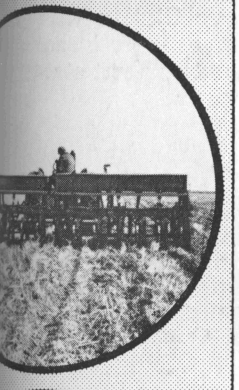
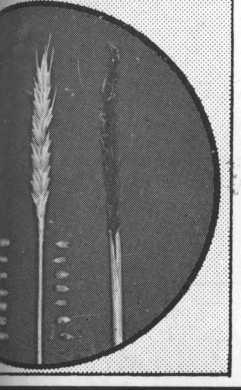
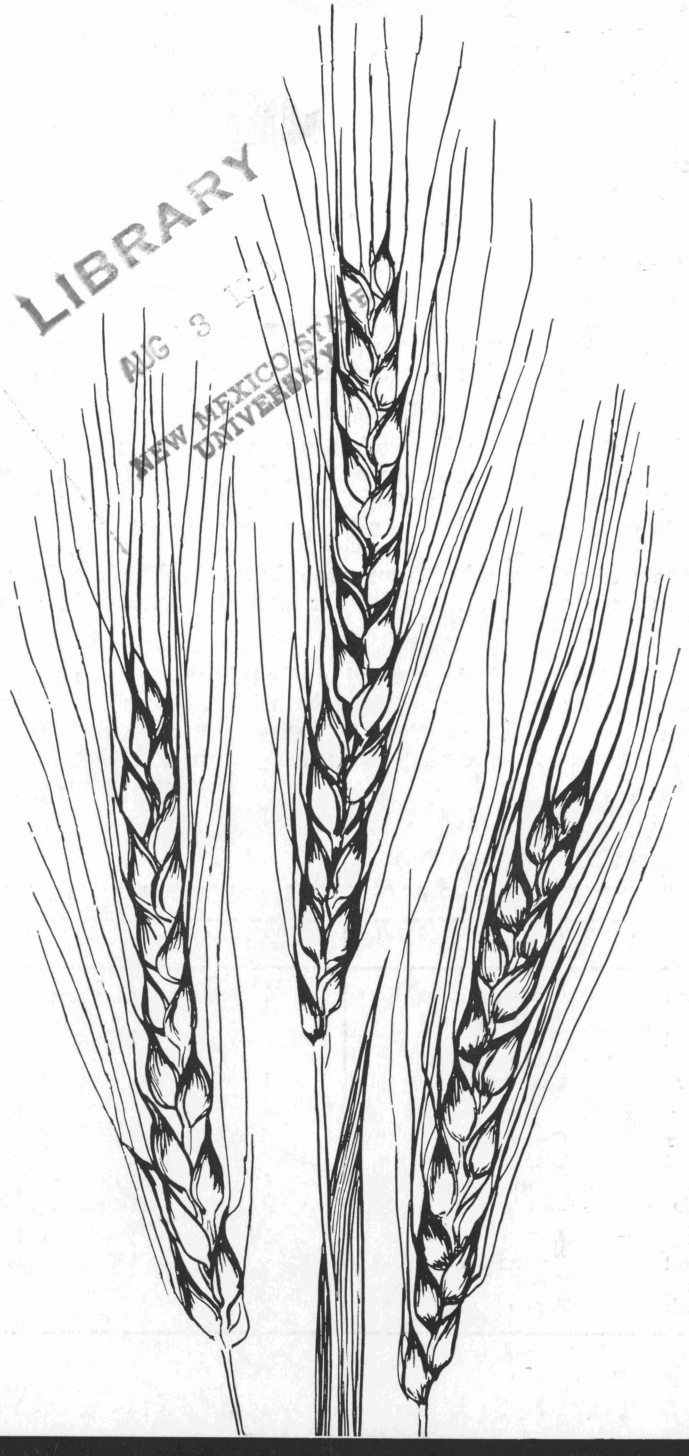
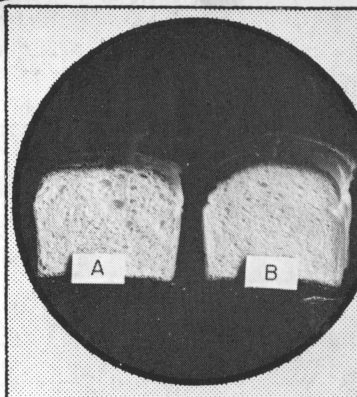
ARCH 1960 BULLETIN 948

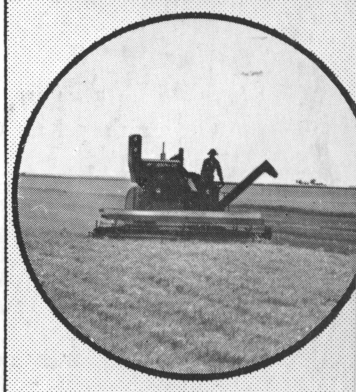
WHEAT PRODUCTION in Texas

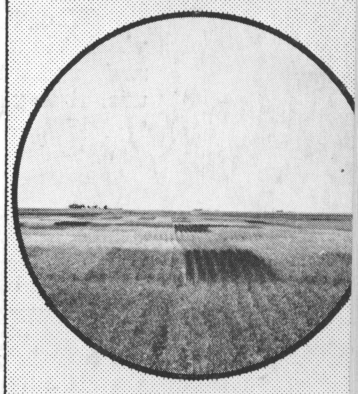


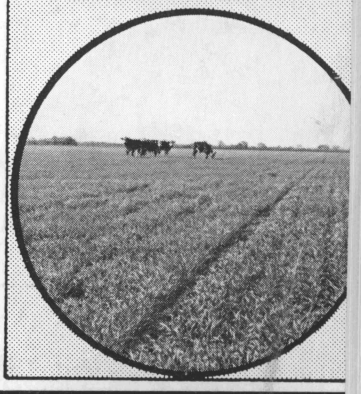












A PART OF THE TEXAS A&M COLLEGE SYSTEM

TEXAS AGRICULTURAL EXPERIMENT STATION
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS
IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE

Summary

Wheat ranks third in acreage and value among Texas farm crops, being exceeded by cotton and grain sorghum. All Texas wheat is fall sown and approximately 98 percent of it is of the hard red winter class. A small acreage of soft red winter wheat is grown in North Central Texas and a small acreage of durum wheat is grown for livestock feed on the Edwards Plateau.

Wheat acreage is distributed widely in the State although an estimated 64 percent is grown on the High Plains or Panhandle area and 24 percent is grown on the Rolling Plains. The remainder is scattered throughout Central Texas with much of this being used exclusively for livestock pasture. Revenue as rent or as gains in livestock weight or milk production from the forage produced by winter wheat is an important additional source of income from wheat.

Most of the wheat is used for the manufacture of flour for commercially baked bread or for family flour for home baking. Quality characteristics are important considerations in the selection of a wheat variety to grow in each area. Varieties having undesirable quality characteristics are less attractive to domestic and foreign buyers of wheat and tend to reduce the general price level in an area. Large wheat acreages now are grown under irrigation and because high yields tend to produce wheat of lower protein, growers should give special attention to the selection of varieties and to the fertilizer needs of the crop under irrigation.

Statewide variety trials are conducted to determine the best varieties for the several growing areas. Yield, hardiness, disease reaction, earliness, resistance to lodging and shattering, as well as quality characteristics, are considered in making recommendations for each area. The leading commercial varieties in Texas at present are Triumph, Wichita, Concho, Comanche, Crockett and Westar. The new varieties Tascosa, Crockett, Bison, Aztec and Milam should be considered as seed becomes available.

Diseases are important factors in production many years and are of potential importance each season. Whether they develop into epidemics depends on the weather, varieties grown and other factors. The major diseases attacking wheat in Texas are leaf rust, stem rust, speckled leaf blotch, root rots and smuts. These and others are described briefly.

The major insects attacking wheat are greenbugs (aphids), spider mites and army or cutworms. Insecticides now are available for the control of these insects where their use is economically sound.

Wheat improvement research is carried out at Amarillo, Denton and College Station with yield trials at many other locations. Objectives include the improvement of disease or insect resistance, the development of better grain or forage varieties and the development of short stature, strong-strawed varieties for growing under irrigation and high fertility conditions.

RECOMMENDED AND ACCEPTABLE WHEAT VARIETIES BY AREAS

Area	Recommended	Acceptable
1	Tascosa	Comanche
	Concho	Wichita
	Crockett	Triumph
	Bison	Aztec
	Westar	Cheyenne
2	Tascosa	Comanche
	Crockett	Westar
	Ponca	Bison
	Concho	Triumph
3	Crockett	Comanche
	Ponca	Knox
	Quanah	Frisco
4	Quanah	Crockett
5	Milam	
6	Quanah	Comanche
	Crockett	Knox
		Frisco
7	Tascosa	Comanche
	Crockett	Westar
		Triumph

Wheat Production in Texas

I. M. ATKINS, K. B. PORTER, KEITH LAHR, OWEN G. MERKLE and M. C. FUTRELL*

WHEAT WAS THE SECOND MOST VALUABLE cash crop in Texas until 1954 when it was surpassed in acreage and value by grain sorghum and cotton. The average harvested acreage of wheat for the 10-year period 1947-56 was 3,634,000 acres, which produced an average production of 44,417,000 bushels. The maximum acreage, 7,310,000 acres, and largest production, 124,270,000 bushels, occurred in 1947. The smallest harvested acreage recently was in 1955, when only 1,508,000 acres survived the hazards of drouth and insects to produce 14,326,000 bushels.

Wheat first was grown in Texas near Sherman about 1833. The acreage expanded greatly in North Central Texas after 1850, and the Dallas-Sherman-Fort Worth triangle and nearby areas provided wheat for the development of a major family flour-producing industry before 1900. Wheat distribution in Texas in 1899 is shown in Figure 1. After 1900 there was rapid development of farming in the western part of the State and by 1919 there were three major wheat producing areas — the North Central Prairies area, the Rolling Plains area and the Panhandle area, Figure 2. Wheat production now as in 1954, is concentrated approximately 64 percent in the Panhandle, 24 percent in the Rolling Plains and 12 percent in Central Texas, Figure 3. A further change is the recent expansion of using the crop as a source of winter pasture for livestock, both under irrigation and under natural rainfall conditions. The acreage seeded exclusively for forage uses was estimated to exceed 190,000 acres in 1957.

Areas of Adaptation

Wheat is grown over a wide range of climatic conditions and on many soil types in Texas. It does best on well-drained, fertile soils and is less well adapted to sandy types. Typically the wheat land of both the Rolling Plains and High Plains is the "tighter" soil, with grain sorghum and cotton being grown on the sandy soils.

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Climatic conditions, such as winter temperatures, rainfall and humidity, are important in establishing the limitations of varieties and types of wheat grown. For easy reference and as a guide for making recommendations, the State is divided into seven areas, Figure 4. These areas are the same ones used in the statewide small grain testing program. Locations of substations and cooperative farm test locations also are shown on this map.

Several types of wheat are grown. These types range from cold-resistant, winter-type varieties in the northwestern part to true spring-type and durum varieties which are fall sown in the southern part of the State. Practically all wheat is fall sown. Table 1 gives climatic data and other information for the locations which conduct wheat variety trials in Texas.

Contents

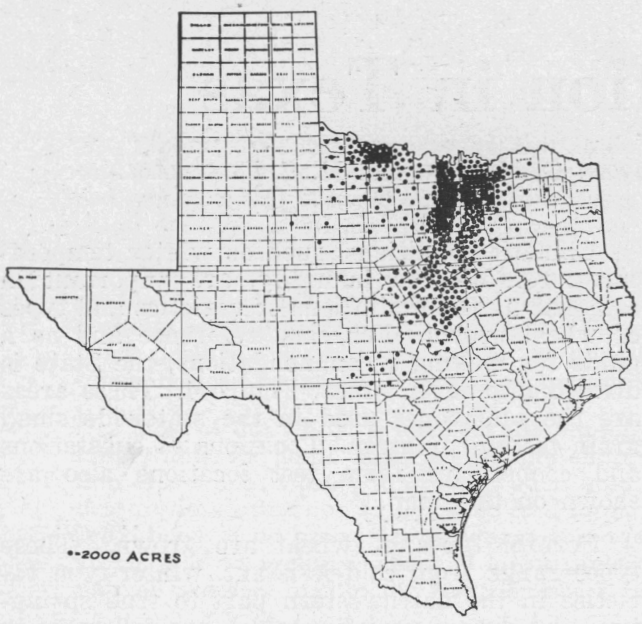

Figure 1. Distribution of wheat in Texas, 1899.

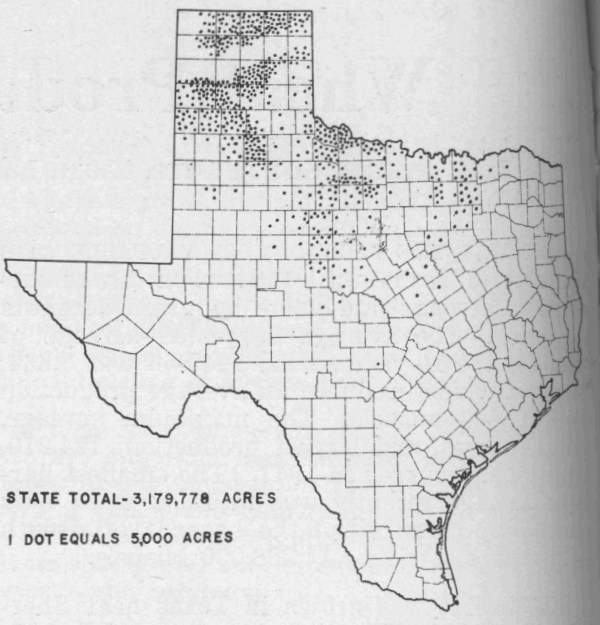

Figure 3. Distribution of wheat in Texas, 1954.

Uses

Practically all wheat grown for grain is used in some phase of the milling industry. The better grades of grain are used for bread or pastry manufacture and the characteristics of varieties for these uses are covered in the section under "Quality." Large quantities of both wheat and flour are exported.

FEED

Normally the better grades of wheat are too valuable for feed but can be used satisfactorily when prices permit. Wheat contains more digestible and total protein and less crude fibre than most feed grains so the ration must be adjusted accordingly. Low grades of wheat, wheat unsuitable for flour production and much of the durum wheat produced in Texas is used in mixed feed.

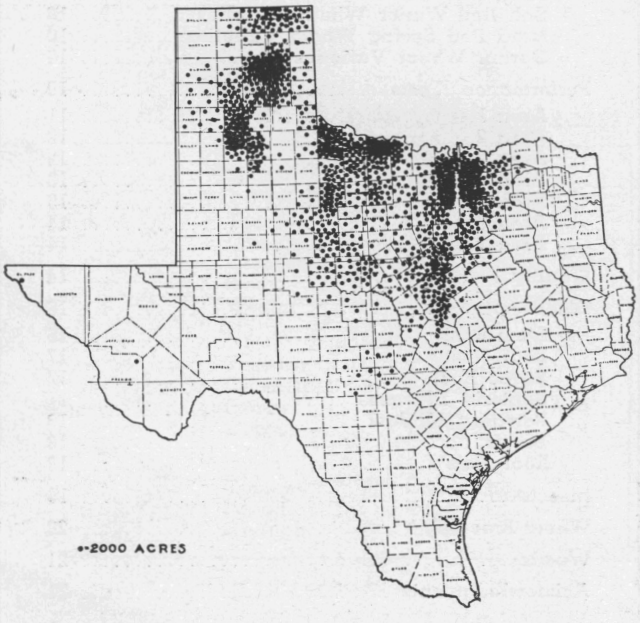

Figure 2. Distribution of wheat in Texas, 1919.

LIVESTOCK PASTURE

Wheat has been used for livestock pasture since the State was settled. The recent expansion of the beef and dairy industries into the more humid sections of Central and East Texas and the expansion of wheat irrigation on the High Plains have increased the use of the crop for green winter forage. Wheat is more cold resistant and will grow to produce forage at lower temperatures than oats or barley.

Wheat sown for grain or exclusively for forage should grow 4 to 6 weeks before livestock are allowed to graze the crop. This will permit the plants to establish a good root system. Livestock should not be allowed to graze wheat when the soil is excessively wet or in such a manner as to cause soil blowing. Close grazing and trampling by livestock may reduce grain yields. When wheat plants begin rapid spring growth and elongation of tillers start, livestock should be removed immediately or grain yields will be reduced. Early maturing varieties such as Knox, Early Blackhull or Triumph may be more seriously and easily damaged by late grazing than later maturing varieties. Suggested dates for removal of livestock in the spring are as follows: area 1—March 15; areas 2, 3, 4, 6 and 7—March 1; and area 5—February 15. A field of wheat being used for winter pasture by a dairy herd is shown in Figure 5.

Culture

Cultural operations for wheat are similar to those for other small grains. Since wheat is grown over wide areas both in dryland farming and under irrigation, cultural operations will vary greatly.

Dryland wheat culture on the High Plains traditionally has been one of continuous cropping to wheat because few cash crops were well adapted to the area. However, the wheat-fallow-wheat or a wheat-sorghum-fallow cropping system is becoming more common. Research conducted at the Southwestern Great Plains Field Station near Amarillo indicates that the use of these cropping systems results in more stable and more profitable production than continuous wheat. Large-scale operations with the one-way or sweep-type plow permit rapid working of the land after harvest. This permits penetration of summer rains and killing of weeds and volunteer wheat. Leaving the stubble as a mulch aids in preventing wind erosion. These practices fit well into both continuous and fallow wheat production. Another system is that of delayed fallow in which the land is not cultivated until the following spring. This practice has proved valuable in area 1. Since rainfall generally is the limiting factor, fertilizers are not required or recommended for most dryland production in this area. Seeding wheat in a trashy seedbed prepared with a sweep-type plow is shown in Figure 6.

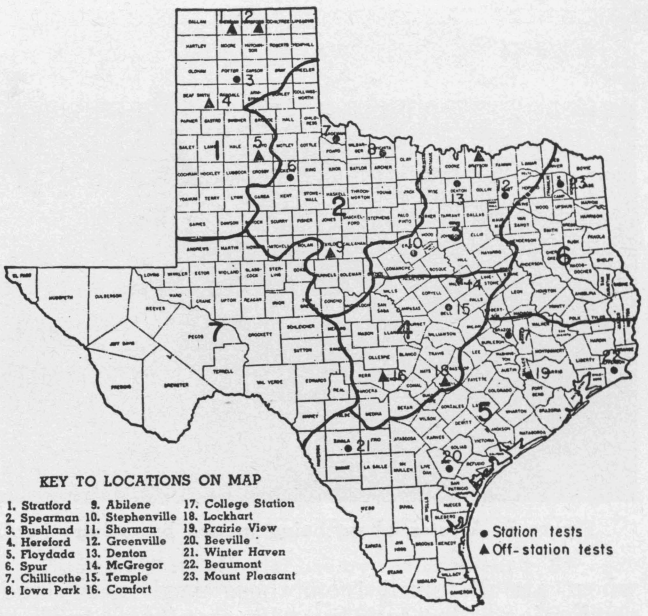

Figure 4. Small grain growing areas and test locations.

Wheat irrigation has become an important farming practice recently. In 1958 it was estimated that 600 thousand acres of wheat were irrigated in area 1. Cultural practices for irrigated

TABLE 1. AVERAGE RAINFALL, TEMPERATURE, LENGTH OF GROWING SEASON AND SOIL TYPE AT TEST LOCATIONS

Location	Elevation, feet	Number years of record	Rainfall: Long-time average: Annual	Rainfall: Long-time average: Growing season[1]	Rainfall: Average 1949-56	Temperature: Average annual	Temperature: Average maximum	Temperature: Average minimum	Length of growing season	Average date: First killing frost	Average date: Last killing frost	Soil type
Area 1												
Stratford	3699	30	17.5	9.9	14.4	55.4	71.0	40.2	177	Oct. 16	Apr. 22	
Spearman	3100	45	21.3	16.7	19.7	57.0	70.7	42.1	185	Oct. 22	Apr. 20	
Bushland	3590	18	17.7	12.7	17.0	57.7	72.9	42.2	193	Oct. 27	Apr. 16	Pullman silty clay loam
Hereford	3806	26	19.6	14.1	15.5	57.5	72.6	42.4	187	Oct. 22	Apr. 18	
Plainview	3250	30	21.3	12.6	15.8	59.8	73.7	45.7	206	Nov. 2	Apr. 10	
Area 2												
Spur	2274	46	20.4	13.6	18.2	62.2	77.3	47.0	216	Nov. 4	Apr. 3	Abilene clay loam
Chillicothe	1406	51	24.3	17.2	23.5	63.4	76.6	50.3	231	Nov. 10	Mar. 24	Abilene clay loam
Iowa Park	978	31	29.0		28.5	65.0	78.2	51.9	221	Nov. 4	Apr. 1	Miller sandy loam
Abilene	1759	71	22.6	19.4	18.9	64.1	76.1	52.1	241	Nov. 19	Mar. 23	
Area 3												
Stephenville	1283	15	26.9	23.8	25.2	65.2	77.1	53.3	239	Nov. 13	Mar. 21	Denton clay
Greenville	550	36	40.0	32.9	37.3	64.1	75.1	53.2	235	Nov. 11	Mar. 15	Hunt clay
Denton	621	44	32.0	24.6	27.2	65.0	77.3	54.2	233	Nov. 12	Mar. 22	San Saba clay
Area 4												
McGregor	713	34	31.6	25.6	23.3				254	Nov. 24	Mar. 24	San Saba clay
Temple	675	44	33.7	27.3	27.2	67.4	79.3	55.4	251	Nov. 24	Mar. 18	Houston Black clay
Comfort	1412	71	30.5	26.5	25.6	64.5	78.2	50.7	216	Nov. 1	Mar. 30	
Area 5												
College Station	314	50	38.9	30.0	33.7	68.4	79.5	57.2	263	Nov. 25	Mar. 6	Lufkin fine sandy loam
Lockhart	518	60	31.6	27.9	24.6	68.5	79.1	57.8	268	Dec. 1	Mar. 4	Houston Black clay
Prairie View	251	42	40.5	25.1	32.8	68.0	90.0	45.0	275	Nov. 28	Feb. 18	Hockley fine sandy loam
Beeville	225	53	29.4	22.9	16.7	70.7	82.5	61.2	291	Dec. 6	Feb. 20	Clareville clay
Winter Haven	596	36	23.2			74.0	84.7	63.2	330	Dec. 20	Jan. 25	Willacy sandy loam
Beaumont	18	43	54.2	39.4	49.9	68.6	80.3	57.4	271	Nov. 25	Feb. 27	Beaumont clay

[1]September 1 to June 1.

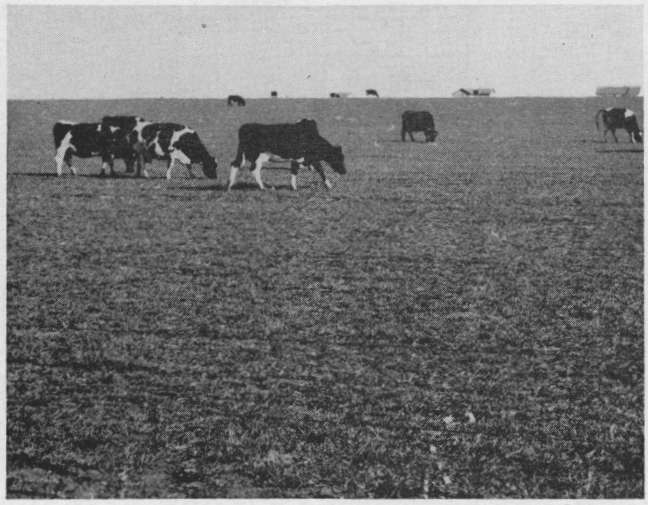

Figure 5. Winter wheat being grazed by a dairy herd.

wheat are different from those used in dryland production. The land usually is plowed with a disc or moldboard plow and the straw is turned under. Weeds and volunteer wheat are controlled with the usual implements. In many cases the land may be leveled and then listed. Then these beds or ridges are reduced by harrowing before seeding. The wheat is sown with a disc drill on the beds and in the furows. The furrows are used as an aid in irrigating the crop, Figure 7.

Continuous wheat production under irrigation soon may deplete the soil nutrients so that they must be added if high yield levels are to be maintained. Additional nutrients may be added by growing a legume crop or by adding commercial fertilizer, either in solid or liquid forms. An analysis of the soil will be needed to determine the elements needed on each field. The proper balances of water and plant nutrients are essential in irrigated wheat production. This is not only important for high grain yields and efficient use of irrigation water but for maintaining proper protein levels in the grain. High yields without adequate nitrogen in the soil may cause production of low quantity and quality of protein in the grain which may result in unsatisfactory milling and baking characteristics.

The first irrigation often is made prior to seeding time to store moisture for seeding the crop. Another common practice is to seed the crop and then irrigate. Unless the crop is sown early for grazing purposes, this is the only fall irrigation necessary. The rate of water use by winter wheat grown under optimum fertility and irrigation conditions was studied in 1956 at Bushland, by Jensen[1] and results are shown in Figure 8.

Although wheat uses relatively small amounts of moisture during the fall and winter, it may use as much as .3 inch per day during the boot and heading growth stages. A crop yielding 45 to 50 bushels per acre usually will require 27 to 30 inches of water during its growing season. This may be supplied from precipitation or moisture stored prior to seeding or from irrigations during the season. For best wheat growth this should be distributed during the year to coincide with the rate of water use by the crop during its different stages of growth.

Wheat often is grown continuously on the same land in area 2. Average rainfall in this area ranges from 20 to 30 inches, but summer fallowing one season to insure production the second year is not a good risk, so little summer fallowing is practiced. Conservation of moisture from summer rains is practiced widely by immediate plowing of stubble after harvest and by keeping the ground free of weeds until fall. One-way or sweep-type plows are used almost universally, and often fields are plowed within hours after harvest is completed. Rotation with oats for win-

[1]Jensen, M. E. Research shows when to irrigate winter wheat. Soil and Water. 5:22-23, November 1956.

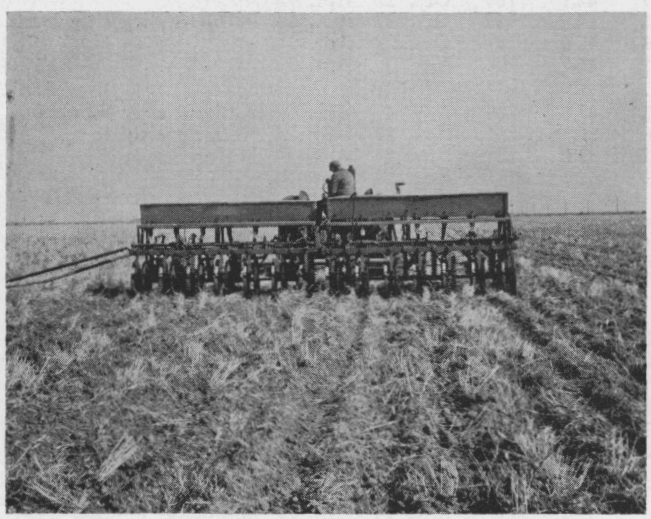

Figure 6. Seeding wheat in a trashy seedbed prepared with a sweep-type plow.

Figure 7. Irrigating wheat using furrows as water guides and spreaders.

ter pasture and feed and with grain sorghum as a cash crop are the most common rotations. More than half of the land in area 2 is in native pasture so there is need for large acreages of feed crops. Nearly all wheat is used for winter pasture for livestock. Normally, the livestock are removed about March 1 so that the wheat can mature a grain crop, but in unfavorable seasons large acreages are grazed to maturity.

Wheat production in the more humid areas 3, 4, 5 and 6 is handled on a much smaller scale than that in areas 1 and 2. Usually wheat is grown in rotation with corn, grain sorghum, cotton, other grain crops or legume crops.

Rates and dates of seeding vary greatly across the State because of the wide range in climatic conditions and the uses made of the crop. For simplification and easy reference, the suggested rates and dates by areas are given in Table 2.

Fertilizer recommendations for both irrigated and nonirrigated wheat for all areas are given in Texas Agricultural Extension publications available at county agricultural agents' offices. Usually moisture is the limiting factor in dryland wheat production in areas 1 and 2 and commercial fertilizers are not profitable. Commercial fertilizers usually are profitable when wheat is grown under irrigation but conditions vary so greatly that general recommendations are not practical. When wheat land is leased for pasture, a greater investment in fertilizer often is justified than when grain alone is produced.

The use of commercial fertilizers is a profitable investment under most conditions in the more humid areas 3, 4, 5, and 6 for forage and grain production. Top dressing with 30 pounds of nitrogen in late March often will greatly increase grain yields. Often where the crop is used largely for forage production, as on a dairy farm, the addition of 30 pounds of nitrogen at intervals of 2 months during the winter has been found profitable.

Varieties

The first wheat variety recorded in Texas was the "little Red May" wheat brought by settlers from Missouri into the Dallas area before 1850. About 1870 the Mediterranean wheat was brought

TABLE 2. SUGGESTED RATES AND DATES OF SEEDING WHEAT BY GROWING AREAS

Area	Rate of seeding, pounds per acre		Date of seeding
	Nonirrigated	Irrigated	
1	30	45-60	Sept. 1 - 20
2	45	60	Sept. 15-Oct. 15
3	75		Oct. 15 - Nov. 1
4	75		Nov. 1 - 15
5	75		Nov. 15 - Dec. 1
6	75		Oct. 15
7	60	75	Oct. 15 - Nov. 1

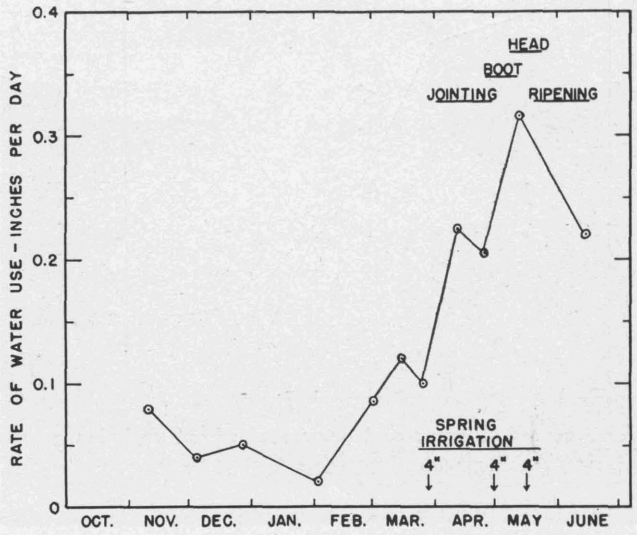

Figure 8. Rate of water use by winter wheat under optimum irrigation conditions with times and amounts of spring irrigation shown, U. S. Great Plains Field Station, Bushland, 1956.

to this area by settlers from the East. These two types made up the majority of the acreage for many years; and as late as 1919, when the first wheat variety survey was made by the U. S. Department of Agriculture, 57.6 percent of the Texas acreage was devoted to soft wheat varieties.

The Turkey type wheats were brought to Central Kansas by Russian immigrants about 1873 and spread into Northwest Texas where they soon became the dominant type grown. Pure-line selections were made from these wheats by state, federal and private breeders and varieties thus selected made up a majority of the acreage until 1944. The percentages of the Texas acreage devoted to groups of varieties during 1919-57 are shown in Figure 9. Data for 1957 are based on local estimates; all others are from U. S. Department of Agriculture publications.[2] During the past 15 years many new varieties have been distributed by state and federal agencies. The most recent estimate of the varieties grown in Texas is shown in Figure 10. Because varieties change so rapidly under present conditions, only those of greatest commercial interest at this time are described. For convenient reference they are arranged alphabetically and not in order of importance commercially. All varieties except Triumph, Red May and Mediterranean were developed by state experiment stations in cooperation with the U. S. Department of Agriculture.

HARD RED WINTER WHEAT VARIETIES

Apache (Cheyenne x Early Blackhull) was distributed by the New Mexico Agricultural Experiment Station at Clovis. The cross was made at Woodward, Oklahoma, but the selection, Apache, was made at the Fort Hays Branch Sta-

[2]Data taken from U.S.D.A. Department Bulletin 1498, Circulars 283, 424, 634, 761, 861 and Agricultural Handbook 108.

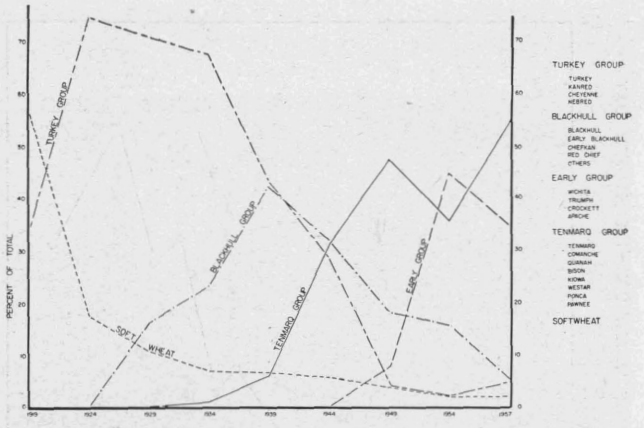

Figure 9. Types and groups of wheat varieties grown in Texas, 1919-57.

tion of the Kansas Agricultural Experiment Station. This variety is moderately early maturing, usually 2 days later than Wichita. Plants are tall and the straw often is weak. Spikes are awned and glumes usually are white although under some conditions they may have black stripes. The variety has produced good yields but is very susceptible to the rusts.

Aztec (Red Chief x Comanche) was distributed by the New Mexico Station in 1959. The Aztec cross and selection were made at the Nebraska Agricultural Experiment Station. This variety is late maturing, tall and appears best adapted to the higher elevation areas of western Texas and eastern New Mexico. Plants are tall but the straw is strong. Spikes are awned and the glumes white. The variety has grain of high test weight with excellent milling and baking characteristics.

Bison (Oro-Tenmarq x Chiefkan) was developed and distributed at the Kansas station. It is recommended as a replacement for Kiowa, a

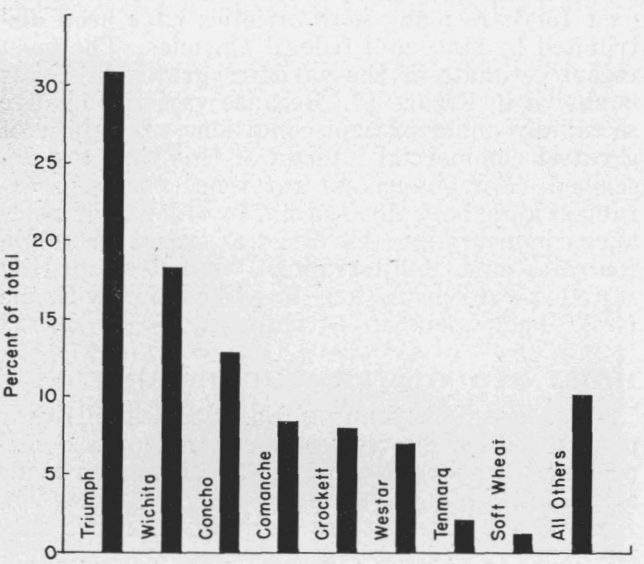

Figure 10. Percentage of total acreage sown to wheat varieties in Texas, 1959.

sister strain, because of its better quality. The variety is midseason in maturity, moderately tall and has strong straw. Spikes are awned and the glumes are white with black stripes. Bison has yielded well in areas 1 and 2 but is not adapted to other areas because of its high susceptibility to rusts. It also is very susceptible to loose smut.

Cheyenne is a selection made from the original Turkey wheat by the Nebraska station. The variety has yielded well in irrigated tests in Texas but less than others in dryland tests. Cheyenne is late maturing and highly susceptible to the rusts; hence it is adapted only in area 1. Plants are shorter than those of most varieties and the straw is strong. Spikes are awned and the chaff is white. Grain quality is excellent and adapted to production of bakery flour.

Comanche (Oro x Tenmarq) was developed by the Kansas station but distributed simultaneously by the Kansas, Oklahoma and Texas stations in 1942. The variety is widely adapted and because of its excellent milling and baking characteristics is more or less a standard for comparison of many characteristics. It is midseason in maturity and moderate in height, has good straw strength and is resistant to prevalent races of bunt. It is susceptible to leaf and stem rust. It has been popular for 15 years, although recently newer varieties have outyielded it. Comanche is recommended in areas 1, 2 and 3.

Concho (Blackhull-Hard Federation x Comanche) was developed and distributed by the Oklahoma Experiment Station. The variety is midseason in maturity, plants are moderately tall and the spikes are awned. Its brown glumes distinguish it from most commercial varieties grown in areas 1 and 2. Concho has produced excellent yields both under irrigation and on dryland and it is recommended in areas 1 and 2. It is susceptible to loose smut, stem rust and some races of leaf rust. The grain quality is good under most conditions.

Crockett (Sinvalocho-Wichita x Hope-Cheyenne) x Wichita) is a moderately early variety distributed by the Texas Agricultural Experiment Station in 1956. Because of its superior quality characteristics and disease resistance, it is recommended to replace Wichita, Triumph and Early Blackhull. The variety has produced outstanding yields in all Texas trials and is recommended for areas 1, 2 and 3 and also may be used in parts of areas 4, 6 and 7. Crockett is about 1 day later than Wichita and resembles it in many characteristics. Plants are tall, spikes are bearded and the white chaff sometimes has black stripes. In the seedling stage, the variety is susceptible to leaf rust, but it develops a high degree of resistance from jointing to maturity. Also, it has shown some resistance to speckled leaf blotch or Septoria. The milling and baking characteristics of Crockett are good, even approaching those of Comanche under many conditions. A field of Crockett wheat is shown in Figure 11.

Kiowa (Oro-Tenmarq x Chiefkan) is a sister strain of Bison and similar to the latter. The milling and baking characteristics are less desirable so it has been withdrawn from the approved list of varieties.

Milam (Bowie x Lee) is a new disease-resistant forage wheat released in 1960 for growing in South Texas. It is an intermediate winter type, lacking in cold resistance and adapted only to the area south of Austin. Milam has a high degree of stem rust resistance and moderate leaf rust resistance. Seedling growth is semierect, plants are relatively short, the straw is strong so the crop stands well for combine harvesting. The variety has fairly good quality characteristics but it not equal to Quanah. Milam was developed cooperatively by the Texas station in cooperation with workers of the Rockefeller Foundation in Mexico.

Quanah (Comanche x Mediterranean-Hope) x (Comanche x Honor-Forward) was developed by the Texas station and distributed in 1951. It is adapted only to the more humid, high rainfall areas 3 and 4, where its disease resistance is a valuable asset. It lacks sufficient cold or drouth resistance for other areas. Quanah has resistance to many races of leaf rust, stripe rust, stem rust, Septoria and bunt and its general disease tolerance is among the best known. It is highly susceptible to loose smut. The quality characteristics of Quanah are equal to those of Comanche under most conditions. Quanah wheat is shown in Figure 12.

Ponca (Kawvale-Marquillo x Kawvale-Tenmarq) was developed by the Kansas station and distributed jointly by the Kansas and Oklahoma stations in 1951. The variety is better adapted to the higher rainfall areas and has yielded well under irrigation. It is less drouth resistant than many other varieties. It is recommended for growing under irrigation in area 1, and for areas 2 and 3, where its disease resistance is a valuable asset. Ponca has high resistance to prevalent races of leaf rust, stripe rust, speckled leaf blotch and loose smut. It is midseason in maturity, of moderate height and has good straw strength. Plants have white chaff and the spike is awned. Under most conditions the milling and baking characteristics are nearly equal to those of Comanche.

Tascosa (Kanred-Hard Federation-Tenmarq x Mediterranean-Hope) x Cimarron) is a new variety developed by the Texas station and released to certified growers in 1959. Seed generally will not be available until 1960. This new variety is midseason in maturity, has moderate height and good straw strength. During the testing stages its outstanding characteristics were high test weight, good milling and baking characteristics and high yield. Tascosa (named for the pioneer settlement near Amarillo) is recommended for areas 1 and 2. The plants have awned spikes and the glumes are brown.

Figure 11. A field of Crockett wheat, Stratford, 1958.

Triumph (pedigree unknown) was developed and distributed by Joseph Danne, a private plant breeder of El Reno, Oklahoma. It is the earliest maturing adapted commercial variety, being 6 to 10 days earlier than Comanche. Although very popular, as indicated by the large acreage in Texas, Triumph has averaged considerably lower yields than midseason varieties such as Concho and Tascosa. The grain is suitable for family flour but is not well suited to production of bakery flour. Since 1958 a new strain called New Triumph has been released. It is similar to the older strain but has yielded better and, under some conditions, is 1 day earlier.

Westar (Kanred-Hard Federation x Tenmarq) was developed by the Texas station and distributed to growers in 1944. Acreage of Westar increased rapidly and it was grown on more than 2 million acres in 1949, but its popularity recently has declined. Westar continues to yield well in Texas trials and is recommended for areas

Figure 12. A field of Quanah wheat.

1 and 2. The variety is midseason in maturity, is tall and has strong straw. It is resistant to some races of leaf rust, but is very susceptible to stem rust. Westar grain produces a good quality flour suitable for commercial baking.

Wichita (Early Blackhull x Tenmarq) is an early maturing variety developed at the Kansas station. Under most conditions, it is 2 or 3 days later than Triumph. Like Triumph, it is very susceptible to leaf rust but may escape serious damage because of earliness. Wichita is tall, the straw may be weak under some conditions and the grain may shatter under some conditions. The quality characteristics are those of a family flour. Wichita should be replaced by Crockett in all growing areas.

Several other varieties are grown on a small scale. These include Tenmarq, Early Blackhull, RedChief, BlueJacket, Pawnee, Kanred, Blackhull, Turkey and others. None are recommended.

SOFT RED WINTER WHEAT VARIETIES

Frisco (Fronteira x Red May) x Red May) was developed by the Texas station for growing in the Dallas-Sherman area to supply an improved variety for family flour production. The variety is similar to the Red May wheat grown in that area for over 100 years but differs in being slightly earlier, more rust resistant and more productive. Plants of Frisco are early maturing and short, while the spike is awnless and has brown chaff. Frisco is resistant to leaf rust and to some races of stem rust. While somewhat harder in texture than the Red May parent, it is a satisfactory soft wheat for family flour production.

Knox was developed by the Purdue Agricultural Experiment Station of Indiana. Because of its early maturing and good soft wheat quality, Knox was placed in Texas trials in 1949 and found to be adapted to the Dallas-Sherman area. The pedigree of Knox is complex and involves many crosses over a long breeding period. It is the earliest maturing variety adapted to North Central Texas, being about 6 days earlier than Frisco and usually 2 weeks earlier than Mediterranean. Because of this extreme earliness, it may be damaged by late freezes some years. Plants are fairly short and strong strawed with an awnless spike and white glumes. Knox has considerable resistance to leaf rust in the more mature stages but is susceptible in the seedling stage. It is very susceptible to stem rust but usually escapes damage because of its early maturity.

Vermillion is a sister strain of Knox wheat. Its yield record is equal to that of Knox and recently has been introduced to the State by commercial seedsmen.

Mediterranean wheat was brought from the Eastern States by settlers about 1870 and in 1919 made up 56 percent of the Texas acreage. In 1954 only 84,000 acres were grown. The variety now grown commercially is a mixture of many varieties of hard and soft wheats because of natural survival over many years combined with mixtures from combines, volunteer and other sources. Denton, a Mediterranean selection, was distributed in 1926 but no pure seed sources are available now. Typical plants of Mediterranean are tall, late maturing and fairly weak strawed. Spikes are awned and glumes are brown.

Red May wheat was brought to Texas about 1833 by the early settlers and, until Mediterranean wheat was introduced after the Civil War, it was the predominant variety. Little Red May is grown now because hard wheat varieties, Frisco and Knox, have replaced it. The plants are early maturing and comparatively short. Spikes are awnless and glumes are brown.

Seabreeze (Mediterranean-Hope x Gasta) was developed by the Texas station for forage growing in extreme South Texas. It approaches a true spring wheat in growth habit. Only a small acreage of Seabreeze now is grown. The variety is early maturing, fairly short and resistant to some races of leaf and stem rust. The spikes are awnless and the glumes white.

Several other soft wheat varieties are grown on small acreages. These include Atlas 66, Coker 47-27, Austin, Clarkan, Vigo, Blackhawk and KanQueen.

HARD RED SPRING WHEAT VARIETIES

Occasionally spring wheat is sown in the Texas Panhandle but it is not recommended because yields are erratic and the crop is not dependable. Seed supplies are not maintained, so commercial seed must be shipped in from the Northern States. Lee and Selkirk are the principal varieties available. These varieties also are included in fall-seeded trials in South Texas, but none are grown commercially.

DURUM WHEAT VARIETIES

A small acreage of durum wheat is grown in area 4 from Waco southwestward into the Edwards Plateau. It has been grown since about 1890, when bread wheats were no longer satisfactory because of rust damage. These wheats are used in mixed feed or fed on the farm by the grower. The so-called native durum probably is a mixture of Kubanka, Arnautka and Nicaragua, all of which were introduced. More recent introductions were Stewart and Nugget. Langdon and Sentry have been tested in recent years and are the most rust resistant.

Performance Tests

Performance trials are conducted with wheat on a statewide basis and detailed data on yield, test weight, reaction to diseases and other agronomic characteristics are reported annually in

mimeographed form and recently have been published in Texas Agricultural Experiment Station Bulletin 899, "Performance of Small Grain Varieties in Texas." Growing areas and testing station locations are given in Figure 4, while data on weather, length of growing seasons and soil types are given in Table 1.

AREA 1

Area 1 is made up largely of the High Plains or the Texas Panhandle. Until recently this area was devoted largely to ranching and dry farming, but within the past 15 years large acreages have been placed under irrigation. Whereas in 1930 only a few thousand acres of wheat were irrigated, it is estimated that more than 600,000 acres were irrigated in 1958. Winters are severe in this area, and only winter wheats of moderate to high cold tolerance can be grown successfully. Figure 13 shows harvesting operations on a wheat farm in this area.

Figure 13. Harvesting operations on a wheat farm in the Texas Panhandle.

Yields and agronomic data for wheat varieties grown in replicated dryland and irrigated trials at the U. S. Great Plains Field Station at Bushland and cooperative farm locations in area 1 are given in Table 3. Until recently irrigation water was used as crop insurance rather than to produce maximum yields.

Tascosa, Concho, Apache, Crockett and Aztec are the five leading varieties under irrigation in area 1. Tascosa, Apache and Aztec have been less extensively tested than the other two. Comanche, Bison and Ponca also have produced satisfactory yields and are recommended for this area. Among early varieties, Triumph has produced better yields than Wichita or Early Blackhull.

Concho, Tascosa, Apache, Aztec and RedChief are the five leading varieties in yields in dryland tests. Again Tascosa, Apache and Aztec were included in fewer tests. Crockett ranked sixth and Bison ninth. The early maturing varieties were lower in comparable yield than midseason maturing varieties. Recommended varieties for either dryland or irrigated wheat production areas include Tascosa, Concho, Crockett, Comanche and Bison. It is suggested that the acreage of Wichita should be replaced by Crockett or Tascosa. Aztec, Westar, Cheyenne, Tenmarq and Turkey have excellent milling and baking characteristics but are late maturing.

TABLE 3. COMPARABLE YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN IN DRYLAND AND IRRIGATED YIELD TESTS AT STATIONS IN AREA 1, 1949-59

Variety	Yield of grain, bushels per acre					Test weight, pounds[1]	Date first head[1]	Date full ripe[1]	Plant height, inches[1]	Winter survival, percent[1]
	Dryland tests			Irrigated tests						
	Average	Rank in yield	Number of tests	Average	Number of tests					
Tascosa	18.6	2	8	30.5	13	59.2	5-12	6-23	27.7	
Concho	18.8	1	15	30.2	22	57.4	5-13	6-23	28.3	86
Apache	18.6	3	8	28.4	12	59.6	5-10	6-21	27.4	91
Crockett	18.0	6	17	27.8	22	58.5	5-12	6-22	29.7	90
Aztec	18.5	4	5	27.7	5	59.2	5-18	6-26	30.8	
Triumph	16.8	15	15	27.6	13	58.6	5-8	6-19	27.9	88
Comanche	17.1	13	17	27.3	22	57.8	5-15	6-23	29.5	84
Bison	17.9	9	8	27.3	12	57.9	5-14	6-23	30.7	91
Ponca	16.9	14	13	27.3	20	57.0	5-15	6-24	29.7	87
Kiowa	17.7	10	10	27.1	14	58.2	5-13	6-23	29.8	88
Blackhull	17.0	13	11	27.0	10	57.8	5-17	6-25	31.2	92
Cheyenne	17.9	8	4	26.6	9	57.8	5-19	6-26	29.7	
BlueJacket	17.7	11	10	26.6	12	59.4	5-17	6-24	31.0	
Westar	17.4	12	17	26.6	22	56.6	5-15	6-24	30.7	85
RedChief	18.1	5	17	26.3	22	59.5	5-16	6-25	32.3	90
Pawnee	18.0	7	12	26.3	11	57.5	5-14	6-22	27.5	86
Wichita	16.4	17	17	25.4	22	58.6	5-9	6-20	29.1	93
Tenmarq	16.3	18	17	25.3	22	56.1	5-18	6-25	31.0	83
Kharkof (Turkey)	16.3	18	17	25.2	22	56.3	5-20	6-27	31.7	89
Early Blackhull	16.8	16	17	25.1	22	59.2	5-7	6-19	29.4	85
Quanah	15.0	21	10	23.9	8	56.9	5-17	6-25	29.5	52

[1]Average of dryland and irrigated tests.

The highest test weight grain has been produced by Apache, RedChief, BlueJacket, Tascosa, Crockett, Aztec and Early Blackhull. Pawnee, Tascosa and Triumph were the shortest varieties while RedChief, Kharkof, Blackhull and Tenmarq were the tallest. Only Quanah showed significant damage by low temperatures in this area.

AREA 2

This area is made up largely of the land-use areas designated as the Rolling Plains and North Central Prairies. A considerable portion of these areas is devoted to ranching. Small grains are grown on the heavy soils, while cotton, grain sorghum or feed crops usually are grown on the sandy soils. The area ranges from 1,000 to 2,300 feet in elevation and lies roughly in the 20 to 30-inch rainfall belt. Winter temperatures are fairly severe, but plants usually remain well hardened, and wheat is seldom injured by low temperaatures. Late spring freezes occasionally damage early maturing varieties.

Performance trials have been conducted for many years at Iowa Park and Chillicothe. Variety tests were started at Spur in 1949 but, because of drouth, data were obtained in only three seasons. Trials were started at Abilene in 1953, but severe drouth destroyed the tests in all but one season. Tests at Iowa Park are irrigated when necessary to maintain normal growth. Data on comparable yields of grain, test weight and agronomic characteristics are given in Table 4.

Tascosa ranks first in Area 2, both in dryland trials and under irrigation at Iowa Park. Furthermore its average test weight, 61.8 pounds per bushel, is exceeded only by RedChief with 61.9 pounds. Crockett, Ponca, Concho, Apache and Bison rank next in order in dryland yield trials. Under irrigation Concho ranked second, Crockett third, Westar fourth and Apache fifth. The early varieties Triumph, Wichita and Early Blackhull have produced relatively low yields in this area and should be replaced by the higher yielding, higher quality varieties Tascosa, Crockett, Ponca and Concho.

Leaf rust affects yield in this area. Quanah, Crockett and Ponca have the highest resistance to leaf rust of commercial varieties tested. Although differences in plant height were not great, Tascosa and Triumph were the shortest while BlueJacket and RedChief were the tallest.

AREA 3

The Grand Prairie, Blackland Prairie and West Cross Timbers land-use areas of North Central Texas make up area 3. The elevation varies from 600 to 900 feet and the average rainfall ranges from 28 to 38 inches. Winter temperatures are less severe than those of areas 1 and 2, but rapid drops in temperature following periods of warm weather and rapid growth of plants may cause damage occasionally, particularly when they occur in late spring.

Yield trials have been conducted for many years at Denton and Greenville, but only since 1949 at Stephenville. Data on grain yields, test weight and agronomic characteristics are reported in Table 5. Both hard red and soft red winter wheat varieties were tested and are grown commercially in this area.

Crockett, Concho, Ponca, Quanah and Tascosa were the five highest yielding varieties in tests

TABLE 4. COMPARABLE YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN IN DRYLAND AND IRRIGATED YIELD TESTS AT STATIONS IN AREA 2, 1949-59

Variety	Yield of grain, bushels per acre					Test weight, pounds	Date first head	Date full ripe	Plant height, inches	Leaf rust, percent	Estimate of forage value[3]
	Dryland tests[1]		Irrigated tests[2]								
	Average	Number of tests	Average	Rank in yield	Number of tests						
Tascosa	20.7	10	37.6	1	4	61.8	4-23	5-28	26.3	47	99
Crockett	20.4	21	34.8	3	10	61.1	4-22	5-27	27.7	13	109
Ponca	20.0	19	32.0	7	7	60.4	4-24	5-28	27.7	22	100
Concho	19.8	16	35.4	2	8	60.6	4-24	5-29	27.8	28	101
Apache	19.1	9	31.3	11	5	60.4	4-23	5-27	27.9	49	84
Bison	18.9	7	31.1	13	2	60.4	4-22	5-28	27.4	30	111
Kiowa	18.7	13	32.1	5	6	60.8	4-23	5-29	26.8	44	96
BlueJacket	18.5	8	30.2	16	3	61.7	4-27	5-30	31.9	58	108
Comanche	18.2	21	32.0	6	10	59.8	4-24	5-29	27.7	36	100
Westar	17.9	19	33.0	4	10	59.5	4-25	5-30	28.3	26	94
Wichita	17.8	21	31.3	10	10	60.8	4-18	5-25	27.3	55	102
Tenmarq	17.4	21	31.7	9	10	59.4	4-25	5-31	28.4	51	94
Quanah	17.2	9	31.8	8	5	59.9	4-22	5-29	27.5	Tr	120
Kharkof (Turkey)	17.1	21	30.6	14	10	58.9	4-29	5-33	28.5	41	93
Early Blackhull	17.1	21	31.2	12	10	61.1	4-16	5-24	28.3	49	109
RedChief	17.0	21	30.5	15	10	61.9	4-26	5-31	29.5	53	100
Triumph	16.6	20	29.2	17	8	60.6	4-16	5-21	26.6	53	102

[1]Tests conducted at Chillicothe, Spur, Abilene and Merkel.
[2]Tests at Iowa Park only.
[3]Visual estimate of forage value, Comanche 100 percent.

in Area 3. Concho and Tascosa are more susceptible to the rusts than the other varieties so Crockett, Ponca and Quanah are recommended for growing. The early maturing varieties Triumph, Wichita and Early Blackhull produced lower yields and are very susceptible to leaf rust so should not be grown.

There is a market for soft wheat in the Sherman area and the better soft wheat varieties Vermillion, Knox and Frisco have produced yields nearly equal to those of the best hard wheat varieties. Unless there is a local market for the soft winter wheat varieties, they are not recommended.

Disease resistance is of major importance in this area. Quanah has the best resistance to leaf and stem rust and speckled leaf blotch and because of its excellent milling and baking qualities, it is recommended as first choice. Ponca and Crockett also are satisfactory but Concho and Tascosa may be damaged seriously by the rusts. Vermillion, Knox and Frisco are moderately resistant to leaf rust and also may escape damage because of their earliness.

AREA 4

Area 4 of Central Texas differs from area 3 principally in the degree that temperature influences the crop. Winters are mild and winterkilling normally is not a factor in production of adapted varieties. The area includes parts of the Central Basin and Edwards Plateau land-use areas. Elevation in the Edwards Plateau ranges from 1,200 to 1,800 feet in contrast to about 600 feet in the Central Basin. More severe winter temperatures and late spring freezes characterize the Edwards Plateau area.

Performance tests for area 4 were conducted at McGregor on Grand Prairie soil, at Temple on Blackland Prairie type soil and at Comfort in the Edwards Plateau. Data on grain yield, test weight and agronomic characteristics in the tests, which include hard red winter, soft red winter and durum varieties, are given in Table 6. Durum varieties have been grown in this area as feed grains for many years. Until recently their rust resistance made them more satisfactory than the available bread wheats.

Quanah, Crockett and Tascosa have produced the highest average yields of grain in tests conducted in this area. Quanah has greater tolerance to the rusts and other leaf diseases than any other variety available for this area and is recommended above all others. The variety also is among the best for forage purposes. The milling and baking characteristics of this variety are superior to those of any other adapted variety. Frisco, Vermillion and Knox soft wheats have produced satisfactory yields during the testing period but, because of their high susceptibility to stem rust, they are not recommended. The durum varieties produce satisfactory yields and may be grown for livestock feed. They are less desirable as a grazing crop than winter wheat varieties.

AREA 5

Area 5 is made up of the southern part of the Blackland Prairie, the Coast Prairie and parts of the Rio Grande Plain land-use areas. Winters

TABLE 5. COMPARABLE YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN AT SUBSTATIONS IN AREA 3, 1949-59

Variety	Yield of grain, bushels per acre: Average for area	Number of tests	Test weight, pounds	Date first head	Date full ripe	Plant height, inches	Percent: Leaf rust	Percent: Stem rust
HARD RED WINTER WHEAT VARIETIES								
Crockett	26.3	35	60.2	4-26	5-28	32.9	11	8
Concho	24.7	27	58.2	4-29	5-29	31.5	32	19
Ponca	24.5	27	58.5	4-28	5-29	31.6	19	17
Quanah	24.4	35	58.8	4-27	5-29	31.4	5	5
Tascosa	24.4	16	60.0	4-26	5-27	30.5	36	14
Early Blackhull	23.4	32	60.6	4-21	5-25	32.4	54	11
Comanche	23.3	35	58.0	4-28	5-30	31.6	36	13
Triumph	22.8	35	59.3	4-21	5-25	30.0	60	10
Westar	22.6	4	58.4	4-29	5-31	32.5	30	20
Wichita	21.6	14	59.8	4-25	5-25	31.2	62	13
Tenmarq	20.9	32	58.0	4-30	5-31	33.0	60	18
Kharkof	20.9	9	58.3	4-31	6-3	30.9	53	13
Kiowa	20.7	6	58.7	4-27	5-28	31.5	57	12
RedChief	20.0	10	60.4	4-30	6-1	33.6	54	33
SOFT WINTER WHEAT VARIETIES								
Vermillion	25.4	8	56.0	4-19	5-22	32.3	6	15
Knox	25.1	22	57.9	4-19	5-21	31.6	10	10
Frisco	23.9	30	57.6	4-25	5-27	30.3	3	9
Red May	21.6	30	56.8	4-28	5-28	29.7	21	24
Austin	21.1	7	57.1	4-25	5-27	33.9	45	9
Denton	20.0	30	57.0	5-1	6-1	35.0	17	31
Vigo	15.1	4	56.3	5-3	5-29	36.1	27	37

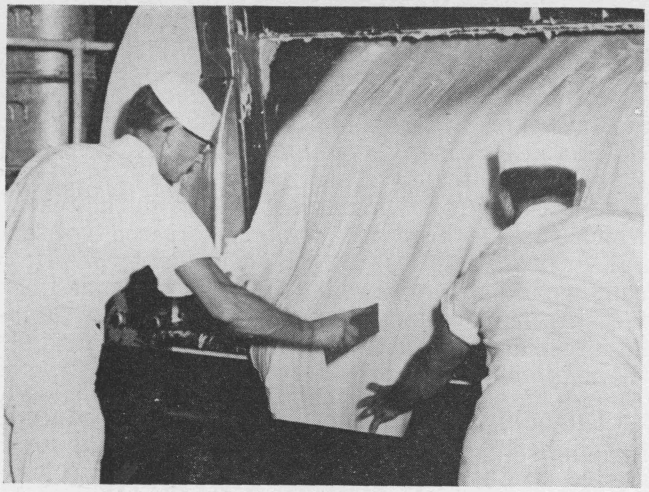

Figure 14. Bread dough as mixed in a modern bakery plant. This mass of dough will produce hundreds of loaves of bread.

are mild, so intermediate winter-type and true spring-type wheat varieties may be grown from fall seeding. Diseases are serious factors in grain and forage uses of the crop, often destroying the crop left for grain, Table 7.

Limited variety tests have been conducted at College Station, Prairie View and Beeville in this area. Milam, a new intermediate winter type wheat variety made available to growers in 1960, is the highest yielding bread wheat. Lee, a spring wheat, has done well and the durum varieties Sentry and Langdon also yield well. Wheat is used largely for winter pasture in this area.

AREA 6

Only small acreages of wheat are grown in area 6. Rainfall in this area ranges from 35 to 45 inches per year and humidity is high, so diseases are major factors in production. Most small grains are used for forage purposes, and oats are better suited for hay, silage or winter pasture in this area. Only disease-resistant wheat varieties such as Quanah and Ponca should be grown.

AREA 7

Area 7 is devoted largely to ranching and wheat is sown only for grazing. Small acreages are sown when favorable fall rains occur or where irigation water is available. The Crockett and Quanah varieties are adapted to this area.

Quality

The quality of a wheat variety with respect to its adaptation and usefulness in the manufacture of flour is important in the selection of a wheat variety and also in wheat breeding. Quality characteristics are the result of the interaction between inherited genetic characters and environmental conditions. Varieties that inherit undesirable characteristics produce poor quality wheat under most conditions, others may produce good quality wheat under favorable conditions, but the grain is not satisfactory for bakery-flour production when grown under unfavorable conditions. Still others produce wheat which makes desirable flour under most conditions. The

TABLE 6. COMPARABLE YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN AT STATIONS IN AREA 4, 1949-59

Variety	Yield of grain, bushels per acre	Number of tests	Test weight, pounds	Date first head	Date full ripe	Percent		Plant height, inches	Estimate of forage value[1]
	Average for area					Leaf rust	Stem rust		
			HARD RED WINTER WHEAT VARIETIES						
Quanah	22.5	25	58.5	4-21	5-29	7	5	34.9	98
Crockett	20.8	25	59.5	4-23	5-27	19	10	34.3	87
Tascosa	20.0	13	60.7	4-24	5-29	49	31	32.8	92
Early Blackhull	19.7	25	59.7	4-18	5-24	53	12	35.5	87
Comanche	19.4	9	56.9	4-26	5-29	38	14	34.6	82
Tenmarq	16.8	25	56.7	4-27	6-1	53	25	35.2	88
Triumph	12.0	3	58.8	4-20	5-27	70			84
Wichita	12.0	4	60.9	4-23	5-29	50			73
			SOFT RED WINTER WHEAT VARIETIES						
Frisco	25.3	14	57.8	4-20	5-25	4	13	35.2	92
Vermillion	23.6	4	57.3	4-12	5-24	12	16	35.5	102
Knox	21.9	15	58.2	4-14	5-22	19	34	33.9	93
Coker 47-27	20.8	11	55.8	4-13	5-19	27	17	38.5	137
Atlas 66	19.7	15	55.0	4-17	5-26	28	4	34.4	108
Red May	18.0	10	56.5	4-24	5-26	44	45	32.8	92
Denton[2]	17.3	24	55.8	4-29	6-1	29	38	35.8	91
Austin	19.6	25	56.1	4-21	5-27	34	9	36.4	100
			DURUM VARIETIES						
Sentry	24.4	15	61.2	4-12	5-22	14	Tr	37.2	106
Stewart	22.9	25	60.4	4-17	5-25	9	13	42.6	113
Langdon	22.8	12	59.5	4-16	5-24	22	0	38.3	107

[1]Visual estimate of forage value, Austin 100 percent.
[2]Mediterranean strain.

Figure 15. Baking laboratory at Arlington State College, where milling and baking tests of wheat from yield trials are conducted.

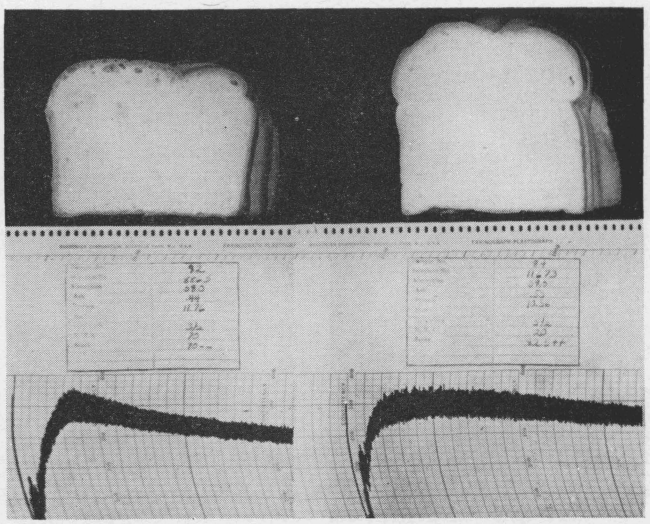

Figure 16. Bread made from a poor quality wheat variety (left); note porous loaf and low volume, compared to bread (right) made from Comanche, a good quality variety.

environmental conditions that contribute to good or unsatisfactory quality are not well understood. High temperatures, the amount of nutrients available at critical growth periods, moisture conditions of the soil, as well as weather conditions during the harvesting period, influence quality.

The majority of bread now is manufactured in commercial bakeries and, because many mechanical devices are involved, any error in the ingredients or weakness in the flour may result in a large loss to the bakery. Figure 14 shows an 1,800-pound mass of dough coming from a giant mixer in a modern bakery. Thousands of loaves are produced each day in a bakery of this type.

Large-scale elevator and milling operations make it impossible to separate the wheat from a given farm or even a small community. Therefore it is desirable for all producers in one area to grow good varieties of uniform quality and develop a market for large supplies of good quality wheat. Milling concerns and terminal elevators that deal in wheat for domestic and foreign use keep well informed on varieties grown and discriminate against areas that continue to grow undesirable varieties.

The choice of a wheat variety to grow should be based on its quality as well as its performance in the field. Fortunately, growers in Texas have high yielding, well-adapted varieties which meet most of these needs. Also, as part of the wheat improvement program, all new strains being considered for release are tested thoroughly for quality. Facilities are available at Arlington State College for tests of Texas commercial varieties and new strains. Before release they also are tested by the Regional Quality laboratory of the U. S. Department of Agriculture, Manhattan, Kansas, and often are tested by cooperating commercial laboratories. The laboratory at Arlington State College is shown in Figure 15. The importance of differences in inherent quality characteristics is shown in the loaves of bread made from a poor quality wheat variety compared to bread made from Comanche, a good quality variety, Figure 16. Comanche and Tas-

TABLE 7. COMPARABLE YIELDS AND AGRONOMIC DATA FOR WHEAT VARIETIES GROWN AT SUBSTATIONS IN AREA 5, 1949-59

Variety	Class	Yield of grain, bushels per acre	Number of tests	Test weight, pounds	Date first head	Date full ripe	Plant height, inches	Percent		Estimate of forage value[1]
		Average for area						Leaf rust	Stem rust	
Sentry durum	durum	26.9	6	61.3	3-30	5-11	39.8	7	14	88
Milam	HRW	24.5	10	59.7	3-28	5-10	34.8	8	Tr	109
Langdon durum	durum	24.1	6	59.0	3-31	5-11	41.2	15	Tr	94
Supremo	SRW	20.3	20	58.0	3-26	5-4	38.5	10	15	127
Lee (spring type)	HRS	20.1	18	56.8	3-23	5-7	34.5	10	30	124
Coker 47-27	SRW	19.3	12	56.7	3-29	5-8	39.1	19	14	136
Stewart durum	durum	18.9	7	58.1	4-5	5-13	45.8	13	39	87
Seabreeze	SRW	18.4	18	56.3	3-2	4-18	34.8	33	14	133
Atlas 66	SRW	17.8	14	53.6	4-3	5-12	35.5	13	18	128
Bowie	SRW	17.6	17	56.7	3-31	5-9	35.3	5	53	116
Quanah	HRW	16.3	20	55.5	4-8	5-15	36.9	9	12	92
Austin	SRW	13.2	20	52.0	4-5	5-12	35.3	32	15	100

[1]Visual estimate of forage value, Austin 100 percent.

cosa are high quality varieties, RedChief is a poor quality variety and Triumph is a mellow gluten wheat well suited to family flour but often less suitable for bakery flour.

Although varieties differ greatly from season to season, their relative behavior usually is much the same. On the basis of many experimental quality tests in state and regional trials, the following grouping of commercial varieties may be made:

Group 1.—High quality varieties suitable for production of bakery flour: Cheyenne, Turkey, Aztec, Comanche, Bison, Tascosa, Tenmarq and Quanah.

Group 2.—High quality varieties under most conditions but not equal to group 1 in gluten strength and mixing tolerance: Ponca, Concho, Crockett and Westar.

Group 3.—Mellow gluten wheats suitable for family flour production or for bakery flour when produced under favorable conditions: Wichita, Apache, Kiowa, Pawnee, Triumph, Blackhull.

Group 4.—Poor quality varieties with weak gluten under most conditions: Early Blackhull, RedChief, Chiefkan, BlueJacket, NewChief.

Group 5.—Soft red winter wheats suitable for family flour production: Knox, Frisco, Red May, Mediterranean, Atlas 66, Coker 47-27.

Diseases

Diseases are important hazards to wheat production in Texas. The mild, humid winter weather of South Texas provides favorable conditions for establishment, survival and increase of pathogens causing foliage diseases, particularly the wheat rusts. The early-spring buildup of these diseases may provide airborne spores which are carried to all parts of the State and, when conditions are favorable, the diseases develop into major epidemics. Such rust epidemics occurred in 1949, 1957, 1958 and other years, resulting in severe losses of grain, reduced grain quality and increased harvesting cost because of lodging of the crop. The diseases of wheat are described in detail in TAES Bulletin 921, "Diseases of Small Grains in Texas." Only brief descriptions will be included here. The principal leaf diseases are shown in Figure 17.

STEM RUST

Stem rust, *Puccinia graminis* var. *tritici* Ercks S E. Henn., is perhaps the most dreaded wheat disease because it causes severe damage to yields and grain quality. A field completely destroyed by stem rust is shown in Figure 18. The disease is caused by a parasitic fungus which enters the leaves, stems or spike through stomata. In 6 to 10 days the fungus begins reproducing itself and appears as brick-red, elongated pustules on the surface of the plant parts, Figure 17 F. These pustules contain thousands of microscopic spores, which may be carried by wind currents to nearby plants where they germinate in rain or dew and cause new infections. The fungus uses nutrients and water needed by the plant for grain production and when infection is high the stems are weakened, the plants lodge, the grain is shrivelled, yields are low, the test weight is lowered and the market price is reduced. The time of infection, weather conditions and races of inoculum blown into a field are important factors in de-

Figure 17. Principal leaf diseases of wheat: (A) normal leaf; (B) powdery mildew; (C) speckled leaf blotch; (D) stripe rust; (E) leaf rust; (F) stem rust on leaf; (G) stem rust on stem.

termining the amount of damage that will occur. The disease is a constant hazard in areas 3, 4, 5 and 6 and may cause losses in some years in areas 1 and 2.

The stem rust fungus is made up of many races similar to a variety in crop plants. Races vary in prevalence and ability to attack varieties of wheat; therefore, a variety may be resistant one year and susceptible another year or under other conditions. New races may originate on the alternate host, the common barberry, wherever this plant becomes infected; they may originate by hyphal fusion in the tissue of the wheat plant or by mutation. Race 15B is a relatively new and virulent race which caused widespread damage during 1954-57 because there were no resistant commercial varieties. More recently biotypes of races 17, 29 and 48 have increased and caused concern among breeders and wheat growers.

Widespread growing of resistant varieties not only protects the grower but reduces the spread of spores to fields of susceptible varieties. A number of resistant varieties have been distributed in Texas, but their effectiveness in reducing inoculum and damage has been reduced by changes in prevalence of races of rust. Austin wheat was distributed for Central Texas in 1943. The acreage of Austin expanded rapidly until it was grown on an estimated 750,000 acres because of its resistance to leaf and stem rust. However, races of stem and leaf rust that could attack Austin increased rapidly and by 1955 it was no longer a satisfactory variety. Quanah is well adapted for growing in areas 3, 4 and 6 and has excellent tolerance to stem and leaf rust. Frisco, Crockett, Comanche, Tascosa, Concho and some durum varieties have resistance to given races but are susceptible to race 15B, one of the most prevalent at present.

Extensive tests of fungicides for the control of stem and leaf rust are underway. Several compounds that will control rust effectively have been found but, at present, they are not economically practical or they have not been cleared by the Pure Food and Drug Administration. Rusts may infect wheat in Texas from early fall until May of the following season so control by fungicides over this long period presents problems.

LEAF RUST

The leaf rust of wheat, *Puccinia recondita* Rob. ex. Desm. f. sp. *tritici*, is different in many respects from stem rust, although it belongs to the same genus. Commonly called "red rust" by growers, it often is not considered important, but highly controlled tests have shown that it reduces the number and size of seed and yields under many conditions.

Leaf rust appears on the wheat plant as small, reddish-orange pustules, Figure 17E. They may be present on either side of the leaf but usually do not penetrate through the leaf in contrast

Figure 18. Field of wheat destroyed by stem rust at College Station, 1954.

to stem rust pustules, which are larger with frayed edges and often extend through the leaf. The leaves and leaf sheath can be attacked but the spike or stem proper usually are not attacked. Leaf rust infects and may spread at temperatures below 70° F., whereas stem rust does not reproduce well until the temperature reach 75° F.

Growing resistant varieties is the most economical means of avoiding leaf rust damage. Fortunately, several well-adapted varieties have high resistance to leaf rust and several others are resistant to many races. The highest degree of resistance is found in the Quanah, Ponca and Frisco varieties. Crockett and Knox are resistant from the booting stage to maturity but are susceptible in the seedling stages. Westar, Concho, Mediterranean, Austin and Seabreeze are resistant to many races, but in recent years races that can attack them have increased.

STRIPE RUST

Stripe rust, *Puccinia striiformis* West., was prevalent in Texas during the wet, cool spring seasons of 1957 and 1958. It had not been known to cause damage previously. Stripe rust produces bright-yellow pustules between the leaf veins, Figure 17 D. The varieties Karkof (Turkey type), RedChief and Ponca and some experimental strains were resistant under field tests in 1957 and 1958, while Wichita, Concho, Crockett and Westar were highly susceptible.

SEPTORIA DISEASES

Two species of Septoria may attack wheat and both are favored by cool, moist weather.

The speckled leaf blotch, *Septoria tritici* Rob., occurs nearly every year in Texas but usually is relatively inconspicuous and the damage is overlooked. Speckled leaf blotch appears first as pale green to yellow spots on the leaf. These lesions enlarge as the fungus invades other tissues. As the tissue is killed, it turns brown and later, grey to black fruiting bodies called pycnidia are formed,

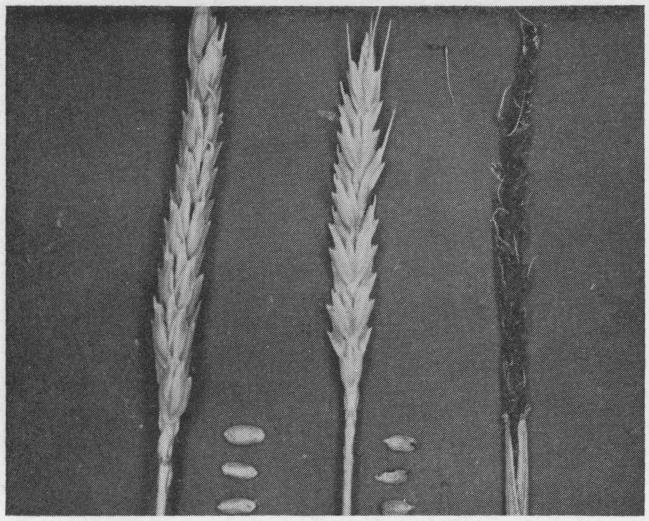

Figure 19. Normal head of wheat (left) contrasted with head infected with bunt (center) and head destroyed by loose smut (right). Note smut balls produced by bunted head (center).

Figure 17 C. When conditions are favorable, large areas of leaf tissue may be killed, thereby reducing the effective leaf areas and yields. Varieties that have shown some tolerance under Texas conditions include Crockett, RedChief, Mediterranean, Quanah and Ponca. Seed treatment with organic mercury fungicides, crop rotations and plowing under crop residues to prevent infection from old straw and volunteer plants will aid in the control of this disease.

The glume blotch, *Leptosphaeria nodorum* Muller (*S. nodorum* Berk., conidial stage) is less common than speckled leaf blotch, but serious epidemics of this disease occurred in 1935, 1941 and 1957. This fungus attacks culms and spikes, causing blackening of affected areas. The stems are weakened and may bend or break just above the nodes, causing great difficulty in harvesting the crop. Seed from these diseased plants may be shrivelled and yields seriously reduced. Seed treatment with organic mercury fungicides and clean cultural practices are valuable in controlling this disease. Relatively little is known about varietal resistance.

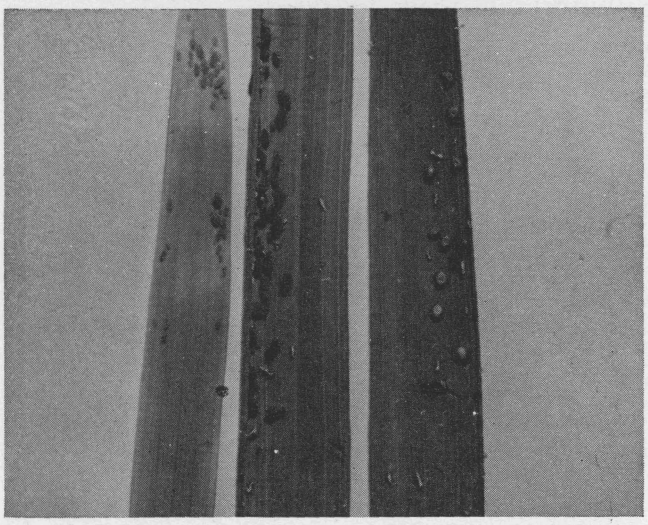

Figure 20. Greenbugs on leaf of wheat (left) showing characteristic yellowing of leaf tissue, corn leaf aphids (center) and parasitized aphids (right).

POWDERY MILDEW

Powdery mildew, *Erysiphe graminis* DC. f. sp. *tritici* E. Marchal, normally is not important, but under some conditions it may damage the crop, reducing forage and grain yields. Mildew appears on the leaf surface as a mass of white mycelium (Figure 17 B) but only the epidermal cells of the leaf tissues are invaded by the fungus. Plant food and water are taken from the host plant. The disease occurs during cool, cloudy weather. The only means of control is growing resistant varieties. Crockett, Ponca, RedChief, Wichita, Knox and Atlas 66 are resistant to some races of the fungus.

SMUTS

Two smut organisms attack wheat in Texas and are of economic importance. Loose smut, *Ustilago tritici* (Pers.) Rostr., destroys the grain and all glume structures, leaving only the central stem or rachis of the spike, Figure 19. Spores produced by the fungus are spread by wind currents and infect the healthy plants at flowering time. These tiny spores germinate and penetrate the young ovary, where they remain dormant until the seed germinates. When the infected seed starts growth the fungus develops along the growing point and systematically invades the tissue and finally replaces the head with a mass of smut spores.

Varieties differ in their reaction to the disease and to races of the causal fungus. Ponca, Pawnee, Triumph and Austin are resistant. Comanche, Wichita, Westar and several others are susceptible but usually do not develop high percentages of smut under field conditions. Quanah, Concho, Kiowa and Bison are highly susceptible and often become heavily infected under natural conditions.

Surface treatments of seed with organic mercury fungicides are not effective in controlling loose smut because the fungus is within the seed. Formerly a difficult hot-water treatment of the seed was necessary. Recently a new method has been devised.[3] Briefly, this treatment is as follows: (1) partially fill burlap bags with wheat and soak in water at room temperature for 6 hours, (2) place in a closed container (an oil drum or barrel) with a tight lid for 72 hours and (3) spread out to dry. With this method the fungus is killed without serious damage to the seed.

[3]Weibel, D. E. and Atkins, I. M. The long-soak method for controlling loose smut of wheat, (1957). TAES Progress Report 1986.

The seed then should be treated with a fungicide to reduce seedling diseases and the field should be isolated so that the crop will not become reinfected.

Stinking smut, or bunt, *Tilletia foetida* (Wallr.) Liro., differs from loose smut in that the glumes and other parts of the spike remain intact and only the internal part of the kernel is replaced by smut spores. These smut balls resemble seed and often are overlooked in the field. At harvest time they are broken and the smut spores scattered to healthy kernels, where they lodge in the brush at the end or in the crevice of the kernel. At germination time the next season, the fungus spore germinates and penetrates the young seedling, continuing growth within the plant and finally replacing the seed with a mass of smut spores, Figure 19.

Bunt infection is influenced greatly by soil temperatures at seeding time. Soil temperatures below 68° F. are more favorable than higher temperatures. The disease is prevalent more often in areas 1 and 2, where nights are cool, than in areas 3 and 4.

Several well-adapted varieties are resistant to most prevalent races of bunt. These include Quanah, Concho, Bison, Kiowa, Apache and Comanche. Also, seed treatment with dust or slurry fungicides is effective in controlling bunt. Treatment of all planting seed is recommended.

ROOT ROTS

Root rots of wheat have been prevalent in Texas for a number of years. The losses from this disease vary depending on the previous crop grown on the land and the environmental conditions during a given growing season. Losses have occurred on the Rolling Plains, especially in Foard and Baylor counties, for several years and during the 1958-59 growing season losses occurred in the eastern part of the Texas Panhandle.

The disease is caused by a complex of organisms. *Helminthosporium sativum* Pamm, King. and Bakke. has been the predominant species. *Fusarium sp.* ranks second. *Rhizoctona solani* Kuhn, *Sclerotium rolfsii* Sacc., and other species of fungi have been isolated. Under some conditions *Septoria sp.* have been known to girdle the plant and cause a culm rot.

The control of root rots is difficult. Seed treatments with liquid organic mercury compounds will reduce this disease, but will not give control where the organisms are living on infested straw. Crop rotation with broadleaf crops will give some control. Varieties that are tolerant to the disease have been found in the spring wheats. A program of screening of winter wheats in the world collection is in process by the Texas station.

Figure 21. Wheat spikelet and a spikelet separated to show parts of wheat flower.

Insects

A number of insects may cause serious damage to wheat when conditions for their development are favorable. A complete description of these insects, with suggested means of control for each, is given in TAES Bulletin 845, "Greenbugs and Some Other Pests of Small Grains" November 1956.

The most serious insect pest of wheat is the greenbug (aphid), *Toxoptera graminum* (Rond.). Several other aphids also may attack wheat, but usually they do not cause serious damage. Greenbugs cause a characteristic yellowing or reddening of the leaf tissue where they feed. Under favorable conditions for greenbug reproduction, plants are weakened or killed, causing yellow or dead areas in fields. If the infestation continues, these spots may enlarge and engulf large areas

Figure 22. Wheat breeding and testing nursery, Bushland, 1958.

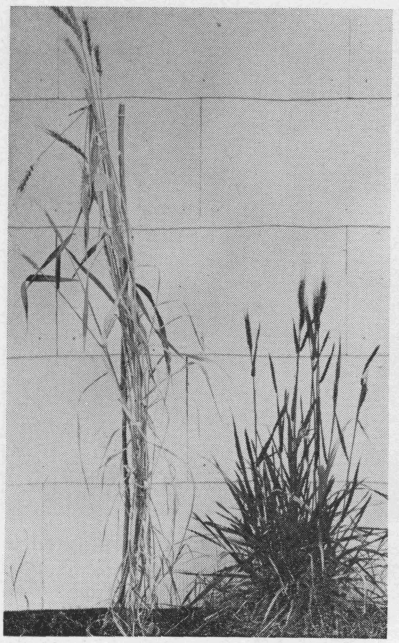

Figure 23. Normal plant of Comanche wheat (left) compared with Norin 10 short-wheat plant (right).

or entire fields. Greenbugs are shown in Figure 20.

Effective insecticidal sprays for the control of aphids are available but under many conditions are too expensive for economical control. Recently two varieties of wheat with genetic resistance to greenbugs have been found. A search is underway to find additional sources of resistance. This resistance is being transferred to adapted varieties by modern breeding methods.

Another group of pests which attack wheat are spider mites. The more important under Texas conditions are the brown wheat mites, which occur in the drier areas of West Texas, and the winter grain mite, which occurs more frequently in the more humid areas. Spider mites are not insects but tiny spiders. They damage the crop by cutting the leaf tissues and feeding on the juice. The winter grain mite is controlled easily, but the brown wheat mite is difficult to kill with chemicals. Also, it occurs most frequently in low-rainfall areas where it is not practical to invest much in control measures. The spider mites migrate slowly, so both crop rotation and summer fallow are effective in reducing populations.

Figure 24. Short wheats in yield tests at Amarillo, 1958. Concho in foreground is severely lodged.

Wheat Breeding

Research work to develop new varieties of wheat especially adapted to Texas needs is carried on as part of the total small grain improvement program of the Texas station. Extensive breeding to develop new varieties is conducted at Amarillo, Denton and College Station, while variety and strain tests often are conducted at as many as 20 locations in the State. Fundamental studies of disease and insect resistance, shattering, lodging, cultural operations, fertilizer, quality and other phases are conducted at the main breeding stations.

Wheat is self-fertile and varieties must be cross pollinated by hand to produce hybrid seed. Because of this tedious hand pollination and the large amount of planting seed necessary, the production of hybrid seed, as with corn and grain sorghum, is impractical. The parts of a wheat flower are shown in Figure 21. After a cross is made, the progenies must be grown and selected for 4 to 8 years before true-breeding strains can be obtained for trial. Several years are necessary for thoroughly testing the new strains, determining the desirable and undesirable characteristics and testing for quality and many other characteristics. Breeding and testing work often requires 10 to 15 years before a new variety is ready for commercial growing and, consequently, a major investment in research money. However, if the new variety has distinct advantages in resistance to disease, insects, drouth or other hazards, the increased revenue in yield or stabilizing production may return large dividends on the research expenditure when projected to a large acreage.

Varieties of many characteristics are needed to fit specific needs of the several growing areas because of the wide range of climatic conditions in Texas. Diseases, insects, drouth, lodging, shattering, test weight, quality for milling and baking and value for winter pasture should be considered since they may contribute to grain production or returns to the grower. Figure 22 shows the extensive wheat nursery at Bushland, 1958, where varieties and strains are grown in 8-row nursery plots.

An example of the need for special varieties for special needs is the present "short wheat" breeding program of the Texas station. Rapid

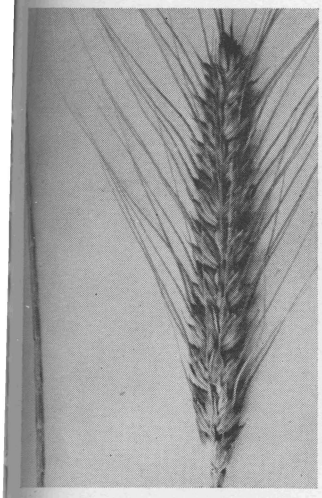

Figure 25. Goatgrass or jointgrass, Aegilops sp., (left) compared with a head of wheat.

expansion of wheat irrigation in area 1 has emphasized the need for special wheat varieties for growing under irrigation. Problems that develop include lodging, shattering, production of excessive straw growth, efficient use of water and fertilizer, as well as criticism by mills of the wheat quality grown under irrigation.

A program to develop short-stature wheats of desirable agronomic characteristics and good milling and baking qualities is now underway. A very short wheat was introduced from Japan by the U. S. Department of Agriculture. Transfer of this short stature to adapted varieties through modern breeding methods is in progress in several states. The original strains as well as derived strains have been used in the Texas breeding work. The original short stature Norin 10 wheat from Japan is shown in Figure 23 while Figure 24 shows the new strains derived from this breeding in yield trials under irrigation at Amarillo. High yields were produced without lodging of the crop, whereas Concho, shown in the foreground, lodged rather severely. Additional tests of these strains are necessary before they become available for commercial growing.

Weeds

The most serious weeds in Texas wheat are the annuals, goat grass (*Aegilops* sp.), or joint grass, cheat and little barley; and the perennials, bindweed, blueweed and Johnsongrass. A spike of goat grass is shown in Figure 25. Seeds of these annual weeds are difficult to separate from the wheat seed. Control measures include cultivation and delayed seeding in the fall or rotation with fallow or clean-cultivated row crops.

Perennial weeds require more intensive control measures of clean cultivation, sprays or combinations of the two where infestations of weeds are serious. Recent results of research on weed control are reported in TAES Progress Reports 1862, 1954, 1987, 1995 and TAES Bulletin 902, "Spot-spraying Johnsongrass."

Broadleaf annual weeds may present a serious problem in the production or harvesting of the crop under some conditions. Many of these may be controlled by spraying with 2,4-D or other herbicides. The latest recommendations on weed spraying may be obtained from the local county agricultural agent's office.

Acknowledgments

These investigations were conducted cooperatively by the Texas Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

Acknowledgment is made to the following people and agencies taking part in statewide small grain variety tests: Lucas Reyes and Edward Neal, Substation No. 1, Beeville; J. W. Collier and R. M. Smith, Substation No. 5, Temple; D. I. Dudley, Substation No. 6, Denton; Paul Marion and Wm. P. Hatchett, Substation No. 7, Spur; J. R. Quinby, Substation No. 12, Chillicothe; L. E. Brooks, Substation No. 16, Iowa Park; O. E. Smith, Substation No. 18, Prairie View; B. C. Langley, Substation No. 20, Stephenville; M. J. Norris and H. O. Hill, Substation No. 23, McGregor; Dow D. Porter, U. S. Cotton Field Station, Greenville; C. E. Van Doren, U. S. Southwestern Great Plains Field Station, Bushland; Owen Merkle, Main Station, College Station.

Off-station tests were conducted at Abilene in cooperation with F. M. Churchill and Keith Justice, Abilene Christian College; at Stratford through the cooperation of the Sherman county Wheat Producers Association; at Floydada through the cooperation of Roy Hale and William Rogers; at Dumas through the cooperation of Ed Stallwitz and Martin Gossett and at Comfort through the cooperation of the Comfort Seed Growers Association.

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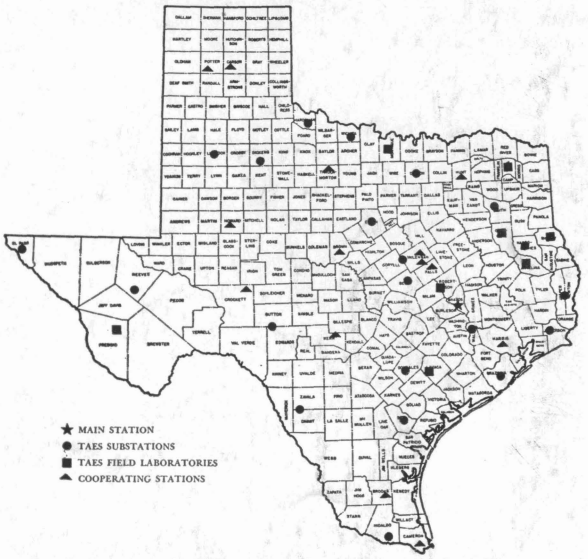

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of ten parts of the Texas A&M College System

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 400 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tommorrow's Progress