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A History of Small Grain Crops in Texas

Wheat, Oats, Barley, Rye 1582-1976




The Texas Agricultural Experiment Station
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The Texas A&M University System

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Wheat for Man's Bread Introduction, Production, and Research 1582-1976

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WHEAT FOR MAN'S BREAD

Introduction, Production, and Research

1582 – 1976

Wheat is one of the oldest of cultivated crops because the dry, hard seeds are easily stored, attractive, and nutritious. Man learned to cultivate this plant, which he found growing wild, and soon began to select the types best suited to his needs. Barley and rice may have been cultivated before wheat, but all three are described in the earliest records (Leonard, 72). Wheat was grown in China as early as 2700 B.C. It was grown by the people of the Stone Age in Switzerland. Carbonized wheat grains discovered by archeologists in the tombs of Egypt are estimated by carbon dating to be 6,000 to 7,000 years old. Wheat is mentioned several times in the Christian Bible and also in Rigveda, the Indian scriptures.

The first cultivated wheats were probably primitive hulled types which were spread over the Western part of Europe during the Stone Age. There are several theories as to how the present bread wheats originated. Some historians believe that they originated in the Tigris or Euphrates valleys, while others believe they originated in the Syria or Palestine area of the Near East. Percival (90) suggested that the durum wheats came from Abyssinia and the bread wheats from Afghanistan or northern India. Theie are no wild forms of modern bread wheat, so some believe that these arose by natural crossing of the wild species *Triticum* and wild, related species of grasses, such as those of *Aegilops*.

E. S. McFadden, agronomist with the U. S. Department of Agriculture and the Texas Agricultural Experiment Station, and E. R. Sears, cytologist with the U.S. Department of Agriculture and the Missouri Agricultural Experiment Station, cooperated to develop the theory that common bread wheat arose by natural crossing of a durum-type wheat, *Triticum diccoides* Korn., and *Aegilops squarrosa* L., a wild grass which grows as a weed in the Near East. After the cross occurred, the chromosomes of the hybrid plant were doubled in some manner so that the plant became fertile and reproduced. McFadden and Sears (78) made such a cross, doubled the chromosomes by means of the drug colchicine, and produced a fertile plant which they crossed to bread wheat. This plant was capable of reproduction, indicating that the bread wheats could have developed in this manner.

Although wheat is now grown on all the continents and in more than 50 countries around the World, it is not native to the Americas. Wheat is the major food crop of Europe, the Americas, Australia, and many countries of Asia and Africa. The total World acreage is greater than that of any other grain crop, although the total production in pounds or tonnage sometimes is less than that of rice because rice produces greater yields per acre.

INTRODUCTION OF WHEAT TO THE AMERICAS

There are some undesirable facets of the conquest of the Americas by European countries, but there are desirable effects as well. The introduction of European work and food animals and many crop plants, vegetables, and fruits caused significant changes in the life of native Indians. Wheat is a significant countributor to this change as it soon became the major human food in America, replacing corn.

Wheat was introduced through two independent and widely separated pathways--first, by the Spaniards and French into the Southwest and, second, through the eastern U.S. colonists who came for the most part from Northern Europe.

The Spanish

Morrison (80), who translated the journals of Christopher Columbus, records that on the second voyage, in 1493, Columbus wrote the Queen of Spain, "For your information, we brought with us from Spain all sorts of seed and tried them here--namely wheat, beans and chickpeas etc."

Whitaker (121) related that soon after the conquest of Mexico City, Cortez requested the Crown to issue a decree that "every ship bring crop seeds and domestic animals to the New World." Wheat and barley, in addition to corn, were the first crops grown by the Spaniards, and by 1535 the area around Mexico City was exporting wheat to the West Indies. Whitaker comments also on the first wheat grown in the Americas. It seems that a negro servant was making a "Guisado" (stew) for Cortez, his master, and found a few grains of wheat mixed with the rice. He planted this seed in a flower pot, grew it to maturity, and thus started the cultivation of wheat.

Wheat and other grain crops were taken northward as the Spanish conquered and settled Mexico. The settlement of Saltillo was started in 1575 when 20 families arrived. Carter (28) writes that from the 275 springs in the valley near the Sierra Galena range, grants of land and water rights were given to each family. Soon they were growing corn, wheat, and vegetables for sale to the mining areas nearby. Saltillo became the southern terminus of the roads to New Mexico and Texas.

From the Saltillo area, Spanish settlement and influence moved northward through Parras, Torreon, San Bartelome to Santa Barbara on the Conchos River of Mexico by 1580. Exploration into New Mexico and Texas was based at this point for a time beginning with the famous Coronado expedition of 1540. From 1580 to 1680, numerous expeditions, still searching for the riches of Quivira, started from this area. Some were very large. Wellman (121) describes Coronado's expedition as consisting of 336 soldiers, some women and children, and more than 1,500 horses and mules, behind which was driven the commissary on foot with cattle bawling, sheep bleating, and hogs squealing.

Translations by Casteñada (29) show that an expedition, led by Fray Agustin Rodriquez and Francisco Sanchez Chasmuscado, left Santa Barbara in June 1581, traveling down the Conchos River to the Rio Grande. Here they met a friendly tribe of Indians, the Jumanos. They crossed into Texas and explored parts of southern Texas and New Mexico. This expedition went along the Rio Grande about six leagues above La Junta where they "observed a beautiful valley where the soils were suited to the cultivation of grain." They returned to Santa Barbara in January 1582.

Later in 1582, Antonio de Espejo led another expedition to the Rio Grande, crossed the river and went north to near present Santa Fe, returned through the Plains, and probably reached the Canadian River of Texas. This expedition also found the Jumanos Indians friendly and learned that Cabeza de Vaca had visited these people in his wanderings in 1535.

Translations of the Rodriquiz and Espejo expeditions by Casteñada (29) show that the Jumanos Indians were an agrarian tribe that had lived along the Rio Grande for hundreds of years. They lived in fairly permanent houses and in caves of the area and cultivated crops. Kelley (71) states that archaeological reconnaisance and excavations show that these Indians had lived in that area for a long time and that prehistoric people occupied the area for several thousand years before them.

The Jumano Indians had traded with the Spanish for many years prior to 1581. Each summer they went to the Parras area to work in the mines and plantations or ranches of the Spanish, then returned in the fall to harvest their own crops. Casteñada (29) states, "In their long association with the Spanish, they had learned to cultivate corn, wheat, beans, tobacco and cotton. The records state specifically that Espejo observed fields of wheat and corn on both sides of the Rio Grande." This then appears to be where wheat was first cultivated in Texas. However, the Spanish did not establish permanent settlements at the La Junta (Presidio) area at this time. This occurred about 100 years later and came from the El Paso area.

The Juan de Onate expedition also originated in the Santa Barbara area but went north through Chihuahua to Paso del Norte in 1598 and into the Santa Fe area of New Mexico (Hallenbeck, 55). Onate established the first permanent Spanish settlement in what is today the United States. It was on the San Gabriel, a branch of the Rio Grande River. Here, in 1599, the settlers seeded wheat and by 1601 produced 3,200 bushels of wheat for food. The area flourished until 1680, when the Indians revolted and drove the Spanish back to the Chihuahua area.

Settlement of the El Paso area dates from 1628, when Fray Antonio de Artega and Father Garcia de San Francisco de Zuniga established the Senecu Mission. The oldest church in this part of the Southwest is Nuestra Senora de Guadalupe, in present-day Juarez. It was started in and finished in 1668. By 1680, there were 1,000 parishioners who owned 9,000 cattle and 13,000 sheep in the El Paso area. Father Garcia built the first irrigation ditch around the falls of the Rio Grande. The land was under cultivation, growing wheat, corn, beans, grapes, vegetables, and fruit.

After the Indian revolt of 1680, there was little Spanish settlement for some time. Father Alvarez returned to El Paso in 1706 and started reestablishing the church. From 1790 to 1850, the area prospered. Wheat was apparently one of the major crops used to feed the expanding empire. Sonnichsen (105) states that from 1800 to 1850 farms raised great quantities of wheat, which was ground into flour at the local mills. Juan Ponce de Leon, a freighter, obtained a tract of land on the north side of the river in 1827 and grew great fields of wheat and corn, where El Paso now presents acres of brick and asphalt."

Bishop Pedro Tamaron of Torreon visited the El Paso missions in 1760 and reported seeing fine fields of wheat and corn. Pike (91) in 1807 and Linn (73) in 1829 both describe the "beautiful fields of irrigated wheat" at El Paso. According to Calleros (26), the oldest field in continuous cultivation in the United States, dating from 1682, adjoins the Ysleta Mission.

The settlement of the Presidio, Texas, area by Spaniards occurred about 100 years after the first expeditions visited the area in 1582. (Observations of wheat growing at that location were reported earlier.) Casteñada (29) writes that Don Pedro de Rivera observed fields of wheat and corn near Presidio in 1726. In 1731, Captain Joseph Idoyago visited the mission at San Cristobal on the Texas side of the Rio Grande and observed crops of wheat and corn. Juan Dominquez de Mendoza, who visited the area in 1748, reported, "At the La Junta presidio named La Navidad en las Cruces, there were Jumanos Indians on both sides of the river who were versed in the Spanish language and all cultivated maize and wheat."

Father Nicholas Lopez and two assistants went from El Paso to the La Junta area in 1684 at the request of the Jumanos Indians. Several mission churches and villages were established, none of which have survived to modern times. At the junction of Alimetes Creek and the Rio Grande River, the Indians built a church which the Father called La Navidad en Las Cruces; the village was called El Apostol Santiago, These did not survive, but at a later date, 1770 to 1810, a mission called El Fortin de San Jose was built on this site. More recently, in 1848, a trader and rancher named Ben Leaton bought considerable acreage in this area and built a fort and trading post. Parts of the older El Fortin mission were incorporated into his fort. Portions of both structures were incorporated into a Fort Leaton historical site of the Texas Parks and Wildlife Department, completed in 1978.

Time and weather have destroyed most of the old forts, missions, and presidios of that period. Adobe bricks, however, remain intact for long periods in such dry areas as the Big Bend. Hendry (62) found seed and plant parts of wheat, oats, barley, and rye in adobe bricks from missions built i

Figure 1A: Grain and straw sections from adobe bricks of Landin Mission of Saltillo, Mexico, in 1747.

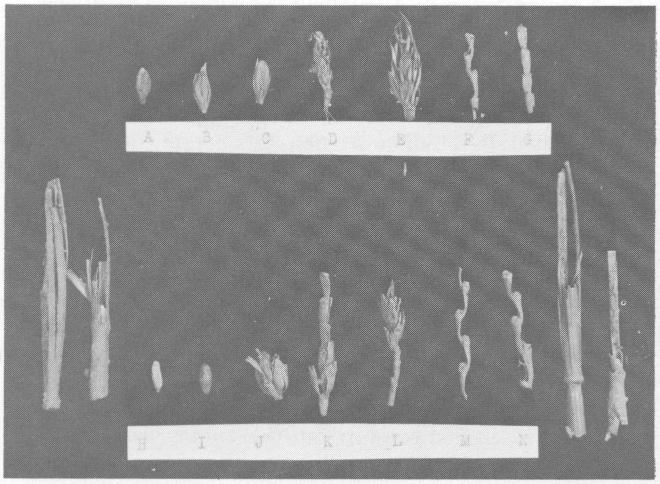


Figure 1B: Adobe bricks from Fort Leaton Historical Site showing how wheat and grain may be preserved in adobe brick.

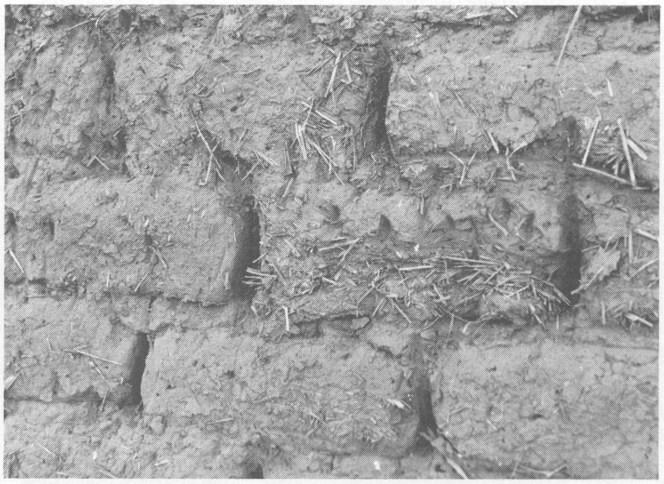


Figure 1C: Fort Leaton Historical Site near Presidio, Texas. Note flood plain of Rio Grande and mountains of Mexico in distance.

Figure 1D: Flood plain of the Rio Grande where wheat may have been grown in Texas in 1582.

California before 1700. This writer (I. M. Atkins) has not been able to obtain authentic bricks of this period from either the El Paso or Presidio areas, but samples were obtained from the old Landin Mission church near Saltillo, Mexico. Seed and plant parts of wheat and barley from this mission are shown in Figure 1A. Figure 1B shows a newly pressed brick, illustrating how straw and grain may be pressed and preserved in pressed adobe bricks. The restored Fort Leaton Historical Site is shown in Figure 1C and the flood plain of the Rio Grande River at Fort Leaton is shown in Figure 1D, with the mountains on the Mexican side in the distance. This field or one like it could well be the location of the first field of wheat in Texas near 1582. Caves in the Big Bend area contain artifacts, paintings, and pictographs of earlier times. A metate or grinding stone used by the Indians for grinding seed was found in a cave by Blake Williams (see section Milling, Figure 19A).

Independently of the settlements at El Paso, a number of attempts were made to explore and establish settlements east of the El Paso area. According to Chiodo (33), a priest and several soldiers made a semi-permanent settlement in Real County in 1629. Considerably later, in 1762, Mission Buno was established at Montell in Real County; it stood for 50 years. Remains of irrigation ditches and fields cleared for farming still can be seen. A mission, San Clemente, was built by the Spanish in Runnels or Coleman County in 1683, according to Chabot (32), but in 1969 Conners (39) found the remnants of the mission on the San Saba River in Menard County. There is no record of wheat being grown at either of these locations, but it could have been.

The Spanish were greatly concerned about French settlements and exploration at this time. Ashford (4) recounts the story of five expeditions by Captain Alonzo de Leon from south of the Rio Grande between 1685 and 1690. These were designed to drive out the French and establish permanent settlements. Among the supplies listed for the trip were 150 loads of flour (probably burro loads). This indicates that wheat and flour were readily available at Saltillo in 1690. Even 150 years later, in 1828, General Teran reported that Saltillo flour was available at Austin, at a price of 43 pesos per barrel (Bolton, 18).

Attempts to colonize Texas continued. According to Chabot (31), the St. Denis and Ramon expedition explored as far as the San Antonio area in 1716 and, upon their return, recommended that 30 families be settled in the area. With another expedition, the Marquis de Aguayo went to San Antonio in 1719 and, upon his return to Mexico, recommended that 200 families be brought from the Canary Islands. Plans for this program were developed and, in 1731, the first 52 persons came via Vera Cruz and Saltillo, arriving March 9. As a presidio had already been built, the families were given quarters in the presidio, and the records show that "It was the season for planting. By March 31, lands between the San Antonio River and San Pedro Creek were cleared for immediate planting. By June 30, two fanegans (a fanegan is about 2.58 bushels) of corn, some wheat, barley, cotton and vegetables were sown."

Other missions were established in similar manner. All were planned to be self sufficient. All had farms on which cotton, grain, flax, vegetables, and sugar cane were grown (Johnson, 67). Although corn and other grains are mentioned in several reports, wheat apparently did not immediately become established as a crop. All San Antonio missions had good irrigating ditches and grew cotton, grains, and vegetables (Bolton, 18). In 1745, the four San Antonio missions grew 4,000 bushels of corn, but wheat is not mentioned. They had at this time 9,000 head of horses, cattle, sheep, and goats. The ranches extended downstream along the San Antonio River for 14 miles.

The last missionary at San Jose was Father Jose Manuel Pedrijo, 1789 to 1794. The San Jose Mission, built 1720-1749, is shown in Figure 2A. According to Habig (53), Pedrijo trained the Indian women to operate looms and weave cloth. He also improved the products of the farm, growing wheat and barley, as well as corn, beans, and vegetables. A large granary (Figure 2B) was built in 1749, and in 1794 there were 432 bushels of wheat on hand. During this period, Father Pedrijo designed and built a mill to grind corn and wheat.

Arenson (3) described the irrigation facilities built by the Spanish from El Paso to San Antonio. The first irrigation ditch for the four San Antonio missions was built in 1729; by 1745 all had good irrigation facilities, using water from the San Antonio River. At this time the river averaged 60 feet wide and 5 feet deep. The irrigation ditch which ran to Mission San Francisco de la Espada is still in use, 140 years later (Figure 2C). An aqueduct carrying the Espada ditch over Piedra Creek is shown in Figure 2D.

Bolton (18) translated the records of three little-known missions built in Central Texas from 1745 to 1758. Fray Mariano de los Dolores y Viana of San Antonio led a small group of soldiers and settlers to near present-day Rockdale (50 miles northeast of Austin on the St. Zavier River, now called the San Gabriel). They built three missions and a rock dam to divert the water to irrigate fields. Then they "planted maize, grain, potatoes and beans." In addition to maize, grain is mentioned, so it seems probable that wheat and barley were planted. The missions were abandoned in 1758.

When the St. Zavier missions failed, the Padres moved the remaining supplies to the San Saba River area where a presidio already had been built. The mission at San Saba was built during a period of friendship with the Indians. Again, Bolton (18) relates that "In accordance with the Viceroy's instructions, the soldiers were assigned land to cultivate and the soil was prepared for sowing grains." Wheat may have been seeded at San Saba during this period.

One instance of the growing of wheat in Central Texas is well recorded. An early settlement and mission was made at Pilar de Bucarili on the Trinity River east of present-day Madisonville. The settlers of Adaes, an earlier settlement near Natchitoches, Louisiana, did not want to return to San Antonio when the East Texas missions were abandoned, so they settled at Bucarili. Bolton (18) states, "In 1777 they grew a good crop of wheat."

The French

The Spanish and French were in competition for the territory west of the Mississippi River at this time. The

Figure 2A: San Jose Mission, San Antonio, Texas, built 1720-49. Restored 1927-41.

Figure 2B: The granary at San Jose Mission, San Antonio, Texas, built in 1749.

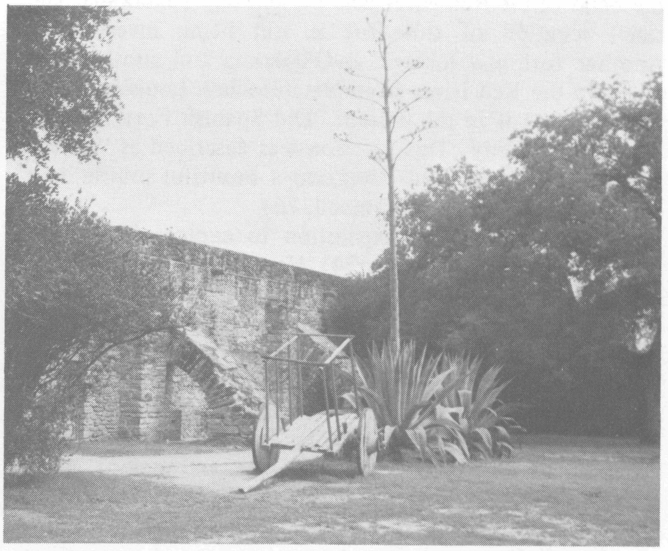


Figure 2C: The irrigation canal from the San Antonio river to Mission Espada. Built in 1743 and still in use.

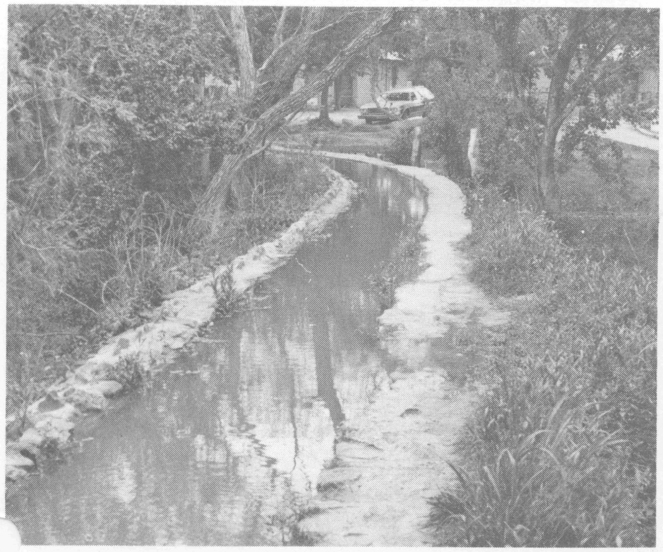


Figure 2D: Aqueduct across Piedra creek carrying the irrigation ditch shown in Figure 2C.

war between France and Spain in 1718 stimulated the colonies to establish claims to what is now Texas. In the French and U.S. army archives, McConnell (76) found that the French mobilized at Natchitoches, Louisiana, and sent Bernard de la Harpe up the Red River with a force to establish forts and hold the territory. La Harpe and assistants established a small fort among the Caddo Indians at the bend of the Red River near present-day Texarkana. The exact location of this fort is still being investigated. Another fort was located in Oklahoma and another 500 miles up the Red River from Natchitoches, Louisiana. This would locate it in the present "Old Spanish Fort" area of Montague County. This location was described as "on the south bank of the Red River, on a beautiful prairie, in a very fertile country" (McConnell, 76).

John Sibley led an expedition to explore Texas and Louisiana in 1806 (Lowrie, 74). He was accompanied by a guide, Francis Grappe, who was born and grew to manhood at the French fort near Texarkana. His father was the Caddo Indian agent there for 35 years. Grappe stated that "the Caddoques (Caddos) had lived here from time immemorial." Before Louisiana was ceded to Spain, several French families settled at the fort. They cultivated crops of corn, wheat, beans, tobacco, pumpkins, and melons. Burrs for grinding grain were brought from France, and a small mill was built. Grappe states that "they grew several crops of wheat." However, in a later statement, he mentions "little wheat was grown because the seasons were either too dry or too wet." He also mentions that the wheat was sown in March and harvested in June, indicating that it probably was of a spring-type variety.

Other evidence of growing wheat in this area is given by Bolton (19) from letters of De Mezieres, the agent at Natchitoches, who in 1771 wrote the Governor at New Orleans, "Your Lordship is already informed of the establishment of wheat culture in this district but, as that which I sowed last year failed because of the wet season, I beg of you to order six fanegans (about 16 bushels) of wheat seed, two fanegans of rye and some barley."

The name "Old Spanish Fort" for the Montague location does not mean Spanish ownership when it was established but resulted from later developments. After the Comanche and Apache Indians sacked the Spanish San Saba Mission in 1758, the Spanish organized an expedition under General Parilla to punish the Indians and drive them back into the Plains country. This expedition left San Antonio in July 1759 and reached the Red River area of North Texas in October. Here the Spanish were surprised to find a fortified fort flying the French flag. The Comanche and Taovayo Indians, with a few French soldiers, defeated Parilla's troops, and they retreated to San Antonio.

The Taovayo Indians were a semi-agrarian subtribe of the Wichita tribe, who had lived at this location for many years. Some authors believe that Coronado visited them on his trip into the area. They lived in established houses much of the year and cultivated some crops. Morrow described their cone-shaped grass houses as looking like "beehives" (Henderson, 61). At the Montague location, they had a fortified village with entrenchments, stockades, and underground tunnels for escape. The French observed one village having 123 houses with 10 to 12 bunks in each. They grew corn, wheat, beans, and pumpkins. The French abandoned this fort in 1762, and a later report (McConnell, 76) states that the Taovayos were driven back into East Texas by Osage Indians in 1795.

After Texas was ceded to Spain by the French in 1762, De Mezieres, the agent at Natchitoches, made a treaty with the Taovayos in 1770 (Bolton, 19). The villages of San Bernado, on the Oklahoma side, and San Teodore, on the Texas side of the Red River, became Spanish trading posts but are now extinct. The present Spanish Fort location was later called Burlington.

Henderson (61) prepared a map of this area (Figure 3A) showing the location of the villages. A field of wheat growing in this area in 1978 is shown in Figure 3B. Anglo-American settlers of Montague in 1858 found remnants of the old fort and named it "Old Spanish Fort." A historical plaque now marks the site (Figure 3C). In 1834, U.S. army troops, the Dragoons, visited the fort. With them was an artist, George Catlin, who painted the village of the Taovayos (Figure 3D), occupied by Osage Indians in 1834.

Northern Areas

Wheat was first grown in northeastern America at Plymouth in 1602, according to Carrier (27). Farmers in Pennsylvania began growing wheat about 1643, and it soon became their leading crop. Wheat was sown at Jamestown, Virginia, in 1611. As most Europeans preferred wheat bread, the crop moved westward as the country was settled and soon became the major food grain. Immigrants to Texas from the midwestern, northeastern, and southeastern states, carrying crop seeds of all kinds with them, were undoubtedly the sources of the first wheat production in Texas as described in the following sections.

WHEAT DURING THE TEXAS COLONIAL PERIOD

The El Paso Area

Although the El Paso area does not at present grow much wheat, this and adjoining areas of Mexico were important producers of wheat in earlier days. In 1858 the population of El Paso was 300 and the area now comprising the main business district was filled with fields of wheat, corn, and vegetables (White, 23). Linn (73), Reid (95), and Cox (40), each on trips to California about 1850, commented on the excellent wheat grown at El Paso. Bell (15) in 1854 observed that "Wheat yields a good crop and mills make as fine a flour as could be desired."

Taylor (108), who went by horseback from San Antonio to El Paso and on to California in 1876, observed wheat as one of the principal crops in the river valleys of the Guadalupe, San Marcos, Llano, San Saba, and Colorado. He states "Though cotton, corn, wheat, oats, and barley are grown here, wheat is the favorite crop—but it is not profitable because we are too far from market. If we had a railroad to Houston and Galveston, they could become major shipping points for wheat and flour. They sow it in the fall and pasture their cattle and horses on it in the winter, thereby reducing the risk of frost. The harvest varies from 25 to

Figure 3A: Map of Old Spanish Fort area, north of Nocona, Texas, where the French built a fort, settled families and grew wheat 1719-58. (Courtesy I.P.T.A. Printers Inc.)

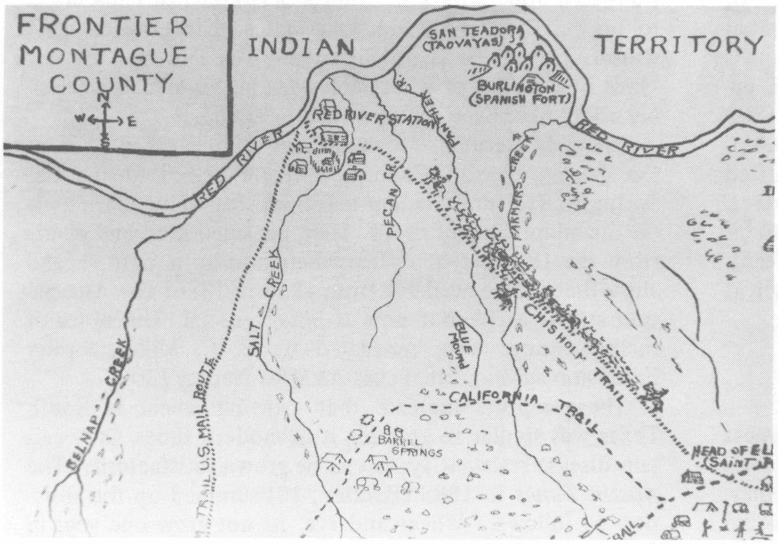
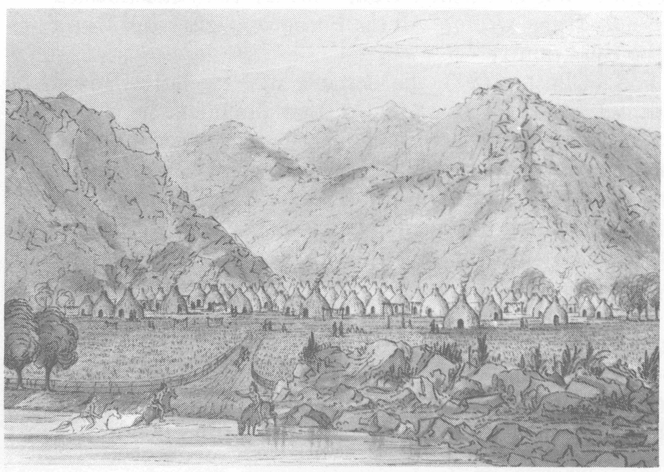


Figure 3B: State historical marker at Old Spanish Fort, north of Nocona, Texas.

Figure 3C: A field of wheat in the Old Spanish Fort area where wheat was probably grown by the French and Indians between 1719 and 1758.

Figure 3D: A Taovayo or Caddo Indian village of straw huts as seen by Catlin at Old Spanish Fort in 1834. (Painting by Geoge Catlin; courtesy The Dover Publications, New York.)



40 bushels per acre. Fredericksburg has three flour mills with a joint capacity of 300 barrels per day."

Of Fort Stockton he reports, "There is an irrigated valley of 3000 acres near here where a farmer grows wheat, barley, and corn." Of Fort Davis, he says, "There is a flour mill here and considerable quantities of very fine wheat are raised in the Toyah valley a few miles north." Farther west at El Paso, he reports (1876) "Here are great crops of wheat, barley, corn, grapes, and vegetables, all irrigated from the Rio Grande."

Apparently wheat production in the El Paso area declined after 1850; the U.S. Agricultural Census of 1860 (118) shows only 16,889 bushels and in 1900 only 3,460 bushels. After 1900, crops grown on irrigated land shifted to alfalfa, cotton, and vegetables. Very recently, however, there has been renewed interest in growing wheat in far West Texas—the 1975 agricultural census in the Trans-Pecos crop reporting district shows 30,000 acres of wheat (115).

South Central Texas

Settlement of South and East Texas began in earnest about 1820, although Nacogdoches, San Antonio, Goliad, and a few other places date their establishment still earlier. Settlements were frequently made by ethnic groups—the Germans in the Hill Country, the immigrants from Alsace-Loraine at Castorville, the Irish at Refugio, the Polish at Pana Maria, and the Czechs in Fayette County. At about the same time, AngloAmericans and others were coming overland into East and Northeast Texas.

Wheat as a crop was apparently rather slow in becoming established in these areas. Mary Austin Holley, sister of Moses Austin, traveled in Texas in 1833. She wrote (65), "Experiments have been made in growing wheat, oats, barley, rye, and flax and they have succeeded in the undulating country back from the Coast." She also advised all immigrants to bring all types of seed, especially grains and grasses.

Muir (81), traveling through South Texas in 1837, wrote, "Corn is the only breadstuff here. Wheat of the States will not answer in so warm a climate." Walker (119) quotes Mrs. Collin, a pioneer of Cameron, "In 1846, corn and cotton are the only crops here. Flour costs as much as $100 per barrel sometimes." On the other hand, Bracht (22), who was in business from 1845 to 1848 and traveled in South Texas, wrote, "All the European grain crops thrive in the Hill Country."

F. L. Olmsted (87), the designer of New York Central Park, visited Texas in 1848. At New Braunfels, he visited L. C. Ehrenberg, a German minister and trained botanist who ran a home for children whose parents had died on their way to Texas. Olmsted observed in Ehrenberg's garden, wheat from Europe, Algiers, Arabia, Egypt, and St. Helena. This might be called the first wheat variety test in Texas.

A few years later, a farmer at Fredericksburg grew 110 kinds of wheat obtained from the U.S. Patent Office. By 1860 farmers had changed from spring to winter wheats because the spring wheats headed too early and were damaged by frost (Jordan, 70). While on a trip to California in 1849, Cox (40) passed La Grange and remarked that "Wheat was observed in their fields and this speaks well for the soil."

Farm and Ranch magazine, April 1890, quoted a correspondent, "In 1844, my brother Rufus sent abroad for two bushels of seed wheat. From this he grew the finest crop of wheat ever grown in Lavaca County." Baker (10) translated four letters of John Moczigemba of Pana Maria to his relatives in Poland. One states, "Here we have no winter. The wheat is not like ours, it is Turkish." As few kinds or varieties of wheat will grow in this area, this possibly could have been durum wheat or emmer.

An early German settlement was established in 1835 at Cat Spring, Austin County. Farmers organized the Cat Spring Agricultural Society in1856 to conduct experiments on the adaptation of crops. They obtained seed and plants from the U.S. Patent Office, their homes in Europe, and any other source available from 1856 to 1886. The Association still is active but now is largely social. The notes of their meetings were translated by E. C. Miller, former Extension agronomist, Texas A&M University (30).

These reports indicate that growing wheat in South Texas was similar to growing it in modern times. Only certain disease resistant types can be grown satisfactorily. The *Austin Times* in 1883 (Barkley, 12) summed up the situation as follows, "Wheat and rye do not grow one year in five in the Milheim-Cat Spring area but oats do well." Batte (14) stated that 535 bushels of wheat were grown in Milam County in 1850, but the 1859 census showed no wheat grown.

Central Texas

The fort built by the French near Texarkana in 1719 did not survive (McConnell, 76). Permanent settlement in this area started between 1820 and 1830. James Clark settled four families on the Red River, above present-day Clarksville, in 1819 (Clark, 36). They put the first land into cultivation about 1830, growing cotton, corn, and wheat. Wheat production expanded rapidly after 1840, and by 1860 Lamar County produced 149,000 bushels of wheat.

A trading post was established at Preston Bend, north of Sherman, in 1833; a few settlers reached Greenville in 1839; John Neely Bryan settled on the Trinity at the location which became Dallas in 1841; the Peters Colony came to McKinney in 1843; and Denton County was established in 1846 (Richardson, 98). The Socialist French colony of La Reunion settled on the south bank of the Trinity, near present Dallas downtown skyscrapers, in 1852. According to Hammond (56), "Their fields ripened abundant crops of wheat and corn."

The rapid settlement of this area is shown by fact that 10 years after Denton was established, there were 600 registered voters. Parker County was organized in 1856, and by 1860 had 6,000 residents (Holden, 64). He quotes the *Clarksville Northern Standard* that from 1850 to 1860 frequently there were 50 settler's wagons passing through Clarksville per day. It is estimated that 400,000 people immigrated to Texas in 1876. Undoubtedly most settlers brought crop seeds, including wheat.

An important factor in the expansion of wheat acreage from 1850 to 1900 was the developments in planting, harvesting, and threshing equipment. Brown (23) believes the first wheat grown in Dallas County was that grown by William C. Cochran in 1845. George Jackson (68), who moved with his family to Farmers Branch (Dallas County) in 1849, describes wheat growing as follows, "We grew three acres the first year, harvested it with a cradle and threshed it with a flail." A cradle is shown in Figure 4A.

Wheat growing in Denton County is described by Rogers (99) as follows, "My family moved to Denton County in 1850, when I was 16 years old. My father seeded wheat by scattering it by hand, plowing it in, cutting the grain with a cradle, shocking the bundles, then cleared a place on the ground and used horses to tramp out the grain."

Cyrus Hall McCormick invented the first reaper in 1831 (77), and soon it and machines designed by others were available to growers. An early, mower-type, horse-drawn grain harvester advertised in the 1858 *American Agriculturalist* (1) is shown in Figure 4B. These machines were rapidly improved and soon bound as well as cut the sheaf. Harvesting with the horse-drawn, self-binder in Denton County in 1896 is shown in Figure 4C.

The flail (Figure 5A) had been used for threshing grain for centuries. The next stage in development of grain threshing was the use of horses or other livestock to tramp out the grain from the sheaf. It was a common practice during the American colonial period. Smithwick (104), an early settler of the Hill Country, traveled to California in 1861. He wrote, "All along the Rio Grande there were little Mexican pueblos. It was the time for harvest and in each village there was a threshing floor. The straw was arranged around a pole. A band of horses were driven into the enclosure and around the center pole at a gallop. The horsemen formed a ring around them to keep them from breaking away. The stack was thus trampled down, the straw shaken out and the grain cleaned." (Figure 5B). Figure 5B is a copy of a famous painting by O. E. Berninghaus entitled "Threshing at the Taos Indian Pueblo," depicting this method of threshing about 1850.

The threshing machine was invented about 1850, and improvements followed rapidly. Figure 5C shows an early thresher in which a team of horses provide the power by means of a treadmill. Later, steam-powered engines were developed for driving threshers and pulling plows. The first wheat was grown in Dallas County in 1845, and by 1856 the county had 40 Emory threshing machines (Richardson, 98). In 1887, 1,300 binders were sold in Dallas County (*Farm and Ranch,* 51). Figure 5D shows a large custom threshing crew in operation near Canyon in 1922.

Planting operations also were crude during the colonial period. Bowyer (21) quotes from the diary of Elder Horn, whose family moved to McKinney in 1846, "My gang plow is answering a first rate service as I shall have no trouble in plowing in my small grain." However by 1880, farmers were planting wheat with a drilling machine from Michigan which could plant 8 acres per day (Richardson, 98).

All these improvements in machinery furthered the expansion of wheat acreage so that the production in Texas increased from 41,729 in 1850 to 2,500,000 bushels in 1880. The Texas Almanac (110) records that Denton and Wilbarger Counties each produced 2 million bushels in 1904.

Farther south in Central Texas, settlement and crop production also were rapidly expanding (Tyler, 116). The Tennessee Colony settled at Nashville, below Waco on the Brazos, in 1834. Waco was established in 1851, Salado in 1851, Lampassas in 1848, and wheat was grown in McClennan County in 1850. Wheat, rye, and barley were grown for home consumption until about 1870, when these became commercial crops as well. Many water mills for grinding the grain were constructed along the Balcones Fault line between the Blackland area and the Edwards Plateau.

The Rolling Plains

Wheat and other crops became established in the Rolling Plains approximately 20 years later than in Central Texas. Some settlement of the area started about 1850, but the combined effects of the Civil War and Indian depredations caused considerable retrenchment from 1860 to 1870. The line of settlement in 1860 was from Montague County southwest through Fort Griffin to Kerrville. The population of the Rolling Plains was less in 1870 than in 1860, but resettlement started again in 1867 (Holden, 64).

The settled area in 1876 was 50 miles west of that in 1870. Along the railroads, it extended in some places as much as 150 miles farther west. An estimated 400,000 settlers came into Texas during this period, and the population increased from 4,142 in 1850 to 755,260 in 1900. In one year, June 1876 to June 1877, an estimated 5 million acres of land were homesteaded in this area.

Farm groups, real estate agencies, chambers of commerce, railroads, and the large centers of population promoted settlement of the Rolling Plains through circulars, advertisements in eastern news media, and promotion folders prepared by immigration groups. The Dallas Fair was established in 1886 and the Fort Worth Spring Palace in 1889 to display the products grown in Texas. Railroads established demonstration fields along the right-of-way where crops and vegetables were grown for display. Special round-trip fares, as low as $25 from Chicago, were offered.

This expansion was an outgrowth of some of the first farming in the Rolling Plains, which was done by the Indians. In 1854, Major Robert S. Neighbors, U.S. Indian Agent for Texas, convinced the Texas Legislature to set aside 12 leagues of land for an Indian reservation (86). This area of 37,000 acres was located on the Salt Fork of the Brazos River just south of Graham, Young County. Some of the semi-agrarian Indians from East Texas were moved there in 1856. They had always grown corn for food; however, this climate was not well adapted to growing corn so Neighbors introduced wheat. Wheat proved to be a well-adapted crop and soon was accepted by the Indians, and in 1859 they grew 1,560 bushels, probably the first wheat in the Rolling Plains.

Approximately 1,000 acres of sod on 12 farms were broken out in Brown County in 1870 (Harris, 59). The Donnell Brothers moved to Young County in 1876 to begin ranching, but in 1877 they built a flour mill on Clear Creek (Crouch, 42), even though there were only a few fields of wheat nearby. Farther west in Coleman (Bruce, 24), a Mr.

Figure 4A: Hand-operated cradle for harvesting grain. Introduced to America about 1776 and the common instrument of grain harvesting until 1840. (Courtesy International Harvester Co.)

Figure 4B: Horse-drawn mechanical harvester of the 1[illegible] period. (Courtesy *American Agriculturalist* magazine.)

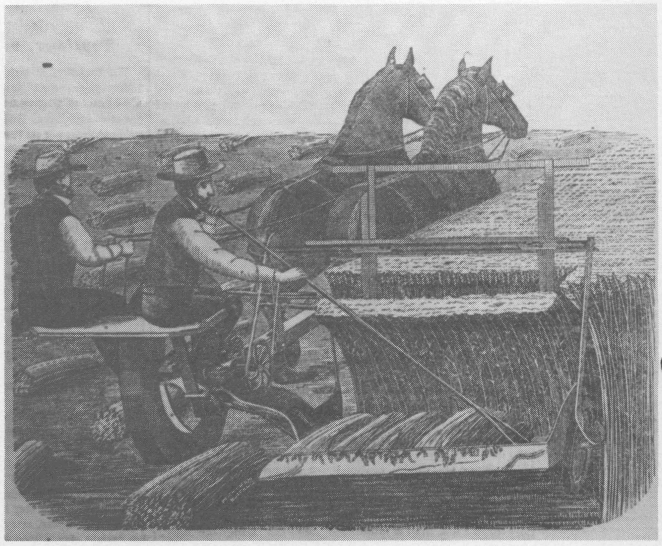


Figure 4C: Harvesting with horse-drawn binders about 1900. (Courtesy Texas & Pacific Railroad.)

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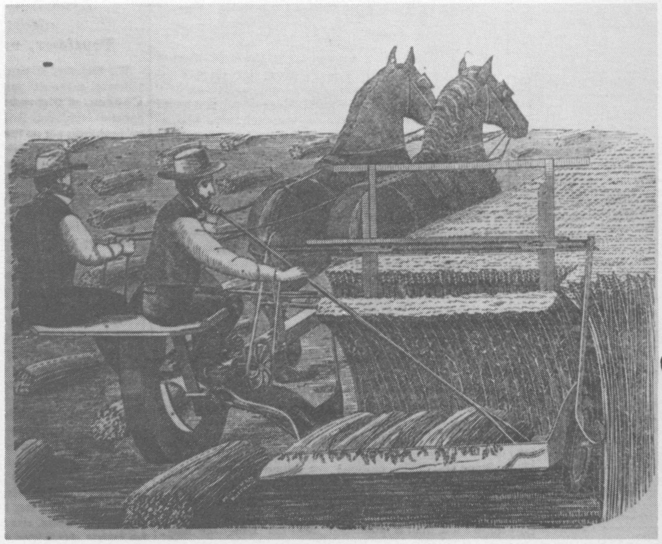

Figure 4C: Harvesting with horse-drawn binders about 1900. (Courtesy Texas & Pacific Railroad.)

Cheatham grew wheat in 1874, bought the first thresher in the area, and built a flour mill. He put flour in bright red and blue cotton sacks printed with Cheatham's Best XXXX flour. Before this, flour was usually packed in barrels.

The first wheat was grown in Wilbarger County in 1890, but the crop failed in 1892 and 1893. However, it was soon re-established, and by 1904, the County grew 2 million bushels of wheat (Collins, 37). Wheat as a cash grain crop is still important in the Rolling Plains. In 1977, the Waggoner Ranch at Vernon continues, as it has for many years, to grow wheat on a 14,000-acre field along the Wichita River south of Vernon.

Hardeman County produced four carloads of wheat in 1888, and after a bumper crop in 1891, immense areas of prairie land were plowed out. Soon hundreds of carloads of wheat were produced each year. As late as 1895, wheat land was advertised at $10 per acre in the Wichita Falls area (Neal, 85). The *Farm and Ranch* Magazine of January 1894 (51) reported that a Mr. Specht of Iowa Park had grown wheat for 25 years, never producing less than 25 bushels per acre.

Farming started in the Abilene area in the 1880's, but many farms were abandoned during the 23-month drouth of 1886-87 (Duff, 48). The first carload of wheat was shipped from Shackelford County in 1883. Near Baird, Callaham County, the Texas and Pacific Railroad established an experimental or demonstration farm where grains, cotton, vegetables, and fruit were grown to impress settlers (Blackburn, 17). Farther west at Stanton, Martin County, a smiliar demonstration farm was established (Hutto, 66). German settlers were brought in to establish the new town of Mariensfield, which later became Stanton. They grew wheat, cotton, barley, rye, oats, and sorghums for feed. Wheat averaged 39 bushels per acre in 1884, and samples were sent to the World Fair at New Orleans, where one won a gold medal.

Baker (9) says that farther west, in Hall County, the first wheat was grown in 1891, but Mrs. Taylor[1] states that 10 acres of wheat were grown at Childress in 1887. A colony of German families settled in Baylor County in 1878. These were from Indiana and were reported to have paid $1.50 per acre for 400,000 acres of land. Another group, from Pennsylvania, homesteaded on 54,400 acres in Throckmorton County in 1878 and established the town of Williamsburg. Wheat immediately became a major crop in these counties (Holden, 64).

The High Plains

Some settlers went to the High Plains before 1890 but generally that was the era of the big cattle ranches. Most settlement occurred from 1890 to 1920, some 20 years later than the Rolling Plains settlement. In 1880 only 648 acres were classified as tilled land, but by 1900 there were 3,059 farms with 244,628 acres of tilled land (Nall, 82).

Early explorers expressed unfavorable evaluations of the High Plains area. Major Stephen H. Long led a military expedition into the Canadian River area in 1820. Nall (82) quotes from Long's military records, "In regard to this section of the country, I do not hesitate to say that it is wholly unfit for cultivation." Marcy, who explored the area in 1849 said, "The Llano Estacado is a desolate waste of uninhabited solitude which always has been and must remain uninhabited forever" (76). Even after experimenting with crops from 1906 to 1919 at the U.S. Department of Agriculture Experiment Station at Amarillo, (Ross, 101) expressed the opinion that the area should remain largely in grass and large ranches.

The first towns established in the High Plains area were Mobetee in 1875, Old Tascosa in 1876, and Old Clarendon in 1878. Spikes (106) believes that the first land cultivated on the High Plains was at the Quaker settlement of Estacado in Crosby County in 1879. This settlement did not survive, but a 20-acre field was broken out of sod and feed grains and vegetables grown. Later, in 1912, large acreages were put under cultivation at this location by the C. B. Livestock Company.

Apparently wheat was seeded at several locations between 1885 and 1900, and it is difficult to determine which was the first planting. The XIT ranch[2] grew oats in 1887 and 1888, but wheat is not mentioned until 1889 when it was planted at three units of the ranch. Wheat, oats, and barley were seeded for several years, but yields were low and there were many failures. The Tasocosa *Pioneer,* first newspaper in the High Plains, stated in 1888 that "Colonel Goodnight has planted 100 acres of wheat, the first ever sown here" (Archambeau, 2). Both Phillips[3] and Nall (82) credit G. T. Oliver of Washburn and W. W. Ferguson of Silverton with growing wheat the same year.

The records of the XIT ranch (123) report that a 335-acre field of Little Red May wheat variety was grown at White Deer in 1892. It averaged 18 bushels per acre, and the entire lot of 6,096 bushels was hauled to Wichita Falls by wagons. Wheat was grown in 1892 in Hale County, also, although the County was organized in 1876, and the first settler came in 1882. However, no wheat was shipped from Plainview until the railroad reached there in 1907 (Cox, 41), but in 1919 Hale County produced 2.5 million bushels of wheat.

Wheat acreage expanded rapidly in the High Plains area after 1980. Lipscomb County commissioners purchased a carload of seed wheat and distributed it to growers in 1890. George Tyng, manager of the White Deer Land Company, Gray County, experimented with wheat from 1892 to 1894, growing it beside the railroad to demonstrate its culture to prospective land buyers (Nall, 84). Acker[4] reports that L. A. Pierce grew the first wheat in his community, 22 miles southwest of Amarillo, in 1898. A neighbor, a Mr. Reece bought the first binder in 1898 and J. C. Womble

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1 *Personal interview of Mrs. Joe Taylor with G. L. Browning. Panhandle Plains Historical Museum, Canyon, Texas.*

2 *XIT ranch records in the Archives of the Panhandle Plains Museum, Canyon, Texas.*

3 *Phillips, Francis. The development of agriculture in the Panhandle-Plains of Texas to 1920. MS. Thesis, West Texas State Teachers College, Canyon, Texas, 1946.*

4 *Archie Acker file. Interviews with L. A. Pierce. Panhandle-Plains Memorial Museum, Canyon, Texas.*

Figure 5A: Flailing wheat as portrayed by F. R. Petrie. (Courtesy Texas Memorial Museum, Austin, Texas.)

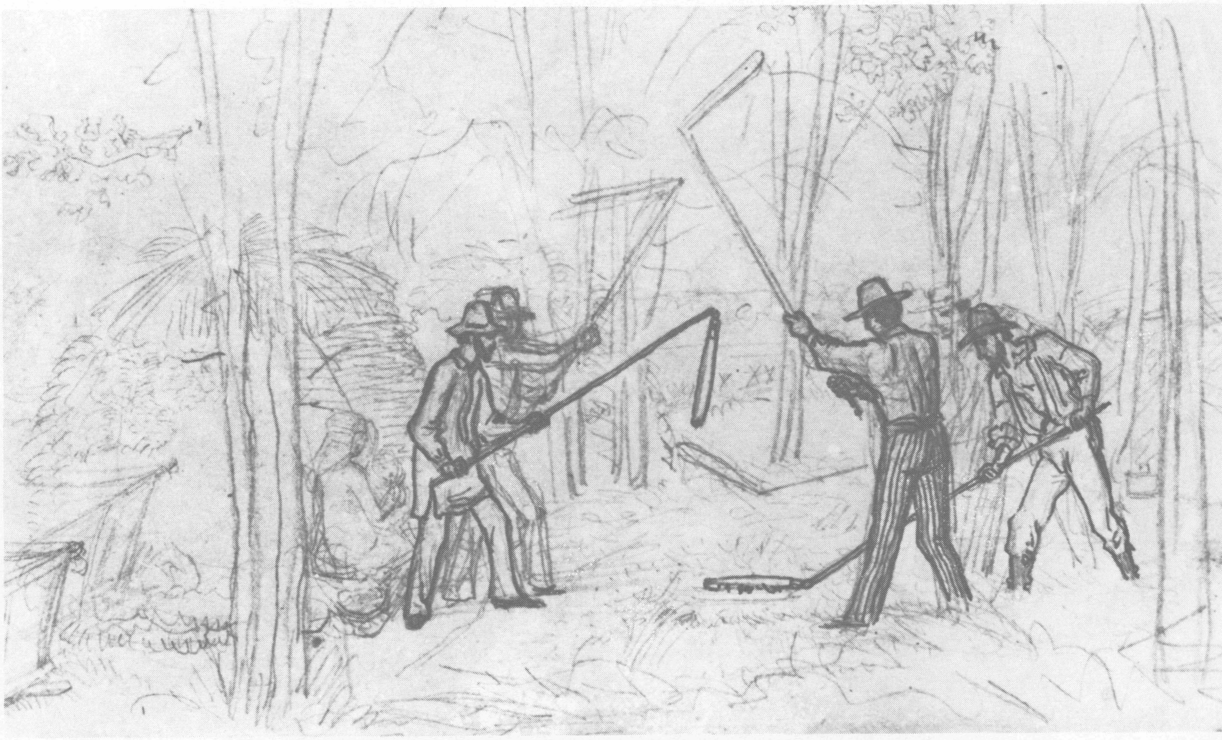


Figure 5D: A custom threshing crew at Canyon, Texas, about 1920. (Courtesy Panhandle Plains Museum, Canyon, Texas.)

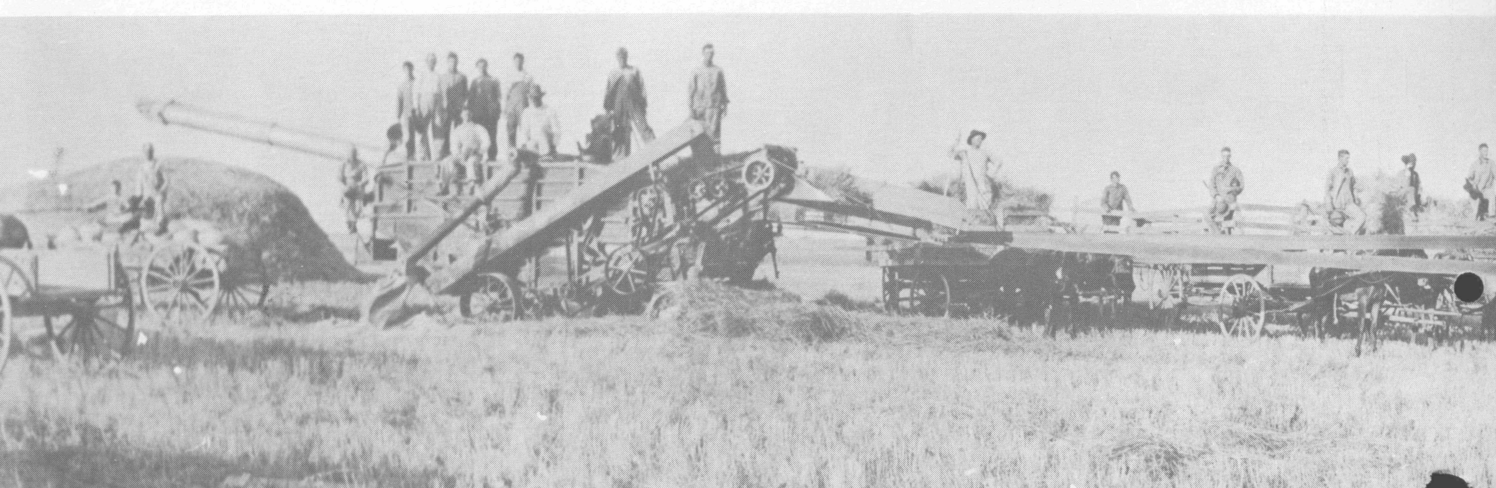


Figure 5B: Threshing time at Taos pueblos. A painting showing a pattern of threshing in Spanish countries for hundreds of years. Painting by Berninghaus. (Courtesy Woolaroc Museum, The Frank Phillips Foundation, Bartlesville, Oklahoma.)

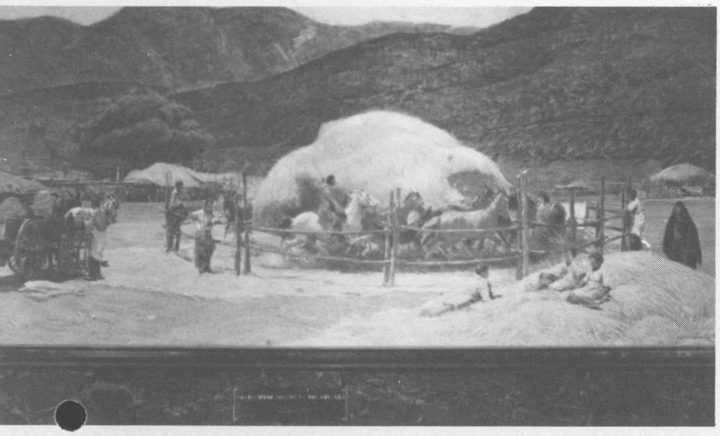
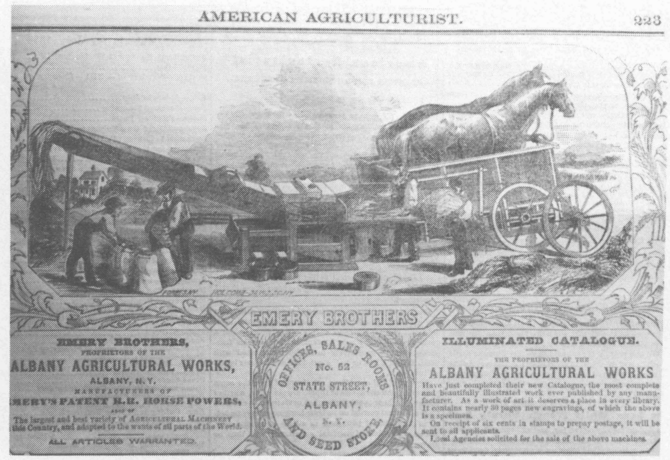
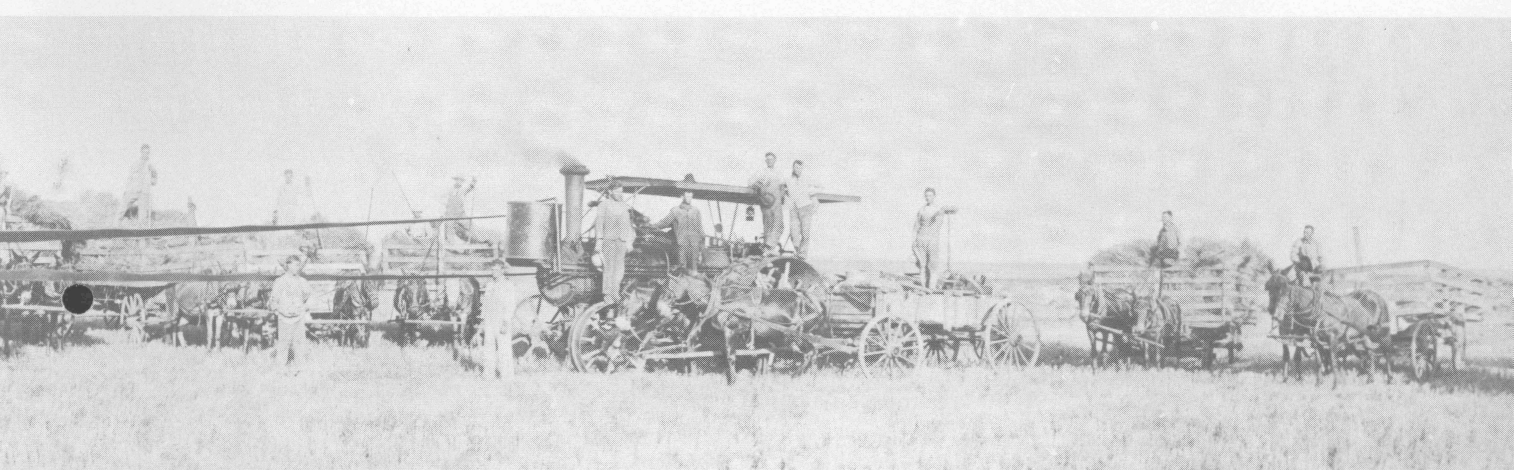


Figure 5C: An early horse-powered, treadmill thresher of 1850 vintage. (Courtesy *American Agriculturalist* magazine.)





bought the first "ground hog" thresher in 1903. The first rail car of wheat was shipped from Canyon in 1905. J. N. Askren grew 100 acres of dryland wheat at Hereford in 1903. On the North Plains, Cas Thompson and M. D. Minor grew the first wheat in Moore County in 1903. Hansford County held its first County Fair in 1907. O. P. Beagle and Sam Brillhart grew the first wheat in Ochiltree County in 1903, but the first commercial crop of wheat was hauled to Liberal, Kansas in 1912 (Nall, 84).

As was true some 20 years earlier in the Rolling Plains area, the High Plains area was subject to high pressure land promotion from 1900 to 1920. Real estate companies, large ranch organizations, railroads, and chambers of commerce for many counties and cities used news stories, advertising leaflets, and commercial advertising to attract settlers and sell land. The railroads continued to run special trains with lowered fares to encourage groups and individuals to inspect the land, which to Eastern buyers, seemed very cheap. Many of the big ranches were broken up into smaller units at this time; railroads had land for sale, and State land was available in several ways. Undeveloped land sold for $1 to $5 per acre and partially developed land from $5 to $15 per acre.

Earth Magazine (50) estimated that 2,500 families passed through Amarillo during 1907 on their way to settle in the High Plains area. William P. Soash, a promoter from Waterloo, Iowa, organized and conducted 87 special trains to Texas from 1905 to 1908. Each train carried 75 to 150 prospective land buyers, who were charged only $25 round-trip rates from Chicago (Nall, 82).

Another development which stimulated the growing of wheat on the High Plains was the introduction of Turkey wheat from Russia by Mennonite settlers of Kansas. This new hard red winter wheat, brought to Kansas in 1874, was more cold tolerant and drouth resistant than the soft red winter varieties grown previously. Coinciding with the introduction of hard red winter wheat was the development of the steel, roller-type, grinding wheels, which could grind the harder textured wheats. Railroads assisted in promoting the new type of wheat because it meant new business for them. The Santa Fe Railroad brought in and distributed 15,500 bushels of Turkey seed wheat to Texas growers in 1912. The Santa Fe also distributed Turkey seed wheat to settlers in Ochiltree, Hansford, and Lipscomb Counties in 1917.

For centuries wheat was threshed by hand or with the flail (Figure 5A). Later horses or other animals were used to tramp out the grain (Figure 5B). Farm machinery developed rapidly from 1850 to 1930. From the small threshers shown in Figure 5C, large custom machines driven by steam or oil were developed about 1900 (Figure 5D). The header, which cut off only the upper part of the plant and delivered it to a barge is shown in Figure 6A. From the header barge, the crop was threshed on a custom thresher (Figure 6B). Breaking the sod in Crosby County in 1912 with horse-drawn plows is shown in Figure 6C. Soon larger plows and gang plows were designed for use with the large tractors then becoming available (Figure 6D).

Combines were developed first in the Pacific Northwest but began influencing wheat cultures in the High Plains about 1922. Nall (83) states that 2,682 combines were shipped into the High Plains in 1927. It was estimated that use of these machines reduced the amount of labor for production of wheat from 4.6 man-hours to 0.75 hour per acre. *Earth Magazine* of April 1928 (50) shows photographs of solid-trainloads of new combines coming into the Great Plains from Western Harvester Co., International-Harvester Co., Nicholos-Shepherd Co., and John Deere Co. (Figure 7A).

World War I exerted a major influence on the increase of wheat acreage in the High Plains. The price of wheat went from 90 cents per bushel in 1914 to $2.71 during the war. When the United States entered the war, the government guaranteed a price of $2 per bushel, and appeals to grow wheat were published by state and federal agencies (Figure 7B) (Nall, 84).

As the railroads had effectively compaigned to bring settlers to the area, they then attempted to establish permanent agriculture. All employed agricultural agents, established farm magazines or information folders; several established demonstration farms along their lines where the growing crops could be shown to visitors. The Santa Fe ran special wheat trains throughout the Great Plains. Figure 7C shows an announcement of such a demonstration train.

Several large-scale farm operators of the High Plains area influenced wheat production in that region. Hardy Campbell of Lincoln, Nebraska, known as an expert on dry-farming methods, established demonstration farms at Bovina and Farwell where he attempted to show farmers his methods of moisture conservation. The methods included cultivation of the fields with a special Campbell subsoiler and packer which was supposed to prevent moisture loss from the surface. A number of growers followed his plan for some years. However, he operated these farms only in 1905 and 1906, then left. Later, Campbell was employed by the city of Midland to establish an experimental farm and demonstrate crops that could be grown in that area. This enterprise also was a failure (Nall, 84).

Hickman Price, an executive of Fox Movie News, leased 30,000 acres in Swisher, Castro, and Deaf Smith Counties in 1928 for large-scale wheat production. By attaching large gangs of plows and tillers to six tractors, he could plow 320 acres per day (Figure 6D). He purchased six large combines to harvest the large acreages. The drouths of the 1930's, plus the depressed price of wheat, caused his operation to fail and disband (Nall, 84).

The operations of Charles William Post also influenced the establishment of crops on the High Plains. Eaves (49) describes Post's dream city in Garza County where he purchased 250,000 acres of land, established the town of Post, built residences and business facilities, and established farms and irrigation systems. An experimental farm of 160 acres was established where wheat and other grain crops, fruits, and vegetables were tested from 1908 to 1926.

Prices of wheat were lower after World War I, dropping to $1.09 in 1921 and continuing at a lower level. Drouth was severe in some areas in certain years, yet the High Plains continued crop expansion throughout the 1920's. Wheat acreage reached 3,381,000 by 1930 (Bonnen, 20). Ochiltree and Hansford Counties each grew 4 million bushels of wheat in 1929. During the 1930's, the wheat acreage

Figure 6A: Harvesting wheat with a header near Plainview, Texas, 1918. (Courtesy Leo Witkowski, Hereford, Texas.)

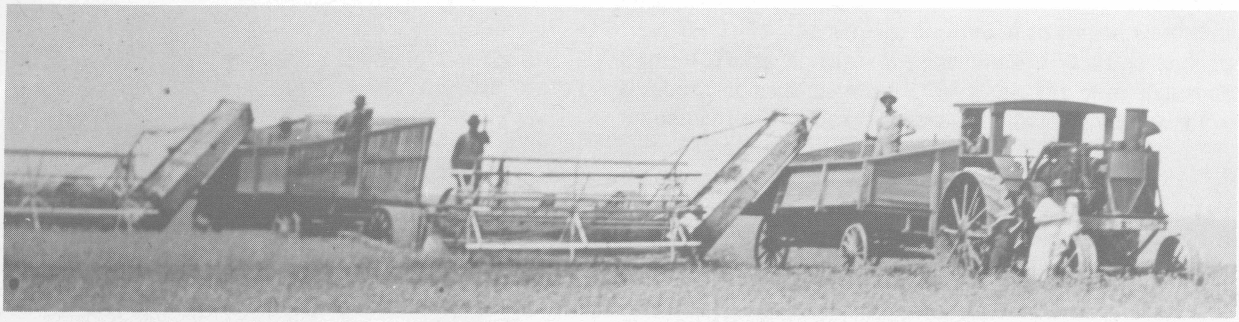


Figure 6B: Threshing header-cut wheat from a header barge, Plainview, Texas, 1918. (Courtesy Leo Witkowski, Hereford, Texas.)

Figure 6C: Breaking sod for seeding wheat at Crosbyton, Texas, in 1908. (Courtesy Spikes, 106.)

Figure 6D: Large-scale drill machine used on the Hickman Price farms, Tulia, Texas, 1928.

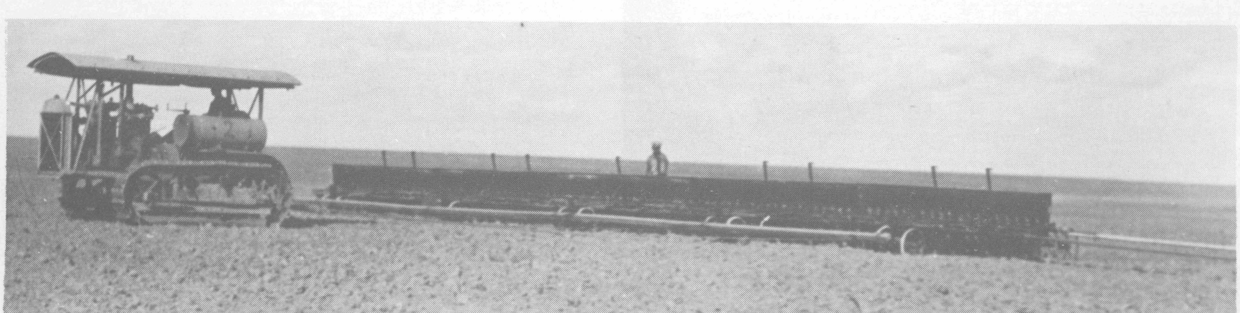


Figure 7A: Trainload of Holt combines delivered to Amarillo, Texas, in 1926. (Santa Fe Railway Photo.)

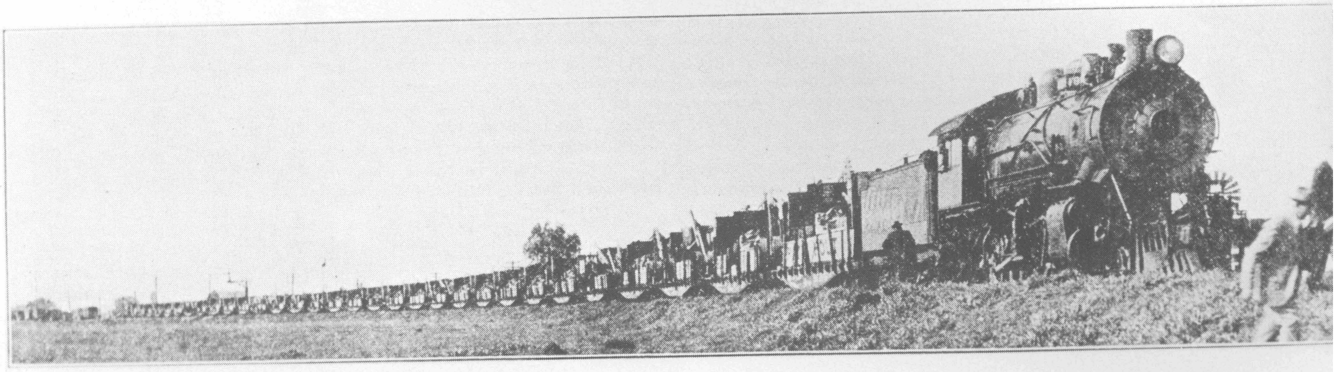


Figure 7B: Leaflet promoting wheat production for World War I food production. (Santa Fe Railway Photo.)

WHEAT
FOR PATRIOTISM
AND PROFIT

"Fifty Million Bushels of Wheat In 1918!"

This Must Be the Battle-Cry of Texas This Year

The United States is now at war with Germany—the greatest military power the world has ever known. If Germany succeeds in starving our two great allies, Great Britain and France, WHICH SHE IS NOW DOING, she will overrun and conquer the whole of Europe, and we ALONE will have to face Germany strengthened a hundredfold.

Guns and ammunition our allies have in plenty, and we shall soon be sending millions of our men to strengthen their fighting lines, but food they lack, and food they must have or their cause and our cause is lost.

Fifty million bushels is more than three times the 1917 indicated wheat yield of 14,700,000 bushels, but Texas can raise fifty million in 1918. TEXAS MUST RAISE FIFTY MILLION IN 1918.

"Give us Bread! Give us Bread!" our allies are calling to us today.

Shall we let them call in vain? France, who succorred us in our Revolution; England, whose fleet protected Admiral Dewey from these self same Germans at Manila Bay in 1898! Shall Texas be behindhand in this mighty struggle for civilization and the liberties of all mankind? NEVER! TEXAS WILL DO HER DUTY. FIFTY MILLION BUSHELS OF WHEAT IN 1918!

REMEMBER the rape of Belgium, the massacre of the Lusitania, the slaughter of innocent women and children in undefended towns, the murder of Edith Cavell, the revolting atrocities in northern France, the sinking of hospital ships, the horrible agonies by poison gas and liquid fire, the plotting against the integrity of our own country and the flagrant violations of every law of decency and civilization that has been going on for three years under the great German doctrine of "Might is Right!"

"Give us Bread! Give us Bread!" our allies are calling. For three years now, though unprepared at the beginning of the struggle, they have borne the brunt of the most barbarous attack of all time, planned and prepared for nearly half a century. For three years they have fought our fight, the fight of democracy and of the whole civilized world.

And now we are in the fight, as President Wilson says, "To make the world safe for democracy." What can Texas do best to help win the war? Heed the call of our allies, "Give us Bread! Give us Bread!" and answer it with

Fifty Million Bushels of Wheat In 1918!

WILL THERE BE A FAIR PROFIT IN WHEAT?

Wheat is almost certain to sell at very high prices for more than two years. Even at the low average production of 15 bushels per acre this means an excellent profit, and there is very little land in Texas now under cultivation that with favorable weather conditions could not raise 25 bushels of wheat per acre if properly planted.

THEREFORE, RAISE WHEAT FOR PATRIOTISM AND PROFIT!

Texas Industrial Congress, and
The Texas State Council of Defense
FRANK KELL, Chairman Food Supply and Conservation Committee.

Figure 7C: Leaflet announcing the Santa Fe Wheat Train. (Courtesy *Earth Magazine*.)

Santa Fe Better Wheat Special
In Texas, June 8-13, 1925

Under the Auspices of the Texas A. & M. College, the Southwestern Wheat Improvement Association and the Santa Fe Railway

Main Phases of the General Problem of Wheat Growing Discussed:

1—Relation of wheat to other crops and livestock.
2—Preparation of soil and rotation.
3—Pure seed.

Presented by A. H. Leidigh, Assistant Director, Experiment Station and J. R. Edmonds, District Agent, A. & M. College.

H. M. Bainer, Director, Southwestern Wheat Improvement Association.
J. D. Tinsley, General Agricultural Agent, Santa Fe Railway.

This synopsis of talks prepared by Mr. Bainer.

"SAFETY FIRST" WHEAT FARMING

The objects of the "Safety First" Wheat campaign are:

Not more acres to wheat but more wheat per acre.

Not to urge the growing of wheat alone but to combine wheat with feed crops and livestock.

Not to discuss the amount of rainfall or the high evaporation of the Plains but to suggest a system of farming that will collect and save the moisture that falls.

Not to outline a plan of farming for the good years alone, but one that will be suitable for the dry years, as well.

WHEAT FARMING AS RELATED TO OTHER CROPS AND LIVESTOCK

Diversified Farming. The farmer who rotates his wheat with feed crops, disposing of them through livestock, is establishing a safe system of farming.

To diversify, at least enough to produce one good cash crop like wheat and plenty of feed for livestock, will not only bring in good returns, but will help distribute labor and assist materially in keeping the land free from weeds, insects and plant diseases.

While wheat is the leading crop of much of the Panhandle, it is not as dependable or profitable when grown by itself as when it is included in a rotation with other crops.

Under limited rainfall conditions, no farmer can afford to depend on wheat alone or any other single crop; he must diversify and have more than one thing to sell.

in Texas remained at approximately 3.5 million acres, but yields in some years at some locations dropped to 2 to 5 bushels per acre. The drouth and dust storms of this era are well known. (See section on hazards, Figure 17C.)

Widespread use of the large combines stimulated the development of the smaller, tractor-drawn combine for use on smaller farms. The family-type farm combine was developed in the 1930's and rapidly replaced the binder and custom thresher in the more humid portions of the state. Many of these combines were designed to harvest not only small grains but soybeans, peas, sorghums, and even corn. They were suited to use either for direct combining or, with pick-up attachments, for threshing grain dried in windrows (Figures 8A and 8B).

During recent years, combine harvesting has become a commercial enterprise for a limited number of people. Large, self-propelled combines, often in crews of two to six or more, start seasonal operation in Texas in early May and move northward through the Great Plains as the wheat matures, to finish in late August in North Dakota or Canada. Some of these commercial crews then return to South Texas and move northward with the harvesting of the grain sorghum crop (Figure 8C).

So wheat became a major crop in Texas. Introduced by the Spaniards as early as 1582, it became an important crop along the Rio Grande until about 1850. With the settlement of North Central Texas about 1830, the crop rapidly spread over Central Texas and became one of the major crops of the area from 1850 to 1900.

As the Rolling Plains were settled from 1870 to 1900, wheat of soft red winter varieties was grown. Later the hard red winter varieties replaced the soft wheats in this area. Finally, the soft red winter varieties taken to the High Plains were replaced by the hard red winter or Turkey strains. After 1960, the hard red winter varieties spread into Central Texas. The story of introduction and spread of the wheat crop in Texas is illustrated in Figure 9.

ACREAGES AND DISTRIBUTION OF WHEAT IN TEXAS

The first official estimate of crop acreages in Texas was that of 1866 when 75,000 acres produced an estimated 750,000 bushels of wheat. Estimates have been made each season since 1866, and a 100-year summary was published by the Texas State Department of Agriculture in 1976 (114). A few private estimates were made prior to 1866. For example, a reader of the *American Agriculturalist* (1) reported that in 1848 Navarro and Limestone Counties produced 48,000 bushels of wheat. Stoltz (107) states that Kauffman County was the first center of wheat production in Texas but that growers later grew cotton instead of grain.

Wheat acreage increased to 300,000 acres by 1876 and to 1 million acres by 1899. By this time, a substantial acreage was being seeded in the Rolling Plains area. Figure 10A shows the distribution of wheat in 1879 and Figure 10B distribution in 1899. The acreage continued to shift westward as cotton acreage increased in Central Texas so that by 1909 there was a substantial acreage of wheat on the High Plains. By 1919, the three growing areas, i.e., North Central Texas, the Rolling Plains and the High Plains, each grew about equal acreages of wheat (Figure 10C). The acreage in Texas for the first time exceeded 2 million acres with 2,490,000 acres.

After 1919, the acreage continued to spread westward as Central Texas acreage became more diversified and grain sorghum acreage increased. By 1954, the High Plains grew 64 percent of the Texas acreage of wheat, the Rolling Plains area 24 percent, and Central Texas grew only 12 percent of the crop. This same pattern of distribution continued after 1954; however, there was some shift of acreage back into South Texas and the El Paso area. The development and distribution of Milam wheat in 1860 by the Texas Agricultural Experiment Station and the introduction from Mexico of semi-dwarf spring varieties caused a renewed interest in wheat in South Texas. The Mexican varieties are used for grain production, and Milam, Sturdy, and Coker 66 winter types for winter pasture and grain. The acreage increased from a few thousand acres grown before 1960 to 212,000 acres grown in 1975 (Figure 10D) (113).

Another change in Texas wheat culture after 1945 was the shift to irrigated production on the High Plains. From 39,000 acres in 1939, the irrigated acreage of wheat increased to 268,000 acres in 1948, 686,280 acres in 1959 and to 1,052,424 acres in 1968 (Atkins, 8). In 1975, the irrigated acreage of 1,430,000 yielded 37.3 bushels per acre. The average for non-irrigated acreage was 18.2 bushels. The total acreage was 6,500,000 acres, of which 5,700,000 acres were harvested.

Under Texas conditions the seeded and harvested acreages may differ considerably because of losses to drouth, diseases, insects, and winterkilling, and to grazing the crop to maturity. These differences are shown graphically in Figure 11. The record production of wheat in Texas was in 1975 when 131 million bushels were produced. The greatest acreage was seeded in 1947 when 7,585,000 acres were sown. Acreage and production data by 5-year averages from 1866 to 1975 are given in Table 1.

VARIETIES GROWN

Beyond the general classification of winter, spring, or durum types, very little was known about varieties of wheat until modern times. Ball (11) states that the common bread wheats were grown in northern Europe but that in southern Europe, the club and white wheats were more common. The wheat brought to the El Paso area by the Spaniards was probably club or common white but could have been durum. Hendry (62), from his study of seed in California Mission adobe bricks, identified the varieties Little Club, Sonora, and Propo. Clarke (34) states that these varieties had been grown by the Yuma and Pima Indians from earliest U. S. history.

Variety surveys of wheat grown on farms in the United States was started by the U. S. Department of Agricluture in 1919 (Clarke, 35) and have been conducted every 5 years since (117). (Data for Texas are given in Table 2, 1919-1944, and Table 3, 1949-1974, and shall be referred hereafter by the year surveyed.)

Wheats brought by the Spaniards from the wheat production areas along the Rio Grande to San Antonio and

Figure 8A: Windrowing grain in preparation for threshing from the windrow, Denton, Texas, 1946.

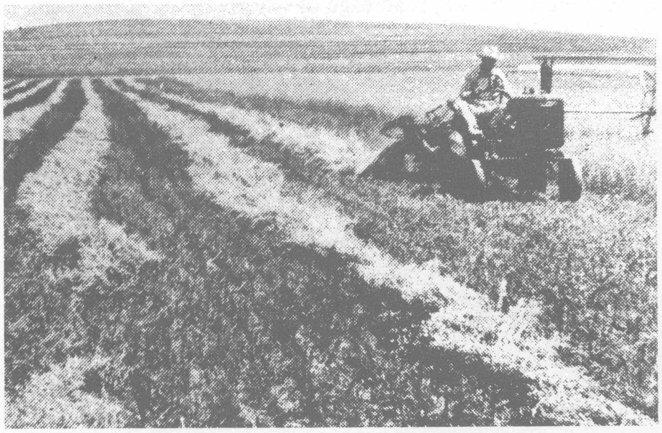


Figure 8B: Threshing grain from the windrow with a small single-farm combine, Denton, Texas, 1946.

Figure 8C: Commercial harvest brigade of large, self-propelled combines, Hereford, Texas, 1978. (Courtesy *Hereford Brand*.)

Figure 9. Paths of entry of wheat into Texas and date of entry.

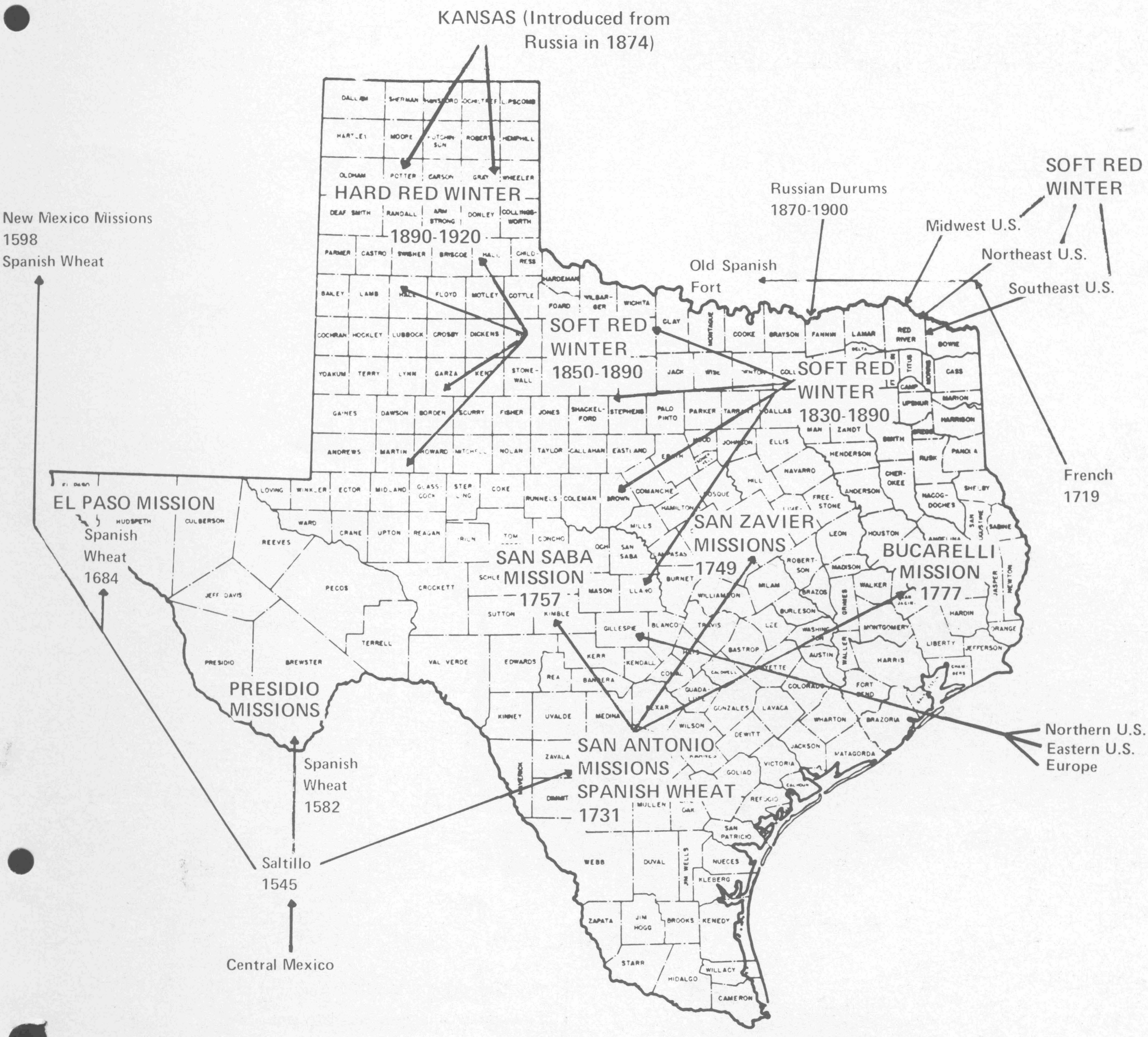


Figure 10A: Distribution of wheat in Texas in 1879. (Bonnen, 20.)

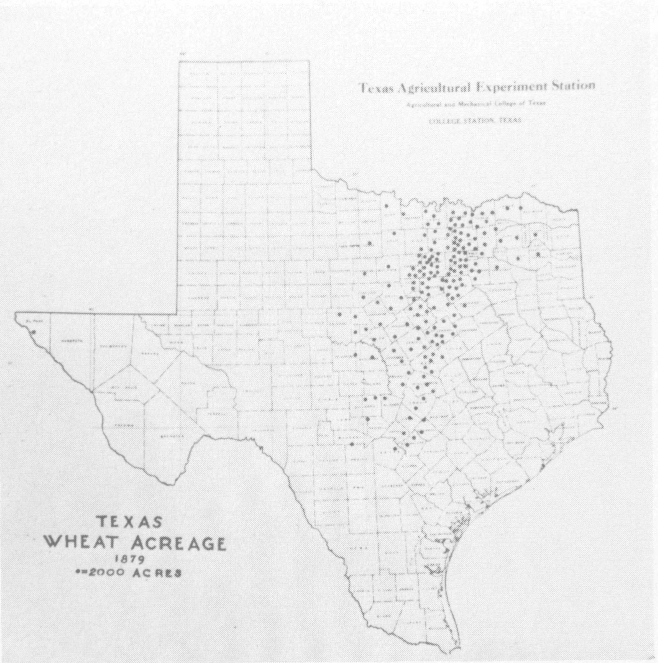


Figure 10B: Distribution of wheat in Texas in 1899. (Bonnen, 20.)

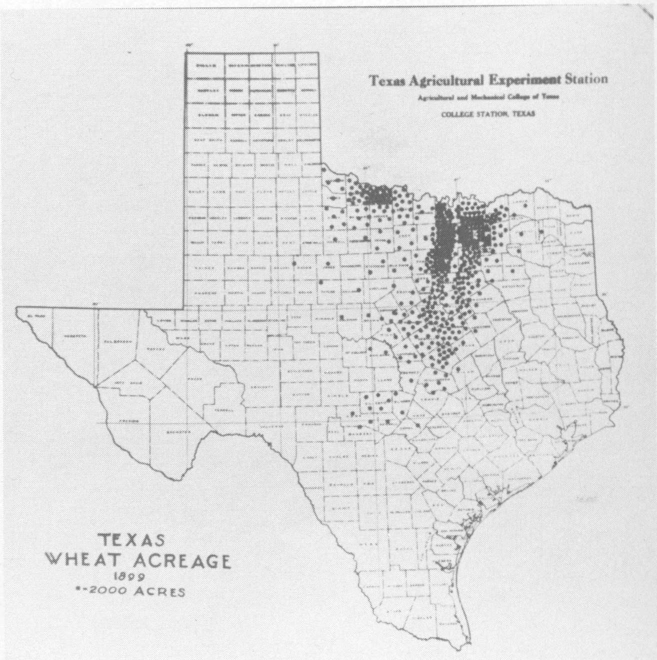


Figure 10C: Distribution of wheat in Texas in 1919. (Bonnen, 20.)

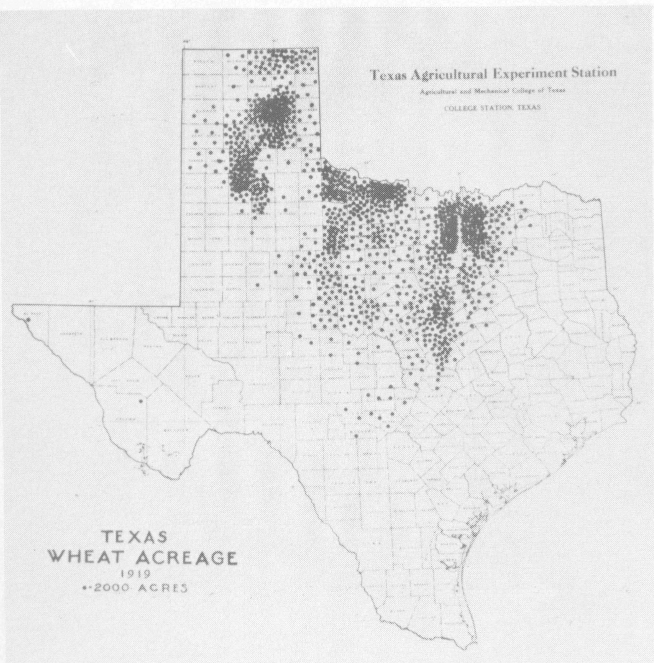


Figure 10D: Distribution of wheat in Texas in 1975. (Courtesy Texas State Department of Agriculture, 113.)

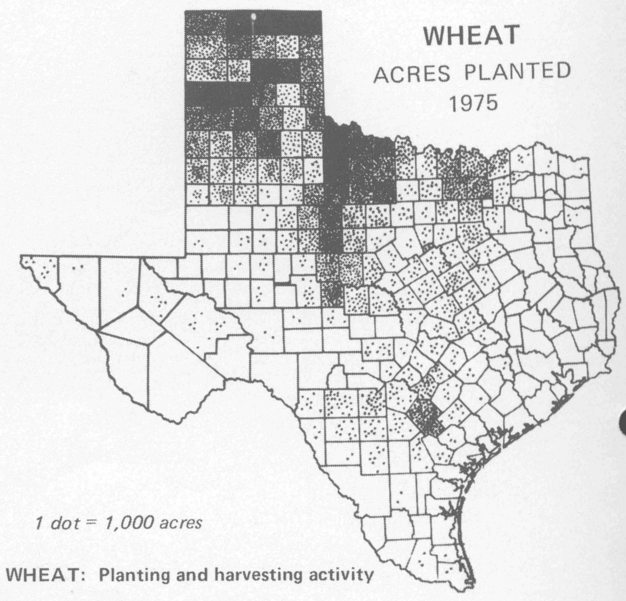


TABLE 1. WINTER WHEAT IN TEXAS ACREAGES–SEEDED AND HARVESTED, YIELD PER ACRE, PRODUCTION, AVERAGE PRICE, VALUE BY 5-YEAR PERIODS, 1866-1975*

Year	Seeded acreage	Harvested acreage	Yield per harvested acre	Production bushels	Average price per bushel	Value of crop
	Thousand acres	Thousand acres	Bushels	Thousands	Dollars	Thousand dollars
1866-1870	---	77	6.7	676	---	---
1871-1875	---	152	12.9	1,990	---	---
1876-1880	---	348	9.1	3,215	---	---
1881-1885	---	356	12.0	4,241	---	---
1886-1890	---	329	10.3	3,444	---	---
1891-1895	---	370	12.2	4,524	---	---
1896-1900	---	735	14.2	10,792	---	---
1901-1905	---	855	9.9	8,776	---	---
1906-1910	---	539	10.5	6,149	---	---
1911-1915	1,103	1,054	12.8	13,726	0.94	13,155
1916-1920	1,913	1,497	11.3	18,203	1.93	36,016
1921-1925	1,828	1,437	10.2	10,647	1.16	16,670
1926-1930	3,079	2,618	12.9	33,782	1.05	34,252
1931-1935	4,701	2,947	9.3	30,105	0.61	15,105
1936-1940	4,621	3,252	9.6	31,443	.79	24,361
1941-1945	4,638	3,944	13.1	51,132	1.24	65,354
1946-1950	6,773	5,544	11.8	69,562	1.95	136,989
1951-1955	5,024	2,500	9.9	25,117	2.13	53,670
1956-1960	3,817	2,894	17.5	52,632	1.83	94,823
1961-1965	4,041	3,119	19.9	63,065	1.73	106,432
1966-1970	4,483	3,103	21.7	66,656	1.39	92,225
1971-1975	4,852	3,179	22.2	71,583	2.64	210,181

*Data courtesy Crop and Livestock Reporting Service (114).

Figure 11. Texas Wheat Acreage. (Courtesy Texas State Department of Agriculture, 113).

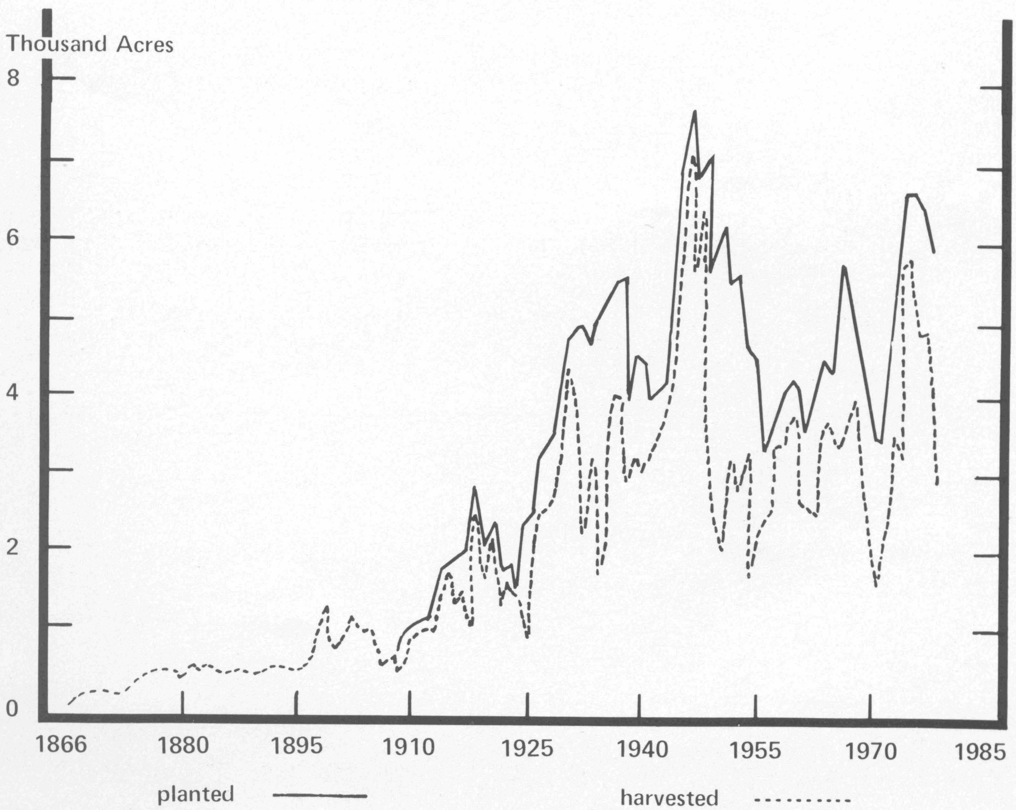


TABLE 2. ACREAGES OF WHEAT VARIETIES IN TEXAS, 1919-1944

Variety	Acreages 1919	1924	1929	1934	1939	[illegible]
Hard Red Winter						
Blackhull		397	391,869	936,846	1,597,707	1,007,214
Cheyenne					354	67,861
Chiefkan					15,066	254,041
Comanche						12,413
Early Blackhull					20,303	130,789
Kanred		411,803	588,300	659,854	235,328	308,934
Red Chief						49,507
Tenmarq				8,107	261,538	1,375,971
Triumph						221
Turkey	813,200	570,786	1,527,123	2,109,177	1,476,914	961,772
TOTALS	813,200	982,986	2,507,292	3,713,984	3,607,210	4,168,723
Soft Red Winter						
Austin						6,054
Currell		124	5,375	842		
Denton			14,948	48,596	33,648	24,456
Fulcaster	43,400	22,690	14,136	14,046	9,966	4,462
Fultz	22,200	2,688	2,909	2,078	7,259	358
Harvest Queen		271		148		
Jones Fife			429	1,282		
Mediterranean	1,331,900	195,050	293,353	217,058	211,504	198,598
Poole	300					
Purplestraw	4,200	120				
Red May	7,000	2,694	2,235	4,188	4,144	29,002
Russian Red	15,000		10,735			
Sonora	2,400	153	30			
TOTALS	1,426,400	223,790	342,721	285,402	266,067	262,930
Spring Type						
Baart	400	26				
Marquis	3,100	13,758	34,326	5,296	60	
Preston		2,696	7,006			
TOTALS	3,500	16,480	41,332	5,296	60	
Durums						
Arnautha	14,400	2,112	7,951	6,764	1,934	625
Kubanka	400	724		396	409	
Mindum				2,527	223	
Marouani		4,691				
All Others	26,000	18,255	41,781	19,121	24,322	17,350
TOTALS	40,800	21,091	49,732	28,808	27,582	17,975
Others-All Classes	117,479	62,742	28,454	46,987	17,593	
GRAND TOTAL	2,401,379	1,311,776	2,969,511	4,087,000	3,919,000	4,450,000
Percent -						
HRW	33.9	78.6	85.1	92.0	92.5	93.7
SRW	64.4	17.9	11.8	7.1	6.8	5.9
Spring		1.3	1.4	0.1		
Durum	1.7	2.1	1.7	0.7	0.7	0.4

other settlements. This may explain in part why wheat did not become established as a crop as these are neither disease resistant nor cold tolerant in South or Central Texas, although they probably grew well in the dry climate of El Paso. Sonora wheat was included in the Dallas Fair exhibits as late as 1896 (43), and the 1919 wheat survey recorded 2,400 acres of Sonora wheat grown in Texas. Several farm magazines mention California wheat, and in the 1867 *Texas Almanac* mentions that "California wheat is late and rusts badly" (110). Smithwick (104), on a trip to California in 1861, visited El Paso and reported that the Pima Indians "brought to our camp the whitest, cleanest wheat I have ever seen."

Sonnichen (105) records the occurrence of an unusual type of wheat observed by James O. Pattie, who visited El Paso in 1826. Mr. Pattie states, "I was struck by the beautiful vineyards and wheat fields. The wheat is of a kind I have never seen before as the stalks usually yield two heads each." Whether this was club or poulard-type under unusual conditions cannot now be determined.

Some of the problems farmers had in growing wheat in Central Texas (see page 6) probably resulted from use of varieties not adapted to the area. According to the *Austin American* of 1883, "wheat does not grow one year out of five" (Barkley, 12). The *Farm and Ranch* of July 1892 quotes H. B. Hillyer, "Wheat from the North and East will do fine for a few years but soon runs out. Growers have to resort to new varieties and import new seed."

What were the varieties available for immigrants to bring to Texas? Red Lamas, the prototype of Red May, was grown in England before 1700 and in America before the Revolutionary War. Red Chaff, (also call Goldcoin) dates back to 1798; Mediterranean was brought from Italy about 1819; Purplestraw was grown in the Southeast as early as 1822; and Zimmerman originated in Maryland about 1837 (Rentz, 97).

Soft Red Winter Wheats

Little Red May was the first variety of wheat grown in North Central Texas according to the 1904 Texas Almanac (110). It was grown in Collin and Greyson Counties as early as the 1830's. Apparently it was an important variety until after 1900. The 1919 wheat survey reported 7,000 acres of Red May in Texas. Jenske[5] of Fredricksburg, recalled in 1949 (he was then 84 years old) some facts about wheat when he was a boy. Mr. Jenske stated that his father went to Dallas every fall to get new seed of Red May for the fall planting. The Mediterranean variety did not come into that area until after the Civil War.

Mediterranean Era

Although introduced in 1819, Mediterranean wheat did not become important in Texas until after the Civil War. From 1875 to 1925, it dominated the acreage in Texas. An editorial in the *Farm and Ranch* of August 1907 (51), states, "Most farmers have settled down to the conclusion that Mediterranean is the best variety we can plant." Mediterranean has been grown under many synonyms, i.e., Bluestem, Missouri Bluestem, Lancaster Red, Acme, Red Chaff, Swamp, Mortgage Lifter, and others (Clarke, 34).

Even in the drier parts of the State, Mediterranean gave good yields. Youngblood (124) reported that 120 acres on the farm of a Mr. Latham, Dalhart, averaged 18 bushels per acre in 1908. John Specht, Iowa Park, grew Italian Red Wonder (probably Mediterranean) wheat in 1886, and it yielded twice as much as his other wheat (51).

Apparently Mediterranean wheat served the needs of the milling trade of this period. Millers', in a convention in Dallas in 1886, said that Mediterranean was the best milling wheat (51). The Alliance Mill of Denton, Texas won first prize for the best flour exhibited at the Dallas Fair from 1886 to 1896, the St. Louis Fair in 1895 and 1896, and the Paris Exposition of 1900 and 1904.[6] The Krum Mill, Krum (Denton County), won a blue ribbon at the Chicago World's Fair of 1904 and honorable mention at the Paris Exposition of 1910 (Davis, 45).

The first wheat variety survey in 1919 showed Mediterranean grown on 1,331,900 acres or 55 percent of the Texas acreage (Table 1). However, by 1934, the acreage had declined to 195,250 acres as hard red winter wheat replaced the soft wheats in the Rolling and High Plains areas. By 1954, the Mediterranean acreage was down to 1.452 acres, but a few fields can still be found in Texas (USDA, 117).

Other Soft Wheats

Fultz and Fulcaster were the only other varieties grown extensively in Texas. Fultz was a beardless selection from Lancaster (Mediterranean) made by a Mr. Abraham Fultz in 1862 in Miffin County, Pennsylvania. Futlz was grown under synonyms of Jersey Fultz, White Pearl, Bluestem Fultz, and Bluestem (Clarke, 34). The U. S. Department of Agriculture increased and distributed seed in 1874, some being obtained by the Cat Spring Agricultural Society at Cat Spring, Texas. Fultz was grown extensively in the eastern states with 4,800,000 acres recorded in 1919. An estimated 22,200 acres were grown in Texas in 1919 (117).

Fulcaster was developed from a cross of Fultz x Lancaster. The variety was developed by S. M. Schindel, Hagerstown, Maryland, and released in 1886. In 1919 it occupied 2,576,000 acres in the United States and 43,000 acres in Texas. By 1944, the Texas acreage had declined to 4,460 acres. On the basis of comments in the press, it is believed that the Fulcaster occupied considerable acreage in Central Texas about 1900. Fulcaster was grown under many synonyms–Swamp, Acme, Bluestem, Bearded Bluestem, Bearded Purplestraw, Valley, Dietz, Dietz Longberry, Egyptian Amber, Golden Chaff, Ironclad, Lancaster, Red Wonder, Stoner, Miracle, Mortgage Lifter, Tuscan, and others.

Purplestraw wheat was grown in the Southeast as early as 1822 but was not extensively grown in Texas. The 1919 survey showed only 2,400 acres and that of 1924 only 120 acres. Synonyms for Purplestraw were Alabama Bluestem, Georgia Bluestem, Early Purplestraw, and others.

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[5] *Personal interview with John N. Jenske, Fredricksburg, Texas, 1949.*

[6] *Information in the files of the Morrison Milling Company, Denton, Texas, the successor to Alliance Milling Company.*

TABLE 3. ACREAGES OF WHEAT VARIETIES IN TEXAS, 1949-1974

Variety	Acreages					
	1949	1954	1959	1964	1969	1974
Hard Red Winter						
Agent						84,000
Apache		3,872	84,651			
Aztec					6,948	
Bison			6,046	44,387	14,762	22,400
Blackhull	523,020	133,100	36,864	548	2,433	5,600
Blue Jacket	4,800	261,360			762	
Caddo				5,133	419,894	519,700
Caprock						84,000
Centurk						95,000
Cheyenne	43,200	21,780	12,259		2,345	
Comanche	873,120	511,104	373,963	90,562	47,125	22,400
Chiefkan	72,720	74,536	5,957			
Concho			521,249	380,204	333,622	319,500
Crockett			337,990	300,092	149,135	89,600
Daane						5,600
Early Blackhull	668,090	84,216				
Fox						5,600
Funk-W332						11,200
Gage					2,234	
Kaw				304,945	119,440	56,200
Kanred	96,980	16,456	3,004			
Kan Queen		21,296				
Kiowa		23,716	34,080	11,289	3,986	
Kanking		15,004				
Nebred	4,800	2,904				
Palo Duro						364,100
Pawnee	175,450	22,264	3,756			
Ponca			23,696	11,113	14,941	
Quanah		68,728	135,757	98,864	18,678	
Red Chief	68,680	157,300	6,922		8,207	
Red Jacket		9,196				
Scout					205,850	291,400
Scout 66					12,021	178,000
Scoutland						5,600
Sturdy					277,828	892,300
Tascosa			1,043	467,059	518,673	584,200
Triumph	1,321,040	829,092	1,300,572	475,619	405,957	318,600
Triumph, Improved				755,814	561,427	443,400
Triumph, Imp. New				148,228	87,359	39,200
Triumph, Super				136,601	48,821	
Triumph, Rosita			11,754	20,620	12,004	28,000
Triumph, 64				29,907	7,067	
Tenmarq	584,490	98,252	92,044	10,748	1,633	
Turkey	107,990	27,588	16,659	746		
TAMU - W101						72,800
Warrior					994	3,765
Westar	2,004,170	968,484	287,852	12,017	5,067	
Wichita	605,540	1,273,888	724,888	498,005	348,311	384,200
Yukon						56,000
TOTAL HRW	7,157,090	4,624,136	4,030,542	3,804,618	3,640,755	4,978,400

Table 3. Acreages of wheat varieties in Texas, 1949-1974 (Continued)

Variety	Acreages					
	1949	1954	1959	1964	1969	1974
Soft Red Winter						
Arthur						28,000
Austin	209,000					
Atlas 66			4,118	593	7,842	
Ben Hur					473	5,600
Blackhawk		2,420				
Denton	572					
Frisco			6,006	1,731		
Fulcaster		968				
Coker 47-27		4,840				
Coker 68-15						5,600
Clarkan		2,901				
Knox			118,168	120,493	142,589	106,300
Knox 62				10,249	51,123	44,700
Monon				13,606	2,051	
Mediterranean	204,700	84,700	45,831	7,665	144	
Red May	19,060	1,452				
Riley					3,034	
Riley 67					388	
Vermillion					2,909	
Vigo		968				
TOTAL	433,332	98,249	176,543	157,246	207,644	190,200
Spring Wheat						
Ceres		13,552				
Chaparrel						22,400
Milam				7,150	107,010	100,700
Nadadores						16,800
Penjamo 62					14,903	61,600
Seabreeze	6,750	2,420		2,002	3,221	
TOTAL	6,750	15,972		9,152	126,348	201,500
Durum						
Kubanka		5,324	162			
Nugget			593	135		
Stewart		8,224				
Unlisted variety	24,600					
TOTAL	24,600	13,552	755	135		
All Others	77,418	87,604	81,284	28,329	140,318	124,400
TOTALS	7,697,000	4,840,000	4,287,000	4,002,000	4,124,000	5,600,000
Percent						
HRW	92.9	95.5	94.0	95.1	88.3	88.9
SRW	5.6	2.0	4.1	3.9	5.0	4.0
Spring	0.1	0.3			3.1	3.6
Durum	0.3	0.3				

Goldcoin was an important variety in the Eastern states at this time. It was grown also as Clawson, Niagara, American Banner, White Russian, and Winter King. It was included in most early wheat tests and listed in many farm papers. Among other varieties advertised in the farm press around 1900 were Sibley's New Golden, Poole, Fultz, Fulcaster, Fultz-Mediterranean, and Mediterranean.

The first wheat trials by the Texas Agricultural Experiment Station conducted on farms at McGregor and Wichita Falls included 230 varieties and samples of wheat from Eastern states and the U. S. Department of Agriculture. The Substation at Denton was established in 1911 and immediately began testing many of the varieties listed in previous pages.[7] Seed of some of these probably were made available to growers for commercial production.

Charles Richardson, a settler at Henderson, tested the varieties Harris White, Cumby White, Phillips Red, Tappahannock, and Red May in 1865 (May, 75). Wheat from Algeria, Arabia, Egypt, and St. Helena was tested at New Braunfels in 1849 (Olmstead, 87). Jordan (70) reported that a farmer at Fredricksburg grew 110 varieties of wheat in 1859; the varieties tested are not known. The Cat Spring Agricultural Society tested Polish wheat in 1858, Tuscan (Fulcaster) in 1858, Touzelle from France in 1869, Shoemaker in 1876, and Fultz in 1876 (30).

H. A. Holbert, Coleman, reported (51) growing Prosperity (American Bronze) and Millers Pride (Mediterranean) in 1903. Russian Red or Red Russian (similar to Poole) was grown on 15,000 acres in 1919 (51).

Modern Soft Wheats

Because Mediterranean was the popular variety of Central Texas, efforts to improve it were begun by the Texas Agricultural Experiment Station about 1930. The variety Austin, a leaf and stem rust resistant Mediterranean type, was released in 1936. It was grown on an estimated 500,000 acres by 1945 and was recorded on 200,000 acres in 1949. Acreage declined soon after 1949 because of the presence of new races of rust that could attack it.

Cooperation between the Texas and Purdue Agricultural Experiment Stations, starting in 1948, provided several new soft wheat varieties for Texas growers. Knox (112), Vermillion, and Monon were released jointly and proved unusually well adapted in the Sherman-Dallas area. The acreage of Knox reached 150,000 acres in 1954 and remained at approximately this level until 1970. Knox 62 was released to replace Knox, and more recently the Purdue varieties Arthur, Arthur 71, Abe, and Oasis were grown on a substantial acreage in North Central Texas.

Since 1974, Coker 68-15, developed by the Coker Pedigree Seed Company, Hartsville, South Carolina, has been distributed in North Texas. Because of its high grain yield, semi-dwarf plant stature, and good forage characteristics, it has largely replaced the taller Purdue strains. Estimates of the acreages of these varieties were not yet available in 1978.

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7 *Unpublished data in annual reports of the Texas Substation No. 6, Denton, for 1911 and other years.*

Hard Red Winter Wheats

Turkey Era

Probably no other event is of greater agricultural importance in the Midwest and Southwest than the introduction of Turkey wheat by the Mennonite settlers of Kansas about 1874 (Quisenberry, 93). Previous to this time, the growing of wheat was hazardous because neither the soft red winter wheat nor the spring wheat varieties were truly well adapted to these areas where drouth and winterkilling were of major significance. As pointed out earlier, Ross (101) questioned the advisability of growing small grains at Amarillo as late as 1916.

The movement of Turkey wheat from Kansas into the High Plains must have occurred largely through immigrants moving to Texas or personal contacts of growers because there is little news media reference to Turkey wheat until considerably after 1900. A few references predate this time. The *Farm and Ranch* of October 1900 and October 1901 (51) contains advertisements of seed of Turkey wheat. In 1901, J. R. Ratekin Seed Co., Shenandoah, Iowa, advertised a shipment of 10 carloads of Turkey wheat to Dallas for reshipment to other points. The David Hardy Seed Company and the Texas Seed and Floral Company, both of Dallas, also offered seed of Turkey wheat at about this time.

Turkey wheat was included in the first Experiment Station tests at Amarillo in 1906 (Ross, 100) and at Texas Substation No. 6, Denton, in 1911. Records of the Denton Substation show that Turkey seed wheat was sold to E. C. Buell, Roanoke, in 1911. A few growers ordered seed directly from more nothern areas where the variety was known. An item in the *Farm and Ranch* of March 1902 (51) stated that M. C. Woods, Montague, was ordering seed of Turkey wheat. Judge L. Goeth (52), superintendent of the Tennessee Corporation farms at Crosbyton, Texas, wrote the owners in 1911, "We sent to North Platte, Nebraska for 10 bushels of Turkey Red wheat seed." After the Kansas Agricultural Experiment Station released Kanred wheat in 1917, the *Farm and Ranch* (51) of October 1920 reported that Edgar A. Kemp of Young County had ordered two carloads of Kanred wheat from Kansas because "it yielded twice as much as Fulcaster."

Although 57 percent of the Texas acreage in 1919 was seeded to Mediterranean and other soft wheat varieties, by 1929, only 26 percent of the acreage was sown to soft wheats, and the hard red winter varieties occupied 74 percent. After the 1940's, soft wheat varieties were grown on only about 8 percent of the acreage and this all in North Central Texas. Very small acreages of spring and durum varieties were grown until the 1960's, when the Mexican semi-dwarf varieties were introduced. Small acreages of Turkey, Kanred, and Cheyenne were found until about 1960. Practically all have been replaced by varieties developed in State and Federal plant breeding programs.

Blackhull Era

A selection from Turkey, but with different plant and quality characteristics, was developed by Earl G. Clark, Sedgwick, Kansas, This selection, named Blackhull, was increased from a single plant found in 1912 and released in

1917 (Call, 25). Because of its good storm resistance and high test weight, it immediately became popular and spread throughout the Southwest. From its release in 1917, Blackhull acreage increased to 391,869 in 1929 and 1,597,000 acres in 1939. Mr. Clark later developed from Blackhull crosses the varieties Chiefkan, Superhard Blackhull, Kanhull, RedChief, Chief, New Chief, BlueJacket, RedJacket, KanKing, and the soft wheat varieties Clarkan, Moking, and Kanqueen. An early maturing strain of Blackhull, Early Blackhull, was developed by A. P. Haeberle, Cold Water, Kansas. The Blackhull group of varieties occupied very large acreages in Texas, Oklahoma, and Kansas until the mid-1950's. Because their quality was so different from that needed, the milling and baking trade was able to have them placed on a discount basis about 1945, and the acreage soon declined.

Tenmarq, Comanche, Westar, and Wichita Group

Plant breeding efforts in Texas and other Southwestern states from 1925 to 1940 resulted in the release of new varieties which began to take over the acreage of Turkey. Tenmarq was released in Kansas in 1928 and in Texas in 1934. It was widely adapted, and acreage increased to 1,375,000 acres by 1944 (Table 2). It continued to be an important variety until about 1960. Comanche and Wichita were developed and realeased jointly by the Kansas, Oklahoma, and Texas Agricultural Experiment Stations in 1939, and both continued to occupy large acreages until the 1950's. Comanche acreage reached its maximum, 873,120 acres, in 1949, and Wichita reached its maximum acreage of 1,273,880 in 1954. Westar was developed by the Texas Agricultural Experiment Station and released in 1942. It immediately became popular, being grown on more than 2 million acres in Texas in 1949 and in eight other states. It continued to an important variety until about 1964. All varieties of this group were of excellent milling and baking quality, so they found favor with wheat processors.

Mid-Early Group

Building on the favorable characteristics of Tenmarq, Comanche, and Blackhull wheats, research efforts from 1935 to 1955 achieved major improvements in new wheat varieties for Texas in the release of Quanah, Crockett, Caddo, and Tascosa. Quanah was the first hard red winter wheat ever released in the Southwest which possessed a high degree of resistance and tolerance to the diseases prevalent in Central Texas. Since its range of adaptation was rather limited, the maximum acreage reached was only 135,757.

Caddo, Crockett, and Tascosa characteristics combined the high test weight, the storm resistance of the Blackhull wheats, and the desirable milling and baking characteristics of the Turkey-derived varieties. At the time of their release, they included considerable leaf rust resistance. The Crockett acreage reached 300,000 in 1959 and continued in this general range until the 1970's. Caddo and Tascosa were grown on approximately one-half million acres after 1964. Because of Tascosa's excellent storm resistance, it was very popular in the irrigated wheat growing areas from Amarillo to Lubbock (Figures 13A and B).

Kaw, developed in Kansas, and Concho, developed in Oklahoma, were mid-season varieties which occupied significant acreages in Texas during this same period, 1955 to 1965 (Table 2).

Early Maturing Group

Joe Daane, a private plant breeder of El Reno, Oklahoma, developed several early maturing strains of wheat during the period of 1940 to 1960. Their earliness permitted them to escape many diseases, and they produced good yields. One of these was Triumph which increased from only 221 acres in the 1944 variety survey to more than 1 million acres in 1949. Acreage of Triumph and Triumph derivatives continued large until the mid-60's. Selections or derivatives of Triumph released by Mr. Daane included Improved Triumph, Newest Improved Triumph, Super Triumph, Triumph 64, Sunbeam Triumph, and Orienta. After his death, his material was deeded to the Oklahoma Agricultural Experiment Station which released the varieties Daane and Nicoma. More than 2 million acres of the Triumph strains were grown in Texas for many years but have been replaced by the Texas semi-dwarf varieties to some extent.

Semi-Dwarf Revolution

Sturdy, Caprock, TAM W-101, and TAM W-103 were the first semi-dwarf hard red winter wheats developed in the United States. The spectacular increase in the acreages of these varieties from 1967 to 1976 is shown in Table 1 and graphically in Figure 12. The short stature, strong straw, and resistance to shattering made possible the practical utilization of high increments of fertilizer and irrigation water to produce maximum yields. Two commercial fields exceeded 100 bushels per acre and yields of 70 to 90 bushels were not uncommon.

These new varieties were used extensively in plant breeding programs of commercial firms and state institutions, especially in the research on development of hybrid wheat. A field of Sturdy alongside a field of the tall variety Caddo is shown in Figure 13C. The strong, short straw of Sturdy is shown by Earl C. Gilmore (Figure 13D), wheat research leader.

Spring-Type Bread Wheats

Until the advent of the Mexican semi-dwarf varieties, spring wheat was not an established crop in Texas. Small acreages were seeded from time to time, but usually in emergencies. An estimated 3,100 acres of Marquis and 400 acres of Baart were recorded in the 1919 survey and 34,326 acres of Marquis were recorded in 1929.

The Texas Agricultural Experiment Station developed and released the spring-type variety Seabreeze for the Coastal Bend area of Texas where 6,750 acres were grown in 1954. However, the variety never became well established. Milam, an intermediate winter-spring type, was released in 1959 and was recorded on 100,000 acres in both 1969 and 1974 (Table 4). Milam's good forage characteristics, as well as grain yields, made it a useful variety.

Growers began bringing in the Mexican semi-dwarf spring varieties about 1960. Although not adapted to winter pasture uses, they produced good grain yields from mid-winter seeding. Wheat acreage restrictions were re-

Figure 12. Acreages of Texas Semi-dwarf and High Test Weight Wheat Varieties in Texas, Oklahoma, and Kansas, 1959-76

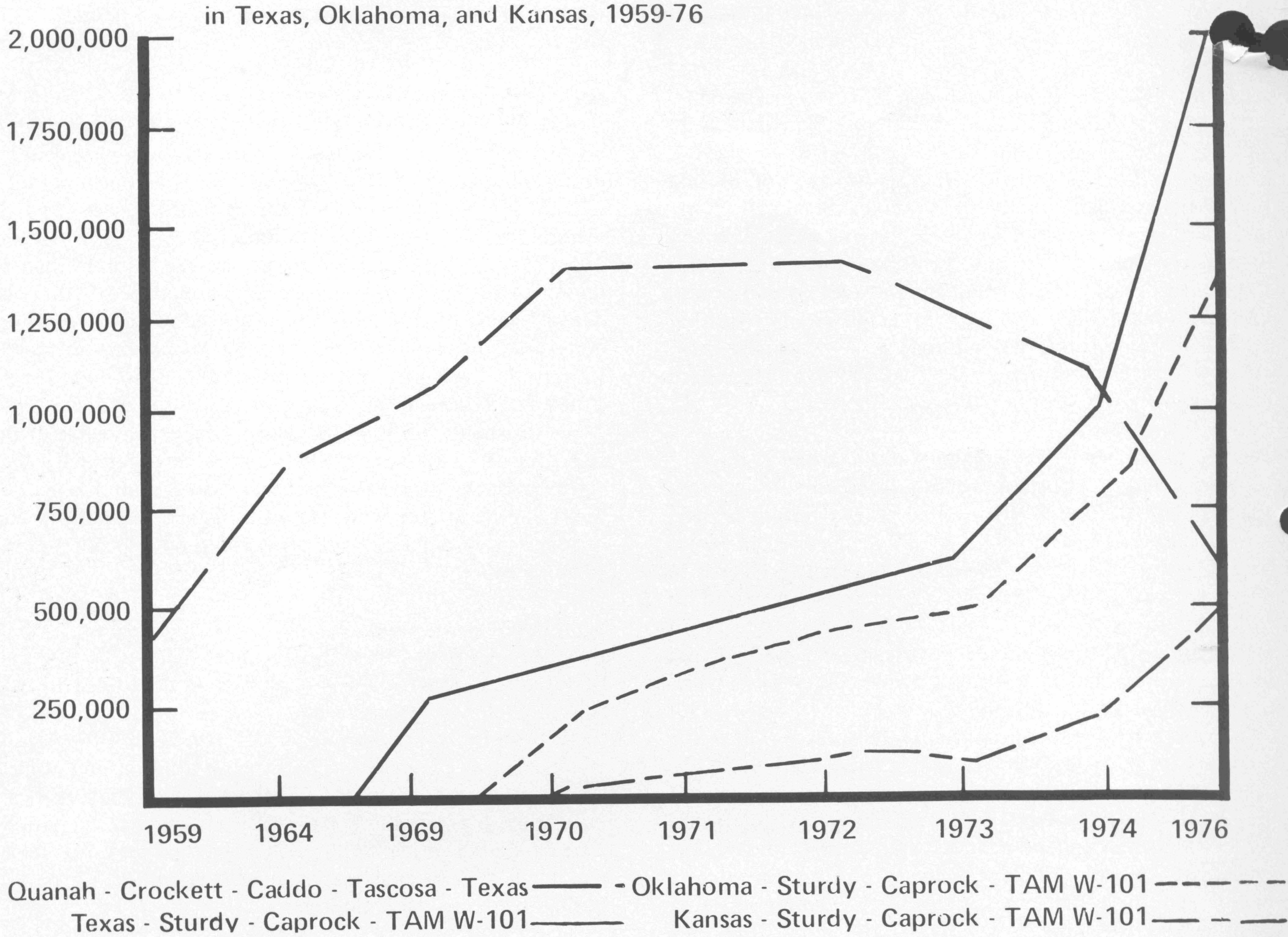


TABLE 4. OFFICIAL AND PRIVATE ESTIMATES OF ACREAGES OF TEXAS SEMI-DWARF AND HIGH TEST WEIGHT WHEAT VARIETIES, 1959-76

Variety	1959	1964	1969	1970	1971	1972	1973	1974	1976
Texas									
Sturdy			277,828	350,000*	1380,000*	425,000*	498,000*	892,300	1,200,000*
Caprock								84,000	220,000*
TAM-W101								84,000	600,000*
Tascosa	1,043	467,009	518,673	636,943*	700,000*	730,000*	625,000*	584,300	400,000*
Caddo		5,123	419,894	446,600*	460,000*	475,000*	490,000*	519,700	200,000*
Crockett	337,900	300,900	149,135	185,790*	150,000*	140,000*	100,000*	89,600*	50,000*
Quanah	135,757	98,864	16,500	52,000*	40,000*	40,000*	20,000*		
Milam		7,554	107,000	53,700*	60,000*	75,000*	90,000	100,700	20,000*
Oklahoma									
Sturdy				212,000	385,250	483,574	396,000	448,800	498,000
Caprock						62,768	102,000	183,000	220,000
TAM-W101								170,800	602,700
Kansas									
Sturdy				6,780	47,480	111,000	106,000	180,000	248,000
TAM-W101									314,400

*Unofficial estimate.

Figure 13A: The acreage of irrigated wheat increased dramatically from 1945 to 1960. A field of irrigated Tascosa wheat near Dimmit, Texas, 1958.

Figure 13B: Strong-strawed, hail resistant Tascosa wheat near Bushland, Texas, 1964.

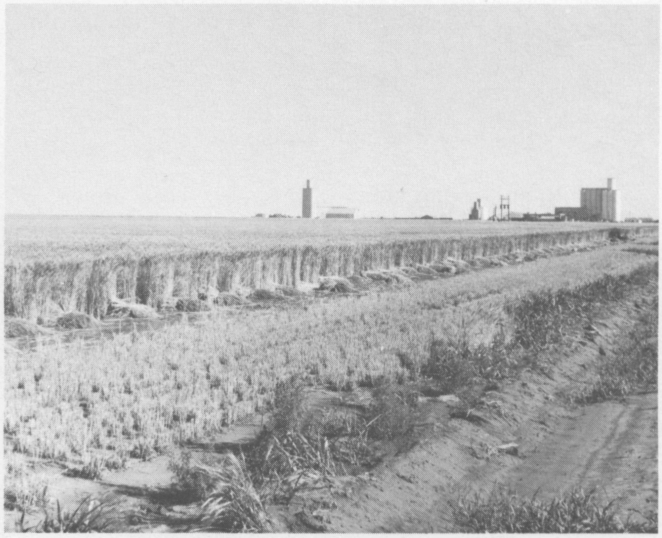


Figure 13C: New semi-dwarf variety Sturdy compared to tall variety, Caddo, near Wichita Falls, Texas, 1969.

Figure 13D: Earl C. Gilmore demonstrating the short stature and strong straw of new semi-dwarf variety Sturdy.

moved about this time. As a result of these changes, spring wheat increased from only a few thousand acres before 1960 to 770,000 acres in South and Southwest Texas in 1975. The winter-type varieties Sturdy, Caprock, Coker 68-15, and a few others, grown for winter pasture as well as grain, are included in this total.

During seasons of favorable spring rainfall or when winter killing of the small grains occurs, spring wheat may be sown on the High Plains to a limited extent but usually is not practical.

Durum Wheats

The durum or macaroni wheats have been grown in Texas since Colonial days. Reference was made earlier to a "Turkish wheat, which was different" grown at Pana Maria in 1857 and to the wheats grown "from Algeria, Egypt and Arabia" as reported at New Braunfels by Olmstead (87). These probably were durum, but they did not become established. The *Farm and Ranch* of January 1898 reports that J. L. Burgess of Hill County received durum wheat from the Patent Office in 1857.

Most of the early references to durum wheat call it Nicaragua durum, which Clark (34) states is the same as Arnautka and was brought from Russia in 1864. Much of the early interest in durum wheat stems from the poor adaptation of soft red winter and spring bread wheats in the Miswest as it was settled. The U. S. Department of Agriculture sent Mark A. Carleton to Russia in 1898 to find new drouth resistant, disease resistant and cold tolerant wheat varieties. In 1901, the Department imported 800 bushels of Kubanka durum and smaller amounts of several other varieties and types. By 1907, an estimated 4.5 million acres of durum wheat were grown in the United States.

Tests of Kubanka durum and other wheats from Russia, Algeria, and Turkestan were made cooperatively by the Texas Agricultural Experiment Station, the U. S. Department of Agriculture, and the *Farm and Ranch Magazine* on 200 farms in Texas in 1903. Carleton traveled in Texas and spoke to the Farm Congress at Texas A&M University about the results of these tests. The *Farm and Ranch* of July 1904 (51) reported that, according to A. J. Schultz, Iowa Park, macaroni wheat yielded more than his common wheat and could be seeded either fall or spring. Also, a Mr. Tull, McClennan County, wrote, "Medeah durum can be successfully grown both here and in Castro County." The early experimental tests at Amarillo and at Denton included Medean, Velvet Don, Nicaragua, Kubanka, and Saragella durums.

Apparently by 1906, there was sufficient durum grown that the milling trade began to oppose growing it. The *Farm and Ranch*, July 1907 (51), reports "Mills have now universally rejected it." The *Farm and Ranch*, July 1907 (51), reported that the Hartley Grain Company had on hand several carloads of durum wheat, which they could not sell. Also, the November 1909 issue reported that E. F. Farmer, Haskell, had grown durum wheat successfully for 6 years but that "no mill will grind it." These factors apparently caused the abandonment of the growing of durum wheat in Texas.

Emmer, Spelt, and Poulard Wheats

According to older citizens of South Texas, Emmer (colloquially called Speltz) was grown as a windbreak in vegetable fields from San Antonio south as long as they can remember. Whether this seed was brought in by the early Belgium, Flemish, or German farmers cannot now be determined. Emmer, a durum-type wheat, on which the outer glumes do not thresh free (covered seed) and a true spelt, a 21 chromosome wheat, also with covered seed, grown for feed in Europe, were both tested in the first cereal experiments at Amarillo and at the Denton Substation starting in 1911. Ross (100) reported in 1916 that Black Winter Emmer had averaged 16.9 bushels per acre in dry-land tests. The *Farm and Ranch*, April 1902 (51), has an editorial promoting the use of Emmer as a feed grain. Small fields of Emmer may still be found on dry, rocky hillsides in the Edwards Plateau and in vegetable fields of South Texas.

Poulard is a durum-type wheat with branched heads, which is sometimes exploited by farmers or seedsmen because its large spikes appear to indicate high yields. The *Farm and Ranch*, October 1911 (51), quotes A. M. Dougherty, Denton, that his "Egyptian wheat made a second growth after cutting and looked like broomcorn." Under most conditions Poulard has not been grown successfully.

Varieties of wheat grown on Texas farms changed constantly through the years as growers introduced and tested new ones, and plant breeders made improved varieties available. New or different varieties were means of combating disease and adapting to local conditions. The acreages of major variety types grown from 1919 to 1949 are shown in Figure 14 and from 1949 to 1976 in Figure 15 (USDA, 117). (The data for 1976 are based on private estimates.)

Although soft wheat varieties were grown on the majority of the Texas acreage in 1919, this changed quickly to the hard red winter wheat varieties when they became available. Turkey strains, and later Blackhull strains, dominated the acreage from 1924 to 1945. Varieties bred from selections or hybrids such as Tenmarq, Comanche, Wichita, and Triumph, occupied increasing acreages in 1934 and thereafter. Westar dominated the Texas acreage from 1947 to 1954, and the Triumph strains made up a dominant portion of the acreage from 1947 to the 1960's. New high test weight, high quality, and high yielding varieties bred by the Texas Agricultural Experiment Station, i.e., Quanah, Crockett, Caddo and Tascosa, were the major varieties from 1959 to 1975.

The development of the semi-dwarf, together with wider use of fertilizer and irrigation water, influenced the rapid shift to these new short wheats starting in 1970. By 1976, they were the most widely planted varieties and continued to spread in Texas and into Oklahoma and Kansas after that time.

HAZARDS OF WHEAT PRODUCTION IN TEXAS

Wheat production in Texas may be subject to a number of hazards of major significance–locally or even statewide

Figure 14. Texas Acreages of Variety Groups, 1919-49

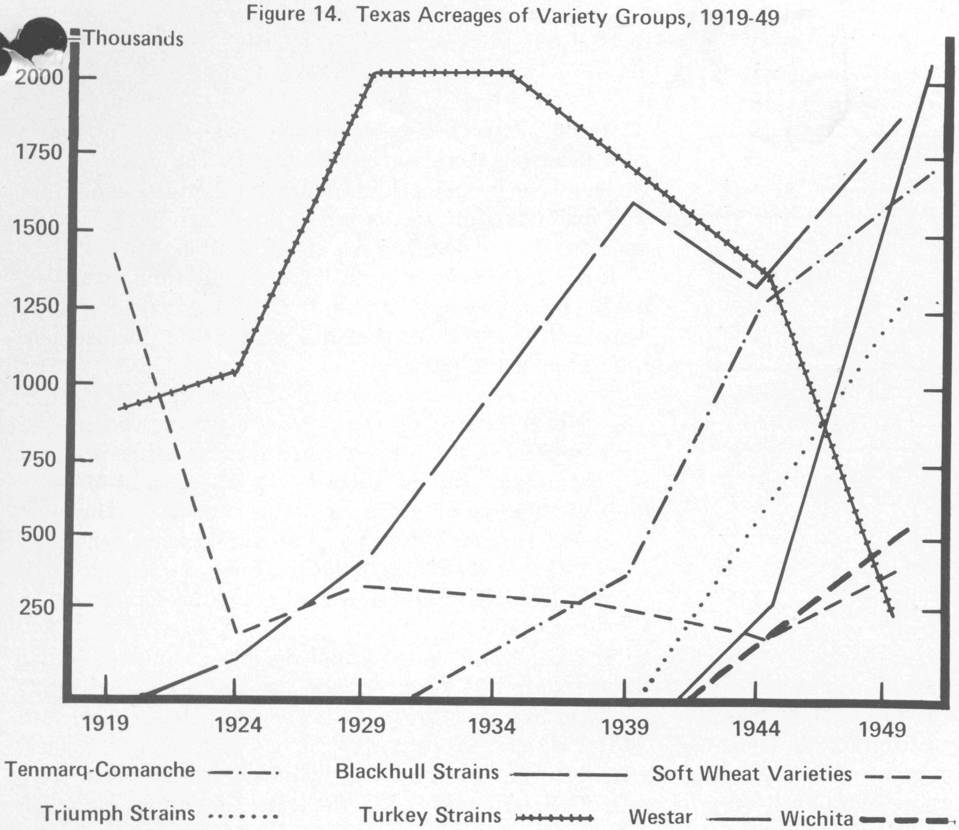
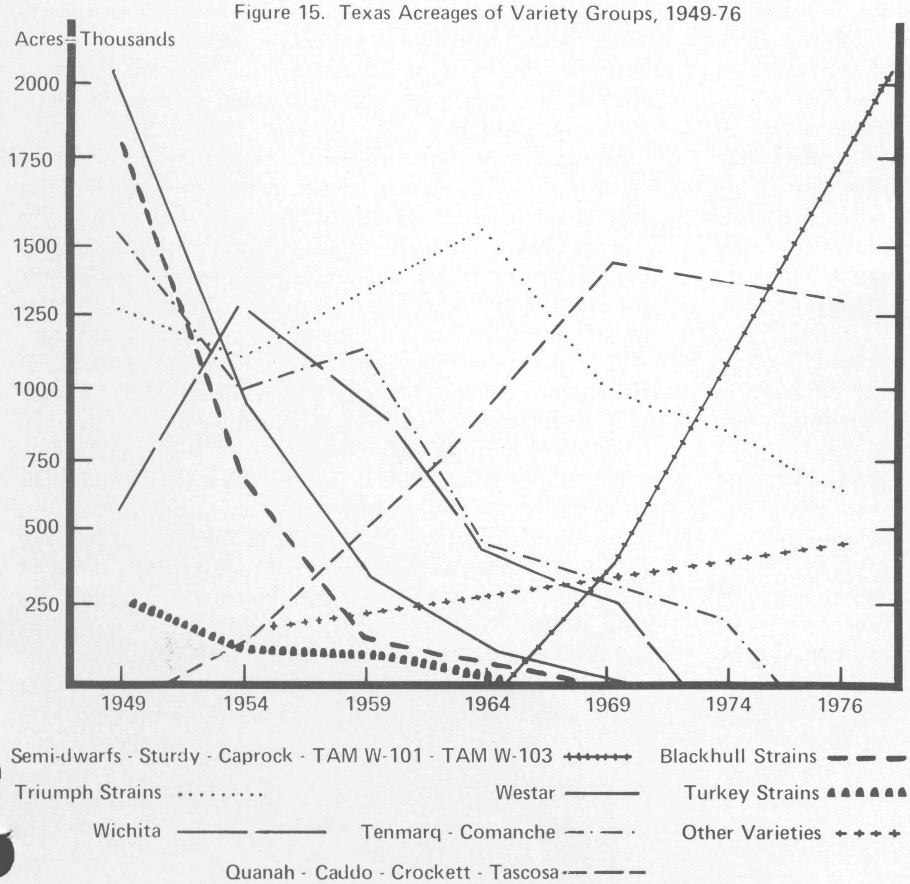


Figure 15. Texas Acreages of Variety Groups, 1949-76



in some seasons. Frequency of occurrence of some of these hazards at four locations is given in Table 5.

Table 5. Number of crop seasons in which certain major hazards influenced wheat production in Texas, 1932-63 (Atkins, 8).

Location	Greenbugs 1	Leaf rust	Stem rust	Fall rust infection	Septoria
Amarillo	9	5	3	7	2
Chillicothe	4	11	2	3	5
Denton	6	17	8	7	5
College Station	2	15	13	3	1
	Fall drouth	**Spring drouth**	**Excessive rainfall**	**Winter killing**	**Spring freeze**
Amarillo	15	15	0	3	5
Chillicothe	5	5	1	1	3
Denton	6	3	5	2	3
College Station	1	3	8	0	1

Insects

Insects frequently become serious hazards of production as soon as a crop is seeded on large acreages. There were no means of controlling insects in the early periods. Grasshoppers apparently attacked many crops of the early settlers. They ate all the wheat in Williamson County in 1848, 1856, and 1858 (Scarbrough, 103). Clark (36) quotes the Northern Standard that the 1854 and 1855 wheat crops of Denton County were destroyed by grasshoppers. At Fort Belnap in 1858, "The grasshoppers passed Fort Chadborne for three days as dense as a snow storm" (Johnson, 69). More recently, grasshoppers were serious hazards in the drouth years of the 1930's and the 1950's.

Aphid species attack small grains at several stages of growth and can cause serious losses. One species, the "greenbug," may be especially damaging because of its ability to reproduce during cool weather when predators and parasites are not active. Greenbugs (Figure 16A) may destroy small areas of a field, large fields, or even large production areas. Until very recently, no effective economical measures of control were available.

Extensive outbreaks of greenbugs occurred in Texas in 1901, 1916, 1942, 1951, with less extensive outbreaks in several other years (Atkins, 5). The 1901 infestation extended from McClennan County northward into Missouri. The 1907 infestation covered a similar area and destroyed an estimated 50 million bushels of grain. The 1942 infestation destroyed small grain from Central Texas to Central Oklahoma, with an estimated loss of 61 million bushels of grain valued at $81 million. Several other species of aphids cause less spectacular damage to grain.

Spider mites of several species may damage wheat. The brown wheat mite is a pest in the drier parts of the state and the winter grain mite in the more humid areas. The Tulip mite, a microscopic species, transmits the virus causing wheat streak mosaic. Rotation and killing of volunteer plants are effective measures in the control of mites.

Chinch bugs, army worms, and soil insects are among other insects which may cause serious damage to wheat.[8]

Diseases

As with insects, diseases become increasingly important as a crop is grown on large acreages. The diseases most frequently mentioned in literature are the rusts and smuts. The major leaf diseases of wheat are shown in Figure 16B and described in detail by Atkins and Futrell (6).

Rusts apparently became important as soon as settlers began growing wheat in North Central Texas. The 1869 *Texas Almanac* (110) printed a long article on rust, portions of which follow:

> Rust is the dreaded disease of the wheat crop in North Texas. This is a parasitical growth, which appears in the form of a red dust on the leaves and later on the straw. . . . The rust stops circulation of nutrition of the crop. . . . The consequence is that the grain shrinks and ripens early. If the crop is attacked early, a complete failure will result but usually it produces a short crop.

The Cat Spring Agricultural Society abandoned testing of wheat after 20 years because the crop was so frequently damaged by rust (Jordan, 70). The *Farm and Ranch,* June 1887 (51) quotes a Mr. Kilpatrick, Collin County, "Wheat was destroyed by the root blight or something of this nature. The roots turn black, the leaf rusts and the grain fails to fill. Thousands of acres will not be worth harvesting."

Major epidemics of rust occurred in 1935, 1949, and 1957 (Table 6) (Atkins and Futrell, 6). Although these losses are above normal, some damage occurs nearly every year. Figure 16D shows a field of Mediterranean wheat destroyed by rusts at College Station in 1957. Stripe, a cool season rust, was observed doing damage in 1942, 1949, and 1958.

There are no effective, economical fungicides for the control of leaf diseases of wheat. Although research in this field is extensive, at present the only practical control is to grow a disease resistant variety. Growers early recognized the value of resistance, a characteristic probably responsible for the popularity of Mediterranean wheat, which maintained a type of rust tolerance over a period of years.

The plant breeding program of the Texas Agricultural Experiment Station has emphasized the breeding of resistant varieties and has released Austin, Westar, Quanah, Milam, and Sturdy which at the time of release had a high degree of resistance. Other varieties with more limited types or degrees of resistance have also been released. Most leaf diseases of wheat reproduce by means of spores, which are similar to the seed of more complex seed plants. Races of the disease occur which may be compared to a variety of a crop plant. These races vary in their ability to attack varieties, and the races change from time to time. When the races change, a variety resistant at one period may become susceptible to new races that arise or occur. These changes

8 More information on insects of wheat and their control is presented in Daniels et al. (44).

TABLE 6. ESTIMATES OF LOSSES FROM WHEAT DISEASES IN TEXAS IN SEVERE-LOSS YEARS 1935, 1949 and 1957 (ATKINS, 6)

	1935 Loss in crop in		1949 Loss in crop in		1957 Loss in crop in	
Diseases	Percent	Bushels	Percent	Bushels	Percent	Bushels
Leaf rust	2.0	237,000	11.1	12,436,350	3.9	1,489,111
Stem rust	10.0	1,185,000	4.8	5,845,100	0.7	245,157
Septoria			3.4	4,217,440	5.0	1,866,981
Smuts			0.2	179,310	Tr	13,095
Others	3.5	295,000	1.1	1,343,225	1.1	416,522
TOTALS	15.5	1,717,000	20.5	24,021,545	10.7	4,009,904

Figure 16A: Greenbugs, an aphid which attacks the wheat crop in Texas.

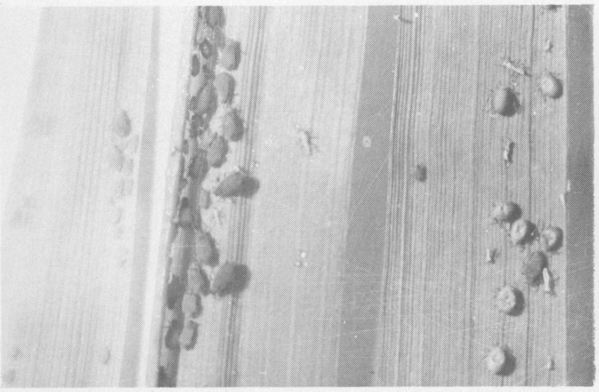


Figure 16B: Leaf diseases of wheat.

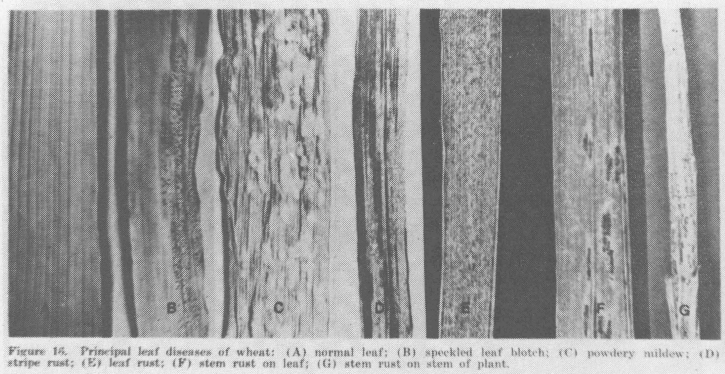


Figure 16C: Loose smut of wheat destroys the entire head or spike of the plant.

Figure 16D: A field of wheat destroyed by stem rust, a fungus disease, College Station, Texas, 1956.

cause major problems in the development of the varieties of crop plants.

Kernel smut (stinking smut or bunt) destroys the kernels of wheat, replacing the seed with a mass of smut spores, and loose smut (head smut) destroys the entire head or spike (Figures 16C). Effective fungicides for seed treatment to prevent smut infection now are available, and disease losses are due to failure to treat the seed.

Some of the early treatments for the control of smut were very unusual compared with present practices. An article in the 1857 *American Agriculturalist* (1) of 1843 reports that the first seed treatment was by Oliver de Cerres of England. He soaked the seed and skimmed off the light seed, much of which was smutty. Treatment of seed with lime started in 1625. The *Agriculturalist* of 1873 advised growers to use chamber lye and a weak solution of salt to kill smut spores. Still later in 1873, the journal gives specific instruction on control of smut as follows, "Spread the wheat seed on the barn floor, upon 4 bushels of seed dash 10 to 16 quarts of human urine, add 6 quarts of freshly slacked lime and plant immediately."

Weather

One of the most frequent and widespread hazards of wheat production is drouth. Lack of rainfall or its uneven distribution can be very damaging to the establishment of the crop, determining yield and quality of grain and the value of the crop for winter pasture. The great drouths of the 1920's 1930's, and 1950's were widespread. More local drouths occurred in many seasons. Baker (10) cites a 14-month drouth in Karnes County in 1856-57 which caused the soil to crack 12 inches wide in places. Extensive drouths during 1886 and 1887 in the Abilene area caused settlers to abandon their homes and return to East Texas. A drouth in the northern Rolling Plains from 1891 to 1894 (Collins, 37) also caused abandonment of farms.

The famous and widely publicized drouths of the 1930's were caused by a combination of circumstances. Not only was rainfall below normal and poorly distributed, but large areas of light textured or sandy soils had been broken out of sod and put into cultivation as part of the World War I effort. Several years of continuous cropping to wheat and the use of shallow tillage implements contributed to soil blowing. The one-way plow used extensively during this period (Figure 17A) contributed to the wind erosion. Severe soil blowing and damage to land common in this period is shown in Figure 17B. A dust storm approaching Big Spring is shown in Figure 17C.

Low temperature damage to crops is another hazard of wheat production in Texas. The Texas "blue norther" has an unenviable reputation. Seedling plant damage and stand thinning, winterkilling of areas or entire fields and spring freezes damage the wheat crop in many seasons. Historically, some of the major freezes include that cited by Penny (89) when the Brazos River froze over as far south as Hood County in 1848 and 1849; and others cited by Richardson (98)–one in 1855 and one on June 11, 1877, when crops were killed as far south as Austin. The great freezes of 1886 and 1889, which caused losses of cattle and crops from Texas to Florida, are well recorded.

Wheat is more tolerant to low temperature than oats or barley but it may be damaged in several ways. Serious winterkilling of wheat in entire fields or parts of fields or in certain areas of the state occurred in 1929, 1935, 1943, 1949, 1962, and 1963. The loss from winterkilling in 1963 was estimated to be 677,000 acres with a crop value of $29 million. Winterkilling of wheat on top of contour water furrows of irrigated wheat is shown in Figure 18A, and damage from a late spring freeze in 1957 near Quanah is shown in Figure 18B.

Shattering and lodging of the grain are other hazards that may reduce yields or cause increased cost of harvesting. With the tall standard-height varieties, which grew from 36 to 50 inches in height, lodging was a serious factor under irrigation or other high yield situations (Figure 18D). The lodged crop is difficult and expensive to harvest and results in loss of both amount and quality of grain. With the advent and subsequent wide use of semi-dwarf varieties, lodging is of less importance than formerly.

Shattering may be caused by weakness of the outer glumes in some varieties or from hail and wind damage to wheat. The development of storm and shatter resistant varieties has been a major objective of the breeding program. Recent varieties made available to Texas growers are all highly resistant to these hazards. Damage from hail to a wheat crop is shown in Figure 18C. The variety Tascosa is grown extensively in the area between Amarillo and Lubbock where hail storms are frequent.

An experiment in rainmaking was conducted by the U. S. Army in 1891, after the severe drouths of the 1880's. Observers had associated heavy rainfall with the firing of cannon during wars. Gun powder and dynamite explosions were used in an attempt to increase rain in the Midland to El Paso area, but the results were not positive (Rayburn, 94).

MILLING OF WHEAT

Wheat is usually milled to convert it to a suitable human or animal food. A mortar and pestle grinding device was used by primitive peoples for centuries. Figure 19A shows a "metate" stone found in an Indian cave near Presidio, the area where wheat was first grown in Texas.

The first wheat grown in Texas was used to supply only the needs of the family or to trade for other food or supplies. On the frontier, wheat was often eaten whole after soaking. Many settlers brought small hand mills with them or devised some type of grinding method. A common method was to hollow out a stump where corn or wheat could be beaten into flour. Hall (54), whose family moved to Collin County in 1946, stated, "The closest grist mill was at Bonham. A merchant at McKinney shipped in a supply of small hand mills in 1858." Bates (13), whose family came to Denton County in 1853, writes ," We had to take our wheat to Colbert Ferry north of Sherman for grinding."

However, the first mills in Texas date back to long before the settlement of North Central Texas. An early mill was built at the French settlement on the Red River near present-day Texarkana (see section on introduction of wheat). French families came up river from Natchitoches,

Figure 17A: One-way plow used extensively for wheat land tillage in West Texas from 1930 to 1950.

Figure 17B: Wind and sand damage to wheat fields near Hereford, Texas, in 1935.

Figure 17C: A dust storm approaching Big Spring, Texas, in 1935. (Courtesy U.S. Soil Conservation Service.)

Figure 18A: Winterkilling of wheat on lister beds near Stratford, Texas, in 1963.

Figure 18B: Late spring freeze damage to wheat near Quanah, Texas, in 1957.

Figure 18C: Severe hail damage to wheat near Hereford, Texas, in 1963.

Figure 18D: Severe rain, hail and wind damage to wheat near Hereford, Texas, in 1963.

Figure 19A: "Metate" grinding stone found in an Indian cave near Presidio, Texas. (Courtesy Blake Williams.)

Figure 19B: Old mill building at San Jose Mission, San Antonio, Texas. Built in 1794, the mill was powered by a Norsk water turbine wheel.

Figure 19C: Norsk water turbine wheel at San Jose Mission mill. Built in 1794; restored in 1936.

Figure 19D: Stone grinding wheel and wheat bin at San Jose Mission mill, built in 1794.

Louisiana, and lived at this location from 1719 to 1762. They grew wheat and other crops, brought stone burs from France, and built a small mill to grind their grain (Mc Connell, 76).

Although the Spanish first grew corn at San Antonio because the Indians preferred corn over wheat as a food, when Theodore de Croix inspected the San Jose Mission in 1777, he gave special instructions that they were to grow wheat and barley as well as corn and beans (Bolton, 18). The inventory of the granary in 1794 showed 432 bushels of wheat in storage. Father Pedrajo was the last Missionary at San Jose from 1789 to 1794. During this period he supervised the building of a mill beside the irrigation ditch, which ran on the north side of the Mission. The remains of this old mill were found in 1936 and restored (Johnson, 67). It is described as a Norsk mill using a bladed water turbine for power. Water from the irrigation ditch is stored in a stone-lined tank above the turbine. Views of the restored turbine and stone mill are shown in Figure 19B, C, and D.

Apparently there were mills in northern Mexico even before this time. The Aguayo expedition of 1719-22 included in their supplies, ". . . 350 cargos of flour and 150 cargos of corn" (Bolton, 18) (probably a burro load). Sonnichsen (105) describes El Paso of the 1820's as: "Juan Ponce de Leon settled at El Paso, grew wheat where the El Paso business district now stands and built a mill at the falls of the Rio Grande in 1827."

A group of Mormons built a grist mill on the Colorado River six miles above Austin, in 1842. Because of floods, they later moved it to Hamilton Creek near Burnet. When they left Texas, Smithwick (104) bought the mill and operated it. He describes this mill as a "crude, cumbersome, home-made apparatus with the burs made of native granite stone and the 26-foot water power wheel made of native wood."

Lang's mill, near Doss on the Pedernales River 20 miles northwest of Fredericksburg, is probably the oldest Texas mill still standing. The dam and water wheel were first built to serve a sawmill; later they were used for a brewery, and then a grist mill as the mill was adapted to changing conditions. The mill was washed away in 1854 and again in 1862, but it was rebuilt each time and remained in operation until 1888. Only portions remain today (Figure 20A) (Biggers, 16).

The oldest mill in continuous operation in Texas is the Pioneer Mills of San Antonio. The forerunner of this mill was the Guenther Mill, built on Live Oak Creek west of Fredericksburg in 1851. The mill stones came from France and were hauled from Indianola (extinct port city near Houston) by wagon train. The water wheel, gears, and other parts were made from wood by the pioneers. Because of flood problems, the Guenthers moved to San Antonio in 1859. Since then, the mill has been rebuilt several times and kept modern as milling equipment and procedures changed. It was one of the first to install steel roller mill-wheels. The Pioneer Mills of today are shown in Figure 20B (92).

Numerous mills were built along the fault line where the Edwards Plateau drops off to the Central Blacklands. Since dependable water power was available here, mills were built during the period 1855 to 1880 at Georgetown, Austin, Round Rock, Salado, Clifton, Waco, and other locations. The expansion of wheat acreage during this time provided grain for the mills. Douglass (47) estimates that by 1900 there were 500 community mills in Texas.

The first mill in the Fort Worth area was built at O'Bar, later named Azle, a suburb of Fort Worth, in 1859. The City Mills were built on the east bluff of the Trinty in 1874, and others followed soon. The Dallas Elevator and Milling Company was organized by a group of farmers and merchants in 1872 with the object of promoting the growth of wheat and sale of its products (110). A grist mill had been built in 1845 at Farmers Branch north of Dallas. The Brazos Mill of Waco was built in 1875 to serve the 30,000 acres of wheat grown in the area. Both the McSpadden and Ingram Mills and the Prairie Mill were established at Terrell in 1876 (Stoltz, 107).

The present (1978) Morrison Milling Company of Denton, one of two original mills still in operation since before 1900, was organized in 1886 as the Farmer's Alliance Milling Company to furnish a market for wheat growers. In 1900 it became the Alliance Milling Company, a corporation, and in 1936 was purchased by E. W. Morrison. During the period 1875 to 1920, when Mediterranean wheat dominated the acreage, the Alliance Mill won many prizes for its flour (see section "Mediterranean Era"). It has been modernized several times and now operates 24 hours per day much of the year, producing wheat and corn mill products. The company has been a leader in the development of quick-service kitchen products.

Farther west the Donnell Brothers built a water-powered mill near Graham in 1877 (Figure 20C), (Couch, 42). M. R. Cheatham built a mill at Coleman in 1874 (Bruce, 24). On the High Plains, the Harvest Queen Mill was built at Plainview in 1907. Others followed rapidly as these areas became the major wheat producing areas of Texas.

IMPROVEMENT OF THE CROP

Under natural conditions, the strongest animal or the best adapted plant may survive to dominate and perpetuate the species. However, as man domesticated crops, he selected the types best suited to his needs and caused them to survive by protecting them against hazards. Wheat is no exception to this pattern. While some of the wild species of wheat or related species of *Aegilops* or *Agropyron* may still survive in the wild in certain parts of the world, modern bread wheats would not survive in the wild. Just how bread wheats evolved in nature is not known, but it is assumed that they arose over eons of time by natural crossing, mutation, or doubling of chromosomes or combinations of these processes.

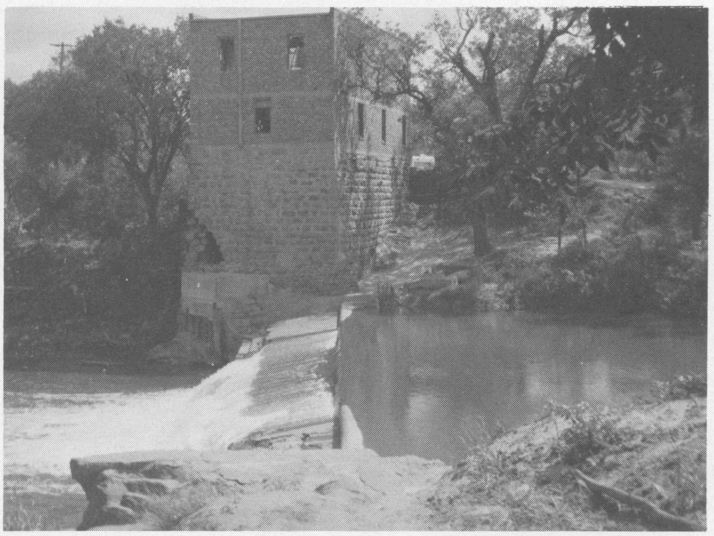
Early Efforts to Improve Wheat

As man began to grow wheat for food, he observed differences among plants and selected the type best suited to his needs. The first improvements came from plant selections out of mixed populations developed in nature. For example, the Fultz variety was selected from Lancaster,

Figure 20A: Remnants of old Doss Mill near Doss, Texas. Built in 1849 for a saw mill, brewery, and grist and flour mill. As seen in 1949.

Figure 20B: The modern Pioneer Flour Mills, San Antonio, Texas. Built as Guenther Mill, Fredericksburg, Texas, in 1857; moved to San Antonio in 1859. (Courtesy Pioneer Flour Mills.)

Figure 20C: The old Donnell Mill on the Clear Fork of the Brazos River near Graham, Texas, in 1877.



an old variety introduced from England. Blackhull was selected from Turkey wheat, a type brought to Kansas by Mennonite settlers from Russia. Kanred, Cheyenne, and Denton are pure-line selections made by research workers at experiment stations.

The first wheat crosses were made by private plant breeders working for seed companies in England, France, and Sweden. In the United States, a number of private plant breeders made crosses of wheat varieties before experiment stations were established. General Harmon (57) of New York introduced or selected the varieties Flint, White May, English Velvet, and Yorkshire. George A Dietz (46), Chambersburg, Pennsylvania, claimed in 1847 that he had the only experimental farm. He developed the varieties French White Mediterranean, Hungarian Red Chaff, Rochester Red Chaff, Egyptian Red May, Italian White, and California White. Cyrus G. Pringle, Charlotte, Vermont, produced the varieties Surprise and Defiance, which were marketed by the B. K. Bliss Seed Company of New York. A. N. Jones, a farmer of Newark, New York, made more than 15 wheat crosses and developed the varieties Jones Fife and Red Wave. Introduction from abroad was, of course, a major means of finding new wheat varieties for growers to test.

Early Wheat Improvement in Texas

The Texas Agricultural Experiment Station was established in 1889. The first research efforts were aimed at determining the adaptation and management of crops and obtaining the best varieties. Wheat had become a well-established crop of 300,000 acres by this time. Cooperative farm tests of 200 strains of wheat were conducted at McGregor and McKinney in 1890, according to Director Connell (38). From 1890 to 1910, seed of many crops were offered to growers for adaptation tests, with the request that growers give a report on results. Among the varieties of wheat tested in 1902 were domestic varieties and some from Russia, Egypt, and North Africa (111).

Crop testing in cooperation with the XIT ranch at Channing, was started by the U. S. Department of Agriculture in 1903, and the Amarillo Experiment Station was established in 1906. Work from 1906 to 1919 is reported by Ross (100, 101). Another U. S. Department of Agriculture experiment station was established at San Antonio in 1904 (Hastings, 60). The Division of Forage Crops, U. S. Department of Agriculture, established a station at Chillicothe in 1906 where 17 varieties of wheat were tested. This later became Texas Substation No. 12. The Amarillo Experiment Station and the small grain plantings of 1906 are shown in Figure 21A and B. The Texas Substations 5 and 6 were established at Denton and Temple in 1911. The 1915 small grain tests and threshing equipment of that time are shown in Figures 21C and D.

Associated with these early experiments on adaptation was the distribution of seed of some strains. The better strains were increased. Substation No. 6 sold seed of Mediterranean, Red May, Kubanka durum, and Kharkof hard red winter wheat from 1911 to 1914. Black Winter emmer and Red Winter spelt, new feed grains at that time, also were distributed.

The Amarillo Experiment Station records do not show that seed of wheat varieties were distributed but they probably were. Several references speak of crop seed received from the U. S. Patent Office during the period from 1860 to 1900.

The Selection Period

From 1880 to 1930, the pure line selection method was used extensively in the development of crop varieties. Wheat of this period probably was considerably mixed. Farm machinery—drills, binders, threshers, wagons, bins, and elevators—afforded opportunities for mixing of strains, with very few facilities to keep strains pure.

Immediately upon establishment of Substation No. 6, selection work started. The superintendent, T. W. Buell, reported in 1911, "We have made selections in Fulcaster, Mediterranean, Fultz, Poole, Red Wonder and other wheats." Many strains received from other experiment stations and by introduction were mixed and offered opportunities for selection work.

Purified seed of some named varieties were released from time to time. Pure line strains of Mediterranean, No. 3015-72, 3015-81, and 5933-34 were sold for a time during the 1920's. Another strain, No. 3015-66, was given the name Denton and released to farmers in 1926. This variety was grown on 48,948 acres in 1934 and was grown to some extent until about 1945.

After the introduction of the hard red winter wheat strains, many selections were made from Turkey, Crimean, Kharkof, and others. While no Texas selections were distributed, the varieties Kanred and Cheyenne, derived from Turkey, were grown in Texas. Keliehor's Russian, a tall late mixed variety introduced from Russia by Joe Keliehor of Plainview was grown on some acreage in the 1920-1930 period. Many selections were made from this stock, but none proved of value.

Development of the Modern Small Grains Program

Small grain research from 1911 to 1930 was concentrated at Denton, with limited work at College Station, Temple, and Chillicothe. The Amarillo Experiment Station was closed in 1919 and the San Antonio Station in 1932.

The development of State-Federal regional programs of research with the cereal crops was initiated in 1930. Funds and responsibility were given the Office of Cereal Crops and Diseases, Bureau of Plant Industry, Agricultural Research Service, U. S. Department of Agriculture. Texas and many other states set up cooperative programs under this plan. K. S. Quisenberry was assigned the hard red winter program and was located at Lincoln, Nebraska. Later Regional Coordinators were L. P. Reitz and Virgil Johnson. Regional nurseries to test adaptation, disease reaction, insect effects, winterkilling, drouth tolerance, and quality were established with the necessary agronomists, pathologists, entomologists and cereal chemists to develop breeding programs and carry on the tests (Reitz, 96). Salmon et al. (102) in 1953 reviewed 50 years of wheat improvement in the United States, including part of this program.

As part of this program, I. M. Atkins was stationed at

Figure 21A: The old USDA Experiment Station east of Amarillo about 1906.

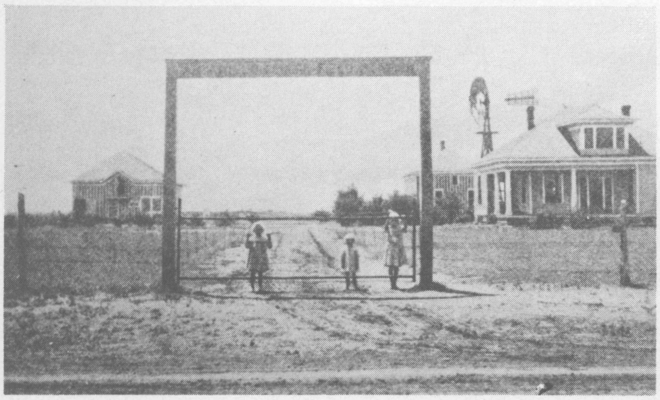
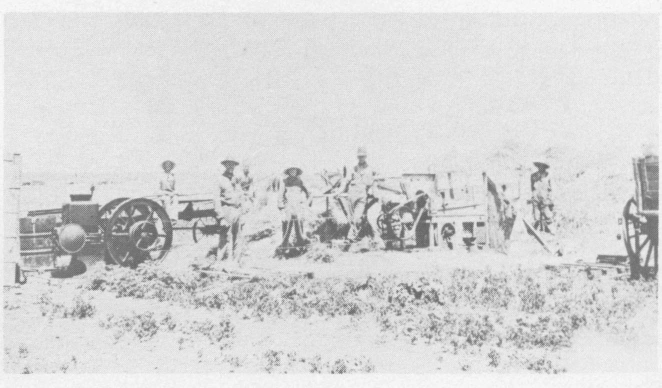


Figure 21B: Small grain experimental plantings at the USDA Experiment Station near Amarillo, Texas, 1906.

Figure 21C: Small grain plantings at Substation No. 6, Denton, Texas, about 1915.

Figure 21D: Threshing small grain experimental plots at Texas Substation No. 6, Denton, Texas, 1915.



Denton, Texas, Substation No. 6, in 1930. E. S. McFadden was moved from South Dakota to College Station in 1936. M. C. Futrell was stationed at College Station in 1949, and Harvey Chada was stationed at Denton in 1951. The scope of research at Denton was greatly expanded in 1930, and I. M. Atkins was given responsibility for cooperative testing in the High and Rolling Plains, where there was no active work on small grains.

Work was initiated with county agricultural agents of the Texas Agricultural Extension Service in the High Plains, using variety strip testing on farms. A breeding nursery and large field test plots were sown at Amarillo through cooperation with Price Memorial College, a junior college which had a farm and some facilities. This cooperation continued until 1938. Variety strip tests were conducted at from 16 to 20 locations in 10 counties for a few years, but later this was reduced to a few locations. Testing at Substation No. 12, Chillicothe, was expanded in 1931 and included a breeding nursery after 1938. Variety testing was initiated at Iowa Park in 1931 and continued to the late 1970's. To meet the need for more adequate testing in the Rolling Plains area, tests were initiated at the Spur Substation in 1949 and in cooperation with Abilene Christian College in 1953. Additional tests were initiated in Central Texas at Greenville in 1936, at Stephenville in 1948, at Sherman in 1953, and at McGregor in 1953. A group of farmers from Comfort asked for tests starting in 1949, and these were conducted from 1949 to 1957.

TheBushland Research Center

The U. S. Southwestern Great Plains Research Station was established in 1936 by the Soil Conservation Service for studies of wind erosion, moisture conservation, weed control, and cultural studies of crops. Cooperation with the Texas Agricultural Experiment Station was initiated immediately and David A. Reid, agronomist, was stationed at Bushland in 1938. In 1977 the Texas A&M University Agricultural Research and Extension Center was established in nearby Amarillo.

The research program of small grains was enlarged under Reid and included regional nurseries and expanded testing of breeding lines at several locations on the High Plains, Stratford, Plainview, Hereford, and Wellington. Since 1946, K. B. Porter has been in charge of the Bushland small grains program. Under his direction both research and facilities have been improved and expanded. Basic research has been conducted, and results have been published on shattering in wheat, winterkilling, lodging, test weight, milling and baking quality, greenbug resistance, and the development of hybrid wheat. Varieties released from this station include Westar, Tascosa, Sturdy, Caprock, TAM W-101, and TAM W-103.

After severe infestations and losses from the greenbug (aphid) in 1942, 1951, 1952, along with smaller losses in other years, work on greenbug control and breeding for resistance was initiated with the employment of Norris Daniels in 1951. Many basic data on insect control and behavior have resulted from his research. The modern facilities at the U. S. Southwestern Great Plains Field Station at Bushland, the large field plots of wheat under test at Bushland, and some of the new semi-dwarf strains bred by K. B. Porter. Owen Merkle, USDA agronomist, are shown in Figures 22A, B, and C.

Substation No. 6, Denton

From very limited facilities in 1911 (Figure 21C), the Denton Substation became one of the most widely known centers for small grains research in the South. The expansion into the Regional program in 1930, followed by more adequate funds and facilities starting in 1946, permitted expansion of the breeding and testing work to cover the entire state. Under the leadership of I. M. Atkins, work was expanded to Chillicothe, Iowa Park, Spur, Abilene, Stephenville, Temple, McGregor, Comfort, Prairie View, and Lockart, plus additional disease testing in South Texas and cooperation with several Mexican stations. I. M. Atkins moved to College Station in 1954.

In response to the disastrous greenbug infestation in 1942 and several later ones, Atkins and Dahms (5) discovered greenbug resistance in wheat, barley, and oats. The U. S. Department of Agriculture assigned Harvey Chada, entomologist, to an expanded research program on greenbugs and other insects (44). The U. S. Department of Agriculture further expanded the work on breeding at Denton in 1953 with the employment of Dale Weibel, later replaced by Earl Gilmore (1958-60) and James E. Gardenhire (1960-date).

Breeders at the Denton Substation probably developed or distributed more improved varieties than those at any other single station in the South, or perhaps the United States. Starting in 1926 with Denton wheat, these include Austin, Supremo, Seabreeze, Travis, Bowie, Westar, Quanah, Frisco, Crockett, Caddo, Tascosa, Sturdy, and, in cooperation with the Purdue Experiment Station, the soft wheat varieties Knox, Knox 62, Monon, and Arthur. In addition, Substation No. 6 released Tennessee Winter barley, the basis for establishement of barley as a crop in Texas, followed by Finley, Wintex, Texan, Cordova, Era, and TAMU-B401. They also developed and released the oat varieties Frazier, Nortex, New Nortex, Fultex, Alamo, Alamo-X, Mustang, Bronco, and Norwin, and contributed to the release of Cortez and Coronado.

Studies on lodging in cereals provided the basis for the first short wheats involving the club types–breeding combinations which resulted in the high test weight-high quality varieties of Crockett, Caddo, and Tascosa; continuous release of varieties with improved disease resistance; and development of isogenic line concept for comparing strains differing in simple traits. The isogenic line concept has now been used in basic studies in many crops and fields, resulting in more than 300 publications. Scenes at the Denton Substation No. 6 are shown in Figures 23A, B, C, and D.

College Station

Undoubtedly a number of people on the headquarters staff were concerned with the early testing of small grains. The *Farm and Ranch* of July 1902 (51) reported that F. Holzman, a Texas A&M College graduate, was employed to carry on the cooperative small grain tests, but no further record of this person can be found. A. H. Leidigh, agronomist at A&M, was in charge of corn and small grain from 1915 to 1925. P. C. Mangelsdorf held this position

Figure 22A: The modern facilities of the U.S. Southwestern Great Plains Research Station and Texas A&M Research and Extension Center, Bushland, Texas.

Figure 22B: Large field plots of wheat varieties for yield and quality tests at Bushland, Texas, 1965.

Figure 22C: Modern small grain breeding nursery plots at Bushland, Texas, near Amarillo. O. G. Merkle (left) and K. B. Porter (right), scientists.

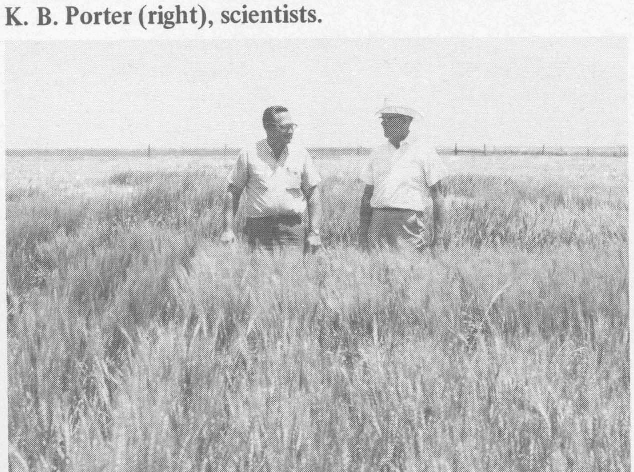


Figure 23A: Texas Substation No. 6 as seen from air, 1956.

Figure 23B: Field day visitors on hill pasture of Texas Substation No. 6, Denton, Texas. Looking toward station grounds, 1956.

Figure 23C: Transporting Station visitors around Substation No. 6 in the horse and buggy days of the 1920's.

Figure 23D: Regional station visitors in 1938 at Texas Substation No. 6, Denton, Texas. Left to right: P. C. Mangelsdorf, TAES, College Station, Texas; J. H. Parker, Kansas Agricultural Experiment Station, Manhattan, Kansas; K. S. Quisenberry, USDA, Lincon, Nebraska; and P. B. Dunkle, Superintendent.

from 1925 to 1938 and made the wheat crosses from which Austin and Westar varieties were developed.

Research on breeding for rust resistance was enlarged in 1936, when E. S. McFadden was transferred to College Station. His famous earlier work of transferring the rust resistance of the emmer wheat to bread wheat won him many prizes, including the *Reader's Digest* and Scott awards. McFadden, with some of the species used in developing his theory of the origin of wheat, is shown in Figure 24A.

Rust research was further expanded in 1951, when Pathologist M. C. Futrell was stationed at College Station (Figure 24B). His basic work on the nutrition of the rusts, their spread in Texas and nationwide, and the development of new races, contributed to better understanding and control of these diseases. The wheat breeding nursery at College Station is shown in Figure 24C.

Research on the root and foot-rots of wheat and on virus diseases was initiated in 1958 by Lee Ashworth and later carried on by Robert Tolar. Facilities for the growing of wheat for disease studies under controlled conditions were greatly enlarged during this period.

Quality testing of experimental strains to determine their suitability to the market needs was initiated in 1948 in cooperation with Arlington State College, at that time a branch of Texas A&M University. In Figure 24D, Paschal Scottino, chemist, is shown judging the characteristics of the experimental samples. Later this work was moved to College Station under the supervision of Lloyd Rooney and enlarged to include quality studies of both wheat and sorghum.

Breeding Wheat by Hybridization

Although the selection method of wheat improvement was that used most extensively before 1920, few hybrids were made, and only a few varieties were developed from crossing selected varieties. The first record of wheat crosses found in Texas Agricultural Experiment Station publications is that in the 1912[9] annual report from the Denton Station. T. W. Buell reported that 15 wheat crosses were made, involving the varieties Mediterranean, Red May, and Dawson Golden Chaff.

The process of hybridization begins with selection of the varieties to be crossed. These must be carefully selected to combine the characteristics needed in the new variety. The flower parts of a wheat spikelet are shown in Figure 25A. After emasculation (removal of the anthers or male parts from the female parent variety before pollen shedding), the mature pollen from the male parent variety is transferred with hand tweezers to the stigma of the female parent when it is receptive. Figure 25B shows this process being carried out in the greenhouse at College Station by Owen G. Merkle, agronomist, and Madhukah K. Kerde, a graduate student from India.

The hybrid resulting from the above cross must be grown through six to eight generations before true-breeding selections can be isolated. Selections must then be tested over a period of years to determine their usefulness, range of adaptation, and quality. The development of a variety by hybridization involves from 8 to 15 years before it is available for commercial growing.

Plant breeding work to develop wheat varieties for the many climateic and soil conditions in Texas requires much specialized equipment, considerable land and building facilities, labor and technical assistance. Finally, the quality testing also requires specialized equipment and trained personnel.

Some of the specialized equipment used in this work is shown in Figure 26. Planting equipment used for seeding hundreds and even thousands of strains is shown in A. A small harvester for experimental small grain plots was designed at Denton in 1948 (Figures 26B, C). This small harvester was built by a local machine shop, and more than 35 were shipped all over the Midwest, where they have been used for many years. Threshing equipment for single heads of wheat or small plot samples is available but not shown. A small plot combine built by a commercial company cuts and threshes small plots for yield tests but may mix the grain (Figure 26D). Other plots cut and threshed by other equipment are grown for seed purposes.

Improving the Soft Wheats

The soft red winter wheats, Red May, 1830-75; and Mediterranean, 1875-1930; were the first wheats grown in North Central Texas. Selections from Mediterranean produced Denton wheat and strains T. S. 3015-72 and T. S. 3015-81. As these strains were susceptible to leaf and stem rust, an early objective was to add rust resistance.

Rust resistant spring wheats became available about 1925. Hope wheat, developed by E. S. McFadden, and others developed in Minnesota and North Dakota were available. P. C. Mangelsdorf crossed McFadden's Hope with Mediterranean in 1928. The variety Austin, released in 1938, in addition to being rust resistant, gave good grain yields and had desirable forage characteristics. By 1945, Austin was grown on 500,000 acres in Texas, but then new races of rust began to attack it and the acreage declined rapidly. Austin and sister strains were used in the development of Quanah, Tascosa, Frisco, and in breeding lines used in plant breeding programs in Kansas, Nebraska, and Indiana.

Because older varieties were no longer satisfactory and Austin now was rusted, the soft wheat milling trade asked the Texas Agricultural Experiment Station if satisfactory varieties could be obtained elsewhere. Cooperation was initiated with the Purdue Agricultural Experiment Station in 1948. Advanced lines from Purdue were tested at Denton, Sherman, Greenville, and Temple from 1948 to 1959. Promising lines from this material were named Knox, Vermillion, and Monon and released jointly by the Indiana and Texas stations. Knox proved so well adapted and popular that by 1956 it dominated the soft wheat acreage of North Central Texas. Knox was later replaced by Knox 62. Breeding work at Denton resulted in the variety Frisco, a rust resistant Red May type. However, it did not become popular, so was grown on only a limited acreage. None of these lines was well adapted in South Texas because of their winter growth habit.

Unpublished data in annual reports of the Texas Substation No. 6, Denton, for 1911 and other years.

Figure 24A: E. S. McFadden with some of his wheat species.

Figure 24B: The wheat breeding nursery at College Station, 1956. (Left to right) I. M. Atkins, M. C. Futrell, and Dale Weibel.

Figure 24C: The small grains nursery at College Station with campus of Texas A&M University in background.

Figure 24D: Paschal Scottino evaluating bread samples from experimental wheat strains. Arlington State College, Arlington, Texas, 1952.

Figure 25A: Wheat flowers.

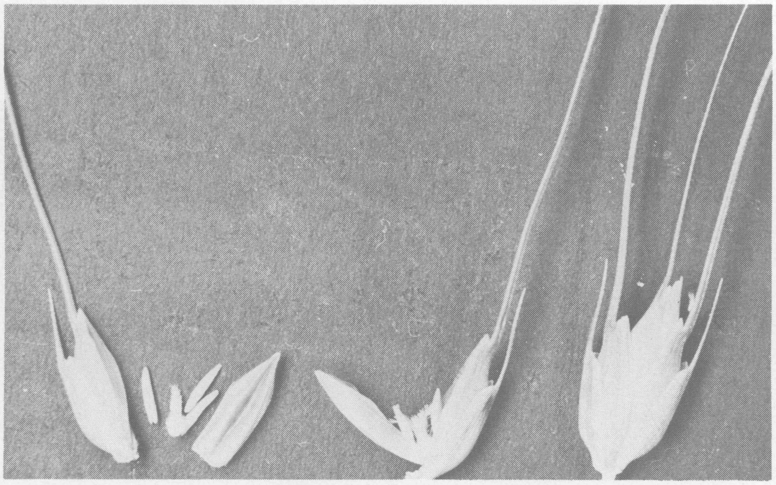


Figure 25B: Emasculating wheat flowers in preparation for making crosses of two varieties in the greenhouse. O. G. Merkle (left) and Madhukak Kherde (right), a graduate from India.

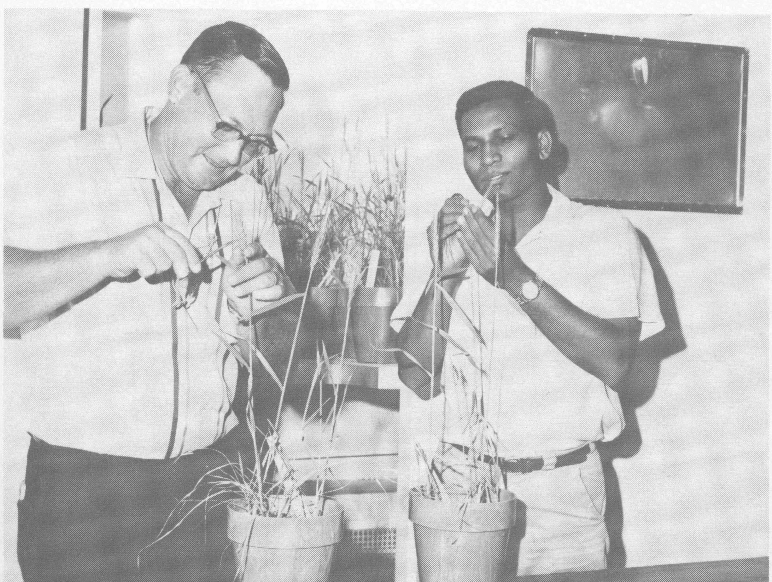


Figure 26A: Small-plot planting equipment. Planting four-row nursery wheat plots at Denton, 1949.

Figure 26B: Small self-propelled nursery harvester designed at Texas Substation No. 6, Denton, Texas.

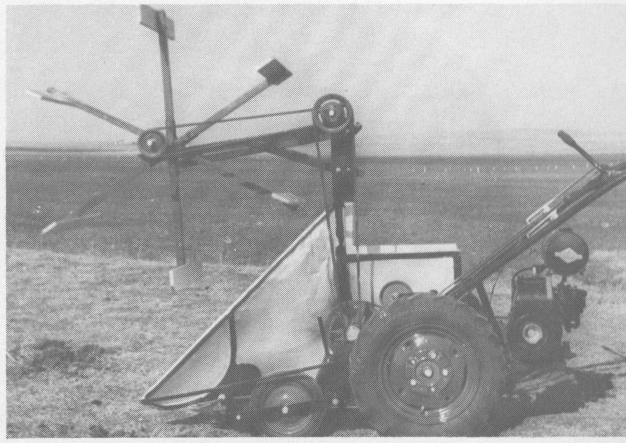


Figure 26C: Harvesting small experimental plots of wheat at Bushland, Texas, 1967.

Figure 26D: Small-plot combine for harvesting nursery wheat plots, Bushland, Texas, 1974.

Breeding work by E. S. McFadden at College Station, also using sibling lines of Austin, produced the varieties Supremo and Seabreeze. Again new races of rust developed, so Supremo was not released in Texas; however, it was found to be adapted in Mexico, where 150,000 acres were grown in 1950.[10] Small acreages were seeded in South Texas from seed brought back from Mexico.

During the 1940's, a stem rust race called 15B caused very serious damage to wheat from Texas to North Dakota. This race was able to attack all commercial varieties of bread and durum wheat being grown. From 1940 to 1950, E. S. McFadden developed the 15B-rust-resistant varieties Travis and Bowie, and seed were increased for distribution. They were recalled before commercial release when still another race developed, which could attack these varieties. As with Austin, these were used extensively in breeding work from Texas to Canada.

Finally, considerable relief from the rust problem was achieved by the release of Milam, an intermediate winter type, useful for both winter pasture and grain in South Texas. Acreage restrictions also were released at this time so that Milam was planted on 100,000 acres by 1969 and continued in use for 10 years.

After Knox 62 was released to replace Knox, several other Purdue varieties were introduced for the soft wheat area. These were in succession, Arthur, Arthur 71, and recently Abe and Oasis. Also Coker 68-15, developed by the Coker Pedigree Seed Company, Hartsville, South Carolina, proved to be widely adapted in Texas in the 1970's and was extensively grown. The excellent forage characteristics, good grain yields, and semi-dwarf plant type encouraged its use even in South Texas.

Improving the Hard Red Winter Wheats

Turkey Wheats: The Turkey wheats were brought to Kansas by Mennonite settlers in 1874 and moved into Texas about 1900. Turkey and Kanred, a Turkey selection, were the dominant varieties from 1924 to 1940, occupying 86 percent of the Texas acreage in 1929. Improvement work in the 1920's and 1930's was concerned with selections from Turkey and a local strain called Keliehor's Russian. Although hundreds of strains were tested, none was released as a new variety.

Utilizing Turkey strains as a base, P. C. Mangelsdorf began in 1926 to make crosses to improve the Turkey type. Included were crosses to spring wheats and to Hard Federation, a white-seeded, strong-strawed, Australian wheat. Hundreds of strains from these crosses were tested at Denton and Amarillo from 1930 to 1945. From this breeding work came the new variety Westar, released in 1942. Westar was immediately very popular and by 1949 occupied 2 million acres in Texas and was grown also in eight other states from Illinois to Oregon.

Cooperation through the Regional program made available the Kansas strains which developed into the popular varieties Comanche and Wichita. These were tested and distributed jointly by the Texas, Oklahoma, and Kansas Agricultural Experiment Stations. Both varieties were grown on one-half million acres each for many years between 1950 and 1965.

Blackhull Wheats: Blackhull and derivatives of Blackhull–Early Blackhull, Chiefkan, Red Chief, BlueJacket, and others spread to increased acreages from 1935 to 1945 until they exceeded the acreage of Turkey strains. Because the Blackhull wheats had distinctly different milling and baking characteristics from those of Turkey strains, they became a problem in the milling trade (Heyne, 63).

Realizing the agronomic problems of the Turkey wheats and the quality problems of the Blackhull wheats, the Texas State-Federal program in 1938 had as its objective to combine the good characteristics of each type into new wheats for Texas. Chiefkan, Red Chief, Early Blackhull, and Blackhull were crossed with Westar, Comanche, Wichita, and other Turkey derivatives, and these hybrids were then crossed to disease resistant varieties or experimental strains from many sources. This breeding work from 1938 to 1955 resulted in new varieties with combined disease resistance, high yield, storm resistance, high test and good quality which have dominated the Texas acreage from 1950 to 1975.

Quanah was the first variety released from this breeding program. While only indirectly related to the Blackhull wheats, it combined a high type of disease resistance and tolerance with good yield and superior quality. Although less well adapted to the drier acres of the State, Quanah found a useful place in Central Texas where the acreage reached 135,000 in 1959. Unfortunately the variety was highly susceptible to loose smut, and this reduced its usefulness.

Following Quanah, Crockett, Caddo, and Tascosa were released from 1954 to 1959. Crockett and Caddo were related to Early Blackhull and of the Wichita maturity class. Both have high test weight, good yielding ability and good milling quality. Each was grown on 100,000 to 600,000 acres from 1959 to 1974, indicating their wide acceptance.

Tascosa probably represents the highest achievement of the objectives of this program of improving the Blackhull wheats. It combines a high degree of storm resistance, strong straw, and high test weight with superior yield and quality. Tascosa has been grown on 100,000 to 700,000 acres from 1962 to 1976 and, in some seasons, has occupied from 60 to 90 percent of the acreage in the high frequency hail area from Amarillo to Lubbock. Some hail insurance companies have given a discount to growers who plant Tascosa in preference to varieties with less storm resistance. The superior test weight of Tascosa, Caddo, and Crockett as compared to Turkey or even Comanche varieties is shown in Figure 27.

The approval of the Milling and Baking Trade for Texas wheats has greatly increased since the release and widespread use of Quanah, Crockett, Caddo, Tascosa, and more recently the semi-dwarfs. Jones Davidson,[11] cereal chemist of Burrus Mills in 1974 stated, "In the 1940's we were

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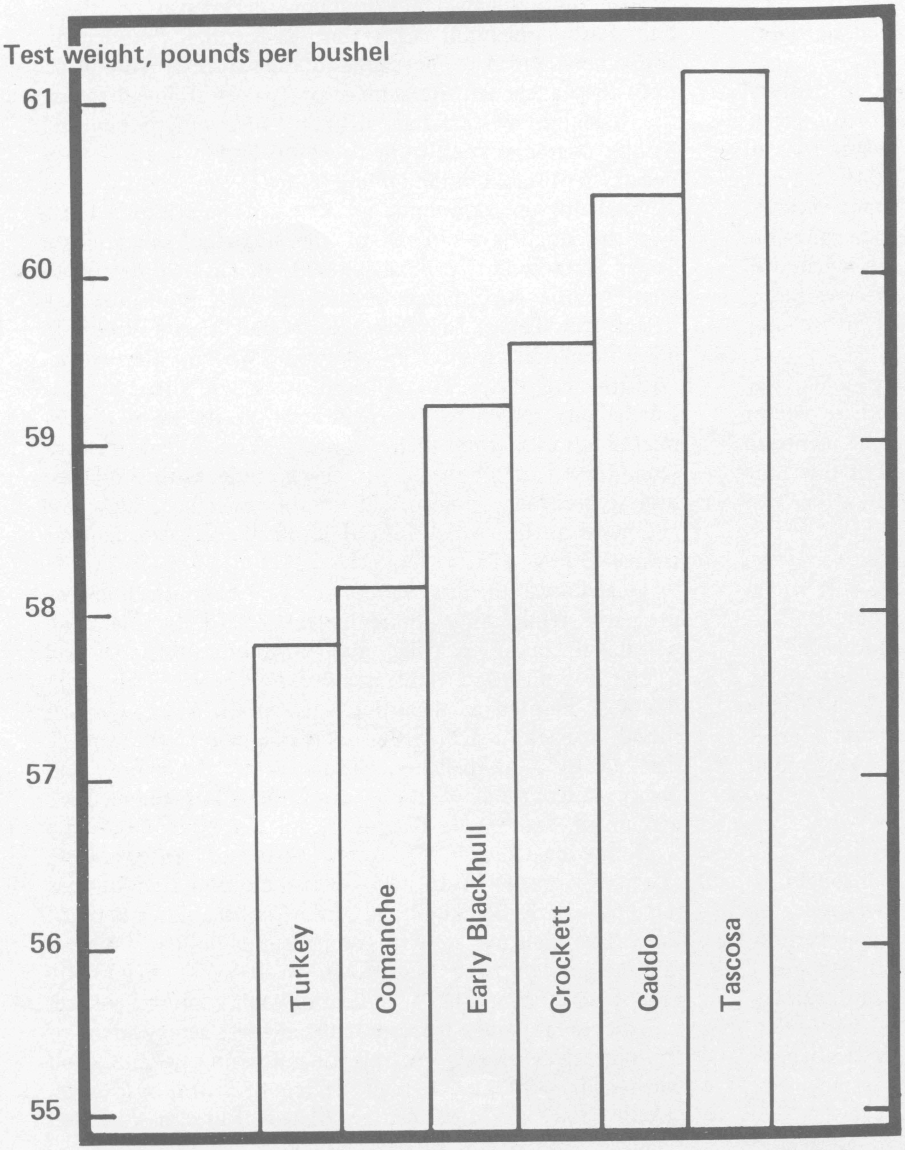
[10] *Private correspondence with Norman Borlaug, Rockefeller Foundation, Mexico City, D. F. On file in the Agronomy Department, Texas A&M University.*

[11] *Private correspondence from Jones Davidson, Cereal Chemist, Burrus Mills, Fort Worth, Texas.*

Figure 27. Mean Test Weight of Dryland-Grown Wheat Varieties at Bushland, Texas, 1958-64



trying to make bakery flour from Chiefkan, Red Chief, Early Blackhull and Blackhull so we had to rely heavily on introduction of strong gluten spring wheats to supplement our poor quality wheats. By 1960, we had sufficient quantity of Quanah, Caddo, Tascosa and others so that our quality was acceptable. We are now getting help from Sturdy and Caprock." Figure 28A shows differences in loaf volume and texture of bread made from Comanche, a good quality variety (left) and from Chiefkan (right).

Mid-Seasons and Early Wheats: Growers of wheat in Texas are always interested in early maturity in order to escape the hazards of rain and hail or simply to deliver the crop to the early market. Consequently, in the early 1940's when varieties earlier than Turkey and Mediterranean became available, there was a rapid shift to these early varieties. The major change came when Early Blackhull, Triumph, and Wichita became available. Early Blackhull was grown on a limited acreage in the 1930's but reached its peak in 1949, when 600,000 acres were grown.

Wichita and Triumph were released about 1940 and spread rapidly throughout Texas and the Southwest. Several Triumph strains were released and the acreage of all strains reached 1,500,000 acres in 1949 (117). From that time until very recently, Triumph strains have occupied from one to two million acres. The acreage of Wichita reached its peak in 1954 when 1,300,000 acres were grown. More than 500,000 acres of Wichita were grown each year from 1954-1970.

The Semi-dwarf program–Redesigning the Wheat Plant: Modern culture of wheat involves complete mechanization of the crop from planting to harvest. Growers select suitable soil, fertilize or irrigate in terms of economics or facilities, and let the crop stand until it is completely ripe and sufficiently dry for storage. Therefore, the tall, rank varieties grown 100 years ago are poorly adapted to modern usages. Plants, which grow from 36 to 60 inches tall, may lodge, shatter, or the straw may break down so that grain is lost or damaged; in addition, the cost of harvesting is increased. A field of Tenmarq wheat, approximately 50 inches tall, at Denton in 1937, is shown in Figure 28B.

Attempts to improve the standing ability of wheat was started at Denton in 1934 (Atkins, 7). The tall varieties Mediterranean, Tenmarq, Red May, and Fulcaster were the commercial varieties then being grown. The World Collection of wheat of the U. S. Department of Agriculture was grown to select strong-strawed varieties as parents in a breeding program. The club-type wheats from Australia and the Pacific Northwest were among the parents used. This program continued until 1946, when the Japanese strains became available. Unfortunately, no strain from this breeding work was considered of sufficient value to be released. Figure 28C shows some of the short, strong-strawed strains developed in this program.

The modern program of semi-dwarf breeding came as a result of the introduction of several dwarf winter wheats from Japan. After World War II, S. C. Salmon, former Wheat Research Leader, U. S. Department of Agriculture, was stationed in Japan with the U. S. Army of Occupation. On one of the northern islands of Japan, Salmon found these dwarf winter wheats (Figure 28D). Norin 10, Seu Seun 27 and others were brought to the United States and distributed to breeders. The Norin 10 strain was used extensively in breeding semi-dwarf varieties for the Pacific Northwest. Gaines was the first semi-dwarf wheat to come from this breeding; it was followed by Nugaines and many others. Using this material as parents, the Rockefeller-Mexico research workers here produced many semi-dwarf spring wheats for Mexico and other countries around the World.

At this same time (1947) crosses with Norin 10 and Seu Seun 27 were made at Denton with the best adapted commercial varieties and experimental strains. After the hybrids had segregated, thousands of progeny lines were tested at Denton, Chillicothe, and Amarillo. The more promising lines were tested in all production areas and in the Regional Nursery. After comprehensive testing for yield, disease reaction, and quality, one strain was named Sturdy and released to growers in 1967. A sister strain proved more productive under irrigation and was released as the variety Caprock in 1972. From bulk hybrid material obtained in regional tests, but selected and tested at Bushland, the variety TAM W-101 was released in 1974. The semi-dwarf nursery at Denton is shown in Figure 29A and Sturdy is compared to the tall varieties Knox and Quanah in Figures 29B and 29C.

Hybrid Wheat: Cytoplasmic male sterility was found in wheat species hybrids about 1960. Both commercial seed companies and State-Federal institutions in several states initiated work towards developing hybrid wheat for use on farms. Members of the Texas staff initiated work at all three breeding stations. Male sterility was transferred to many well-adapted commercial varieties. Later, restorer genes were discovered and incorporated into adapted varieties. Finally, hybrids were made from these male and female lines and tested for yield in comparison with the best commercial varieties. Hybrid vigor could be demonstrated in some materials, but the gain in yield has not yet proved sufficient to justify the commercial production of wheat hybrids for use on farms. Problems include partial restoration, modifying restorer genes, poor pollination in steriles and in crosses, mixing from wind-blown pollen, plus unpredictable gains in yield. Figure 29D shows Keith Lahr of the Chillicothe Station making wheat crosses in the hybrid wheat program in 1968.

Relationships of Wheat Varieties

The varieties of wheat grown in Texas from 1920 to the present time (late 1970's) are inter-related in many ways. The improvement of varieties is usually based on the best varieties available at a given time. Each new variety is usually built from crosses that combine the best commercial variety with one or several traits from another variety that may be superior in certain characters. The result is the gradual building of a pedigree chart similar to that found in animal breeding. Figure 30 shows the basic lines from Turkey wheat from which selections were made; improvement characteristics from other wheats were then added in a series of crosses.

Figure 28A: Bread samples from strong gluten wheats Comanche (A), Tascosa (B), Early Blackhull (C), and Red Chief (D), grown at Bushland, Texas, in 1959.

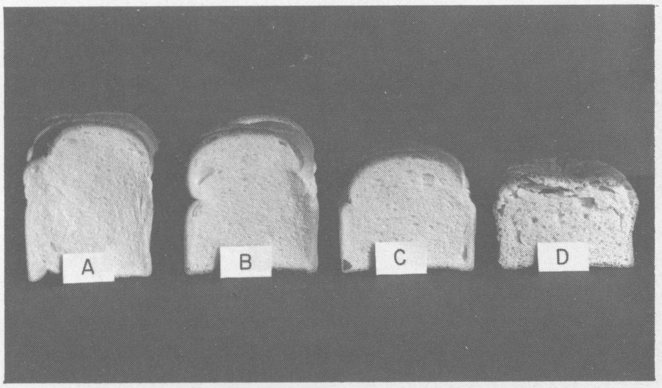


Figure 28B: Tall variety of wheat, Tenmarq, grown at Denton in 1937, 40 to 60 inches in height.

Figure 28C: Short and tall segregates from the cross Kanred x Coppei (club type) at Texas Substation No. 6, Denton, Texas, in 1939.

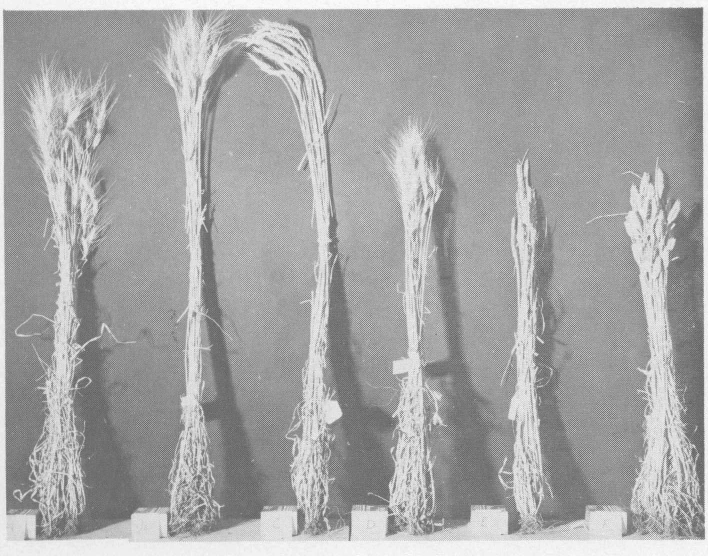


Figure 28D: Semi-dwarf Japanese variety of wheat, one parent of Sturdy wheat (right). Tall variety Quanah at left.

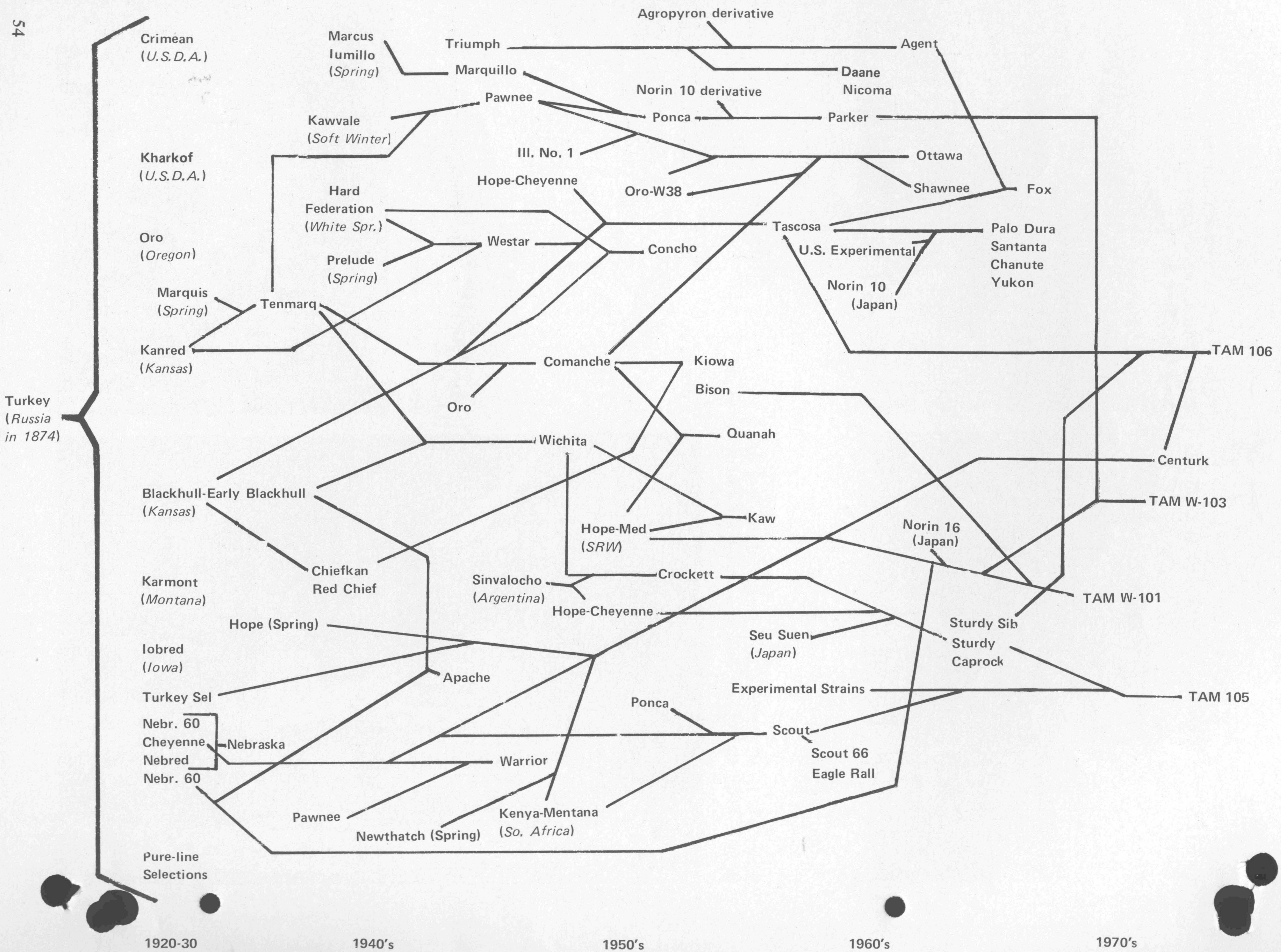
Figure 29A: The semi-dwarf wheat nursery at Denton in 1964.

Figure 29B: C. O. Spence, county agent, demonstrates the height of Sturdy wheat (right) as compared to a tall variety, Knox (left), Sherman, Texas, 1972.

Figure 29C: I. M. Atkins shows height differences of Quanah, a tall variety, and Sturdy, a semi-dwarf variety.

Figure 29D: Keith Lahr, Chillicothe, demonstrates the many crosses of wheat involved in attempts to develop hybrid wheat, 1968.

Figure 30. Pedigree chart of wheat varieties grown in Texas.



Value of a Plant Breeding Program

Wheat research is expensive and requires the services of well-trained scientists and adequate facilities. The question may then be asked, What are the dividends? There are many returns, but some are difficult to evaluate: Higher yields, better test weight, better quality, reduced hail and storm losses, reduced lodging and shattering, more economical use of water and fertilizer, increased value for winter pasture, and protection from disease and insects and others. (Testimonials from growers for many of these characteristics and value of new varieties are on file.) Reitz (97) has reviewed these advantages on a regional level.

Any increase in yield, even though small, when projected to a large acreage, adds up to significantly increased production and income. During its period of use, Westar wheat averaged 2 to 4 bushels per acre more than the Turkey wheats grown previously. When this is projected to 2 million acres, as was grown in 1949, this means an increased production of 4 million bushels.

An effort has been made (Figure 31) to demonstrate the value in grain yields of Tascosa wheat as compared to Turkey. Under dry farming conditions in Texas, Tascosa has consistently yielded 2 to 4 bushels more than Turkey (lower two lines on Figure 31). Under irrigation, where the potential of a variety can be utilized, Tascosa has outyielded Turkey by from 5 to 20 bushels per acre. Furthermore, its ability to stand for harvesting without lodging or shattering adds greatly to its value. Based on the acreages of Tascosa seeded from 1959 to 1972 and a 5 year moving average yield, the increased production from Tascosa for this period has been estimated to be 54 million bushels of grain worth $82 million. Other new improved varieties have added to this return from investment in wheat improvement.

Wheat production and utilization have changed in Texas during the past 40 years, the period of organized wheat research. The use of better adapted cropland for growing wheat, increased use of irrigation, increased use of fertilizers on both dry-land and irrigated acreages, and increased use of the crop for winter grazing have all influenced wheat production. The improvement in milling and baking characteristics of the wheat produced has also contributed to the value of the crop in the market place.

During the early 1930's, partly because of severe drouth, average yields of wheat in Texas often ranged from 8 to 12 bushels per acre. This range continued until about 1950. From 1950 to 1978, there was a gradual, and sometimes rather rapid, increase in average yield (Figure 32). The release of disease resistant varieties with high yield potential and improved quality, and the control of hazards, coincide with and contributed to this increase. The combination of these factors has made Texas a significant contributor to United States and World wheat production. Continuing research promises continuing progress in production of this important food crop.

WHEAT VARIETIES DEVELOPED OR DISTRIBUTED IN TEXAS BY THE TEXAS AGRICULTURAL EXPERIMENT STATION (TAES)

Year	Variety	Developed by	Improved characteristics
1908	Turkey	Introduction	Drouth resistance, hardiness
1922	Mediterranean 3015-72		Leaf rust resistance
1922	Mediterranean 3015-81		Leaf rust resistance, earliness
1924	Denton	Selection	Leaf rust resistance, yield
1926	Kanred	Kansas	Drouth and cold tolerance
1934	Tenmarq	Kansas	Yield, quality
1938	Comanche	Kansas	Yield, quality, leaf rust resistance
1938	Austin	TAES	Rust resistance, yield
1942	Wichita	Kansas	Earliness, yield, test weight
1944	Westar	TAES	Yield, quality, leaf rust resistance
1944	Seabreeze	TAES	Earliness, rust resistance
1946	Supremo	TAES	Disease resistance, yield, forage
1949	Bowie	TAES	Disease resistance, yield, forage
1949	Travis	TAES	Disease resistance, yield, forage
1951	Quanah	TAES	Disease resistance, quality, yield
1953	Frisco	TAES	Disease resistance, earliness
1956	Knox	Purdue	Yield, forage, disease resistance
1956	Crockett	TAES	Yield, test weight, earliness
1956	Caddo	TAES	Yield, test weight, quality
1958	Tascosa	TAES	Storm resistance, test weight, yield
1966	Sturdy	TAES	Storm resistance, yield, quality
1969	Caprock	TAES	Storm resistance, yield, quality
1973	Tam W-101	TAES	Storm resistance, yield
1975	Tam W-103	TAES	Storm resistance, yield, earliness

SOME CONTRIBUTIONS OF THE WHEAT RESEARCH PROGRAM IN TEXAS

Development or introduction of varieties adapted to the several growing areas of the state (preceding list). A total of 24 improved varieties was supplied Texas growers from 1911 to 1974.

Basic studies of the rusts and other diseases of wheat: overwintering, spread, nutrition of the rusts; isolating new sources of resistance or combining old sources for use in improvement work. Examples include isolation from emmer or other species, Mediterranean, Sinvalocho, Renacimiento, Fronteria, Hope, etc.

Basic studies of loose smut of wheat: its influence on yields, means of prevention by seed treatment or isolation of foundation seed, varietal resistance.

Discovery of greenbug resistance in wheat, oats, and barley: genetics and nature of resistance, cultural and insecticidal control; breeding resistant varieties.

Basic studies of straw strength in wheat: effects of

Figure 31. Five-Year Moving Average of Turkey vs Tascosa Wheats on Dryland and Under Irrigation in Texas, 1957-1974

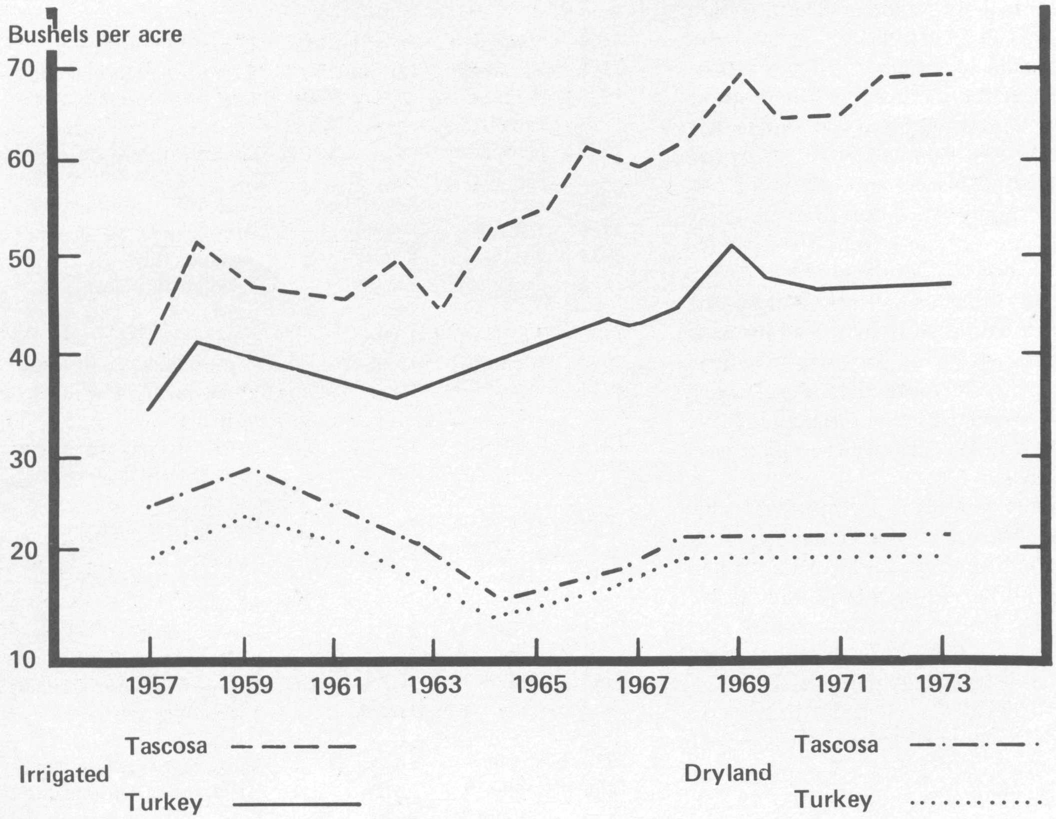
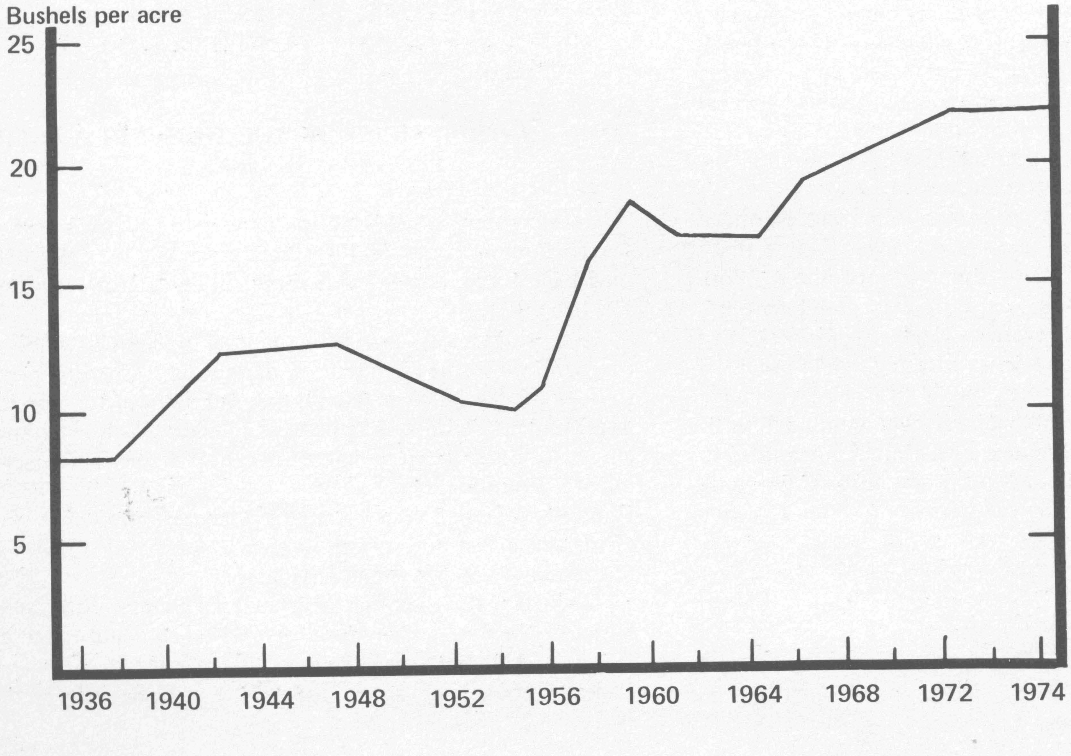


Figure 32. Five-Year Moving Average of Yield of Wheat in Texas, 1936-74



lodging on yield, development of new methods of measuring lodging resistance, inheritance of strength of straw.

Basic studies on plant height: influence on forage production, yielding ability, quality, grain characters, test weight, use in production of hybrid wheat.

Basic studies on the origin of bread wheat: the relationships of species; transfer of characters to common wheat; use of related species as a source of resistance to rusts, Septoria, and mildew; and plant and seed characters.

Invention of a small, self-propelled nursery harvester for harvesting experimental nursery plots.

Development of the isogenic line theory and process for comparing the influence of single genes on plant development, crop yields, effect of diseases, etc. Procedures adopted widely by scientists with publication of more than 250 papers where the idea was used.

Basic studies on shattering in wheat: development of storm resistant varieties Tascosa, Sturdy, Caprock, Caddo, and others.

Basic studies on hybrid wheat: its potentials; methods of crossing; effect on yield, seed size, and forage production; and procedures for use.

Basic studies on quality: the use of the sedimentation test in determining quality; effect of height, seed size, and other factors on quality.

DISSEMINATING INFORMATION FOR CROP IMPROVEMENT

Grower Organizations

At Cat Spring (Austin County), a group of German settlers organized the Cat Spring Agricultural Society (30) in 1856. Their purpose was to experiment with crops and varieties of crops to determine what could best be grown in that area. From 1856 to 1886, they obtained seed of field crops and vegetables, fruit trees, shrubs, and vine crops of many sorts. At the end of the season, the members reported on the success or failure of the variety or crop. They obtained these samples from the U. S. Patent Office, from friends in other states, and from relatives and friends in their homelands. After 1886, the group became largely social in nature, but it continues as an organization 100 years later. The original meeting hall is shown in Figure 33A.

Other growers, too, recognized the value of combined knowledge and experience. At the Texas Corn Growers Association meeting in Waco in 1906, A. M. Ferguson suggested that a Texas Seed Growers Association be formed. The *Farm and Ranch* of November 1909 states that a Small Grain Association was organized at the Dallas State Fair with A. J. Van Cleve of Burkburnet as president. However, no further reference to this organization has been found.

The first Texas Wheat Growers Association was organized at Amarillo in 1921. This developed into a marketing organization of some importance, later became the National Grain Company, then in 1929 changed back to the Texas Wheat Growers Association. More recently it became Producers Grain Corporation, a cooperative (82).

The present Texas Wheat Growers Association was organized in 1950. The Directors are shown in Figure 33B. Later a Rolling Plains Wheat Growers Association was organized as part of the parent organization. These and other grower organizations have assisted in obtaining funds for wheat research. Members of the Texas Wheat Growers Association, along with members of the wheat research group of the Texas Agricultural Experiment Station, are shown in Figure 33C observing the wheat experiments at College Station in 1956.

Agencies for Inspection and Certification of Seed

The Texas 25th Legislature of 1887 set up a department of Agriculture, Insurance, Statistics, and History. In 1905, this organization was given the responsibility of inspecting trees, plants, and shrubs for diseases. In 1907, the Legislature established a Department of Agriculture with an elected commissioner. This department became very active in providing agricultural information to the farmers and published many bulletins on agricultural subjects.

An Act requiring the labeling of seed was enacted in 1919, but the establishment of rules and regulations for the certification of wheat, cotton, and grains did not come until 1930 (115). R. V. Miller was the first chief of this division under the State Department of Agriculture. After this date, the inspection and certification of planting seed has been the approved means of securing disease and weed free, pure seed of grain varieties.

A number of county or area-wide organizations were formed to grow and market certified seed. The Denton County Pedigreed Grain Association grew and marketed Nortex oats and Denton wheat, the first varieties distributed by the Texas Experiment Station. Recently (October 1976), the Texas Certified Seed Association was merged with the Texas Seedmens Association into the Texas Seed Trade Association with headquarters at Waco. Farmers, commercial seedmen and specialized growers and suppliers are thus grouped together in efforts to improve the quality and availability of good seed.

Extension and Forerunners of Extension Service

Farmer's Congress meetings were first organized in 1898 by Texas A&M College and continued through 1914 as a means of education. Meetings were given wide publicity in the farm press of that day, and railroads gave special rates and sometimes provided special cars and trains for travel. Some meetings were attended by as many as 2,000 farmers.

Apparently in 1910 there was a change in sponsorship of such meetings. H. H. Harrington, President of Texas A&M College, told the thirteenth Congress, "It is not the function of Texas A&M College to organize farmers' institutes and develop extension work (58)." The Texas State Department of Agriculture then sponsored the Farmers' Institutes from 1911 to 1920.

Under modern conditions, the other half of the research program is that of taking the information from research to the growers. The Texas Agricultural Extension Service now has a highly developed staff of county agricultural, and home economics extension agents and area specialists.

Figure 33A: The Cat Spring Agricultural Society Hall at Cat Spring, Texas, 1856 to 1976.

Figure 33B: The Directors of the Texas Wheat Growers Association, 1950. (Left to right) R. C. Buckles, Leo Witkowski, Kenneth Kendricks, Kenneth Edwards, and R. V. Converse.

Figure 33C: Wheat Research Advisory Committee at College Station, Texas, in 1956. (Left to right) Kenneth Kendricks, Fred Dines, K. B. Porter, M. C. Futrell, R. C. Buckles, Dale E. Weibel, E. S. McFadden, and George W. Rivers.

The Texas Agricultural Extension Service was started in 19[illegible] was a cooperative project of the Texas Agricultural Experiment Station and the U. S. Department of Agriculture. The first local agent was established in Smith County in 1904. By 1914, some 60 counties had employed county agricultural agents. The Smith-Lever Act of 1914 provided funds for cooperative educational work with men and women and, through club work, with boys and girls.

Providing subject matter specialists in some counties or areas came much later. The first area wheat specialist was Fred Dines, who served from 1951 to 1954. Since 1965, Frank Petr has been Extension Area Agronomist, located at Amarillo.

An annual field day or other special days for different interest groups have provided one means of distributing information to many people at one time. Substation No. 6 at Denton started a series of special days in 1921 which have continued to the present time. Very large crowds attended these days during the 1920's as indicated by the cars at a field day at Denton in 1924 and truck transportation of groups of farmers at McGregor in 1962 (Figures 34A and 34B). A wheat demonstration plot is shown in Figure 34C. The number of visitors at the Denton field days and on other occasions for the period 1921 to 1935 is given below:

Number of visitors at Texas Substation No. 6, Denton

Year	Field Day	Others	Total
1921	1,125		1,125
1922	1,238		1,238
1923	1,200	872	2,072
1924	1,600		1,600
1925	1,000	461	1,461
1926	2,000	562	2,562
1927	1,500	510	2,010
1928	2,000	987	2,987
1929	2,000	786	2,786
1930	1,500	1,149	2,649
1931		1,121	1,121
1932		945	945
1933	1,000	300	1,300
1934	250	742	992
1935	1,500	1,099	2,597

Fairs and Demonstrations

County, area, and state fairs were established in many communities soon after they were settled. The earliest noted was in 1852 at Corpus Christi. Ellis County held fairs before the Civil War. The sixth annual fair was held at Austin in 1880, indicating that the first must have been held in 1875 (Barkley, 12). The Dallas State Fair was started in 1886. Director Connell states (38) that Texas A&M College displayed 81 samples of oats, 56 samples of wheat, 11 samples of barley, and 4 samples of rye at the State Fair in 1895.

Probably the most striking display of agricultural products was that at the Fort Worth Spring Palace of 1889 and 1890 (Figure 35). This giant building was constructed of grain and forage products on a wooden framework and designed for the display of crops and vegetables from all parts of Texas. It was planned and promoted by Robert A. Cameron, Commissioner of Immigration for the Fort Worth and Denver Railroad. A week's celebration and show culminated in a great ball attended by 7,000 people from all parts of the state. On the last night of the 1890 fair, the Palace caught fire, supposedly from a discarded cigarette, and burned down in a few minutes. Fortunately only one person was killed, but others were injured (Paddock, 88). After 1900, most counties had fairs for exhibiting crop and livestock, and many area fairs were organized.

During modern times, rapid and diverse means of newspaper, telephone, radio, television, and county extension services have reduced the importance of fairs as a means of education in agriculture. However, there is still regional recognition of agriculture's importance. The principal wheat producing area, the High Plains, has held a wheat pageant each season since 1946. Held at Perryton, Ochiltree County, in August each year the pageant consists of parades, programs, and exhibits, culminating in the coronation of a Wheatheart of the Nation. Cities, counties, and areas of Texas and nearby Oklahoma and New Mexico enter talented and beautiful girls in the contest.

Various means of "taking the meassage" to the people were used during the period of settlement and establishment of crop production in Texas. The Santa Fe Railroad published a magazine, *The Earth* (50), from 1904 to 1938, which gave information on crops from Texas to California. The demonstration fields established by rail companies (see section "Rolling Plains") and the field days had one purpose in common: to demonstrate the value of the area for settlement. Later the emphasis shifted to "improvement" and "extension" of the bounty of the land. Current wheat production is one success story of that emphasis.

Figure 34A: Cars at a field day at Denton, Texas, Substation No. 6, in 1924.

Figure 34B: Transporting visitors at a field day at McGregor in 1962.

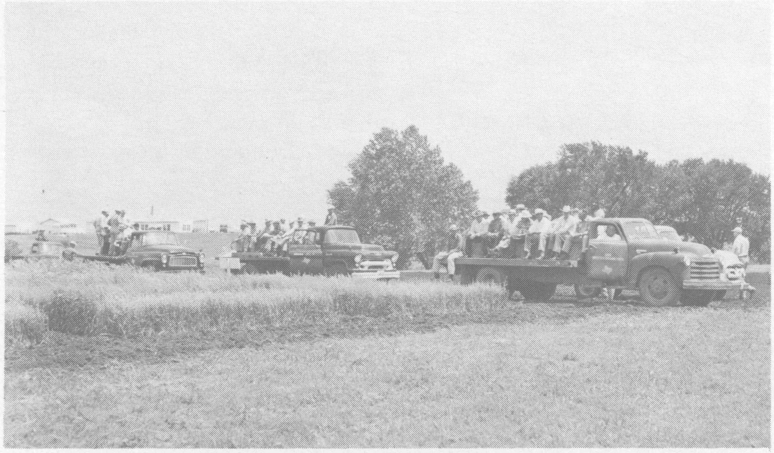
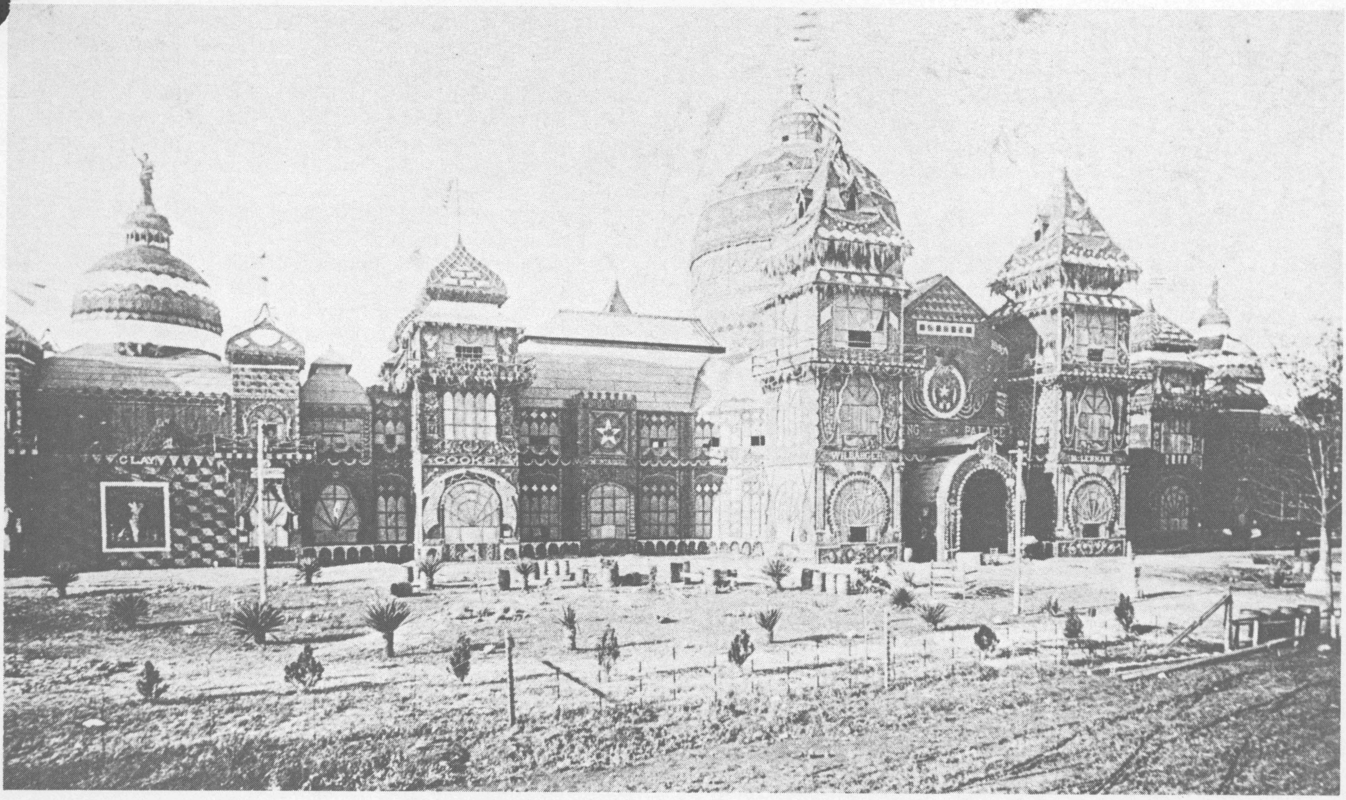


Figure 34C: A farm wheat demonstration of varieties at Plainview, Texas, in 1968.

Figure 35: The Fort Worth Spring Palace. (Courtesy Amon Carter Museum, Fort Worth, Texas.)



Texas A&M University, Agricultural Experiment Station Personnel Making Important Contributions to Small Grains Research

Department of Agronomy and Main Station Farm, College Station

1918-1925	A. H. Leidigh, small grains leader.
1926-1938	P. C. Mangelsdorf, agronomist, corn and small grain.
1936-1955	E. S. McFadden, agronomist, U. S Department of Agriculture.
1954-1969	I. M. Atkins, section leader, small grains, flax.
1949-1956	George W. Rivers, agronomist.
1953-1961	M. C. Futrell, pathologist, rust research, U. S. Department of Agriculture.
1963-1968	R. A. Kilpartrick, pathologist, U. S. Department of Agriculture.
1968-1974	Francis Gough, pathologist, U. S. Department of Agriculture.
1968-date	Earl C. Gilmore, agronomist, wheat research.
1965-date	Robert Toler, pathologist, wheat diseases.
1962-date	Lloyd C. Rooney, cereal chemist.

Texas Substation No. 1, Beeville, Texas

1938-date	Lucas Reyes, agronomist.

Texas Substation No. 4, Temple, Texas

1946-1976	M. J. Norris, agronomist.

Texas Substation No. 6, Denton, Texas

1911-15	T. W. Buell, superintendent.
1917-1921	C. H. McDowell, superintendent.
1922-1947	P. O. Dunkle, superintendent.
1930-1954	I. M. Atkins, agronomist, U. S. Department of Agriculture.
1946-1952	M. J. Norris, agronomist.
1952-date	J. H. Gardenhire, agronomist.
1946-1971	D. I. Dudley, superintendent.
1953-1958	D. E. Weibel, agronomist, U. S. Department of Agriculture.
1958-1960	E. C. Gilmore, agronomist, U. S. Department of Agriculture.
1951-1958	Harvey Chada, entomologist, U. S. Department of Agriculture.
1929-1972	Nolan Thurmond, foreman.
1946-date	Eugene Wilkenson, technician.

Texas Substation No. 12, Chillicothe

1925-1961	J. R. Quinby, superintendent.
1955-date	K. A. Lahr, agronomist

U. S. Great Plains Research Station, Bushland

1938-1945	David A. Reid, agronomist.
1947-date	K. B. Porter, agronomist.
1951-date	Norris Daniels, entomologist.

Texas Agricultural Extension Service

1951-1954	Fred Dines, Extension agronomist.
1965-date	Frank Petr, Extension agronomist.

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Oats in Texas Through Three Centuries 1731-1976

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OATS IN TEXAS
THROUGH THREE CENTURIES
1731-1976

Oats have not been under cultivation as long as the other cereal crops. There is no definite record to lead botanists to believe that oats were known to the ancient Chinese, Hebrew, or Hindu peoples (Stanton, 61). The common oat appears first to have been found growing wild in regions of Western Europe; from there it spread to various parts of the world.

The first authentic historical notes on cultivated oats appear in writings of Columella, Diescordes, Pliny, and others of the early Christian era. These indicate that the common oat, *Avena sativa* L., was grown by Europeans for grain and the red oat, *Avena byzantina* C. Koch., for forage, particularly in Asia Minor. The general belief was that oats were probably first observed as weeds in fields of barley and later domesticated. It may have been grown by the ancient Slovakian peoples who inhabited Western Europe during the Iron and Bronze Ages.

INTRODUCTION OF OATS TO THE AMERICAS

Oats are not native to the Americas; like all other cereals but corn, they came into North America through two routes. The first was with Northern Europeans, who used oats as a grain and forage crop for livestock and, to a lesser extent, for human food. No doubt many of them brought seed of oats with them as they settled along the east coast to form the new Colonies.

An even earlier record of introduction in North America is known. Carrier (21) quotes from a letter of a fisherman, printed in London in 1809, who stated that during a visit to Newfoundland in 1578 "I have in sundry places sowen wheate, barlei, oates and rie." Mason (46), the U. S. Commissioner of Patents in 1853, reported that Captain Gosnold grew oats on Elizabeth Island, off the coast of Massachusetts, in 1602. Gray and Thompson (36), however, believe that the first oats were grown by the Raleigh colonists of Virginia in 1586, who planted a crop, but returned to England before it was harvested.

The first permanent colonists of Virginia grew oats in 1607 (Gray, 36), and the Dutch settlers of Manhattan Island grew oats in 1626 (Mason, 46). George Washington wrote in his diary of 1764 that he "seeded a few oats in the fall to see if they would stand the winter." Later, in 1786, Washington planted 580 acres of oats (Haworth, 39).

Oats did not move westward until about 1730, when Pennsylvania Mennonite farmers moved into the Shennandoah Valley and the Piedmont area (Gray, 36). Oats spread westward more slowly than other grains and, until 1839, were confined largely to the eastern states (Stanton, 61).

Texas pioneers from the eastern and northern states, too, brought seed of oats and other grains, but there are few records of this. One must assume that many of the varieties grown in the East and North were introduced into Texas from 1830 to 1900.

The second path of introduction of grains into Texas was by way of the West Indies and Mexico.[1] As Mexico and southern Texas were settled by the Spanish, corn was grown as the main food grain, but soon wheat and other grains were mentioned in accounts of the period. However, there are relatively few references to the growing of oats. Hendry (40) provides the best evidence of the use of oats in these areas. In the adobe walls of old missions, built in northern Mexico, California, and Arizona, he found both red and white colored oat seed. Atkins (14) examined adobe bricks from the ruins of "Landin Mission" built near Saltillo in 1745. Seed and spike parts of wheat and barley but no oat fragments or seed were found.

All Texas missions were planned to be self-supporting, with farms on which they grew cotton and sugar cane as well as grain crops (Johnson, 43). Numerous chroniclers of these early missions mention the growing of corn, wheat, and other grains. The "other grains" may or may not have included oats. Apparently oats were not of great importance in this period. Castenada (22) translated the diary of Bishop Pedro Tamaron of Durango, who visited El Paso in 1760 and reported that corn and other grain crops were cultivated.

OATS IN THE COLONIAL PERIOD

German and other European settlers colonized Texas from 1820 to 1890. At about the same time, Anglo-American settlers came to Texas from the eastern, northern and southeastern states by overland routes and through Gulf ports. Here again was opportunity for the introduction of oats into Texas.

Stephen F. Austin (17) in his, *Description of Texas in 1828-1833,* stated that "Some experiments have been made in growing wheat, oats, barley, rye and flax and these have succeeded in the undulating country back from the Coast." A few years later in 1840, Allen (5) in his *Guide to the New Republic,* advised immigrants that "of the grains, the cultivation has just begun. In the undulating and mountainous portions of the country, all the grains produce in abundance. In the level parts of the country, all the grains except wheat and buckwheat may be cultivated with success."

Felix Bracht (20), who engaged in business at New Braunfels from 1845 to 1855 and traveled extensively in Texas, wrote, "All European crops, wheat, oats, barley and rye, do well in the Hill Country [Edwards Plateau] area of South Texas." Also, Ferdinand Roemer (56), a German scientist and author who traveled statewide observed in 1847 that "Oats are grown successfully in the Colorado River Valley near Bastrop." Crystal Ragsdale (52) recorded

[1] *These introductions are described in "Wheat for Man's Bread, Introduction, Production, and Research," pp. 1-17 of this publication.*

an interview with Mrs. Elise Willrich, a pioneer of La-Grange, who stated that wheat, oats, barley, and rye thrived in the LaGrange area.

However, another opinion was expressed by Goodman (35). "They grow no oats or barley here [Leon County] as we have no use for them. The cattle, hogs and horses can feed themselves on the range throughout the year."

ESTABLISHMENT OF OATS AS A CROP

Oats in Central and East Texas

Starting about 1845 and accelerating after the Civil War, the settling of Central and East Texas occurred rapidly, with much land being put into cultivation. For example, Parker County was organized in 1856 and by 1860 had a population of 6,000 people. Likewise, Denton County was organized in 1846 and in 10 years had 600 registered voters, (Richardson, 54). W. C. Holden (42), in a review of immigration into Texas, observed that 50 wagon trains per day came through Clarksville in the fall of 1858. Small grains were the surest crop in Hill County in 1852 (Kilpatrick, 44).

T. C. Conners (28) found and reproduced the report of an explorer, Edward Smith of England, who traveled in North Texas in 1849 to evaluate it for English investors. Smith observed that "Oats grow well in every county but we saw few crops because corn is preferred as a feed for livestock."

The first U. S. Agricultural Census was made in 1850 (69). At that time oat production of 199,017 bushels was reported from North Central Texas. By 1870 the acreage was only 34,000, but by 1880 it had increased to 300,000.

Coinciding with the settlement of North Central Texas, the introduction of Red Rustproof oats occurred after the Civil War. These and other winter hardy varieties provided both grain and winter pasture. By 1900 the acreage had increased to 847,225, and by 1919 to 1,500,000.

Oats in the Rolling Plains

Settlement of the Rolling Plains area followed soon after that of North Central Texas. Some settlers arrived before the Civil War, but withdrew to more protected areas during the fighting and before the frontier forts were reestablished. The U. S. Army, in cooperation with the Texas government and Texas Rangers, established a series of forts from the Oklahoma Territory to the Rio Grande from 1846 to 1858. Many of these were abandoned during the War, and later, with others reestablished to protect West Texas settlers. The Rolling Plains was settled rapidly after 1875.

Livestock production was the major industry of the Rolling Plains, but many ranches also broke out sodland along the streams to put in small acreages of feed crops. Marcy (45), who spent 30 years on the frontier of this area with the U. S. Army, recorded that Jesse Stern, the Comanche Indian Agent at Camp Cooper [about 7 miles north of historic Fort Griffin in Throckmorton County] conducted an experiment in 1853 which demonstrated that farming was practical in the area. Stern turned the sod with a prairie plow and planted corn and oats. The crops were successful and produced bountiful yields of grain.

Another instance of the early culture of oats occurred at the establishment of Fort Sill in 1869 (Richardson, 55). An officer, Colonel Whaley, saw an opportunity to make a profit and resigned from the Army to begin growing oats. Whaley put into cultivation land in the bend of the Wichita River in present-day Clay County and grew 15,000 to 20,000 bushels of oats each year, which he sold to Fort Sill at $1.25 per bushel.

Railroads, real estate agencies, and chambers of commerce in cities and counties promoted land sale in the Rolling Plains from 1875 to 1900. Descriptive folders, advertisements in eastern papers, and special train excursions were used to attract settlers. The Texas and Pacific Railroad established demonstration farms at Baird, Stanton, and Midland where cotton, corn, grains, fruits, and vegetables were grown to show to prospective settlers (Blacklen, 19). The Santa Fe Railroad also set up demonstrations along the right-of-way to show what crops could be grown (*Earth Magazine*, 32). The 1850 population of all of West Texas was only 4,412, but by 1900 had increased to 755,260. During this period an estimated 5 million acres were homesteaded in the Rolling Plains alone (Holden, 42).

Oats on the High Plains

Although a few small farms were established earlier, the bulk of the High Plains area was put into cultivation between 1890 and 1920. Francis Phillips[2] and G. L. Nall (50) have reviewed the establishment of agriculture on the High Plains. Phillips states that the first field of oats was grown in 1878 on the T-Anchor Ranch near Canyon [Randall County]. The oats grew well but a herd of buffalo destroyed them before maturity.

In his history of Old Tascosa, the forerunner of present-day Amarillo, E. P. Archambeau (7) states that Tascosa had its beginning in 1876, when Casimira Romero drove 3,000 sheep into the area from Moro County, New Mexico. Romero and his relatives settled in the Canadian River area northwest of Amarillo and established the town. (Their adobe home stood for 70 years and only recently has been razed.) In 1946, Archambeau (6) interviewed Jose Ynocencion Romero, a son of Casimira Romero, who recalled, "My father in 1879 planted a crop of oats in a field in order to establish alfalfa. I never saw such a crop in my life. The men cut the oats with cradles and bound it for feed."

Items from the *Tascosa Pioneer*, published from 1886 to 1888, were reprinted in the *Dodge City Times;* White (73) has made these available. An item from Mobeeti in August 1884 stated, "Those of our farmers who had an oat crop this season claim 50 to 75 bushels per acre, but there is no way to prove it as we have no threshers. There is no doubt that small grain is the crop for this country."

L. F. Sheffy (58) has made available information from

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[2] *Phillips, Francis 1946. The development of agriculture in the Panhandle-Plains of Texas to 1920. Unpublished MS. thesis, West Texas State Teachers College, Canyon, Texas.*

the records of the Franklyn Land and Cattle Company, an English-owned ranch which operated from 1882 until 1957. This ranch occupied parts of three counties with headquarters at White Deer. In 1882 B. B. Groom, manager, wrote the owners for permission to plant oats and wheat. The next summer he reported growing 5,000 bushels of oats.

The Texas Almanac of 1883 (63), in an article entitled "Report on the Texas Panhandle," states that corn and oats were grown in Crosby County in 1880. Records of the XIT Ranch[3] near Dalhart show that oats were seeded in 5-acre fields on all four divisions of the ranch from 1886 to 1889. The 1886 crop was successful but the others were failures. Oats were also grown in Carson County in 1896 (Randell, 53).

The U. S. Department of Agriculture established experiment stations at Dalhart and Amarillo in 1906 and tested oats there from 1906 to 1916 (Ross, 57). During these early years, only spring-type or non-hardy winter-type varieties were available, and in general the crop was not successful. In modern times more cold-tolerant varieties are available and can be fall-sown for grain, winter pasture, and hay.

ACREAGES AND DISTRIBUTION

Annual estimates of acreages and production of crops for Texas began in 1866 (Figure 1A). Prior to 1926 only planted acreages were recorded; after this date, reports included both seeded and harvested acreages.

Seeded and harvested acreages vary greatly from one season to another, being influenced by several factors. Data for the period 1866 to 1975 have recently been published by the Texas Crop and Livestock Reporting Service (65). Averages by 5-year periods were computed (Table 1).

Oats have been used for winter pasture for livestock, as well as for grain, since the introduction of the Red Rustproof strains after the Civil War. Usually livestock were removed from the fields about March 1, and the crop was allowed to mature a grain crop. In the 1930's there began a trend to graze an increasing proportion of the crop to maturity or until it was killed. The crop was often more valuable for grazing to fill in the period from late winter until permanent pastures were available. Small grain forage provided a high quality feed for breeding herds or for young animals. Another trend began in eastern Texas at this time to reduce the acreage of row crops and return land to permanent or supplemental grass pastures. Other factors influencing this trend to graze oats to maturity were the use of tractors to replace draft animals, the introduction of hybrid corn and sorghum, and the development of varieties with greater forage producing potential.

The largest acreage of oats ever planted in Texas was 2,834,999 acres sown in 1955. Of this only 45 percent, or 1,283,000 acres, was harvested. The unharvested acreage included that grazed to maturity and that lost to winter killing, to drouth, to diseases, and to insects. From 1959 to 1975 the harvested acreage was low. The lowest percentage ever harvested for grain was in 1971 when only 9 percent (222,000 acres) was harvested from that seeded (2,359,000 acres).

Production of oat grain reached a peak in 1919, when 62,205,000 bushels were produced. Other years of high production were 1926 with 57,086,000 bushels and 1931 with 61,435,000 bushels. These peak periods occurred when draft animals were the source of power on the farm, and oats were fed to all classes of livestock and poultry. Production of grain dropped to an average of 16,853,000 bushels for the period 1966 to 1975. By contrast, the average production from 1916 to 1930 was 36,114,600 bushels.

The distribution of oat acreage for 1879, 1909, and 1975 is shown in Figures 1B, 1C, and 1D. In 1879 the acreage was all in East and Central Texas; by 1909 grain was still largely centered in the eastern parts but had spread to the Rolling Plains and to a lesser extent, to the High Plains. From 1930 to 1975, oats distribution in Texas has changed little.

VARIETIES OF OATS GROWN

Northern Varieties

Relatively little is known about the oat varieties grown in Texas during the colonization period 1830 to 1870. Where oats are mentioned, they are referred to only as a crop. Most of the immigrants to the United States came from northern Europe where the common spring-type oat, *Avena sativa* L., was then grown. This type is generally not cold or drouth tolerant and probably was not very satisfactory in Texas.

The *Country Gentleman,* a national farm magazine first published in Philadelphia in 1853, and *American Agriculturalist,* published from 1843 to date, have numerous letters, articles, and advertisements which give clues as to what was grown or available. These early magazines mention the varieties Siberian, Black Tartar, Scotch Imperial, Sunrise, and Probsteier.

A Philadelphia farmer wrote in 1872 that he grew seven kinds of oats, namely, Common, Prince Edward Island, New Brunswick, Norway, Surprise, Nova Scotia and Scotch Potato (Dunton, 31). R. Von Olinda (70) reported in 1867 that Surprise oats was selected from a sample of wheat obtained from the Patent Office. The editor of the *Country Gentleman* reported in 1856 that Poland oats should be named Dutch or Friezeland, that Siberian oats had recently been introduced, and that Black Tartarian originated from a single head found in other oats (Tucker, 67).

The editor described seed of Black Tartar as glossy black and weighing 36 pounds per bushel, but pointed out that J. A. Clark, Marion, Ohio, grew black oats from France which weighed 48 pounds per bushel. In 1859 the editor reported on growing oats in the South, suggesting California white oats or Prince Edward Island black oats as the best varieties. For winter grazing, he suggested Egyptian oats

[3] *Records of the XIT Ranch on file in Archives of the Panhandle Plains Museum, Canyon, Texas.*

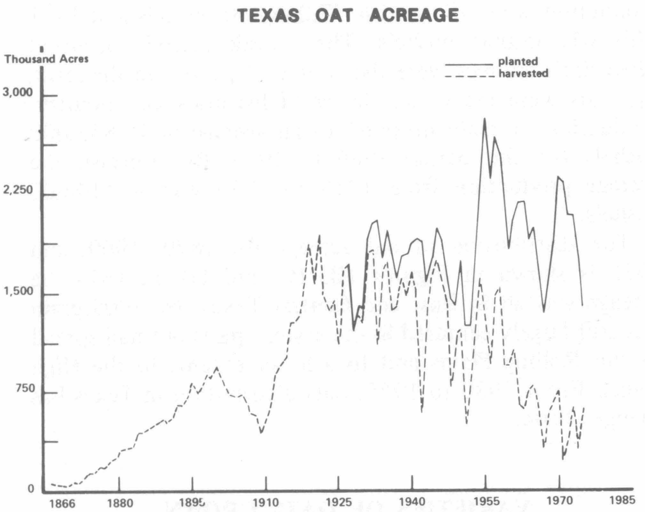

Figure 1A: Texas oat acreage, 1866-1975. (Courtesy State Department of Agriculture.)

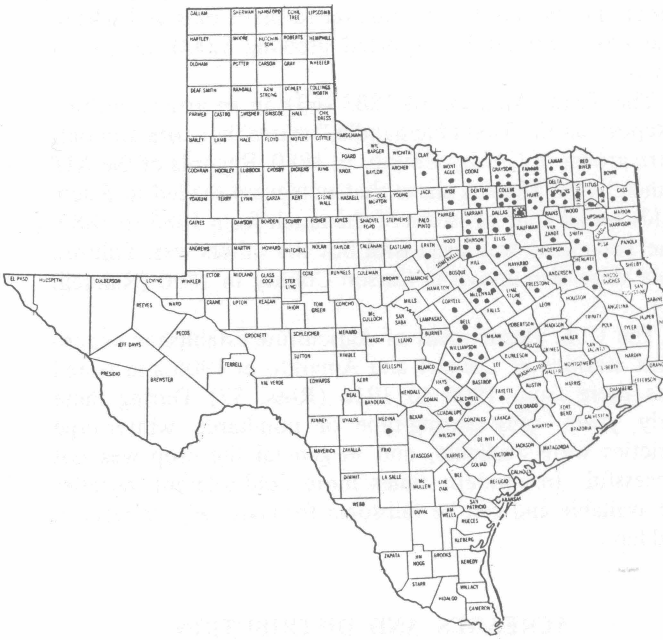

Figure 1B: Distribution of oats in Texas in 1879. Each dot represents 2,000 acres. (Constructed from figures in the United States Census of 1880, Vol. 3, *Agriculture* pp. 205-208.)

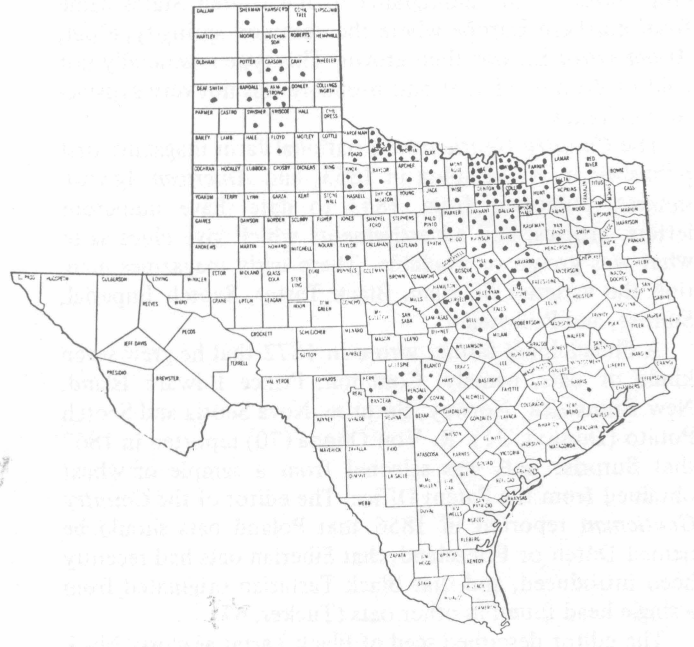

Figure 1C: Distribution of oats in Texas in 1909. Each dot represents 2,000 acres. (Constructed from figures in the United States Census of 1910, Vol. 3, *Agriculture* pp. 678-700.)

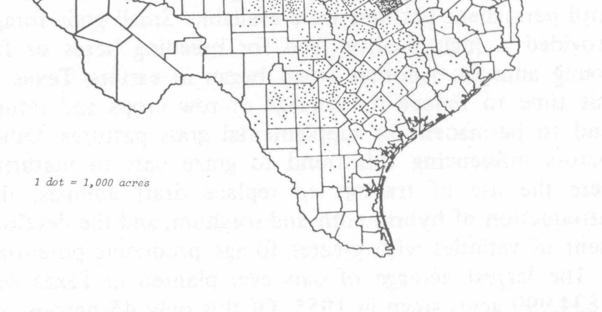

Figure 1D: Planted acreage of oats in Texas, 1975. (Courtesy Texas State Department of Agriculture.)

TABLE 1. OATS IN TEXAS, ACREAGE, YIELD, PRODUCTION, AND VALUE BY 5-YEAR PERIODS*

Period	Acreage planted	Acreage harvested	Yield per harvested acre	Production, bushels	Season average price per bushel, dollars	Value of production, dollars
1866-70		32,800	26.6	869,000		
1871-75		78,400	26.6	2,163,000		
1876-80		228,200	24.2	5,472,000		
1881-85		378,000	26.3	9,947,400		
1886-90		500,000	21.8	10,921,000		
1891-95		672,000	26.9	18,064,000		
1896-1900		830,400	30.3	25,426,400		
1901-05		736,000	27.0	19,567,000		
1906-10		560,000	26.1	15,008,000	0.54	6,195,000
1911-15		932,000	27.9	26,452,000	0.48	11,496,000
1916-20		1,505,800	24.6	37,780,000	0.73	27,158,000
1921-25		1,459,800	23.2	33,618,800	0.51	16,734,000
1926-30	1,473,400	1,437,200	25.4	36,938,810	0.45	16,267,000
1931-35	1,945,000	1,616,000	26.6	40,897,200	0.29	11,031,000
1936-40	1,770,600	1,500,600	24.3	36,740,000	0.34	12,087,400
1941-45	1,822,400	1,336,600	22.3	29,418,200	0.65	18,844,200
1946-50	1,640,200	1,234,000	21.0	26,275,000	0.85	21,918,600
1951-55	1,889,600	1,096,800	21.6	24,443,000	0.83	19,422,600
1956-60	2,325,000	1,166,600	23.6	28,069,000	0.69	18,904,800
1961-65	2,069,800	778,800	24.6	19,488,000	0.74	14,201,400
1966-70	1,788,000	592,400	31.8	19,713,000	0.74	14,191,400
1971-75	1,951,800	436,400	30.4	13,992,800	1.16	16,888,600

*Courtesy Texas Department of Agriculture (65).

brought from Scotland (Tucker, 68).

There seems to be some confusion about Egyptian oats as White (72) of Athens, Georgia, stated that winter oats were a recent introduction from France and were called Egyptian oats by some and Jones oats by others. Shephard (59) reported that his brother traveled in Egypt and brought home a few grains of Egyptian oats in 1875. These had large, brown seed and grew very tall. Still later, in 1878, the Pennsylvania Experiment Station reported tests of oats in which the varieties Irish, Andres King, Canadian, Waterloo, White Dutch, White Schoeman, and Lyell were grown (51). Some or all of these oat varieties could have been brought into Texas and tested on farms.

The Cat Spring Agricultural Society [Austin County] (23) reported receiving Excelsior oats in 1872, Henry oats in 1875, and Red Rustproof oats several times between 1873 and 1876. F. Fries (33) of Salem, North Carolina, advertised seed of Black, White, and Red Rustproof oats for sale in the March 1886 issue of the *Progressive Farmer and Southern Farm Gazette.* In August of the same year, he advertised Henry oats, which were rust and frost proof (34).

An early seed swindle was recounted by the editor of the *American Agriculturalist* in 1887 entitled the "Bohemian Oat Swindle" (3). The article stated that the Bohemian Oat and Cereal Company had caused great distress among farmers. The agents of this company offered to sell seed of Bohemian oats to farmers at $15 per bushel. The firm agreed to buy the product of the first crop at $15 per bushel, less 33-percent commission. They selected for this demonstration the leading farmers in a community. The first season was the period of preparation. The second season was the "swindlers' harvest." The product of the first season was then sold again for $15 per bushel and the salesmen disappeared. The editor stated that "No farmer in his senses can believe that Bohemian or any other oats are worth $15 per bushel."

Winter Oats

Reports of growing fall-seeded or winter-hardy oats are scarce in early literature. As mentioned, George Washington planted oats in the fall of 1764, but it is not known whether they survived (39). F. A. Coffman (26) credits Zade with the information that winter oats (called "heavy or English oats") did not reach Germany until 1757 and produced black grain. Oats, which could be fall seeded and survive most seasons were first observed growing along the Atlantic Coast from Virginia through the Carolinas. Stanton (61) believes that these may have been brought by the earliest Virginia colonists, but this cannot be confirmed. Such oats were known in Germany and France, as well as England, but were known locally as Virginia Grey, Winter Turf, Grazing Oats, or Grey Winter. A similar oat was grown in Oregon as early as 1873.

References to the Winter Turf oats in farm magazines and advertisements indicate that this type of oat was not brought into Texas until about 1890. It appears to have been grown to some extent until 1910, but few records of Winter Turf oats appear after that time. The Drumn Seed and Floral Company of Dallas (30) published an advertisement in the *Farm and Ranch* , October 1892, which stated that "Winter Turf oats produce 60 to 100 bushels per acre, are rust proof and not affected by cold." Winter Turf oats were included in the small grain tests of the Texas Agricultural Experiment Station many times from 1894 to 1920 (66). In 1894, Director J. H. Connell (27) announced that small quantities of oat seed were available to growers, including Winter Turf, Early Archangel, Wide Awake, Giant Side Oats, White Russian, Black Russian, and White Welcome.

Red Rustproof Oats

The saga of the Red Rustproof oat, its origin, southern popularity, and use in the development of better adapted varieties, is unique in oat history. From Civil War times until 1955, Red Rustproof oats were the dominant variety in 16 southern states. Stanton (62) estimated that in 1919 they occupied 6,015,204 acres in the United States. (Figure 2 shows the distribution of Red Rustproof oats in 1919.)

Red Rustproof oats were not generally known until about 1865, and until recently, their origin was uncertain. An 1889 advertisement in a seed catalogue from Pennsylvania suggests that a crop found in Georgia after the conflict between Mexico and the United States, 1846-48, was planted by soldiers of the War with Mexico who brought the seed home with them (Coffman, 26). An earlier version of the oats' origin is recorded in the 1876 Georgia State Agricultural Society records and credits Mr. Merriam of South Carolina with the first crop. He supposedly obtained the seeds from a neighbor who brought them back from Mexico in 1848 (Coffman, 26).

George Hendry (40) also gives evidence for the Mexican origin of Red Rustproof oats. Hendry removed adobe bricks from certain old misions of northern Mexico, southern California, and Arizona and found in them both white and red seeded oats. The red oat seed was identified as *Avena byzantina.* Although there is no evidence that modern Red Rustproof oats can be traced to these earlier Mexican sources, this type of oats can be found in Spain and Algeria today and probably was brought to Mexico by the Spanish.

There are relatively few references to Red Rustproof oats in farm magazines between 1850 and 1900 (magazines surveyed by author). In 1874 A. B. Allen (1), the editor of *American Agriculturalist,* stated, "There are rust proof oats grown in the South where the crop is subject to rust." Later, in 1876, he reported that a North Carolina farmer grew 4 acres of Red Rustproof oats which yielded 12.5 tons of sheaf oats and 300 bushels of grain (2).

The 1904 *Texas Almanac* (64) published a lengthy article on growing oats in Texas which reported that

> As late as 1875, black oats was the variety planted in Texas. About 1875, experiments were made with the large red or bearded oats known as Red Rustproof. Since that time, the seed of this type has been in brisk demand for planting purposes. The seed also is shipped to the Southeast, where oats are grown and fed in the sheaf to work aninals. The first carload of Red Rustproof oats was shipped from Sherman to the Southeast in 1877.

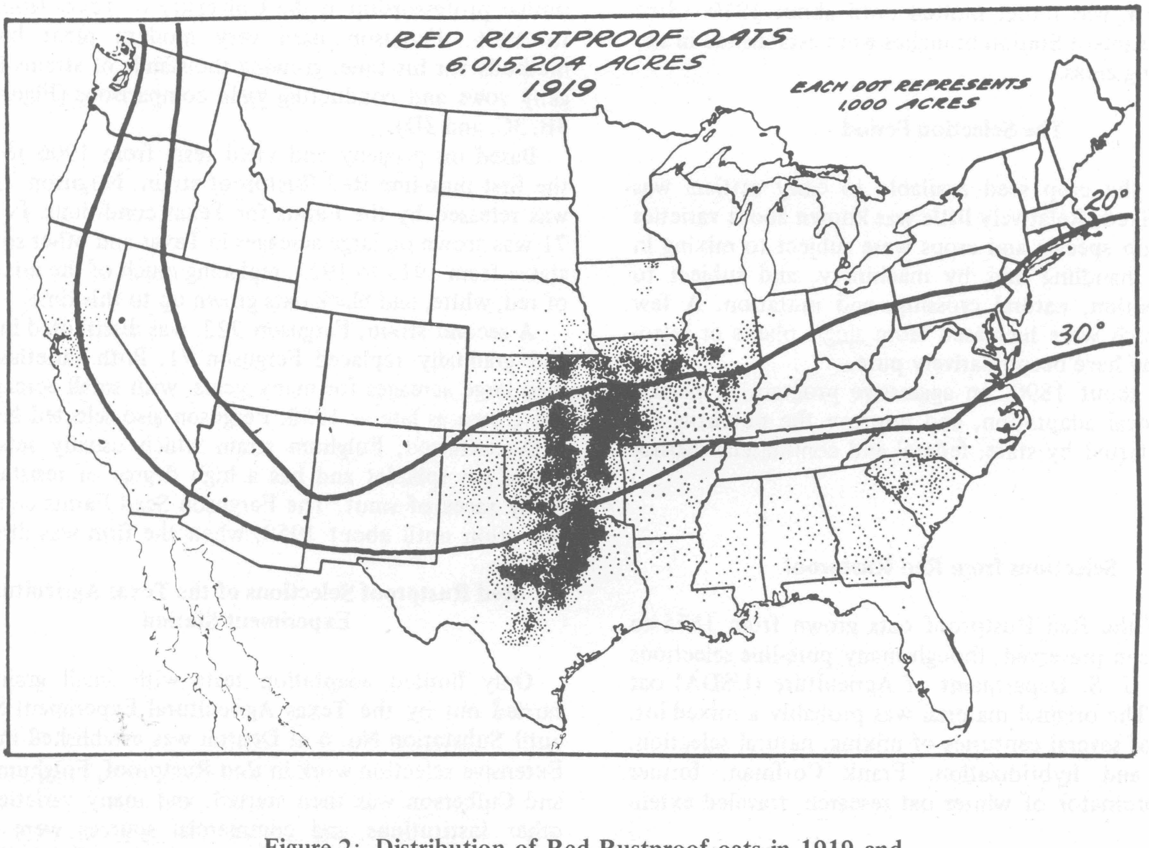

Figure 2: Distribution of Red Rustproof oats in 1919 and the location of the two isotherms of 20°F and 30°F. (Courtesy of U. S. Dept. Agr. Dept. Bul 1481.)

A. M. Ferguson, a private plant breeder of Ferguson Seed Farms in Howe, Texas stated in a 1947 interview[4] that he believed Red Rustproof oats were brought to Texas after the Civil War. North Texas became the center for shipment of Red Rustproof seed to the Southeast, and hundreds of carloads were shipped each season. Ferguson also thought that this type of oats soon replaced the Northern white oats, which were unsatisfactory because they were subject to cold and rust injury.

Red Rustproof oats and named selections from the original, soon replaced all other types, and occupied the majority of the acreage in the South for nearly 100 years. Growers found that the Red Rustproof strains supplied winter pasture and relatively stable grain production because they were tolerant to cold, drouth, diseases, and insects.

IMPROVEMENT OF THE OAT CROP FOR BETTER ADAPTATION TO TEXAS

Agricultural research and formal plant breeding in the United States were very limited before the establishment of state agricultural colleges and universities. Soon after the passage of the Hatch Act by the U. S. Congress in 1872, many states established schools of agriculture and experiment stations. In Texas, the Texas Agricultural and Mechanical College was established in 1872, but the experiment station was not established until 1889. The scope of research work was rather limited until about 1910, when several Experiment Station branches were established in the major farming areas.

The Selection Period

Most of the crop seed available to early settlers was probably mixed. Relatively little was known about varieties within a crop species and crops were subject to mixing in commercial handling and by machinery, and subject to natural selection, natural crossing, and mutation. A few varieties which were increased from single plants or introductions may have been relatively pure.

Starting about 1890, an aggressive program to purify, select for local adaptation, and improve the potential for yield was started by state, federal and commercial institutions.

Selections from Red Rustproof

None of the Red Rustproof oats grown from 1875 to 1900 has been preserved, though many pure-line selections are in the U. S. Department of Agriculture (USDA) oat collection. The original material was probably a mixed lot, the result of several centuries of mixing, natural selection, mutation, and hybridization. Frank Coffman, former USDA Coordinator of winter oat research, traveled extensively throughout the South from 1926 to 1960 and noted many fields of unselected Red Rustproof which "showed great diversity in plant characters, kernel colo and plant type ranging from early to late maturity, short and tall plants, with grey, yellow, black and red kernels and varying degree of awning (26)." He also observed tha more than 50 named varieties were selected from Red Rustproof.

State, federal, and commercial institutions as well as farmers made selections from Red Rustproof. Some had only local use but others were widely grown. Among the more widely grown strains were Ferguson 71 and 922, Nortex and New Nortex, Alabama Red Rustproof, and Hasting's 100-Bushel Red Rustproof. From Red Rustproof also came Fulghum and Fulghum derivatives, and Burt and its derivatives.

Oat Improvement by Ferguson Seed Farms

From 1890 to 1930, a period of great expansion of oat acreage in Texas, the Ferguson Seed Farms of Sherman and Howe made major contributions to the development and establishment of pure-line varieties of oats, wheat, corn, cotton, and other crops in Texas.

A. M. Ferguson, the founder and owner of Ferguson Seed Farms, graduated from Texas A&M College; afterward he studied at Cornell University, University of Missouri, and the Shaw Botanical Garden at St. Louis. He became botany professor at Texas A&M College in 1899, then accepted a similar professorship at the University of Texas from 1900 to 1906. Ferguson used very modern plant breedin methods for his time, growing thousands of strains in progeny rows and conducting yield comparisons (Figures 3A, 3B, 3C, and 3D).

Based on progeny and yield tests from 1906 to 1913, the first pure-line Red Rustproof strain, Ferguson 71 oats, was released by the Farms for Texas conditions. Ferguson 71 was grown on large acreages in Texas and other southern states from 1913 to 1922, replacing much of the mixed lots of red, white, and black oats grown up to this time.

A second strain, Ferguson 922, was distributed in 1922, and gradually replaced Ferguson 71. Both varieties occupied large acreages for many years, with small acreages being grown as late as 1950. Ferguson also selected Navarro, a shortstrawed, Fulghum strain which usually sets three grains per spikelet and has a high degree of resistance to many races of smut. The Ferguson Seed Farms continued operation until about 1950, when the firm was dissolved.

Red Rustproof Selections of the Texas Agricultural Experiment Station

Only limited adaptation tests with small grain were carried out by the Texas Agricultural Experiment Station until Substation No. 6 at Denton was established in 1911. Extensive selection work in Red Rustproof, Fulghum, Burt, and Culberson was then started, and many varieties from other institutions and commercial sources were tested. Efforts to improve the Red Rustproof oat resulted in th 1926 development of Nortex oats, a strain of Red Rus proof selected on the E. F. Davis farm, Krum. Foundatio

[4] *Private interview with A. M. Ferguson of Ferguson Seed Farms, Howe, Texas, at Denton, Texas in May 1947.*

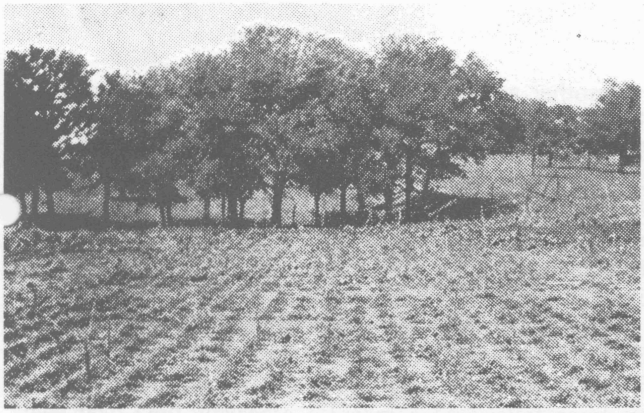

Figure 3A: Oat research on the Ferguson Seed Farms, Howe, Texas, 1909: Progeny tests for winterhardiness. (Photos Figures 3A, B, C, D, courtesy Sam Ferguson, llas, Texas.)

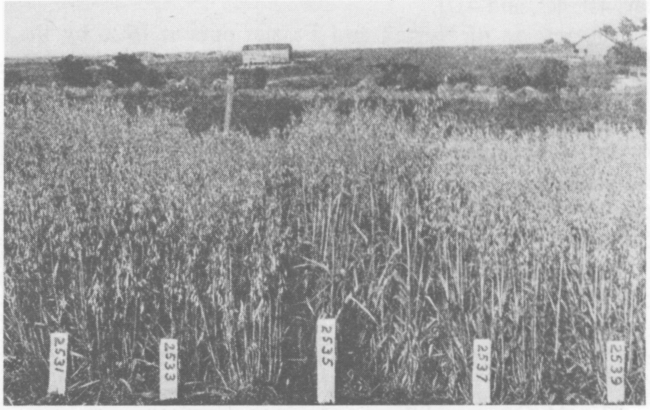

Figure 3B: Oat progeny rows for first harvest, Ferguson Seed Farms, 1909.

gure 3C: Seed increase fields of new varieties, Ferguson ed Farms, 1909.

Figure 3D: Harvesting foundation seed of oats; binders of the period, Ferguson Seed Farms, 1909.

seed were distributed from 1926 to 1938, and Nortex was widely grown in Texas and other Southern states. A sister strain, T. S. 1118-69, was released and grown on a more limited scale.

Continued breeding work up to 1936 resulted in the release of New Nortex, a selection from Appler Red Rustproof. The original Appler strain was grown at the Denton Station from 1919 to 1930 and many strains selected and tested from it. New Nortex had greater yield potential and soon replaced the original Nortex. From 1936 to 1955 New Nortex occupied a dominant place in the oat acreage of Texas. Small acreages of this oat may still be found (Figures 4A, 4B, 4C, and 4D).

The release of Nortex and Frazier oats in 1926 by the Texas Agricultural Experiment Station stimulated the organization of the Denton Pedigreed Grain Association for the increase and distribution of seed of these new varieties. The Association operated until 1938, when it was bought by Harpool Seed Inc., of Denton. This organization has continued to distribute certified seed of small grain varieties developed by the Texas Agricultural Experiment Station.

Other pioneer seed companies that have distributed seed of improved varieties include the Robert Nicholson Seed Company, Dallas; the McGregor Milling and Grain Company, McGregor; the Ruhmann Seed Company, Waco; and the Douglass W. King Seed Company, San Antonio.

The McGregor Milling and Grain Company was established in 1907 and has been operated by four generations of the Crouch family. For many years a flour mill was operated as part of the firm, but in recent years the firm has instead sold certified and other high quality seed of adapted small grain varieties and conducted a general grain business. Non-certified seed of high quality have been distributed under a firm name of "Green Tag" seed.

The Robert Nicholson Seed Company was established before 1900 and introduced seed of small grains and corn from northern states from 1896 to 1930. Many of the varieties referred to earlier were introduced by this firm. Since 1940, the firm has been involved mostly in urban needs, particularly garden seed and supplies.

The Ruhmann Seed Company of Waco was involved in the early distribution of Red Rustproof oats to eastern states. Douglass W. King Company of San Antonio has been active in the sale of oat seed since the 1930's and of all field crop seeds since 1946.

Red Rustproof Selections in Other States

A considerable number of Red Rustproof oat selections were developed and marketed in other southern states from 1890 to 1930. Hastings Seed Company of Atlanta, Georgia, developed Hasting's Hundred Bushel Red Rustproof oats in 1907 which was an important variety in the South for many years. Other named strains in Georgia were Appler Red Rustproof by J. E. Appler, Bancroft Red Rustproof by R. M. Turner, and, in 1938, Turruf by the Georgia Agricultural Experiment Station. The Alabama Agricultural Experiment Station released Red Rustproof 43a in 1930 and 740 in 1935. Cook Red Rustproof was selected by A. Butler of Alabama in 1915. The Tennessee Agricultural Experiment Station released Cliff Red Rustproof in 1930.

In Mississippi, McGehee Red Rustproof was developed and sold by J. S. McGehee of Laural Hill, Mercier Red Rustproof by W. B. Mercier of Centerville, and Delta Red b the Stoneville Pedigreed Seed Company of Stoneville. In 1945, the Stoneville company released Nortex 107. In Louisiana, J. F. Patterson of Baton Rouge selected an sold Patterson Red Rustproof, and in California, California Red Rustproof and Coast Black were selected and distributed.

Red Rustproof later became an important variety for spring seeding in states bordering the winter oat area, such as Kansas, Missouri, and Illinois (Figure 2).

Fulghum Selections

Another group of oat varieties and strains derived from Red Rustproof were the Fulghum strains. According to Stanton (60), the original Fulghum oat was found in a field of Red Rustproof in Georgia in 1892 by J. A. Fulghum of Warrington. The Fulghum plant found may have been a hybrid or perhaps was genetically unstable as it resulted in a number of named strains of economic importance simply by the process of pure-line selection.

Well-known selections from the Fulghum variety include Frazier, developed and released by the Texas Agricultural Experiment Station in 1926; strains developed and released by commercial seed companies, especially the Coker Pedigreed Seed Compnay of Hartsville, South Carolina; Early Red Rustproof developed and released in Nebraska; Nicholson's Extra Early developed by the Nicholson Seed Company in Dallas; and Kanota, developed and distributed b the Kansas Agricultural Experiment Station.

Kanota was probably the most famous of the Fulghum strains as it became a major variety in Kansas, Missouri, Illinois, and California. It was grown in the South for its early maturity, as compared to Red Rustproof, and used for spring seeding along the northern border of the winter oat belt. Stanton (60) estimated that in 1936, Fulghum and Fulghum derivatives were grown on 6 million acres in the United States.

Burt Selections

Another variety derived from Red Rustproof and grown extensively was Burt oats. Burt, like Fulghum, was found as a single plant by a Mr. Burt of Green County, Georgia. Also like Fulghum, it either was a natural hybrid frequently out-crossed, or was genetically unstable. Named varieties selected from Burt included Early Ripe, Early Harvest, Early Burt, and Early Man. The variety Otoe was developed by the Nebraska Agricultural Experiment Station, and Brunker and Trojan by the Colorado Agricultural Experiment Station. Burt never attained the importance of Fulghum or Red Rustproof, but was grown on a small sca in Texas during the early 1900's (Coffman, 25).

Culberson Selections

Although the records are incomplete, Stanton (6 believes that the Culberson oat variety originated in t Piedmont area of North Carolina as a selection from Re

Figure 4A: Field of foundation New Nortex oats at Texas Substation No. 6, Denton, Texas, 1936. (Left to right) L. E. Brooks, horticulturist, Texas Substation No. 16, Iowa Park, Texas; P. B. Dunkle, superintendent, Texas Substation No. 6, Denton, Texas; E. A. Miller, Extension agronomist, Texas A&M College, College Station; C. H. McDowell, superintendent, Texas Substation No. 16, Iowa Park, Texas.

Figure 4B: Paul B. Dunkle, superintendent of Substation No. 6, Denton, Texas, from 1922 to 1947. A leader in research and extension work in North Texas, Dunkle's major contributions were in development of Nortex, New Nortex, and Frazier oats, Finley and Wintex barleys, and Denton wheat.

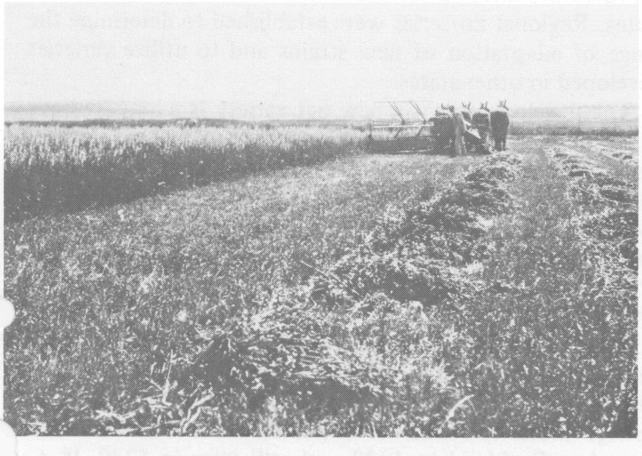

Figure 4C: Harvesting Nortex oats with grain binder at Denton, Texas, 1931.

Figure 4D: A commercial threshing crew at work near Denton, Texas, 1936. Oats were threshed in this manner until nearly 1940.

Rustproof. The variety has small, grey-white or "dirty white" seed and is more winter hardy than Red Rustproof. Named selections derived from Culberson include Dwarf Culberson, Hairy Culberson, and Tech, a black-seeded strain. These have occupied large acreages in the South but have been of minor importance in Texas.

J. M. Howell (41), former editor of *Farm and Ranch,* offers another suggestion for the origin of the Culberson variety. In July 1900 he stated,

> Culberson oats originated with Mr. J. M. James of Dallas, Texas. He began breeding them 10 years ago to develop more cold tolerant, rust resistant oats. In 1897, his crop yielded 90 bushels per acre, was as tall as a man's shoulder yet they did not fall down. In 1898, his Culberson oats withstood 10 degrees below zero F. when other oats were killed, and made 80 bushels per acre.[5]

Winter Turf Selections

The cold-tolerant oat variety, Winter Turf (known variously as Grey Winter, Virginia Grey, and Grazing Oat) is probably the oldest variety used for fall seeding. As mentioned, winter hardy oats may have been known in Europe as early as 1857 (Stanton, 61). Winter Turf is the only variety of that period that is not traceable to Red Rustproof.

The early records of the Texas Agricultural Experiment Station show that Winter Turf was tested and small lots of seed released in 1894 (Connell, 27). The Dallas Fair and Exposition (29) listed a class and premiums for show samples of this variety from 1896 to 1906. Farm magazines advertised seed of Winter Turf oats frequently from 1890 to 1910. In 1909, A. E. Groves (37), editor of *Southwestern Farmer,* wrote,

> If our East Texas friends will plant Winter Turf oats after cotton, they will kill three birds with one stone; namely, they will get a fine cover crop, a fine winter pasture crop and a fine green manure crop to plow under ahead of their spring cotton crop.

However, Winter Turf never became a major variety in Texas.

Black-Seeded Oats

Black-seeded oats are mentioned in many early publications. Apparently they were a common mixture in other varieties. Black-seeded varieties mentioned in literature were Black Tartar, Old Island Black, North Finish, Black Mesdag, Coast Black, and Joanette.

In a study of wild and feral oats, Atkins (14) found plants with black seed and many other plant types throughout Texas and in some areas of Mexico. Apparently this type had some survival value under natural conditions (Figure 5).

Oats were first cut by hand with sickles and later with binders. One of the first binders was designed by Cyrus McCormick of Virginia in 1831. Binders or reapers became generally available about 1860, and with continued improvement, were used until about 1940. Threshers were developed during this same period, powered first by treadmills using animals or rotating horse-drawn power devices, and later by steam engines and gasoline-powered tractors. Binders and threshers of this period are shown in Figures 3D, 4C, and 4D.

IMPROVING OATS BY HYBRIDIZATION

The science of plant breeding developed rapidly after 1900. One of the methods used by the plant breeder to achieve variability in plant populations and to combine or transfer characteristics from two or more successful varieties was hand crossing. Prior to the development of crossing techniques, the breeder could select only from nature. This variability came from natural crosses, mutations, or other forms of genetic change, followed by survival of the type most able to perpetuate itself under natural conditions.

Cooperative Plant Breeding Program

An expanded program of plant breeding to improve the cereal crops for Texas was initiated by the Texas Agricultural Experiment Station in 1930, in cooperation with the USDA's Division of Cereal Crops and Diseases. A few years previous to this, the U. S. Department of Agriculture had initiated regional crop improvement programs and had appointed crop section leaders for wheat, oats, barley, flax, corn, and grain sorghum.[6]

New facilities for research were provided by the State at the several locations while varieties and strains of the USDA's world collection of small grains were made available for testing, use in crossing, or making selections. Bulk hybrids of many combinations were developed by the crop coordinators who made them available to breeders in all states. Regional nurseries were established to determine the range of adaptation of new strains and to utilize varieties developed in other states.

The development of a new oat variety is a long, tedious process usually extending over a period of 10 to 15 years. Hand crossing of parents must be made in a humid atmosphere, such as in a greenhouse (Figures 6A and 6B). The hybrids must be grown through four to eight generations before pure-line selections can be isolated for testing.

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[5] *Private correspondence with Frank Coffman (1976) former USDA Oat investigation leader for winter oat research, who stated that he did not think this could be the eastern strain of Culberson.*

[6] *As a part of the crop improvement program, the author was stationed at Texas Substation No. 6, Denton, Texas in September 1930 and E. S. McFadden was stationed at College Station, Texas, in 1936. David A. Reid was stationed at Bushland in 1938 and still later in 1949, M. C. Futrell, plant pathologist, was stationed at College Station, Texas.*

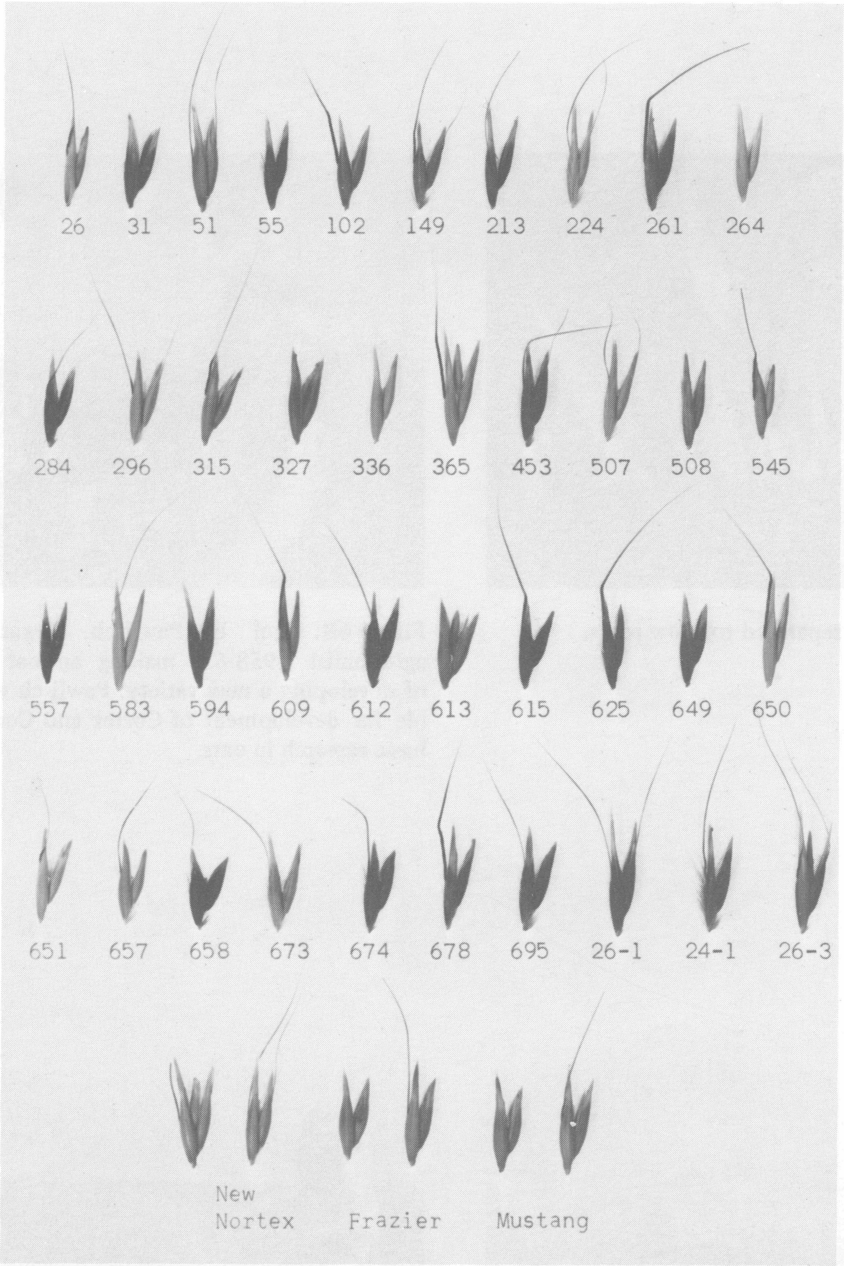

Figure 5: Feral oats found along roadsides in Texas.

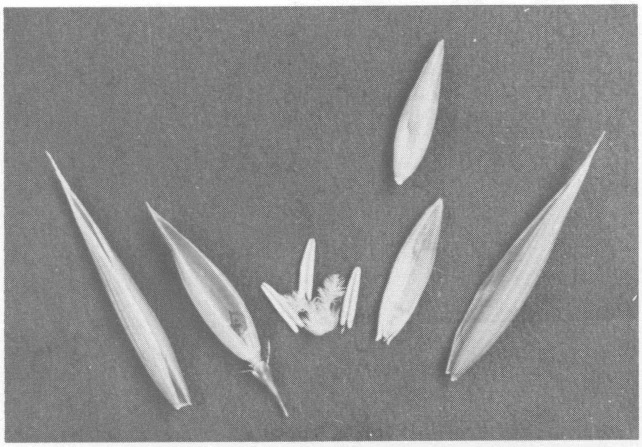

Figure 6A: An oat flower separated to show parts.

Figure 6B: Paul E. Pawlisch, Texas A&M University agronomist 1958-63, making an oat cross as the start of developing a new variety. Pawlisch was largely responsible for development of Cortez and Coronado oats and for basic research in oats.

Figure 6C: Strong-strawed new variety, Fultex oats (left) compared to weaker strawed Red Rustproof oats (right).

Figure 6D: Alamo oats at Denton, Texas, 1951, the first leaf and stem rust resistant variety of winter-type oats in Texas.

Once a strain is selected for testing, it must be subjected to various potential hazards to which it may be subjected in later years. Finally, after the strain passes these tests, it must still be tested for yield and agronomic adaptation in the environment where it is to be grown, and finally seed must be increased to quantities adequate for farm production.

Improvement of the Plant Type

The Red Rustproof oats, grown almost exclusively from 1875 to 1940, were well adapted to Texas conditions in many respects but had several serious faults. Among these were weak straw, thick heavy glumes, moderately large awns, low forage production under some conditions and inadequate winter hardiness under some conditions.

When the combine-harvester began to replace the binder and thresher in wheat culture about 1920, there was a desire to use the same machinery for oats. The weak straw of Red Rustproof type varieties caused problems in harvesting with the combine (Figure 9A).

About 1930, several varieties of oats resistant to domestic races of leaf and stem rust and having superior plant and grain types compared with the Red Rustproof strains were imported to the United States. Among these were Bond, Victoria, Trispernia, Santa Fe, Alber, and Berger. Crosses were made between these and the adapted varieties.

From the cross of Fulghum and Victoria, the variety Fultex was developed at Denton and released to growers in 1938. Fultex had short, strong straw, plump, high test-weight grain, was resistant to leaf rust, and would stand for combine harvesting (Figure 6C). A sib of Fultex was crossed to an experimental strain from the cross Victoria x Hajira-Banner, a strain resistant to stem rust. From this cross the variety Alamo was developed and released to growers in 1951 (Figure 6D).

Alamo was the first oat variety resistant to leaf and stem rust released in the South. It was widely adapted and produced high yields of excellent quality grain (Atkins, 10) but proved to be susceptible to *Helminthosporium* blight which reduced its value. From the seed of Alamo, irradiated with X-rays and neutrons, came progeny from which the more resistant and cold tolerant variety Alamo-X was developed. Alamo-X was not only resistant to blight but to several new races of leaf rust to which Alamo was susceptible; it was also more cold tolerant than Alamo, and so was more widely adapted (12, 13).

From crosses of Fulghum and Victoria, the Coker Pedigreed Seed Company of Hartsville, South Carolina, developed several Fulgrain and Victorgrain strains. Some were widely grown in Texas from 1945 to 1960. From a cross of Nortex x Victoria, the varieties Ranger and Rustler were bred for grain and forage uses in South Texas.

Crosses of Victoria with Winter Fulghum strains produced Mustang and Bronco in Texas (9) and Arlington and Atlantic in Virginia. These cold-tolerant varieties were the first to establish fall seeding of oats in the High and Rolling Plains (Figure 7A). From the cross Bond x Alber came the Arkansas varieties Taggart and Delair grown commercially in Texas.[7]

[7] *A more extensive discussion of oat production is given by Atkins (16).*

Breeding for Improved Cold Tolerance

Severe low-temperature damage and reduction of forage production of oats for pasture are important factors in oat production in Texas. (See section on hazards.) During the past 50 years, marked progress has been made in developing varieties with greater tolerance to low temperatures and to the sudden temperature changes which occur in Texas.

No appreciable differences in cold tolerance were found among the Red Rustproof strains. The discovery and development of the Winter Fulghum strains by the Tennessee Agricultural Experiment Station and the USDA provided the first well-adapted cold-tolerant strains. Crosses with Fulwin, Tennex, Forkedeer, and Pentagon provided hybrid material from which winter-hardy, adapted varieties, such as Mustang, Bronco, Norwin, Wintok, and Cimmaron, were developed (Figure 7A).

The practical value of such improvement work and the means whereby new strains are selected in years when low temperatures cause differential killing of oat strains and genotypes is evident. Strains which survive such tests may eventually be released as better adapted new varieties (Figure 7C) which will contribute increased and more dependable production of grain, winter pasture, and hay. The scope of this state-federal research program is illustrated by the small 1931 nursery (Figure 7D) compared to the extensive breeding nurseries in 1956 (Figure 8).

Breeding for High Forage Production

The difference in the number of seeded and harvested acres in Texas in recent years demonstrates the importance of forage production as a source of income from oats. Clipping tests of forage production at intervals during the season are one means of evaluating varieties (Figure 9B). Varieties differ greatly in their total forage production but also in the part of the season in which they produce their maximum forage; i.e., highest production in the fall versus highest production in the spring. Growers base their variety choice on production patterns as well as on total production (Figure 9C). Mustang, Alamo, Alamo-X, and others produce abundant fall forage if seeded early. Bronco and Walken produce their maximum forage in the spring months. Erect spring types may be damaged by grazing as well as by low temperatures.

Resistance to diseases is very important in choosing a variety for grazing purposes, and often new varieties must be developed or introduced to protect the crop from disease. When Victoria derivatives became susceptible to prevalent rust races, the varieties Suregrain and Moregrain were used extensively in the 1950's and later Oro, Nora, and Florida 500 were used. During recent years, Cortez and Coronado have filled this need, and more recently TAM 0-312, Coker 234, and Coker 227 have occupied large acreages for both forage and grain production (Figure 9D).

Desirable forage characteristics are inherited in a complex manner. Usually large populations of hybrid progenies from crosses must be screened and tested in order to obtain new superior forage varieties.[8]

[8] *Additional information may be found in Atkins' Forage Evaluation Studies (15).*

Figure 7A: Survival of Mustang oats at Iowa Park, Texas, in 1951. Mustang is immediately in front of L. E. Brooks, superintendent, Texas Substation No. 16. Low survival of Red Rustproof strains is shown in the foreground.

Figure 7B: Oat breeding nursery at Texas Substation No. 6, Denton, Texas, 1949, where many strains were winter-killed and others survived a severe low temperature period.

Figure 7C: J. H. Gardenhire, agronomist and plant breeder, with sheaf of new variety, Norwin, developed under his leadership.

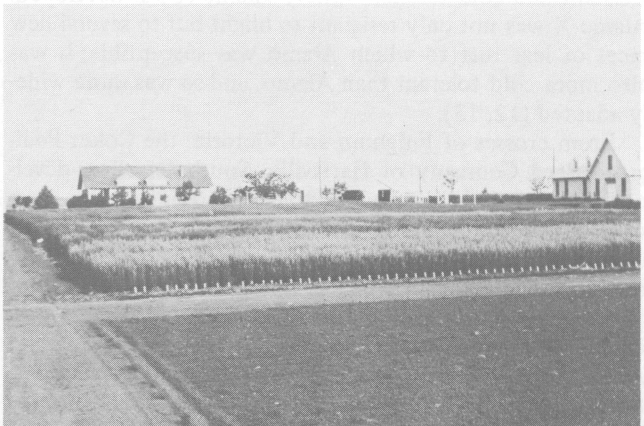

Figure 7D: Small grain nursery at Texas Substation No. 6 Denton, Texas, 1931.

Figure 8: Aerial view of Texas Substation No. 6, Denton, Texas, 1956, showing extensive small grain breeding nurseries.

Figure 9A: Lodging of Red Rustproof oat strains at Denton, Texas, 1936.

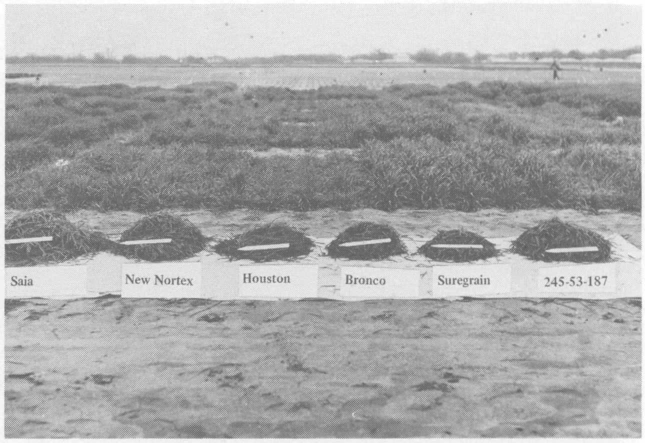

Figure 9B: Forage produced by oat varieties may be clipped to determine the relative production and season of highest production.

Figure 9C: Oat varieties representing an erect, spring growth habit (left); intermediate winter growth habit (center); and prostrate growing winter type (right).

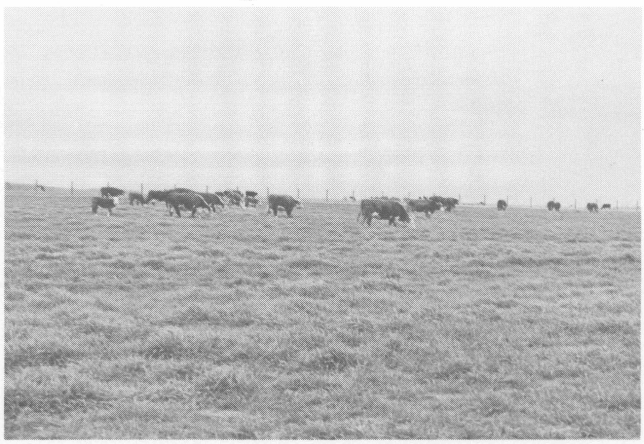

Figure 9D: Livestock grazing oats for winter pasture at Prairie View, Texas, 1954.

Breeding for Rust Resistance

In 1930 a number of introduced varieties provided germ plasm for an expanded oat improvement program to develop adapted rust resistant varieties.

Bond (Australia); Victoria, Santa Fe, Berger, and Alber (Argentina); Trispernia (Germany); and others were used extensively in crosses. As races changed, it was necessary to search for new sources of resistance or combine resistance from older sources in order to protect the crop from rust damage. Varieties released in Texas, which provided protection for a period of time included Fultex, Ranger, Rustler, Verde, Alamo, Alamo-X, Mustang, Bronco, Houston, Norwin, Cortex, Coronado, and, recently, TAM O-301 and O-312. Rust resistant varieties developed in other states and grown in Texas include Fulgrain, Victorgrain, Suregrain, Moregrain, Oro, Nora, and Coker 234.

Control of crown (leaf) rust of oats through a continuing series of varieties with different genes or combination of genes for resistance was effective until the late 1960's. New races then evolved in nature which could attack, to some degree, all cultivated varieties of oats in the United States. In cooperation with research personnel in Israel, an extensive search was made in the Middle East for rust resistance among the wild species of *Avena,* as rust disease is prevalent throughout that area. Nature has by process of natural selection produced strains with higher degrees of rust resistance or tolerance. Resistance was particularly marked in the wild hexaploid oat, *Avena sterilis.* Many strains were brought to the United States, tested, and isolated as highly resistant to various races. These were then made available to plant breeders and commercial companies. By crossing, backcrossing, selection and reselection, utilizing greenhouses, and summer double-cropping for increase, M. E. McDaniel developed the new varieties TAM O-301 and TAM O-312 in only 5 years (49).

Personnel in other states also developed varieties with crown rust resistance from *A. sterilis.* The value of such research to growers and consumers alike is not easily measured, but there is no doubt that new resistant varieties can prevent widespread rust epidemics and thereby increase crop production.[9]

Breeding for stem rust resistance has not been as successful as that for leaf rust resistance. Most sources of resistance to stem rust were found in the spring oat varieties of *Avena sativa,* grown in nrothern states. These have been difficult to successfully transfer for use in the South. Also, races of stem rust have changed frequently. Texas varieties released with some resistance to stem rust include Alamo, Alamo-X, Verde, Houston, Cortex, Coronado, and TAM O-301.

The Victoria Blight Epidemic

Breeding to incorporate disease resistance into oat varieties suffered a disastrous setback soon after Victoria was introduced. Victoria Blight, a new disease caused by a new species of *Helminthosporium,* was either introduced with Victoria or, if already present in soils, was stimulated by the presence of highly susceptible varieties. Crown rust resistance in Victoria was closely linked with Victoria Blight susceptibility; therefore, all varieties with Victoria leaf rust resistance were subject to damage or killing by blight.

Victoria Blight caused widespread serious damage to oats. Although initially less important in the fall-sown oat area, Victoria Blight finally forced abandonment of Victoria-derived varieties throughout the United States. Breeding work to incorporate other sources of resistance to rust and Victoria Blight were initiated.

Fultex, Alamo, Ranger, Rustler, Fulgrain, Victorgrain, Stanton, and other southern varieties were often damaged by Victoria Blight when grown on infected soil. In 1940 Southern breeders turned to Bond, Landhafer, Trispernia, and other sources of crown rust resistance. The new varieties Southland, Suregrain, Moregrain, Midsouth, Ora, and Nora were developed in these programs. Mustang and Bronco were more tolerant to blight than some varieties and continued in production for a time, especially in the colder regions of Texas. Alamo-X was developed by irradiaton of Alamo and proved more winter hardy as well as resistant to crown rust and Victoria Blight (Atkins, 13).

Varieties Developed in Texas

During the past 60 years of plant breeding in Texas, the Texas Agricultural Experiment Station in cooperation with the U.S. Department of Agriculture has developed or released a total of 17 new varieties for use by growers (Table 2). In addition to these, new varieties developed in adjoining states or by commercial seed companies have been tested and released to Texas growers by the Foundation Seed Section.

No official census of the oat varieties grown in Texas has ever been made but an estimate is presented in Table 3.[10] The Red Rustproof strains, largely Ferguson 922 and 71, and Nortex and New Nortex dominated the acreage from 1875 to 1955. Since the latter date, varieties developed in the breeding programs of Texas and other states have dominated the acreage.

The introductions, pedigrees, and parental relationships of most of the varieties grown in Texas since 1890 are shown in Figure 10.

TABLE 2. IMPROVED VARIETIES OF OATS DEVELOPED AND RELEASED IN TEXAS IN THE COOPERATIVE RESEARCH PROGRAM OF THE TEXAS AGRICULTURAL EXPERIMENT STATION AND THE UNITED STATES DEPARTMENT OF AGRICULTURE

Year released	Variety	Parents of cross or crosses
1926	Frazier	Pure-line selection from Fulghum
1926	Nortex	Pure-line selection from Texas Red Rust proof
1936	New Nortex	Pure-line selection from Texas Red Rust-proof

[9] *Descriptions of these new varieties are given by McDaniel (48, 49).*

[10] *The author in cooperation with other researchers and members of the trade made the estimate.*

TABLE 3. ESTIMATE OF OAT VARIETIES GROWN IN TEXAS IN PERCENTAGE OF TOTAL ACREAGE, 1900-1975*

Variety	1900	1905	1910	1915	1920	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975
Alamo											Tr	2	4	2	Tr	
Alamo-x													Tr	10	6	2
Alber										1	1	1	1	1	Tr	Tr
Arkwin													1	1	Tr	
Bronco												Tr	5	8	2	Tr
Burt	2	5	5	5	5	1	Tr									
Camellia										1	Tr					
Cimarron													1	1	Tr	Tr
Coker 227																Tr
Coker 234															Tr	20
Coronado														Tr	5	10
Cortez														Tr	3	8
Culberson	2	2	5	5	2	1	Tr									
Ferguson 71			5	10	10	15	15	10	5	5	Tr					
Ferguson 922						Tr	5	15	20	20	10	5	5	Tr	Tr	
Ferguson 560												Tr	Tr	Tr		
Forida 501													Tr	3	3	3
Forkedeer													Tr	1	1	
Frazier						Tr	5	5	5	2	Tr					
Fulghum	2	5	10	10	10	10	5	2	2	1	Tr					
Fulgrain									Tr	1	2	2	Tr			
Fultex									Tr	2	5	2	Tr			
Moregrain												1	5	12	20	10
Mustang											Tr	8	16	8	4	Tr
New Nortex								Tr	10	30	45	50	35	20	15	8
Nora													Tr	5	10	18
Nortex						Tr	15	30	35	5	8	5	2	Tr		
Nortex 107											1	1	1	Tr		
Norwin													Tr	1	1	Tr
Ora												Tr	5	10	12	10
Ranger									Tr	4	1	Tr				
Rustler									Tr	3	1	Tr				
Suregrain												3	8	12	8	
Taggart										Tr	2	1	1	Tr		
Tex. Red R. proof	79	68	60	55	58	43	28	13	10	8	3	1	1	Tr		
Traveler											Tr	1	1	Tr		
Victorgrain										Tr	8	8	3	1		
Wintok											1	2	2	1	1	Tr
Winter Turf	5	10	5	5	5	5	2	Tr	Tr							
TAMU 312															Tr	5
Others	10	10	10	10	10	10	10	5	5	5	5	5	5	5	3	3

*Est[illegible] developed [illegible] the author, other researchers, and members of the Trade.

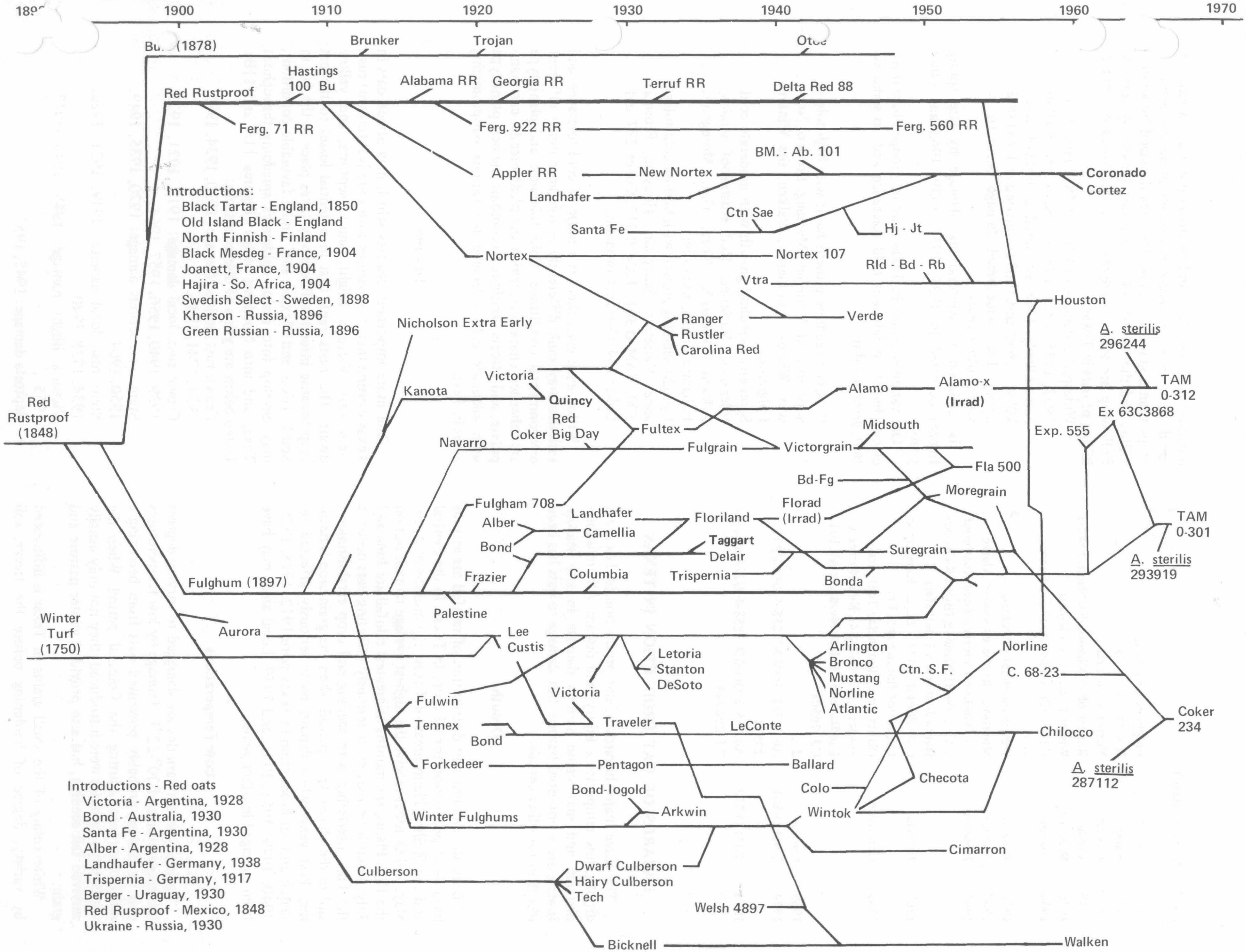

Figure 10. Pedigree of oat varieties grown in Texas, 1900-1976.

TABLE 2. (Continued.)

1938	Fultex	Fulghum x Victoria
1940	Ranger	Nortex x Victoria
1940	Rustler	Nortex x Victoria
1943	Verde	Ranger sib. x Victoria-Richland, 5542-1
1950	Mustang	Winter Fulghum x Victoria
1954	Alamo	Fultex sib. x Victoria-Hajira-Banner, 4019
1956	Bronco	Winter Fulghum x Victoria
1962	Alamo-X	Mutation– irradiated seed of Alamo
1965	Houston	(Fulwin-Lee-Victoria x (Red Rustproof x Victoria-Richland) x (Bond-Rainvow-Hajira-Joanette x Landhafer)
1967	Norwin	Colo-Wintok, 5118 x Hajira-Joanette x (Atlantic-Clinton-Santa Fe)
1969	Coronado	(Santa Fe x Clinton-Sac 2x Hajira-Joanette, C.I. 6671) 4x New Nortex x Landhafer 5x (Black Mesdag x Ab.101, C.I. 7650)
1969	Cortex	do.
1974	TAM O-301	Ab 555/3/Ora/63C3858-4-2/Ora/P.I. 295919
1974	TAM O-312	Ab.555/3/Ora/63C3858-4-2/2/Alamo-X/P.I. 296244

HAZARDS OF OAT PRODUCTION IN TEXAS

The three major hazards of oat production in Texas are drouth, low temperature injury, and disease. All are unpredictable and may cause serious damage in any season. Insects are a potential hazard, but damage to oats has been less than for other cereals.

Drouth

Both the amount and distribution of rainfall are serious hazards of production for all crops in Texas. In the Central and the Rolling Plains areas of Texas, the months of April, May, and October receive the highest average rainfall but on the High Plains, the months of greatest rainfall are June and July. Drouth periods most seriously affecting oats occur in the fall, interfering with seeding and crop establishment, and in the March-April period when the grain crop is heading. Past years when drouth most seriously affected research and oat production in Texas were 1912, 1918, 1925, 1940, 1949, 1951, 1956, and 1959. Local areas may have been damaged in other years.

Low Temperatures

Spring-type oat varieties are damaged to varying degrees by temperatures of 20°-32°F. Damage by low temperatures and by disease probably prevented oats from becoming a satisfactory crop during the Colonial period. When the winter-type varieties were introduced, they not only usually survived fall seeding, but also provided winter pasture and grain.

Winterkilling of the small grains in Texas is influenced by variety, degree of hardening before the freeze, soil moisture and fertility, and temperature fluctuations. A rapid drop in temperature is usually more damaging t crops than a gradual decline. The area damaged by winterkilling and the severity of damage vary greatly by seasons. Following are some examples of serious losses by winterkilling of oats in Texas:

Widespread damage in 1916, 1928, 1930, 1931, 1933, 1935, 1943, 1947 (estimated at 250,000 acres killed), 1948 estimated at 400,000 acres killed), 1962 and 1963 (estimated at 1,163,000 acres). Less widespread damage occurred in several other years.

In addition to winterkilling, damage by late spring freezes occurred in 1931, 1932, 1939, 1943 and other years.

Oat varieties grown in Texas may be grouped into three classes based on inherent cold tolerance and, to some extent, growth habit:

Prostrate seedling growth habit with high tolerance to cold. Varieties: Mustang, Bronco, Norwin, Wintok, Cimmaron, Walken, the Winter Fulghums.

Semi-erect seedling growth with moderate cold tolerance. Varieties: Red Rustproof strains, Arkwin, Alamo-X, Nora, Ora, Moregrain, Fulghum strains, and others.

Upright seedling growth with limited cold tolerance. Varieties: Suregrain, Houston, Florida 500, TAM 0-301, TAM 0-312, Coker 227 and Coker 234, Cortex, Coronado.

Within each class there is a range of cold tolerance, and varieties may rank differently in tolerance under different environmental conditions. Cold tolerance and plant type are inherited characters, which the plant breeder can manipulate, and efforts continue to combine the best plant type with adequate cold tolerance for various oat-producing areas in Texas.

Diseases

The more important diseases which may attack oats in Texas causing minor or serious losses are leaf (crown) rust, stem rust, Victoria Blight, smut, septoria, and yellow dwarf. The rusts rank first in potential losses to the oat crop because infection frequently takes place in the fall in South Texas and Mexico and, under favorable conditions, may develop into major epidemics spreading throughout Texas and into Northern states (Figures 11A and 11B). Listed below are years of disease attacks:

Crown rust, serious damage: 1920, 1934, 1935, 1938, 1941, 1949.

Crown rust, local damage: 1919, 1921, 1926, 1939, 1940, 1950, 1957, 1964.

Stem rust, serious damage: 1920, 1935, 1949, 1950, 1964.

Stem rust, local damage: 1919, 1921, 1926, 1934, 1938, 1940.

Victoria Blight damage: 1945, 1946, 1947, 1955.

Septoria damage: 1945, 1957.

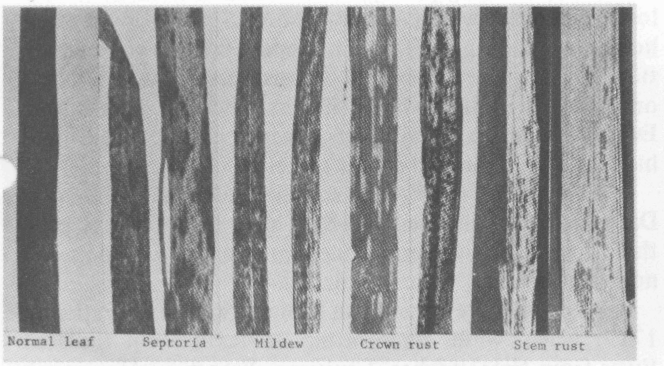

Figure 11A: Leaf diseases of oats: (Left to right) Normal leaf, and leaves infected with septoria, mildew, crown rust, and stem rust, respectively.

Figure 11B: A field of oats completely destroyed by leaf (crown) rust at College Station, Texas, 1955.

.gure 11C: Oat plants damaged by Helminthosporium ight. Normal plant at left.

Figure 11D: Wild and feral oats growing along roadside in Texas.

Losses in some seasons are a major factor in farm economy. For example, the losses from the rusts amounted to 17.9 percent of the crop or 6,098,000 bushels in 1950 and 10.6 percent or 5,138,000 bushels in 1958. Serious damage from leaf rust is demonstrated in Figure 11B. There is no practical means of control of these air-borne leaf diseases other than developing resistant varieties. During the past 40 years, an aggressive program to provide resistant varieties of oats to growers has been maintained by the Texas Agricultural Experiment Station in cooperation with the U. S. Department of Agriculture.

Breeding for resistance to disease is complicated by the fact that many diseases are made up of different biotypes or races (similar to a variety in crop plants). These races may increase or decrease in prevalence, and new races may develop in nature. Therefore, an oat variety may temporarily be disease resistant but later succumb to a new race. For example, from 1930 to 1950 varieties derived from Victoria were highly resistant to leaf rust races in Texas, but then became susceptible to new races which became prevalent. The resistance of Landhafer was effective for a time; later that of Trispernia was effective. More recently, resistance from *Avena sterilis* has been used in the breeding programs to develop the varieties TAM 0-301, TAM 0-312, Coker 234, and Coker 227. This source was effective in protecting the crop until 1976 but a new race then developed which could attack this source of resistance.[11] The damage caused by rust and *Helminthosporium* blight is shown in Figure 11C.

Insects

Oats are probably damaged less by insects than most crops. The greenbug, an aphid which can reproduce at low temperatures of the winter months, often causes local and sometimes widespread damage to oats and other cereals. This and other aphids may transmit a virus causing the Yellow Dwarf disease. Very serious and widespread damage was caused by aphids in 1907, 1921, 1922, and 1942 (Atkins, 8). The 1942 outbreak spread from Central Texas to Central Oklahoma and destroyed an estimated 62 million bushels of grain. Serious damage to wheat occurred in Northwest Texas in 1950 and 1951 (Chada, 24).

Other aphids, spider mites, army worms, chinchbugs, and other insects may cause less widespread and serious damage.

Weeds

Probably the most serious weed species of oats is the wild oat, *Avena Fatua L.*. As oats are not native to the Americas, it is assumed that the wild species was brought in with the cultivated crop. Some references to wild oats predate the settlement of the area. Whether the writers saw wild grass species resembling oats or the wild oats were actually there, is unknown (Figure 11D).

A pioneer woman, Esther Collins, visited Robertson's colony on the Brazos in 1837 and observed that "The men were interested in the tall, luxuriant grasses, four feet tall, that covered the Brazos River botton near Marlin, especially the wild oats and wild rye" (Walker, 71). Another early observer of wild oats found them on the tributaries of the Brazos (Bealy, 18). There is speculation as to how these supposed "wild oats" got there before the area was settled. One theory is that they were inadvertently left by early Spanish explorers who traveled through the Brazos area in establishing the first East Texas missions in 1690. Later, in 1759, the Parilla Expedition went from San Antonio north to punish the Apache Indians for destroying the San Saba Mission. They found the French fort, now called Old Spanish Fort, on the Red River. One could theorize that a few oats, including perhaps a few seeds of wild oats, were lost along the way (Allen, 4). The Spanish loved their horses and took great pride in keeping them in good condition. Perhaps a few handfuls of oats were in the saddlebags or a few bags might have slipped onto the pack mules. Even a few grains of wild oats, escaped at that time, would have had 150 years to become established.

The leader of the French socialist colony established at Dallas in 1853 reported in 1851, after exploring the area, that "I found a superior richness in the soil, wild oats and numerous grasses" (Hammond, 38).

Oats could have come in an earlier French exploration in 1719, when, while transporting 25 families up the Red River from Natchitoches, Louisiana, French explorers took wheat seed and planted it at the site of what was later called the Old Spanish Fort (McConnell, 47). Perhaps there were kernels of wild oats in the wheat seed. Again, this is only theory. Wild oats growing along the roadside in Denton County are shown in Figure 11D.

USES OF OATS

Nearly all the oat grain produced in Texas is used for home livestock feed or is sold to local mills; 85 percent of United States production of oat grain is used for feed (Stanton, 61). Oats make one of the best concentrate feeds for breeding stock of all kinds. Oats have about the same protein content as grain sorghum and barley but do not have as much as wheat. The amino acid balance of oat protein is better than that in other cereals. Oat hulls have about 12 percent crude fiber, barley 6 percent, and wheat 2 percent. Oats have more than twice the ash content of wheat. The higher ash and fiber provide a more balanced non-fattening feed than wheat, corn, or grain sorghum.

About 80 million bushels of oats are used in the manufacture of oatmeal, rolled oats, oat flour, and other oat products in the United States. The milling extraction is from 35 to 65 percent, depending upon the variety and plumpness of grain. Traditionally, Texas oat grain has been high in hull percentage and thus has not found favor in the milling industry. Oat flour contains no gluten and so cannot be used alone for making bread; however, it can be mixed with wheat flour in low proportions. Oat flour contains an antioxident which aids in preserving other products such as lard, butter, margarine, peanut butter, salted nuts, and potato chips. Avenex, a special grade of oat flour, is utilized in preserving milk, ice cream, fish, candies, bacon, and coffee.

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[11] *A more extensive discussion of oat diseases is given in another publication (Atkins and Futrell, 11).*

Oat hulls, another product of the milling of oats, are fed livestock and especially to young chickens, as they provide minerals not found in many feeds. Furfural is a product of oat hulls and is a major solvent in the refining of mineral and vegetable oils, in the purification of wood resins, and in the production of synthetic resins such as bakelite. It is also used in the making of adiponitrile, a nylon intermediate. Some pharmaceutical products are made from oat hulls through the furfural resins, including a substitute for penicillin.

The value of oats as a winter pasture for livestock was recognized as soon as the winter-type oat varieties were introduced. As pointed out earlier, a large percentage of the oat acreage in Texas is often grazed to maturity rather than harvested for grain. Livestock grazing a winter oat pasture are shown in Figure 9D. With favorable moisture and temperature conditions, oats may provide winter pasture for one to three animals per acre over a period of 3 to 5 months. Differences in growth habits influence the amount produced and the time of maximum forage production by oats. The three growth-habit types of oats are shown in Figure 9B: spring or upright, intermediate or semi-erect, and winter or prostrate.

The oat crop of Texas contributes much more to agricultural income than the visible cash value of the oat grain. Winter pasture for livestock is one such contribution of great value because oat pastures are available at the time when permanent pasture grasses are dormant. Other less visible values are its uses for green manure, silage, green-chop feeding, control of winter soil erosion, and hay. Since its introduction and establishment in Texas between 1830 and 1890, the oats crop has thus become a vital part of the Texas economy, contributing cash receipts of about $7 million in 1978 in addition to "less visible" contributions.

RESEARCH WORKERS AND CONTRIBUTIONS

Worker	Period	Major Emphasis or Contribution
A. H. Leidigh	1918-25	Selection work in Fulghum and Red Rustproof strains.
C. H. McDowell	1917-45	Selection work in Fulghum and Red Rustproof strains, Supt. Substation Nos. 5, 6, 16, 19.
P. C. Mangelsdorf	1926-38	Project leader small grains, corn. Ranger, Rustler varieties.
P. B. Dunkle	1922-47	Supt. Substation No. 6, Varieties Frazier, Nortex, New Nortex.
I. M. Atkins	1930-69	Project leader 1946-69, varieties Fultex, New Nortex, Mustang, Bronco, Alamo, Alamo-X, Houston, Cortez, Coronado.
E. S. McFadden	1936-55	Basic research; varieties Ranger, Rustler, Verde.
G. W. Rivers	1949-55	Varieties Alamo, Alamo-X, Houston, Mustang, Bronco.
M. C. Futrell	1949-67	Research on diseases.
P. E. Pawlisch	1959-64	Basic research; varieties Houston, Cortez, Coronado.
M. E. McDaniel	1965-date	Basic research; varieties TAM 0-301 and TAM 0-312.
J. H. Gardenhire	1952-date	Basic research; varieties Alamo-X, Bronco, and Norwin.
K. B. Porter	1946-date	Oat research at Bushland.
M. J. Norris	1946-77	Oat research at McGregor and Temple.
Lucas Reyes	1940-date	Oat research at Beeville.
K. A. Lahr	1955-77	Oat research at Chillicothe.

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Barley in Texas from Colonial to Modern Times 1668-1976

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BARLEY IN TEXAS FROM COLONIAL TO MODERN TIMES 1668 - 1976

Barley is one of the oldest and most widely adapted plants to be cultivated by man. It is not native to the New World; we must look to the Old World for information on its origin and development. Theories differ as to the location of the first cultivated barleys, and some are still being modified as new information is found. According to Wiebe (61), the place of origin may have been Ethiopia, the Near East, China, or India.

The growing of barley in Iran around 7,000 B.C. is reported by Hole (33). Kramer (40) found instructions on growing barley in a cuneiform script from Nippur, written about 1700 B.C. The Egyptians used barley extensively as a feed and food crop and probably developed the art of brewing. They believed it to be the first cereal cultivated by man and traced its origin to their goddess Isis. Barley was one of the crops destroyed by the Biblical plagues of Egypt, as reported in Exodus 9:31.

Barley is grown throughout the world under a wide range of conditions. It may be found on the high plateaus of Tibet, within the Artic Circle in Russia (where seasons are less than 60 days), and in North Africa, Ethiopia, and the Near East. Varieties have been developed to survive relatively low winter temperatures, while others may be injured by only light frosts. Man has selected or developed types suitable for livestock grain or winter pasture uses and for brewing, and hull-less types suitable for human consumption.

IN THE NEW WORLD

Barley was introduced into the United States through two routes: 1) into the New England and Atlantic Coast states by colonists from northern Europe; and 2) by the Spaniards into Mexico, and from there into California, New Mexico, Arizona, and Texas.

Barley and other cereal grains were grown at Martha's Vineyard, Massachusetts, in 1602 and by Virginia colonists as early as 1611 (Harlan, 31). Dutch colonists on Manhattan Island, New York, in 1626 also grew barley, but it was not as well adapted to this area as were the other cereals and thus did not become an important crop. The first center of barley production was New York; it later moved to the Midwest soon after 1800 and has remained there since. A second important area of barley production is in the West Coast states.

The second path led from the West Indies (Dominican Republic), to Cuba, Mexico, and into Texas. On Columbus' second voyage, he brought seeds and livestock. In a letter to the King he wrote, "For the preservation of health, after God, it is necessary that they be provided with the provisions to which they are accustomed–I say, wheat, barley, peas and vines" (Morrison, 44). Later, in 1524, Cortez requested the Crown to pass a decree that every ship should bring crop seeds and domestic animals (Whitaker, 58). Consequently, the small grains were introduced many times and immediately became important crops, spreading northward through the mountain valleys as those were settled by the Spaniards.

Saltillo, Coahuila was established in 1568 (Carter, 12). Twenty families came north to form a permanent colony in 1575. This became the southern terminus of the road to Texas and New Mexico. In nearby valleys there were 265 springs which supplied abundant water. Grants of water and land were given each family. Irrigation ditches were built, and soon the new colonists were growing corn, beans, wheat, and other grains, as well as vegetables and fruit. The nearby mining areas looked to Saltillo for foodstuffs.

A visitor to Saltillo on December 4, 1767, was Solis, an officer of the Catholic Church at Zacatecas. He wrote in his diary, "In this part of the country there are abundant fields of wheat, barley and corn as well as extensive vineyards" (Forrestal, 25).

Hendry (32) showed that barley, wheat, and oats reached California, Arizona, and New Mexico from Sonora, Mexico before 1700. He dissolved adobe bricks from missions built in this period. Barley of the Coast type and other small grains were found in the bricks. Atkins (5) found seed of barley and spike parts in adobe bricks taken from the Landin Mission near Saltillo, which was built in 1745 (Davilla, 19). (See Figure 1A, *Wheat for Man's Bread,* p. 3.)

From Saltillo, barley apparently came into Texas through two paths. Juan de Onate led an expedition of 400 men, accompanied by 138 families, 83 cargos (apparently burro loads) and 3,000 horses, cattle, and sheep, northward from Saltillo through the present El Paso area into New Mexico. They dedicated Pasa del Norte (El Paso) on May 4, 1598 and established several villages, built missions, and put some land into cultivation. The first irrigation ditch, taking water from the Rio Grande, was built by Father Garcia in 1659 and remained in use until modern times. By 1668, a permanent mission church was built, and the settlers began to cultivate crops using irrigation water from the river (Sonnichen, 49).

However, according to White (59), there is little evidence that farming became established in the El Paso valley until after the Indian revolt in 1680. The settlement of El Paso became permanent in 1685, and by 1692 there were 1,000 inhabitants. Conditions improved for the next 33 years, and when General Rivera of Mexico inspected the area in 1726, he observed that "East of El Paso, there was a spacious valley, where they grow wheat and other grains, corn, beans, grapes, fruit and vegetables."

Lt. Zebulon Pike observed large fields of wheat and other grains at El Paso in 1807 (Pike, 46). Later Juan Ponce de Leon settled at El Paso in 1827, purchased land on the north side of the river, where El Paso now stands, and grew wheat, corn, and other grains (Sonnichen, 49).

The second and later path into Texas came with the establishment of the missions in South and East Texas. Johnson (36) writes that all missions were planned to be self supporting–"All missions had farms on which they grew corn, grains, flax, fruits and vegetables."

Spanish explorers and missionaries made numerous trips into Texas between 1680 and 1750, establishing missions in different areas (Castaneda, 13). Fray Massanet and the Marquis de Aguayo traveled in Texas from 1719 to 1722 with the purpose of driving out the French and resupplying the East Texas missions. Upon their return to Saltillo, they recommended that families be brought from the Canary Islands to establish permanent settlements in Texas. Under this plan, the first group of 54 persons was brought through Vera Cruz to Saltillo and on to San Antonio on March 9, 1731. A presidio had previously been built in the bend of the river near present San Pedro Springs. Chabot quotes the diary of Father Massanet as follows: "It was the season for ploughing. Lands were allotted for sowing and, by the end of June, two fanagas of corn were sown; also, some beans, barley, cotton and vegetables" (Chabot, 15).

Bolton (10) has translated many of the records of three little known mission settlements in Central Texas, near present-day Rockwall (Milam County). These missions were built and operated from 1745 to 1757. They were located on the St. Xavier River, now called the San Gabriel. Father Ortiz, the missionary in charge, states, "They planted maize and other grain crops." When the San Gabriel missions were abandoned, the missionaries moved some of the supplies over to the San Saba River area, 100 miles west where a presidio was being built. Here, according to Dunn (21), a mission was founded in 1757. The Padre at this mission wrote, "In accordance with the Viceroy's instructions, the soldiers wre assigned land to cultivate and the soil was prepared for sowing grain." While barley is not specifically mentioned at either of these missions, corn and other grains are, and it is believed that barley was included.

The last missionary at the San Jose Mission at San Antonio was Father Joe Manuel Pedrijo, 1789-1794, who improved the products of the Mission (Habig, 29). Previously, wheat had not been grown to any extent because the Indians preferred corn. During this period, instructions were given that wheat, barley, and beans, as well as corn, were to be grown.

In 1804, a census of the regions of New Spain was made from official estimates and reported to the Real Tribunal del Consultado de Vera Cruz. Under the heading of agriculture, the statistical report shows "wheat and barley-none, although experience shows that both do well here (Guice, 28)."

IN THE TEXAS COLONIAL PERIOD

In writings by or about the European settlers in Texas during the 1800's there are few references to barley. Stephen F. Austin (Barker, 7) in his *Descriptions of Texas in 1828,* stated that "some experiments have been made in growing wheat, oats, barley and flax and these have been successful in the undulating country back from the Coast." His sister, Mary Austin Holley, in 1833 also reported that barley could be grown (34) and urged immigrants to bring all types of seed.

Feliz Bracht was in business at Fredricksburg from 1845 to 1848 and traveled extensively over Texas (11). He observed that "all European grain crops thrive in the Hill Country northwest of San Antonio."

However, barley was slow in gaining a foothold in South Texas (Jordan, 38). It was brought to Texas about 1830 by German settlers but in 1860 made up less than 1 percent of the crop area. In other areas it was even less prevalent. Christopher Columbus Goodman (26) in 1839 stated, "In Leon County they plant no oats or barley as they have no use for it. The horses, cattle and hogs can feed themselves on the range the year round."

Interest in growing barley apparently increased somewhat at mid-century. Barley for home use was grown in Bell County in the 1850's (Tyler, 57), and Kirkpatrick (38) stated that barley and wheat were the surest crops in Hill County in 1852. The Cat Spring Agricultural Society of Austin County experimented with many kinds of crop seeds from 1857 to 1880. In 1857, they received from the U. S. Patent Office a small sample of Peruvian barley (14).

The German Colony at Stanton (Martin County) grew barley in 1881 (Hutto, 35). The Texas and Pacific Railroad established demonstration farms at several locations. The one at Baird (Callaham County) from 1880 to 1883, grew many grain crops, (Blacklen, 9). The Santa Fe Railroad established farms at Sealy, Kippell, and Gainesville for demonstrating the growing of grain and other crops (22).

Some success with barley was reported by a farmer, E. E. Griffith, of Salado in 1905. He said he grew nine crops of barley without a failure (*Farm and Ranch Magazine,* November 1905, 25). A history of Tarrant and Parker Counties (51) states that barley is usually seeded for winter pasture.

The Eastern, Central, and Rolling Plains areas of Texas were settled very rapidly from 1870 to 1900. References to barley are scarce in the accounts of this period. As a forerunner of this settlement, the U. S. Army built a series of forts from Fort Worth to Fort Concho (San Angelo). In 1871, the Army bought 240,000 bushels of barley for feed, which was delivered by wagon freight to these forts (Haley, 30). It is possible that small portions of this were used for seed. For example, Taylor (52) traveled across Texas from Houston to the Presidio and El Paso area by horseback in 1876 and observed barley growing at Boerne, Fredricksburg, and The Llano Valley. The Army personnel at Fort McKavitt fed his horse barley grain. On the return trip, at Ben Fricklen in Tom Green County, he observed, "Here is the greatest barley farm of Texas, embracing several hundred acres. Yields are said to be 50 to 75 bushels per acre as the fields are irrigated from the Concho River. This is sold to the government for use by the cavalry at Fort Concho."

The first agricultural census of Texas, 1866 (55), reported 3,000 acres of barley, and the acreage remained near that amount until 1910 (Table 1). An 1892 (June) issue of *Farm and Ranch* stated, "Barley is not well known in the South" (24), and a 1902 editorial asked, "Why is not more barley grown in Texas" (24).

Advertisements in farm papers are an indication of what is being planted and the success of the crop. Throughout the period 1890 to 1910, numerous advertisements

TABLE 1. BARLEY IN TEXAS: ACREAGES, YIELD, PRODUCTION, AND VALUE, BY 5-YEAR PERIODS, 1966-75*

Years	Planted acreage	Harvested acreage	Yield per harvested acre	Production bushels	Season average price per bushel, dollars	Value of crop in Texas, dollars
1866-70		2,200	20.1	43,400	1.31	56,400
1871-75		3,200	22.9	73,800	1.04	82,200
1876-80		5,600	19.8	110,000	0.68	74,000
1881-85		5,000	17.6	88,000	0.74	65,800
1886-90		3,400	13.4	45,400	0.63	29,200
1891-95		3,800	19.0	71,400	0.63	45,000
1896-1900		4,000	20.4	81,400	0.56	45,800
1901-1905		4,600	18.4	85,800	0.74	62,400
1906-1910		5,400	19.9	111,800	0.79	88,600
1911-15		15,000	22.2	336,800	0.71	229,200
1916-20		49,000	17.6	100,840	1.09	109,040
1921-25		122,000	16.1	1,977,400	0.63	1,237,800
1926-30	191,000	178,000	18.4	327,680	0.58	1,902,400
1931-35	199,600	157,600	15.7	2,628,200	0.40	852,000
1936-40	222,400	170,200	15.5	2,631,200	0.46	1,131,200
1941-45	419,800	283,600	17.6	5,157,000	0.79	3,918,800
1946-50	180,200	133,800	16.0	2,141,800	1.19	2,549,000
1951-55	189,400	106,600	15.2	1,669,800	1.14	1,805,600
1956-60	436,600	310,400	21.6	7,007,000	0.86	5,853,800
1961-65	418,400	234,000	20.6	4,968,200	0.90	4,430,200
1966-70	190,800	123,800	26.8	3,435,000	0.92	3,112,400
1971-75	127,400	67,200	30.6	2,108,000	1.54	3,290,600

*Data courtesy Texas State Department of Agriculture (53) featured barley seed, most of which were northern varieties or seed shipped in from northern states. Apparently, there was little locally produced seed available at this time. The *Farm and Ranch*, (October 1890, 24) advertised "Northern barley" for sale by Milam and Paterson, Fort Worth. In *Farm and Ranch* (July 1892, 24), the Texas Seed and Floral Company advertised "New crop barley seed." In the same issue, a grower inquired, "Where can I get beardless barley." The Salzer Seed Company, LaCrosse, Wisconsin, advertised Salzer Silver King and other northern varieties of crops throughout this period (24). Although farmers attempted to grow barley throughout the 1800's, seemingly it was not generally a highly profitable crop.

The introduction of barley into the Texas High Plains area is likewise poorly documented. Settlement of this area occurred from 1890 to 1920. The brief references on barley culture usually do not state the source or whether the crop was fall or spring seeded.

The XIT Ranch experimented with barley, oats, and wheat at several ranch headquarters from 1886 to 1892 (62). Barley produced low yields or was a failure under dryland conditions, hence the crop was abandoned as a source of feed. C. W. Post of Battle Creek, Michigan fame, came to Texas in 1906. He bought 250,000 acres of land in Garza and adjoining counties, set up a model city and farms with supporting industries, and experimented with many grain and forage crops, including barley (Eaves, 23). Gough (27) tested barley and other grains at Crosbyton in 1913.

About 1910, barley growing became practical in the Dalhart-Ochiltree area. Stavropol barley was brought to Kansas by the Mennonite settlers, who also introduced Turkey wheat (Wiebe, 61). Stavropol, Coast, and Manshurry from the Northeast, along with the two-row variety Chevalier, were grown in the Panhandle about 1910 (Malley, 41).

As recorded earlier, barley was grown at El Paso as early as 1668, and its culture is recorded several times in the period of 1700 to 1900. The editor of *Farm and Ranch* (October 1890, 24) visited El Paso in 1888 and observed fields of barley yielding 40 to 60 bushels per acre under irrigation. The Texas & Pacific Railroad (56) reported that El Paso County produced 6,305 bushels of barley in 1896. Whether barley was continuously grown in the El Paso area throughout 1700 and 1800 cannot be determined. *The Earth* magazine (22) of July 1912 reported that E. A. Shakelton of Pampa grew barley successfully, averaging 33 bushels per acre. Also, the December issue observed that winter barley was a more successful crop than spring barley.

ACREAGES AND PRODUCTION 1866-1975

Barley production expanded slowly in the state. From its introduction into the El Paso area by Spanish explorers and missionaries in 1668 until it was brought to the San Antonio missions was 70 years. A century after that it was introduced into southern and eastern Texas repeatedly, but it did not become an established crop until about 1900. Data on acreage and production from 1866 to 1975 are given in Table 1 (55).

Barley acreage increased from 3,000 to 6,000 acres from 1866 to 1910. Prior to 1910, only northern spring-type varieties were available, hence the crop was subject to damage from winterkilling, drouth, and diseases. With the availability of the Tennessee Winter type varieties, the crop became more dependable and could be used for winter pasture as well as grain production. Acreage increased rapidly and by 1920 had reached 89,000 acres.

Since 1920, barley acreage has fluctuated from 100,000 to 300,000 most seasons. The periods of largest seeded acreage were from 1939 to 1945 and from 1957 to 1964. The maximum acreage in Texas was in 1961 when 582,000 acres were seeded and 421,000 acres were harvested. Under Texas conditions there is usually a significant reduction in the acreage harvested compared to that seeded. Some acreage is lost each season to the hazards of drouth, winterkilling, insects, and diseases. Considerable acreage is grazed to maturity, and the amount harvested in this manner fluctuates with weather conditions and the prospects of producing a grain crop.

Major barley acreage recently has shifted back into the El Paso area, where it was first grown. Reduced returns from cotton, alfalfa, and other high value crops and increased salts in irrigation water, to which barley is somewhat tolerant, is responsible for this shift. The acreage in the area has increased from 500 acres in 1968 to 29,500 in 1975 (Figure 1).

VARIETIES GROWN

Varieties of barley grown in Texas varied originally according to their paths of entry. Hendry (32) identified the seed obtained from 12 of the 14 missionary sites in northern Mexico and the California-Arizona area as being of the Coast type, originating probably in northern Africa. This probably was the type brought to El Paso and later to the San Antonio area by the Spanish. Varieties of this type are spring-growth habit and subject to injury by low temperature and diseases. While they may have produced well under irrigation at El Paso, they probably were not well adapted in South Texas.

References to crops brought by the German settlers of South Texas fail to mention variety names insofar as the author has been able to determine. Settlers from the eastern and northern states probably brought spring-type varieties, either of the Manchurian type or of the two-row Chevalier. According to Wiebe (60), much of the barley grown in the Northeastern states at this period was of mixed stocks coming from England, Scotland, or Western Europe. The two-row Chevalier barley was discovered in England in 1819 (17) and had spread to the United States. The eastern and northern farm magazines of the 1850 to 1900 period carried advertisements from seed houses for Mansury, Nepal Hulless, Hudson Bay, Black Barley, Highland Chief, Salzer Silver King, and others. Texas farm magazines of the period also carried advertisements for some of these varieties.

Varieties tested in the first experiments by the Texas

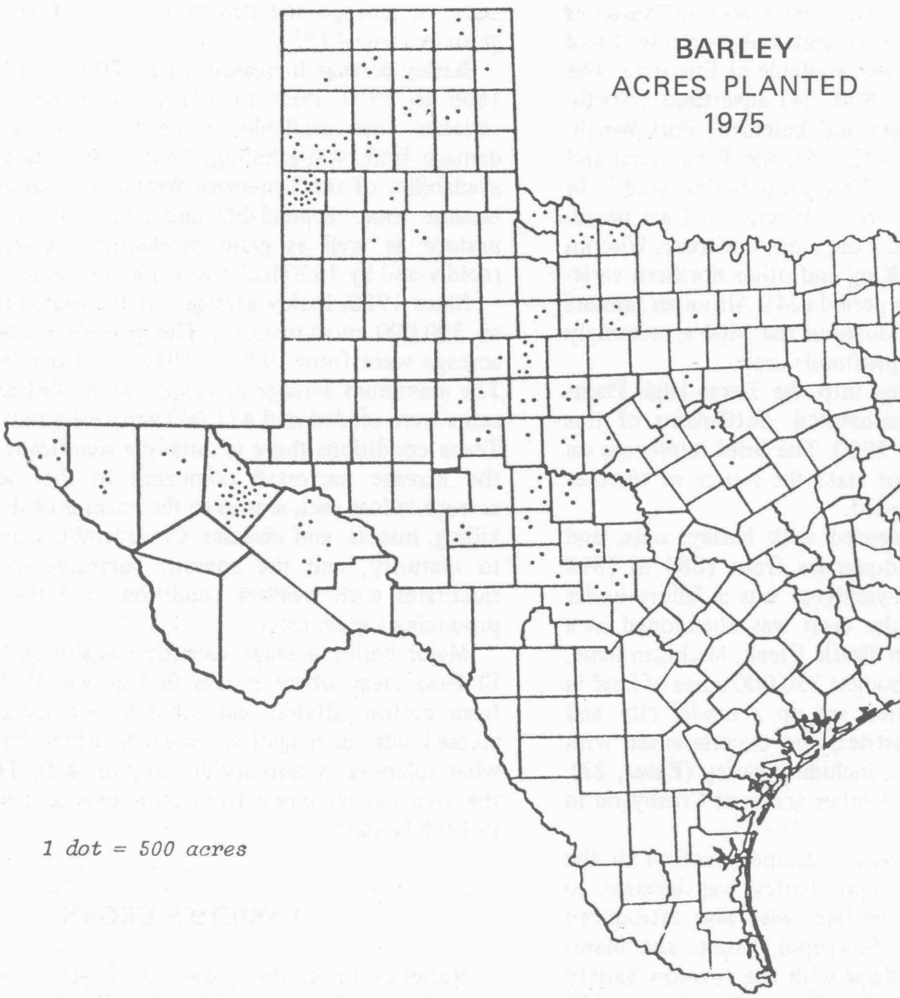

Figure 1: Distribution of the planted acreage of barley in Texas in 1975. (Courtesy Texas State Department of Agriculture, 55).

Agricultural Experiment Station at New Hope in Dallas County were Beldi Dwarf, Telli, Chevalier II, Svanhals, Kitzing, Hanna, Hankow, and Bohemian (Harlan, 31). At Amarillo, the spring-type varieties Horsfod, Hanna, Manchuria, White Smyrna, and Club Mariout were tested in 1906 (Ross, 48). These were failures and were dropped from the tests. On the other hand, Tennessee Winter proved better adapted and was tested until the Station closed in 1919. It was the general practice at that time to distribute to growers any variety or crop seed that was promising; it is therefore likely that some of these varieties were distributed. Mally (41) reported in 1910 that barley had become a successful crop in the Dallam-Ochiltree area with use of the varieties Manshury and Chevalier. Figure 2A shows some of the variety-types available for growing in the United States.

Stavropol barley spread into the Texas High Plains from Kansas, and along with the variety Coast, made up most of the acreage of spring-sown barley from 1900 to 1925 (Harlan, 31).

Variety names are missing from the few records of barley mentioned in Central Texas histories. The Cat Spring Agricultural Society recorded in its minutes (14) that members received seed of Peruvian barley from the U. S. Patent Office in 1857, but there is no further mention of its use. The 1911 annual report of the Texas Agricultural Experiment Station (54) shows that the varieties Smyrna, Russian, Stavropol, and Caucaus were tested from spring seeding at Denton.

The introduction of the winter and intermediate-winter types was responsible for barley becoming a satisfactory fall-sown crop in Texas. As pointed out earlier, the varieties of these types were developed from the Tennessee winter type grown along the Atlantic Coast for many years prior to 1900. The source of this type is not known, but Derr (20) believes it came from the Balkan region of Europe as barley of these types is grown there.

The Tennessee Agricultural Experiment Station began improvement work with this type of barley about 1894 (53), and a number of other states began work soon thereafter. Gradually two types emerged from this improvement work: 1) a prostrate growing, cold-tolerant, winter type and 2) an intermediate-winter, more upright growing, moderately cold-tolerant type which does not require vernalization for normal reproduction. This type is better suited to use for winter pasture.

Varieties of the winter type developed and distributed in specific states are found in the more northern portions of the winter-barley growing area. Among these are Ward (Oklahoma Winter), Reno and Kirwin (Kansas Winter), Kentucky No. 1 for Kentucky, Wisconsin Winter for Wisconsin, Michigan Winter for Michigan, Dayton for Ohio, Hudson for New York, Jackson, Tennessee Winter, and Beardless No. 5 for Tennessee, and others. These cold-tolerant varieties have made it possible to extend the winter barley area northward.

Varieties of the intermediate-winter type developed and distributed include Finley and Wintex in Texas, Woodwin and Tenkow in Oklahoma, Fayette in Arkansas, and others. Generally the intermediate-winter type varieties have been used in the Rolling Plains and Eastern Texas, while the more hardy type has been grown on the High Plains. More recently, varieties developed by hybridization have replaced the earlier selected varieties, and the acreage has included Cordova, Rogers, Will, Kerr, TAMU-Era, and Tambar 401.

BREEDING TO IMPROVE BARLEY FOR TEXAS CONDITIONS

Initial improvement work on barley was probably done on both an agency and individual basis. Agency work was started as soon as the Texas Agricultural Experiment Station was established. The first work consisted of testing varieties and strains received from other areas and those introduced by the U. S. Department of Agriculture. At the 1895 State Fair of Texas, the Texas Agricultural Experiment Station displayed many types of grain, including 11 varieties of barley. Adaptation studies were initiated at Dallas in 1905 (54) and near Dalhart in 1905 by the U. S. Department of Agriculture (Ross, 48).

Preceding this organized research, no doubt many immigrants and settlers experimented with barley from their home areas. For example, Charles B. Richardson of Henderson grew barley and other grains as early as 1865 (May, 42). The colonization division of the Texas and Pacific Railroad established demonstration farms at Baird, Stanton, and Midland from 1883 to 1896. Many crops, including barley, were grown on these farms. The Santa Fe Railroad also established farms along its lines from 1890 to 1920, where crops, vegetables, and fruit were tested.

Organized research gained significant impetus with the establishment of the Texas Agricultural Experiment Station Substation at Denton in 1911. This station was the center for small grain research for 60 years. Annual reports (54) of the Station show that seed of Tennessee Winter barley was obtained from the U. S. Department of Agriculture experiment station at Dalhart in 1911. This barley performed well and was immediately released to the public. Three growers near Denton obtained from 30 to 100 pounds of Tennessee Winter seed from the Station in 1914. The following year the Station grew 39 acres of Tennessee Winter for distribution of seed. In 1916, V. L. Cory, superintendent (54) wrote in his annual report that "Tennessee Winter barley is a reliable crop. Farmers of this area owe its introduction to the Experiment Station." This was the beginning of successful growing of barley in Texas. Growers recognized its value for winter pasture as well as for grain, and the acreage quickly climbed to 100,000 acres in 1922.

Facilities, knowledge, and personnel for crop improvement work were very limited in those early days of research. Most improvement work consisted of purification of the mixed lots of seed available or selection of unusual plants. Procedures for testing strains in small nursery plots were developed as shown in Figure 2B. As these individual plant progenies were increased and tested, they were grown in field plots and harvested with machinery as shown in Figure 2C.

Breeding work from 1911 to 1925 resulted in the development of the intermediate-winter type variety Finley, a selection from a field near Denton. This variety was grown on a limited acreage in Central Texas until 1938

Figure 2A: Head types of cultivated barley: (Left to right) hooded, short-awned, awnless, compact, 2-row white, 2-row black, 6-row black, 6-row white chaff.

Figure 2B: Small nursery plots of experimental barley strains where hundreds of strains are compared under identical conditions, Texas Substation No. 6. Denton, Texas, 1946.

Figure 2C: Experimental field plots of Wintex and Texan barley at Texas Substation No. 6, 1946.

TABLE 2. ESTIMATES OF PERCENTAGES OF THE TOTAL CROP FOR BARLEY VARIETIES GROWN IN TEXAS, 1910-1975

	Percentage of total													
Variety	1910	1915	1920	1925	1930	1935	1940	1945	1950	1955	1960	1965	1970	1975
Arivat-Ariman													1	2
Coast	40	30	20	5	5	5								
Cordova										10	50	40	34	30
TAMU-Era													4	8
Finley				5	10	20	15	5	2					
Florida 102												Tr	2	2
Goliad										2	4	4	2	2
Harbine							2	5	2	2	6	2		
Kearney										5	10	6	3	
Kerr														2
Luther													1	1
Reno (KS.W.)						5	5	5	5	1	1			
Rogers										2	3	28	18	18
Stavropol	40	40	40	30	15	10	5	2	2					
Tambar 401														8
Tenkow							3	3	2	Tr				
Tenn. Win.	Tr	10	30	45	55	45	35	25	25	15	5			
Texan							Tr	5	10	5	5	2		
Tokak													1	1
Tunis								1	3	2	1	1		
Ward				5	5	5	5	10	4	2	2	2		
Will											Tr	10	30	25
Wintex							15	40	40	45	10	5	2	
Wocas													1	1
Zora												1	1	

when a more productive variety, Wintex, was released from the Denton station. Wintex was very popular and was grown on large acreages from 1938 to 1955. It produced well in the drier parts of the State and spread into New Mexico and Oklahoma. A field of Wintex barley at Denton in 1938 is shown in Figure 3A.

Cooperation with adjoining states and the U. S. Department of Agriculture regional improvement programs was initiated in 1930. The U. S. Department of Agriculture began furnishing bulk hybrid populations developed by crossing up to 1,000 strains and the following year, by crossing the F_1 plants of these crosses. After natural selection had taken place, selection of strains for specific areas was practiced. From this material, the variety Texan (Atkins, 1) was developed and distributed in Central Texas in 1941. Texan was resistant to mildew and loose smut, providing protection from these diseases to growers in Central Texas. Texan acreage was largely confined to the Central Texas and Hill Country of the Edwards Plateau (Figure 3B).

Following the successful development, distribution, and grower acceptance of Finley, Wintex, and Texan barleys, these well-adapted varieties were crossed in 1938 to produce a new hybrid population. Working with the progenies of this cross, scientists developed the new variety Cordova and released it in 1951 (Atkins, 2). Cordova had many desirable characteristics, especially resistance to mildew and smut, smooth awns, good quality grain, excellent yielding ability, good forage characteristics, and good standing ability. Cordova was widely grown in Texas and adjoining states from 1951 to recent years. A private estimate in 1963 indicated it was grown on 48 percent of the Texas acreage. An excellent field of Cordova is shown in Figure 3C.

Breeding work carried on at College Station and in South Texas by E. S. McFadden during this period emphasized the use of barley for winter pasture. The varieties Goliad (43) and Tunis, with superior disease resistance and forage characteristics, were released for growing in that area.

As part of the regional improvement program, many varieties from other States were tested, and some were found to be useful to Texas growers. Foundation seed of Rogers, Will, and Kerr were brought in for increase and release to Texas growers. Acreages grown were substantial. Harrison, a very cold-tolerant variety from Indiana, and Zora, from Arkansas, also were made available to local growers by the Foundation Seed Section of the Texas Agricultural Experiment Station.

Plant breeding work to develop varieties resistant to the greenbug was initiated immediately after the disastrous greenbug infestation in 1942 (See details in the section on insects). The varieties Omugi, Dohadak, Dobaku, Smooth Awn 6, and others proved to be resistant and were crossed to adapted varieties such as Cordova, Texan, Rogers, and others. Entomologists and plant breeders cooperated in this breeding program after 1942 and developed several varieties of wide adaptation which gave growers protection from this insect.

Kearney (Porter, 47), a Nebraska winter hardy variety, and Will, developed in Oklahoma, were released in the 1950's. More recently Kerr was released in Oklahoma and Texas. TAMU-Era (50), a variety similar to the widely adapted variety Cordova, was developed at Denton and released by the Texas Agricultural Experiment Station in 1969. All these varieties now occupy large acreages in the Southwest (Figure 3D).

No official surveys of barley varieties grown in Texas have been made. However, the writer, in cooperation with other barley research workers and commercial seedsmen, estimated percentages of acreages planted to commercial varieties (Table 2) grown from 1910 to 1976. A list of varieties developed or released in Texas is given in Table 3.

TABLE 3. VARIETIES OF BARLEY DEVELOPED IN TEXAS OR OUT-OF-STATE VARIETIES OF WHICH FOUNDATION SEED WAS INCREASED AND RELEASED TO TEXAS GROWERS

Variety	Year released	Developed by	Reference	Characteristics
Tennesse Winter	1914	Introduced		First cold-tolerant variety, established barley in Texas
Finley	1925	TAES		First intermediate-winter, high yields, forage uses.
Wintex	1938	TAES	P.R.607	Intermediate winter, high yields, widely adapted
Tunis	1942	TAES		Disease resistance, excellent forage characteristics
Texan	1942	TAES	P.R.755	Intermediate winter, mildew and smut resistance
Goliad	1948	TAES	P.R.1426	Spring type, winter pasture, disease resistance
Cordova	1953	TAES	B.760	Intermediate winter, mildew and smut resistance, high yields, wide adaptation
Kearney	1957	Nebr.	L.251	Cold tolerant, greenbug resistant
Rogers	1959	Okla.	B490	Cold tolerant, aphid resistant, high yields
Will	1964	Okla.	B631	Cold tolerant, greenbug resistant, high yields
Era	1965	TAES	L-778	Intermediate winter, high yields, greenbug resistant
Tambar 401	1971	TAES	L-1074	Intermediate winter, high yields, disease resistant

Figure 3A: Field of Wintex barley at Texas Substation No. 6, Denton, Texas, 1938. Examining the field are (left to right) P. B. Dunkle, superintendent, Substation No. 6; E. A. Miller, Texas Agricultural Extension Service; L. E. Brooks, horticulturist, Substation No. 16, Iowa Park; and C. H. McDowell, superintendent, Substation No. 16, Iowa Park, Texas.

Figure 3B: Field of Texan barley in the Hill Country near Fredricksburg, Texas, 1946.

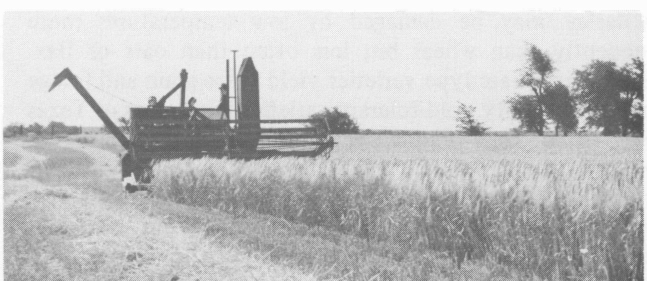

Figure 3C: Harvesting a field of Cordova barley on the farm of John Wells, Plano, Texas, 1954.

Figure 3D: A foundation field of Era barley at Texas Substation No. 6, Denton, Texas. J. H. Gardenhire, who developed Era barley, is shown at the left.

HAZARDS OF PRODUCTION

Acreages and production of barley in Texas vary greatly from season to season, perhaps more than for any other major crop. The hazards of drouth, winterkilling, diseases, insects, lodging, hail, rainfall distribution, as well as economic factors, influence the production of barley. (See Atkins (3) for an extended discussion of barley production.)

Rainfall Amounts and Distribution

The amount and distribution of rainfall is probably a major factor in determining the seeded acreage, the value of the harvested crop, and grain yields. Drouth can be a major hazard because only a small percentage of the acreage is grown under irrigation. The acreage spring seeded in the High and Rolling Plains areas is greatly dependent upon moisture conditions at a very limited period in the spirng. Likewise, the acreage fall sown for winter pasture is greatly dependent upon rainfall during a short period in late summer. Later in the crop season, rainfall in the late winter and spring determine whether this crop is grazed off or allowed to produce a crop of grain.

Excessively wet seasons, also, may be hazardous to barley production. In such seasons, barley is frequently attacked by diseases, reducing both yields and quality of grain.

The frequency with which these hazards seriously influence barley yields in Texas is shown in Table 4. Drouth is the major hazard in the western part of the State and diseases are the major hazard in the humid eastern and southern parts.

Insects

Several species of insects can, and often do, cause serious reductions in stand, vigor, and forage and grain yields in barley grown in Texas. (Detailed information on small grain insects is given by Daniels (18) and by Chada (16).)

Several species of aphids attack barley, but the most serious is the so-called "greenbug", *Schizaphis graminum* (Rond) (Figure 4A). The greenbug can live and reproduce at temperatures fatal to most other aphids. During the relatively mild winters of Texas, they can increase to such numbers that the seedling plants of cereals are damaged or killed. During such periods the natural enemies of the greenbug often are present only in small numbers and cannot control the greenbug. Small areas, large areas, or entire fields of grain may be destroyed. A serious infestation of greenbugs was reported by Atkins and Dahms (6) in 1942. This infestation started in Central Texas and spread northward to Central Oklahoma. The loss in the three small grains crops was estimated to be more than 45,194,681 bushels of grain valued at $26,472,079. Other serious outbreaks of greenbugs occurred in 1890, 1901, 1907, and 1922, damaging grain throughout Central Texas. Infestations confined to the High Plains occurring in 1951 and 1952 caused destruction of most of the wheat.

During the infestation in 1942, Atkins and Dahms (6) discovered that certain Oriental barley varieties were resistant to this insect. The varieties Omugi, Dohadak, Dobaku, Sonbaku, Smooth Awn 86, and others were able to withstand greenbug attack (Figure 4B), survinving to produce a crop when all surrounding varieties were killed. The discovery provided the basis for an immediate breeding program to transfer this resistance to adapted varieties. Laboratory procedures were developed (Figure 4C) whereby the reaction of varieties or breeding line to attacks by greenbugs could be determined accurately and rapidly. Breeding work carried on by J. H. Gardenhire, Harvey L. Chada, and others provided Texas growers with the new variety TAMU-Era (50), a well adapted variety resistant to greenbugs. Similar work in Oklahoma provided the varieties Will and Kerr.

Barley is also the favorite host plant for the chinch bug, *Blissus leucopterus* Say. The chinch bug frequently increases on barley, causing some damage, then crawls to nearby fields of corn or sorghum. Barley also may be injured by the winter grain mite, the brown wheat mite, army worms, and other insects.

Low Temperatures

Barley may be damaged by low temperatures more frequently than wheat but less often than oats or flax. The intermediate-type varieties yield more grain and forage than do the very cold-tolerant varieties in all areas of Texas except the High Plains. Seedling growth of the intermediate-type varieties is expressed in more rapid, upright growth with broader leaves; consequently, the plants may be more succulent when severe cold snaps occur. However, when well hardened, the intermediate-type varieties will usually survive Texas winters.

TABLE 4. FREQUENCY OF SERIOUS DAMAGE TO THE BARLEY CROP IN TEXAS CAUSED BY CERTAIN ENVIRONMENTAL HAZARDS, 1932-63.

Location	Fall drouth	Spring drouth	Excessively wet	Winter killing	Spirng freeze	Green-bugs	Leaf rust	Mildew
Amarillo	15	15	0	6	5	9	1	0
Chillicothe	5	5	1	2	3	4	2	2
Denton	6	3	5	4	3	6	4	8
College Station	1	3	5	0	1	2	8	14

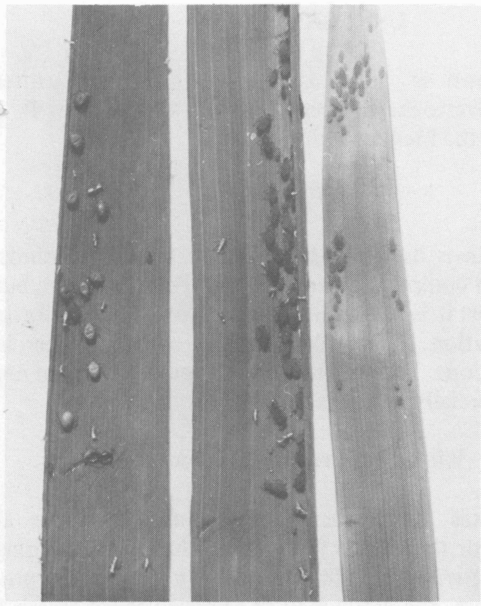

Figure 4A: (Left) Greenbugs (aphids) on a leaf of barley; (right) discoloration of leaf caused by feeding of the insects.

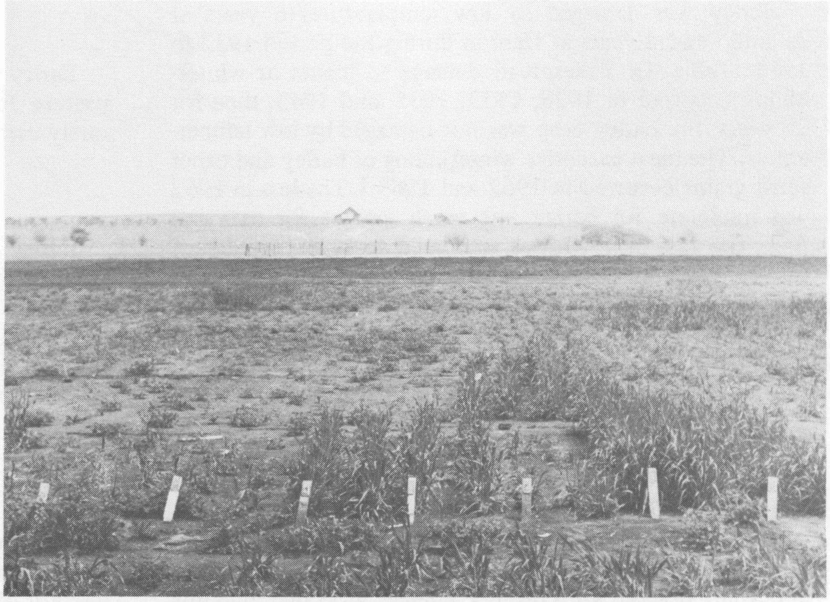

Figure 4B: Field infestation of greenbugs at Denton, Texas, 1942. Several varieties were found with genetically inherited resistance to the greenbug and formed the basis for breeding for resistance to greenbugs. All surrounding varieties were destroyed.

Figure 4C: Harvey L. Chada, entomologist, U. S. Department of Agriculture, in insectary, showing method of testing barley and other cereals for resistance to the greenbug, Substation No. 6, Denton, Texas, 1954.

Figure 4D: Winterkilling of the spring-type barley variety Cebada Capa at McGregor in 1963. Adjoining varieties of the intermediate-winter type were damaged only moderately.

Barley was damaged by low temperatures 6 years at Amarillo and 4 years at Denton during the period 1932 to 1963 (Table 4). Widespread damage to plants or winterkilling occurred in 1928, 1933, 1935, and 1943; then for 20 years, the barley crop was not damaged by low temperatures. The most extensive winterkilling of barley and other small grains occurred in 1962 and 1963.[1] The loss in 1962 was moderate for barley but much greater for oats and flax. The loss in 1963 was estimated to be 49 percent of the barley crop or 240,000 acres; grain and forage were valued at $6,494,000. Complete killing of tender varieties is demonstrated in Figure 4D, where Cebade Cap was killed at McGregor in 1963, and adjoining plots of intermediate-type varieties such as Cordova survived with little damage.

Diseases

Diseases are of greater importance in the humid eastern part of the state than in the drier sections. Small grain diseases are treated by Atkins and Futrell, (4). The more important diseases are Powdery mildew, Erysiphe graminis (DC) Merst.; spot blotch caused by *Helminthosopium sativum* Pam., King et Bakake; barley stripe caused by *Helminthosporium graminum* Rab.; leaf rust caused by *Puccinia hordei,* Otth., and barley yellow dwarf, a virus disease transmitted by insects. Several other leaf attacking and seed-borne diseases may occur occasionally. The smuts occur but can be kept under control by seed treatment. Leaf diseases of barley are shown in Figure 5A and smutted heads in Figure 5B.

Diseases usually are more destructive in seasons of high rainfall and humidity. Serious losses occurred to the barley crop in 1935, 1949, and 1957 (Table 5). Less serious losses for the state, but influencing local areas, occurred in other years. Such losses discourage the growing of barley in certain areas and contribute to the wide fluctuation in acreage and production.

TABLE 5. ESTIMATES OF LOSSES CAUSED BY BARLEY DISEASES IN TEXAS IN 1935, 1949, 1957.

	Percent of crop	Loss (bushels)
1935		
Leaf rust	0	0
Stem rust	5.0	146,000
Helminthosporium	0.2	6,000
Mildew	0	0
Others	4.0	117,000
1949		
Leaf rust	0.9	26,400
Stem rust	0	
Helminthosporium	3.7	105,000
Mildew	2.3	61,600
1957		
Leaf rust	1.1	61,068
Stem rust	0.2	10,042
Helminthosporium	5.2	281,850

[1] *Losses to the small grains and flax crops in Texas caused by low temperatures in 1962 and 1963. Mimeographed. Texas Agricultural Experiment Station, Department of Soils and Crops.*

USES IN TEXAS

Barley grown in Texas is used for grain and winter pasture for livestock, or a combination of the two. It is rarely used in the brewing industry.

Grain For Feed

Barley grain is used as a feed for livestock of all kinds. It is similar in composition to corn and grain sorghum, but has more fiber; it is valued at about 98 percent of corn in a fattening ration. The hulled grain is slightly higher in protein than corn. The hull-less grain type varieties are not grown commercially in Texas.

Winter Pasture For Livestock

Under Texas conditions, barley is usually grown at least in part for the winter forage it produces. When spring weather and growing conditions are favorable for the production of grain, the cattle may be removed about March 1 and the crop allowed to mature grain. If, on the other hand, conditions are not favorable, the barley may be grazed until all plant growth is killed out. The large differences in seeded and harvested acreages (Table 1) are due largely to this practice of grazing. Some acreage is lost each year to drouth, insects, diseases, and winterkilling. In 1975, for instance, 153,000 acres of barley were seeded, but only 87,000, or 56 percent, were harvested.

For winter pasture, barley establishes a stand and provides forage more quickly than do oats or wheat. When seeded in August or September, and conditions are favorable, barley may provide winter pasture from October until March; if the crop is grazed out to maturity, it will produce pasture until late May.

The winter, intermediate-winter, and spring-type barley varieties have distinctly different early growth patterns and respond differently to grazing and to low temperatures. Figure 5C shows the early season growth habit of Will, an obligate winter type; Cordova, an intermediate-winter type; and Goliad, a near spring-type variety. The true-winter-type varieties develop more slowly in the fall and are more cold tolerant but may be grazed later in the spring. The intermediate-winter type varieties are truly intermediate in growth habit, cold tolerance, and growth pattern between the winter and spring types. They will survive most Texas winter conditions and provide a well-balanced forage supply throughout the winter season. The true spring varieties produce forage rapidly after seeding but may be injured by close grazing and by low temperatures. Figure 5D shows a field of Texan barley used for winter pasture at Temple in 1946.

Brewing

Barley grain of special quality or the malt may be shipped into Texas for brewing. Neither the varieties grown nor the quality of grain produced in Texas is suitable for brewing purposes. Some attempts have been made to test varieties suitable for brewing by growing them under irrigation in the High Plains, but this has not been successful.

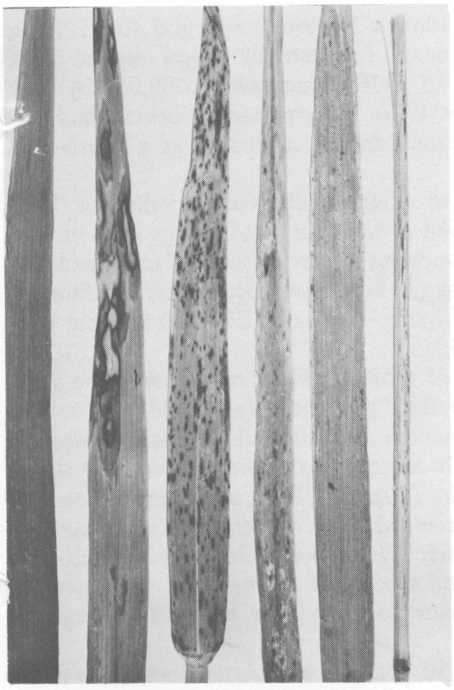

Figure 5A: Foliage diseases of barley (left to right): Normal leaf, barley scald, barley stripe, powdery mildew, barley leaf rust, and barley stem rust.

Figure 5B: Barley smut: loose smut compared to (right) normal head.

Figure 5C: Growth types of barley. (Left) winter-type variety Will; (center) intermediate-winter type variety Cordova; (right) spring-type variety Goliad.

Figure 5D: Livestock grazing on fall-sown barley at Temple, Texas, 1948.

Some breweries were established in the early German settlements of South Texas. A brewery was built at La-Grange soon after the town was established in 1833. At Doss (Gillespie County) a dam was built on the Pedernales River to supply water and water power for a grist mill and brewery (Biggers, 8). According to Newcomb (45), a brewery was built adjoining the Alamo in 1855 by the Menger family. "Menger" beer was produced there until 1877, when the brewery was torn down to build the Menger Hotel, still operating at that location. The malt and hops for this brewery were brought by boat from New York to Houston, and then by wagon-train freight to San Antonio. Corn probably was used as the brewing grain. The Fort Worth Brewing Company was established in 1890 and in 1901 produced 3,000 freight cars of Fort Worth beer (Knight, 39). Since the repeal of the federal and state prohibition amendments, a number of large national breweries have been established in Texas, but none use Texas grown barley for brewing.

CONTRIBUTIONS OF RESEARCH TO BARLEY PRODUCTION

Although barley was introduced into the El Paso area as early as 1668, into the San Antonio area in 1731, and repeatedly into South Texas from 1830 to 1900, it did not become established. It was not a successful commercial crop in Texas until the 1910-1920 period. Not until cold tolerant varieties of winter-growth-habit were introduced by the U. S. Department of Agriculture and the Texas Agricultural Experiment Station from 1905 to 1911, did barley acreage spread. The acreage ranged around 3,000 acres from 1860 to 1910; it increased to 89,000 by 1920 and to 100,000 in 1930. Early research workers thus were responsible for establishment of barley as a satisfactory farm crop.

Development of intermediate-type varieties for Texas conditions provided a dual grain and forage crop of wide adaptation. The varieties Finley, Wintex, Texan, and Cordova, developed by the Experiment station staff, influenced further spread of barley acreage to 300,000 in some years from 1935 to 1950.

The discovery of genetic, varietal resistance to the insect commonly called the "greenbug" (an aphid) was a landmark in barley research. This formed the basis of breeding for resistance to the insect and the development of resistant varieties TAMU-Era (50), Will, Kerr, and others which have for many years provided growers with protection from the ravages of this insect. Basic scientific studies which were instrumental in the success of the breeding work were reported and continue to contribute to the understanding of the problem.

Over the past 50 years, new varieties have been developed for the three major growing areas, providing adequate low temperature protection combined with the maximum forage production for a specific area. Protection from mildew damage has been provided for Central and South Texas in the varieties Texan, Cordova, TAMU-Era, Tambar 401, Goliad, Tunis, Florida 102, and others. These varieties also have tolerance to other leaf diseases—again providing protection from these hazards to growers of barley.

PERSONS INVOLVED IN BARLEY RESEARCH

Many people contributed significantly to barley research in Texas. Some, together with their major contributions, position or interest, are listed. Some, inadvertantly, may have been omitted.

Period	Individual	Contributions, position, and interest
1911-15	T. W. Buell	superintendent, Substation No. 6; release of Tennesse Winter variety and establishment of barley as a crop.
1922-47	P. B. Dunkle	superintendent, Substation No. 6; variety testing, development of Finley and Wintex barleys.
1926-38	P. C. Mangelsdorf	agronomist, Texas Agricultural Experiment Station, small grains and corn section leader.
1929-54	I. M. Atkins	agronomist, U. S. Department of Agriculture, Substation No. 6; barley breeding; variety testing; development of Wintex, Texan, Cordova varieties; discovery of greenbug resistance in barley.
1954-69	I. M. Atkins	small grain and flax section leader; State small grains program; barley breeding.
1938-46	D. A. Reid	agronomist, Amarillo Experiment Station, Bushland; variety testing; barley breeding.
1961-72	D. A. Reid	agronomist, U. S. Department of Agriculture, winter barley regional coordinator.
1938-60	G. A. Wiebe	agronomist, U. S. Department of Agriculture, barley section leader.
1938-55	E. S. McFadden	agronomist, U. S. Department of Agriculture, barley breeding and improvement, College Station.
1946-75	M. J. Norris	agronomist, Texas Agricultural Experiment Station; located Denton, McGregor and Temple; variety testing, forage testing.
1949-76	J. H. Gardenhire	agronomist, Substation No. 6; Texas Agricultural Research and Extension Center, Dallas; barley breeding and improvement; greenbug resistance studies; development of TAMU-Era and Tambar 401 varieties.
1946-76	K. B. Porter	agronomist, Texas Agricultural Research and Extension Center, Amarillo; barley breeding and improvement; Kearney and other varieties.
1951-60	Harvey Chada	entomologist, U. S. Department of Agriculture, Texas Substation No. 6, Denton; greenbug resistance in barley.
1954-76	Norris Daniels	entomologist, Texas Agricultural Research and Extension Center, Amarillo; greenbug resistance in barley.
1949-64	M. C. Futrell	plant pathologist, U. S. Department of Agriculture, College Station; diseases of barley.
1955-76	Keith A. Lahr	agronomist, Texas Agricultural Research and Extension Center, Vernon; barley variety grain and forage testing.
1965-76	M. E. McDaniel	agronomist, Texas Agricultural Experiment Station, College Station; barley breeding; barley grain and forage testing; disease resistance studies.

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Rye in Texas 1731-1976

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RYE IN TEXAS
1731-1976

RYE IN THE NEW WORLD

Rye has been cultivated by man for about 2000 years, but there appears to be no record of rye in the pre-Christian era (Leonard, 22). Rye is not native to the New World. It was brought into the eastern United States by the English and Dutch settlers. Carrier (6) quotes Bradford as stating that rye was grown at Plymouth Rock in 1628. Rye was grown for bread by the German farmers of Pennsylvania as early as 1796 (Gray, 15).

Rye culture spread westward with the movement of settlers. At the time of the first census in 1839, the center of production was in Pennsylvania, but in the next 10 years it moved to the North Central states, where it has remained since (Leonard, 22). Like the other cereals, it was brought to Texas by settlers from the North and East and by the Spaniards into Mexico and from there into Texas.

Rye is the most cold tolerant of the cereals and is grown beyond the Arctic Circle in Finland and at the northern limit of the Canadian grain-producing belt. It survives most winters in North Dakota and Montana. Rye is an important food in certain ethnic groups and is favored over other cereals for use on sandy soils. The crop is grown on a much smaller acreage than other cereals. Total rye production in the United States from 1952 to 1961, was 4 million acres compared with 54 million acres for wheat (Leonard, 22).

RYE IN TEXAS

Undoubtedly many immigrants brought rye seed to Texas, but records of such introductions are scarce. As food was a critical item of survival for the early settlers, the major attention was given to corn and wheat. Also, ryes brought from the more northern climates were winter types and were not well adapted in Texas.

Hendry (16) and several other authors record the fact that wheat, rye, barley, oats, and flax were introduced to Mexico by the Spaniards and became well established. As these people moved into Texas, they brought crop seed with them. Johnson (19) states that all Spanish missions were planned to be self-supporting and that livestock and crop seeds were brought to provide food for the soldiers, settlers, and the Indians, who moved into the missions. However, there seems to be few records of the growing of rye by the Spanish in Texas.

The first reference to rye growing in Texas is from Austin (1), who explored the southern part of the State in 1821 and again in 1833. After the 1821 trip, he wrote, "A mountain range extends across the headwaters of the Brazos, Colorado, and Nueces Rivers [probably what is now called the Edwards Plateau area]. This mountain region will at some time in the future supply Texas with good wheat flour, also rye, hemp and fruits." After the 1933 trip, Austin wrote, "Some experiments have been made in growing wheat, rye, oats and flax, which has been successful in the undulating country back from the Coast." Just where he observed these crops is not recorded.

Edward (11), another traveler in Texas in 1835, stated "Wheat, rye, oats and barley can be grown." Also Bracht (4), who traveled in Texas and was in business at Fredricksburg for a time, wrote, "All the European grain crops do well in the Hill Country." Latham (21), who traveled in Texas in 1842, observed on the farm of Colonel Burleson at Bastrop that "rye looks good and other small grains do well."

However, rye apparently did not become of any great importance in South Texas; Jordon (20), who reported a survey of crops in 1860, found that less than one-eighth of German farmers even mentioned rye as a crop. Also, Goodman (13), who lived at Kossee in Limestone County in
1855, wrote, "They grow no rye or barley here, having no use for it as the cattle can feed themselves on the range throughout the year."

At Cat Spring, Austin County, (7) the Cat Spring Agricultural Society was formed in 1856 to search for improved methods of farming and for testing new crops and varieties of crops. They brought in seed from their home country and from eastern states and obtained new crops and varieties from the Patent Office. Rye is frequently mentioned in the minutes of their meetings. On September 1856, the usefulness of "summer rye" was discussed. In January 1859, the statement was made that "rye falls down and should be planted with oats." In July 1872, the organization received from the Patent Office small packages of the rye varieties Stuessel, Baden, Pomikel, Wolcheck, Stoppel, and Waach. In October 1875, a winter rye was distributed to members. However, there were few reports on these rye varieties tested.

The number of references to rye before 1900 are also few. Harper (14), who lived at Kossee in Leon County, reported that after the Civil War, "We grew rye, oats, barley and some wheat." Apparently some rye was grown and reached the market, as Douglass (10) in a statistical report of Texas industry, reported that 85 barrels of rye flour were produced.

Between 1890 and 1915, there appear a number of classified advertisements of rye seed for sale. The *Farm and Ranch* of July 21, 1894 (12) offered Finland rye to Texas growers. On November 6, 1895 (12), a grower requested sources of seed of White winter rye. Halloway Seed Company of Dallas offered seed of "a new rye" to readers (14). On August 19, 1913, Black rye seed was offered for sale (12). On July 20, 1918, The Texas Seed Breeding Farms (12) offered seed of Abruzzi and Rosen rye to readers.

In *Progressive Farmer* of August 14, 1915, D. R. Coker of the Coker Pedigreed Seed Company, Hartsville, South Carolina, wrote a feature article on the value of Abruzzi rye (9). He pointed out that advantages of the new rye variety and stated that, "We received a bushel of Abruzzi

TABLE 1. RYE: ACREAGE, YIELD, PRODUCTION, AND VALUE IN TEXAS, 1866-1975 BY 5-YEAR AVERAGES*

Period	Acreage planted	Acreage harvested	Yield per acre, bushels	Production, bushels	Season average price per bushel, dollars	Value of production, dollars
1866-70		3,000	9.6	29,200	1.22	35,400
1871-75		3,000	10.4	31,200	1.26	39,400
1876-80		3,000	9.3	28,000	0.88	24,000
1881-85		3,800	11.5	43,800	0.90	38,400
1886-90		4,600	10.8	49,400	0.80	39,200
1891-95		4,800	11.7	56,400	0.74	41,600
1896-1900		4,000	12.0	48,200	0.72	34,400
1901-05		3,000	9.8	29,600	0.83	24,400
1906-10		1,200	11.3	13,800	0.96	12,800
1911-15		2,200	13.2	29,000	0.98	28,400
1916-20		8,400	11.0	92,600	1.48	141,400
1921-25		5,800	8.7	51,800	0.96	46,600
1926-30		3,200	11.6	39,000	0.89	35,600
1931-35	6,000	2,600	9.7	26,600	0.54	10,400
1936-40	21,400	11,200	9.6	99,800	0.62	58,400
1941-45	43,000	19,600	9.9	193,400	0.87	168,800
1946-50	83,300	28,400	8.4	234,000	1.47	351,000
1951-55	131,800	29,800	7.6	240,200	1.34	313,400
1956-60	106,800	21,000	12.2	242,800	0.97	249,600
1961-65	157,200	26,800	14.3	386,400	0.95	364,000
1966-70	289,200	33,400	16.1	542,000	1.08	544,800
1971-75	333,800	32,400	15.5	523,000	1.59	818,800

*Courtesy Texas State Department of Agriculture.

rye seed from the U. S. Department of Agriculture in 1906. Selections were made from 1909 to 1911, when one strain was released to growers. This new variety became popular and was widely grown in the Southern States."

The agricultural census reports only 3,108 bushels of rye produced in Texas in 1850 (34) but 28,500 in 1870 (31). Acreages from 1890 to 1940 usually ranged from 3,000 to 5,000, although much rye was planted for pasture and does not appear in the harvested acreages. From 1949 to date; both seeded and harvested acreages are given (28). Since 1965, the seeded acreage has usually been near 200,000, but the harvested acreage is about 100,000. The maximum acreage seeded was 395,000 acres in 1970.

Acreages, production, and other data on rye by 5-year averages are given in Table 1 (29). However, this does not include the value of winter pasture, which is an important portion of the value of rye. Figure 1 shows the distribution of rye in Texas in 1875. The crop is rather widely distributed over the State but usually is grown on the lighter soils.

VARIETIES OF RYE

Early references to rye mention only the crop, with very little about its sources. It is believed that perhaps all were the winter-types grown in northern climates. Those perhaps were poorly adapted and may not have headed normally under Texas conditions. No information has been found concerning the type or varieties of rye brought by the Spaniards.

The first reference to upright growing, less cold tolerant varieties of rye in Texas was in an article by D. R. Coker (9). The Coker Seed Company released a strain of Abruzzi rye selected from that obtained from the U. S. Department of Agriculture. Other strains developed by selection from Abruzzi by other agencies included Wood's Abruzzi, Wren's Abruzzi, Tennessee Abruzzi, Athen's Abruzzi, and Rosen. A similar type, called Balboa, was selected from strains received from Italy by the Tennessee Experiment Station (Mooers, 25).

No breeding work with rye has been done in Texas. Several southeastern states have conducted such breeding work and have released improved forage-type varieties for use in Southern states (Morey, 24). Such varieties may not be sufficiently cold tolerant to grow in northern states. Florida Black and Gator were released by the Florida Agricultural Experiment Station (Chapman, 8); the Georgia Experiment Station released Weser rye (Morey, 23); Mississippi released Explorer (Barnes, 2); Oklahoma released Elbon, Bonel (Holt, 17) and, more recently, Maton (Bates, 3). These are fine new varieties suitable for winter pasture for livestock.

During recent years, in an attempt to obtain additional forage yields from rye, so-called strain-cross ryes have been produced by a number of seed companies. Rye is largely cross pollinated, and Sechler and Chapman (26) have demonstrated that there is an excellent expression of heterosis in forage production when two in-bred strains are crossed. Several commercial companies have crossed high producing forage lines to produce strain-cross hybrids, but others have simply mixed seed of two varieties to produce partially hybrid seed for sale. Although strain-crossed rye strains were sold for a time, the results have not warranted the high cost of seed in many instances, and sales have declined.

USES OF RYE IN TEXAS

The major use of rye in Texas is as a winter grazing crop for livestock. In recent years less than 25 percent of the rye seeded was harvested for grain (Table 1). As an example, 549,000 acres of rye were seeded in 1949, yet only 27,000 acres were harvested.

Rye not only is more cold tolerant than the other cereals, but the juvenile plants will continue to grow and produce forage at lower temperatures than other cereals. The forage-type rye varieties now grown in Texas may be seeded in late August or September and will usually produce forage which can be grazed within a few weeks. The succulent forage then is available for many months and under sprinkler irrigation and other favorable conditions, will often produce pasture for 7 or 8 months. Rye matures earlier than the other cereals and, unless properly managed and fertilized, may become unpalatable.

Northern varieties of rye are usually more cold tolerant, but the seedling plants remain prostrate throughout the winter months and do not produce as much forage as the southern forage ryes. Holt (18) and Briggle (5) have provided publications on management practices for rye.

Rye may also be mixed with other cereals–vetch, winter-peas, or clovers–for winter pasture, hay, green-chop feeding, silage, or green manure. Such mixtures may be used to produce large tonnages of green manure in all types of orchards, in rotation with peanuts, soybeans, or sorghum hay crops. Rye is frequently used on sandy soils as a wind and soil erosion control crop.

Rye may be grown as a cash grain crop; usually, however, the grain marketed or seeded comes from fields which have been pastured and then allowed to produce a grain crop after livestock have been removed. Such practice contributed to the low yields obtained. On heavy soils rye usually yields less than wheat or oats, but on sandy soils it may yield more than the other cereals. Comparative yields of rye and wheat are shown in Table 2.

TABLE 2. RYE AND WHEAT YIELDS AT CHILLICOTHE, TEXAS, 1961-66

Year	Common rye	Elbon rye	Scout 66 wheat
1961	23.7	19.4	39.2
1962	8.8	10.4	11.4
1963	21.2	14.7	26.3
1964	11.3	12.8	19.9
1965	14.8	13.7	21.4
1966	5.9	10.0	15.2
Average	14.3	13.5	22.3

Figure 1: Distribution of rye in Texas in 1975. (Courtesy Texas State Department of Agriculture, 32).

Considerable quantities of the U. S. commercial rye crop are used for manufacture of rye flour. Certain ethnic groups prefer rye flour or rye-wheat flour mixtures for bread products. Rye makes a dark flour of lower gluten strength than wheat. Mixtures in various proportions are used for both bread and pastry products. As early as 1860, as few as 85 barrels of rye flour were proudced in Texas (Douglas, 10). About 100 years later, 1965, an estimated 4,500,000 bushels of rye were ground into flour in the United States, and the annual average consumption of rye flour was 1.6 pounds per person (Shellenberger, 27). Rye grown in Texas is not often used in the manufacture of distilled spirits, although some may be used occasionally.

While rye has never become a major cash grain or forage crop in Texas, it occupies a unique place throughout the State because of its contribution to grain, winter pasture, green-chop clipping, green manure, and cover crop for sandy land. Prior to 1915, the acreage was usually less than 30,000 acres, but in recent years it has increased until for the period 1965 to 1975 rye occupied 500,000 acres in most seasons. Should research provide real breakthroughs, such as hybrid rye or other improvement of major practical importance, rye may offer special opportunities for farm income.

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