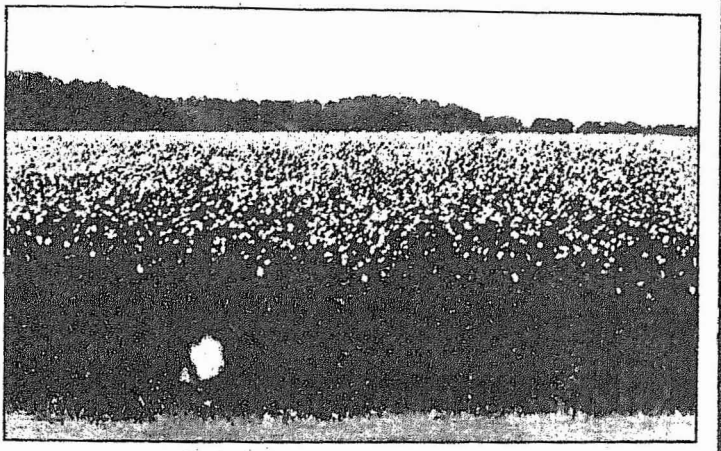
FLAX FACTS



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THE UNITED STATES DEPARTMENT OF AGRICULTURE

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GROW MORE FLAX

Why?

1. Only half as much flaxseed is produced in the United States as is consumed. There is no surplus problem with flax.
2. Flax has been a profitable crop for a period of years and the price outlook continues good.
3. The United States pays over $40,000,000 annually for flaxseed brought in from foreign countries. Why not attract this money to the Northwest?

How?

1. Use only seed of wilt-resistant varieties on old land. It is not possible to identify seed of wilt and rust-resistant varieties by appearance. Start by purchasing certified seed and in this way obtain seed of known origin.
2. Grow flax in regular rotation as far as practicable. This provides a favorable place for the flax crop and should result in better yields and higher incomes per acre.
3. Flax does best in rotations following corn or other cultivated crops and clover or grass sod. Where summer fallowing is practiced, flax may either follow the summer fallow directly or come the next year on burned stubble.
4. Sow as early as practicable on a clean firm seed bed. Flax may be sown at the same time as wheat and oats or immediately thereafter without serious danger from frost. Some delay in seeding to provide clean seed beds is good practice.
5. Clean land is necessary for flax. Where fields have many weed seeds present on the surface, delay the seeding of flax until the weeds have been destroyed. Harrow such fields early to hasten germination of the weed seeds and cultivate afterward to kill the seedlings. Spring plowing aids in the control of weeds but must be made firm before the flax is sown.
6. Provide a firm seed bed for flax. Clean corn, sugar beet, or potato land disked lightly in preparation for seeding flax provides ideal conditions. Where land is plowed in spring for flax, it should be made firm enough so that no air pockets remain below before the flax is sown.

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FLAX FACTS

THE FLAXSEED OUTLOOK

The flaxseed situation in the United States has been unusual from 1909 to the present in that production has averaged slightly less than half of the consumption, although the acre income from flax in North Dakota, Minnesota, and South Dakota has been fairly consistently higher than that for spring wheat or oats. This relationship has held notwithstanding the all-too-general practice among farmers of sowing spring wheat and oats early on the best land and leaving the flax seeding until late on such land as may be left over.

Huge sums of money have been sent to foreign countries each year to purchase the large amount of flaxseed needed above that produced in the United States. This unfortunate situation has continued for so long that unusual effort appears justifiable to bring to the attention of farmers in the Northwest the facts regarding the production and use of flaxseed. The experiment stations and agricultural colleges of the four leading flax-producing states, North Dakota, Minnesota, South Dakota, and Montana, and the United States Department of Agriculture join with the manufacturers and large users of linseed oil in the Northwest in forwarding this movement. This is in furtherance of the projects of the extension divisions of the agricultural colleges of these four states to encourage a larger acreage with increased production of flax. With the information now at hand, farmers of the Northwest should be able to arrive at a more logical decision and program of action than they have in the past. If a large proportion of flaxseed, now purchased in foreign countries each year can be produced here, the money sent abroad will find its way to northwest farmers. In this way both farmers and business men who, after all, are very much dependent on each other, will profit.

Income Per Acre Main Deciding Factor

While there are other advantages of growing flax in preference to spring wheat or oats as a cash crop, the main deciding factor in favor of growing flax is that it results in higher average incomes per acre. Table 1 gives the gross income per acre for flax, spring wheat, and oats for 1902 to 1929, inclusive, in the four northwest states.

For convenience the income per acre for 1902-3 is averaged and following that are averages by five-year periods to 1929. The 1929 results are preliminary, and are not averaged in with the results for other years.

Since the production cost per acre of the three crops is approximately the same, it was not thought essential to present net income per acre in additional tables.

For each five-period for 1909 to 1928, inclusive, in North Dakota, Minnesota, and South Dakota, flax showed a higher gross income per acre than spring wheat or oats. The advantage in favor of flax has been, with a few exceptions, greater during the last eleven years than for the period 1909-18.

In Montana the income per acre for flax has not averaged higher than for spring wheat or oats. This is largely due to the growing of wheat and oats on the most productive lands and to the practice of sowing flax late.

TABLE 1. GROSS PER ACRE OF FLAX, SPRING WHEAT, AND OATS BASED ON YIELDS AND DECEMBER PRICES IN YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

Year	North Dakota			Minnesota		
	Flax	Spring wheat	Oats	Flax	Spring wheat	Oats
1902-3	$ 6.66	$ 8.61	$ 9.43	$11.60	$ 8.76	$10.11
1904-8	9.74	9.36	9.27	10.99	10.33	9.49
1909-13	11.35	8.75	7.92	14.42	12.83	10.56
1914-18	18.56	15.58	10.85	23.72	23.20	17.31
1919-23	15.36	10.92	7.56	22.97	14.11	12.18
1924-28	14.87	13.79	8.39	20.62	17.66	13.01
1929	13.49	9.58	5.76	25.83	14.61	13.51
	South Dakota			Montana		
1902-3	$ 8.48	$ 7.76	$10.64	$ 7.26	$17.37	$ 6.26
1904-8	10.32	9.34	9.38	9.94	19.53	19.41
1909-13	10.69	8.78	7.55	14.70	18.52	17.93
1914-18	20.47	19.56	16.00	16.05	21.25	17.67
1919-23	19.26	12.32	10.87	9.80	10.54	9.84
1924-28	15.55	13.15	9.60	14.21	16.84	14.43
1929	16.52	9.41	12.69	8.96	8.64	8.67

Consumption of Flaxseed Exceeds Production

As shown in Table 2 the consumption of flaxseed in the United States has exceeded the net domestic supply each year. Net domestic supply is the total production in the United States less the seed needed for the next crop.

TABLE 2. FLAXSEED PRODUCTION AND CONSUMPTION IN THE UNITED STATES

Year	Total acreage	Average yield per acre	Total production	Seed needed for sowing next crop	Net domestic supply	Total consumption	Amounts imported	Net domestic supply in per cent of total consumption
	1000 A.	bu.	1000 bu.	1000 bu.	1000 bu.	1000 bu.	1000 bu.	%
1902-3	3,487	8.1	28,293	1,718	26,575	25,916	.....	102.7
1904-8	2,570	10.1	25,822	1,583	24,239	22,354	.....	109.4
1909-13	2,490	7.9	19,505	1,501	18,004	26,950	8,946	65.9
1914-18	1,680	8.0	12,922	1,033	11,889	24,512	12,623	48.5
1919-23	1,499	7.2	10,773	1,183	9,590	31,864	22,274	30.0
1924-28	2,993	7.9	23,695	1,830	21,865	40,650	18,995	53.5
1929	2,990	5.6	16,838	2,168†	14,670*	42,000†	27,330†	34.9

* December 1 estimate, United States Department of Agriculture.
† Estimated.

Acreage and production of flax seed declined for each five-year period to the low point for 1919-23. On the other hand consumption increased materially during these periods so that the low net domestic supply for the period was only 30 per cent of the consumption.

Owing to the favorable position of the flax crop as compared with spring wheat brought about by the more general use of disease-resistant varieties, better cultural methods, and the tariff enacted in 1922, the acreage and production rose during the period 1924-28 to 2,993,000 acres and 23,695,000 bushels, respectively. However, as consumption of seed for this period averaged 40,650,000 bushels and the average net supply was only 53.5 per cent of

the amount consumed, an average of 19 million bushels had to be imported annually.

In 1929, although the acreage in the United States was approximately as high as for the preceding five-year period, the average yield was the lowest in 10 years, or 5.6 bushels per acre. This low average yield was due to extended drought. Based on the estimated production and consumption of flaxseed in 1929, the net supply in the United States will be only 34.9 per cent of the required amount which makes it necessary to import approximately 27 million bushels of seed during the current year.

The average acre yield of flaxseed for the period 1924-28, inclusive, was 8 bushels. Even if the acre yield in 1929 had been 8 instead of 5.6 bushels, the net amount available for crushing would have been only 21,750,000 bushels, and the amount necessary to import approximately 20,250,000 bushels.

The largest acreage of flax grown in the United States since 1902, 3,469,000 acres, was produced in 1924. That year the average yield per acre was 9.2 bushels. Only three out of the last ten years has the average yield in the United States been over 9 bushels per acre. Even with the combination in 1924 of an exceptionally high acreage and high average yield per acre, the net supply in the United States was only 72.3 per cent of consumption.

Tariff on Flaxseed is Effective

A tariff of 40 cents per bushel on all flaxseed and 3.3 cents per pound on all linseed oil imported to the United States went into effect in 1922. In 1929 the tariff was raised to 56 cents per bushel on seed imported with no change for linseed oil.

The tariff on flaxseed is effective owing to the fact that less is produced than is consumed. On the other hand, the tariff of 42 cents per bushel on spring wheat is not always effective because of the large surplus of all wheat produced. The tariff on flaxseed will still remain effective when production in the United States is increased to the point where the net yearly supply reaches within 5 or 6 million bushels of the total consumption. Any year when the net supply exceeds consumption, with a surplus to export, the tariff will not be effective.

Situation Favors Increased Domestic Production

Total flaxseed production for each year, 1925 to 1929, inclusive, was higher than for any previous period. This large increase in world production took place chiefly in Argentina. However, in the immediate future there seems to be no reason to expect further large increases there or in other foreign countries.

Flaxseed prices in the United States have been comparatively satisfactory during these years of high world production and there appears to be no reason why they will not continue on approximately as high a level. The tariff increase on flaxseed in 1929 and the possibility of another raise indicate higher, rather than lower, prices for flaxseed in the United States provided production remains somewhat lower than consumption.

A Profitable Flax Program for the Northwest

The average consumption of flaxseed in this country for 1924-28 was 40,650,000 bushels and the production less the sowing supply 21,865,000 bushels. This made it necessary to import approximately 19 million bushels each year: The average flax acreage during the period was 2,993,000.

There is at the present every indication that the income per acre for flax will continue higher than that for spring wheat if grown on equally productive land. These facts make the following program appear logical on farms in the Northwest.

1. Maintain flax acreage in the United States each year at approximately 4,000,000 acres. This will be an increase of 33 per cent above the average of 2,993,000 acres for 1924-28. With an average yield of 9.3 bushels per acre, this acreage should result in a net domestic supply of approximately 35 million bushels per year.
2. Provide a regular place as far as practical for flax acreage in the crop rotation. This would result in growing the same acreage approximately each year and provide a favorable place for the crop. Better yields and higher incomes per acre should result.
3. Arrange early each year for an adequate amount of high-grade seed. To sow 4,000,000 acres of flax each year requires approximately two and one-half million bushels of seed. If seed must be purchased, the sooner it is done, the better.
4. Sow at a time which will give the highest yields per acre. Usually this is much earlier than is generally practiced.

Conditions in the four leading flax-producing states vary considerably. Specific suggestions to farmers in each of the four leading flax-producing states are given on pages 8 to 32.

Flax Not Hard on the Land

Contrary to the ideas held by some, flax is no harder on the land than wheat or oats as far as the removal of plant nutrients from the soil is concerned. The ten-year average yield per acre of flax, wheat, and oats with proportionate yields of straw in North Dakota, Minnesota, South Dakota, and Montana are given in Table 3.

The amount of nitrogen, phosphoric acid, and potash removed by these yields of grain and straw are included in the table. Both the seed and straw of flax are higher in nitrogen content than the

TABLE 3. AMOUNTS OF PLANT NUTRIENTS PER ACRE REMOVED IN AVERAGE YIELDS PER ACRE OF GRAIN AND STRAW

Crop	Average yields per acre		Nitrogen	Phosphoric acid	Potash
	Grain	Straw			
	bu.	tons	lbs.	lbs.	lbs.
Flax	7.7	0.83	34.7	9.6	21.5
Spring wheat	11.9	1.32	30.1	1.09	35.3
Oats	27.8	1.10	30.4	12.9	38.1

grain and straw of spring wheat and oats, but the yields per acre are lower. A flax crop of 7.7 bushels with the 0.83 ton of straw removes 4.6 pounds more nitrogen per acre than a 11.9 bushel crop of spring wheat with its straw and 4.3 pounds more nitrogen than a 27.8 bushel crop of oats including straw. However, the spring wheat and oat crops remove slightly more phosphoric acid and

considerably more potash than the flax crop. Except for the potash these differences are small. They show that an average crop of flax removes no more plant food from the soil than average crops of spring wheat or oats.

Market for Flax Straw

Approximately 80,000 tons of flax straw are used each year in the manufacture of insulating material, tow for upholstering, and coarse wrapping cord. A large percentage of this amount is used in the Twin Cities. Straw used for this purpose is graded according to average length and weed content. Grade 1 must be dry, sound, well-baled and contain not to exceed 5 per cent of foreign growth, or 5 per cent chaff, and the fibers must average 10 inches or more in length. Grade 2 must meet the same specifications as grade 1 except that the fibers must be at least 6 inches long. Since length of the straw is one of the main factors that determine the grade and price of flax straw to be sold, the crop should be cut as low as practicable. Sowing on smooth seedbeds permits cutting the crops low. Chaff in the bales lowers the market value of the straw; on the other hand, this is the part that livestock relish most. Care in stacking flax straw by avoiding depressions in the stacks that carry water toward the center instead of turning it off eliminates much of the wet straw problem.

Prices for straw from the 1929 crop, f. o. b. cars Minnesota Transfer, are $11 per ton for grade 1 and $9.50 for grade 2.

It costs approximately $3 per ton to bale flax straw and $1.50 per ton to haul it to the station and load it into cars. The freight rate within a radius of 150 miles of the Twin Cities is about $3 per ton. This leaves approximately $3 per ton for No. 1 straw on the farm. On many farms part of the baling and all of the hauling charge goes to the farmer as wages during the dull season.

Flax Diseases

One reason why flax is a profitable crop is its relative freedom from destructive diseases. There are several diseases which sometimes cause considerable damage and which are capable of causing still greater damage. Fortunately disease epidemics occur infrequently and can be fairly well controlled.

The most destructive diseases of flax in the United States are wilt, rust, and pasmo. Wilt can be largely controlled by growing wilt-resistant varieties like Bison, Buda, Redwing, Linota, and Chippewa, and by early planting. If these wilt-resistant varieties are sown early, the grower need not fear that wilt will cause appreciable damage. Rust and pasmo are less easily controlled, but Redwing, Bison, Buda and Linota are partially resistant to rust, and new varieties which combine wilt-resistance and rust-resistance are being developed and should be available within a few years.

Losses from disease can be reduced to a minimum by the following precautions: (1) Always select the proper variety, preferably one of those mentioned above and be careful about the source of seed supply. It is undesirable to use seed which has been grown outside of the flax area of the northwest states. Avoid using untested foreign seed because of the danger of introducing new

diseases. (2) Use very clean seed. It should be fanned thoroughly to remove light, shriveled kernels and bits of straw and chaff on which there may be disease germs. (3) Practice a proper rotation. Sow clean seed on clean land. This will reduce the amount of wilt, rust, and pasmo. (4) Sow flax as early as practicable. The seedlings are quite resistant to frost, and early maturity resulting from early planting helps in reducing the amount of wilt and rust.

Development of New Flax Varieties

During the past 20 years great progress has been made in the improvement of the flax crop. This has been accomplished by developing disease-resistant varieties to replace the common flax which formerly grew on the new lands of Minnesota and the Dakotas.

About 1900 Professor H. L. Bolley, of the North Dakota Agricultural Experiment Station, discovered that the failure of flax on old land was due to a fungous disease, flax wilt, which lives in the soil for several years after it is introduced. To develop a wilt-resistant variety, therefore, it is necessary to grow flax on wilt-infested soil so the susceptible plants will be killed off and only the resistant ones survive. It was in this manner, by selection on "wilt-sick soil" that Bolley and other workers at the North Dakota Station developed the wilt-resistant varieties, North Dakota Resistant No. 114, Buda and Bison. Linota was also developed at the North Dakota Station. A similar method has been used at the Minnesota station where the Redwing and Chippewa varieties were developed. At the North Dakota and Minnesota stations the plots of land used for testing for wilt-resistance have been cropped to flax continuously for a long period of years. On these plots, only the most wilt-resistant varieties will survive.

FLAXSEED—INCREASED PRODUCTION IN NORTH DAKOTA

H. L. Bolley, Botanist and Plant Pathologist, and H. L. Walster, Agronomist, North Dakota Agricultural Experiment Station

Since flax became a common crop in North Dakota, the state has seeded annually an acreage approximating one-half that planted in the United States. Excepting late years, the state has produced approximately one-half the flaxseed annually marketed in the United States. During the past five years, there has been produced in North Dakota only about 40 per cent of the entire production in the United States. Statistics show 1924 to be the high production year since 1902.

During the entire period 1902 to 1929, inclusive, flax acreages in North Dakota have suffered unwarranted ups and downs. The low point in acreage was reached in 1921 with 430,000 acres yield-

ing 6.5 bushels per acre, valued at $1.43 per bushel as the average December 1 farm price. The high point was reached in 1924 with 1,873,000 acres yielding 8.5 bushels per acre, valued at $2.27 per bushel as the average December 1 farm price. In 1929 there was a return to a heavier acreage, the preliminary estimate for that year being 1,463,000 acres, yielding 4.7 bushels per acre, valued at $2.87 per bushel as the average December 1 farm price.

Production per acre, year by year, has fluctuated considerably, according to climatic and soil conditions. The lowest yield per acre recorded for North Dakota since 1919 is placed at 4.7 bushels for 1929. This low yield was largely due to the severe drought which affected most of the state.

The average acre yield during the last ten years has been approximately 7 bushels per acre, with an average December 1 farm price of $2.06 a bushel and an average acreage of 1,132,000.

Table 4 shows what has happened to flax in North Dakota since the crop of 1902.

TABLE 4. FLAXSEED PRODUCTION IN NORTH DAKOTA 1902-29*

Year	Acreage	Yield per acre	Total yield in bushels	December 1 farm price per bushel
	1000 A.	bu.	1000 bu.	
1902	2,160	7.2	15,552	$1.03
1903	1,814	7.3	13,245	.81
1904	1,233	10.6	13,078	.99
1905	1,357	11.6	15,743	.84
1906	1,466	9.9	14,510	1.02
1907	1,700	8.0	13,602	.96
1908	1,530	9.0	13,770	1.19
1909	1,068	9.6	10,246	1.57
1910	1,117	3.6	4,021	2.35
1911	1,200	7.6	9,120	1.84
1912	1,246	9.7	12,086	1.14
1913	1,000	7.2	7,200	1.21
1914	840	8.3	6,972	1.28
1915	660	9.9	6,534	1.78
1916	790	10.3	8,137	2.52
1917	965	3.9	3,764	3.00
1918	800	7.8	6,240	3.45
1919	650	4.6	2,972	4.41
1920	761	5.3	4,033	1.78
1921	430	6.5	2,795	1.43
1922	521	9.3	4,845	2.14
1923	1,050	7.7	8,085	2.12
1924	1,873	8.5	15,920	2.27
1925	1,461	6.5	9,496	2.26
1926	1,380	5.5	7,590	1.93
1927	1,242	8.2	10,184	1.84
1928	1,143	7.3	8,344	2.01
1929	1,463	4.7	6,876	2.87
Averages for last 10 years	1,132	6.95	7,816	$2.065

*Data from office of Crop Estimates, Bureau of Agricultural Economics, United States Department of Agriculture.

The prices for flaxseed received by North Dakota farmers for 1929 have been relatively high, touching an average of $3.01 per bushel on October 15. This is the highest average price received

on the fifteenth of any month since July, 1920, when $3.44 was reached.

Flaxseed—A Pay Crop

North Dakota farmers recognize that the flaxseed crop, **properly handled on lands of reasonable quality,** usually produces a pay crop for individual growers. Statistics have usually confirmed such estimates of the **value** of the crop for the state as a whole, even though it has commonly been quite carelessly planted as a **side issue** in the various cropping schemes.

Whether a crop is of value in a cropping scheme depends much upon its comparative value as related to associated crops. Table 5 shows comparative costs and crop values for flax and spring wheat.

TABLE 5. ACRE VALUE AND COST OF PRODUCING FLAX AND WHEAT IN NORTH DAKOTA

	Flax		Spring Wheat	
	Gross acre value	Total cost per acre	Gross acre value	Total cost per acre
1922	$19.90	$15.06	$12.69	$13.41
1923	16.32	13.38	6.36	11.82
1924	19.30	14.67	19.78	12.43
1925	14.69	14.17	15.33	12.41
1926	10.62	12.33	9.36	10.74
1927	15.09	16.82	13.05	12.93
1928	14.67	15.02	11.67	13.11
Average	$15.79	$14.49	$12.61	$12.71
Net average gain		1.30	Net average loss	0.10

*Table compiled by O. M. Fuller, Farm Management Department, North Dakota Experiment Station. The figures are based on average yields and December 1 farm prices. Those for 1924-28 are based on approximately 150 survey records, taken each year in various sections of the state.

Prospective Crop Values

Considering the present prices, with no possible carry-over in the United States and the comparatively low 1929 Argentine production, the price of flaxseed may be expected to continue comparatively high during the coming year. It is probable, therefore, that growers in other states and countries will tend to increase their acreage. Thus a large **world crop** may be a possibility in 1930. Yet, as consumption in the United States now far exceeds the annual production of flaxseed, there would seem to be no reason why North Dakotans should not hold their cropping efforts to a reasonably high acreage and bushelage. Individual growers who have reasonably weed-free lands, suitable for high yields of flaxseed, are warranted in attempting an increased production. **Increased yields per acre in flaxseed, without proportionate cost, should be profitable.** Each grower should remember, however, that carelessness in selection of seed and soil or in planting spells failure in cash returned.

Safe Acreage in North Dakota

As North Dakota has been able to exceed a 15 million bushel production since 1902, in all but three years and as the United States, as a whole, has never, excepting 1924, produced over 30 million bushels which is approximately 10 million bushels short of the present average annual United States consumption, **it would**

appear to be safe for North Dakota farmers to plant an annual acreage somewhat exceeding that of 1924.

It should be particularly noted that, excepting 1924, the high production years fell between 1900 and 1910, when the heaviest, best quality virgin lands of the state were being turned and seeded to flax.

Goal Lines for North Dakota

With a favorable price outlook and a favorable situation with respect to foreign production, it looks like good judgment for North Dakota's agriculture to set the following goals:

1. Increase the yield per acre through
   a. Assigning cleanest lands to flax.
   b. Using high yielding, disease-resistant varieties.
   c. Earlier planting.
   d. Better preparations of seed beds.
   e. Using flax in best types of crop rotation.
2. Bring flax acreage up to 2,000,000 acres.

Choice of Land for Flax

Higher yield per acre is far more important to the North Dakota farmer than increased bushelage through additional acres. Use sound judgment in selecting the land for flax. Do not break up native grass lands of poorly drained sloughs, dry hills, or knolls underlaid by light sand, shale, or loose gravel. On either new or old lands, use areas which are underlaid by a firm clay or other moisture-holding subsoil. Give the flax crop advantage of the clean lands. Know the condition of the soil with respect to weeds. Many fields, apparently clean, may be quite foul with the ungerminated seeds of wild oats, mustard, French weed, Russian thistle, or pigeon grass.

Long pastured sod lands preferably where legumes have been grown and weed seeds have had a chance to rot are recommended. Clean corn lands or clean fallow lands are good. Always select areas which admit of proper surface drainage. Avoid conditions which cause caking, cracking, and crust formation. Avoid old lands, filled with weed seeds, unless steps have been taken to sprout such seeds and to destroy the young weeds.

Flax in Crop Rotations

Standardize the flax crop on your farm. Place it in permanent rotation systems with other standard crops. North Dakota farmers cannot afford to leave this crop out of their regular rotation schemes. **Use flax to improve your crop rotation and thus give flax a fair chance.**

A proper crop rotation demands crops of widely diverse nature in each series. The flax crop is valuable enough to be planted in sufficiently large areas to be alternated with the usual areas of other crops in the rotations.

In planning a particular rotation series, it is highly desirable to include crops which are not attacked by the same diseases. The flax crop, although afflicted by diseases of its own, is not attacked by the common diseases which affect corn, potatoes, small grains, or the clovers.

In trials conducted at Fargo, the four-year rotation: **corn, wheat, clover, flax** has given good results with both the cash crops, wheat and flax. The clover used was red clover; sweet clover would undoubtedly have been similarly effective. Two clover hay crops were harvested each year. If sweet clover is used in this rotation it would not be wise to grow seed.

The following order of cropping is also recommended, especially for heavy lands: (1) **small grains** (seeded with alfalfa, clover or grasses); (2) **hay** or pasture; (3) **corn,** potatoes, or summer fallow; (4) **flax.**

As a nurse crop for alfalfa, clover, or grasses, flax has no equal because it does not heavily shade the young forage plants and because its sturdy stubble affords winter protection. Advantage should be taken of these qualities of the flax crop. On light soils and in regions of lesser rainfall, a short rotation: (1) **corn,** potatoes, or summer fallow; (2) **flax** (seeded with alfalfa, clover, or grasses); (3) **hay,** or pasture, is recommended.

Seed Varieties and Seed Selection

Dakotans are no longer justified in gambling with the kind and quality of flaxseed. There are no lands that are free from wilt and other flax destroying fungi. The time has come to grow your own seed **each year.** If you have not now saved suitable seed from last year's crop, procure seed of a wilt- and rust-resistant variety, if possible. Do this early. Late spring is a bad time to buy flaxseed for sowing purposes. Do not sow weed seeds with the flax. **Clean and grade carefully.** If in doubt about the resistance of the seed which you expect to plant, send a sample to the Pure Seed Laboratory and ask for a wilt test. For this you should allow at least 30 days in order to have the report before planting.

Seed quality. Use only bright, plump seed. If in doubt as to germination, **test the seed or have it tested.** Avoid all scaly, lightweight, off-colored seed. It is sometimes safe to use frosted seed of a reliable variety, if the percentage of germination is known. Plant accordingly.

Varieties recommended for the general crop. There probably is not enough seed of the various resistant varieties available for planting all of the acreage in North Dakota. We recommend Bison and Buda. If these are not available, use any other available resistant variety as Linota, North Dakota Resistant 114 and North Dakota Resistant 52. In case of doubt as to the **identity** of any lot, send full records and a sample to the Pure Seed Laboratory. They should be able to help you decide on the merits.

Buda (North Dakota Resistant No. 119) is more wilt-resistant and more rust-resistant than Linota. It is later than Linota and, grows taller. Bison is highly resistant to both wilt and rust.

Preparation of Seed Beds

Seed beds which do not have to be plowed are firmer than seed beds which have been prepared by spring plowing. Lightly disked and levelled, clean corn land is the ideal flaxseed bed. Prepare for the next **flax crop by doing some extra work on your last corn field.**

In case of weedy lands of other type, as for example, wheat or other cereal stubble, spring plowing aids in the control of weeds. Such seed beds are apt to be undesirably loose, therefore pack carefully, both before and after seeding flax. Be sure to work the seed bed down sufficiently to make it possible to have the moisture come through the subsoil to within an inch of the top. Make the land so firm that the drill will press the seed down, evenly, only about one inch under a moist dirt mulch. **A firm, compact soil underlying shallow planted seed always gives best results.** Leave no loose soil. Remember that air spaces, especially under the furrow slices of sod lands, are very destructive. The flax roots should be able to go straight through into the subsoil.

Time To Sow Flax

If the seed bed is properly prepared to furnish an even moisture supply to the young flax roots, do not fear spring frosts. Wherever possible, **plant approximately as early as you would plant wheat or soon thereafter.** Watch the rainfall and soil moisture closely, and plant accordingly, usually just following a moderate rain. According to location, soil type, and weather conditions, the date of planting will probably fall between April 25 and May 25. Early seeding is beneficial because flax wilt is more destructive under high soil temperatures. Pigeon grass and many other weeds also develop rapidly under high temperatures; hence plant flax early before the soil temperature gets high enough to favor the rapid development of the flax crop's two most serious enemies, weeds and wilt.

If crusts form, fresh-work the soil before planting. Plant immediately. If after heavy rain, crusts are formed before the flax is up, break up the crusts with a fine-toothed harrow or other implements.

Rate of Seeding

In the eastern half of the state on heavy lands of reliable moisture content, sow approximately 28 pounds per acre of small seed varieties such as Buda, Linota or North Dakota Resistant No. 114. Sow 20 to 25 pounds per acre, under like conditions, in the western half of North Dakota.

In the case of the large seed varieties, such as Bison, use 35 to 45 pounds on heavy lands.

Regulate the Drill

See that your drill works uniformly. Regulate it so that approximately 4 seeds of flax fall per inch from each drill shoe. It has been found that, in many cases, if the drill is set to sow one-half bushel of a small seed variety, such as North Dakota Resistant No. 114, the drill may drop too few seeds of a variety with larger seeds. There should be growing in the field from 2 to 4 plants per inch of drill row. **If, on account of weeds or otherwise, you must sow late, plant from one-third to one-fourth more seed per acre.**

Seed plot. Aside from your regular crop, plant a seed plot. Use one of the best rust- and wilt-resistant varieties, preferably

Bison or Buda. This seed plot should be planted on well-worked, old, wilt-producing land, so if there chances to be any admixture of non-resistant flax in the seed, the soil of the seed plot may destroy the non-resistant plants.

Fig. 1. Seeds of Bison Variety are Approximately One-Third Larger Than Buda and North Dakota Resistant No. 114. One-Third More Seed per Acre of Bison or Other Large Seeded Variety Must Be Sown To Obtain Desired Stand of Plants

Harvesting, Threshing, Storing Seeds

Keep watch on the maturity of the crop. Do not let the crickets and grasshoppers take your profits. Cut, shock, stack, and thresh so as to save the seed in bright, plump quality. Avoid shelling. For sufficient length of straw, the binder is highly rec-

ommended because the bundles can be stood on cut ends and the seed bolls kept off the ground. Do not allow bunched flax to lie on the ground longer than necessary to dry. Thresh without stacking when possible. Stack, if thresher is not early available. In case of combined harvesting, **cut and thresh only when thoroughly mature and dry.** Consider the moisture content of the seed carefully before storing. When threshing, avoid cracking the seed.

In case of the seed plot, so harvest and store the seed that there can be no possibility of mixing in other varieties of flax. When raising flax for sale as seed for sowing purposes, confer with the Pure Seed Laboratory, its field inspectors, and the seed certification staff. **A competent seed grower in any portion of the state may gain remuneration for himself and become a public benefactor.**

FLAX, A PROFITABLE CASH CROP IN MINNESOTA

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During the two-year period. 1902-3, and each five-year period from then on, and for 1929 also, the gross income per acre from the flax crop averaged somewhat higher than the income per acre for spring wheat and considerably higher than that for oats. This is shown in Table 1 on page 3.

In Table 6 are given the net returns per acre for two cash crops, flax and spring wheat, and two crops grown both as cash and feed crops, oats and corn. The average cost of production per acre for flax, spring wheat, oats, and corn for the eight-year period 1922-28, was $17.02, $15.89, $15.22, and $15.23 per acre, respectively.

Table 6. Net Return per Acre in Minnesota from the Flax, Spring Wheat, Oat and Corn Crops Based on December 1 Average Yields and Prices as Given in Yearbooks of the United States Department of Agriculture and Average Costs of Production for the Period 1922-28 from the Division of Farm Management, University of Minnesota

Year	Flax	Spring wheat	Oats	Corn
1922	$5.77	$-1.26	$-2.88	$2.50
1923	4.05	-3.59	-2.57	4.74
1924	9.21	12.13	2.86	5.94
1925	5.49	1.50	-2.70	2.21
1926	1.49	-0.96	-5.53	1.03
1927	1.61	-3.93	-4.57	1.95
1928	-0.62	-1.24	-2.16	3.75
1929	8.81	-1.28	-1.71	5.42
Average	4.48	-0.17	-2.41	3.44

Only one year out of eight, 1928, did flax fail to show a fair net profit per acre. This was due to a decreased yield per acre brought about largely through damage by flax rust. A reoccurrence of a flax rust epidemic like that of 1928 can be avoided by the use of rust-resistant varieties. In contrast to this, spring wheat returned

a net profit per acre for only two, and oats only one year out of the eight.

During this period the average net return per acre for flax was $4.48 as compared with a loss of 17 cents for spring wheat and $2.41 for oats. Corn returned a net profit each year of the eight and an average for the period only slightly lower than that for flax.

Suggested Flax Program in Minnesota

The financial outlook for the flax crop in Minnesota over a period of years in the future appears considerably more promising than that for either spring wheat or oats. Under the circumstances farmers in the state can carry out to their financial advantage approximately the following flax program over a period of years.

Plant One Million Acres Each Year

The favorable position of the flax crop from year to year as compared with spring wheat and oats resulted in an increase in acreage from 310,000 in 1922 to 814,000 acres in 1926. This is the record acreage for the state and was reached without decrease in yield per acre. In 1927 and 1928 the acreage dropped off slightly and in 1929 there was a decided drop to 523,000 acres.

TABLE 7. FLAX ACREAGE IN THE MAIN FLAX-PRODUCING SECTION OF MINNESOTA, 1924-29, WITH REDUCTIONS IN 1929 LARGELY AS A RESULT OF THE DAMAGE TO THE CROP BY RUST IN 1928

Section of state	1924	1925	1926	1927	1928	1929	Reduction in acreage in 1929
	acres	acres	acres	acres	acres	acres	acres
West Central.....	250,400	244,800	266,500	248,600	216,600	125,900	90,700
South West.....	109,900	126,400	148,600	168,000	167,500	102,100	65,400
Northwest.....	156,200	158,900	174,700	152,200	130,800	130,500	300
South East.....	70,200	79,700	85,150	80,000	80,700	67,200	13,500
Central.....	84,210	83,800	86,530	60,300	72,100	51,300	20,800
South Central....	39,970	40,700	46,490	43,200	53,900	42,700	11,200
Other sections....	6,090	5,700	6,030	4,700	4,400	2,800	1,600
State total...	712,000	740,000	814,000	757,000	726,000	523,000	203,000

This marked reduction in acreage in 1929 took place mainly in west central, central, south western, south central and southeastern parts of the state and was due to the discouraging effects of the unsatisfactory yields per acre from the flax crop in 1928 brought about largely by damage by flax rust. These decreases are shown in Table 7. There was no decrease in acreage in the northwestern section where rust did little damage the year previous.

To reach an average of one million acres in the state means an increase of 477,000 acres above the exceptionally low flax area in 1929. However, the acreage in the state reached 814,000 in 1926 with no lowering of the average yield per acre. Reaching that acreage again should present few difficulties. Only 186,000 additional acres of suitable land are required to round out the million. The increase of 291,000 acres of flax required to bring the acreage up to where it was in 1926 and a good share of the additional 186,000 acres necessary to make the even million should come in the west central, central, south western, south central, and southeastern

sections of the state where the marked reductions were made in 1929. An increase of 25,000 to 30,000 acres can well be made in the northwestern section.

Growers starting the production of flax or increasing the present acreage, should give particular attention to the essentials of good flax cropping, in order that yields per acre may be maintained or increased. The higher the yield per acre without proportionate increases in the cost of production the greater the net profits per acre.

Grow Flax in Good Rotations

The flax crop does not ordinarily grow as tall as wheat or oats and it does not shade the ground as completely. Therefore, it is less able than wheat, oats, or other grains to compete successfully with weeds growing on the land at the same time. Also the seeds of flax are relatively small and the young seedlings somewhat less vigorous than those of the grains. Mainly for these reasons, flax does best on land that is fairly free from weed seeds and weeds and where it can be sown at the proper time on a firm, well-prepared seed bed.

In trials at University Farm over a period of years, flax has averaged 15.0 bushels per acre following corn: 14.1 bushels following legumes; 9.6 bushels following grasses; and 8.6 bushels following grains. These results indicate that the best place in a rotation for flax is following corn. Sugar beet land is satisfactory also. The next best place in the rotation for flax is following legumes. However, on Minnesota farms this place in the rotation is usually given over to corn and rightly so. Minnesota produces approximately four million acres of corn annually. It is on this land that the largest acreage of flax should be grown. When flax follows itself or grain crops, the lowest average yields per acre are obtained.

Flax an Excellent Companion Crop

Flax is one of the best crops with which to sow grasses, clovers and alfalfa and the best stands of these hay and pasture crops are usually obtained on disked or fall plowed corn fields. Sweet clover sown early with flax may make so rank a growth that it will bother at harvesting time. Delaying the seeding somewhat remedies this situation.

Arrange for Seed Early Each Year

The flax crops in past years have been marketed largely in the four-month period, September to December, inclusive. All too often so high a percentage of each crop is marketed during this short period that scarcely enough is retained at home from which to prepare the necessary good seed for use the following year. Now is the best time to consider the seed situation. If there is seed on hand, look it over to determine whether it can be brought into a first-class condition by use of the fanning mill. If not, make arrangements immediately for the necessary supply. The best seed is usually purchased first, leaving the poorest for those who secure their supply later. With a large increase in acreage in prospect

in 1930, it is very important to arrange for seed early. High class seed is free from admixtures of all kinds, high in germination, and of a high yielding variety.

Quantity of Seed Needed

Increased yields of one bushel per acre have been obtained in the central and southern parts of Minnesota in state-wide trials from seeding 42 pounds of flaxseed per acre over seeding at the one-half bushel rate. In the Red River Valley, however, one-half bushel of high-grade seed per acre has given as good results as a higher rate of seeding. Bison seed is approximately one-third larger than the seed of other varieties grown in Minnesota. Therefore, the amount of seed of this variety used should be proportionately greater. To sow a million acres of flax in the state will require nearly three-fourths of a million bushels of seed annually.

Seed of Disease-Resistant Varieties Worth a Premium

For a considerable number of years the greater proportion of the flax crop in Minnesota has been necessarily grown on old land with consequent greater damage from weeds and disease than when it was grown on new breaking. When flax is grown on land that has previously produced this crop, the only assurance growers can have that their crops will be comparatively free from serious flax diseases is to purchase from reliable sources seed of varieties that are known to be resistant to diseases. Practically the only way to be certain of securing seed of a disease-resistant variety is to purchase (1) registered or (2) certified seed. The Minnesota Crop Improvement Association and similar organizations in the other flax-producing states publish yearly or oftener certified seed lists giving the names and addresses of growers, with information regarding varieties grown and amounts for sale. These lists may be had each year by writing to the experiment stations for them.

The varieties of flax recommended for use in the state are Buda and Redwing. Bison has yielded well but has been tested for only a two-year period. Recommended varieties must be tested for at least three years. These varieties have proven to be the highest yielding varieties in the state. Each one is resistant to both the wilt and rust diseases. Only limited quantities of Redwing seed are available in 1930. Buda and Bison seed is available in quantity. Where seed of the two recommended varieties and Bison can not be obtained, it will be necessary to plant seed of Linota, Chippewa and North Dakota Resistant No. 114. Although these varieties have proven less desirable for use in the state than the other three, Linota is moderately resistant to rust and all three are resistant to wilt and therefore much to be preferred over flax without a known history or performance record.

The risks from damage by rust make it inadvisable to sow seed of Winona particularly in the southern two-thirds of the state. Seed imported from Argentina should not be sown in Minnesota. Crops from it have averaged three to four inches shorter than those of the recommended varieties and hence it is less able to compete with weeds. Only when conditions are exceptionally favorable

does the Argentine flax yield as high as the recommended varieties. Argentine flax is particularly subject to damage by the comparatively new disease, pasmo. This disease appears to be borne on the seed to some extent and apparently may be spread in that way. So-called "Bush" flax has been tested and found not adapted to conditions in the state. Much of the flax produced in Montana is grown on new land where wilt-resistant varieties are not necessary. Seed of these non-wilt-resistant varieties grown in Montana is not suitable for use in Minnesota.

Preparation of Seed Beds

The flax crop does best when sown on seed beds that are firm underneath and well pulverized to a depth of two to three inches and level at the surface. Fall plowed land, particularly meadows and pastures and cornfields that have been kept fairly free from weeds the previous year, provide the firm seed beds.

The amount of surface tillage necessary in spring to pulverize and level the surface depends on the kind and condition of the soil. Some fields need only harrowing while others require shallow disking or spring toothing followed by harrowing prior to seeding in order to put them in proper condition.

Early cultivation to cover such weed seeds as wild oats and lamb's quarters and start them to germinating is necessary where fields are known to have many such seeds present. Subsequent cultivation kills the seedlings.

Spring plowed land must either stand long enough to become firm underneath before the seeding is done or it must be packed. Using the disk set practically straight aids in doing away with the air spaces in spring plowed land.

Sowing Early Results in Highest Yields

Early sown flax makes enough growth to hold in check foxtail, barnyard grass, and redroot pigweed, the seeds of which do not usually germinate until during the first part of May. Wild oats, lamb's quarters, wild buckwheat and perennial weeds are not controlled by early seeding of flax.

Disease resistance in flax varieties is only relative. Flax sown early makes much of its growth when temperatures are unfavorable to the development of the diseases.

The number of bolls and seeds per boll is greater on early sown flax plants than on those from late seedlings. This results in higher yields from the earlier seedings.

Flax may be sown at the same time or immediately following grain crops with little or no danger from killing by frost. Flax plants in the seedling stages and later can stand temperatures as low as 25° F. or slightly lower without being injured.

Delay in seeding flax until after corn planting time usually results in difficulties with foxtail (pigeon grass) and redroot pigweed unless the fields are kept free from weeds by cultivation up to seeding time. Seedings made a week or ten days later than corn planting time usually average considerably lower in yield than those made in April or early May.

Care after Seeding

Occasionally after flax has been planted on well prepared seed bed, heavy rains occur and crusts form when the surface dries. Unless this crust is broken, many of the seedlings cannot come through. Harrowing lightly as the surface is becoming dry prevents this difficulty.

Flax Wheat Mixture Aids in Controlling Weeds

A combination of 42 pounds of flaxseed and 45 pounds of seed wheat per acre, mixed in the granary and sown at usual wheat seeding time has an advantage over flax alone particularly in the control of such weeds as lamb's quarters and wild buckwheat. The fact that this mixture must be sown early to give the wheat the best conditions for development provides the best conditions for the growth of the flax also. Statewide trials of mixtures of wheat and flax over a four year period, 1923 to 1926, showed an advantage of 6.1% in yield for the 42 pound flax and 45 pound wheat mixture over flax and wheat grown alone on the same fields.[1,2] In Goodhue County a large acreage of this mixed crop is grown each year.

There are two disadvantages in growing the combination crop. (1) The cost of separating the seed on the farm prior to marketing offsets to some extent the advantages. However, the difference in size of seed of the two crops makes separation easy. In Goodhue County a home-made machine of relatively large capacity is in use. Separation at the local elevator is the next best practice. Shipping the mixture in car lots to the terminals has not proved particularly satisfactory. (2) Mixed flax straw cannot be used by industries in the manufacture of various fiber products.

Combine Harvesting Threshing Flax

Flax is less subject to crinkling (breaking over of the stems) and shattering than the coarse grains. Therefore, flax may be left standing in the fields with little danger of loss in yield or quality until the seed is ripe enough to be stored safely in quantity. Flax seed that has reached a moisture content of 10 per cent or less can be stored safely.

Prolonged rainy weather or heavy rains followed by several days of damp weather, particularly after the flax seed has reached the combine stage, usually results in some decrease in yield and quality of the seed.

The seeds and small pieces of stems of green weeds left with the flaxseed on threshing with a combine raise the moisture content of the flaxseed. This presents the most serious obstacle to the successful use of the combine in harvesting and threshing flax. The fact that many of the weeds in flax continue to grow up to the time the flaxseed has reached a 10 per cent moisture content makes it practically necessary to cut the flax with a windrower. Handled in this way the weeds dry out rapidly and present no difficulties in the stored flax.

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[1]Wheat and Flax as Combination Crops. Minn. Agri. Exp. Sta. Bull. 206. University Farm St. Paul, Minn.

[2]Flax cropping in mixture with wheat, oats and barley. U. S. Technical Bull. 133. Washington, D. C.

FLAX AS A CROP FOR SOUTH DAKOTA

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The relative importance of flax as a crop in South Dakota is attested by the fact that South Dakota ranks third among the states in acreage and production of flaxseed; being exceeded only by North Dakota and Minnesota. The interest that growers have manifested in the crop is shown by the steady increase in acreage from 193,000 in 1922 to 637,000 acres in 1929. Evidently this increase is a result of finding it possible to produce flax at a profit not only on "new breaking," but in recent years, on cultivated lands. Here flax increasingly becomes a part of systematic cropping, along with other small grains, often following corn. One common crop sequence is (1) corn, (2) small grain or flax, (3) legume.

Inasmuch as domestic supply of flaxseed in the United States has annually fallen short of the amount consumed there has been a strong demand and increasing market price. It seems safe to state that the world supply of flaxseed is limited at the present time so that there is no great likelihood of overdoing the flax acreage in South Dakota.

Points of Importance in Flax Production

There are several points to remember in raising flax. Of most importance are the following: (1) Condition of seedbed; (2) rate of seeding; (3) date of seeding; (4) wilt resistant and (5) high yielding variety.

Preparation of seed bed. Flax may be classified as a small grain and like them, it responds to a well-prepared but firm seed bed. It is generally agreed that new land may be prepared by turning over the sod just deep enough to be rolled flat with a heavy roller, and then seeded. If flax is put on land following a cultivated crop, such as corn, it may be seeded like small grain without plowing, either after disking or double disking, or directly on corn ground that has had weeds eradicated by cultivation. The seed bed should be loose enough on top to permit the drill to cover the seed evenly about one inch but should be fairly compact below.

Flax in rotations a good nurse crop. Part of the increased flax area in South Dakota has been attributed to the use of flax in systematic crop rotations. This use, in turn, is due not only to the production of successful crops of flax, following corn, for example, in the place often occupied by small grain, but likewise, flax has been found to serve reasonably well as a nurse crop for such legumes as alfalfa or sweet clover. These legumes have commonly been seeded with wheat, oats, barley and, in recent years in various places also with flax. It is important that a systematic rotation afford the possibility for including a legume crop which helps maintain the nitrogen and humus content of soils. The evi-

dent fitness of flax to serve as a nurse crop goes far toward placing it as a standard crop for South Dakota farms.

Date of seeding. Experiments with seeding flax at different dates have been carried far enough to indicate that the highest yields come from seeding at an optimum date, which usually falls in April. The desirability of seeding at this time is increasingly understood by growers although it is not always easy to follow. Seeding after the optimum date apparently reduces the average yield by as much as two bushels per acre for each week of delay in parts of South Dakota where trials have been made and where flax is an important crop.

The foregoing statement is made even though it is recognized that freezing weather may occur, though not frequently, and because flax seeded early may be damaged some by freezing of young plants. Nevertheless, the gain from seasonable seeding is sufficient to more than compensate for any losses of this kind.

Table 8 gives average yields from date of seeding trials carried out in most instances for a period of 17 years at Highmore, Eureka, and Cottonwood.

TABLE 8. YIELDS FROM SEEDING FLAX AT SUCCESSIVE DATES

Date	Highmore	Eureka	Cottonwood
March 1	0.0	...	...
March 15	1.4	...	...
April 1	6.6	...	...
April 15	8.1	9.2	5.8
May 1	7.4	8.8	6.0
May 15	7.1	7.4	4.8
June 1	2.7	5.4	5.8
June 15	0.7	3.2	5.0

The average yields, although not absolutely consistent, indicate that it is important to sow flax by April 15 at Cottonwood, Highmore and Eureka as in other parts of the state.

No phase of field management in flax-growing is quite so important from the standpoint of increasing production without additional cost as seeding at the optimum date. Seeding flax on such a date can be approached by having a supply of seed ready and preparing the seed bed early so as to proceed promptly.

Rate of seeding. It is important to put on a sufficient amount of seed per acre to secure a maximum yield and it is also important, especially in a year when the amount of seed available is none too large, not to sow more seed than necessary. Experiments at Highmore for a period of 13 years, 1917 to 1929, using 8 different amounts of seed per acre, from 10 quarts to 20 quarts, give average yields per acre for thickness of seeding flax as follows: 10 quarts, 5.1 bushels; 12 quarts, 5.4 bushels; 15 quarts, 5.6 bushels; 17 quarts, 5.8 bushels; 20 quarts, 6.3 bushels. Up to, and including 1924, the maximum rate of seeding in this experiment was 20 quarts per acre. The experiment shows that under the conditions indicated on cultivated land the maximum yield was produced with seeding as much as 20 quarts per acre.

Beginning with 1925 and including the season just closed, the rate of seeding in this experiment at Highmore was increased to 27 quarts, to discover whether more than 20 quarts of seed per acre would produce a still greater yield. The average yields indicate that more than 20 quarts per acre on cultivated land will secure a somewhat higher yield. Average yields for the 5-year period just closed are as follows: 20 quarts, 4.8 bushels; 22 quarts, 4.9 bushels; 25 quarts, 5.2 bushels; 27 quarts, 4.6 bushels.

The series of yields, although taken for a brief period, indicate that it is desirable to sow from 20 to 25 quarts per acre on cultivated land if flax is seeded alone to secure maximum yields. Thicker seedings are required on land where weeds are prevalent. The conclusion is that a clean seed bed is desirable not only in other respects, but also for economy of seed.

Rate of seeding tests carried out on new breaking are unfortunately not available. However, good flax crops have been produced on new breaking in South Dakota with seeding as little as 8 quarts per acre and good crops have been obtained on old land with as low as 15 quarts per acre. New breaking is generally free from weeds which may result in the lighter rates of seeding than usual giving satisfactory yields.

Varieties of flax. It is generally understood that much of the success in growing flax, especially on cropped land as a part of systematic rotations, is a result of introducing disease-resistant varieties, especially North Dakota Resistant No. 114 (South Dakota No. 688) and later Primost, South Dakota No. 25. Some seed of these and possibly other wilt-resistant strains are available at present in South Dakota and should be utilized to the fullest advantage. Yield tests carried out at Eureka, Highmore, and Brookings in 1929 indicate the average yields for varieties tested co-operatively with the United States Department of Agriculture, Office of Cereal Investigations (Table 9).

TABLE 9. AVERAGE YIELD PER ACRE FOR 1929 OF FLAX VARIETIES AT EUREKA, HIGHMORE, AND BROOKINGS

Variety	Yield per acre	Variety	Yield per acre	Variety	Yield per acre
	bu.		bu.		bu.
Linota	7.6	Redwing	6.9	Commercial	....
Buda	7.5	Rio	6.6	Argentine	5.7
Bison	7.4	N.D.R. 114	6.4	Damont	3.6

The newer wilt-resistant varieties all produced notably better yields than varieties susceptible to wilt and especially more than the commercial seed from Argentine that evidently has not had the advantage of selection.

Flax and Wheat as a Mixed Crop

Flax and wheat have been produced at Brookings, experimentally, clear and in mixture, for 7 successive years. The rates of seeding in this experiment for clear flax was 2 pecks (28 pounds) per acre; clear wheat, 5 pecks per acre; in mixture, flax 1 peck (14 pounds), and wheat 2½ pecks. The varieties, Marquis wheat and North Dakota Resistant No. 114 flax, have been utilized.

In the foregoing experiment clear flax produced an average of 12.1 bushels per acre for 7 years, valued at $26.65; clear wheat, 12.9 bushels per acre, valued at $14.31; whereas the yield of flax produced in mixture was 4.2 bushels per acre, valued at $9.31; and of wheat in mixture, 10.9 bushels, at $12, making a total of $21.31. Obviously in this experiment the total value of clear flax per acre was greater than that of wheat and flax produced in the mixture. Some analysis of yields produced, in value of crop from seeding flax and wheat clear and in mixture, not only at Brookings but on several farms where observations have been possible, indicate that in instances where there is some apparent advantage from seeding wheat with flax the advantage is owing to the control of weeds brought about by the wheat. Weeds, such as foxtail or pigeon grass, barnyard grass, redroot (pigweed), lamb's quarters, and bindweed are less vigorous in the mixed crop than in flax alone. Wild oats, Frenchweed, and other weeds, on the other hand, are not checked by the mixed crop.

The apparent advantage in mixed seeding, owing to possible weed control, is partially offset by the necessity for separating in the resulting crop.

Experiments have been carried out with seeding flax in mixture with barley and also with oats. Results indicate wherever there is any advantage from seeding flax in mixtures it will be from seeding with wheat, rather than with barley or oats. At Brookings, when flax was seeded with barley the total production of flax in the mixture was an average of 0.7 bushels per acre for 3 years. This low production makes it fairly evident that barley overshadows flax to such an extent when they are seeded in mixture that it is unprofitable. The average yield of barley seeded clear at Brookings for 3 years was 51.5. The average yield of barley seeded in mixture was 50 bushels per acre. This indicates that the small yield of flax in the mixture was unprofitable.

Results from seeding flax with oats at Brookings indicate that oats will overshadow flax which makes that kind of mixture unprofitable. The average yield of clear oats for 3 years at Brookings has been 37.3, whereas the average yield in mixture has been 32.1 The yield of flax produced from seeding in mixture with oats was 1.7 bushels per acre. These and other considerations show that if it is desirable to seed flax in a grain mixture, it should be made with wheat rather than oats or barley.

The Combine Suitable to Harvesting Flax

Observations and some experimental work with using the combine in harvesting flax in South Dakota indicate this new machinery may be as suitable for harvesting flax as it is for small grains, in general.

Moisture determinations on flax harvested with (1) combine and (2) binder, and reported by K. H. Klages in South Dakota Bulletin No. 244 indicate that the mean moisture content of flaxseed harvested by the two methods is almost the same. Harvesting flax when damp should always be guarded against, and the same precautions should be taken for harvesting with a combine and storing as for other grain.

FLAX AS A CASH CROP IN MONTANA

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Importance of Flax in Montana

During the past few years over 90 per cent of the United States crop of flaxseed has been produced in North Dakota, Minnesota, South Dakota, and Montana, ranking in production in the order named. Montana produces approximately 5 per cent of the annual flax crop of the United States. Table 10 shows the figures on flax in Montana for the 15-year period, 1915 to 1929, inclusive, arranged in 5-year periods to show the changes that have taken place. It should be remembered that during the 5-year period, 1915 to 1919, flax prices were affected by two factors, war-time conditions and low yields owing to an unprecedented drought.

TABLE 10. FIFTEEN YEARS OF FLAX PRODUCTION IN MONTANA*

Year	Acres	Bu. per acre	Total bu.	Price Dec. 1	Acre value
1915	250,000	10.5	2,625,000	$1.70	$17.85
1916	325,000	9.5	3,088,000	2.48	23.56
1917	583,000	3.0	1,749,000	2.95	8.85
1918	547,000	3.0	1,641,000	3.38	10.14
1919	370,000	1.3	481,000	4.40	5.72
Average	415,000	5.5	1,916,000	$2.98	$13.22
1920	407,000	2.6	1,058,000	$1.75	$4.55
1921	110,000	5.0	550,000	1.40	7.00
1922	84,000	7.2	605,000	1.97	14.18
1923	110,000	8.2	902,000	1.93	15.83
1924	246,000	8.7	2,140,000	2.21	19.22
Average	191,400	6.3	1,051,000	$1.85	$12.16
1925	244,000	4.5	1,098,000	$2.20	$9.90
1926	171,000	4.7	804,000	1.85	8.69
1927	170,000	10.2	1,734,000	1.75	17.85
1928	183,000	8.5	1,556,000	1.92	16.32
1929	293,000	3.2	938,000	2.80	8.96
Average	212,200	6.2	1,226,000	$2.10	$12.34

*Data from the Montana Co-operative Crop Reporting Service, Helena, Montana.

Flax and Wheat as Cash Crops

Flax is strictly a cash crop and in Montana its chief competitor is spring wheat. In those areas where both flax and wheat are adapted, farmers are confronted with the problem of determining which crop will give the greater net returns.

Table 11 shows the December 1 farm price of flax and spring wheat in Montana during the last eight years, together with the spread in price between the two crops.

TABLE 11 DECEMBER 1 FARM PRICE OF FLAX AND SPRING WHEAT IN MONTANA

Year	1922	1923	1924	1925	1926	1927	1928	1929
Flax	$1.97	$1.93	$2.21	$2.20	$1.85	$1.75	$1.92	$2.80
Spring Wheat	.89	.82	1.24	1.40	1.13	.97	.84	.96
Spread in price	$1.08	$1.11	$0.97	$0.80	$0.72	$0.78	$1.08	$1.84

Table 12 gives the gross value per acre of flax and spring wheat in the six leading flax counties. While wheat appears to have the

advantage over flax during the last five years, it is well to remember that, in general, wheat receives more care in the preparation of the seed bed and time of seeding than does most flax planted in Montana.

Considering the shortage in the supply of flaxseed produced in the United States and the present tariff, farmers may reasonably expect prices which will give satisfactory cash returns, particularly from those fields which produce good average yields.

TABLE 12. GROSS VALUE PER ACRE OF FLAX AND SPRING WHEAT IN THE LEADING FLAX COUNTIES OF MONTANA

Year	County				
	Sheridan	Daniels	Valley	McCone	Richland	Dawson
			Flax			
1924	$24.31	$22.10	$17.68	$17.68	$22.10	$17.68
1925	8.80	11.00	12.10	8.80	8.80	9.90
1926	10.73	10.73	11.10	5.00	5.74	5.92
1927	18.38	16.10	15.93	17.15	18.38	21.00
1928	19.20	16.32	14.40	14.98	16.32	17.28
Average	$16.28	$15.25	$14.24	$12.72	$14.27	$14.36
			Spring Wheat			
1924	$23.56	$23.56	$22.32	$22.32	$26.64	$18.60
1925	12.60	15.40	15.40	11.20	14.00	11.20
1926	14.69	16.95	14.69	4.52	6.78	6.78
1927	18.43	17.46	19.40	17.46	20.37	16.49
1928	15.96	15.12	15.96	14.28	15.12	12.60
Average	$17.03	$17.70	$17.55	$13.96	$16.58	$13.13

Those interested in flaxseed will do well to study carefully the "Agricultural Outlook" and "Intentions to Plant" report issued early each year jointly by the United States Department of Agriculture and Montana State College.

Quality of Montana-Grown Flaxseed

Linseed mills crush practically the entire flaxseed crop of the United States in producing linseed oil, used so extensively in paint, varnish, linoleum, oilcloth, and other products.

Analyses of flaxseed show from 30 to 40 per cent oil. In the process of extracting the oil, 1 bushel of flaxseed (56 pounds) produces approximately 18¾ pounds or 2½ gallons of oil and 37¼ pounds of linseed cake. The yield and the quality of the oil vary according to the origin of the seed, its percentage of water, and the amount of immature, musty, and otherwise damaged seed. Fortunately flaxseed from the northern Great Plains, including Montana, contains a higher percentage of oil than that marketed from other sections of the United States.

Buyers prefer flaxseed which is clean, uniform as to variety, free from immaturity, mustiness, and excessive moisture or other forms of damage. Oil produced from immature seed is greenish brown, while that from ripe seed has a yellowish brown color. Ripe seed produces a greater amount of oil as well as a finer quality.

Information from the terminal markets shows that Montana flaxseed contains less dockage than that grown on the older lands of the other flax states. However, the weed problem is rapidly becoming serious and Montana farmers must give more attention

to clean seed and clean seed beds if they expect to produce clean flax.

Place of Flax in the Cropping System

Flax is likely to produce disappointing returns when raised according to "hit and miss" methods. Farmers who give flax a definite place in the cropping system and use the best of cultural methods generally obtain yields which return a satisfactory profit.

Flax on breaking. The day of flax on breaking in Montana is largely past, and in the future much of our flax must be grown on previously cropped ground. Present economic conditions are such that it does not appear wise to increase materially the total area under cultivation. Therefore, it is believed that in the future flax should be planted on new ground only to the extent needed to care for a normal growth or expansion in the farming business. Flax is one of the best cash crops for breaking and when properly handled usually produces good returns.

Rotations essential on old lands. New land soon becomes infested with weeds; particularly is this true where continuous cropping to small grains such as wheat has been the general practice. Flax is not as vigorous a crop as wheat or oats and will not compete with weeds as well. This inability to compete with weeds and the increasing seriousness of the weed problem on old land suggest the necessity of working out a definite rotation of crops if flax is to be produced on a profitable basis. The best crops of flax on old land in Montana are raised on clean summer fallow or on clean burned stubble.

Flax on burned stubble. Where the three-year rotation is practiced, that is, two crops after one summer fallowing, it has been found that flax compares very well with wheat as a second crop. The crop does not have the advantage of reserve moisture such as it would have on summer fallow, but inasmuch as it requires a firm seed bed and freedom from weeds, it is possible that these two conditions compensate for the lack of moisture. When flax is grown as a second year crop, the previous year's combined stubble is removed by burning. This burning process also destroys the weed seeds on the surface. Very light cultivation is given to the seed bed early in the spring to start the weeds and then just before seeding another cultivation is given. Only the very surface of the ground is worked, thus leaving a firm seed bed. **A clean burn is necessary.**

Flax under irrigation. Very little flax is produced under irrigation in Montana, but those who have grown the crop on clean, irrigated land generally obtained satisfactory results. It is important that the soil be uniform and the field one on which the irrigation water can be applied evenly. If otherwise, the flax often matures unevenly and a poorer quality of seed is produced.

Experimental evidence now available indicates that the flax acreage on the irrigated lands of the state may be increased to advantage. Flax yields well, fits into the rotation readily, and is a good nurse crop for alfalfa and grasses.

Preparing the Seed Bed for Flax

Flax growers of Montana should strive for higher acre yields in an effort to overcome partially the handicap of long hauls and high freight rates. Montana's flax yields per acre are low but can be raised easily since the crop responds readily to good cultural methods. The use of approved methods and efficiency in all operations should be emphasized, as increased yields without a proportionate increase in the cost of production results in greater net profits per acre.

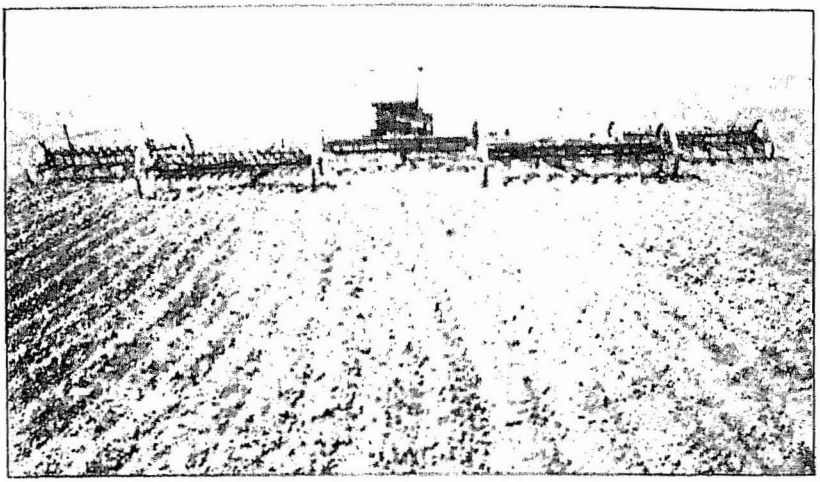

Fig. 2. Preparing a Seed Bed for Flax in Montana. Photograph Courtesy of the Great Northern Railway

Preparing old lands. So far as possible flax should be sown only on clean land. Even if the summer fallow was kept clean during the previous season, the land is likely to be well seeded to Russian thistles and mustard by winds during the winter and early spring months. It is unsafe to seed flax until the weed seeds have sprouted and the young weeds have been killed by cultivation. Early spring cultivation and slightly delayed seeding of flax are becoming more and more common in the summer fallowing sections of Montana. Early in the spring the land should be cultivated with some type of tillage implement which will mix the weed seeds with the soil and hasten their germination. As soon as a crop of seeds shows above ground, cultivate again with a shallow cultivator, such as duck-foot weeder or one of the various blade or rod weeders. After the land has been thoroughly cleaned, sow the flax immediately.

Breaking for flax. Flax does well on breaking and most Montana farmers are familiar with the essentials of raising a good flax crop on newly broken land. For best results (1) break sod early, about 4 inches deep; (2) pack the furrow slices firmly so there will be no air spaces between the sod and the bottom of the furrow; and (3) work the top soil sufficiently to fill in the cracks and form a mulch so as to retain the maximum amount of moisture in the soil.

Varieties of Flax Adapted to Montana

The production of flaxseed of high quality requires the use of pure seed of adapted varieties on clean land. Since wilt is not yet a serious problem in Montana, varieties may be selected largely on the basis of yielding ability. Among the varieties tested thus far, Reserve (C. I. No. 19), North Dakota Resistant No. 52, North Dakota Resistant No. 114, and Bison are the most promising.

In cases where good seed must be purchased, obtain it, if possible, from someone in the same locality who is known to have pure seed of a high-yielding variety, free from weeds and disease. The nearest county extension agent or the Agronomy Department of the Montana Experiment Station at Bozeman will be glad to assist in locating dependable seed supplies.

Preparing Seed Flax for Planting

One of the important factors in successful flax growing is the use of clean, plump, healthy, viable seed. Flaxseed obtained from any source should be thoroughly cleaned with a fanning mill before sowing. Some of the injurious diseases live over in the chaff and immature seed and develop in the soil if such seed is sown; hence cleaning machines which separate the light from the heavy seed by gravity are desirable. If further insurance against the introduction of wilt is desired, disinfect the seed with a formaldehyde solution composed of 1 pound of commercial formaldehyde of standard strength (37.9 per cent) to 40 gallons of water. Spread the seed on a floor or tarpaulin or put in a tight wagon box and apply the solution in a fine spray, stirring the seed constantly while it is being sprayed. Use just enough of the solution to moisten the seed but not enough to cause any portion of it to cake. The mucilaginous seed coat swells rapidly and becomes sticky when too much solution is applied. After treatment seed may be left in a pile and covered with treated blankets or sacks for a few hours or it may be sown immediately.

Early Seeding of Flax Important

Early seeding of flax on clean land returns the most profitable yields. Applied to ordinary farm practice this means that **flax should be planted immediately after small grains are seeded** instead of a month later as is often done. Farmers who plant to harvest flax with a combine absolutely must plant it early enough to insure full maturity of the crop. Green flax cannot possibly be harvested with a combine.

Early seeded flax can take advantage of spring rains and make a steady growth during the cool weather. This advantage enables the crop to compete more successfully with weeds and there is less danger of injury from hot weather and diseases.

Contrary to general belief, flax plants are not readily injured by spring frosts, particularly after they have passed the two-leaf stage. Ordinarily, there is nothing to gain by planting too early. If the land is weedy, it is best to delay the seeding of flax sufficiently to permit thorough cultivation and the killing of weeds, after which the seeding should follow immediately. Some farmers

report that where the land is so weedy that the planting must be delayed until late in the spring in order to kill the weeds, it is very risky to put in any flax.

If moisture is present, shallow planting (1 to 1½ inches) is preferred and press wheel attachments aid materially in securing a rapid and uniform germination. If the soil is light or is inclined to be dry, deeper seeding may be necessary in order to put the seed in contact with moist soil.

Rate of Seeding Flax

On the average non-irrigated farm in the principal flax counties, flax should be sown at the rate of 15 to 20 pounds per acre. On old or weedy land slightly heavier rates of seeding may be desirable. On irrigated land flax is usually seeded at the rate of 35 to 45 pounds per acre. If large seeded varieties such as Bison are used the rate of seeding should be increased by at least one-third. In all cases only clean seed of high germination should be used.

Flax as a Means of Increasing the Use of Equipment

A western farmer invests a greater amount in equipment per worker than does any other farmer. For that reason it is necessary that he be able to use his equipment over as many acres as possible to reduce the overhead cost. For instance, a farmer buys a three-plow tractor with the necessary set of machinery. The total cost of the equipment will be approximately $4,000. As the acreage increases the overhead decreases.

Total investment per acre based on $4,000 for a minimum full line of equipment: When 200 acres are farmed, $20; for 400 acres, $10; for 600 acres, $6.66; for 800 acres, $5; and when 1000 acres are farmed, $4.

The number of acres which can be tilled economically are determined by the length of time which may be allowed for each operation. The seeding period for wheat is comparatively short and any extension of time in this operation means a loss of returns per acre. The optimum time for seeding flax comes after that of wheat, so that by the use of flax in a farm plan the same equipment can cover a greater acreage within the optimum time.

Harvesting Flax

Flax is considered a rather difficult crop to harvest and on many farms this is true. However, when the crop has been planted on a properly prepared seed bed, one should be able to harvest the entire crop without serious loss.

Harvesting with combine. The combine harvester handles the flax crop very satisfactorily, either by cutting direct or using the windrow method. Under ordinary conditions direct combining is the most satisfactory and the most economical method of harvesting. The cost of harvesting the crop with this method is approximately $2.15 an acre. For best results flax that is to be combined should be of a fairly tall variety.

Windrowing. Under certain conditions it is necessary to windrow flax. Where weeds are bad, green seeds and thistle tips will

pass through the sieves and make the moisture content of the flax high when direct combining is practiced. By windrowing the weeds are dried out and blow over the sieves when threshed. The pick-up in rare cases has some difficulty in picking up the windrow that has settled down into a heavy Russian thistle stand. These instances are few. Some seasons the flax stems refuse to dry after the crop has matured. In such cases the windrow system also eliminates this difficulty. An operator having considerable flax acreage should have some means of windrowing the crop when necessary. The additional cost when the windrow method is used is about 50 cents an acre.

Header for harvesting. When the header is to be used, the flax should be dead ripe and thoroughly dry. Also, the header stacks should not be made too wide because of the danger of heating. Stacks need not be tramped, hence stacking may be done by the pitchers. Tight header barges are needed to save all shattered seed.

Binding flax. Flax which is uniform in height and tall enough may be harvested with an ordinary self-binder, the bundles being placed in long shocks until dry. However, flax is not an easy crop to harvest in this way because of difficulties in elevating, separating the bundles, and shocking. Furthermore, the packers cause more or less loss of flaxseed from shattering.

Harvesting with flax attachment or "buncher." Occasionally, flax is cut with a binder on which the binding attachment has been replaced with a flax attachment or "buncher" which drops the flax bunches in windrows.

If the flax is not fully ripe, some difficulty may be experienced in cutting. It is important to keep the sickles sharp and clean. Strips of linoleum are sometimes fastened to the slats of the reel and occasionally additional slats are put in. Canvas is sometimes sewed over the slats to prevent flax from being carried under the platform.

Threshing Flax

In order to do a good job of threshing, flax must be thoroughly dry and well cured. No attempt should be made to thresh damp or tough flax, because it is impossible to make a complete separation; furthermore, damp flaxseed cannot be stored safely. It is not advisable to insist on thoroughly clean flax as it comes from the threshing machine. In order to clean thoroughly, some machines will blow over much good seed with the tailings. This, together with what goes over with the straw unthreshed, may reduce the yield materially.

Storing Threshed Flax

Flaxseed which is thoroughly dry and clean may be stored safely. Flax which is damp when threshed must be watched carefully, because there is considerable danger of heating.

Causes of Flax Failures

The most important causes of flax failures are as follows:

Late seeding. Late seeding of flax is one of the principal causes for failure. Late-seeded flax cannot compete successfully with weeds, and the danger from drought is greatly increased.

Weeds. Weeds constitute one of the greatest enemies of flax and together with late seeding are responsible for most poor yields. Two weeds that interfere seriously with the growth of flax in Montana are the Russian thistle and "Jim Hill" or tumbling mustard. Common or field mustard is another weed pest which flax growers must guard against. It is almost impossible to separate the seed of common mustard from flaxseed with the ordinary cleaning machines. Although it is an annual plant, the seeding habits of this weed are such that eradication is difficult after it once gets a start. When the land was first broken there were but few weeds in the country, but now that a large portion of the land is under cultivation the weed problem has become serious. Consequently the methods of flax growing must be changed somewhat. It is unsafe to seed flax until a good share of the weed seeds have been sprouted and then killed by cultivation. Early spring cultivation and slightly delayed seeding are becoming more and more common in the summer-fallowing practice in northern Montana and southern Alberta and Saskatchewan.

Drought. Flax has about the same resistance to drought as has spring wheat. Many farmers think there is a "critical period" with flax when the weather and moisture must be just about right. However, there is no reason for believing that flax will not give as large cash returns on the dry lands of the state as spring wheat is doing if given an equal chance.

Poor seed beds. Flax requires a firm and well-prepared seed bed. Invariably, poor yields result from "stubbling-in" or careless farming methods. Loose, newly plowed land is not recommended.

Grasshoppers. Because flax stays green longer and is harvested later than wheat the crop has suffered heavily during the years when grasshoppers were a serious pest. The flax, being green and juicy with the partially formed bolls, attracts grasshoppers from the wheat in late July and August because at that time the wheat, oats, and grasses usually are brown and dried. (See Montana Experiment Station Circular 112 for the latest information on controlling grasshoppers.)

Flax-Wheat Mixtures

Results of tests over a period of years show the following:

Not desirable on non-irrigated lands. Much of the flax produced in Montana is planted on non-irrigated land where moisture is the limiting factor in crop production. Experiments in this state strongly indicate that there is no advantage in sowing a mixture of flax and spring wheat on non-irrigated land as is the practice in such states as Minnesota where the seasonal rainfall is greater.

Promising under irrigation. Flax-wheat mixtures under irrigation at Bozeman have given rather satisfactory results during the past six years. The early planting of mixtures composed of 14 pounds of flax and 30 pounds of wheat or 14 pounds of flax and 45 pounds of wheat per acre have given the best results thus far yielding gross returns fully 20 per cent greater than either flax or wheat sown alone.

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