIPAL CROPS GROWN IN THE NORTH-CENTRAL CROP REPORTING DISTRICT OF MONTANA

Crop	SEEDBED PREPARATION			FULL COVERAGE			HEADING, FLOWERING			POST-HARVEST OPERATIONS		
	START	MID-PT.	END	START	MID-PT.	END	START	MID-PT.	END	START	MID-PT.	END
Winter Wheat	AUG 20	SEP 10	SEP 30	MAY 01	MAY 10	MAY 20	JUN 05	JUL 05	JUL 20	AUG 20	OCT 01	OCT 30
Durum Wheat	MAR 26	APR 25	MAY 15	MAY 21	JUN 02	JUN 09	JUL 21	JUL 23	AUG 15	SEP 10	OCT 01	OCT 30
Spring Wheat	MAR 27	APR 23	MAY 14	MAY 20	JUN 01	JUN 08	JUN 20	JUL 21	AUG 15	SEP 10	OCT 01	OCT 30
Rye	AUG 20	SEP 10	SEP 30	MAY 01	MAY 10	MAY 20	JUN 10	JUL 05	JUL 20	AUG 20	OCT 01	OCT 30
Oats	MAR 25	APR 20	MAY 15	MAY 20	JUN 01	JUN 10	JUN 22	JUL 24	AUG 20	SEP 10	OCT 01	OCT 30
Barley	MAR 25	APR 20	MAY 15	MAY 19	MAY 29	JUN 08	JUN 18	JUL 16	AUG 10	SEP 10	OCT 01	OCT 30

TABLE IV-20.- MONTANA: USUAL PLANTING AND HARVESTING DATES, BY CROPS AND PRINCIPAL PRODUCING AREAS

Crop	Usual planting dates	Usual harvesting dates			Principal producing areas and counties
		Begin	Most active	End	
Beans, dry	May 10-June 10	Aug. 25	Sept. 10-Oct. 1	Oct. 5	3, 8
Corn:					
Grain	May 10-June 10	Sept. 15	Sept. 20-Oct. 5	Oct. 15	Statewide
Silage	May 10-June 10	Sept. 1	Sept. 5-Sept. 20	Oct. 5	Statewide
Forage	May 10-June 10	Sept. 5	Sept. 10-Sept. 25	Oct. 1	3, 9
Flaxseed	May 5-June 10	Aug. 20	Sept. 5-Sept. 20	Oct. 5	2, 3
Hay:					
Alfalfa		June 15		Sept. 20	Statewide
Clo-tim		June 25		Sept. 15	Statewide
Wild		July 5		Sept. 15	Statewide
Sugarbeets	Apr. 5-May 20	Oct. 1	Oct. 5-Oct 25	Nov. 5	Statewide
SEED CROPS:					
Alfalfa		Sept. 5	Sept. 15-Oct. 5	Oct. 15	Statewide
Crested wheatgrass		Aug. 1	Aug. 10-Aug. 25	Sept. 1	2, 3, 5, 8, 9
Mustard		Aug. 25	Sept. 5-Sept. 25	Oct. 10	2

TABLE IV-21. — DISTRIBUTION OF WINTER AND SPRING WHEAT VARIETIES
FOR THE FOUR INTENSIVE TEST SITES IN MONTANA
(COUNTY LEVEL DATA)

Percent variety Spring										
County	Winalta	Cheyenne	Warrior	Trapper	Lancer	Winoka	McCall	Froid	Wanser	Other
Glacier	100.0	—	—	—	—	—	—	—	—	—
Hill	73.9	17.3	2.9	5.3	—	0.2	0.4	—	—	—
Liberty	23.0	37.0	—	39.1	—	—	—	—	—	—
Toole	47.0	32.4	5.2	8.8	0.6	1.8	0.6	0.6	1.5	1.5

Percent variety Winter								
County	Fortuna	Manitou	Thatcher	Centana	(a)	Bonanza	Ceres	Other
Glacier	85.3	—	—	—	—	14.7	—	—
Hill	69.7	12.9	11.1	1.7	1.6	—	0.1	2.9
Liberty	88.9	—	3.4	1.8	2.9	—	2.8	0.5
Toole	83.0	—	12.5	—	—	2.7	—	1.8

[a]World Seeds 1809.

INTENSIVE TEST SITE ASSESSMENT REPORT

IDAHO

SECTION FIVE

CONTENTS

PRECEDING PAGE BLANK NOT FILMED

TABLES

FIGURES

5.0 IDAHO INTENSIVE TEST SITES

5.1 REGIONAL DESCRIPTION

Three Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the state of Idaho. These test sites are located in Bannock, Franklin and Oneida counties (fig. 5-1).

5.1.1 Location

TABLE V-1 COUNTY SIZE AND LOCATION OF THE INTENSIVE TEST SITES IN IDAHO

County	Sq. miles	Total acres	N. Lat.	W. Long.	Test site size, miles
Bannock	1122	718,208	42°56.5′	112°25.5′	3x3
Franklin	664	425,024	42°08.0′	111°58.0′	3x3
Oneida	1191	762,200	42°04.5′	112°29.5′	3x3

The test sites in Bannock, Franklin and Oneida counties are located in the southeastern corner of Idaho in the eastern crop reporting district (No. 9).

5.1.2 Physiography

Idaho′s terrain is marked by broad valleys and rugged mountains, arid plains and green prairies, sagebrush deserts and humid forests, spectacular canyons, volcanic deposits and old limestone coastlines, gentle hills and glaciated peaks, rangeland and all types of farms - dry, irrigated and naturally watered.

All of Idaho is in the Columbia River basin, except the southeastern corner, which is drained by the Bear River flowing into the Great Salt Lake basin. Most of the state is tributary to the Snake River and consists of a series of steep mountain masses and ranges running north and south.

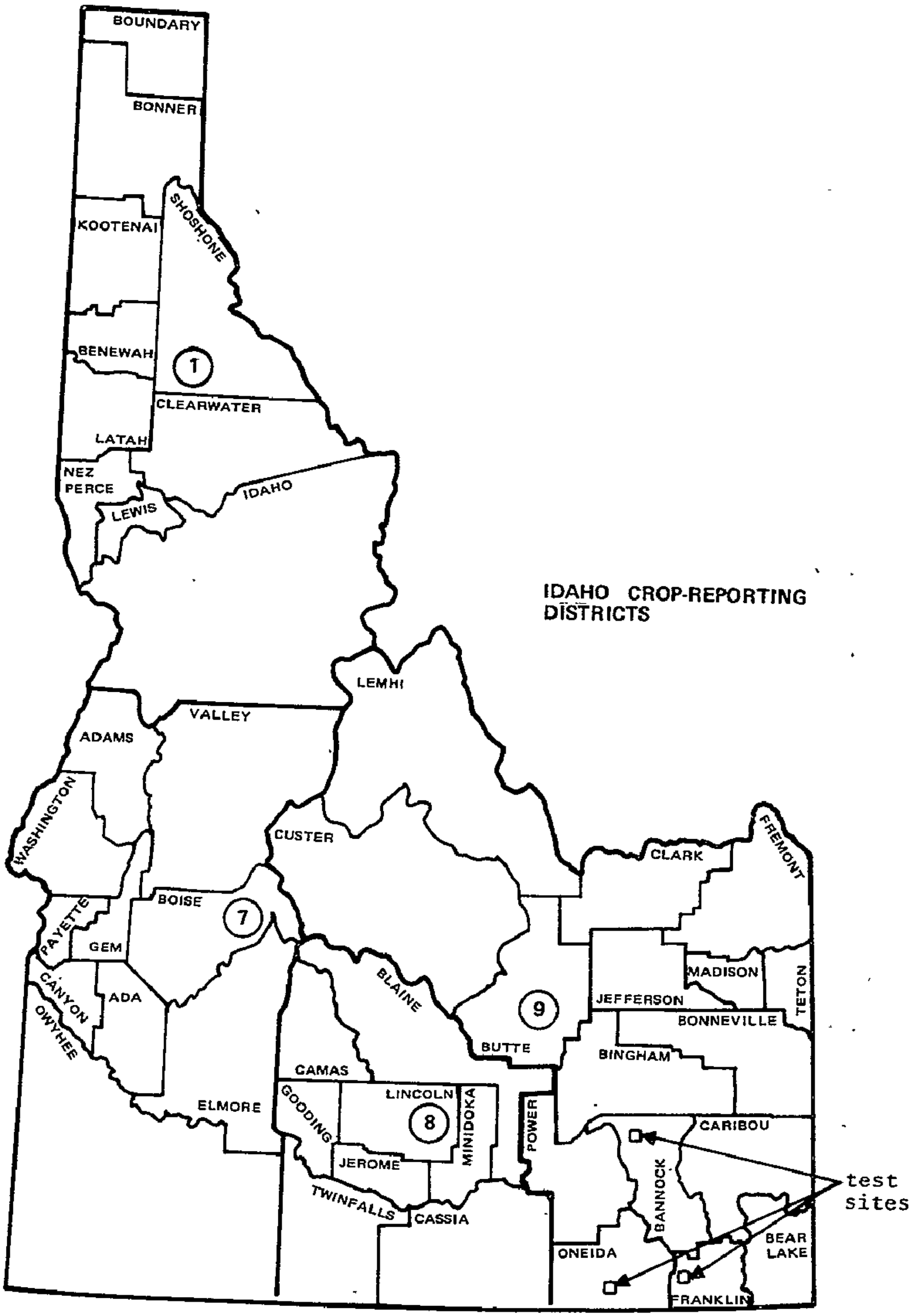


Figure 5-1. – Location of the three Intensive Test Sites in Idaho.

The valleys between these ranges, typical of the southeastern part of the state where the test sites are located, are used intensively for agriculture.

The valley floors vary from fairly level to rather rough and in places are badly eroded. A large part of the area is occupied by old lava flows. Although the mantle of soil laid over the lava beds has tended to make the surface smooth, most areas of any extent are somewhat uneven or rolling. Some valley floors are occupied by large alluvial flats and alluvial fans. The fans, which are of considerable size, vary from gently sloping to steeply sloping or rolling.

In the regions covered by lava flows there are large areas without distinct drainage channels. The surface water goes into small depressions or into crevices in the bedrock.

The much larger central and southern portions of the state, where numerous mountain ranges form barriers to the free flow of air from all points of the compass, average higher in elevation than the northern part. This physical feature of the state explains largely the possibility of growing winter varieties of wheat in this area of the United States.

Physiographic information for each of the three individual counties of interest is not available at the present time.

5.1.3 Climate

Comprised of rugged mountain ranges, canyons, high grassy valleys, arid plains, and fertile lowlands, Idaho reflects in its topography and vegetation a wide range of climates. Located some 300 miles from the ocean, Idaho is influenced by maritime air borne eastward from the Pacific on the prevailing westerly winds. Particularly in winter, the maritime influence is noticeable in the greater average cloudiness, greater frequency of precipitation and mean temperature above those at the same latitude and altitude in midcontinent. Eastern Idaho, which includes Bannock, Franklin and Oneida, has a more continental climate than the rest of the state, a fact quite evident not only in the somewhat greater range between winter and summer temperatures, but also in the reversal of the wet-winter, dry-summer pattern.

The pattern of average annual temperatures for the State indicates the effect both of latitude and altitude. Table V-2 shows some related climatic data for Bannock, Franklin and Oneida Counties. Average monthly, seasonal and annual temperature and precipitation (table V-3) are given for Pocatello, Idaho, a city near the test site in Bannock County. Similar data are not available for Franklin and Oneida Counties. To a large extent, the source of moisture for precipitation in Idaho is the Pacific Ocean. In summer, there are some exceptions to this when moisture-laden air is brought from the south at high levels to produce thunder-shower activity, particularly in the eastern part of Idaho. Precipitation is generally higher in the north than in south Idaho and in the latter, most of the precipitation is received in the winter time.

Snowfall distribution is affected both by availability of moisture and by elevation. The major mountain ranges of the state accomodate a deep snow cover during the winter months, and the release of water from melting snow in late spring furnishes irrigation water for more than 2 million acres. Irrigation water supplies are nearly always plentiful, except on some of the smaller projects where storage facilities are inadequate.

The annual average percentage of possible sunshine ranges from about 50 percent in the north to about 70 percent in the south. Winter, with its frequent periods of cloudy weather, has about 40 percent of possible sunshine in the large open valleys of the south and less than 30 percent in the north, but in July and August the average percentage rises to the upper eighties in the southwest and to near 80 percent in the east and north.

The growing season (freeze-free period), like the average temperature, varies greatly throughout the state because of the differences in elevation, soil type, topography and vegetative cover.

5.1.4 Soils

The southwest region of Idaho where the test sites are located is characterized by a comparatively light annual precipitation, and this gives to the soils certain general characteristics which distinguish them from soils of the more humid parts of the U.S. The soils are generally

TABLE V-2.- ELEVATION, MEAN TEMPERATURE, GROWING SEASONS AND ANNUAL PRECIPITATION IN THE THREE COUNTY TEST SITES IN IDAHO

Location	Elevation, ft.	Mean Daily, °F January Min.		July Min.	Max.	Length of growing season, days	Precipitation Annual	Jan.	July
		Min.	Max.	Min.	Max.		Annual	Jan.	July
Pocatello, Bannock	4454	14.1	31.9	54.8	88.9	142	10.85	1.21	.51
Preston, Franklin	4815	11.2	32.5	50.5	90.2	118	15.49	1.50	.65
Malad City, Oneida	4420	13.1	32.2	53.1	89.0	128	13.97	1.51	.74

TABLE V-3.- AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT POCATELLO, BANNOCK COUNTY, IDAHO

Month	Temperature average, °F	Precipitation average, inches
December	27.4	1.0
January	22.3	1.21
February	27.2	0.92
Winter	25.6	3.13
March	35.8	1.02
April	46.5	1.06
May	55.1	1.13
Spring	45.8	3.21
June	62.8	0.96
July	72.4	0.51
August	70.1	0.55
Summer	68.4	2.02
September	60.3	0.61
October	49.1	0.89
November	35.0	0.99
Fall	48.1	2.49
Year	47.0	10.85

[a]Averages for period 1931-1960.

lighter in color owing to the presence of a smaller percentage of organic matter. They are comparatively rich in the mineral plant foods, which have not been leached out in great extent, but are poorer in nitrogen. However, the soils are leached to a greater extent than are the soils of the drier Snake River plains of the northwest intermountain region to the west and the soils of the arid southwest. Thus, they hold an intermediate portion between truly humid and arid soils, in regard to both organic and soluble mineral content.

The soils of the area may be divided, in general way, into soils with well-developed profiles and those which are comparatively recent and without true profiles. The well-developed upland soils of the area range in color from light brown to strong brown or dark brown. The color varies with the content of organic matter in the soil which is derived largely from the moisture supply for grass grown under natural conditions. The lower open valley lands, under an annual average precipitation of slightly more than 13.5 inches, have light brown or brown soils, whereas in the higher valleys and on mountain slopes where rainfall is greater the soils are brown or dark brown. The variations in color of the soils are also correlated with the variation in the depth to which lime and other comparatively soluble salts have been leached.

The mountains of the region have contributed a large part to the soil material found in the valleys. They are composed mostly of sedimentary rocks, including limestone, quartzites, sandstone and more rarely, shales. The great majority of the soil-forming materials have been transported either by water or by wind. With the exception of the rough mountain land, the soils derived from wind-laid materials cover by far the larger percentage of the area. They consist largely of fine, floury, wind-borne material, or loess, much of which has been carried from a great variety of rocks. It is probable that practically all the soils of the area have been modified to some extent by deposition of wind-blown material. Small areas are covered by coarser sandy material which has been blown short distances, most of it from dry stream channels or from exposed lava beds.

Bannock County soils are of the Mollisol order, Xeroll sub-order and Argixeroll and Haploxeroll great groups.

Franklin County soils are in the same order, suborder and great group as Bannock County.

Oneida County soils are of the same order, suborder, and great groups as Bannock and Franklin with the addition of the Aridisol order, Argid suborder and Haplargid great group. Refer to table V-4 and figures 5-2, 5-3, and 5-4 for a more detailed description.

A comprehensive description of test site soil types can not be given in the absence of current soil survey information for the county locations. This survey is currently being undertaken by the Soil Conservation Service.

5.2 PRINCIPAL CROP PRODUCTION

5.2.1 State

Although Idaho is a rural state, it is easy to forget that agriculture is the cornerstone of the state's economy. It ranks fifth in the U.S. in per capita receipts from farm and first among the western states. Farm receipts come from crops and livestock products in about equal shares. Among the crops grown in the state, vegetables, 80 percent of which are potatoes, are the major source of farm income. In 1970, food grains, consisting mostly of wheat and very little rye, contributed about 8 percent of total farm receipts. Production of feed crops, which include oats, corn, barley, and hay, account for smaller contributions to farm income among crops.

The upper portion of the Snake River Basin has large areas of both irrigated and nonirrigated farmland. At some of the higher elevations in the eastern part of the state, the land is used primarily for livestock ranches and wheat farms. At somewhat lower elevations, some of the principal crops are potatoes, beans, and sugar beets. Hay, consisting primarily of alfalfa, occupies more than one-third of the eastern part of the state.

Although wheat, both winter and spring, is grown in all counties of Idaho, production is more concentrated in the north and east crop reporting districts of the state. In 1972, 81.3 percent of total wheat acreage was grown to winter wheat. About 52 percent of winter wheat acreage was

TABLE V-4.- DESCRIPTIONS OF THE THREE IDAHO COUNTY SOILS

Classification	Description
MOLLISOLS	Soils that have nearly black friable organic rich surface horizons high in bases formed mostly in subhumid and semiarid warm to cold climates.
Xerolls	Mollisols that are in climates with rainy winters but dry summers; during the warm season of the year, these soils are continually dry for a long period; used for wheat, range and irrigated crops.
Argixerolls (formerly Brunizems)	Xerolls that have a subsurface horizon of clay accumulation that is relatively thin or is brownish.
M15-12	Argixerolls plus Xerorthents (shallow), Xeralfs, and Rock land steep.
Haploxerolls (formerly Chestnut and Brown soils)	Xerolls that have a subsurface horizon high in bases but without large accumulations of clay, calcium carbonate, or gypsum.
M16-3	Haploxerolls plus Argixerolls and Xerorthents, gently sloping to steep.
M16-4	Haploxerolls plus Calciaquolls and Argixerolls, gently or moderately sloping.

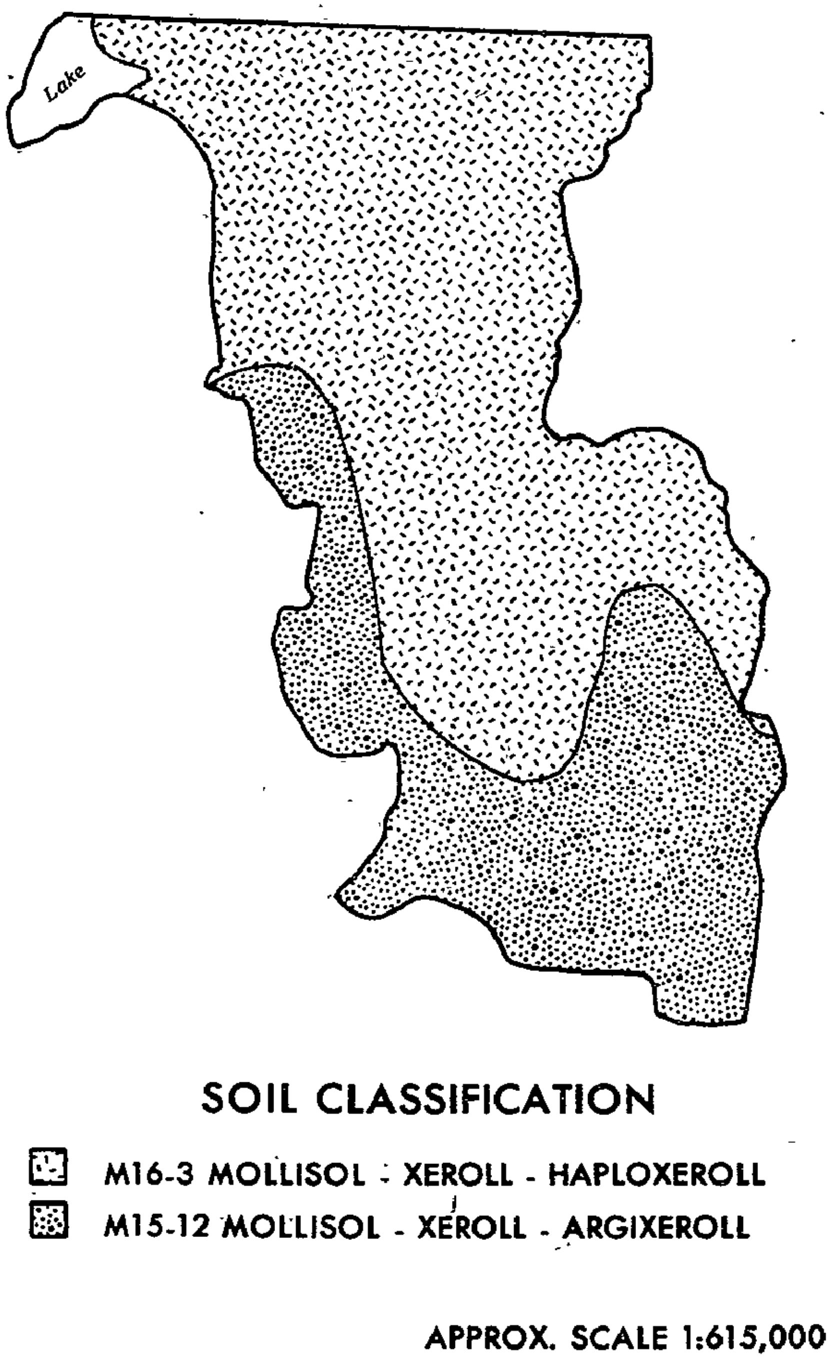


Figure 5-2. — Soil classification map of Bannock County, Idaho.

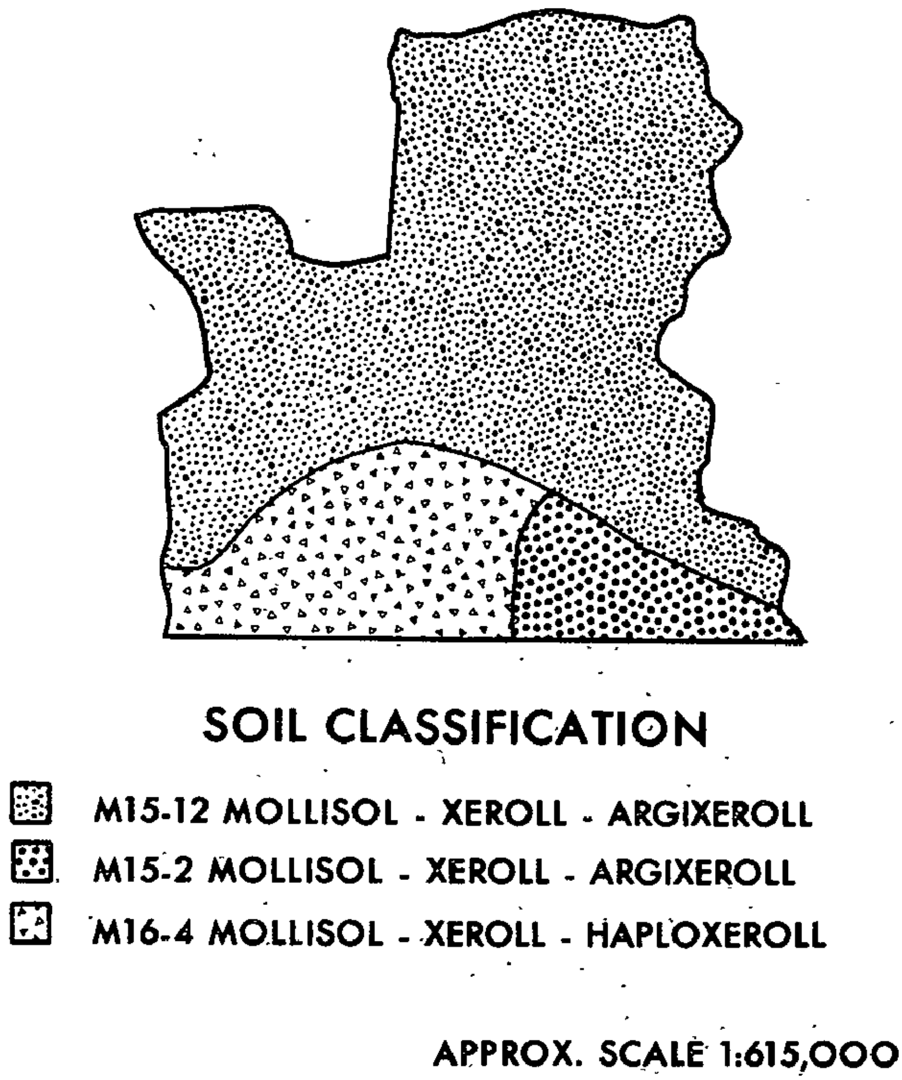
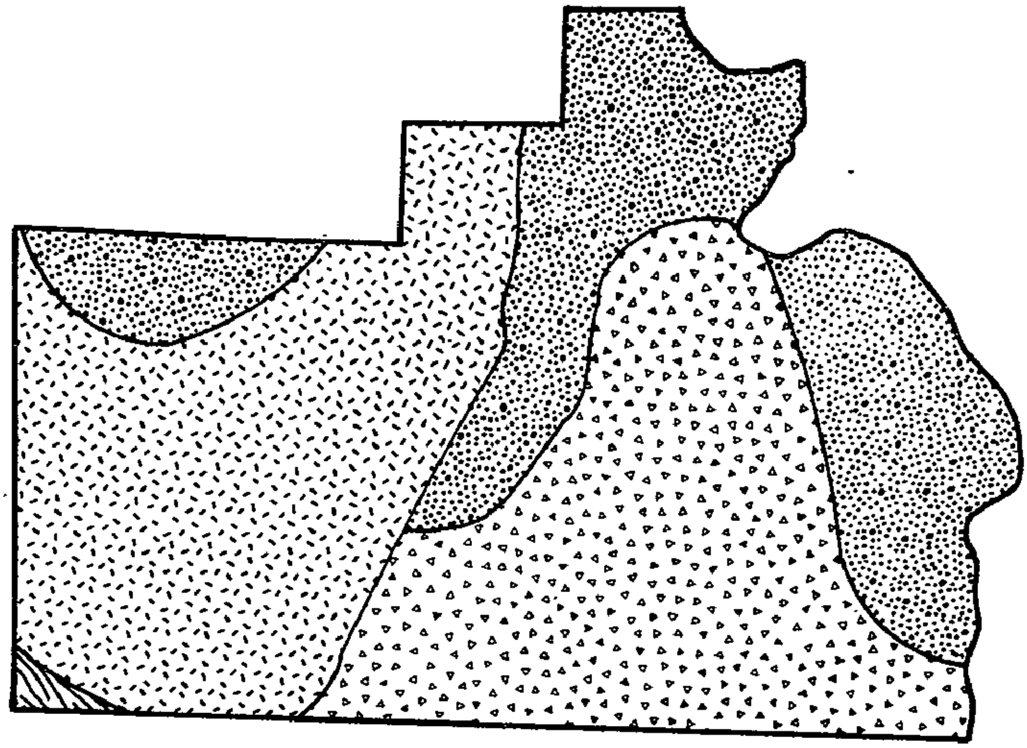


Figure 5-3. — Soil classification map of Franklin County, Idaho.



SOIL CLASSIFICATION

M15-12 MOLLISOL - XEROLL - ARGIXEROLL

M16-3 MOLLISOL - XEROLL - HAPLOXEROLL

M16-4 MOLLISOL - XEROLL - HAPLOXEROLL

D2-5 ARIDISOL - ARGIDS - HAPLARGIDS

APPROX. SCALE 1:615,000

Figure 5-4. — Soil classification map of Oneida County, Idaho.

in the east district and about 32 percent in the north district. Most of the spring wheat (88 percent) is produced in the east and southcentral districts. Overall, Idaho produces winter wheat on about 80 percent of the total wheat acreage.

In the north crop reporting district, wheat is generally grown without irrigation. On the other hand, because of lower rainfall, part of the wheat acreage in the south and east regions is under irrigation. In the east crop reporting district, where the Intensive Test Sites are located in the state, about 20 percent and 66 percent of the winter and spring wheat acreage, respectively, are irrigated. The lesser acreage of winter wheat being irrigated in this region is probably explained by the fact that most of its precipitation is received in the winter (see Climate). The distribution of irrigated and nonirrigated wheat is reported for the county test sites in table V-5.

On the average, wheat yields increased two to three times with irrigation. However, the extent of irrigated acreage is probably limited by the topography of this region.

Commercial fertilizers do not seem to be used extensively by the wheat farmers. In 1969, only 34 percent of farms reporting, comprising 31 percent of the corresponding acreage, applied fertilizers to wheat.

5.2.1.1 Bannock county. About 55 percent of the total land area (718,208 acres) of the county was in farmland in 1969. The average farm size was 705 acres. Of the total farmland (392,167 acres), about 53 percent was cropland and the rest was woodland and other miscellaneous farms. (See table V-7 for land use in Bannock County.) The principal crops grown in the county include winter wheat, barley, potato, hay, and silage crops. Acreage and production for these crops are shown in table V-6.

Wheat, both spring and winter combined, is the major crop grown in Bannock County. A crop distribution and intensity of production is reported in table V-8. Other important crops in the county are barley and hay. Acreage devoted to other crops is quite small.

5.2.1.2 Franklin county. About 63 percent of the total land area (425,024 acres) of the county was in farmland in 1969 (see table V-10). The average farm size

TABLE V-5.- IRRIGATED AND NONIRRIGATED PRODUCTION OF WHEAT BASED ON THE HARVESTED ACREAGE IN THE COUNTY TEST SITES OF IDAHO

Crop	1971		1972	
	Acres harvested	Yield, bu	Acres harvested	Yield, bu
Winter Wheat				
1. Bannock County				
Irrigated	2,000	66.0	500	60.0
Nonirrigated	40,000	34.0	39,500	33.0
2. Franklin County				
Irrigated	2,200	65.0	1,400	56.0
Nonirrigated	17,300	34.0	18,000	34.0
3. Oneida County				
Irrigated	2,500	69.0	1,000	60.0
Nonirrigated	46,000	28.9	46,000	27.5
Spring Wheat				
1. Bannock County				
Irrigated	1,900	63.1	2,200	55.0
Nonirrigated	6,100	21.0	4,900	32.0
2. Franklin County				
Irrigated	1,900	63.0	1,000	50.0
Nonirrigated	2,800	21.0	600	30.0
3. Oneida County				
Irrigated	2,200	49.0	600	45.0
Nonirrigated	9,700	19.6	12,400	29.0

TABLE V-6.- ANNUAL CROP PRODUCTION IN BANNOCK COUNTY, IDAHO

FROM 1971 to 1972

Crop	Planted acres(1000)		Harvested acres(1000)		Yield per harvested acre		Unit
	1971	1972	1971	1972	1971	1972	
Winter wheat	46	42.5	42	39.9	35.5	33.3	bu
Irrigated			2	.	66	60	bu
Nonirrigated			40	39.4	34	33	bu
Spring wheat	8.1	7.3	8	7.1		39.1	bu
Nonirrigated			6.1	4.9		32	bu
All wheat	54.1	49.8	50	47	34.8	34.2	bu
Barley	26.8	28.4	26.5	28.2	46.7	44.7	bu
Irrigated			8.2	8.5	55	65	bu
Nonirrigated			18.3	19.7	43	36	bu
Potato	4.5	4.5	4.5	4.3	210	200	cwt
Other Crops[a]							
Silage corn	.297						
Silage sorghum	.020						
Hay	22.8						
Fruits and Veget.	.141						
Others	4.47						

[a]Acreage only.

TABLE V-7.- LAND IN FARMS[a] ACCORDING TO USE IN BANNOCK COUNTY, IDAHO

Use	1969 Farms	1969 Acres	1964 Farms	1964 Acres
Harvested cropland	346	110,769	383	100,312
Cropland used only for pasture or grazing	210	17,037	198	16,627
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	28	1,298	60	2,011
Cropland on which all crops failed	16	702	21	487
Cropland in cultivated summer fallow	209	61,178	244	61,848
Cropland idle	60	7,776	51	2,783
Total cropland	363	198,760	(NA)	184,068
Woodland pastured	17	4,514	24	10,616
Woodland not pastured	15	3,221	16	3,147
Total woodland	28	7,735	35	13,763
Improved pastureland rangeland	56	8,242	99	9,958
Pastureland and rangeland not improved	179	100,662	(NA)	152,355
Total pastureland and rangeland (other than cropland and woodland pasture)	193	108,904	237	162,313
All other land	259	12,084	363	19,481
Irrigated land	276	46,408	309	39,593
Total pastureland (all types)	313	130,455	(NA)	189,556

[a]Farms with sales of $2500.00 and over

TABLE V-8.- AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN BANNOCK COUNTY, IDAHO IN 1971

Crop	Percent, %
Wheat	47.8
Barley	23.7
Potato	4.0
Silage corn	0.3
Silage sorghum	0.01
Hay	20.2
Fruits and vegetables	0.12
Others	3.9

TABLE V-9.- ANNUAL CROP PRODUCTION IN FRANKLIN COUNTY FROM 1971 TO 1972

CROP	Planted acres(1000)		Harvested acres(1000)		Yield per harvested acre		Unit
	1971	1972	1971	1972	1971	1972	
Winter wheat	21.3	20.5	19.5	19.4	37.5	35.6	bu
Irrigated			2.2	1.4	65	56	bu
Nonirrigated			17.3	18	34	34	bu
Spring wheat	5	1.7	4.7	1.6	38	42.5	bu
Irrigated			1.9	1	63	50	bu
Nonirrigated			2.8	0.6	21	30	bu
All wheat	26.3	22.2	24.2	21	37.6	36.1	bu
Barley	26.6	27.8	25.7	27.5	47.4	47.4	bu
Irrigated			9	9.9	63	64	bu
Nonirrigated			16.7	17.6	39	38	bu
Potato	.8	.8	.8		190	200	cwt
Other crops[a]							
Corn							
grain	.144						
silage	3						
Hay	27.7						
Fruit and veget.	2						
Others	2.3						

[a]Acreage data only.

TABLE V-10.- LAND IN FARMS[a] ACCORDING TO USE IN FRANKLIN COUNTY, IDAHO

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	519	81,648	594	82,841
Cropland used only for pasture or grazing	312	18,879	279	11,318
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	72	2,521	107	6,043
Cropland on which all crops failed	41	801	74	1,495
Cropland in cultivated summer fallow	264	34,060	313	28,584
Cropland idle	80	3,653	83	4,714
Total cropland	533	141,562	(NA)	134,995
Woodland pastured	14	4,894	13	2,356
Woodland not pastured	3	296	1	90
Total woodland	17	5,190	14	2,446
Improved pastureland and rangeland	76	8,481	174	6,720
Pastureland and rangeland not improved	200	74,985	(NA)	121,283
Total pastureland and rangeland (other than cropland and woodland pasture)	239	83,466	398	128,003
All other land	425	15,633	598	10,573
Irrigated land	448	40,456	522	44,403
Total pastureland (all types)	432	107,239	(NA)	141,677

[a]Farms with sales of $2500.00 and over.

was 362 acres. Of the total farmland (265,249 acres) about 58 percent was cropland and the rest were woodland and other miscellaneous farms. (See table V-9 for land use in Franklin County.)

The principal crops grown in the county include winter wheat, barley, potato, hay, and silage crops. Acreage and production for these crops are shown in table V-9.

In terms of acreage, wheat and barley are about of equal importance in Franklin County. In 1972, 25 percent more land was grown to barley than wheat. Another crop of major importance is hay and silage corn. A crop distribution and production intensity is reported in table V-11. Acreage devoted to other crops is extremely small.

5.2.1.3 Oneida county. About 45 percent of the total land area (762,200 acres) of the county was in farmland in 1969. The average farm size was 861 acres. Of the total farmland (341,045 acres), about 68 percent was cropland and the rest were woodland and other miscellaneous farms. (See table V-13 for land use in Oneida County.)

The principal crops grown in the county are wheat, barley, and hay. Other crops of minor importance include potato, corn grain sorghum and others. Acreage and production for these crops are reported in table V-12.

On the basis of acreage and production, wheat occupies the leading role among the crops grown in the county. Crop distribution and intensity are shown in table V-14. More than 50 percent of the total cropland is planted to wheat. The next leading crop is barley.

5.2.2 Cropping Systems

In view of its surface and climatic features, cropping systems such as contour farming, stripcropping, and terracing are practiced in the state. These are primarily geared toward soil and water conservation. The soils of the northern part of the state produce good crops without irrigation. Extensive irrigation systems are found in the vast and fertile Smoke River Plain where most of the potatoes, sugar beets, dry beans, fruit, feed grains, wheat, alfalfa hay, seeds, and vegetables are grown. Crop rotation has not been reported to be practiced extensively in the state.

TABLE V-11.- AREA PLANTED, AS PERCENT OF TOTAL CROPLAND, IN FRANKLIN COUNTY, IDAHO IN 1971

Crop	Percent, %
Wheat	29.6
Barley	29.9
Potato	0.9
Corn	
Grain	0.2
Silage	3.4
Hay	31.2
Fruit and vegetable	2.2
Others	2.6

TABLE V-12.- ANNUAL CROP PRODUCTION IN ONEIDA COUNTY, IDAHO FROM 1971 TO 1972

Crop	Planted acres(1000)		Harvested acres(1000)		Yield per harvested acre		Unit
	1971	1972	1971	1972	1971	1972	
Winter wheat	53	51.5	48.5	47	31	28.2	bu
Irrigated			2.5	1	69	60	bu
Nonirrigated			46	46	28.9	27.5	bu
Spring wheat	12.2	13.3	11.9	13	25	29.7	bu
Irrigated			2.2	.6	49	45	bu
Nonirrigated			9.7	12.4	19.6	29	bu
All wheat	65.2	64.8	60.4	60	29.8	28.5	bu
Barley	25.4	27.8	24.9	27.5	37.7	35.1	bu
Irrigated			3.7	4.1	53	64	bu
Nonirrigated			21.2	23.4	35	30	bu
Potato	.4	.4	.4	.4	170	190	cwt
Other Crops[a]							
Corn	.02						
Silage	.021						
Grain sorghum	.051						
Hay	21.896						
Others	1.2				-		

[a]Acreage only

TABLE V-13.- LAND IN FARMS[a] ACCORDING TO USE IN ONEIDA COUNTY, IDAHO

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	307	104,054	340	117,187
Cropland used only for pasture or grazing	146	16,212	105	14,109
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	55	3,445	49	3,731
Cropland on which all crops failed	35	3,964	14	436
Cropland in cultivated summer fallow	257	93,424	295	85,746
Cropland idle	67	3,699	72	5,963
Total cropland	311	224,798	(NA)	227,166
Woodland pastured	10	4,863	6	2,029
Woodland not pastured	2	400	4	838
Total woodland	11	5,263	9	2,867
Improved pastureland and rangeland	65	17,765	75	7,329
Pastureland and rangeland not improved	159	70,404	(NA)	111,956
Total pastureland and rangeland (other than cropland and woodland pasture)	184	88,169	240	119,285
All other land	220	11,825	322	7,523
Irrigated land	176	24,745	206	22,215
Total pastureland (all types)	244	109,244	(NA)	135,423

[a]Farms with sales of $2500 and over.

TABLE V-14.- AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN ONEIDA COUNTY, IDAHO IN 1971

Crop	Percent, %
Wheat	57.1
Barley	22.2
Potato	0.4
Corn	
Grain	0.02
Silage	0.02
Grain sorghum	0.04
Hay	19.2
Others	1.1

Because of a more adequate rainfall in the northern part of Idaho, crops grown in this area are generally non-irrigated. In contrast, crops grown in the southern portion of the state produce considerably more with irrigation.

Refer to table V-15 for the number of farms and acreage harvested in the counties. Table V-16 relates the number of fields, acreage field size and range in field size for the Intensive Test Sites.

5.2.3 Cropping Calendars

Cropping calendars for the small grains are presented in table V-17. Planting and harvesting dates are presented in table V-18 for the other crops grown in Idaho. The small grain crop calendar data are for the crop reporting district level while the data for the other crops are given on a state level.

5.2.4 Wheat Varieties

Information on the different wheat varieties grown in the three counties of interest in Idaho is not available at the present time.

TABLE V-15.- TOTAL NUMBER OF FARMS AND ACREAGE HARVESTED FOR THE INTENSIVE TEST SITES IDAHO

[COUNTY DATA]

County	No. of farms	Total Acreage
Bannock	457	114,637
Franklin	650	86,463
Oneida	363	106,392

TABLE V-16.- NUMBER ~~OF~~ FIELDS, AVERAGE SIZE AND RANGES IN FIELD SIZE WITHIN THE IDAHO TEST SITES

County	Test Site size, miles	No. of fields	Avg. field size, acre	Range in field size, acre
Bannock	3x3	80-90	55	5-130
Franklin	3x3	295-315	15	2.5-40
Oneida	3x3	60-70	90	10-160

TABLE V-17.- CROPPING CALENDARS FOR THE PRINCIPAL CROPS GROWN IN THE EASTERN CROP REPORTING DISTRICT OF IDAHO

Crop	Seedbed preparation			Full coverage			Heading flowering			Post harvest		
	Start	Mid-pt	End	Start	Mid-pt	End	Start	Mid-pt	End	Start	Mid-pt	End
Winter Wheat	Aug 20	Sep 15	Oct 10	Apr 15	Apr 20	May 25	May 15	Jun 1	Jun 15	Sep 15	Sep 27	Oct 10
Spring Wheat	Apr 5	Apr 25	May 15	May 15	Jun 5	Jun 30	Jun 5	Jun 20	Jul 5	Sep 15	Sep 23	Oct 10
Rye	Aug 20	Sep 15	Oct 10	Apr 15	Apr 20	May 25	May 15	Jun 1	Jun 15	Sep 15	Sep 27	Oct 10
Oats	Apr 5	Apr 25	May 20	May 15	Jun 5	Jun 30	Jun 5	Jun 25	Jul 20	Sep 15	Sep 27	Oct 10
Barley	Apr 5	Apr 28	May 20	May 15	Jun 5	Jun 30	Jun 5	Jun 20	Jul 5	Sep 15	Sep 27	Oct 10

TABLE V-18.- USUAL PLANTING AND HARVESTING DATES BY CROPS IN IDAHO

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Beans, dry	May 15-June 10	Aug. 20	Aug. 25-Sept. 5	Sept. 15
Corn:				
Grain	May 1-May 25	Oct. 10	Oct. 25-Nov. 15	Dec. 10
Silage	May 1-June 5	Sept. 1	Sept. 10-Sept 30	Oct. 10
Forage	May 1-June 5	Oct. 1	Oct. 10-Oct. 30	Nov. 5
Hay:				
Alfalfa		June 5		Oct. 15
Clo-tim		June 20		Sept. 1
Wild		July 10		Aug. 20
Grain		July 25		Aug. 10
Other		June 10		Aug. 15
Lentils	Apr. 15-May 5	Aug. 5	Aug. 15-Aug. 25	Sept. 5
Sugarbeets	Mar. 20-May 10	Oct. 1	Oct. 10-Nov. 10	Nov. 15
SEED CROPS:				
Alfalfa		Aug. 25	Sept. 5-Sept. 25	Oct. 20
Red clover		Sept. 10	Sept. 20-Oct. 10	Oct. 20
White clover		Aug. 10	Aug. 20-Sept. 10	Sept. 20
Merion Kentucky Bluegrass		July 10	July 15-Aug. 1	Aug. 10
Austrian winter peas		Aug. 1	Aug. 15-Sept. 5	Sept. 15

INTENSIVE TEST SITE ASSESSMENT REPORT

WASHINGTON

SECTION SIX

CONTENTS

TABLES

FIGURES

6.0 WASHINGTON INTENSIVE TEST SITES

6.1 REGIONAL DESCRIPTION

Three Intensive Test Sites for the Large Area Crop Inventory Experiment (LACIE) have been selected in the state of Washington. All three test sites are located in Whitman County. Table VI-1 details the county size and the three Intensive Test Site locations.

6.1.1 Location

TABLE VI-1.— WHITMAN COUNTY AND INTENSIVE TEST SITE SIZE AND LOCATION

Whitman County		Test site	N. Latitude	W. Longitude	Test site size, miles
Square miles	Acres				
2,165	1,385,370	1	45°54.6'	117°15.5'	3 × 3
		2	46°50.4'	117°48.3'	3 × 3
		3	47°08.0'	117°26.6'	3 × 3

6.1.2 Physiography

Whitman County is located in the Palouse Hills directly north of the Snake River in southeastern Washington, on the Idaho border. (See fig. 6-1.) The Palouse Hills region, with its composition of loess soil and average annual precipitation of 15 to 25 inches, provides the best soil and moisture conditions conducive to wheat production in the Pacific Northwest. Although the terrain is rolling with generally sloping relief, the loess soil readily absorbs moisture. Also, a reliable seasonal snow cover protects winter wheat from winterkill. In light of these favorable conditions, it is not surprising that the states of Washington and Idaho have the highest wheat yield in the U.S. (47 bu/acre in 1972).

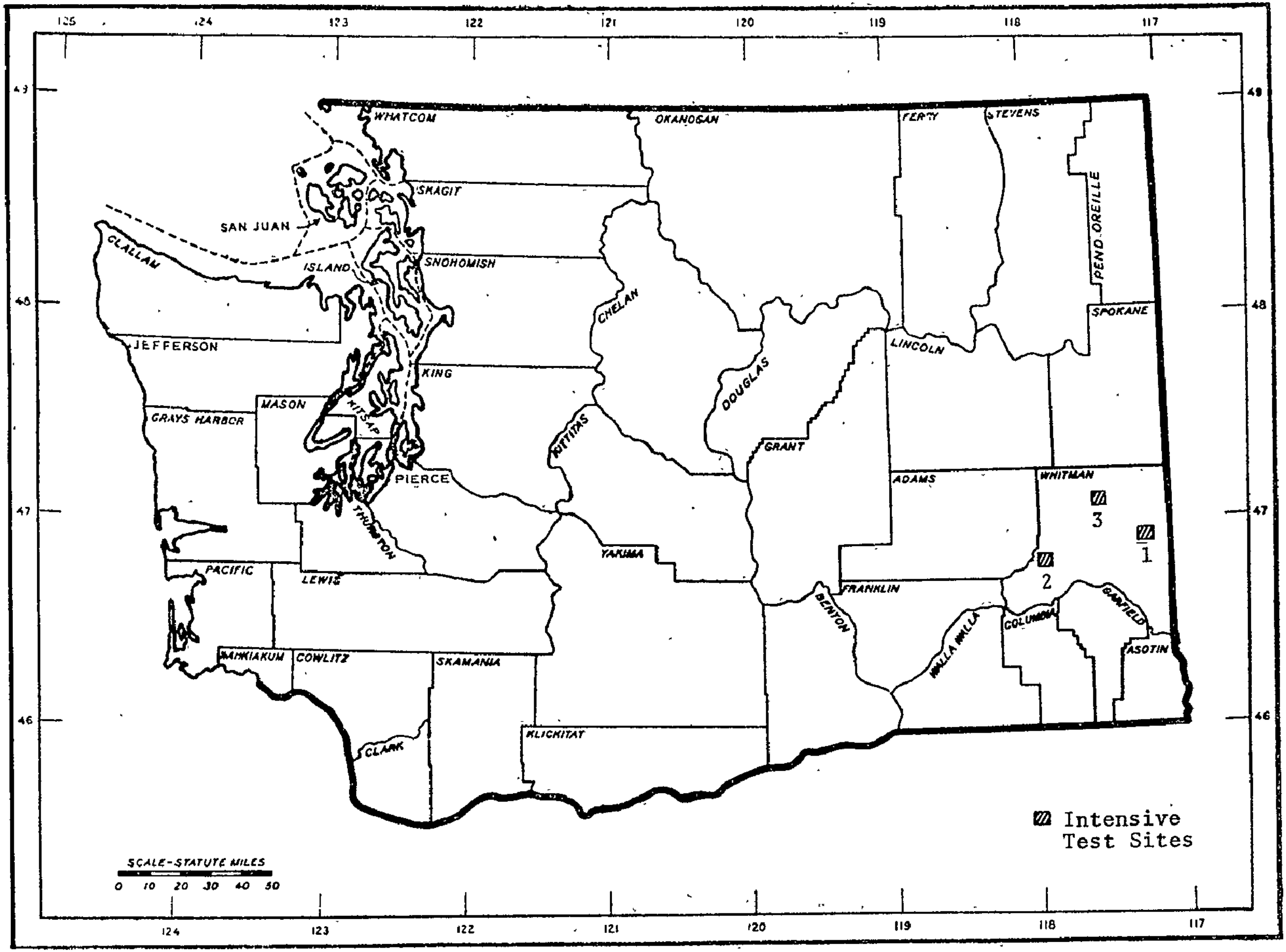


Figure 6-1. — Location of the three Intensive Test Sites in the state of Washington.

ORIGINAL PAGE IS OF POOR QUALITY

Washington is the second leading winter wheat producing state and ranks sixth in spring wheat production. Washington accounted for 8.7 percent (98 million bushels) of the United States spring wheat yields in 1970. Approximately 60 percent of the cropland in Washington is devoted to wheat production.

Whitman County is the leading wheat producing county in the state of Washington, as well as the entire United States. Whitman County also produces approximately 40 percent of Washington's barley.

6.1.3 Climate

The climate of the wheat growing region of Washington to the east of the Cascade Mountains exhibits both continental and marine characteristics. Orographic lifting produces major releases of moisture along the western slopes of the coastal range across to the Cascades. Warming and drying of air as it descends on the eastern slopes of the Cascade Range results in near desert conditions in the lowest part of the Columbia Basin. A gradual increase in precipitation from the lowest elevations of the Columbia Basin towards the Rocky Mountains is also the result of orographic lifting. Ordinarily, drought is not a problem in eastern Washington. The dry season begins at approximately the same time each summer.

Eastern Washington is part of the large inland basin between the Cascades and the Rockies. The Rocky Mountains shield this basin from the continental air masses, especially the cold winter air masses moving southward out of Canada. In the west, the Cascades form a barrier to the eastward movement of moist, comparatively mild winter air as well as the cool air in the summer. Some of the air from each of these sources reaches this section of the state, producing an intermittent continental and marine climate. However, the predominant climatic effect is exerted by prevailing westerly winds. The infrequent intrusion of dry continental air masses usually causes the extremes in both winter and summer temperature.

Specific climatological data for Colfax, the county seat of Whitman County, is listed in table VI-2.

The average number of clear, or only partly cloudy days each month varies from 5 to 10 in the winter, 12 to 18 in spring and fall, and 20 to 28 in summer.

Thunderstorms average 1 to 3 days each month from April through September. Most of the summer thunderstorms occur as isolated cells covering a few square miles. Also, a few damaging hail storms are reported each summer.

Whitman County is located in the Palouse-Blue Mountain section of eastern Washington. Annual precipitation is between 10 to 20 inches over most of the agricultural section, increasing to 40 inches or more in the higher elevations of the Blue Mountains. The average winter snowfall is 20 to 40 inches. The first snow generally falls in November. Winter snowfall can be expected to remain on the ground for periods ranging from a few days to two months between the first of December and March.

The last freezing temperature in the spring is the last of May. The first freezing temperatures usually occur the last of September or the first of October.

During the winter, a loss of heat by radiation at night, and moist air crossing the Cascades and mixing with colder air in the inland basin, results in cloudiness, fog, and an occasional freezing drizzle. "Chinook" winds, which produce rapid rise in temperature, occur a few times each winter.

Frost penetration in the soil depends on the vegetative cover, snow cover, and the duration of low temperatures. In an average winter, frost will reach a depth of 10 to 20 inches. During some winters that have little or no snow cover, frost has reached a depth of 25 to 35 inches.

During the April to September growing season, the average evaporation from a Class A evaporation pan is from 35 to 52 inches. Monthly evaporation in midsummer ranges from 9 to 12 inches. Annual evaporation from lakes and reservoirs is estimated at 26 inches in the mountains and 34 to 42 inches in the wheat growing regions.

TABLE VI-2.— AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT COLFAX, WHITMAN COUNTY, WASHINGTON

Month	Temperature average, °F	Precipitation average, inches
December	33.1	3.04
January	29.2	2.55
February	33.4	1.93
Winter	31.9	7.52
March	40.2	2.14
April	48.2	1.54
May	55.3	1.41
Spring	47.9	5.09
June	60.8	1.64
July	67.8	0.46
August	65.9	0.47
Summer	64.8	2.57
September	59.0	1.12
October	49.4	2.01
November	37.9	2.66
Fall	48.7	5.79
Year	48.4	20.97

[a]Averages for period 1931-1960.

6.1.4 Soils

The soils in Whitman County are for the most part in the Mollisol order with the Alfisol order appearing in the northeast corner of the country. Mollisols are soils that have nearly black friable organic-rich surface horizons high in bases, and are formed mostly in subhumid and semi-arid, warm to cold climates. The suborder of Mollisol, that occurs in Whitman County, is Xeroll. Xerolls are Mollisols that are in climates with rainy winters, but dry summers. During the warm season of the year, these soils are continually dry for a long period. They are used for wheat, range, and irrigated crops. The suborder of Alfisol is Udalf.

The great soil groups to which Whitman County soils belong are Argixeroll (formerly Brunizems) and Hapolxeroll. Argixerolls are Xerolls that have a subsurface horizon of clay accumulation that is relatively thin or is brownish. Haploxerolls (formerly Chestnut and Brown soils) are Xerolls that have a subsurface horizon high in bases, but without large accumulations of clay, calcium carbonate, or gypsum. Hapludalf is the great group of Udalf suborder. (See table VI-3 and fig. 6-2).

The Whitman County soils were predominantly formed in loess, on uplands. Loess soils result from the deposition of wind-transported silt, which has settled out from dust storms over many a thousands of years. It generally has a uniform buff color and lacks any visible layering.

A soil series map of Whitman County, is shown in figures 6-3, 6-4, and 6-5. The three Whitman County test sites include eight of 13 soil associations present in Whitman County. Eleven soil series comprise the 13 soil associations. A brief description of each of the soil series found in the three test sites follows. (See table VI-4.)

Soil map transparencies are available at a scale of approximately 1:24,000. These transparencies can be used to overlay the test site or USDA/ASCS 1:24,000 black and white photography. These transparencies were reduced to fit the 8½-by 11-inch format of this report.

TABLE VI-3. — DESCRIPTION OF WHITMAN COUNTY SOILS

Classification	Description
MOLLISOLS	Soils that have nearly black friable organic rich surface horizons high in bases; formed mostly in subhumid and semiarid warm to cold climates.
Xerolls	Mollisols that are in climates with rainy winters but dry summers; during the warm season of the year, these soils are continually dry for a long period; used for wheat, range, and irrigated crops.
Argixeroll	(Formerly Brunizems) Xerolls that have a subsurface horizon of clay accumulation that is relatively thin or is brownish.
M15-1	Argixerolls plus Argialbolls and Haploxerolls, gently or moderately sloping.
M15-6	Argixerolls plus Haploxerolls, gently or moderately sloping.
M15-11	Argixerolls plus Xerorthents (shallow), Haploxerolls, and rock land, steep.
Haploxerolls	(Formerly chestnut and brown soils) Xerolls that have a subsurface horizon high in bases but without large accumulations of clay, clacium carbonate, or gypsum.
M16-7	Haploxerolls plus Haplaquolls, Durixerolls and rock land, moderately sloping.
ALFISOLS	Soils that are medium to high in bases (base saturation at pH 8.2) and have grey to brown surface horizon and subsurface horizons of clay accumulation; usually moist but during the warm season of the year some are dry part of the time.

TABLE VI-3. – DESCRIPTION OF WHITMAN COUNTY SOILS – Concluded

Classification	Description
Udalf	Alfisols that are in temperate to tropical regions. Soils usually moist but during the warm season of the year may be intermittently dry in some horizons for short periods.
Hapludalf	(Formerly gray-brown Podzolic soils without fragipan) – Udalfs that have a subsurface of clay accumulation that is relatively thin or is brownish.
A7-7	Hapludalfs plus Cryandepts, moderately sloping or steep.

TABLE VI-4. — LEGEND FOR THE WHITMAN COUNTY, WASHINGTON SOIL SERIES MAP

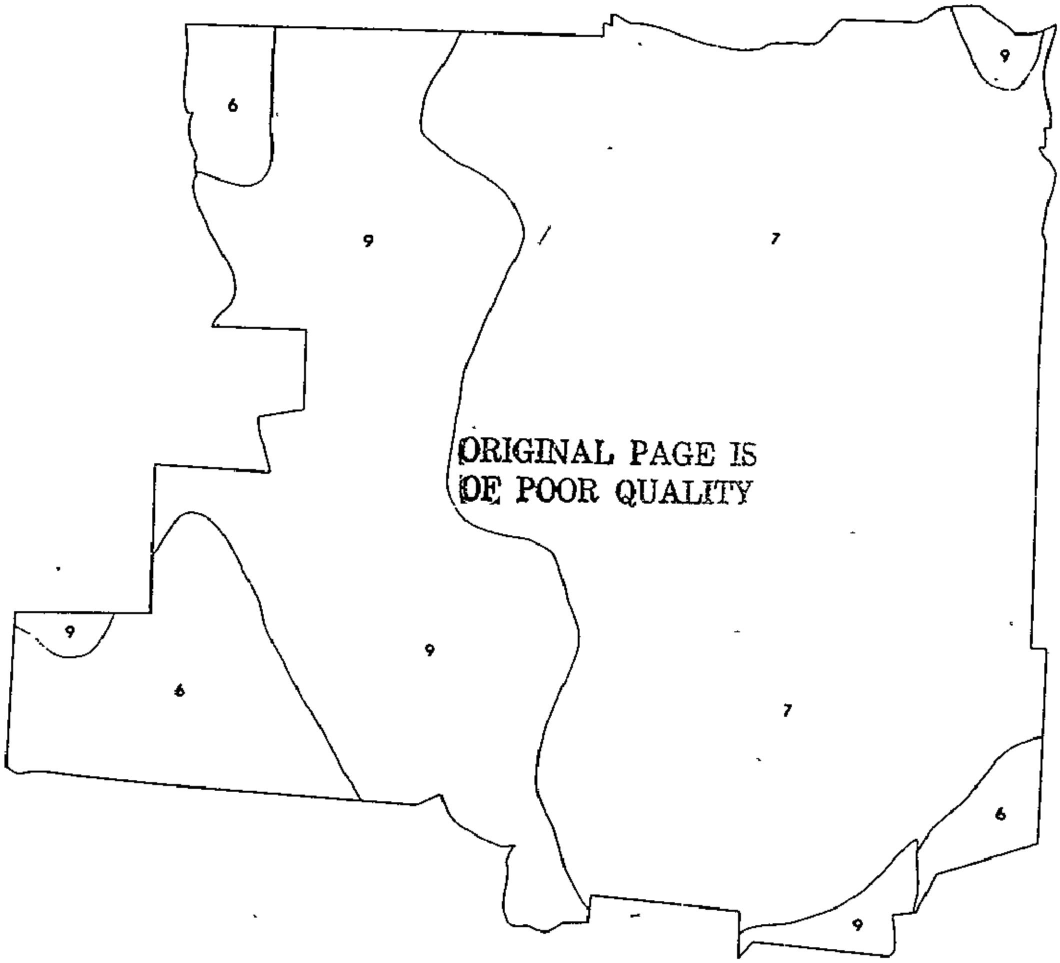
AREAS DOMINATED BY VERY DEEP SOILS FORMED IN LOESS, ON UPLANDS	
1	Walla Walla Association
2	Athena Association
3	Athena-Calouse Association
4	Palouse Association
5	Palouse-Staley Association
6	Palouse-Thatuna Association
7	Palouse-Thatuna-Nall Association
AREAS DOMINATED BY VERY DEEP TO MODERATELY DEEP SOILS FORMED IN LOESS AND IN COLLUVIUM AND RESIDUUM FORM METASEDIMENTS: ON BUTTES	
8	Palouse-Thatuna-Tekoa Association
AREAS DOMINATED BY VERY DEEP SOILS FORMED IN LOESS; IN VALLEYS	
9	Palouse-Athena Association
AREAS DOMINATED BY VERY SHALLOW TO MODERATELY DEEP SOILS FORMED IN LOESS AND GLACIAL OUTWASH; IN CHANNELED SCABLANDS	
10	Anders-Benge-Kuhl Association
11	Bakeoven-Tucannon-Cheney Association
AREAS DOMINATED BY SHALLOW TO VERY DEEP SOILS FORMED IN LOESS AND IN COLLUVIUM AND RESIDUUM FROM BASALT; IN CANYONS	
12	Kuhl-Alpowa Association
13	Starbuck-Alpowa Association

SOIL CLASSIFICATION

- M16-7 MOLLISOL - XEROLL - HAPLOXEROLL
- M15-6 MOLLISOL - XEROLL - ARGIXEROLL
- M15-1 MOLLISOL - XEROLL - ARGIXEROLL
- M15-11 MOLLISOL - XEROLL - ARGIXEROLL
- A7-7 ALFISOL - UDALF - HAPLUDALF

APPROX. SCALE 1:615,000

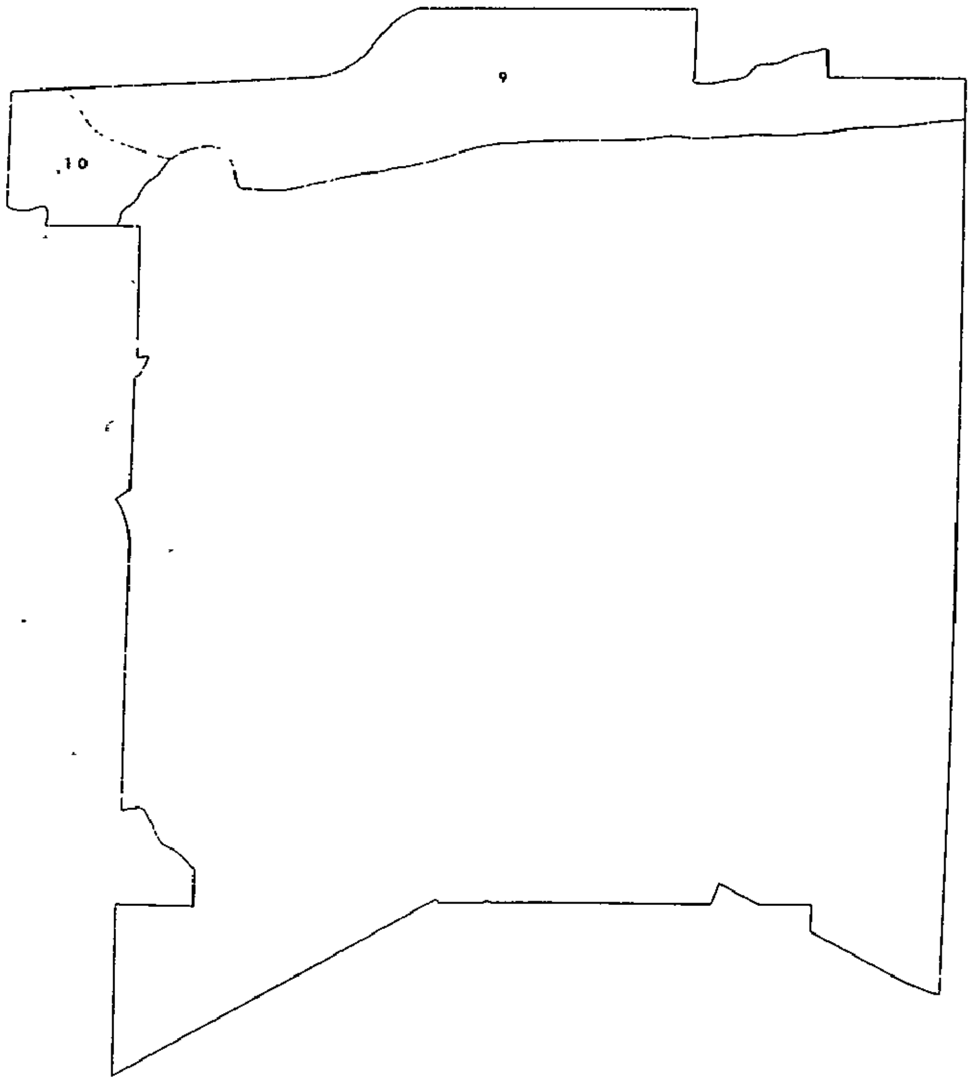
Figure 6-2. — Soil classification map of Whitman County, Washington.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD JSC/NASA
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 6-3. – Whitman County, Washington LACIE Intensive Test Site No. 1 soil classification map.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 6-4. — Whitman County, Washington LACIE Intensive Test Site No. 2 soil classification map.

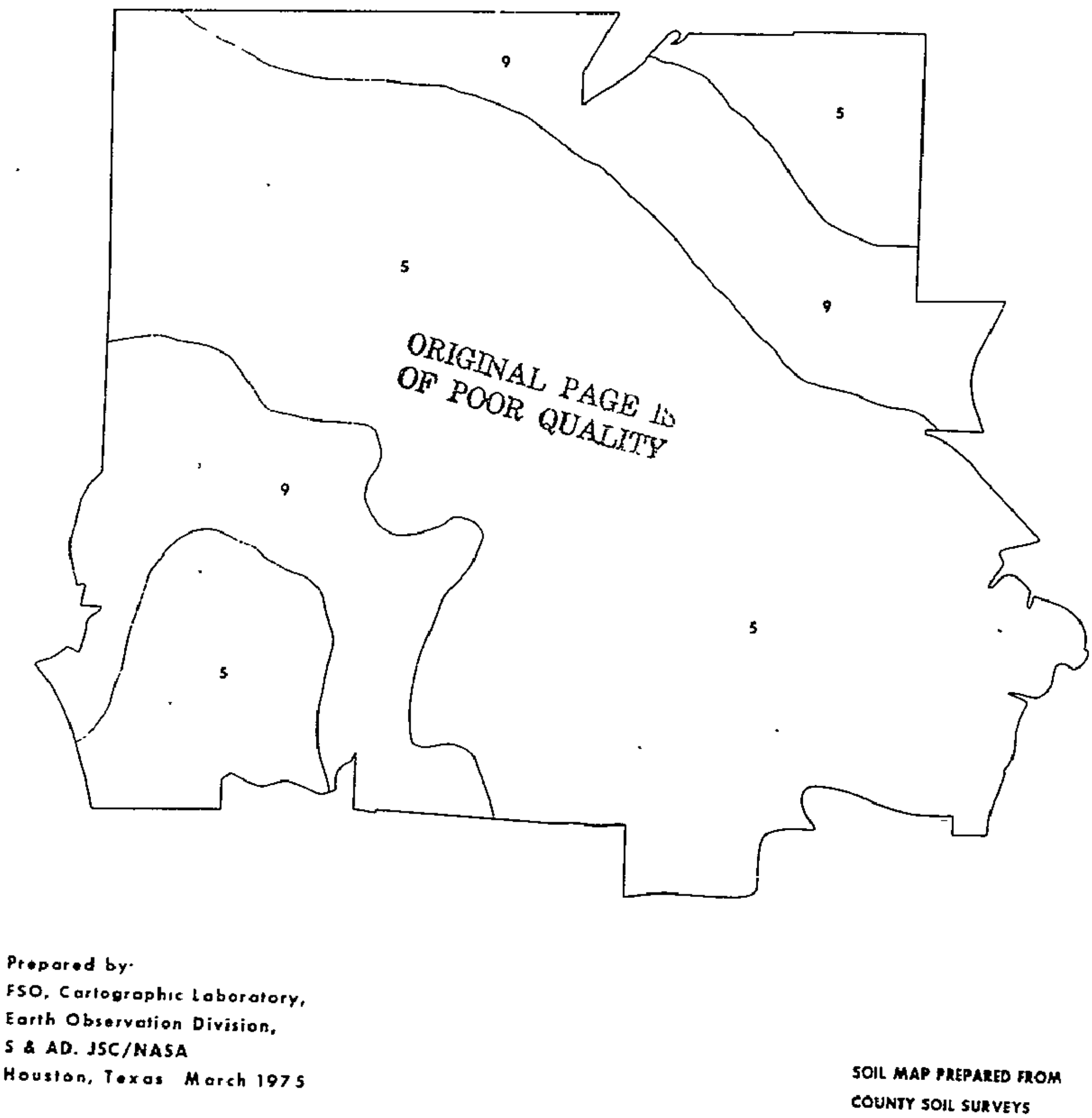


Figure 6-5. – Whitman County, Washington LACIE Intensive Test Site No. 3 soil classification map.

Test Site Soils

Walla Walla Series

The Walla Walla Series is a member of the coarse silt, mixed, mesic family of typical Haploxerolls. Walla Walla soils have dark grayish brown silt loam A horizons, brown silt loam B horizons, and pale brown silt loam C horizons. Walla Walla soils are on nearly level to steep uplands, at elevations of 600 to 2,500 feet. They were formed from loess. These soils are well-drained with slow to rapid runoff and moderate permeability. They are used for small grain crops.

Athena Series

The Athena series is a member of the fine silt mixed, mesic family of Pochic Haploxerolls. Typically, Athena soils have thick, very dark brown and dark gray into brown silt loam A horizons, about 26 inches thick, and dark brown and dark yellowish brown silt loam B horizons.

The Athena soils are on gently undulating to hilly uplands, at elevations of 1,500 to 2,600 feet. The soils are formed in silty loess containing some volcanic ash. These soils are well-drained with slow to rapid runoff, and moderate permeability. Athena soils are largely cultivated, with dry land wheat, barley, and peas, as dominant crops. Hay crops and pasture are also produced.

Coulouse Series

The Coulouse series is a member of the fine silt mixed, mesic family of Calcic Haploxerolls. Typically, these soils have a dark grayish brown silt loam A horizon, moderate prismatic structure in the B2t horizon with calcium carbonate accumulations in root channels and pores above 40 inches. These soils occur at elevations of 1,500 to 2,600 feet on undulating to hilly uplands. They are formed in loess. Coulouse series soils are now largely used for small grain production, peas, alfalfa, and grasses for hay and pasture.

Palouse Series

The Palouse series is a member of the fine silt mixed mesic family of Pochic Ultic Haploxerolls. Typically, Palouse soils have dark grayish brown silt loam A horizons that grade into pale brown weak prismatic silt loam B2 horizons that are very hard when dry, and friable when moist. Palouse soils are now used largely for small grains, peas, lentils, alfalfa, and grasses for hay and pasture.

Staley Series

The Staley series consists of well-drained, medium textured Chenozems, developed from calcareous loess of mixed mineralogy, including volcanic ash. They occur on ridgetops, and upper slopes of rolling uplands, under grass. Staley soils have a dark grayish brown A1 horizon 8 to 14 inches thick, a yellowish brown B2t horizon that is prismatic in the upper part, the aggregates being cemented lime silica.

Staley soils occur at elevations of 2,300 to 2,800 feet. They are well-drained, moderately permeable to caliche with medium to rapid runoff. Staley soils are used for small grain production, as well as alfalfa, and pasture.

Thatuna Series

The Thatuna series is a member of the fine silt mixed mesic family of Xeric Argiabolls. Typically, Thatuna soils have dark grayish brown neutral silt loam A1 horizons that are about 19 inches thick. They also have brown blocky silt loam B2 horizons; pale brown and very pale brown A'2 horizons; light yellowish brown neutral. They have slightly acid silt loam, and salty clay loam B'2t horizons that grade into very deep noncalcareous loam.

Thatuna soils are on nearly level, rolling, to hilly loessal plains, at elevations of 2,400 to 3,200 feet. The upper 1 to 2 feet of the loess deposit contains a small percentage of volcanic ash in some areas. Thatuna soils are moderately well-drained, with medium to rapid runoff, and slow permeability. Most areas of Thatuna soils are cultivated with wheat, barley, hay, pasture, peas, and lentils, as the major crops.

Naff Series

The Naff series is a member of the fine silt mixed mesic family of Ultic Argixerolls. Typically, these soils have a thick dark grayish brown to dark gray A1 horizon. They also have thick, very hard angular blocky B2t horizons, that are yellowish brown in color, over a light yellowish brown firm salt loam C horizon.

The Naff soils occur in undulating to rolling loessal uplands, or slopes, ranging up to 35 percent. These soils occur at elevations of 2,000 to 2,700 feet. They are well-drained with moderately slow permeability and medium to rapid runoff. Naff soils are used for small grains, peas, lentils, hay, pasture, and grazing.

Tekoa Series

The Tekoa series is a member of the loamy skeletal mixed mesic family of Ultic Argixerolls. Typically, Tekoa soils have brown shaly silt loam A1 horizons, pale brown shaly heavy silt loam B2t horizons, very shaly loam C horizons, and bedrock at about 38 inches.

Tekoa soils occur on nearly level to very steep uplands, at elevations of 2,000 to 4,000 feet. The soils formed in residium from shale, siltstone, and sandstone, and a loess mantle. They are well-drained, with slow or very rapid runoff, and slow permeability. Tekoa soils are generally in timber production, grazing, and wildlife. When cleared, they are used for small grains, alfalfa, and grass.

Anders Series

The Anders series is a member of the coarse-loamy mixed mesic family of Typic Haploxerolls. Typically, Anders soils have dark grayish brown and grayish brown silt loam

Al horizons, brown silt loam and generally silt loam B horizons, and basalt bedrock at 27 inches.

Anders soils are on nearly level to steep convex slopes, in the uplands and on terraces, at elevations of 600 to 2,550 feet. The soils formed in glacial outwash materials with a mixture of loess in the upper part. They are well-drained with slow to rapid runoff, and moderate permeability. Anders soils are used for production of small grain, range, recreation, and wildlife.

Benge Series

The Benge series is a member of the coarse loamy over sandy, or sandy skeletal, mixed, mesic family of Typic Haploxerolls. Benge soils have dark grayish brown and grayish brown gravelly silt loam Al horizons, brown gravelly silt loam B horizons, brown very gravelly loam C horizons, and gravel and sand IIC horizons at about 26 inches.

Benge soils are on nearly level to very steep terraces, at elevations of 600 to 2,500 feet. The soils formed in glacial outwash materials with a mixture of loess in the upper part. They are well-drained with slow to rapid runoff, moderate permeability above the IIC horizon and very rapid permeability in the IIC horizon. Benge soils are used for growing orchards, small grains, hay and pasture, mostly under irrigation; and are also used for range, recreation, wildlife, and watershed protection.

Kuhl Series

The Kuhl series is a member of the loamy mixed mesic family or lithic Haploxerolls. The soils typically have a stony, or very stony dark colored silt loam A horizon, a lighter colored stony silt loam B, and are underlain by bedrock at 12 to 20 inches.

Kuhl soils occupy gently undulating basalt plateaus and steep canyon slopes, at elevation of 1400 to 2200 feet. They developed in mixed loess, alluvium, and colluvium from mostly basic igneous rocks. They are well-drained with slow to very rapid runoff, and moderate permeability.

Kuhl soils are suitable for rangeland. The principal vegetation is bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, cheatgrass, and small shrubs.

6.2 PRINCIPAL CROP PRODUCTION

6.2.1 State and County

Washington is the leading state in production of dry peas, hops, spearment, and apples, second in production of wheat, alfalfa, asparagus, pears, cherries, and peppermint; and third in production of potatoes, grapes, and strawberries.

Wheat, Washington's number one crop, far outpriced all other agricultural commodities in value of production for 1972. Production was a record 122,085,000 bushels, although yield dropped from 48.7 bushels in 1971 to 46.9 in 1972. (See table VI-5.)

Whitman County is the leading wheat producing county in the United States as well as the leading barley producer in Washington.

Winter wheat accounts for 99.5 percent of the wheat production in Whitman County (348,000 seeded acres with a yield of 68.5 bushels in 1971).

Sulfur is used extensively in the 16 inch or above rainfall areas and phosphorus may be applied in these areas also. With nitrogen, these are the only fertilizers required in Whitman County.

The major wheat varieties grown in Whitman County belong to the soft winter wheat type used mainly for baking and pastries. The varieties and extent of production are discussed in paragraph 6.2.4.

Refer to table VI-6 for the land in farms according to use. Wheat occupies the majority of cropped land according to table VI-7.

6.2.2 Cropping Systems

Wheat is produced without irrigation in areas that receive from 7 to 25 inches of annual precipitation. In addition, a considerable amount of wheat is cultivated under irrigation. Planting is from the middle of August to the

TABLE VI-5. — ANNUAL CROP PRODUCTION IN WHITMAN COUNTY, WASHINGTON 1972

Crop[a]	Planted acres	Harvested acres	Yield per acre	Units
Wheat	466,700	452,000	58.9	Bushel
Barley	101,200	99,500	53.6	Bushel

[a]Statistical data were not available for the other crops in Whitman County, Washington.

TABLE VI-6.– LAND IN FARMS[a] ACCORDING TO USE IN WHITMAN COUNTY, WASHINGTON

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested Cropland	1345	660,433	1478	692,935
Cropland used only for pasture or grazing	523	32,662	538	26,487
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	223	12,766	275	17,770
Cropland on which all crops failed	26	4,691	19	383
Cropland in cultivated summer fallow	1,117	343,330	1,088	298.161
Cropland idle	243	19,064	145	9,356
Total cropland	1,277	1,065,960	(NA)	1,039,654
Woodland pastured	74	19,097	73	27,670
Woodland not pastured	52	5,045	41	3,299
Total woodland	111	24,142	103	30,969
Improved pastureland and rangeland	121	23,677	235	16,761
Pastureland and rangeland not improved	350	197,105	(NA)	288,209
Total pastureland and rangeland (other than cropland and woodland pasture)	429	220,782	631	304,970
All other land	737	16,278	1,195	16,016
Irrigated land	106	11,652	132	10,594
Total pastureland (all types)	755	268,235	(NA)	357,756

[a]Farms with sales of $2500 and over

TABLE VI-7.- AREA PLANTED AS PERCENT OF TOTAL CROPLAND IN WHITMAN COUNTY (1969)

Crop[a]	Percent, %
Wheat	43.3
Barley	9.4

[a]Statistical data were not available for the other crops; 35.2 percent of the cropland was in summer fallow.

middle of September. The crop is harvested in July. Table VI-8 shows the number of farms and harvested acreage in the county. The number of fields, average field sizes and ranges of field sizes are expressed in table VI-9.

6.2.2.1 Tillage operations. Chiseling and disking is performed in the spring followed by red weeding to maintain stubble on top for soil erosion control. In the summer fallow area, chisel or disk stubble is performed in the fall or put off until the summer fallow operation is started with sweeps or chisels in early spring.

6.2.2.2 Summer fallow. In areas of less than 16 inches of annual precipitation a wheat-summer fallow rotation is used. In areas with 18 inches or more annual precipitation, summer fallow is used only for weed control.

6.2.2.3 Rotation practices. A normal rotation is winter wheat, spring barley, spring seeded peas or lentils then back to winter wheat following peas or lentils. Very little clover or alfalfa is used in the rotation. Wheat is used as a rotation crop on irrigated land. When alfalfa hay is pulled out, winter wheat is seeded, after the harvest the field is seeded back to alfalfa. Wheat is also rotated with sugar beets and potatoes. The wheat is seeded following these crops for wind protection as well as a cash crop with straw available to protect the soil in the spring after the wheat harvest and before the field is re-seeded.

6.2.2.4 Fertilizer. On the average in Whitman County, 90 to 140 pounds of available nitrogen are used per acre on the winter wheat crop. About 80 pounds are applied per acre, prior to fall planting, then 20 to 40 pounds per acre are applied in late winter or early spring, usually as an aerial application.

In areas with less than 16 inches of annual precipitation, the nitrogen application is usually 40 to 60 pounds per acre annually. Nitrogen is applied before the crop is planted, and no top dressing is applied in late winter or early spring.

TABLE VI-8. — NUMBER OF FARMS AND ACRES HARVESTED IN WHITMAN COUNTY (1969)

County	Number of farms	Total acres harvested
Whitman	1.345	660,433

TABLE VI-9. — NUMBER OF FIELDS, AVERAGE SIZE AND RANGES OF FIELD SIZE WITHIN THE WHITMAN COUNTY TEST SITES

County	Test site size, mile	Number of fields	Average field size, acres	Range in field size, acres
Whitman 1	3 × 3	10-25	280	80-600
Whitman 2	3 × 3	10-20	400	20-1400
Whitman 3	3 × 3	20-30	150	10-1200

6.2.3 Cropping Calendars

Tables VI-10 and VI-11 present cropping calendars for the various crops that are grown in Washington. In the absence of information on crops that are exclusively grown in the test site, the calendar is provided on the crop reporting district level.

6.2.4 Wheat Varieties

Adapted wheat varieties are selected for certain areas which will produce grain quality demanded by the trade. Table VI-12 shows the distribution of these varieties within the Whitman County test sites.

TABLE VI-10.– CROPPING CALENDAR FOR THE PRINCIPAL CROPS GROWN IN THE SOUTHEASTERN AREA OF THE STATE OF WASHINGTON

Seedbed preparation			Full coverage			Heading-flowering			Post harvest operations		
Start	Mid-Point	End	Start	Mid-Point	End	Start	Mid-Point	End	Start	Mid-Point	End
BARLEY											
8-30	3-1	3-15	3-25	4-30	5-15	6-5	6-25	7-10	9-20	10-15	11-15
OATS											
3-1	3-20	4-1	4-25	5-10	5-25	6-20	7-5	7-20	9-5	10-1	11-1
SPRING WHEAT											
2-25	3-5	3-15	4-20	5-5	5-20	6-10	6-25	7-10	9-20	10-15	11-15
WINTER WHEAT											
9-1	9-20	10-10	11-1	4-20	5-15	6-5	6-25	7-10	9-20	10-15	11-15

TABLE VI-11.– WASHINGTON: USUAL PLANTING AND HARVESTING DATES BY CROPS

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Barley				
Fall sown	9-1 - 11-1	7-1	7-15 - 8-10	8-20
Beans, dry	5-1 - 6-10	8-20	9-5 - 9-30	11-1
Corn:				
Grain	5-1 - 6-5	10-15	10-25 - 11-20	12-15
Silage	5-1 - 6-5	9-1	9-5 - 10-5	10-15
Forage	5-1 - 6-5	10-1	10-5 - 10-25	11-1
Hay:				
Alfalfa		6-1		9-15
Clo-tim		5-25		8-15
Wild		6-1		8-15
Lentils:	4-10 - 5-10	7-15	7-25 - 8-25	9-1
Peas, dry	4-5 5-1	7-15	7-25 - 8-25	9-1
Rye	8-10 - 11-1	7-5	7-20 - 8-15	9-1
Sugarbeets	3-1 - 4-10	9-20	10-10 - 11-10	11-20
SEED CROPS:				
Alfalfa		8-25	9-10 - 10-15	10-30
Red clover		8-20	9-5 - 10-10	10-15
Merion Kentucky bluegrass		7-10	7-25 - 8-15	9-1
Red fescue		7-10	7-25 - 8-15	9-1
Bentgrass		8-5	8-20 - 9-5	9-25

TABLE VI-12.- DISTRIBUTION OF WINTER WHEAT VARIETIES FOR THE THREE INTENSIVE TEST SITES IN WHITMAN COUNTY, WASHINGTON

Variety	Percent
Gaines and Nugaines	46.6
Paha	16.3
Wanser	13.3
Mord	12.6
Luke	4.0
McCall	3.9
Omar	1.4
Hyslop	0.7
Cheyenne	0.5
Burt	0.05
Golden	0.05
Other Varieties	0.6
	100.0

INTENSIVE TEST SITE ASSESSMENT REPORT

INDIANA

SECTION SEVEN

CONTENTS

PRECEDING PAGE BLANK NOT FILMED

TABLES

Table		Page
VII-15	PRODUCTION AND ACREAGE OF CROPS HARVESTED IN 1969 AND 1964.	7-37
VII-16	LAND IN FARMS ACCORDING TO USE.	7-38
VII-17	AREA HARVESTED AS PERCENT OF TOTAL CROPLAND IN SHELBY COUNTY, INDIANA	7-39
VII-18	NUMBER OF FARMS AND ACRES HARVESTED	7-41
VII-19	NUMBER, AVERAGE SIZE AND RANGES OF FIELD SIZE WITHIN THE INDIANA TEST SITES.	7-41
VII-20	CROP CALENDARS FOR THE CENTRAL CROP REPORTING DISTRICT OF INDIANA	7-43
VII-21	USUAL PLANTING AND HARVESTING DATES BY CROPS.	7-44

FIGURES

7.0 INDIANA INTENSIVE TEST SITES

7.1 REGIONAL DESCRIPTION

Three Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the State of Indiana. These test sites are located in Madison, Boone, and Shelby counties (fig. 7-1).

TABLE VII-1.- COUNTY SIZE AND LOCATION

County	Sq. miles	Total acres	N. Lat.	W. Long.	Test site size, miles
Madison	453	289,920	40°13.5′	85°37.5′	3x3
Boone	427	273,280	40°05.7′	86°33.5′	3x3
Shelby	409	261,760	39°05.7′	85°47.2′	3x3

The test sites are located in the Corn and Winter Wheat Belt where farming is generally of the cash grain - livestock type. The nearly flat to undulating Till Plains section, the result of cumulative glacial deposition, covers most of the state. Local relief of 10 or 20 feet per square mile dominates the area; the major relief of the Till Plains section is created by the systems of end moraines marking the readvances of an oscillating ice front. The Wabash River system, as part of the Ohio River system, drains most of the state. Surface drainage is generally poor and presents problems to the farmer (fig. 7-2).

7.1.1 Location

Madison County is located in the central crop reporting district of Indiana. The test site, 40° 13.5′ N latitude and 85° 37.5′ W longitude, is in the northeast part of the county.

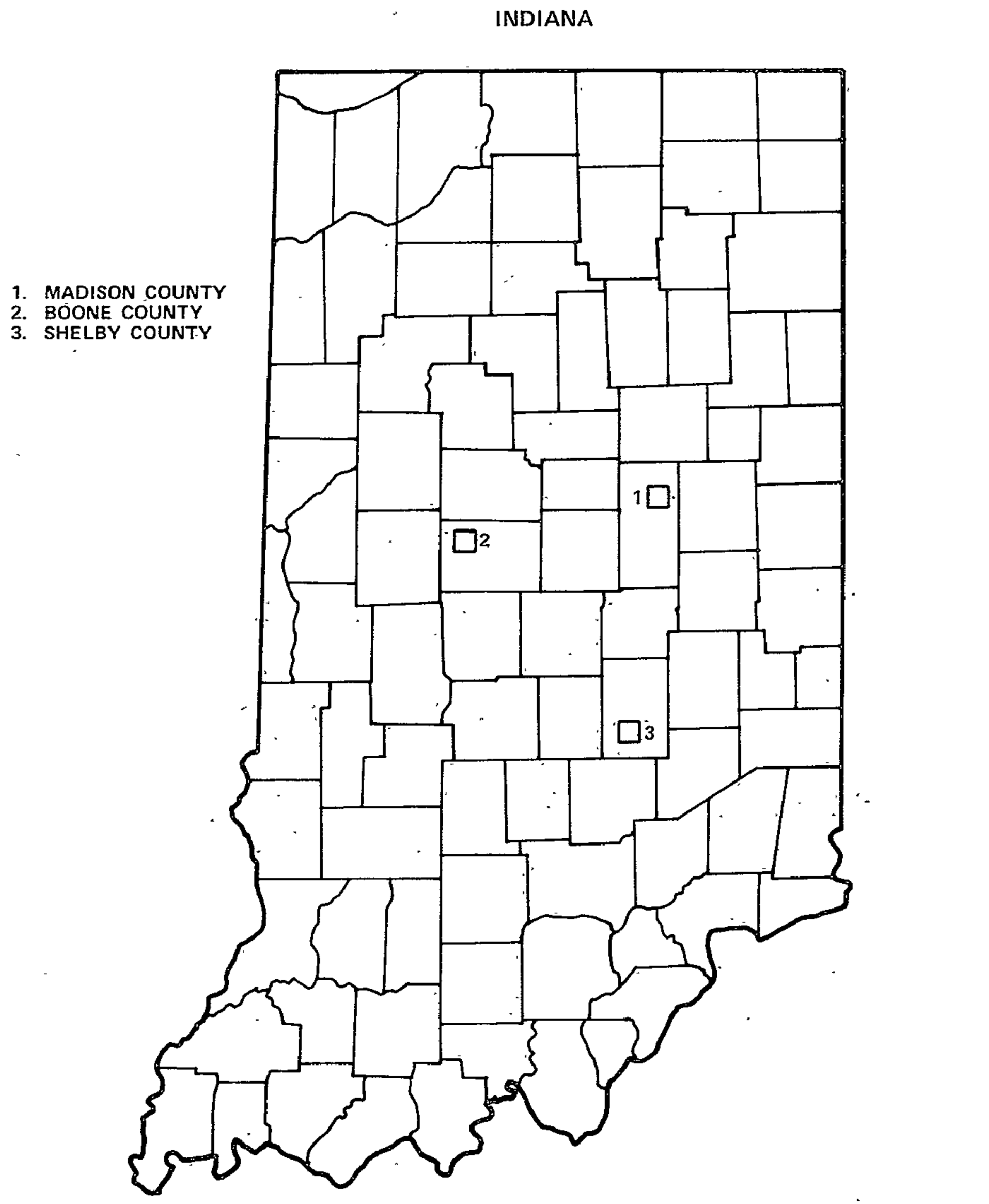
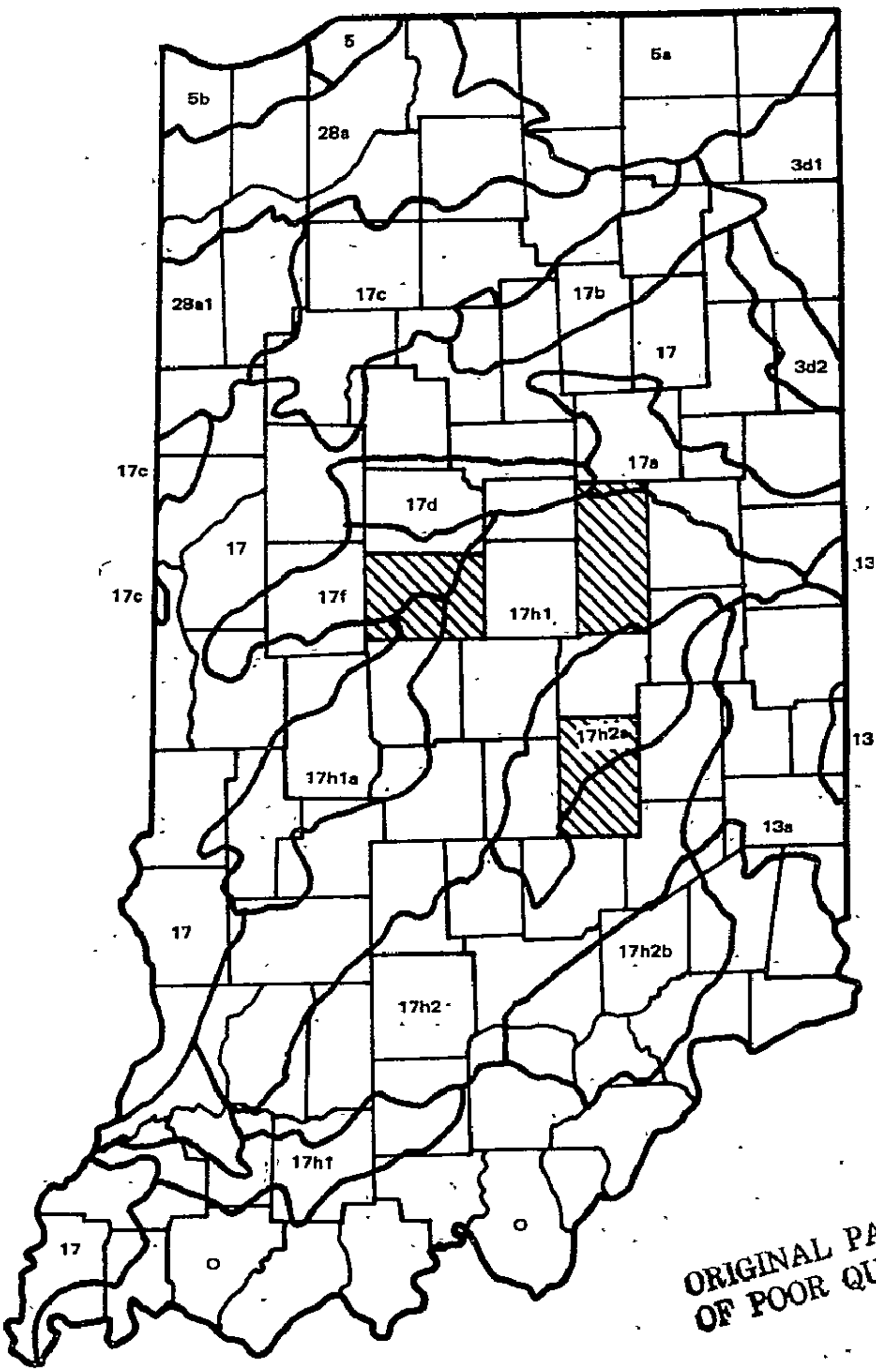


Figure 7-1. - Location of the three Intensive Test Sites in Indiana.



OHIO R. DRAINAGE AREA
O Ohio R.
13 Miami R.
13a Whitewater R.
17 Wabash R.
17a Mississenewa R.
17b Eel R.
17c Tippecanoe R.
17d Wildcat R.
17e Vermillion R.
17f Sugar Creek
17h White R.
17h1 West Fork White R.
17h1a Eel R.
17h2 East Fork White R.
17h2a Draftwood (Blue) R.
17h2b Muscatatuck R.
17i Patoka R.

GREAT LAKES and
LAWRENCE DRAINAGE AREA
3 Lake Erie
3d1 St. Joseph R.
3d2 St. Mary's R.
3d4 Auglaize R.
5 Lake Michigan
5a St. Joseph R.
5b Calumet R.

UPPER MISSISSIPPI
R. DRAINAGE AREA
28 Illinois R.
28a Kankakee R.
28a1 Iroquois R.

Figure 7-2. – Delineations of drainage areas in Indiana.

Boone County is located in the central crop reporting district of the state. The test site, 40° 05.7′ N and 86° 33.5′ W, is located in the northwest section of the county. Available data of the physical characteristics of Boone County are limited; therefore, most of the following information has been derived from an incomplete selection of topographic maps.

Shelby County is located in the central crop reporting district of Indiana. The test site, 39° 27.6′ N latitude and 85° 47.2′ W longitude, is in the southern part of the county.

7.1.2 Physiography

7.1.2.1 Madison County. Glaciation is the principal factor responsible for the present landforms. Madison County is situated on the Tipton Till Plain and is characterized by only small differences in relief. The highest elevation in the county is 1,010 feet and the lowest point is 800 feet. Central areas show evidence of glacial outwash from the Wisconsin glacier. The moraines have gently sloping, not steep, sides and change the local relief little. Kettles are present in the area. The undulating plains are broken only by streams.

The West Fork of the White River cuts the county approximately in half. Big Killbuck Creek and Pipe Creek rise in Delaware County and drain the eastern and north-northeastern parts of the county, respectively. Duck Creek, beginning as a series of ditches in the level back land, drains the northwest corner of the county. In the southern part of the county, Fall Creek flows nearly parallel to Lick Creek and then joins that stream in the southwestern area. A few hundred acres are drained by waterways flowing into tributaries of the east fork of the White River. All of the streams, except those along the northern county line, flow in a southwesterly direction. Ditches have been dredged to alleviate drainage problems of low lying areas.

The elevation of the test site ranges from approximately 880 to 900 feet. There are a few kettles or depressed areas. Alexandria Creek drains the northern part and Little Killbuck flows through the southern part of the test site.

7.1.2.2 Boone County. Boone County is situated on a glacial till plain of very little local relief. Elevation ranges from approximately 820 feet to 1000 feet. The surface is relatively flat, marked with a few kettles in the eastern areas. There are also some widely scattered marsh areas in the eastern parts.

Sugar Creek cuts across the northern section of the county and flows westward. Deer Creek joins Prairie Creek which in turn meanders northward to Sugar Creek. Wolf Creek and Brush Creek are also tributaries of Sugar Creek. Grassy Branch and Main Edlin Branch Ditch joined by Walnut Creek flow to the southwest. Racoon Creek flows in a southwesterly direction. Fishback Creek and Eagle Creek drain the southeastern part of the county; White Lick flows through the south central areas of Boone County. Ditches have been dredged to alleviate drainage problems.

In the test site, the elevation ranges from approximately 850 feet to 910 feet. Deer Creek flows through the area northward and Prairie Creek meanders across the northern part of the test site. There is practically no noticeable local relief.

7.1.2.3 Shelby County. Situated on a glacial till plain, Shelby County has very little difference in local relief. The elevation ranges from around 700 feet to 900 feet. There are some low, gently sloping moraines in the area. About one-third of the county consists of a glacial outwash plain. A few gravel pits dot the area.

The Flatrock River cuts across the southern part of the county. Conns Creek flows south and the little Lewis flows southwest into the Lewis Creek. Brandywine Creek meanders southward into the Big Blue River which flows to the south and then out of the county in the central western area. There are numerous ditches to alleviate drainage problems.

In the test site, the elevation ranges from approximately 730-770 feet. Local relief is relatively flat with a couple of small depressions. The Van Pelt Ditch and Thompson Ditch drain from north to south. The East Fork flows through the test site from north to southwest.

7.1.3 Climate

The climate of Indiana is continental, with warm summers, moderately cold winters, and occasional wide variations in temperature, particularly during the colder seasons. Brief periods of humid weather occur during the summer when Gulf air masses push northward, but they are soon replaced by cooler less humid air from northerly latitudes. Occasionally hot, dry winds prevail from the west or southwest for several days. Sunny days and mild temperatures commonly occur for 2 or 3 weeks in October.

Precipitation is usually adequate for good crops and is well distributed throughout the year. Snow generally falls several times throughout the winter. Thunderstorm winds and tornadoes cause much property damage. Hail often causes loss of crops in local areas.

Floods due to heavy rainfalls, ice jams, and the melting of heavy snowfalls are common. Nearly every year some part of the state suffers from floods; floods have occurred in every month of the year.

7.1.3.1 Madison County. Based on data for the years 1931-1955, the annual average temperature for Anderson in Madison County is 53.8° F; the annual average precipitation is 36.71 inches (table VII-2). July is the warmest month of the year and January is the coldest. Fifty-eight percent of the precipitation occurs during the spring and summer.

According to data for the years 1921 to 1950, the average date of the last freeze is April 26 and the first freeze is October 20. The average length of growing season is 178 days. These dates may fluctuate greatly from year to year. In 1956 the first freeze was September 21, and in 1925, the last freeze was May 24.

7.1.3.2 Boone County. Based on data for the years 1931 to 1955 in Whitestown, Boone County, the annual average temperature is 52.0° F and the annual average precipitation is 37.17 inches (table VII-3). July is the warmest month of the year and January is the coldest. Fifty-six percent of the precipitation falls during the spring and summer.

TABLE VII-2.- AVERAGE[a] MONTHLY, SEASONAL, AND ANNUAL TEMPERATURE AND PRECIPITATION AT ANDERSON, MADISON COUNTY, INDIANA

Month	Temperature average, °F	Precipitation average, inches
December	32.7	2.16
January	31.3	2.55
February	32.8	1.93
Winter	32.2	6.64
March	41.5	3.34
April	52.5	3.53
May	63.0	4.01
Spring	52.3	10.88
June	72.7	3.90
July	76.1	3.40
August	74.3	3.30
Summer	74.3	10.60
September	68.5	3.34
October	57.4	2.45
November	43.0	2.80
Fall	56.3	8.59
Year	53.8	36.71

[a]Averages for period 1931-1955.

TABLE VII-3.- AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT WHITESTOWN, BOONE COUNTY, INDIANA

Month	Temperature average, °F	Precipitation average, inches
December	30.7	2.33
January	29.4	2.92
February	31.1	2.12
Winter	30.4	7.37
March	39.5	3.78
April	50.8	3.44
May	61.6	4.16
Spring	50.6	11.38
June	71.6	3.91
July	75.4	2.81
August	73.1	2.78
Summer	73.3	9.50
September	65.7	3.22
October	54.7	2.82
November	40.6	2.88
Fall	53.6	8.92
Year	51.9	37.17

[a]Averages for period 1931-1955.

7.1.3.3 Shelby County. Based on data for the years 1931 to 1955, the annual average temperature for Shelbyville, Shelby County, is 54.4° F, and the annual average precipitation is 40.24 inches (table VII-4). July is the warmest month of the year, and January is the coldest. Fifty-five percent of the precipitation occurs during the spring and summer months.

According to data for the years 1921 and 1950, the average date of the last freeze is April 26 and the first freeze is October 18. The average length of the growing season is 175 days, but this tends to fluctuate from year to year.

7.1.4 Soils

The soils range from very poorly drained to well-drained and nearly level to sloping. Basically, they are made up of alluvial deposits, outwash sand and gravel, and glacial till.

Soil map transparencies are available at a scale of approximately 1:24,000. These transparencies can be used to overlay the test site on USDA/ASCS 1:24,000 black and white photography. These transparencies were reduced to fit the 8½- by 11-inch format of this report.

7.1.4.1 Madison County. Madison county soils are of the Alfisols order, Udalf suborder, and Hapludalf great group (table VII-5, figs. 7-3 and 7-4).

Test Site Soils

The Blount-Pewamo, Crosby-Brookston, and Morley-Bloun associations are found in the Intensive Test Site. They occupy upland areas of the northeastern part of the county (fig. 7-3 and table VII-6).

Blount Series

The surface layer of the Blount series is 7 to 10 inches of grayish-brown silt loam. The subsoil, about 17 inches thick, is mottled yellowish-brown and dark yellowish-brown silty clay loam to silty clay. Till, grayish-brown clay loam

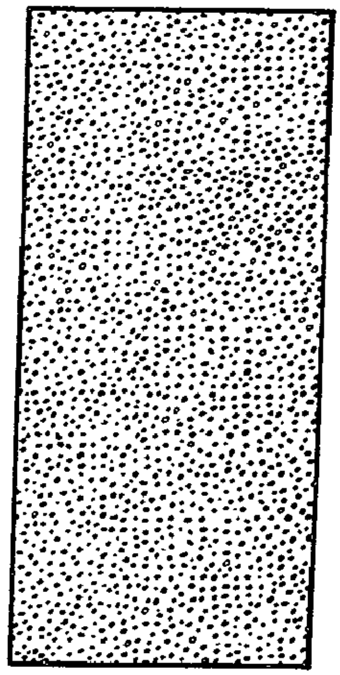
TABLE VII-4.- AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT SHELBYVILLE, SHELBY COUNTY, INDIANA

Month	Temperature average, °F	Precipitation average, inches
December	33.4	2.60
January	32.5	3.35
February	34.1	2.42
Winter	33.3	8.37
March	42.4	3.73
April	53.2	3.67
May	63.6	3.90
Spring	53.0	11.30
June	73.4	4.21
July	76.8	3.45
August	74.8	3.35
Summer	75.0	11.01
September	68.0	3.92
October	57.1	2.44
November	43.2	3.20
Fall	54.4	9.56
Year	54.0	40.24

[a]Averages for period 1931-1955.

TABLE VII-5.- DESCRIPTIONS OF THE THREE INDIANA COUNTY SOILS

Classification	Description
ALFISOLS	Soils that are medium to high in bases (base saturation at pH 8.2) and have gray to brown surface horizon and sub-surface horizons of clay accumulation; usually moist but during the warm season of the year, some are dry part of the time.
Udalfs	Alfisols that are in temperate to tropical regions. Soils usually moist but during the warm season of the year may be inter-mittently dry in some horizons for short periods; used for row crops, small grain, and pasture.
Hapludalfs	(formerly gray-brown Podzolic soils without fragipan).- Udalfs that have a subsurface horizon of clay accumulation that is relatively thin or is brownish.
A7-4	Hapludalfs plus Argiaquolls, gently sloping.

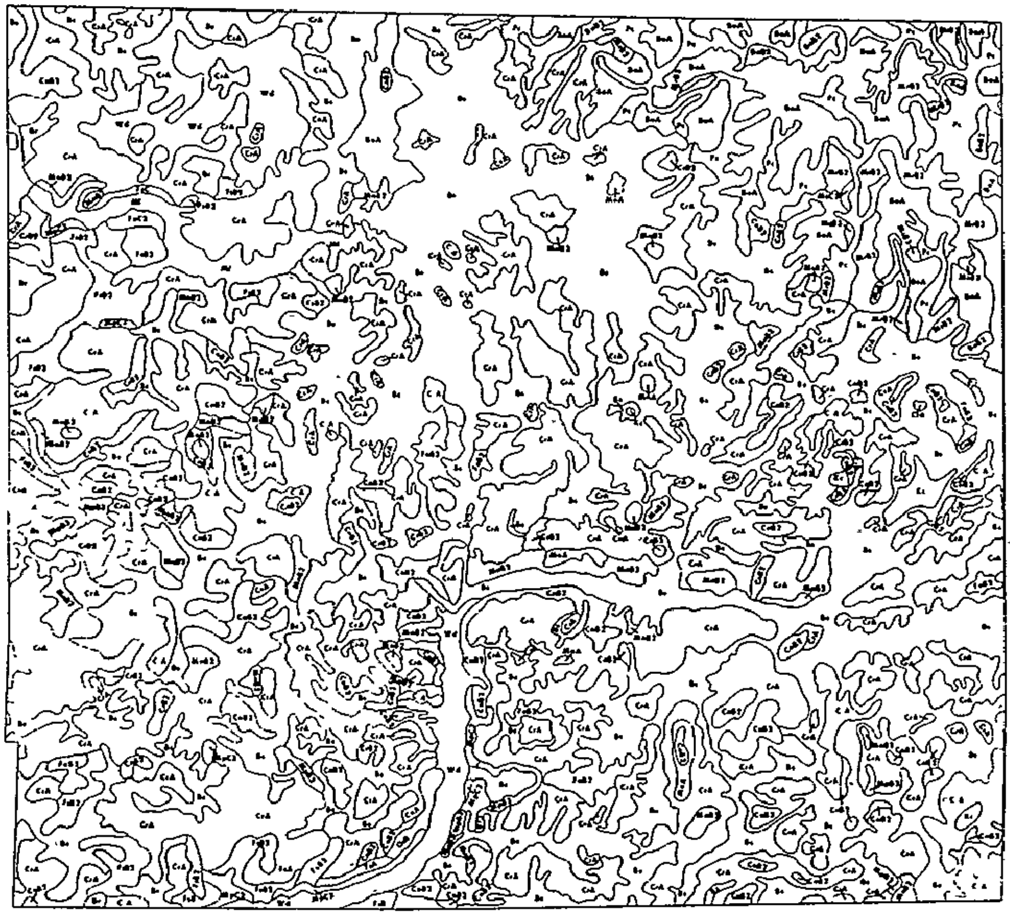


SOIL CLASSIFICATION

A7-4 ALFISOL - UDALF - HAPLUDALF

APPROX. SCALE 1:615,000

Figure 7-3. — Soil classification map of Madison County, Indiana.



Prepared by:
FSO, Cartographic Laborarory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 7-4. — Madison County, Indiana LACIE Intensive Test Site soil classification map.

TABLE VII-6.- MADISON COUNTY SOIL LEGEND FOR INTENSIVE TEST SITES

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, of F, shows the slope. Symbols without a slope letter are for nearly level soils or land types. A final number, 2 or 3, in the symbol, shows that the soil is moderately or severely eroded.

SYMBOL	NAME
BoA	Blount silt loam, 0 to 2 percent slopes
BoB2	Blount silt loam, 2 to 6 percent slopes, moderately eroded
Br	Brookston silt loam
Bs	Brookston silty clay loam
CaA	Camden silt loam, 0 to 2 percent slopes
CaB2	Camden silt loam, 2 to 6 percent slopes, moderately eroded
Cm	Carlisle muck
CnA	Celina silt loam, 0 to 2 percent slopes
CnB2	Celina silt loam, 2 to 6 percent slopes, moderately eroded
Cp	Clay pits
CrA	Crosby silt loam, 0 to 2 percent slopes, moderately eroded
Ed	Edwards muck
Es	Eel silt loam
FaA	Fox fine sandy loam, 0 to 2 percent slopes
FaB	Fox fine sandy loam, 2 to 6 percent slopes
FoA	Fox silt loam, 0 to 2 percent slopes
FoB2	Fox silt loam, 2 to 6 percent slopes, moderately eroded
FoC2	Fox silt loam, 6 to 12 percent slopes, moderately eroded
FoD2	Fox silt loam, 12 to 18 percent slopes, moderately eroded
FrA	Fox silt loam, limestone substratum, 0 to 2 percent slopes
FsA	Fox silt loam, till substratum, 0 to 2 percent slopes
FsB	Fox Silt loam, till substratum, 2 to 6 percent slopes
FsB2	Fox silt loam, till substratum, 2 to 6 percent slopes moderately eroded
FsC	Fox silt loam, till substratum, 6 to 12 percent slopes
FsC2	Fox silt loam, till substratum, 6 to 12 percent slopes, moderately eroded

TABLE VII-6.- MADISON COUNTY SOIL
LEGEND FOR INTENSIVE TEST SITES - Continued

SYMBOL	NAME
FtC3	Fox soils, 6 to 12 percent slopes, severely eroded
FxB3	Fox soils, till substratum, 2 to 6 percent slopes, severely eroded
Gn	Genesee silt loam
Gr	Gravel pits
HeF2	Hennepin soils, 18 to 35 percent slopes, eroded
Hm	Homer silt loam
Hn	Homer silt loam, limestone substratum
Kc	Kakomo silty clay loam
Kg	Kakomo silty clay loam, gravelly substratum
Km	Kakomo silty clay loam, stratified substratum
Ks	Kakomo mucky silt loam, stratified substratum
Kt	Kakomo mucky silty clay loam, gravelly substratum
Lm	Linwood muck
Ma	Made land
Mh	Mahalasville silt loam
Ml	Mahalasville silty clay loam
Mm	Mahalasville silty clay loam, limestone substratum
MnA	Miami silt loam, 0 to 2 percent slopes
MnB2	Miami silt loam, 2 to 6 percent slopes, moderately eroded
MnC2	Miami silt loam, 6 to 12 percent slopes, moderately eroded
MnD2	Miami silt loam, 12 to 18 percent slopes, moderately eroded
MnE2	Miami silt loam, 18 to 25 percent slopes, moderately eroded
MpB3	Miami soils, 2 to 6 percent slopes, severely eroded
MpC3	Miami soils, 6 to 12 percent slopes, severely eroded
MpD3	Miami soils, 12 to 18 percent slopes, severely eroded
MpE3	Miami soils, 18 to 25 percent slopes, severely eroded
MrB2	Morley silt loam, 2 to 6 percent slopes, moderately eroded
MrC2	Morley silt loam, 6 to 12 percent slopes, moderately eroded

TABLE VII-6.- MADISON COUNTY SOIL

LEGEND FOR THE INTENSIVE TEST SITE - Concluded

Symbol	Name
MrD	Morley silt loam, 12 to 18 percent slopes
MsB3	Morley soils, 2 to 6 percent slopes, severely eroded
MsC3	Morley soils, 6 to 12 percent slopes, severely eroded
MsD3	Morley soils, 12 to 18 percent slopes, severely eroded
OcA	Ockley silt loam, 0 to 2 percent slopes
OcB	Ockley silt loam, 2 to 6 percent slopes
Pc	Pewamo silty clay loam
RdE2	Rodman soils, 12 to 50 percent slopes, eroded
Ro	Ross loam
Rs	Ross silt loam
Sh	Shoals silt loam
Sl	Sleeth silt loam
Sm	Sleeth silt loam, loamy substratum
So	Sloan silt loam
Wa	Walkill complex
Wc	Washtenow complex
Wd	Westland silty clay loam
Ws	Westland silty clay loam, moderately deep

to silty clay loam, underlies the subsoil at a depth that averages 26 inches. The plow layer is medium acid and responds well to the addition of lime. The available moisture capacity is moderately high, and general productivity is medium. Erosion is a problem and tile drainage is needed.

Morley Series

The plow layer of the Morley series is grayish-brown silt loam 7 to 10 inches thick. The subsoil, about 19 inches thick, is dark-brown to dark yellowish-brown silty clay loam. Till, consisting of yellowish brown, limy clay loam to silty clay loam, underlies these soils at a depth that averages 26 inches. The thickness of Morley soils above the till varies according to the topography. This soil occurs with somewhat poorly drained, light-colored to moderately dark colored Blount soils on nearly level to gentle slopes. The available moisture capacity is high on more gentle slopes. The plow layer is medium acid, but crops on these soils respond well to the addition of lime and fertilizer. Erosion protection, such as contour tillage and year around ground coverage, is needed.

Pewamo Series

The Pewamo series surface layer consists of about 11 inches of very dark gray to black silty clay loam. The subsoil is gray silty clay loam to silty clay or clay loam that is mottled with yellowish-brown to dark yellowish-brown. Gray limy till of clay loam to silty clay loam texture underlies the subsoil at a depth that ranges from 34 to 60 inches but is generally about 48 inches. Pewamo soils occur with the somewhat poorly drained Blount soils in nearly level to gently sloping areas. The available moisture capacity and general productivity of Pewamo soils are very high. Internal drainage is slow and runoff is very slow or ponded. Wetness is the major hazard; tile and surface drains are needed.

Crosby Series

The surface layers (about 10 inches thick) of the Crosby series are grayish-brown, smooth, friable silt loams. The subsoil is a firm, compact, light brownish-gray clay loam or silty clay loam that is highly mottled with yellowish-brown and gray. Mottled, highly calcareous loam till underlies the subsoil. The depth to calcareous till ranges from less than 24 inches on gentle slopes to 42 inches or more in flat areas. Crosby soils are low in organic matter content. The plow layer is medium acid unless limed. Drain tiles are needed. These soils of high to medium available moisture capacity are slow to drain.

Brookston Series

The surface layer of the Brookston series is 8 to 15 inches of very dark gray silty clay loam. The subsoil is dark-gray silty clay loam to silty clay that is mottled with light yellowish-brown. Till consisting of mottled yellow and brown loam to light clay loam underlies the subsoil. The surface layer is predominantly silty clay loam but ranges to silt loam. Depth to limy till ranges from 42 to 60 inches. Brookston soils are intermingled with the somewhat poorly drained Crosby soils in nearly level areas. These soils are high in organic matter content. Combinations of tile and surface drains are needed to remove excess water as wetness is a major hazard. Brookston soils have high available moisture capacity and are well-suited to grain production.

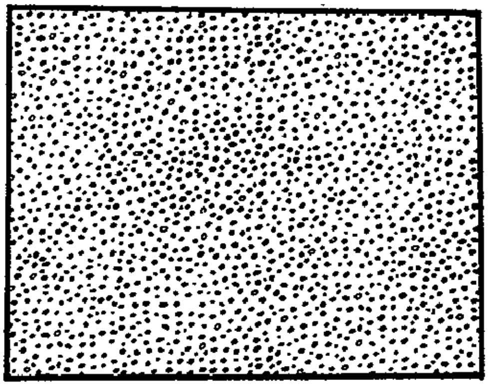
7.1.4.2 Boone County. Boone county soils are of the Alfisol order, Udalf suborder, and Hapludalf great group. (Fig. 7-5 and table VII-5.)

Test Site Soils

The Ockley-Fox, Fincastle-Ragsdale-Brookston, Crosby-Brookston, Genesee-Shoals-Eel, and Miami-Crosby soil associations are present in the Intensive Test Site of Boone County (fig. 7-6, table VII-7).

Ockley Series

The Ockley series occupy nearly level to gently sloping terraces between the uplands and the bottom lands. In cultivated areas, the surface layer consists of about 10 inches of brown silt loam. The subsoil, about 50 inches thick, is brown to dark brown light silty clay loam to gravelly clay loam. It is underlain by light yellowish-brown to brown layers of limy sand and gravel, generally at a



SOIL CLASSIFICATION

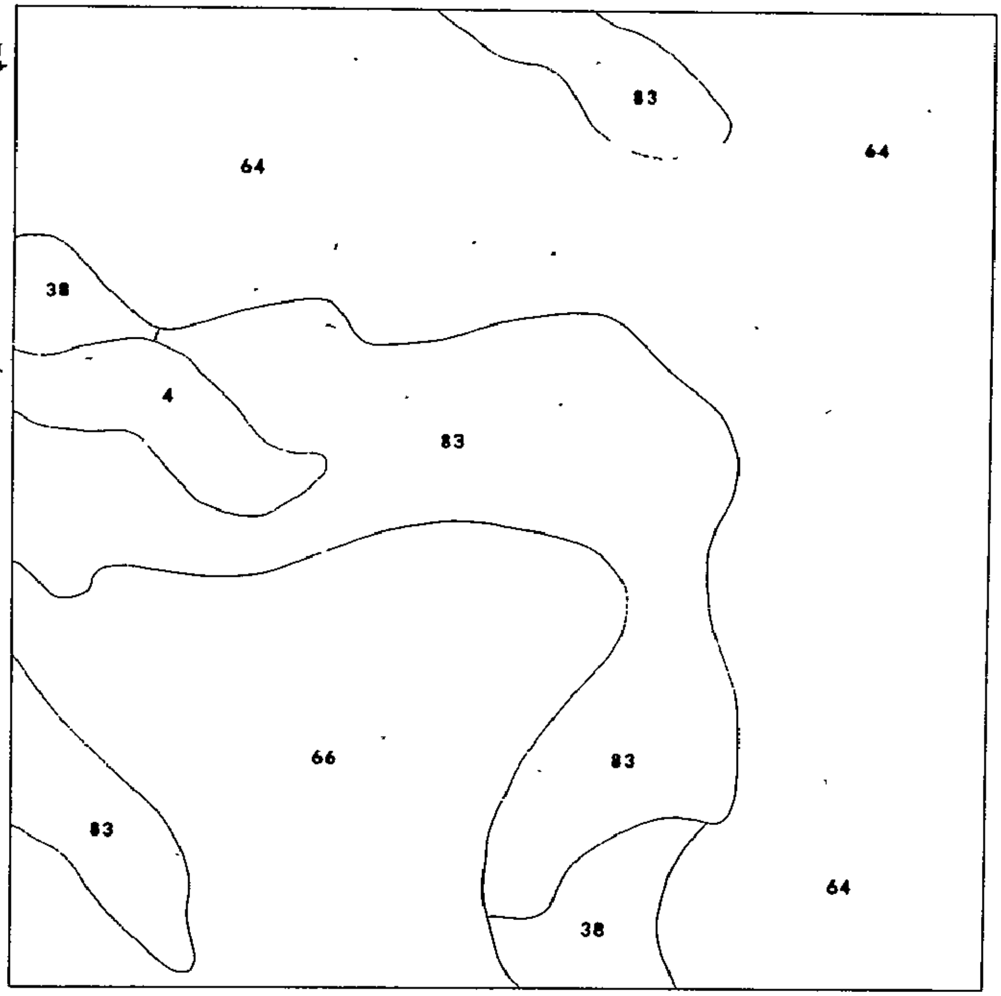
A7-4 ALFISOL - UDALF - HAPLUDALF

APPROX. SCALE 1:615,000

Figure 7-5. — Soil classification map of Boone County, Indiana

TABLE VII-7.- BOONE COUNTY, INDIANA
SOIL LEGEND FOR THE INTENSIVE TEST SITE

Classification	Description
Genesee-Shoals-Eel:	Nearly level, well-drained, loamy Genesee, moderately well drained, loamy Eel, and somewhat poorly drained, loamy Shoals in alluvial deposits.
Mahalasville-Whitaker:	Nearly level, very poorly drained, loamy Mahalasville and somewhat poorly drained, loamy Whitaker in outwash or lake-deposited sand and silt.
Ockley-Fox:	Nearly level, well-drained, loamy soils on outwash sand and gravel.
Crosby-Brookston:	Nearly level, somewhat poorly drained, clayey Crosby and very poorly drained, loamy Brookston in glacial till.
Fincastle-Ragsdale-Brookston:	Nearly level, somewhat poorly drained, silty Fincastle in wind-blown silts and glacial till, very poorly drained, silty Ragsdale in wind-blown silts and loamy Brookston in glacial till.
Miami-Crosby:	Sloping, well-drained, loamy Miami and nearly level, somewhat poorly drained, clayey Crosby in glacial till.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 7-6. — Boone County, Indiana LACIE Intensive Test Site soil classification map.

depth of 60 inches but ranging from 42 to 70 inches or more. These soils have medium to high available moisture capacity. The plow layer is medium acid but responds well to added lime. Protective measures are needed on cultivated areas to control excessive runoff and erosion.

Fox Series

Soils of the Fox series are normally on low terraces bordering the bottom lands or are on higher gently sloping or sloping terraces. The brown silt loam surface layer is 9 to 12 inches thick. The subsoil is brown or yellowish-brown clay loam about 24 inches thick. Very waxy, reddish-brown material makes up the lower part of the subsoil. This material is underlain by stratified limy sand and gravel at a depth that is generally 36 inches but ranges from 24 to 42 inches or more. In depth, to calcareous sand and gravel, the Fox soils range from about 38 inches in the level areas to almost 24 inches in the sloping areas. Tongues of the reddish-brown subsoil extend into the limy sand and gravel. Fox soils occur with the somewhat poorly drained, dark-colored Westland soils. The plow layer tends to be medium acid if it is not limed.

A more detailed description of the Fincastle and Ragsdale series is not available at this time. Refer to Madison County for a description of the Brookston and Crosby soil series.

Genesee Series

The Genesee series consists of deep, moderately dark-colored, well-drained soils on bottom lands along the major streams of the county. The surface layer, 8 inches of dark brown silt loam, is underlain by brown silt loam. The surface layer ranges from very dark gray to dark yellowish-brown and is neutral to calcareous. The content of sand throughout the profile varies considerably and is generally high near the streams. The Genesee soils occur on the stream bottoms with the moderately well-drained Eel soils, with the somewhat poorly drained Shoals soils. These soils have high available moisture capacity, slow runoff, and medium internal drainage. This soil is easy to work for cropping. The soil is easily eroded and must be protected by levees along stream banks.

Shoals Series

The soils of the Shoals series are deep, moderately dark colored, and somewhat poorly drained. They occur on bottom lands along small creeks and in slight depressions or old river meanders. The surface layer is 6 to 8 inches of dark grayish-brown silt loam. It is underlain by a subsurface soil of brown silt loam that is mottled with light gray and brownish-yellow. Gray and dark reddish-brown limy silt loam underlies the subsurface soil. The surface layer ranges from very dark grayish-brown to grayish-brown. It is neutral to mildly alkaline. Thin layers of loam occur in some areas at varying depths. Organic matter has accumulated in the surface layer of these soils. Water moves freely through this soil, so tile is suitable for drainage.

Eel Series

The Eel series consists of deep, moderately dark colored, moderately well-drained soils on bottom lands. The surface layer is 8 to 10 inches of dark brown to very dark grayish-brown silt loam. These soils have had little development other than the accumulation of organic matter in their surface layer which is neutral to alkaline. The depth of mottling ranges from 18 to 30 inches. In some places thin layers of sand occur in these soils. Eel soils have high to very high available moisture capacity. Runoff is slow to ponded and internal drainage is medium. In some areas tile drains are needed.

Miami Series

The Miami series consists of deep, moderately dark colored, well-drained soils on nearly level to steep uplands. The brown to yellowish-brown silt loam surface layer is about 12 inches thick. The subsoil is dark brown clay loam and silty clay loam about 16 inches thick. It is underlain by brown limy loam to light clay loam till that ranges from 24 to 42 inches in depth. Miami soils occur with the somewhat poorly drained Crosby soils on nearly level flats. The plow layer of Miami soils is medium acid if it has not been limed. Protection from erosion is needed. Water moves through the subsoil at a moderate rate.

7.1.4.3 Shelby County. Shelby County soils are of the Alfisol order, Udalf suborder, and Hapludalf great group. (Fig. 7-7, table VII-5.)

Test Site Soils

The Crosby-Brookston and Westland-Sleeth associations dominate the Intensive Test Site. Refer to Madison County for descriptions of the Crosby and Brookston soil series (fig. 7-8, table VII-8).

Westland Series

The Westland series occupies broad depressional flats along rivers and creeks. The surface layer, about 14 inches thick, is a very dark brown or black silty clay loam. The subsoil, about 35 inches thick, is dark-gray silty clay loam to clay loam mottled with yellowish-brown. Gray and light yellowish-brown layers of limy sand and gravel underlie the subsoil at a depth of about 49 inches. The surface layer is silty clay loam in most places, but in some areas it is coarser textured. Depth to limy sand and gravel ranges from 24 to 70 inches or more. Westland soils occur with the somewhat poorly drained Sleeth soils. These soils are generally neutral but occasionally applications of lime may be needed. The Westland soils are well supplied with organic matter and the available moisture capacity is high. Wetness is the major hazard and artificial drainage is necessary to remove excess water.

Sleeth Series

The Sleeth series surface layer, about 16 inches thick, is very dark grayish-brown silt loam. The subsoil, about 32 inches thick, is dark-gray silty clay loam or clay mottled with yellowish-brown. Layers of gray to dark-gray gravel and sand generally underlie the subsoil at a depth of 48 inches, but in some places the underlying material is silt and fine sand. The surface layer ranges from very dark grayish-brown to light grayish-brown. Depth to the limy sand and gravel ranges from 42 to 70 inches or more. The plow layer of the Sleeth soils is medium acid where it has not been limed. These soils have high available moisture capacity and medium to high general productivity. Wetness is a hazard and artificial drainage is needed.

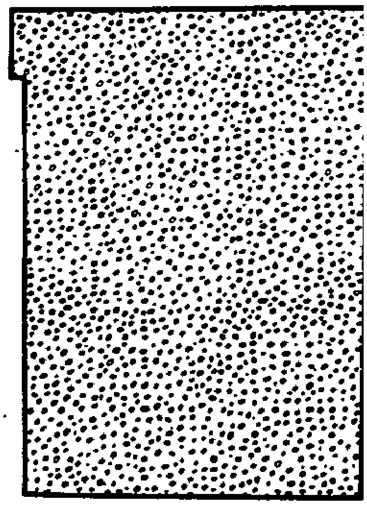
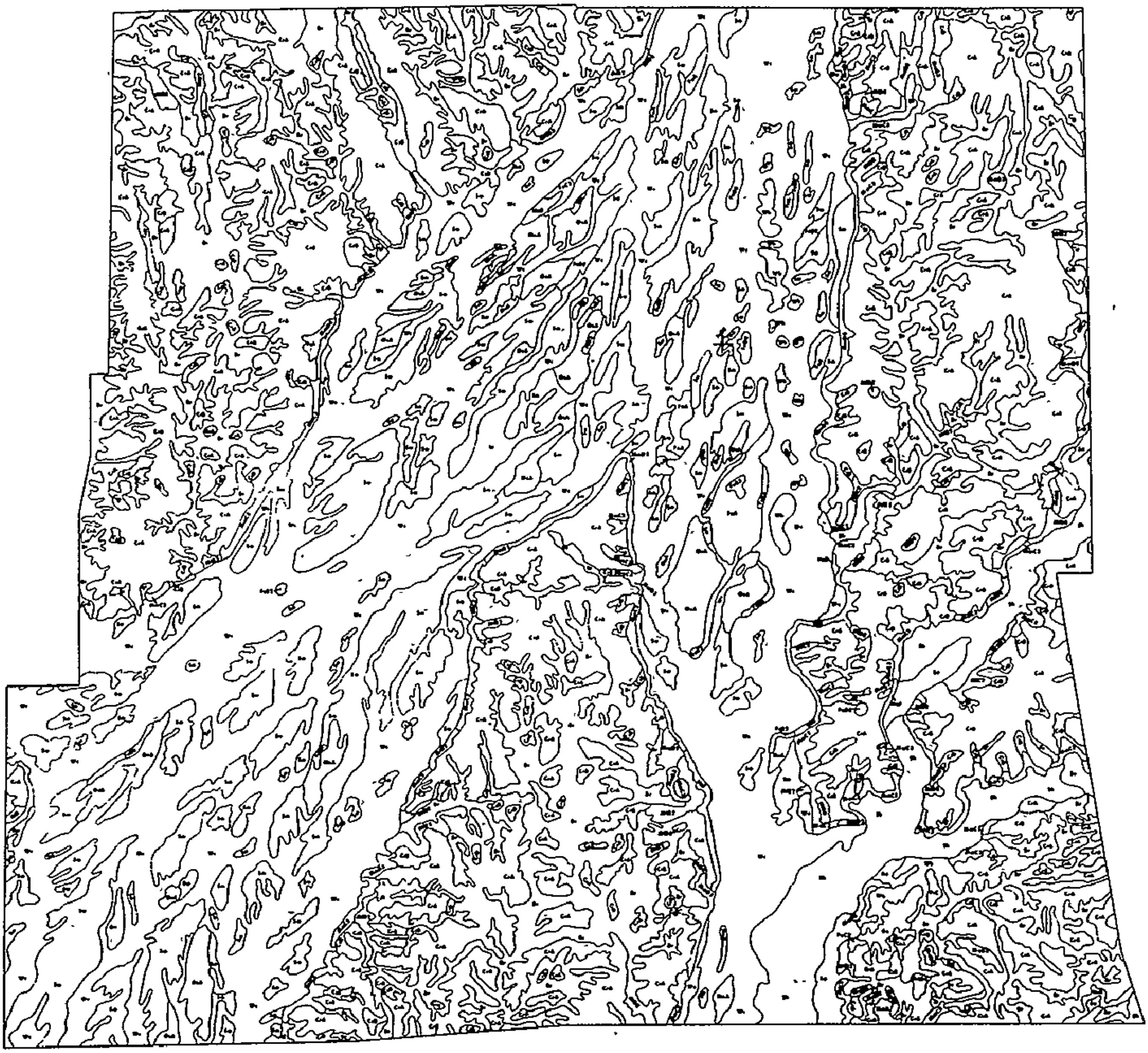


Figure 7-7. — Soil classification map of Shelby County, Indiana.



Prepared by:
FSO, Cartographic Laboratory,
Earth Observation Division,
S & AD. JSC/NASA.
Houston, Texas March 1975

ORIGINAL PAGE IS
OF POOR QUALITY

SOIL MAP PREPARED FROM
COUNTY SOIL SURVEYS

Figure 7-8. — Shelby County, Indiana LACIE Intensive Test Site soil classification map.

TABLE VII-8.- SHELBY COUNTY, INDIANA SOIL LEGEND FOR THE INTENSIVE TEST SITES

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Most symbols without a slope letter are for nearly level soils, but some are for land types that have a considerable range in slope. A final number, 2 or 3, in a symbol shows that the soil is names as eroded or severely eroded.

SYMBOL	NAME
Ay	Ayrshire fine sandy loam
Br	Brookston silty clay loam
CoE	Corydon stony silt loam, 18 to 35 percent slopes
CrA	Crosby silt loam, 2 to 4 percent slopes
CsB	Crosby-Miami silt loams, 0 to 6 percent slopes
Ee	Eel silt loam
FoA	Fox loam, 0 to 2 percent slopes
FoB2	Fox loam, 2 to 6 percent slopes, eroded
FoC2	Fox loam, 6 to 12 percent slopes, eroded
FoD2	Fox loam, 12 to 18 percent slopes, eroded
FsA	Fox loam, loamy substratum, 0 to 3 percent slopes
FXB3	Fox clay loam 2 to 6 percent slopes, severely eroded
FxC3	Fox clay loam, 6 to 12 percent slopes, severely eroded
Ge	Genesee loam
Gn	Genesee sandy loam, sandy variant
Gp	Gravel pits
HeE	Hennepin loam, 18 to 25 percent slopes
HeF	Hennepin loam, 25 to 50 percent slopes
Ko	Kokomo silty clay loam
Lm	Linwood muck

TABLE VII-8.- SHELBY COUNTY, INDIANA SOIL LEGEND FOR THE INTENSIVE TEST SITES - Concluded

SYMBOL	NAME
MaA	Martinsville loam, 0 to 2 percent slopes
MaB2	Martinsville loam, 2 to 6 percent slopes, eroded
Me	Medway silt loam
MIB2	Miami silt loam, 2 to 6 percent slopes, eroded
MIC2	Miami silt loam, 6 to 12 percent slopes, eroded
MID2	Miami silt loam, 12 to 18 percent slopes, eroded
MmB3	Miami clay loam, 2 to 6 percent slopes, severely eroded
MmC3	Miami clay loam, 6 to 12 percent slopes, severely eroded
MmD3	Miami clay loam, 12 to 18 percent slopes, severely eroded
MrB	Miami-Crosby silt loams, 0 to 6 percent slopes
Ms	Millsdale silty clay loam
MtB	Milton silt loam, 1 to 6 percent slopes
NeD2	Negley loam, 12 to 18 percent slopes, eroded
NeE	Negley loam, 18 to 25 percent slopes
NnA	Nineveh loam, 0 to 2 percent slopes
NnB	Nineveh loam, 2 to 6 percent slopes
OcA	Ockley loam, 0 to 2 percent slopes
PaB2	Parke silt loam, 2 to 6 percent slopes, eroded
PaC2	Parke silt loam, 6 to 12 percent slopes, eroded
PrA	Princeton fine sandy loam, 0 to 2 percent slopes
PrB	Princeton fine sandy loam, 2 to 6 percent slopes
PrC	Princeton fine sandy loam, 6 to 12 percent slopes
Qu	Quarries
Ra	Randolph silt loam
Re	Rensselaer clay loam
RoE	Rodman gravelly loam, 18 to 35 percent slopes
Rs	Ross loam, moderately deep variant
Rt	Ross silt loam
Sa	Saranac silty clay loam
Se	Sebewa clay loam
Sh	Shoals silt loam
Sm	Sleeth loam
Wc	Westland clay loam
We	Westland and Brookston loams, overwash
Wh	Whitaker loam

7.2 PRINCIPAL CROP PRODUCTION

7.2.1 State

The principal crops in Indiana are corn, wheat, sorghums, soybeans, oats, and hay. Corn ranks first, soybean ranks second and wheat ranks third in production as well as acreage. Tobacco, rye, barley, flax, and buckwheat are other agricultural crops of the state. Hog and cattle raising are also important economic activities.

Wheat constitutes a small percentage of harvested cropland. Detailed information on wheat cropping practices in Indiana is unavailable at this time.

According to 1964 and 1969 data, the following has occurred in Madison, Boone and Shelby counties: corn and soybean acreage and production has increased while wheat production and acreage has decreased (tables VII-9, VII-12, and VII-15).

7.2.1.1 Madison County. Corn production of 1969 surpassed 1964 by nearly 2,500,000 bushels even though the seeded acreage increased less than 1 percent. Wheat acreage and production both decreased in 1969 in comparison with 1964 figures. Production of sorghum increased by about one-third from 1964 to 1969 and acreage expanded 136 percent. Soybeans production of 1969 exceeded 1964 statistics by slightly over 800,000 bushels but acreage for the same years increased 15 percent. For the same years, there was a decrease in both hay production and acreage (table VII-9). Table VII-11 expresses the area harvested as a percent of total cropland (1969).

Wheat production in Madison County has fluctuated during the 3-year period of 1971, 1972, and 1973. Production in 1973 was nearly 200,000 bushels less than 1972, and 150,000 bushels less than 1971. There was little difference in acreage harvested in 1971 and 1973, but 1972 acreage exceeded these years by 2,200 and 1,800 acres respectively.

TABLE VII-9.- PRODUCTION AND ACREAGE OF CROPS HARVESTED IN 1969 and 1964

[Madison County]

Crop	1969		1964		
	Production bushels	Harvested acreage	Production bushels	Harvested acreage	Acreage % variation
Corn	7,166,757	67,297	4,699,550	67,024	less +1
Wheat	620,813	14,407	783,535	23,271	-38
Sorghums	3,032	111	1,950	47	+136
Soybeans	2,266,606	62,334	1,427,150	54,170	+15
Hay (in tons)	18,018	8,024	24,835	13,008	-39
Other small grains	---	5,717	---	5,937	-4

TABLE VII-10.- LAND IN FARMS[a] ACCORDING TO USE IN MADISON COUNTY, INDIANA

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	980	150,767	1,003	157,005
Cropland used only for pasture or grazing	399	12,551	485	11,455
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	351	15,419	355	10,901
Cropland on which all crops failed	23	255	45	407
Cropland in cultivated summer fallow	21	1,481	---	---
Cropland idle	147	4,640	89	2,429
Total cropland	990	185,113	N/A	182,197
Woodland pastured	330	6,539	421	8,170
Woodland not pastured	289	5,477	338	5,834
Total woodland	524	12,016	649	14,004
Improved pastureland and rangeland	74	1,736	113	1,965
Pastureland and rangeland not improved	85	1,639	N/A	5,246
Total pastureland and rangeland (other than cropland and woodland pasture)	151	3,375	342	7,211
All other land	821	12,397	994	11,593
Irrigated land	4	185	5	281
Total pastureland (all types)	592	22,465	N/A	26,836

[a]Farms with sales of $2,500.00 and over.

TABLE VII-11.- AREA HARVESTED[a] AS PERCENT OF TOTAL CROPLAND IN MADISON COUNTY, INDIANA (1969)

Crop	Percent, %
Corn	36.3
Wheat	7.7
Sorghums	.05
Soybeans	33.6
Hay	4.3
Other small grains	3.0
Other	15.05

[a]Only harvested acreage data available.

7.2.1.2 Boone County. Production of corn in 1969 surpassed 1964 figures by 55 percent even though seeded acreage increased only 8 percent. Wheat acreage decreased 53 percent from 1964 to 1969. This is a decrease of approximately 200,000 acres. Total sorghum production and acreage is minimal but the increases were large. Acreages planted in soybeans increased 16 percent from 1964 to 1969 and production in 1969 exceeded 1964 statistics by nearly 750,000 bushels or 62 percent. Hay acreage and production were reduced significantly in 1969 from 1964 (table VII-12). Table VII-14 expresses the area harvested as a percent of total cropland (1969).

Wheat production during the early 1970's fluctuated considerably. There was an increase of 104,000 bushels from 1971 to 1972 and a decrease of 247,400 bushels from 1972 to 1973. Yields were very poor in 1973, and there was also a decrease of 2,400 in acreage planted.

7.2.1.3 Shelby County. Acreages planted in corn increased 12 percent from 1964 to 1969 whereas production increased about 83 percent for the same years. Wheat production decreased 22 percent, and acreage decreased 42 percent for the same years. Sorghums were not planted in 1964 and made only a minimal showing in 1969. Acreage planted in 1969 increased 10 percent over 1964; production in 1969 exceeded that of 1964 by over 740,000 bushels. Hay acreage and production both decreased considerably for the same years (table VII-15). Table VII-17 shows the area harvested as a percent of the total cropland.

Wheat production increased about 97,000 bushels from 1971 to 1972 and decreased about 197,000 bushels from 1972 to 1973. Yields were 46 bushels per acre in 1971, 50 bushels per acre in 1972, and 35 bushels per acre in 1973. There was little difference in acreage planted during this 3-year period.

7.2.2 Cropping Systems

Soil adaption and methods of harvesting corn are the principal factors in determining whether wheat or oats are used in a 3-year rotation. Where the soils are better adapted to wheat than oats and the corn stalk is cut, a corn-wheat-clover rotation is employed. More than one

TABLE VII-12.- PRODUCTION AND ACREAGE OF CROPS HARVESTED IN 1969 AND 1964

[Boone County]

	1969		1964		
Crop	Production bushels	Harvested acreage	Production bushels	Harvested acreage	Acreage variation, %
Corn	8,723,834	83,720	5,614,050	77,094	+8
Wheat	386,634	9,178	595,055	17,445	-53
Sorghum	2,120	29	104	2	+1450
Soybeans	1,952,024	54,853	1,204,050	47,103	+16
Hay (in tons)	18,080	8,387	24,298	13,807	-39
Other small grains	---	6,052	---	7,776	-22

TABLE VII-13.- LAND IN FARMS[a] ACCORDING TO USE

[Boone County]

Use	1969 Farms	1969 Acres	1964 Farms	1964 Acres
Harvested cropland	1,023	158,527	1,050	161,985
Cropland used only for pasture or grazing	536	16,205	655	16,228
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	321	12,259	257	8,188
Cropland on which all crops failed	22	627	30	416
Cropland in cultivated summer fallow	18	1,212	---	---
Cropland idle	152	5,928	57	1,178
Total cropland	1,040	194,758	N/A	187,995
Woodland pastured	447	11,091	557	13,287
Woodland not pastured	284	7,179	247	4,436
Total woodland	622	18,270	692	17,723
Improved pastureland and rangeland	70	2,422	73	1,518
Pastureland and rangeland not improved	80	2,000	N/A	4,158
Pastureland and rangeland (other than cropland and woodland pasture)	143	4,422	239	5,676
All other land	854	12,395	1,032	13,369
Irrigated land	---	---	1	34
Total pastureland (all types)	758	31,718	N/A	35,191

[a]Farms with sales of $2,500.00 and over.

TABLE VII-14.- AREA HARVESTED[a] AS PERCENT OF TOTAL CROPLAND IN BOONE COUNTY, INDIANA (1969)

Crop	Percent, %
Corn	42.9
Wheat	4.7
Sorghum	—
Soybeans	28.1
Hay	4.3
Other small grains	3.1
Other	16.9

[a]Only harvested acreage data available.

TABLE VII-15.- PRODUCTION AND ACREAGE OF CROPS HARVESTED IN 1969 AND 1964

[Shelby County]

Crop	1969		1964		Acreage variation %
	Production bushels	Harvested acreage	Production bushels	Harvested acreage	
Corn	8,504,922	81,578	4,653,850	71,423	+12
Wheat	585,287	14,259	751,845	24,455	-42
Sorghums	384	12	---	---	---
Soybeans	1,857,151	50,373	1,112,850	45,352	+10
Hay (in tons)	18,609	7,351	25,529	13,607	-46
Other small grains	---	2,927	---	4,368	-33

TABLE VII-16.- LAND IN FARMS[a] ACCORDING TO USE

[SHELBY COUNTY]

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	953	153,397	951	157,874
Cropland used only for pasture or grazing	480	15,024	624	16,208
Cropland in cover crops, legumes, and soil-improvement grasses, not harvested or pastured	373	15,210	325	10,030
Cropland on which all crops failed	21	359	68	918
Cropland in cultivated summer fallow	35	2,211	---	---
Cropland idle	173	6,403	136	3,363
Total cropland	962	192,604	N/A	188,393
Woodland pastured	293	6,906	392	7,791
Woodland not pastured	300	6,655	287	5,838
Total woodland	500	13,561	575	13,629
Improved pastureland and rangeland not improved	64	2,055	97	1,816
Pastureland and rangeland not	124	3,470	N/A	5,992
Pastureland and rangeland (other than cropland and woodland pasture)	174	5,525	333	7,808
All other land	799	10,774	935	11,713
Irrigated land	5	186	11	920
Total pastureland (all types)	653	27,455	N/A	31,807

[a]Farms with sales of $2,500.00 and over.

TABLE VII-17.- AREA HARVESTED[a] AS PERCENT OF TOTAL CROPLAND IN SHELBY COUNTY, INDIANA (1969)

Crop	Percent, %
Corn	42.3
Wheat	7.4
Sorghum	—
Soybeans	26.1
Hay	3.8
Other small grains	1.5
Other	18.9

[a]Only harvested acreage data available.

rotation is often used on the same farm. Variation in the type of soil or slope of the land may dictate a different percentage of corn on one part of the farm than on another part on some farms where the crop is hogged off. One field is planted to corn continuously for a much longer period than is called for by the regular rotation. Convenience of pasturing livestock is another reason for having a minor rotation of small fields.

Irrigated acreage is a very small percentage of the agricultural land. Irrigation is advisable for land with sandy soils that tend to dry out quickly during the warmer summer month. There has been a decrease in irrigated acreage from 1964 to 1969; this could be attributed to better conservation practices (table VII-10, VII-13, VII-16).

Most of the soils in Indiana are medium acid and therefore liming is necessary. Nitrogen, phosphates, and potash are also added to the soil to improve fertility.

Conservation practices of cropland areas are mainly directed toward prevention of soil erosion and drainage of excess water. Several practices are employed to decrease soil erosion. Residue incorporation, annual cover crops, contouring, strip cropping, minimum tillage, and mulch tillage have been found to increase water penetration and reduce runoff. Systems of drainage ditches have been dredged to direct the flow of excess water. Farmers lay drain tiles to assist in drainage without creating further erosional problems.

Refer to tables VII-10, VII-13, and VII-16 for a breakdown of the land in farms according to use. The total area in cropland in 1969 was 185,113 acres while 12,016 acres were in woodland and 22,465 acres were in pastureland of all types. Cropland acreage increased from 1964 to 1969 while woodland and pastureland decreased.

In 1969 the average size of a farm was 209.5 acres in Madison County, 214.8 acres in Boone County, and 224.4 acres in Shelby County. Table VII-18 lists the number of farms and total areas harvested by county. Number average size, and range of field sizes are shown in table VII-19.

TABLE VII-18.- NUMBER OF FARMS AND ACRES HARVESTED

[1969]

County	Number of farms	Total acres harvested
Madison	1661	159,497
Boone	1448	163,120
Shelby	1364	157,530

TABLE VII-19.- NUMBER, AVERAGE SIZE, AND RANGES OF FIELD SIZES WITHIN THE INDIANA TEST SITES

County	Test site size, miles	No. of fields	Av. field size, acres	Range in field size, acres
Madison	3x3	250-270	20	5-100
Boone	3x3	210-230	25	2.5-100
Shelby	3x3	260-280	20	5-60

7.2.3 Cropping Calendars

Winter wheat, barley, and rye are seeded in the fall and harvested in early summer. Oats are planted in April and harvested in July. Corn sorghums, and soybeans are planted in May and June, and are harvested in the fall (tables VII-20 and VII-21).

Spring floods can seriously delay seeding of crops as well as injure the previously emerged winter wheat. A late start in planting increases the risk of crop loss in the fall. If there is an early freeze, some crops may not have time to mature. Snow on the ground during the winter protects the soil from deep freezing, and also serves as a cover that protects forage crops and winter grains from the cold. A summer drought can seriously reduce crop yields.

7.2.4 Wheat Varieties

Paunee, Dual, Vermillion, and B4930 are the major varieties cultivated in Indiana. Distribution data on these and other varieties found in Indiana are not available at the present time.

Table VII-20.- CROP CALENDARS FOR THE CENTRAL CROP REPORTING DISTRICT OF INDIANA

[MADISON, BOONE AND SHELBY COUNTIES]

Seedbed preparation			Full coverage			Heading, flowering			Post-Harvest operations		
Start	Mid-pt	End	Start	Mid-pt.	End	Start	Mid-pt.	End	Start	Mid-Pt.	End
Winter Wheat											
Jul 15	Aug 25	Oct 15	Sep 16	Oct 18	Nov 25	Apr 30	May 25	Jun 25	Jun 21	Jul 11	Aug 06
Rye											
Jul 15	Aug 25	Oct 15	Sep 11	Oct 13	Nov 20	Apr 15	May 15	Jun 05	Jun 16	Jul 16	Aug 06
Corn											
Mar 30	Apr 25	May 30	Jun 30	Jul 10	Jul 18	Jul 20	Jul 25	Jul 30	Sep 25	Nov 08	Dec 27
Oats											
Mar 30	Apr 20	May 30	Apr 20	May 20	May 30	Apr 30	Jun 15	Jul 20	Jul 08	Aug 01	Aug 30
Barley											
Jul 15	Aug 25	Oct 15	Sep 11	Oct 13	Nov 20	Apr 15	May 15	Jun 05	Jun 16	Jul 16	Aug 06
Soybeans											
Mar 30	Apr 25	May 30	Jul 20	Jul 24	Jul 29	Jun 25	Aug 01	Aug 31	Sep 15	Oct 30	Dec 15

TABLE VII-21.- USUAL PLANTING AND HARVESTING DATES BY CROPS

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Hay:				
Alfalfa		May 15		Sept. 5
Clo-tim		June 15		Aug. 20
Lespedeza		Sept. 1		Sept. 20
Other		June 20		Oct. 1
Tobacco: Type 31	May 15-June 15	Aug. 20	Sept. 1-Sept. 20	Oct. 1
Popcorn:	May 5-June 5	Oct. 5	Oct. 15-Nov. 5	Nov. 15
Seed Crops:				
Red clover		Sept. 5	Sept. 10-Oct. 5	Oct. 15
Lespedeza		Oct. 30	Nov. 5-Nov. 15	Nov. 20
Timothy		Aug. 1	Aug. 10-Aug. 20	Aug. 25

INTENSIVE TEST SITE ASSESSMENT REPORT

SOUTH DAKOTA

SECTION EIGHT

CONTENTS

TABLES

FIGURES

8.0 SOUTH DAKOTA INTENSIVE TEST SITES

8.1 REGIONAL DESCRIPTION

Two Intensive Test Sites have been selected for the Large Area Crop Inventory Experiment (LACIE) in the state of South Dakota. These test sites are located in Hand County in the central crop reporting district of South Dakota (fig. 8-1).

TABLE VIII-1. – COUNTY SIZE AND LOCATION OF THE LACIE INTENSIVE TEST SITES IN SOUTH DAKOTA

County	Sq. miles	Acres	N Lat.	W Long.	Test site size, miles
Hand 1	1436	919,040	44°35'	98°58'	5x6
Hand 2	1436	919,040	44°21'	98°46'	5x6

8.1.1 Location

The Intensive Test Site, Hand 1, is located about two miles north of the town of Miller, in approximately the center of Hand County. The Intensive Test Site, Hand 2, is located in the eastern portion on the border of Hand County and Beadle County, and is approximately eight miles north of the Jerauld County line which lies south of Hand County.

8.1.2 Physiography

Hand County is located in the central part of South Dakota. It is bounded on the north by Fault County, on the east by Spink and Beadle Counties, on the south by Jerauld and Buffalo Counties, and on the west by Hyde County. The county is divided into two distinct topographic divisions, the glacial uplands and the glacial flood plains. The glacial uplands vary from gently undulating to strongly rolling, while the glacial flood plains are level areas located along stream

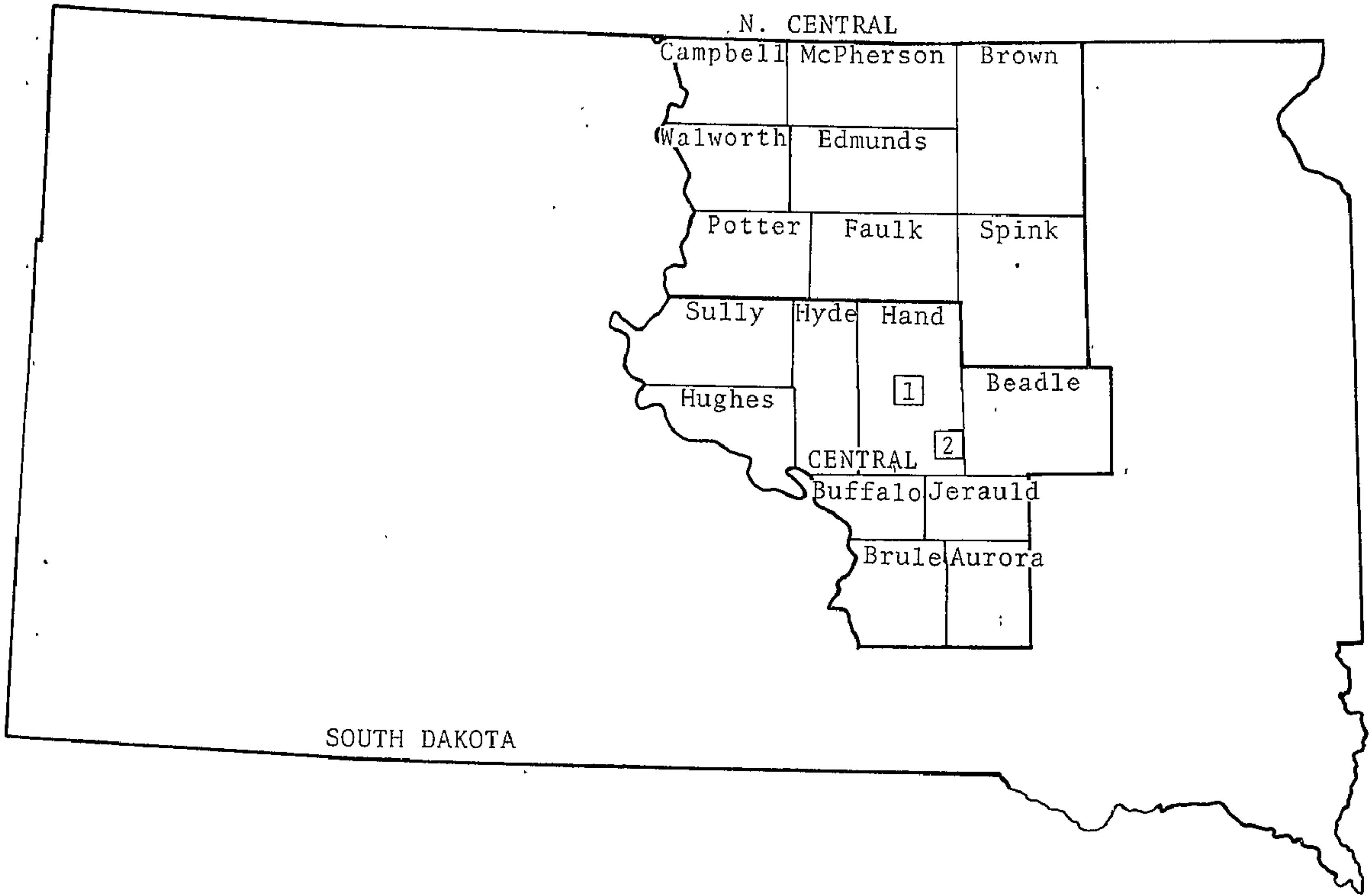


Figure 8.1 – Location of Hand County Intensive Test Sites.

bottoms. The county's drainage system is formed by Wolf Creek with its tributaries in the north, Turtle Creek in the central, and Sand Creek in the southeastern part of the county. Site 1 is topographically level with intermittent streams and gullies. Site 2 is more undulating.

8.1.3 Climate

The climate of South Dakota is typically continental. Situated at about the geographical center of the North American Continent, and near the paths of a large number of cyclones and anticyclones, South Dakota has the extremes of summer heat and winter cold, together with rapid fluctuations in temperature. More than half of the State lies in the semiarid region west of the 100th meridian.

Due to the midcontinental position of the State, at great distance from large bodies of water, and its altitude and latitude, the daily, monthly, and annual ranges in temperature are very marked. Temperatures of 100°F or higher are experienced yearly in some parts of the State from June to September, and readings above 100° F have been recorded also in April, May, and October. These high temperatures are usually attended by low humidity. Below zero weather occurs frequently from November through March.

The seasonal distribution of precipitation conforms to the plains type, and about three-fourths occurs during the crop season, April through September. Normally, the wettest month is June, followed closely by May and July; the driest months are November through February.

As a rule snow cover is not great but occasionally there is a heavy winter snowfall with the amount accumulating to a considerable depth. Snowstorms, accompanied by high winds and subzero temperatures, commonly known as blizzards, occur occasionally.

There is a marked tendency to droughts and the water table has become gradually lowered to the extent that the water situation has become critical in some parts of the state.

The prevailing wind direction during the growing season is generally from the south-southeast and during the rest of

TABLE VIII-2. – AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT REDFIELD, SPINK COUNTY, SOUTH DAKOTA

Month	Temperature average, °F	Precipitation average, inches
December	19.8	0.48
January	13.8	0.50
February	18.3	0.47
Winter	17.3	1.45
March	30.4	0.99
April	46.5	1.82
May	58.8	2.19
Spring	45.23	5.00
June	68.4	3.71
July	75.7	2.04
August	73.3	2.03
Summer	72.4	7.78
September	63.1	1.34
October	50.3	1.22
November	32.4	0.56
Fall	48.6	3.12
Year	45.9	17.35

[a]Averages for period 1931-1955.

the year from the north-northwest. Wind velocities average 8 to 11 miles an hour.

The annual average precipitation for Hand County is 17.58 inches, with 13.31 inches falling during the growing season from April through September. The growing season is about 134 days as the last freeze in spring occurs about May 15, and the first freeze in fall occurs about September 27.

8.1.4 Soils

The Intensive Test Sites in Hand County are on soils of the order Mollisol (see fig. 8-2). The Mollisol soils have nearly black friable organic-rich surface horizons high in bases; formed mostly in subhumid and semiarid warm to cold climates. Hand County soils are of the Mollisol order, Ustoll suborder, and Argiustoll great group.

Houdek-Bonilla Association

This association occurs on nearly level to gently undulating topography. The Houdek are deep, well-drained, loamy soils formed in glacial till. The Bonilla are deep, moderately well-drained, loamy to silty clay loam soils that have thicker and darker colored surface and subsoil layers than the Houdek. The Bonilla occur in the gentle swales and concave positions with the Houdek on the slightly higher upland slopes. Other soils that may be included are the Demky, Cavo, and Tetonka. Most of these soils are used for growing corn, small grains, and alfalfa.

Houdek-Cavo Association

This association occurs mainly on undulating topography. Some depressions, hills and ridges occur in the landscape. The Houdek are deep, well-drained, loamy soils formed in glacial till. The Houdek occur on slightly higher upland slopes. The Cavo soils have loamy or silty surface layers with dense claypan subsoils that are usually below the plowed depth. Other soils that may occur in minor

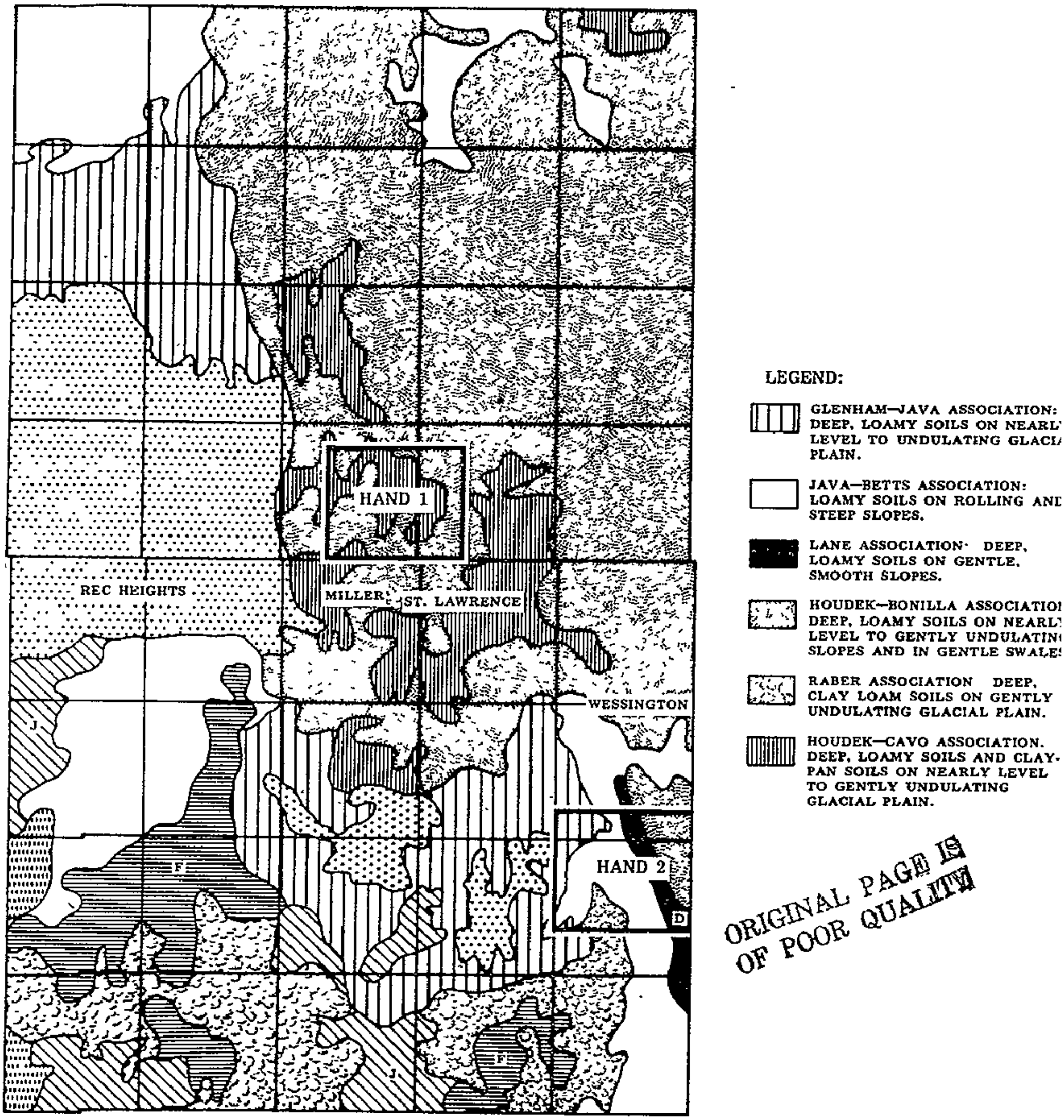


Figure 8-2. — Soils of the Intensive Test Sites in Hand County, South Dakota.

amounts are the Jerauld, Bonilla, and Tetonka. The soils in this association are used mostly for the growing of small grains and alfalfa except where the claypan soils are extensive and are used for hay or pasture.

Glenham-Java Association

This association occurs on nearly level to undulating slopes. There are many shallow depressions and a few low ridges and knolls. The Glenham are deep, well-drained, loamy soils also developed in glacial till, but have thinner surface and subsoil layers than the Glenham. Also included in this association are the thick, dark, loamy soils of the Bonilla series, and the Hoven, Tetonka, and Cavo soils. Soils in this association are used principally for the growing of small grains, hay and alfalfa.

Raber Association

This association occurs on undulating topography. Many depressions and knolls dot the landscape. The Raber soils are deep, well-drained soils with loamy surface layers and clayey subsoils that are developing in glacial till. Other soils that may be included in this association are the Eakin, Tetonka, Hoven, and Cavo. The more level areas of this association are used mostly for the growing of small grains, corn, and alfalfa.

Java-Betts Association

This association occurs on hilly areas. The Java are deep, loamy soils developed in glacial till. The Betts are thin surfaced, medium textured limey soils that have excessive runoff because of the steep slopes. The Betts occupy the ridge tops with the Java soils on the side slopes. Stoney areas, poorly drained depressions, and narrow stream valleys are common. The Glenham, Tetonka, and Raber soils may be included in this association in minor amounts. Most of the areas of this association are used for pasture or hay.

Lane Association

This association occurs on nearly level to gently, smooth slopes. The Lane are deep, dark-colored, loamy to clay loam soils. Most of this area is used to grow small grains, corn, and alfalfa.

See table VIII-3 for a list of the major soil orders.

TABLE VIII-3. – DESCRIPTIONS OF THE HAND COUNTY SOILS

Classification	Description
MOLLISOL	
Ustoll	Mollisols that are mostly in semiarid regions. During the warm season of the year, these soils are intermittently dry for a long period or have subsurface horizons in which salts or carbonates have accumulated; used for wheat or small grains, and some irrigated crops.
Argiustoll	(Formerly Chernozem, Chestnut, and some Brown soils) Ustolls that have a subsurface horizon of clay accumulation that is relatively thin or brownish.
M9-1	Argiustoll, gently sloping.
M9-6	Argiustoll plus Haplustoll, gently sloping.

8.2 PRINCIPAL CROP PRODUCTION

8.2.1 State and County

The principal crops in South Dakota are wheat, oats, barley, rye, corn, flax, sorghum, and hay. Other crops include potatoes and soybeans.

Diversified farming in Hand County is the major enterprise. Field crops make up about 18 percent of Hand County's cash farm income. The major crop produced in terms of value of production in 1967 was hay, followed by wheat, oats, corn, barley, rye, and sorghum.

Corn and winter wheat planted acreage have risen in 1973 over 1972. Acres planted to rye have shown a decrease from 1972 to 1973 (table VIII-4.) The distribution of cropland acreage in 1965 was alfalfa hay, 23 percent; corn, 19 percent; oats, 14 percent; all spring wheat, 10 percent; sorghum and winter wheat, 3 percent each. Table VIII-5 compares the area harvested with total cropland.

Site 1 is entirely cultivated in wheat and corn. Site 2 has approximately 1000 acres of bur oak groves (*Quercus macrocarpa*) and large areas of meadow.

Farms in Hand County are increasing in size. The number of farms with less than 1000 acres declined sharply from 1431 farms in 1935 to 516 farms in 1964. The total number of farms over 1000 acres in size has generally increased from 145 farms in 1935 to 324 farms in 1964. The number of farms of 500 to 999 acres fluctuated moderately from 432 farms in 1935 to 309 farms in 1964. Figures on county land use may be found in table VIII-6.

8.2.2 Cropping Systems

8.2.2.1 Fallowing. Fallowing is usual in both winter and spring wheat crop rotation schemes. Under the fallow system, one-half of the cropland is planted in any given year while the other half is worked fallow to control weeds and insure that the annual precipitation of that year is conserved and retained as soil moisture for the next year's

TABLE VIII-4. — ANNUAL CROP PRODUCTION IN HAND COUNTY (1972-1973)

Crop	Planted acres		Harvested acres		Yield per harvested acre		Unit
	1972	1973	1972	1973	1972	1973	
Corn	73,000	93,000	34,500	46,500	55.0	36.0	bu.
Winter wheat	28,500	33,700	22,200	31,000	36.0	28.0	bu.
Durum wheat	200	200	190	200	25.0	24.0	bu.
Other spring wheat	22,000	31,500	19,400	31,200	21.0	23.0	bu.
Oats	51,000	55,000	43,300	44,000	51.0	43.0	bu.
Barley	14,200	16,000	13,000	15,700	36.0	45.0	bu.
Rye	13,500	8,300	12,000	7,600	37.0	25.0	bu.
Flaxseed	600	700	590	700	11.0	8.0	bu.
Sorghum	4,600	3,200	2,600	1,700	39.0	40.0	bu.
Alfalfa seed			430				
Alfalfa hay			86,000	82,000	1.75	1.40	tons
Wild hay			82,000	60,000	0.95	0.70	tons

TABLE VIII-5. — AREA HARVESTED AS PERCENT OF TOTAL[a] CROPLAND IN HAND COUNTY (1969)

Crop	Percent, %
Corn	12.9
Sorghum	0.7
Wheat	8.5
Other small grains	11.8
Hay (except sorghum)	28.35
Other crops	0.9

[a]Total acreage = 494,913 acres.

TABLE VIII-6. – LAND IN FARMS[a] ACCORDING TO USE IN HAND COUNTY

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	669	307,313	726	355,365
Cropland used only for pasture or grazing	331	94,368	119	11,321
Cropland in cover crops, legumes and soil-improvement grasses, not harvested or pastured	104	14,426	209	30,576
Cropland on which all crops failed	52	6,509	52	3,074
Cropland in cultivated summer fallow	355	50,093	423	35,120
Cropland idle	132	15,628	80	5,503
Total cropland	688	488,337	(NA)	440,959
Woodland pastured	20	684	8	64
Woodland not pastured	83	3,673	43	386
Total woodland	101	4,357	49	450
Improved pastureland and rangeland	103	50,736	71	9,475
Pastureland and rangeland not improved	447	318,242	(NA)	413,169
Total pastureland and rangeland (other than cropland and woodland pasture)	512	368,978	708	422,644
All other land	566	21,462	723	21,650
Irrigated land	13	1,733	5	1,008

[a]Farms with sales of $2500 and over.

crop. Even fallowing will not help to produce much of a crop during years of drought. This suggests the importance of supplementary irrigation. Spring wheat is usually planted on bare fallow or after corn or small grains. The first tilling of the soil for spring wheat is usually done with a chisel in August. Plowing prior to planting starts for the most part the first week in April into the third week. Spring wheat is planted earlier than oats or barley.

Winter wheat accounts for 80 percent of the winter grain with rye the remainder. About April 15, pasture will not show as lush a coverage as the crops. Crested wheat grass (a tamed perennial) is planted for early grazing and usually close to farm buildings for grazing newborn calves.

8.2.2.2 Stubble mulching. Most of the corn is grown for silage. The corn-stubble after silage cutting will leave about 15 to 20 percent cover in the fields. Plowing for corn begins 2 weeks before planting around the first of May. There is limited cultivation in preparation for sowing.

8.2.2.3 Irrigation. The leading crop under irrigation is alfalfa followed by corn, silage, and pasture.

8.2.3 Cropping Calendars

Crop calendars for the small grains are presented in tables VIII-7 and VIII-8.

8.2.4 Wheat Varieties

A list of varieties with percentages planted to each variety in Hand County is not available. Each year a varieties list is published by the Cooperative Extension Service on acceptable varieties. For 1974, varieties of winter wheat acceptable for the Hand County area were Bronze, Centurk, Lancer, and Winoka. Recommended spring wheat varieties are Bonanza, Bounty 208, Chris, Fortuna, World Seeds 1809; with Era, Lark, Olaf, Polk, Protor, Sheridan, and Waldron acceptable statewide. Recommended durum wheat varieties were Hercules, Leeds, Rollette, Ward and Wells.

TABLE VIII-7. – CROPPING CALENDAR FOR THE CENTRAL CROP REPORTING DISTRICT OF SOUTH DAKOTA (HAND COUNTY)

Crop	Seedbed preparation			Full coverage			Heading, flowering			Post-harvest operations		
	Start	Mid-point	End	Start	Mid-point	End	Start	Mid-point	End	Start	Mid-point	End
Winter wheat	July 1	Sept 1	Nov 1	Sept 20	Oct 10	Oct 20	June 1		June 25	Aug 1	Sept 10	Oct 10
Barley	Apr 1	May 10	June 10	May 5	June 10	June 30	June 10	July 15	Aug 20	Aug 10	Oct 30	Dec 30
Oats	Apr 1	June 10	July 5	May 5	June 10	July 5	June 10	June 15	July 5	July 15	Nov 1	Dec 30
Rye	July 1	Sept 1	Oct 30	Sept 15	Oct 10	Oct 20	May 20	June 5	June 15	Aug 1	Sept 10	Oct 10
Spring wheat	Mar 25	May 10	June 5	May 1	June 5	July 5	June 15		July 15	July 15	Oct 30	Dec 30

TABLE VIII-8. — SOUTH DAKOTA: USUAL PLANTING AND HARVESTING DATES BY CROP

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Barley	Apr 5-May 10	July 15	July 25-Aug 10	Aug 15
Corn:				
Grain	May 5-June 5	Oct 1	Oct 20-Nov 5	Nov 20
Silage	May 5-June 10	Aug 25	Sept 10-Sept 20	Oct 1
Forage	May 5-June 10	Sept 1	Sept 20-Oct 5	Oct 10
Flaxseed	Apr 20-June 5	Aug 5	Aug 15-Sept 1	Sept 5
Hay:				
Alfalfa		June 1		Sept 15
Wild		July 1		Sept 5
Oats	Apr 5-May 15	July 15	July 20-Aug 10	Aug 15
Rye	Sept 1-Oct 1	July 15	July 20-Aug 5	Aug 10
Sorghum:				
Grain	May 15-June 20	Oct 1	Oct 10-Nov 1	Nov 10
Silage	May 15-June 20	Aug 20	Sept 5-Sept 15	Sept 25
Soybeans	May 15-June 15	Oct 1	Oct 10-Oct 25	Nov 5
Wheat:				
Winter	Sept 1-Oct 1	July 10	July 15-Aug 1	Aug 10
Other spring	Apr 1-May 5	July 20	July 25-Aug 15	Aug 20
Durum	Apr 1-May 5	July 20	July 25-Aug 15	Aug 20
SEED CROPS				
Alfalfa		Sept 15	Sept 25-Oct 10	Oct 20
Sweet clover		July 20	Aug 1-Aug 20	Sept 1
Kentucky bluegrass		June 15	June 20-July 1	July 10

INTENSIVE TEST SITE ASSESSMENT REPORT

MINNESOTA

SECTION NINE

CONTENTS

TABLES

FIGURES

9.0 MINNESOTA INTENSIVE TEST SITE

9.1 REGIONAL DESCRIPTION

One Intensive Test Site has been selected for the Large Area Crop Inventory Experiment (LACIE) in the state of Minnesota. The test site is located in Polk County.

TABLE IX-1. — COUNTY SIZE AND LOCATION OF THE LACIE INTENSIVE TEST SITE IN MINNESOTA

County	Sq. miles	Acres	N. Lat.	W. Long.	Test site size, miles
Polk	1,396.3	893,635	48°02'	96°35'	5 x 6

9.1.1 Location

The Intensive Test Site, part of the northwest crop reporting district, is located about 7 miles south of the Marshall County line with the eastern edge of the site on the border of Pennington County (fig. 9-1).

9.1.2 Physiography

Polk County lies in the central lowland flat plains physiographic region. The eastern most section of the county has irregular plains. This area contains lake beds of the late Pleistocene epoch; most of the central lowlands were glaciated. The terrain of the site is level.

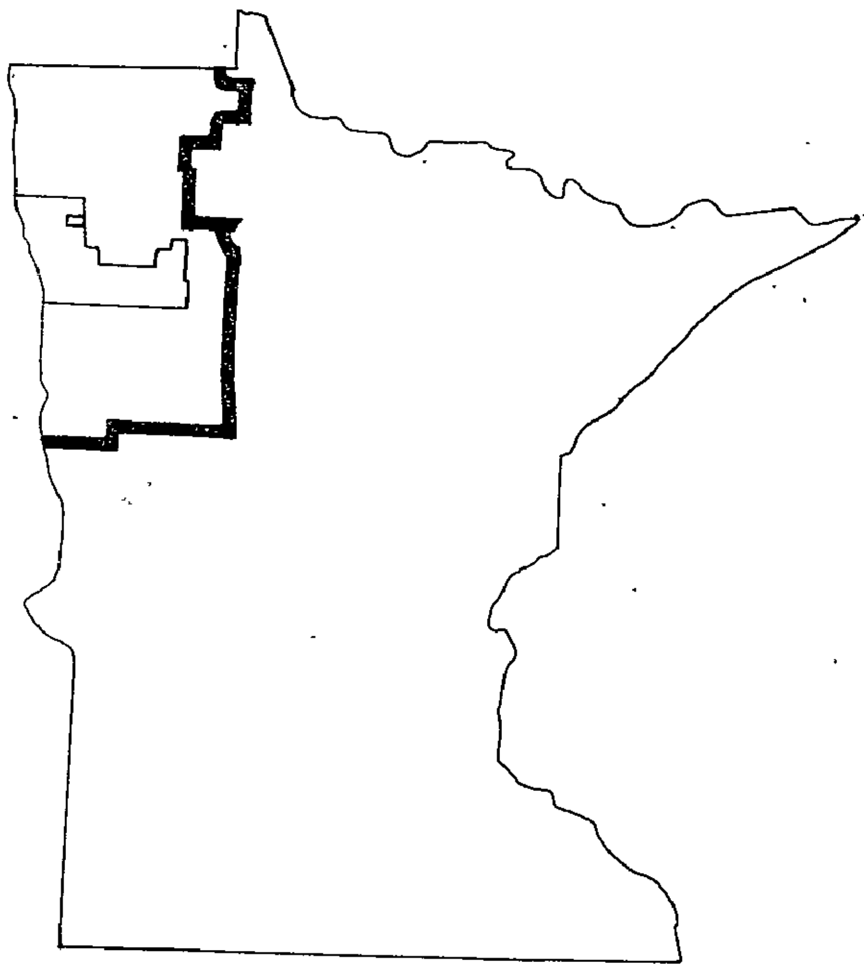


Figure 1. — The Intensive Test Site in Polk County, Minnesota.

9.1.3 Climate

Owing to a midcontinental position, Minnesota has a marked continental climate characterized by wide variations in temperature, scanty winter precipitation, normally ample summer rainfall, and a general tendency to extremes in all climatic features. The most important influence on the climate is the succession of highs and lows (anticyclones and cyclones) that sweep across the northern states from west to east. The disturbances of western Canada and the northern Rocky Mountain region, which are carried eastward across the upper Mississippi Valley, are succeeded by the cooler polar air masses of the anticyclones, resulting in alternating periods of heat and cold and of rainy weather and clear skies.

Because of a favorable growing season, Minnesota maintains a high rank in agricultural production. The growing season is 129 days. The first killing frost in fall occurs about Septtember 24 and the last in spring occurs May 18.

Vegetation is dormant 7 months of the year; the major crops of grain and hay are produced during 4 months, May to August, during which 11.96 inches of the annual rainfall is normally received. Evaporation is less rapid in Minnesota than in regions farther south, consequently the demands of vegetation are not as great. These conditions make the annual rainfall more effective than equal or greater amounts in warmer climates.

Thunderstorms are the principal source of rain during the active vegetation period. An average of one excessive or damaging rainstorm is experienced in each county during the summer season. Crop failures because of droughts can be expected once every 10 years in the western part of the state.

Snowfall varies from 20 inches in the southwestern part of the state to over 70 inches in the extreme northeast. Severe storms such as tornadoes and ice storms are not frequent but occur occasionally. Ice storms usually involve a large areaaand may do extensive damage to trees and overhead wires.

TABLE IX-2. — AVERAGE[a] MONTHLY, SEASONAL AND ANNUAL TEMPERATURE AND PRECIPITATION AT CROOKSTON NW EX. STATION, POLK COUNTY, MINNESOTA

Month	Temperature average, °F	Precipitation average, inches
December	12.1	0.62
January	5.0	0.59
February	9.4	0.59
Winter	8.83	1.80
March	23.0	1.00
April	41.1	1.49
May	54.7	2.60
Spring	39.6	5.09
June	63.7	3.43
July	70.3	2.80
August	68.0	3.13
Summer	67.33	9.36
September	57.4	1.93
October	45.8	1.16
November	26.8	0.92
Fall	43.33	4.01
Year	39.8	20.26

[a]Averages for period 1931-1955.

9.1.4 Soils

The Intensive Test Site, located in Polk County, is on soils in the order Mollisol. The site is located on Aquoll suborder and Haplaquoll great group soils. The Mollisols are soils that have nearly black, friable, organic, rich, surface horizons, high in bases. They are formed mostly in subhumid and semiarid warm to cold climates. The soil suborder Aquoll are seasonally wet Mollisols that have a thick, nearly black, surface horizon and gray subsurface horizons. These are used for pasture, and where drained, for small grains, corn, and potatoes in the north-central states.

Fargo-Bearden Association

These are nearly level, poorly to imperfectly drained soils with black surfaces. They were developed on lacustrine sediments that range in texture from silt loam (Bearden) to clay (Fargo). They are used principally for the production of small grains, corn, potatoes, and sugar beets. These soils are frequently calcareous in all horizons; surface drainage is often required.

Ulen-Tanberg-Sioux Association

These are nearly level, poorly, moderately well and excessively drained soils with dark-colored, neutral to alkaline sandy loam or loamy sand surfaces. They have developed from deep lacustrine sands (Ulen), lacustrine sands over clay (Tanberg) and sandy, gravelly beach deposits (Sioux) in the Red River Valley of Minnesota. They are used largely for cash grain farming. Wind erosion and drought are problems on the old sandy beaches.

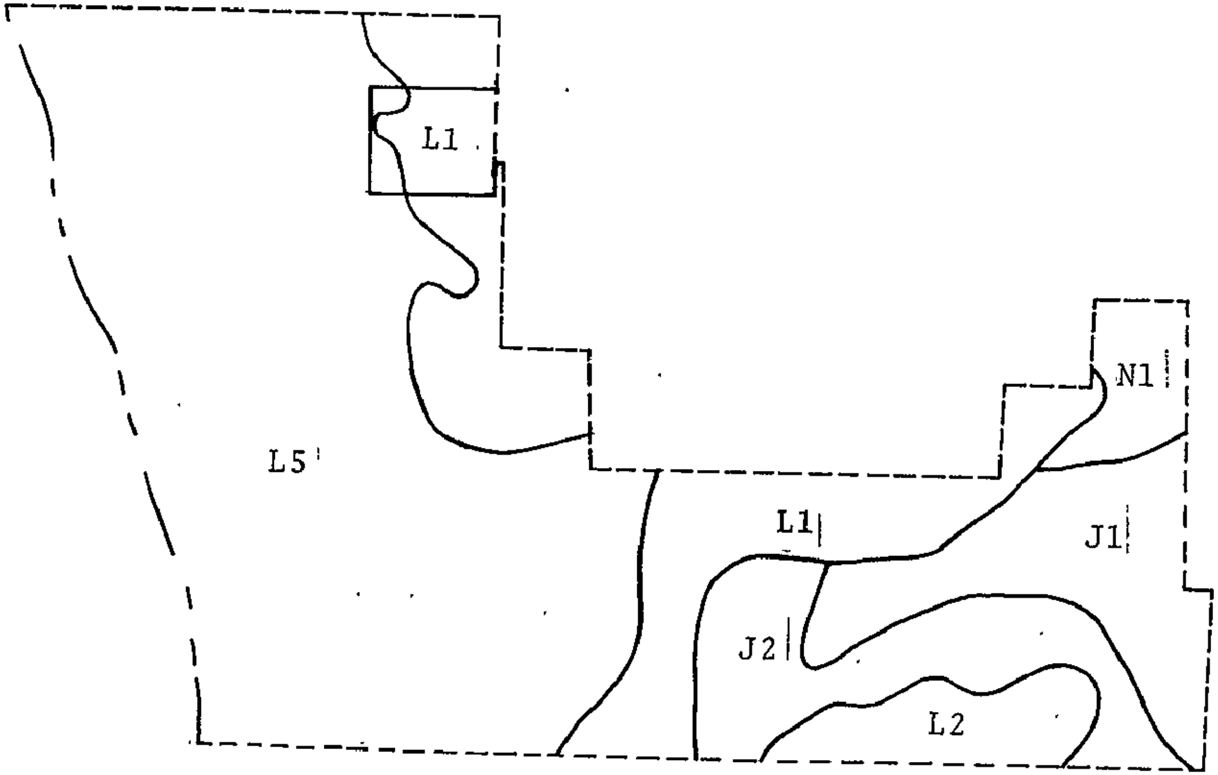
9.2 PRINCIPAL CROP PRODUCTION

9.2.1 State and County

Crop production in Minnesota during 1971 increased 30 percent from 1970. Minnesota produced a record small grain crop in 1971. The 1971 production was 42 percent

TABLE IX-3.— DESCRIPTIONS OF THE MINNESOTA COUNTY SOILS

Classification	Description
MOLLISOL	Soils that have nearly black, friable, organic, rich surface horizons high in bases; formed mostly in subhumid and semiarid warm to cold climates.
Aquoll	Seasonally wet Mollisols that have a thick nearly black surface horizon and gray subsurface horizons; used for pasture, and where drained, small grains, corn, and potatoes in the north central states.
Haplaquoll	Aquolls that have horizons in which
M2-2	Haplaquolls (clayey) plus Calciaquolls, both gently sloping.
Calciaquoll	Aquolls that have a horizon near the surface in which large amounts of calcium carbonate have accumulated.
M1-1	Calciaquolls, gently sloping.
M1-2	Calciaquolls plus Haploborolls, gently sloping.
Boroll	Mollisols of cool and cold regions. Most borolls have a black surface horizon; used for small grain, hay, and pasture.
Argiborolls	Borolls of cool regions. They have a subsurface horizon in which clay has accumulated.
M3-6	Argiborolls plus Haploborolls and Calciaquolls, gently or moderately sloping.



J1 Nebish-Rockwood Association
J2 Waukon-Barnes Association
L1 Ulen-Tanberg-Sioux Association
L5 Fargo-Bearden Association
N1 Peat and Muck

Figure 2. — Soil associations, Polk County.

above 1970 production and 24 percent larger than the 1969 small grain crop. Record yields were established for other spring wheat, durum wheat and barley. The oat yield was the second highest yield of record.

Principal crops in Minnesota are spring wheat, corn, spring barley, oats, alfalfa, and soybeans. Other crops grown include pinto beans, flax, sunflower, and potatoes.

The principal crops in Polk County are oats, spring wheat, barley, hay, potatoes, corn and flax. Table IX-4 shows acreage harvested and yield for the principal crops for 1970 and 1971. Table IX-5 shows the area harvested as a percent of total crops.

Little acreage of the planted crops is under irrigation. In 1969 there were only 373 acres under irrigation. Land usage for Polk County is shown in table IX-6. The average farm size in Polk County is about 470 acres. Field sizes range from 40-80 acres, with 80 acres common. Eighty-six percent of the land area is in farms according to the 1969 Census of Agriculture.

9.2.2 Cropping Systems

In the fall, moldboard plowing leaves little residue in the field. Continuous wheat is grown with no summer fallow. A great deal of alfalfa is grown because of the dairy industry.

Crop rotations are:

1. Three years small grain; corn; 3 years small grain or
2. Three years small grain; sugar beets; 3 years small grain.

Irrigation of crops takes place on the sandy soils but total irrigated acreage in Polk County is limited.

TABLE IX-4. — ANNUAL CROP PRODUCTION IN POLK COUNTY (1970-1973)

Crop	Planted acres (in 1000 acres)				Harvested acres (in 1000 acres)				Yield per harvested acre				Unit
	1970	1971	1972	1973	1970	1971	1972	1973	1970	1971	1972	1973	
All wheat	Figures planted not available				165.4	290.2	268.2	336.4	29.0	39.7	37.8	37.9	bu
Spring wheat					154.8	273.7	256.3	316.6	29.0	40.0	38.0	38.0	bu
Durum wheat					5.0	15.9	a	a	31.0	30.0			bu
Oats					200.6	157.6	114.1	105.7	41.0	61.0	53.0	47.0	bu
Corn					16.3	26.4	14.0	19.1	45.0	60.0	60.0	55.0	bu
Barley					119.1	153.7	160.4	172.6	33.0	50.0	49.0	42.0	bu
Flax					19.4	9.3	3.4	8.2	8.0	12.0	11.0	12.0	bu
Soybeans					2.0	2.3	1.2	4.0	17.0	13.0	16.0	19.0	bu
All hay					78.3	74.0	72.8	74.7	1.9	1.8	2.2	1.8	tons
Potatoes					30.1	30.8	25.7	26.9	130	180	165	140	cwt
Sugar beets					37.1	38.8	41.0	56.5	15.5	16.2	14.3	16.6	tons
Rye					5.0	17.8	5.3	4.9	31.0	31.0	21.0	36.0	bu

[a]No figure-small acreage involved.

TABLE IX-5. — AREA HARVESTED AS PERCENT OF TOTAL CROPLAND[a] IN POLK COUNTY (1969)

Crop	Percent
Corn	1.12
Sorghum	0.08
Wheat	15.93
Other small grains	37.35
Soybeans	0.11
Hay (excluding sorghum)	7.04
Irish potatoes and sweet potatoes	2.74
Other crops	7.30

[a]Total cropland was 893,635 acres.

TABLE IX-6.– LAND IN FARMS[a] ACCORDING TO USE IN POLK COUNTY

Use	1969		1964	
	Farms	Acres	Farms	Acres
Harvested cropland	1,796	618,609	2,059	662,015
Cropland used only for pasture or grazing	662	40,324	890	38,046
Cropland in cover crops, legumes and soil improvement grasses, not harvested or pastured	242	17,115	643	57,350
Cropland on which all crops failed	162	14,760	265	10,802
Cropland in cultivated summer fallow	1,429	184,286	–	–
Cropland idle	289	18,541	1,269	120,476
Total cropland	1,816	893,635	N/A	888,689
Woodland pastured	455	19,524	624	29,072
Woodland not pastured	568	27,983	669	31,256
Total woodland	803	47,507	956	60,328
Improved pastureland and rangeland	112	15,699	86	2,936
Pastureland and rangeland not improved	271	19,612	N/A	27,335
Total pastureland and rangeland (other than cropland and woodland pasture)	342	35,311	421	30,271
All other land	1,422	60,714	2,020	85,166
Irrigated land	5	373	3	109
Total pastureland (all types)	952	95,159	N/A	97,389

[a]Farms with sales of $2500 and over.

9.2.3 Cropping Calendar

Table IX-7 displays the crop calendar for Polk County.

9.2.4 Wheat Varieties

Minnesota produces spring wheat, durum wheat and winter wheat with the majority hard red spring varieties. The hard red spring varieties include Semidwarf, Era, Olaf, and World Seeds 1809. Durum wheat varieties grown are Leeds and Ward. Minter and Winoka are the winter wheat varieties. All varieties are recommended for 1974.

TABLE IX-7. – MINNESOTA: USUAL PLANTING AND HARVESTING DATES BY CROPS

Crop	Usual planting dates	Usual harvesting dates		
		Begin	Most active	End
Barley	Apr 15-May 30	Jul 25	Aug 1-Aug 20	Sep 10
Corn:				
Grain	May 1-Jun 15	Oct 5	Oct 20-Nov 15	Nov 30
Silage	May 1-Jun 15	Sep 5	Sep 20-Sep 30	Oct 15
Forage	May 1-Jun 15	Oct 5	Oct 10-Nov 10	Nov 30
Flaxseed	Apr 25-Jun 15	Aug 15	Aug 25-Sep 30	Nov 10
Hay:				
Alfalfa		Jun 5		Aug 30
Clo-tim		Jun 10		Aug 30
Wild		Jul 10		Aug 30
Oats	Apr 10-May 25	Jul 25	Aug 1-Aug 20	Sep 10
Peas, dry	Apr 20-Jun 1	Aug 10	Aug 25-Aug 30	Sep 20
Rye	Sep 1-Sep 30	Jul 25	Aug 1-Aug 10	Aug 15
Soybeans	May 15-Jun 15	Sep 25	Oct 10-Oct 25	Nov 10
Sugarbeets	Apr 25-May 30	Sep 20	Oct 10-Oct 30	Nov 10
Wheat:				
Winter	Sep 1-Sep 30	Jul 25	Aug 1-Aug 10	Aug 15
Spring	Apr 15-May 30	Jul 25	Aug 1-Aug 20	Sep 10
Durum	Apr 15-May 30	Jul 25	Aug 1-Aug 20	Sep 10
SEED CROPS:				
Alfalfa		Sep 5	Sep 20-Oct 1	Oct 25
Red clover		Sep 5	Sep 5-Oct 5	Oct 15
Sweetclover		Aug 5	Aug 10-Sep 5	Oct 10
Timothy		Aug 1	Aug 7-Aug 20	Aug 30
Kentucky bluegrass		Jul 1	Jul 5-Jul 10	Jul 15

INTENSIVE TEST SITE ASSESSMENT REPORT

BIBLIOGRAPHY

SECTION TEN

10.0 BIBLIOGRAPHY

The following represents the basic references consulted in preparation of the Intensive Test Site Assessment Report.

1. Statistical Reporting Service/USDA, various volumes, published annually.

2. 1941 Yearbook of Agriculture, Climate and Man, USDA.

3. The National Atlas of the United States of America, United States Department of the Interior Geological Survey, Washington, D.C., 1970.

4. Usual Planting and Harvesting Dates, Agriculture Handbook No. 283, U.S. Department of Agriculture, Statistical Reporting Service.

5. Physiography of the United States, Charles B. Hunt, W. H. Freeman and Company, San Francisco, 1967.

6. Conservation Needs Inventory for each state by Soil Conservation Service/USDA.

7. Soil Survey for various counties by Soil Conservation Service/USDA.