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FLAX in TEXAS

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The Texas Agricultural Experiment Station
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FLAX IN TEXAS
1718-1976

Flax, *Linum usitatissimun* L., is one of the oldest of the crops domesticated by man. According to Dillman (18), it was the source of oil and fiber in Ancient Egypt. The mummies found in early Egyptian tombs were wrapped in linen cloth. A reproduction by Wilkinson (58) shows flax harvesting scenes painted on the walls of Egyptian tombs (Figure 1).

Flax is believed to have originated in the Mediterranean region of Europe, as remains of fiber and seed of flax were found in the refuse of the Swiss Lake Dweller people of the Stone Age (Dillman, 18).

The common blue-flowered fiber flax grown in Europe was named by Linnaeus in 1753 (35). Tammes (47) reviewed several theories on the origin of flax and concluded that the common flax originated from *Linum angustifolium* L. which is indigenous to the territory bordering the Mediterranean Sea. Vavilov (56), however, believed that cultivation of flax developed independently in the Mediterranean area of Europe and in Asia (India).

FLAX IN THE NEW WORLD

The history of fiber flax and seed flax in the United States was reviewed by Dillman (18). Fiber from flax was used extensively for linen and other products at the time early colonists settled in America. The cultivation of fiber flax was started almost immediately, and immigrants grew small fields of flax for home use. The flax was first processed on the farm by housewives who became skilled in weaving linen for home use.

Robinson (44) states that fiber flax was one of the first crops grown at both Jamestown, Virginia, and Plymouth Rock, Massachusetts. The Commonwealth of Virginia offered a bounty for the production of fiber flax in 1658, and England offered special inducements to the colonists to produce flax fiber for the mother country. Commercial production of fiber flax began in 1758. The invention of the cotton gin in 1793 started the decline in the use of linen fiber for clothing. Rapid expansion of cotton production after the Civil War spelled doom for fiber flax culture.

From 1859 to 1900, fiber flax production gradually moved westward from the Eastern States to the Midwest and became concentrated in Michigan for a time. About 1900, nearly all fiber flax production moved to Oregon (Hurst, 29). Since World War II, fiber flax production has declined to nearly zero as cotton and synthetic fibers have replaced linen in all types of garments.

The growing of seed flax and the manufacture of linseed oil became important after 1800. As farming expanded in the drier regions of the Midwest, seed flax became an important dryland crop which could be produced with large-scale farm equipment. By 1850, the center of seed flax production had moved from New York to Ohio; by 1900, it had moved to North Dakota, where it has remained since. Landon (33) states that as early as 1873 Kansas produced 63,476 bushels of flaxseed; by 1890, Kansas grew 228,839 acres of flax, producing 2,173,000 bushels.[1]

FLAX IN TEXAS

Settlers began moving into Texas in significant numbers about 1830. Many came from northern and eastern states into Northeast, Southeast, and Central Texas. Others came into Gulf ports of South Texas from the eastern seaboard states and from foreign countries. The most rapid settlement occurred between 1870 and 1900, when most of Eastern and Central Texas was settled. Large areas were brought under cultivation during this period. Undoubtedly flaxseed, both fiber and seed types, were brought in by many settlers, but flax as a commercial crop did not become established during the period.

Long before the settling of Texas by Anglo-Americans and northern Europeans, the Spanish introduction of flax occurred. Johnson (32) states that in 1718, Father Olivares was sent by the Governor of Coahuila and Texas to establish a fort and mission at San Antonio and that, "all missions had farms on which they grew grain, flax, cotton, sugarcane and vegetables." The first immigrants of Canary Island families arrived at San Antonio in 1718. No records of the harvesting of flax at San Antonio during this period have been found. However, known records show that the Indian women were taught to spin and weave wool and cotton, but no linen cloth is mentioned.

About a century later, Stephen F. Austin explored Texas and wrote in 1828 that "Wheat, oats, barley and flax have been tried" (Barker, 10). However, it is not known where he observed these crops growing. Austin's sister, Mary Austin Holley, traveled in Texas a few years later and in 1831 wrote, "Successful experiments have been made in various places with wheat, oats, rye, barley and flax and the results satisfactorily establish the fact that these crops may be cultivated to any extent" (Holley, 28).

Correspondence found in British Archives (Adams, 1) gives reports on Texas from the British Consul at Galveston in 1842. Reporting on the Red River counties of North Texas, they state that "corn, wheat, rye and flax grow well."

Other than these early statements the author has not been able to find any references on flax growing until near the end of this century. During the early days of the development of commercial growing of flax in Texas in 1938, the Texas Agricultural Experiment Station received a letter from J. I. Jamison of Daisetta, a small town in Liberty County, Texas, along the Gulf Coast. Jamison wrote, "When I was 10 years old, my father grew a field

[1] *Additional information on flax growing in the Midwest may be found in Culbertson (15) and Dillman (17).*

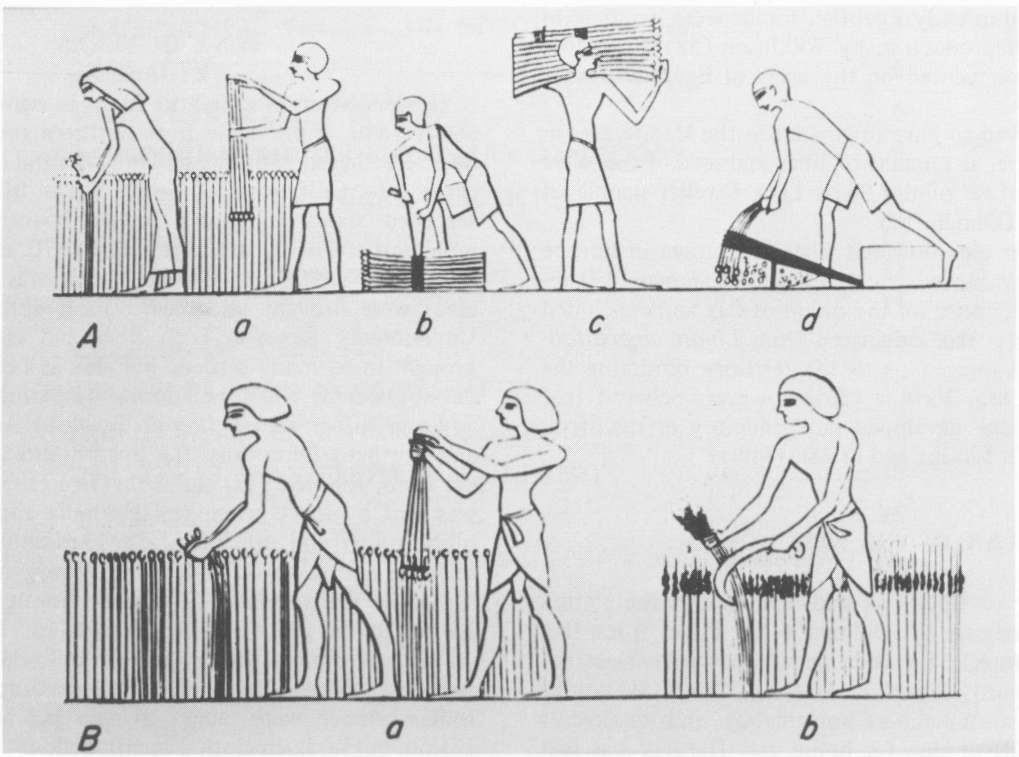

Figure 1. Harvest scenes found in an Egyptian tomb: (Aa) pulling flax, (b) tying flax, (c) carrying flax bundle, (d) stripping seed from flax fiber; (Ba) pulling fiber flax, (b) cutting wheat (Dillman, 18).

of flax in 1862. They used the fiber and considered it worth more than the seed."[2]

Another reference to the use of the flax fiber was found in an historical account of Tarrant and Parker Counties in 1895 (49). In the Agricultural Section of the account is stated, "Flax has been grown in Texas, as fine as any in Ireland. It will produce about two tons per acre, worth about $45.00." No information on where such flax was grown is given.

Farm and Ranch magazine of February 4, 1899 (24), quotes a correspondent of the *Houston Post* as stating that a Mr. Zimmerman of Victoria grew 25 acres of flax that year. The story states the February-seeded flax grew 25 feet tall and yielded 20 bushels of seed per acre and 4 tons of fiber. No adequate explanation of this report is known as flax normally grows only about 24 to 36 inches tall. It seems possible that the name of the crop could have been confused with hemp or jute, being tested at this time. Earlier in January 1895 (23), the same magazine published a long article on the growing of jute and hemp in the Galveston area.

The U. S. Department of Agriculture began census reports on agricultural products in 1850, and 26 bushels of flaxseed were reported for Texas (51). In 1860, the census records 35 pounds of flaxseed in Dallas County, 25 pounds in Greyson County, 25 pounds in Jack County, and 10 pounds in Navarro County (52). In 1870 only 25 pounds of flaxseed were reported (53), but in 1880 a total of 73 bushels of seed and 150 pounds of flax fiber were reported (54). In 1890, the report shows production of 794 bushels of flaxseed, but there is no record of where this was grown (55).

The *Farm and Ranch* magazine of February 1899 (24) has a classified advertisement for flaxseed by the Texas Seed and Floral Company of Dallas, which indicates some interest in the growing of flax in North Texas.

The first commercial fields of flax grown in Texas for which records were found during this study, were grown at Vernon in 1891, 1892, and 1893. *Farm and Ranch,* November 25, 1893 (22), reports that the Dolcaster Brothers moved to Vernon from Kansas in 1891, grew 6 acres of flax in 1891, 25 acres in 1892, and 70 acres in 1893. Yields ranged from 6 to 9 bushels per acre. The closest market was St. Louis, Missouri, where flaxseed was quoted at $1.04 per bushel.

The U. S. Department of Agriculture established experimental field stations at Channing and Amarillo in 1903 to assist in establishing crops in the High Plains area. Field crop experiments were conducted from 1903 to 1916, when the stations were closed. A report of experiments by Ross and Leidigh (45) states that observation rows of flax were grown in 1911 and that additional tests are reported. The report also states that "A farmer living 25 miles northeast of Amarillo grew 250 acres of flax in 1911, which averaged 15 bushels per acre."

This flax success story was publicized in the *Amarillo* News in the fall of 1911, and in February 20, 1912, the paper reported that D. L. Hickox planned to grow 700 acres of flax. The writer estimated that Randall and Potter Counties would grow 15,000 acres of flax in 1912; however, plans must have changed as no additional news items on flax were found.[3]

No further records of the growing of flax on the High Plains were found until 1931. The Texas Land and Development Company purchased 61,360 acres in Hale, Floyd, and Swisher Counties in 1912 and developed 153 family farms with irrigation wells (Brunson, 13). The company grew and demonstrated the growing of grain, flax, forage crops, vegetables, and fruit. *Earth* magazine, an agricultural publication of the Santa Fe Railroad, stated in 1931 that "The T. L. & D. is experimenting with flax in Hale County" (21). The author observed small plantings of flax in Hale County during the 1930's, but the crop did not prove profitable.

In 1937 J. M. Saunders, county agricultural agent at Victoria, wrote the Texas Agricultural Experiment Station[4] that according to local people, a 50-acre field of flax was grown at Victoria in 1900. The crop was cut with a binder, but as no threshing facilities or market was available, the crop rotted in the field.

These early attempts to grow seed and fiber flax did not result in the establishment of the crop in Texas. Perhaps the lack of a market at a reasonable distance, the problem of delivering seed long distances, and the problems of growing and harvesting the crop discouraged growers. Regardless of the causes, more than 2 centuries elapsed from the time flax was first reported to be adapted to Texas in 1718 until it became a commercial crop in the same general area in 1938.

EXPERIMENTAL TRIALS AND DEMONSTRATIONS

The first experimental plantings of flax in Texas were made by the U. S. Department of Agriculture experiment station at Amarillo in 1911. As reported earlier, observation rows were seeded in 1911, and plans were made to continue testing in 1912. However, no further records on flax testing are given.

The U. S. Department of Agriculture's Bureau of Plant Industry, Division of Western Irrigation Agriculture, established the San Antonio Experiment Station in 1904. Preliminary tests of flax were made from seeding in 1914 and 1915. More extensive tests were made in 1916, but the crop was killed by a 20^{O} F temperature. In 1918, five varieties were seeded in 1/10–acre field plots (Letteer, 34). Variety and date-of-seeding trials were made most seasons from 1914 until 1934, when the Station was transferred to the U. S. Soil Conservation Service and used as a grass research and establishment nursery.

Russian flax, C.I. 3, was obtained from the U. S. Department of Agriculture in 1918 by the Texas Agricultural

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[2] *Private correspondence from J. I. Jamison to P. C. Mangelsdorf, Texas A&M University, September 1, 1938.*

[3] *Microfilm files of Amarillo Daily News, Amarillo PUblic Library, Amarillo, Texas.*

[4] *Personal correspondence from J. M. Saunders, county Agricultural agent at Victoria, Texas to P. C. Mangelsdorf, Texas Agricultural Experiment Station, College Station, Texas.*

Experiment Substation No. 3 at Troup. Eight 16-foot rows were seeded every 2 weeks from November through March 1. Yields of 7.1 bushels per acre were obtained from the January 15 seeding and 6.9 bushels per acre from the March seeding.[5]

After serving as agronomist at the U. S. San Antonio Field Station from 1928 to 1930, the author transferred to Texas Substation No. 6 at Denton to serve as plant breeder for the cooperative cereal research program of the Texas Agricultural Experiment Station and the U. S. Department of Agriculture. Seed of five flax varieties, Rio, Morteros, Bison, Rosquin, and North Dakota No. 114, were taken to Denton where spring-sown variety and date-of-seeding trials were conducted from 1931 to 1950 (Atkins, 5).

Much credit for the early testing, promotion, and establishment of flax as a Texas crop must go to A. J. Kuhn, of Kuhn Paint and Varnish Company, Houston.[6] During the period 1932 to 1938, Kuhn wrote many letters to the Texas Agricultural Experiment Station urging the testing of flax as a fall-sown crop for South Texas. From supplies of flaxseed shipped in from Argentina for crushing, he furnished planting seed to W. K. Edwards, Bellville Cotton Oil Company, Bellville. Several small fields were seeded in 1935. From a January seeding, low temperatures killed the crop, but from a February seeding, 11 bushels per acre were harvested.

Texas Substation No. 1 at Beeville began small field plantings of flax in 1934.[7] Larger trials at several locations were grown in 1935 and 1936. Seed were obtained and plans for seeding coordinated by P. C. Mangelsdorf, agronomist in charge of corn and small grain research, Texas Agricultural Experiment Station. R. A. Hall, superintendent of Texas Substation No. 1, Beeville carried out the field work in cooperation with personnel at Angelton, Crystal City, and Beeville. Some cooperative tests on farms were seeded.

In the fall of 1937, three commercial firms, the Kuhn Paint and Varnish Company, the Archer-Daniels-Midland Company, Minneapolis, Minnesota, and the Grady and Poague Seed Company, Kenedy, Texas, provided funds to purchase 100 bushels of Bison flaxseed for commercial plantings and demonstrations. Arrangements were made for fall seeding of 5-acre fields throughout the Coastal Bend from Houston to Brownsville. These plantings were so successful that one carload of flaxseed was shipped to Fredonia, Kansas, for crushing and oil analysis. A few small fields were grown under irrigation near Crystal City, and some fields gave yields of 20 bushels per acre.

In the fall of 1938, the Texas Agricultural Extension Service arranged grower meetings throughout South Texas, and preliminary results of the field trials were reported, together with instructions on growing the crop (McFadden, 36; Miller, 39; Morgan, 40; Jackson, 31, and others). Seed of Bison flax were shipped in from North Dakota for fall plantings, and seed of Punjab were shipped from California.

The acreage seeded for the 1939 crop was estimated to be 20,000 acres distributed over 27 counties. Growers harvested 18,000 acres, which yielded an average of 11.5 bushels per acre. The average price received was $1.65 per bushel, bringing a total of $341,000 in farm income.

Plans for the 1940 crop indicated that 100,000 acres would be seeded, but a threat of a reduced tariff rate in the fall on flax resulted in only 46,000 seeded acres. From this acreage only 29,900 acres were harvested.

Another hazard of production occurred in 1941. Pasmo and flax rust, diseases of flax, became epidemic in the production areas of South Texas. Damage was such that only 15,000 acres were harvested. However, after this early discouragement and a limited acreage from 1937 to 1940, flax became a well-established fall-sown crop in South Texas and provided significant farm income to growers. A bound volume of reports of all these experiments and publications was prepared and is on file in the library at Texas A&M University (Atkins, 7).

ACREAGES

Acreages, production, yield per acre, price per bushel, and farm income from flax for the period 1939 to 1975 are given in Table 1. Acreages are shown graphically in Figure 2 (Courtesy Texas State Department of Agriculture, 50). The greatest acreage occurred in 1949 when an estimated 349,000 acres were harvested. The greatest farm income from flax was in 1948, when 220,000 acres were grown, and a price of $5.85 per bushel was received. Distribution of the 1975 crop is given in Figure 3.

From 1951 to 1957, the Texas flax-growing area experienced a severe drouth. Acreages were reduced; yields were low, and farm income was extremely low. Widespread and severe injury from cold occurred in the flax area in 1962 and again in 1963, resulting in reduced income from flax. Since 1963, the acreages have been relatively small as a result of poor soil moisture conditions at seeding time, low prices on flaxseed, and seedling disease problems. Over the 1939 to 1975 period, the average acreage of flax was 87,000 acres.

WILD FLAX SPECIES IN TEXAS

While cultivated flax is not native to Texas, several wild species may be found growing in parts of the state. When Spanish missionaries came to the San Antonio area, they reported seeing wild flax. Blake (11) quotes from Espinosa's diary of his trip to establish the San Antonio Missions in 1716 as follows, "We entered the Plain of the San Antonio River. There was a great amount of wild flax and wild hemp." Also, Ashford (4) quotes Alacorn in 1719 as observing flax ". . . 2 feet tall."

In modern times, several wild flax species may be found

[5] *Annual Report of Texas Substation No. 4, Troup, Texas. On file at Texas A&M University, College Station, Texas. (Typewritten).*

[6] *Numerous letters from A. J. Kuhn, Kuhn Paint and Varnish Company, Houston, Texas, addressed to personnel of the Texas Agricultural Experiment Station. On file at College Station, Texas.*

[7] *Typed Annual Reports of Texas Substation No. 1, Beeville, Texas. On file at College Station, Texas.*

TABLE 1. FLAXSEED: ACREAGE, YIELD, PRODUCTION, AND VALUE IN TEXAS, 1939-1975

Year	Acreage		Yield per harvested acre	Production	Season average price per bushel	Value of production
	Planted	Harvested				
	Thousand acres		*Bushels*	*Thousand bushels*	*Dollars*	*Thousand dollars*
1939	20	18	11.5	207	1.65	342
1940	46	29	6.0	174	1.58	275
1941	34	15	7.0	105	1.62	170
1942	20	18	11.5	207	2.00	414
1943	38	34	8.0	272	2.61	710
1944	36	34	8.0	272	2.75	748
1945	65	63	8.0	504	2.75	1,386
1946	84	76	7.3	555	3.15	1,748
1947	94	91	9.5	864	5.70	4,925
1948	248	240	5.5	1,320	5.70	7,524
1949	335	308	6.5	2,002	3.44	6,887
1950	208	195	6.5	1,268	2.99	3,791
1951	65	22	3.4	75	4.00	300
1952	132	125	8.5	1,062	3.40	3,611
1953	132	124	7.0	868	3.40	2,951
1954	131	111	5.3	588	2.86	1,682
1955	58	32	3.0	96	2.77	266
1956	36	23	5.5	126	2.79	352
1957	25	18	7.0	126	2.61	329
1958	31	28	12.0	336	2.46	827
1959	49	44	10.5	462	2.90	1,340
1960	122	117	9.5	1,112	2.94	3,269
1961	146	140	11.5	1,610	2.95	4,750
1962	175	25	7.5	188	2.97	558
1963	189	127	5.0	635	2.80	1,778
1964	115	107	11.5	1,230	2.60	3,198
1965	98	94	10.0	940	2.80	2,632
1966	110	89	8.0	712	2.50	1,780
1967	35	25	6.0	150	2.69	404
1968	58	55	13.5	742	2.75	2,041
1969	102	100	13.0	1,300	2.65	3,445
1970	107	90	12.5	1,125	2.30	2,588
1971	43	10	7.0	70	2.30	161
1972	22	15	11.0	165	2.40	396
1973	9	8	10.0	80	3.83	306
1974	40	34	11.0	374	7.80	2,917
1975	60	40	12.0	480	6.55	3,144

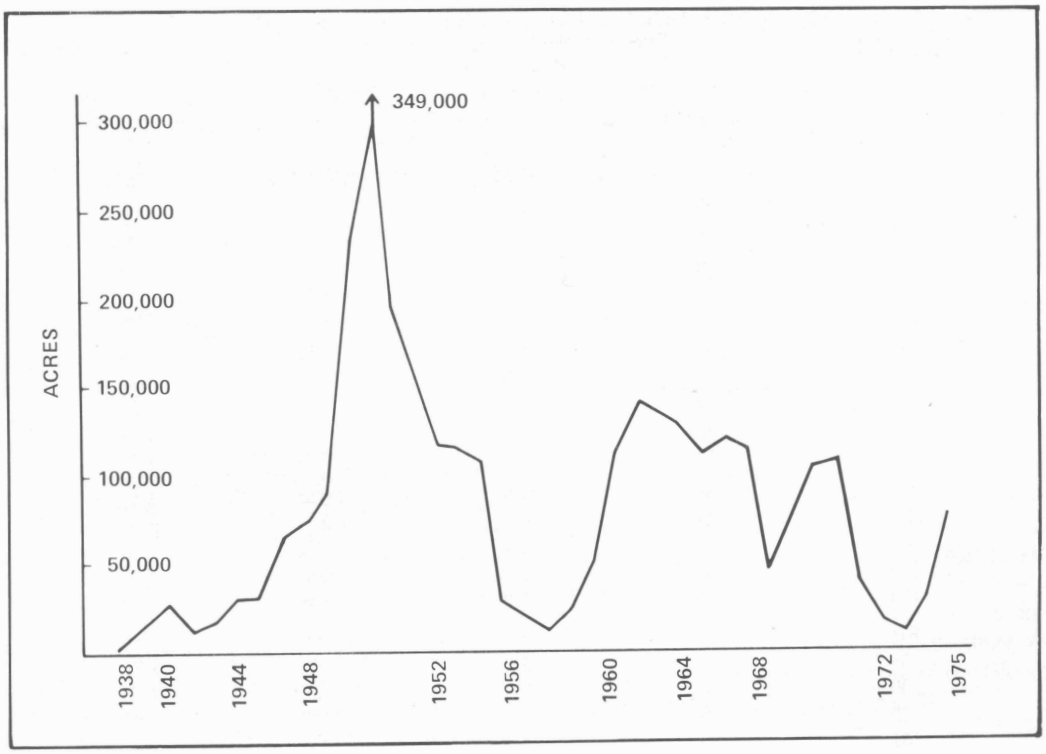

Figure 2. Flax Acreages in Texas, 1938-75. (Courtesy Texas State Department of Agriculture.)

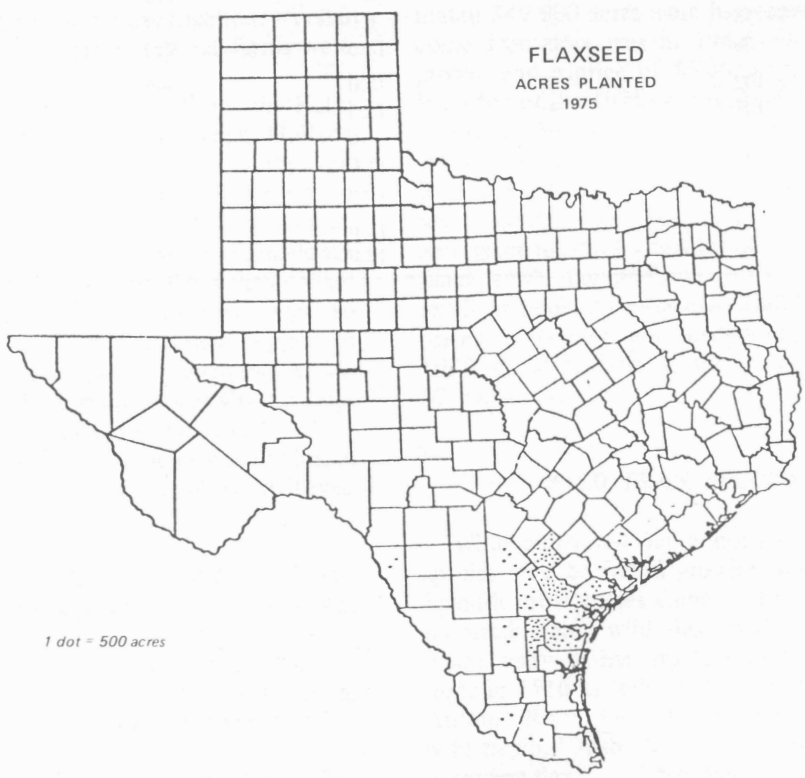

Figure 3. Distribution of Flax in 1975. (Courtesy Texas State Department of Agriculture.)

in the state. Irwin (30) in his book, "Roadside Flowers of Texas," lists blue flax, *Linum pratense* (Norton) Small [= *L. lesisii* , var. *pratense* Norton] and yellow flax, *Linum rigidum,* Pursh., [= *Cathartolinum rigidum* (Pursh) Small] as the most common. The species *Linum rupestre,* or tall flax, *Linum multicaule* Hook., and *Linum medium* (Plancl.) Britt. var. *texanum* (Plancl.) Fern. also may be found.

BREEDING VARIETIES FOR TEXAS CONDITIONS

Practically all varieties of seed flax now grown in the United States are of the wilt-resistant, short-fiber type. Dillman (18) lists six types of seed flax: wilt-resistant, short-fibered, common or Russian, Argentine, Indian, Abyssinian, and yellow seeded. Punjab, introduced to Texas from California and grown under irrigation in the Lower Valley, is of the Indian type.

Bison, the first variety introduced into Texas, occupied most of the acreage for several years. Flax rust, *Melampsora lini* (Pers.) Lev., damaged Bison flax in 1939 and in 1940, forcing a shift to more rust-resistant varieties. Punjab was damaged by pasmo, *Mycosphaerella linorum* (Wr) Garcia-Reda, in the Rio Grande Valley in 1939.

The variety Norsk was obtained from the North Dakota Agricultural Experiment Station for trial in 1938 and proved to be resistant to prevalent flax rust races. Norsk was purified during the winter season in Texas and sent to Aberdeen, Idaho, for a summer increase in 1939. The 2,970 pounds of foundation seed of Norsk were further increased on 100 acres during the late winter of 1939, again providing growers with a resistant variety. Norsk was an important variety from 1943 to 1948.

Rio, another North Dakota variety, preformed well in tests in the Coastal Bend area in 1938 and was resistant to prevalent rust races. Rio also was increased by double cropping and became an important variety from 1939 to 1945. Foundation seed were maintained by the Beeville Station.

Bolley's Golden, also called Golden or Viking, was a North Dakota variety first grown in Texas in 1939. Eleven carloads of Viking were shipped to Texas for fall seeding in 1943. The varieties Light Mauve and Maritime were developed in Texas by E. S. McFadden. They were grown on a small acreage from 1943 to 1949, but as they were not grown in the spring flax area, it was difficult to maintain adequate supplies of seed. The varieties B5128, DeOro, Redwing, Crystal, and Victory all occupied significant acreages from 1945 to 1949 (Dillman, 19). Punjab was grown in the Rio Grande Valley under irrigation and where double cropping was practiced (Figure 4A).

Low temperatures in winter or early spring are important hazards for flax production in Texas. Varieties differ in their ability to tolerate low temperatures. Seeking to provide growers with protection from this hazard, E. S. McFadden and E. C. Dillman, then in charge of flax research for the U. S. Department of Agriculture, began in 1936 a search from world flax varieties for sources of cold tolerance. From the Baltic Region of Central Europe, they found in 1940 a number of winter-type, cold-tolerant flax varieties which were a distinct type from the U. S. northern spring-type varieties. These produced prostrate-growing seedling plants and were probably developed under natural selection in the Baltic area.

Pure-line selection work was initiated on this introduced mixed population, and selected strains were tested in hardiness nurseries at Beeville to as far north as Denton. The large root system and basal-branching habit of the winter-type flax variety is shown by Verne Comstock, U. S. Department of Agriculture flax section leader in Figure 4B.

A composite of several Turkey winter-type flax strains was increased for release in 1946. The new type was late maturing, produced short plants, and the seed were brown instead of yellow. For these reasons Turkey flax was not popular, and its acreage continued to be small. In 1951, seed of a single plant selection from Turkey, Newturk, was increased, and foundation seed released. The same objections applied to Turkey applied to Newturk. These and a period of extreme drouth in the 1950's combined to retard the use of the new variety.

Breeding work to combine the cold tolerance of Turkey winter-type with desirable characteristics of the spring varieties was started in 1943. The crosses most extensively explored were Rio x Roman Winter and Roman Winter x Argentine Pale Blue. The first new Texas variety developed from this material was Caldwell (14). Further selection under conditions of low temperatures and diseases resulted in the varieties Dillman (20) and Mac (38). More recently from additional crosses came a yellow-seeded, winter-type variety named TAM F-201 (48). These well-adapted, winter-type varieties now occupy most of the Texas acreage. Figure 4C shows a flax breeding nursery in bloom at College Station, and Figure 4D shows the survival of winter-type strains in contrast to the killing of spring-type varieties in 1962 at Beeville.

Research on variety adaption and the breeding of better adapted varieties for Texas conditions was conducted from 1938 to 1950 cooperatively by the Texas Agricultural Experiment Station, the U. S. Deaprtment of Agriculture, and the Texas Flax Association of Kenedy. A. C. Dillman was the agronomist in charge of flax research at the national level until his retirement in 1947. J. O. Culbertson was flax section leader from 1947 to 1957, and V. C. Comstock was leader from 1957 to 1973. Many new varieties from all parts of the world were made available for testing in Texas, and many bulk populations from crosses were grown for the selection of new strains.

During the period 1939 to 1954, E. S. McFadden made many crosses between adapted varieties and strains having specific charactersitics needed for growing in Texas. Crosses were made with both the grower and industry in mind. Characteristics of different types were needed more for growing in the Rio Grande Valley than in the Central Blacklands. Cold tolerance was needed for the more northern areas but was less important along the Gulf Coast.

Figures 5A-D show leaders in the research and testing of flax to establish the crop and adapt it for use in Texas.

Figure 4A. A field of irrigated Punjab flax in the Lower Rio Grande Valley, 1949. E.S. McFadden, agronomist in flax research at left.

Figure 4B. Verne C. Comstock, flax section leader, U.S. Department of Agriculture, holding a plant of Caldwell winter-type flax. (Note branching habit and heavy root system.)

Figure 4C. A flax nursery in bloom at College Station, Texas, showing many flower colors, variation in height and maturity.

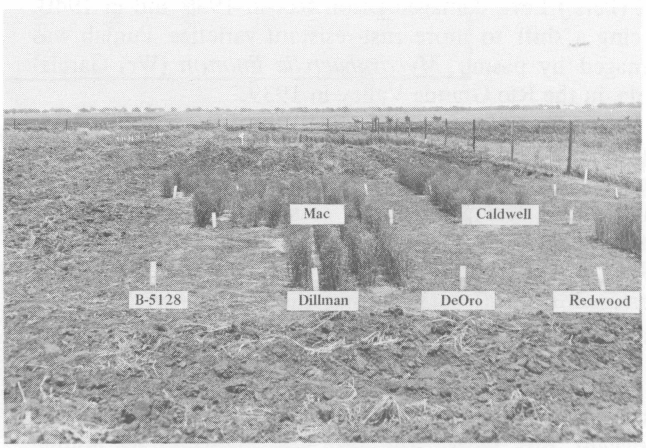

Figure 4D. Differential winterkilling of flax varieties at Beeville, Texas, 1963. (Note high survival of Dillman, Mac, and Caldwell compared to spring varieties, DeOro, Redwood, and B 5128.)

Figure 5. Leaders in the early testing and establishment of flax as a commercial crop in Texas: (A) P. C. Mangelsdorf, agronomist in charge of small grains and corn research, 1924-38, The Texas Agricultural Experiment Station.

Figure 5B. R. A. Hall, superintendent of Texas Agricultural Experiment Station, Substation No. 1, Beeville, Texas, 1924-60.

Figure 5C. A. C. Dillman, agronomist and plant breeder for the Texas Flax Improvement Association, 1947-55. In the background is the Kenedy flax nursery.

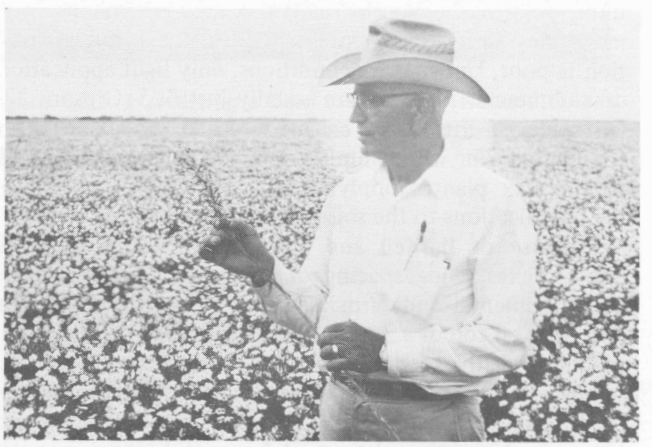

Figure 5D. Lucas Reyes in a field of Golden flax near Kenedy, Texas. A leader in research, extension and promotion of flax throughout the flax growing area, Lucas might well be called "Mr. Flax" of Texas.

RESEARCH ON CULTURAL PRACTICES

The first research on flax was largely concerned with varietal trials to determine the adaptation of the crop. Seed flax is grown and handled in a manner similar to that of the small grain cereal crops, using the same planting, harvesting, and threshing equipment. However, it soon became evident that management to avoid some of the hazards of production under Texas conditions was very important in the culture of fall-seeded flax.

Combination variety–date-of-seeding trials were started at San Antonio as early as 1916 (Letteer, 34). Similar tests were conducted by Dillman (19, 20) and McFadden (36, 37). Tests showed that for a winter crop, flax should be seeded between November and December 15. Later seedings were often injured by low temperatures or had lower yields. Flax is susceptible to low temperatures both in the seedling stage and near blooming time.

Variety–date-of-seeding tests of spring-sown flax were conducted at Denton from 1934 to 1950 (Atkins, 5). Although not a high yielding crop from spring seeding, flax can be grown in North Central Texas. It should be seeded between March 10 and 20, as earlier seedings may be damaged by late frosts, and later seedings encounter the heat and drouth of early summer.

During the early flax experiments in Texas, the possibility of using flax as an alternate crop with rice was investigated. The practice did not prove practical as the heavy, waxy soils of the Gulf Coast and the high rainfall and humidity were unfavorable for growing or harvesting the crop.

Flax responds well to applications of fertilizer if moisture is available, either from normal rainfall or from irrigation. Most of the South Texas flax growing area has only moderate rainfall (approximately 26 inches), but distribution is poor. Under these conditions, only light applications of commercial fertilizer are usually justified (Gipson, 27). On some of the highly calcareous soils, Anderson (2, 3) found that zinc was a limiting element or was unavailable to the flax plant. Supplying zinc by foliar spray or by light applications to the soil gave good response.

Because of limited and poorly distributed rainfall in South Texas, wide spacing of drill rows has been tested in experimental and farm plantings (Figure 6A). Planting two rows on top of a 36- to 42-inch lister bed, as frequently practiced with sorghum, permits cultivation to control weeds and better utilize moisture. While contributing to more stable production, the practice has presented problems in harvesting, hence, it has not become popular. Additional guides to flax culture in Texas are given by Atkins and others (8).

HAZARDS OF PRODUCTION

Low Temperature Injury

Sudden changes in temperature may occur in Texas as a result of rapidly moving cold fronts, locally called "northers." These may occur in the fall, winter, or spring seasons. When changes of 40 to 60 degrees occur within a day's time, many crops may be damaged. Seedling flax may be damaged by near freezing temperatures and established stands by temperatures in the 20's and lower.

During the second year of commercial production, 1940, the Punjab and Bison varieties were damaged by a freeze in the area of the Nueces River. An estimated 17,000 acres, of the 40,000 seeded, were killed by this freeze where temperatures fell to 16° F at Winter Haven and 5° F at Beeville.

Late seeded Rio flax was damaged in 1941. From 1942 to 1950, there was little injury to flax south of the Edwards Plateau. At College Station in 1943, spring-type flax varieties were killed by a temperature of 13° F. Approximately 2,000 acres were killed in San Saba and McCulloch Counties in 1948.

All of South Texas experienced one of the severest freezes on record in 1949, but the flax crop was covered by snow or sleet before the storm so little injury occurred. The low temperature at College Station at this time was a record -3° F, but flax was covered by 5 inches of snow. A late freeze on March 23, 1952, damaged flax in Karnes County.

The most extensive damage to flax, as well as to all small grain crops, occurred in 1962 and 1963.[8] Of 175,000 acres of flax seeded in the fall of 1961, only 25,000 acres were harvested. The loss in farm income was estimated at $5,500,000. This freeze came in mid-January after a period of warm weather in which 70° F to 80° F temperatures were recorded over much of the state. Temperatures dropped in less than 24 hours to the 10° F to 15° F range over the entire flax-growing area.

Breeding work from 1943 to 1959 had resulted in the release of foundation Caldwell flax (14) in 1959. An estimated 16,000 acres of Caldwell were seeded in the fall of 1961. Practically all of this acreage survived the freeze, whereas the majority of Texas acreage was killed or seriously damaged. Foundation seed from the 16,000 acres was saved for fall seeding, and a portion was sent to North Dakota to produce a summer crop. The production from this summer crop was used to seed an estimated 114,000 acres in the fall of 1962.

The January 1963 storm or "norther" was similar to that of 1962 and caused even more extensive damage to small grain crops. However, as the result of the switch to the hardier variety Caldwell, the flax crop was damaged less than in 1962. An estimated 40 percent of the crop was killed in 1963, whereas in 1962 more than 90 percent was lost. Had sufficient Caldwell seed been available for seeding, the damage would have been reduced even more. The striking difference in cold tolerance between Caldwell and other winter-type varieties, and spring-type varieties is shown in Figures 6B and 6C.

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[8] *Estimated losses in the small grains and flax crops of Texas as a result of low temperatures in 1962 and 1963. By I. M. Atkins et al. Mimeographed. Agronomy Department, Texas A&M University.*

Figure 6A. Growing flax in wide-spaced rows to better utilize moisture under dry conditions.

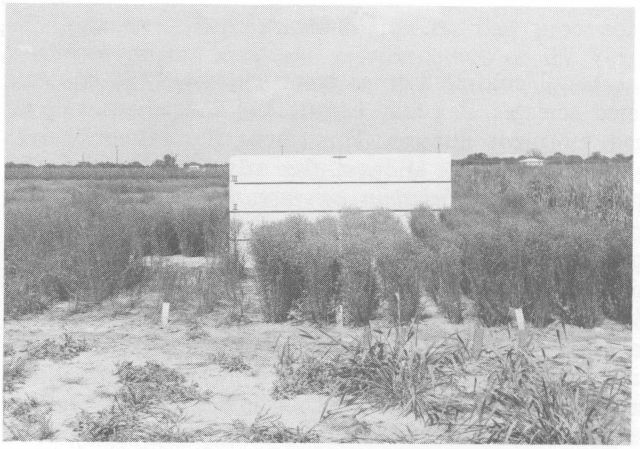

Figure 6B. Caldwell flax (right) survived low temperatures and curly-top virus disease at College Station in 1957, whereas spring-type varieties (left) and in the foreground were destroyed.

Figure 6C. Combine harvesting a field of Caldwell flax near Kenedy, Texas, 1963.

Figure 6D. Harvesting a field of flax near Kenedy, Texas, in 1960. The straw may later be baled for processing into cigarette paper or fine quality writing paper.

Disease

Like all cultivated crops grown extensively in concentrated acreages, flax may be attacked and seriously damaged by plant diseases. Throughout the extensive flax growing areas of the Midwest, flax wilt, caused by the soilborne organism *Fusarium oxysporum* f. *lini,* (Bolley), Snyder and Hansen, has been a major disease. The development of wilt resistant varieties is a classic example of control of disease with resistant varieties (Bolley, 12 and Walster, 57). Before this research, flax could be grown only on new land which was free of the organism. By the time flax became a commercial crop in Texas, most varieties were resistant to flax wilt. Little damage has resulted from this disease to the Texas crop since.

Pasmo, caused by *Mycosphaerella linorum* (Wr.) Garcia-Rada, occurred in epidemic proportions in the Rio Grande Valley in 1939 and 1940, attacking the variety Punjab. A severe epidemic of pasmo occurred in the flax nursery at College Station in 1946. Pasmo was reported from the Corpus Christi area in 1949, and again in 1960. However, pasmo has not been a major disease most seasons.

Aster Yellows, a leaf hopper-transmitted, virus-like disease has been observed in a number of years but only in small areas. Curly top, also a leaf hopper-transmitted, virus disease, was important in 1955, 1956, and 1957 (Atkins, 6). It was during these epidemics that the varieties Dillman and Mac, then experimental strains, showed significant tolerance to curly top and were selected for increase.

Seedling diseases cause injury to flax plants and reduction of stands in many seasons (Frederiksen, 26). During the period 1953 to 1957, seedling diseases caused significant reduction in stands, thereby reducing yields. Pathologists reported damage being caused by *Fusarium, Pythium,* and *Rizoctonia* species.

Flax rust, *Melampsora lini* (Pers.) Lev., was observed in 1938, the first year of commercial production of flax. Flax rust differs from the cereal rusts in that the spores of the organism may be carried on the seed (Flor, 25). Flax rust was probably brought into Texas on planting seedlots. Flax rust was important again in 1940; hence new varieties with greater rust resistance were needed.

E. S. McFadden probably initiated the first winter-summer double cropping procedure to increase seed rapidly in order to protect a crop from serious disease losses. Rio, Norsk, and Viking were increased in Texas, sent to Idaho for planting a summer crop, and their seed returned for fall planting in Texas. Using these and later resistant varieties, flax rust was held in control until the 1960's. Flax rust caused losses in 1966 and less extensive damage in other years because new races had developed (Reyes, 1968).

COMMERCIAL USES

Seed flax, the type grown in Texas, is valued for its oil and linseed meal, produced from the crushed seed, and, to a smaller extent, for the fiber of the straw (Figure 6D) (Atkins, 9). Flaxseed contains 30 to 40 percent oil. The seed is crushed in special flaxseed oil mills or in other mills which may be adjusted to crush flax. The crushed seed, separate from the oil, makes a high protein feed similar to cotton or soybean oil meal.

Linseed oil is used in the manufacture of paints, varnishes, linoleum, oil cloth, washable wall paper, patent leather, printer's ink, as a core oil in the foundry industry, and in other products requiring a drying oil. During recent years, an important use of the oil has been in concrete as a seal on concrete roads, sidewalks, or airport landing strips to reduce the penetration of water into cracks and seams. Concrete sealed with linseed oil does not break up from freezing and thawing in cold weather as badly as unsealed concrete.

The first plantings of flax were initiated at the request of commercial paint manufacturers and by oil crushing plants who were looking for additional sources of supply and processing. As Texas flaxseed became available, several cotton seed crushing plants made the necessary adjustments to crush flaxseed. A large storage facility and flaxseed-crushing plant was built at Kenedy in 1947 by Archer-Daniels-Midland Company, Minneapolis, Minnesota. The drouth years of the 1950's caused this and other processing plants to close, and none are now operating. Most flaxseed is now either exported to foreign countries or shipped by boat from Texas ports to Minneapolis for crushing.

The fiber of seed flax is short, and the tonnage under Texas conditions is usually low. It varies greatly from season to season and from field to field so that efforts to use flax straw have not been very successful. The fiber is used in the manufacture of cigarette paper and high grade stationery. Paper samples were produced from Texas flax by Central Fiber Company of Pisgah Forest, North Carolina, in 1942 and by William Steck & Company, New York, in 1943, but no market developed. The Archer-Daniels-Midland Company set up a flax processing plant at Kenedy in 1947, but it operated only one year.

More recently, two additional attempts to use flax straw in Texas have been made (Reyes, 43). During 1964, the Peter J. Schweitzer Division of Kimberly Clark Corporation, Windom, Minnesota, took samples from the South Texas area for test processing. Also in the same season, the Alpha Cellulose Corporation of Bloomington, Illinois, and later of Lumbertson, North Carolina, built a flax fiber processing plant at Karnes City. The plant operated from 1964 until 1966, when it was destroyed by fire. It was not rebuilt. The price of flax straw was about $10 per ton, and while income from flax fiber supplemented the returns from the seed crop to some extent, it was not a highly profitable sideline. The flax straw in windrows remaining after combining the seed crop is shown in Figure 6D.

Environmental conditions in South Texas are not favorable for storage of grains. The long warm season and high humidity rapidly reduce germination of stored seed and encourage insect infestations unless proper protection is provided. Research on the storage of flaxseed and cereal grains was initiated in 1950 by the Texas Agricultural Experiment Station in cooperation with the U.S. Department of Agriculture. A number of commercial concerns also contributed funds or facilities for this research. Results of these early experiments were reported by Sorenson and others (46).

DIVIDENDS FROM FLAX RESEARCH

The importance of returns from research on a crop are well illustrated in this record of the establishment of a new fall-sown crop for Texas. In most other flax growing areas, seed flax is grown as a spring-seeded crop (Culbertson 15).[9]

Research by State, Federal and private agencies in Texas from 1916 to 1938 established that flax could be grown as a profitable winter crop in Texas. Management practices had to be worked out and limitations of the growing areas determined. The cost of this research would be difficult to estimate. The returns in farm income are presented in Table 1 and range from an estimated $341,000 from 18,000 acres in 1938 to $7,772,000 in 1948. The maximum acreage, 249,000, was grown in 1949, and the average acreage for 37 years was 87,000. Average production during this period was 605,000 bushels valued at $1,946,000. The severe drouth of the 1950's and severe winterkilling in 1962 and 1963 greatly reduced the averages. Thus, this rather limited research program provided Texas growers with a valuable new crop which has brought significant income for nearly 40 years.

The hazard of winterkilling or freeze injury is a constant threat to production of flax in Texas. The introduction of cold-tolerant flax varieties from Central Europe, a part of this research program, provided the basic plant material from which new, well-adapted, cold-tolerant varieties were developed for Texas conditions. From 1956 to 1972, the varieties Caldwell, Dillman, Mac, and TAM F-201 were developed and released to growers. The value of the cold tolerance of these varieties was demonstrated in the 1962 and 1963 season when a severe freeze killed all other varieties. During 1962 only a small acreage of Caldwell seed was available for seeding, and 90 percent of the Texas crop was destroyed. During 1963, when larger acreages of Caldwell were grown, the damage in a similar freeze was only 30 percent. The estimated loss in the 1962 season was $5,500,000, but in 1963 it was only $1,000,000. Had the entire acreage been seeded to these new varieties, the damage would have been minor. Basic studies of cold-tolerance and seedling diseases (Omran, 41), provided further procedures to cope with these problems.

Research on diseases has assisted growers in making available varieties resistant to prevalent diseases and races of diseases. Winter-summer double cropping to rapidly increase seed of new varieties has permitted wide use of these varieties and protection from disease. The varieties Rio, Norsk, and Viking were increased and made available when the susceptible varieties Bison and Punjab were attacked. The development of Caldwell, Dillman, and Mac varieties provided not only cold tolerance but resistance to curly top virus disease.

THE TEXAS FLAX IMPROVEMENT ASSOCIATION

The Texas Flax Improvement Association was organized July 7, 1947, at a meeting called by the Kenedy Chamber of Commerce. Representative growers, flax processors, seedsmen of the area, and representatives of the Texas Agricultural Experiment Station and Texas Agricultural Extension Service were present.

Officers for the association elected at this time were H. H. Schuenemann, president, H. Wienerluck, vice-president, W. H. Atkinson, treasurer, and Directors G. E. Grady, (Kenedy), A. T. Reyland (Kenedy), L. S. Wellean (Crystal City), N. R. McClano (Kenedy), J. A. Weinsche (Bishop), C. T. Cage (Cuero), and J. F. Lott (Goliad). Assistance in funding the organization was given by Archer-Daniels-Midland Company of Kenedy, Texas and Minneapolis, Minnesota.

The Association made plans to employ A. C. Dillman, former flax section leader of the U. S. Department of Agriculture. Upon his retirement, Dr. Dillman was employed to carry on research and promotion work on flax as a fall-sown crop in Texas. Dr. Dillman moved to Kenedy September 1, 1947, in time to organize the work for the 1947-48 crop season. Cooperation was established with the U. S. Weather Bureau, and Kenedy was made an official weather recording station. Research on varieties, management practices, and flaxseed quality was initiated.

The Texas Flax Improvement Association was active in research and promotion of flax until the death of A. C. Dillman in 1953 and E. S. McFadden in 1955. Acreages and interest in flax declined during the extremely dry years of the 1950's and after the severe winterkilling in 1962 and 1963. The Farmers Cooperative Gin and Elevator, Kenedy, under the leadership of Floyd Swope, took over some of the work formerly done by the Flax Association. This group and several seed companies assisted in providing seed of adapted varieties and leadership in flax production. Lucas Reyes, from 1940-1972 at the Texas A&M University Agricultural Research Station at Beeville and more recently at the Research and Extension Center at Corpus Christi, and county agricultural agents of the area have served as sources of new information on varieties and problems in flax production.

THE TEXAS FLAX FESTIVAL AT KENEDY

In 1947, the Kenedy Chamber of Commerce organized a festival to publicize the new fall-sown flax crop of South Texas. Flax festivals were held from 1947 to 1953, except for the 1951 and 1952 seasons when conditions of the crop were not suitable or favorable.

The festival was a gala occasion for the community, with the crowning of a queen, parades, rodeos, dances, dinners, carnivals, and other activities. Nearby towns each elected a duchess to represent them and prepared floats for the parades. Candidates for the queen were sponsored by service clubs and others. In 1947, duchesses represented Beeville, Karnes City, Flashing, Yorktown, Runge, Seguin, Floresville, Cuero, George West, Goliad, and Pawnee. The coronation program for 1947 is shown in Figure 7A.

The 1947-1953 Flax Festival Queens, their Princesses, and the Kings of flax are listed on the following page.

[9] *The improvement of flax in the United States has been reviewed by Culbertson (16).*

THE CORONATION

HER ROYAL HIGHNESS, THE PRINCESS OF FLAX
and Maids of Honor to the Queen

MARY JO LUARK

Escort—Robert Van Sickle

Maid—Phyllis Lister Maid—Dortha Baxter

HIS EXCELLENCY, THE KING OF FLAX
Benjamin Aoueille, Jr.

Crown Bearer Jimmy Mumme

THE ROYAL GUARD OF HONOR

Praeger Neyland Buddy Baker
John Chesnutt Preston Parsons
Earl Schroeder Martin Goff
Bennie Mumme Floyd Mechler

HER GRACIOUS MAJESTY
QUEEN FLAXENA, THE FIRST
YVONNE HUBER

Maid—Elaine McCoy Maid—Manda B. Foster
Maid—Clara Mae Vickery Maid—Betty Lou Kolinek
Train Bearer—Sanda Sue Hamm Train Bearer—Kenneth Gerhart

Pages: Georgia Ann Borrum — Norene Paasch
Heraldess: Peggy Gideon — Thelma Ruth Elliott

ENTERTAINMENT BEFORE THE QUEEN

Court Jester Clay Berry

DANCE OF THE FLAX BLOSSOM—Sylvia Schuenemann, Morma Jean Burns, Eloise Vermillion, Frances Kolinek, Martha Jean Murphy, Kay Copeland, Alice Leasman, Charlotte Braun, Joyce Stafford, Janet Bell, Ginger Avery, Roma Jean McCoy, Joy Louis Gilley, Sandra Kolinek, Barbara May, Richard Parsons, Danny McClendon, Billy Linder, Jimmie Roberts, Robert McClane, Gray Nichols, Mack Dyer.

Court Jester Twirlers — Jimmy Fuller, Juanita Goodner, Eva Lois Bain

Tumblers—Albert Pullin, Alex Homeyer, Stockton Vickery, James Kolinek, James Wyche, Randall McAlister, H. R. Hoak, Clarence Johnson, James Stennitt, Marvin Kolinek, Hubbard Roderson.

Spirit of Flax Blossom — Shirley Ann Brownlow

FLAX STRAW IN MOTION—Billie Rae Archer, Janice Bollin, Patsy Massey, Polly McClure, Peggy Slaughter, Louella Atherton, Dolores Woods, Mary Beth Russell, Betty Jo Martin, Marlene Matthews, Anna Lois Kitchen, Mary Alice May.

Announcer—Mr. Joe Nuson

Figure 7. Activities of the Texas Flax Association: (A) Program of the 1947 Kenedy Flax Festival, Kenedy, Texas.

Figure 7B. The 1950 Flax Festival Queen, Flaxena IV, Miss Eva Lois Bain of Kenedy, Texas.

Figure 7C. The 1950 Flax Festival Coronation Ceremony: Queen, Flaxena IV, Miss Eva Lois Bain, and her Court.

Figure 7D. The 1950 Texas Flax Festival Queen and Princess, Flaxena IV, Miss Eva Lois Bain (left) and Miss Alene James (right) in a field of flax in bloom at Kenedy, Texas.

Year	Title	Queen	Princess	King
1947	Flaxena I	Yvonne Huber	Mary Joe Luack	Benjamin Auoeille, Jr.
1948	Flaxena II	Bobbie Joe Roberson	Nancy Kauffman	C. E. Nichols
1949	Flaxena III	Shirley Ruckman	Dorthy McAda	
1950	Flaxena IV	Eva Lois Bain	Alene James	Ed Ruhmann
No festivals were held in 1951 or 1952.				
1953	Flaxena V	Rose Marie McAda	Cynthia Ann May	Sam A. May, Jr.

The prologue of the first flax festival in 1947 states

> The coronation symbolizes the crowning of a queen of a mythical kingdom, a kingdom of fantasy. The new domain is being created in this area. The object of the crowning of this queen is to cement the unity of the district so as to stress the importance of our new crop, which is bringing in revenue beyond our fondest hopes. Kenedy is the hub of this new domain of flax. We have made an effort to carry out a theme of flax in this coronation. This is not a coronation of an individual but a coronation of our theme "FLAX."

Many people of Kenedy and other communities were involved in the festival. The director of the first festival was Ruth Burney. People in the Kenedy area give credit to R. A. David as being the "man behind the scenes" in planning these festivals. He wrote many of the scripts, directed the coronations, and supervised the parades.

The 1950 flax festival was probably the most elaborate. Thousands attended the parade and the crowning of the Queen, Flaxena IV, Miss Eva Lois Bain (Figures 7B and 7C). Governor Allan Shivers attended the festival and led the parade. The Governor set aside May 1-7 as Texas Flax Week and issued the following proclamation:

> Therefore, I, as Governor of the State of Texas, hereby designate the week of May 1-7 as Texas Flax Week and call attention of all Texans to the new agricultural enterprise, which so greatly added to our economy. (Signed) Allan Shivers, Governor of Texas.

The last flax festival was held in 1953. The 2-day event included a western parade of beautiful horses and a performance by the Fourth Army Band from San Antonio. The Grand Parade was held May 2 with floats for the duchesses of 15 to 20 area towns, local floats, and fifteen bands. This coronation program was on the National Farm and Home radio hour from coast to coast, a program sponsored by the U. S. Department of Agriculture.

The attractiveness of a field of flax in bloom is shown in Figure 7D, together with the 1950 flax festival queen, Flaxena IV, Lois Bain, and Princess Alene James.

No further flax festivals were held because of reduced acreage and importance of the crop during the severe drouth of the 1950's, followed by severe winterkilling in 1962 and 1963. However, interest in flax continues, and the potential for an important source of agricultural income remains. The reduction in petroleum products and their increased cost may in time permit the flax crop to compete in the paint and linseed oil industry and in supplementary livestock feeds.

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E. C. Dillman, agronomist in charge of flax research, U. S. Department of Agriculture, Washington, D. C., 1920-1947. Later, 1947-1955, in charge of flax research for the Texas Flax Improvement Association, Kenedy, Texas.

H. J. Kuhn, owner and manager, Kuhn Paint and Varnish Company, Houston, Texas.

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