AgriLIFE EXTENSION
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Keys to Profitable Flax Production in Texas

Gaylon Morgan, ***Extension Agronomist, College Station***
Tom Isakeit, ***Extension Plant Pathologist, College Station***
Larry Falconer, ***Extension Agricultural Economist, Corpus Christi***

Increased interest in oil-seed crops for bio-fuels and petroleum replacements has renewed some interest in several oil-seed crops that were once quite common in Texas, including castor and flax. This publication will provide general management information of flax for Southern Texas. See Fig. 1.

Flax was first commercially grown in Texas in 1938 and peaked in 1949 with 330,000 acres. Through the 1950's and 1960's the acreage was somewhat stable at around 100,000 acres. However, following the droughts of the late 1950's, flax production never rebounded like the other major row crops. Additionally, many of the industrial uses of flaxseed oil, more commonly known as linseed oil, were replaced with cheaper petroleum based oil products.

The first flax varieties were introduced from Canada and the northern tier of the U.S.A. These early flax varieties were not winter hardy and the major flax industry developed in South Texas where winters were relatively mild and winter-kill was not problematic. From the 1940's through the 1960's, the major flax-growing counties were Karnes, Jim Wells, Bee, Wilson, Atascosa, Live Oak and Nueces. As more cold tolerant varieties were developed, the acreage spread into the southern Blackland Prairie counties.

Fig. 1. Flax at early bloom growth stage. Picture by Blair Fannin.

Uses of Flax

Flax seed normally yields 36 to 41 percent of oil based on dry weight, linseed has many industrial uses, including manufacturing paint, varnish, linoleum, oilcloth, printer's ink, patent and imitation leather products, and many other products. Linseed oil also was used on concrete pavement and bridges as a protective seal against freeze-thaw damage and deterioration caused by deicing salts. Many of the uses of linseed oil have been replaced with petroleum products; however, with increased instability in petroleum oil prices and the push for "green" fuels and chemicals has renewed interest in adapted crops like flax.

Additionally, there is an emerging market for flax seed for human consumption, as an omega-3 oil and anti-carcinogenic lignan source. Flax oil can be consumed as whole seed, in bakery products, or as a concentrated pill. Flax meal, also called linseed meal, is a high quality livestock feed and can be used as a protein supplement for livestock. It contains approximately 35 percent protein and 3 percent oil. Eggs from chickens fed flax seed are currently being marketed as "omega eggs" for their high omega-3 oil content.

Fiber flax is grown in Europe and Asia to make fine linen cloth. Fiber flax varieties are very tall with few branches and low seed production. However, there are numerous uses for flax straw from flax seed varieties. The fiber in flax stems is used to make fine papers, including cigarette paper, and padding in upholstered furniture. Nevertheless, for all practical purposes, all the flax varieties in North America are grown for their seed value, oil and meal.

Cropping Sequence

In South and Central Texas, flax is fall-sown and fits well in a rotation with cotton, corn or grain sorghum. When moisture is sufficient, a 1-year rotation of flax and a summer legume may be used. Crop rotation aids in controlling plant diseases and weeds. Continuous years of flax should be avoided, since some diseases are carried over in the crop residue, such as Plasmo.

Soil and Climatic Conditions

It is recommended to plant flax on the same type of land as wheat or oats, where good soil drainage is very important. Flax is adapted to most soil types, but especially to deep, fertile loam soils. In South Texas, flax production was concentrated on soil types that varying from fine sandy loams to sandy clay loams. Also, flax has been grown successfully on the heavy clay soils of the Coastal Prairie.

Due to the fact that flax has not been grown in Texas for a long time, the only seed currently available are spring-type flax varieties from the Northern USA and Canada. Although frost seldom kills flax seedlings, seedling plants just emerging are the most susceptible to injury but can withstand temperatures down to 28 degrees F for a few hours. After seedlings have a second leaf, they can withstand temperatures into the low 20 degree F range.

During the 1950-60's, Texas A&M University released several "cold-tolerant" varieties for Texas. These winter-hardy varieties that are adapted to South Texas and in Central Texas as far north as Waco could be increased relatively quickly, if demand develops in the future.

Seedbed Preparation

Seedbed preparation for flax is similar to that for small grains. Harvest the previous crop as early as possible. Shred and incorporate the crop residue. Any needed deep plowing should be done early in the summer. Preparing the seedbed early increases the possibility of adequate moisture for planting and crop establishment. A burndown herbicide application before planting is recommended to minimize early season weed problems. Preplant or preemergent herbicides may also be applied at this time. See the Weed Control section for herbicides labeled for flax production. A firm seedbed free of weeds and excess residue is ideal.

Seeding Rate

Rate of seeding per acre varies with size of seed, germination and row width. The seeding rate for large-seed varieties with good germination should be 25 to 45 pounds per acre when using a grain drill. The smaller seeded varieties can be planted at a lower seeding rate. An target plant population is not known at this time. Seed should be clean and treated with an approved fungicide.

Time of seeding

Sow flax early enough to allow the plants to become well established before freezing temperatures occur. After plants have branched at the crown, cold-hardy varieties can withstand much lower temperatures without serious injury. Avoid sowing flax too early in the fall or late spring frosts may damage the crop at the bloom stage. In South Texas, when moisture conditions permit, plant between November 10 and December 10. In this area, flax seeded after January 1 usually produced lower yields than December seedings. If moisture is available, October 15 to October 30 is an ideal time for planting flax in the Temple area. See Fig. 2 for an example of the impact of planting date on flowering date.

Fig. 2. Impact of planting date on flax flowering and maturation. Planting dates of Nov 8, Nov 30, Dec 4, Dec 18, Jan 3, Jan 18, Jan 30, Feb. 15 from right to left. Picture taken on April 4, 2008 in College Station.

Fertilizers

Responses to fertilizer applications depend upon moisture conditions, previous crop and fertility status of the soil. Experimental data generally show fertilizer applications to be profitable under good management and favorable moisture.

When large amounts of low nitrogen residue, such as grain sorghum stubble, are returned to the soil before planting flax, apply 3 pounds of nitrogen per expected bushel of yield. However, the nitrogen rate should not exceed 80 pounds per acre. This fertilizer recommendation is based on recommendations from North Dakota State University publication A-1038. Further research is needed to identify the best nitrogen rates for flax in Texas. A split fertilizer application may be made if moisture is limited at planting. Splitting the nitrogen application may also reduce freeze damage caused by early lush growth. When the fertilizer application is split, apply all the phosphorus and 15 to 20 pounds of nitrogen before or at planting, and topdress the remainder of the nitrogen before blooming if moisture is adequate. Flax is very efficient at extracting phosphorous from the soil. Research in the North Dakota reported very low response to phosphorous applications, unless the soil was low to very low in phosphorous. Refer to soil analysis for fertilizer requirements for other nutrients. The best guide for fertilizer application is always a soil analysis.

Zinc can be a yield limiting nutrient and symptoms may include stunting, yellowing out and terminal die-back. If these symptoms are widespread, an application of 15 pounds of zinc sulfate per acre should suffice to maintain yield. Chelated or other zinc material can be used at equivalent rates. Zinc may be applied as a foliar spray. Apply 15-30 gallons per acre of one-fourth to one-half percent solution made by putting 1 to 2 pounds of zinc sulfate in 50 gallons of water to minimize chances of leaf burn. Excessive amounts of phosphorus may induce zinc deficiencies. A soil test is useful in keeping the soil phosphorus level within allowable limits.

Weed Control

Winter and summer weeds can be troublesome in flax due to limited herbicide availability. Henbit, clover, mustard, wild carrot and several grasses are the important winter weeds which reduce flax seedling growth and development. The summer weeds, sunflower, lambsquarter, Johnsongrass and thistles, may compete with flax late in the season and also interfere with harvest.

Labeled herbicides include Bromoxynil, Curtail M, MCPA, and Trifluralin for broadleaf weeds. Poast and Select herbicides are labeled for managing many grass weeds in flax. See the label for rates and application timings.

Method of Planting

Flax should be planted with a grain drill into a level, firm seedbed free of excess crop residue and clods. A relatively shallow planting depth is recommended but is somewhat dependent on soil texture and moisture conditions. In fine-textured soils of good tilth, ¾ to 1 ¼ inches usually is deep enough. On lighter soils, a depth of 1 to 1 ½ inches may be necessary. Use of a culti-packer or drill with press wheel attachments usually is beneficial as the packing promotes rapid germination and good stands.

Planting flax at 7 or 8-inch drill spacing, with normal rainfall, generally results in highest yields. However, flax may be planted in 28 to 38-inch rows in dry years or on weed-infested soils. Planting on wide rows allows weed control by cultivation.

Insects

Insects have not been a real problem in Texas flax production except as the carrier of curly top disease. Armyworms and cotton bollworms sometimes cause damage to late-sown fields by eating the flowers and green bolls. False chinch bugs occasionally migrate from adjoining fields after blooming and suck the juice from developing seeds. In a few instances, white grubs have been observed in damaging numbers. If the population of such insects becomes sufficiently great, insecticides are available which give effective control.

Diseases

The important diseases of flax in Texas were identified by plant pathologists during the years of highest production, from the 1940s through the 1960s. In recent years, small-scale plantings of flax in different parts of Texas have been relatively free of disease. Increasing the scale of production will eventually lead to economically-damaging levels of disease development. Although there are at least a dozen infectious diseases of flax reported world-wide, only a few pathogens pose serious risks to production under Texas climates.

Pasmo – a fungus, *Septoria linicola.* This disease has the potential to increase extensively and cause substantial leaf damage in a matter of days (Fig. 3). It starts as circular, yellow to brown spots on the cotyledons and lower leaves. Stems later become infected, starting at the point of attachment to the leaf. On stems, brown bands alternate with non-infected, green tissue. These bands combine as the infected plant ripens prematurely.

Fig. 3. Pasmo symptom: brown bands on stems, alternating with green bands.

The disease causes defoliation, damages fibers, reduces seed size and yield, and the quantity and quality of oil. Bolls may fall off, and plants are prone to lodging. Wet weather late in the growing season increases disease severity. The fungus survives on residue from the crop.

Control: Crop rotation and plow under crop residue. Some varieties are more tolerant to the disease than others.

Damping-off and seedling disease – various fungi, *Rhizoctonia solani*, *Pythium* sp., *Fusarium* sp. The disease can occur in patches in the field. Plants are killed before or after emergence. Seedlings turn yellow, wilt, and die. Roots are rotted. Historically, stand losses in south Texas have ranged from 10-50%. Cracked seeds are more likely to become infected (Fig. 4). The disease is more severe under cool, wet weather conditions.

Control: Use high-quality seed treated with fungicides. Do not plant seed any deeper than necessary and provide a firm seedbed

Fig. 4. Cracked seeds are more prone to infection by fungi.

Rust – a fungus, *Melampsora lini.* Yellow pustules are produced on all plant parts above ground (Fig. 5). Plants lose their leaves and the yield and quality of seed and fiber are reduced. The disease is more severe with rainy weather. Later in the season, pustules turn black, which indicates the production of spores that can over-winter on crop residue.

Fig. 5. Rust symptoms on leaves and a stem.

Control: Use resistant varieties. Do not follow flax with flax. Plow under crop residue. Use clean seed that is free of crop residue.

Curly top – a virus. Plants infected as seedlings have distorted, wavy leaves that are bunched at the growing point (Fig. 6). The plant yellows and dies. Older plants that become infected also have distorted leaves. In addition, the tip of the stem is coiled and branches grow laterally, rather than upright. The flowers are small or the buds do not open. Petals are twisted and puckering. The number of tillers are reduced, as well as seed set.

Fig. 6. Appearance of curly top.

Curly top was especially prevalent in south Texas during the drought of the 1950s, possibly because conditions favored the beet leaf hopper, *Circulifer tenellus*. High levels of disease have occurred with early planting dates, which may be associated with greater leafhopper activity.

Control: Caldwell, a variety developed in Texas, may have some tolerance to this disease.

Aster yellows – a phytoplasma. The apical leaves of stems turn yellow. Secondary shoots grow from axils of leaves (Fig. 7). There is a proliferation and greening of flowers, but the petals are small or absent. Bolls fail to develop. Plants may occasionally be partially infected, with normal-looking branches that produce normal bolls. Reduction in seed yield of two-thirds has been observed with severe epidemics.

This pathogen is vectored by the aster leafhopper, which is also known as the six-spotted leafhopper (*Macrosteles quadrilineatus*). The pathogen and vector have a wide host range.

Control: There are no resistant varieties available.

Fig. 7. Plants with aster yellows.

Cotton root rot – a fungus, *Phymatotrichopsis omnivora*. Flax is susceptible to infection, but since it is usually grown during the cooler part of the year, it usually escapes the disease.

Recommended Varieties

Flax is a self-pollinated crop, and the seed is produced in a boll or capsule. A complete boll can have 10 seeds, but most bolls will have fewer, averaging around six seeds. Seeds can be brown, golden or yellow (Fig. 8). Yellow-seeded varieties are more susceptible to seed decay and seed damage because of their thinner seed coat. For this reason, yellow-seeded varieties usually have lower seedling vigor. Most flax varieties have blue flowers; however, some varieties have white flowers.

Since virtually no flax has been grown in Texas for over 40 years, very little information is currently available on variety selection for Southern Texas. Based on initial research, a wide range of maturities are available. On-going variety trials at numerous locations in Southern and Central Texas are currently underway in order to identify the best adapted and highest yielding varieties. Once multiple years of data are available, the results will be available at http://varietytesting.tamu.edu/

Fig. 8. Brown-seeded and yellow-seeded flax seed on the right and left, respectively. Picture by Daniel Hathcoat.

Harvesting

Begin harvesting flax only when the bolls and upper plant parts have turned brown and the straw is yellow (Fig. 9). Flax can be harvested safely at moisture levels up to 18 percent, but seed over 8 percent must be dried before storage. Harvesting flax at a high moisture content, while some bolls and plants are immature, can result in dockage at the selling point. Harvesting can be done with a regular grain combine when the crop is mature, or by windrowing and later using a pick-up attachment. Harvesting should be prompt as flax seed is easily damaged by wet weather. The seed is covered with a mucilaginous coating. This coating becomes sticky when wet. During a wet harvest, this coating may discolor, giving the seed a weathered appearance and a reduced test weight (Fig. 10). Windrowing may be advisable to hasten harvest if high-quality planting seed is the objective.

Based on research conducted in 2008 and 2009 at the College Station and Beeville, the yield potential of 30-40 bu/a is realistic under limited irrigation. At College Station, the yields ranged from 33 to 42 bu/a with an average yield over 15 varieties being 39 bu/a. At the Beeville location, the yield range was 22-42 bu/a, and an average yield over 15 varieties being 32 bu/a.

Flax harvested for seed must be handled more carefully than most other crops because cracking frequently reduces germination. Concaves and cylinder speed should be adjusted as frequently as necessary to prevent cracking and injuring the seed. Yellow-seeded varieties are more susceptible to seed damage because of their thinner seed coat. To minimize damage, rubber roller attachments are available for harvesting planting seed. Flax seeds are small and slippery, and equipment and storage facilities must be free of holes and cracks. Similar to other high oil content crops, storage time should be minimzed.

Fig. 9. Flax at harvest time. Picture by Blair Fannin prior to harvest. Picture by Aaron Turner.

Fig. 10. Weathered flax seed (left) due to exposure to wet conditions prior to harvest. Picture by Aaron Turner.

Marketing

Western Europe purchases most South Texas flax. It competes with Canadian and Northern U.S. produced flaxseed. The volume of flax seed produced and marketed poses a major consideration for South Texas export terminals- limited supplies create difficulty in volume commitments for forward deliveries.

Market grades help determine producer price. Major considerations in determining grade are moisture content and test weight. Premiums are offered to growers for No. 1 or No. 2 grade which contains less than 9.5 percent moisture. Discounts for grades below these specifications reflect the market's need in terms of value.

Farm Program, Marketing and Production Economics Considerations

Flax is considered a minor oilseed for farm program purposes, which makes the crop eligible for price support and disaster assistance through the programs administered by the Farm Service Agency of USDA. To participate in price support and disaster programs the Farm Service Agency acreage reports for flax should be filed with FSA, as with other program crops. Planting of flax on base acres is permitted, and would have no affect on any current DCP payments for farms that were otherwise eligible. Flax is eligible for CCC loan support, and the national average CCC loan rate for flax is currently $9.30 per hundredweight, and will increase to $10.09 per hundredweight in 2010. However, county loan rates are currently at $7.29 per hundredweight for areas in South Texas that were producers of flax. Crop insurance availability would be limited until the producer could establish production history on their flax production.

North Dakota is the largest producer of flax in the U.S., with over 90% of the acreage planted since 2006. Montana is the second leading producer of flax in the U.S., followed by South Dakota and Minnesota. U.S. producers planted 354,000 acres of flax in 2008, this was 56 percent below 2006 acreage. The sharp drop in flax acreage was a response to the decrease in the price received from flax by farmers, which dropped from a season average of $8.07 per bushel in 2005/2006, to $5.80 per bushel in 2006/2007 while prices for alternative crops such as corn and soybeans increased dramatically. Flax seed prices responded to the drop in production, and prices ranged between $12.55 and $13.35 per bushel in 2008. The US has crushed more flax seed for oil than it has produced in 7 of the last 10 years, and imports have ranged from 21% of domestic production to 124% of domestic production over that time span. Exports of flax have ranged from 15% of domestic production to 34% of domestic production in the same timeframe.

The market for flax seed in South Texas is not well developed at this time. For producers in South Texas, any production from this region should be grown under contract with an elevator or end-user. At this time, some crushing facilities are on the drawing board which might be able to use flax seed as an input, and there are existing plants in northern Mexico that use alternative oilseeds such as canola which might also be feasible markets in the future.

See **Table 1.** for estimated costs and returns for dryland flax production in the northwest Coastal Bend region.

Additional Information:

Additional information can be found in the North Dakota State University publication, A-1038.

Acknowledgements:

This publication is based on the 1970 publication titled “Keys to Profitable Flax Production” MP 967 by R. J. Hodges, Jr., E. C. Gilmore, Lucas Reyes, W. P. McNally and Richard R. Hoverson.

Table 1. Estimated Costs and Returns for Dryland Flax Production in the Northwest Coastal Bend.

ITEM	UNIT	PRICE	QUANTITY	Total Amount	Your Farm
INCOME					
Flax seed	bu	$ 13.35	15	$ 200.25	
TOTAL INCOME				$ 200.25	
DIRECT EXPENSES					
Custom					
Fert. Application	acre	$ 5.00	1	$ 5.00	
Herbicides					
Glyphosate (Generic)	qt	$ 4.25	0.5	$ 2.13	
2,4D LV6	pt	$ 1.56	0.67	$ 1.05	
Seed					
Flax Seed	lb	$ 0.48	20	$ 9.60	
Fertilizer					
32-11-3 6S	ton	$ 415.80	0.095	$ 39.50	
Hauling and Handling					
custom haul - flax	bu	$ 0.35	15	$ 5.25	
Other					
pickup vehicle charge	acre	$ 2.80	1	$ 2.80	
OPERATOR LABOR					
Tractors	hour	$ 11.00	0.2632	$ 2.90	
Self-Propelled	hour	$ 11.00	0.103	$ 1.13	
DIESEL FUEL					
Tractors	gal	$ 2.00	2.8985	$ 5.80	
Self-Propelled	gal	$ 2.00	1.398	$ 2.80	
REPAIR & MAINTENANCE					
Implements	acre	$ 2.72	1	$ 2.72	
Tractors	acre	$ 3.64	1	$ 3.64	
Self-Propelled	acre	$ 6.87	1	$ 6.87	
INTEREST ON OP. CAP.	acre	$ 3.85	1	$ 3.85	
TOTAL DIRECT EXPENSES				$ 95.04	
RETURNS ABOVE DIRECT EXPENSES				$ 105.21	

FIXED EXPENSES					
Implements	acre	$ 5.37	1	$ 5.37	
Tractors	acre	$ 6.52	1	$ 6.52	
Self-Propelled	acre	$ 11.82	1	$ 11.82	
TOTAL FIXED EXPENSES				$ 23.71	
TOTAL SPECIFIED EXPENSES				$ 118.75	
RETURNS ABOVE TOTAL SPECIFIED EXPENSES				$ 81.50	
RESIDUAL ITEMS					
NWCB Land Charge	acre	$ 35.00	1	$ 35.00	
Management Charge	%	$ 200.25	5%	$ 10.01	
RESIDUAL RETURNS				$ 36.00	

Note: Cost estimates are based on producer and specialist input. Not to be used w/o updating after 8/15/2008.

Produced by the Department of Soil and Crop Sciences
Texas A&M University, College Station, TX
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