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Flax Culture in South Dakota

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R.K. Bennett

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BULLETIN NO. 169

NOVEMBER, 1916

AGRICULTURAL EXPERIMENT STATION

In Co-operation with United States Department of Agriculture
Bureau of Plant Industry

SOUTH DAKOTA
STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS
AGRONOMY DEPARTMENT

Flax Culture in South Dakota

BROOKINGS, SOUTH DAKOTA

Bowen Publishing Co., Huron, S. D.

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EXPERIMENT FARMS.

Brookings.....Brookings County
CottonwoodJackson County
Eureka.....McPherson County
HighmoreHyde County
Vivian.....Lyman County

SUMMARY.

1. South Dakota ranks fourth among the states in flax production.

2. The total production for this state is rapidly decreasing and the industry will soon be lost if measures are not taken to prevent it.

3. Careful attention to the essentials, such as variety, rotations, soil preparation, selection and treatment of seed, time, rate and depth of seeding, weed prevention and disease prevention will make it possible to produce flax permanently and profitably.

4. Flax commonly grown in South Dakota is all of the small seeded, blue flowered European type. Several pedigreed varieties have been selected by the North Dakota and Minnesota experiment stations. Of these, North Dakota Resistant No. 52 (S. D. 29) has yielded best at Highmore and Select Russian N. D. 1215 (S. D. 686) has yielded highest at Newell.

5. Clean plump seed is necessary. This can be had by setting off a portion of the field for seed purposes and removing any weeds by hand and by thorough cleaning of seed.

6. Common diseases of flax are wilt, rust and canker. Rust can be avoided by early seeding. Wilt and canker can be combated by treating seed and sowing on new land or land where flax has not been grown for several years.

7. Long rotations are desirable. The flax crop should follow pasture, meadow or clean cultivated crop.

8. Flax requires a firm seed bed. This helps insure even germination and even maturity.

9. Flax should be sown as early as convenient.

April seeding has given best average yields at Cottonwood, Eureka and Highmore.

10. Two pecks per acre or a little less is probably the best rate of seeding. Experiments have not been conducted long enough to settle this point definitely.

11. Shallow seeding, about one inch deep, is best as deeper seeding may not come up.

12. Flax is a good crop for irrigated lands, but care should be taken not to over-irrigate or irrigate too late.

13. Flax can be harvested with a header if thoroughly ripe and dry, but a binder is usually preferable so that the bundles can be set up in small shocks to dry thoroughly before threshing.

14. Flax must be dry when threshed as damp flax will not thresh cleanly and the seed is liable to heat damage in the bin.

15. Flaxseed is used mainly for the manufacture of linseed oil and oil cake. The straw is a valuable by-product which can be used for making tow, paper and paper products.

FLAX CULTURE IN SOUTH DAKOTA

BY

A. N. HUME, MANLEY CHAMPLIN AND JOHN MARTIN.

History and Importance. ¹

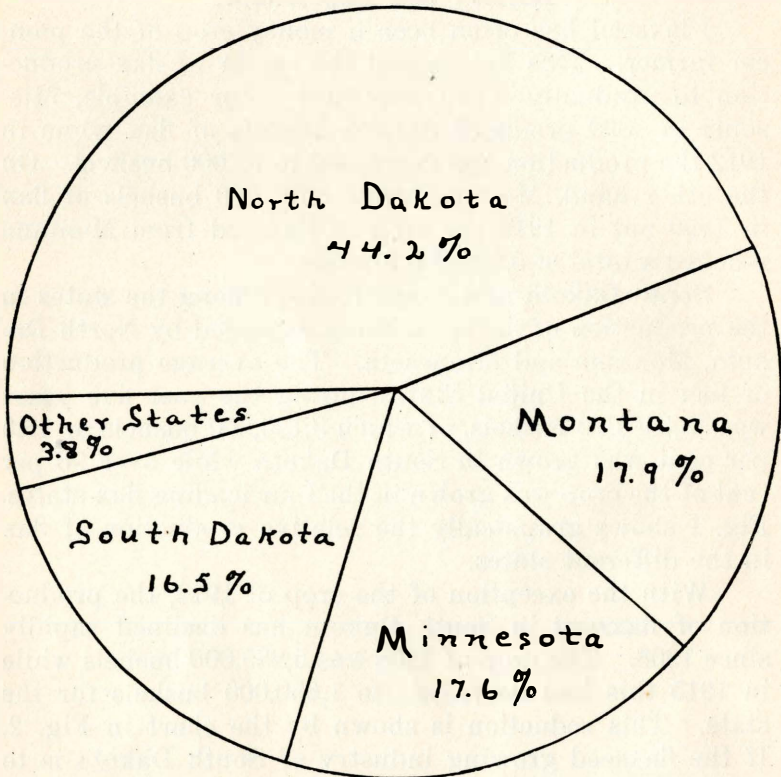
Flaxseed has often been a money crop of the pioneer farmer. This has caused the center of flax production to gradually move westward. For example, Missouri in 1899 produced 611,888 bushels of flax while in 1912 the production has decreased to 72,000 bushels. On the other hand, Montana grew only 220 bushels of flax in 1899 but in 1912 the crop of flaxseed from Montana reached a total of 5,520,000 bushels.

South Dakota now ranks fourth among the states in the production of flaxseed, being exceeded by North Dakota, Montana and Minnesota. The average production of flax in the United States during the past five years was 18,940,000 bushels, of which 3,130,000 bushels or 16.5 per cent was grown in South Dakota while over 96 per cent of the crop was grown in the four leading flax states. Fig. 1 shows graphically the relative production of flax in the different states.

With the exception of the crop of 1912, the production of flaxseed in South Dakota has declined rapidly since 1908. The crop of 1908 was 5,885,000 bushels while in 1915 this had decreased to 1,650,000 bushels for the state. This reduction is shown by the chart in Fig. 2. If the flaxseed growing industry of South Dakota is to be saved it will be necessary to utilize existing knowledge of flax culture and to continue investigations with a view to making our present information more definite. It is the purpose of this bulletin to present the existing information on flax culture in concise form for the use of the South Dakota flax grower.

¹ The experiments reported were conducted on the Cottonwood, Eureka and Highmore substations, of the South Dakota Experiment Station and on the Belle Fourche Experiment Farm of the Office of Western Irrigation Agriculture, U. S. Department of Agriculture at Newell under cooperative agreement between the Agronomy Department of the South Dakota Experiment Station and the Office of Cereal Investigations of the U. S. Department of Agriculture.

Fig. 1. Production of flaxseed in the United States, average of five years, 1911 to 1915 inclusive, 18,940,000 bushels.



There are certain things that must be given attention in the improvement of the flax crop. These include: the variety, the rotation, the method of soil preparation, the selection and treatment of seed, the time, rate and depth of seeding, and the prevention of disease.

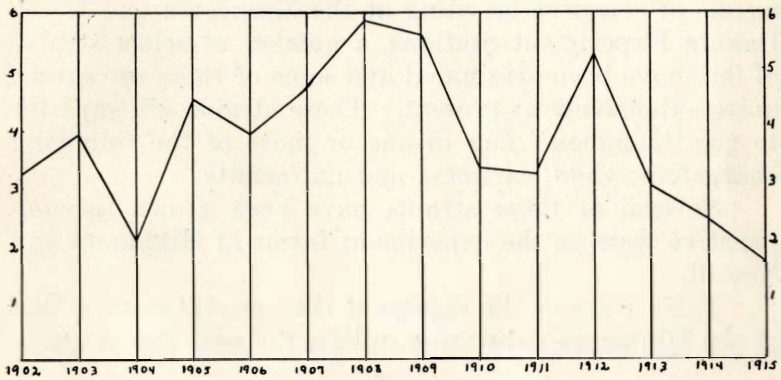


Fig. 2. Diagram showing production of flaxseed in South Dakota from 1902 to 1915, inclusive, figures at margin representing millions of bushels.

GROWING THE CROP.

Varieties.

Although there are several types of flax grown in different parts of the world which differ materially in height of plant, color and size of flower and seed, all that is grown commercially in South Dakota comes from European sources. This type has small dark brown seed, blue flowers and stems which are usually 18 to 24 inches in height. Most of the flax grown is of no particular variety, being known merely as "common" flax. By means of selective breeding at the Minnesota and North Dakota Experiment Stations, a number of select strains of flax have been originated and some of these are grown quite extensively at present. These strains are superior to the "common" flax in one or more of the following characters; yield, earliness and uniformity.

Several of these strains have been grown in comparative tests on the experiment farms at Highmore and Newell.

Table 1 shows the results of the varietal tests of flax at the Highmore substation during the past five years.

TABLE 1.

AVERAGE AND ANNUAL YIELDS OF THE FLAX VARIETIES AT THE HIGHMORE SUBSTATION, 1911 TO 1915, INCLUSIVE.

Variety	S. D. No.	C. I. (a) No.	Yield per acre in bushels					5 year average
			1911	1912	1913	1914	1915	
Russian (N. D. No. 155).....	155	17	1.5	2.5	7.5	24.1		7.1
Russian (N. D. No. 155).....	691	19			5.3	32.1		
Select Russian (N. D. No. 608).....	154	1	2.6	4.3	6.2	29.5		8.5
Select Russian (N. D. No. 1215).....	686	3			8.0	33.9		
N. D. Resistant No. 52.....	29	8	1.9	3.5	8.7	32.1		9.2
N. D. Resistant No. 114.....	688	13			9.2	26.8		
Primost (Minn. No. 25).....	25	12	1.75	4.0	4.7	20.5		6.2
"Common".....	30	29		4.8	3.8	20.5		
Smyrna.....	699	30				2.6		
N. D. No. 1340.....	361	5	1.7					

(a) Cereal Investigation number.

Flax was a complete failure at Highmore in 1911 on account of drouth and was almost a failure in 1912 and 1913. The yields during the season of 1915 were very

satisfactory. The variety known as North Dakota Resistant No. 52 has the highest average yield for the five year period, 9.2 bushels. This variety was originated at the North Dakota Experiment Station by the selection of plants which showed high resistance to flax wilt disease. Select Russian N. D. No. 608 (S. D. 154) has yielded an average of 8.5 bushels of flaxseed during the five year period.

Varietal tests of flax under both dry land and irrigated conditions have been conducted on the Belle Fourche Experiment Farm, near Newell, Butte County, South Dakota, for the past four years. Table 2 gives the results of the test on the dry land.

TABLE 2.
ANNUAL AND AVERAGE YIELDS OF THE FLAX VARIETIES
GROWN ON DRY LAND AT THE BELLE FOURCHE EX-
PERIMENT FARM, 1912 TO 1915, INCLUSIVE.

Variety	S. D. No.	C. I. No.	Yield per acre in bushels				
			1912	1913	1914	1915	4 year average
Russian (N. D. No. 155).....	691	19	8.9	5.2	0.87	22.0	9.2
Russian (N. D. No. 155).....	155	17	7.5				
Select Russian (N. D. No. 608).....	154	1	10.6	3.3	2.2		10.2
Select Russian (N. D. No. 1214).....		2	10.6				
Select Russian (N. D. No. 1215).....	686	3	11.2	5.6	.8	23.6	
S. P. I. (a) No. 9906.....		4	8.2				
N. D. No. 1221.....		16	10.4				18.1
Smyrna.....		7	11.4	2.8	2.4		
Smyrna.....	699	30					16.7
N. D. Resistant No. 52.....	29	8		4.5	2.4		
N. D. Resistant No. 114.....	688	13			1.5		17.8
Primost (Minn. No. 25).....	25	12	9.1	4.8	1.7		

(a) S. P. I. Seed and Plant Introduction number.

Satisfactory yields of flax were secured on dry land at Newell in both 1912 and 1915. Select Russian N. D. No. 1215 (S. D. 686) has given the highest average yield during the four year period. This variety was also originated at the North Dakota Experiment Station. The yields of Primost, Minn. No. 25 (S. D. 25,) have been somewhat less than those of the Russian varieties.

The yields of the varieties of flax under irrigation at the Belle Fourche Experiment Farm are shown in Table 3.

TABLE 3.

ANNUAL AND AVERAGE YIELDS OF THE FLAX VARIETIES
GROWN UNDER IRRIGATION AT THE BELLE FOURCHE
EXPERIMENT FARM, 1912 TO 1915, INCLUSIVE.

Variety	S. D. No.	C. I. No.	Yield per acre in bushels				4 yr av.
			1912	1913	1914	1915	
Russian (N. D. No. 155)	691	19	12.5 (b)	5.3	10.0	14.1 (d)	10.4
Russian (N. D. No. 155)	155	17	10.1 (b)				
Select Russian (N. D. No. 688)	154	1			3.7 (a)		
Select Russian (N. D. No. 1215)	686	3			11.8	14.5	
Smyrna		7		4.4 (a)	1.5 (a)		
Smyrna	699	30				6.0 (b)	
N. D. Resistant No. 52	29	8	11.9 (a)	4.8	5.8 (a)	13.6 (d)	9.0
N. D. Resistant No. 114	688	13			11.1	12.4 (d)	
Primost (Minn. 25)	25	12	11.1 (a)	5.3	11.6 (c)	12.9	10.2
"Common"			11.3 (b)				

- (a) One plat only
- (b) Two plats only
- (c) Eight plats
- (d) Injured by hail

Owing to the poorer soil on which the irrigated flax varieties have been grown, the yields have not been much higher than the same varieties when grown on dry land. The yields shown in the above table are therefore not a true indication of the returns to be expected from flax under irrigation. Usually three plats of each variety are grown each year but this has not always been possible. Three varieties suffered a loss by hail of about ten per cent of the seed, while standing in the shock in 1915. The best variety of flax to be grown under irrigation in South Dakota has not yet been definitely determined but the results seem to indicate that Select Russian, N. D. No. 1215 (S. D. 686) is to be preferred.

At the Highmore substation and also to a less extent on the experiment farm at Newell, selection and testing of improved strains and the growing and increase of recently introduced varieties of flax is being carried on. It is hoped that varieties will be discovered which are superior to the ones now being grown.

In addition to this, the seed of those varieties which are now known to be good is being increased and is sold to growers at reasonable prices.

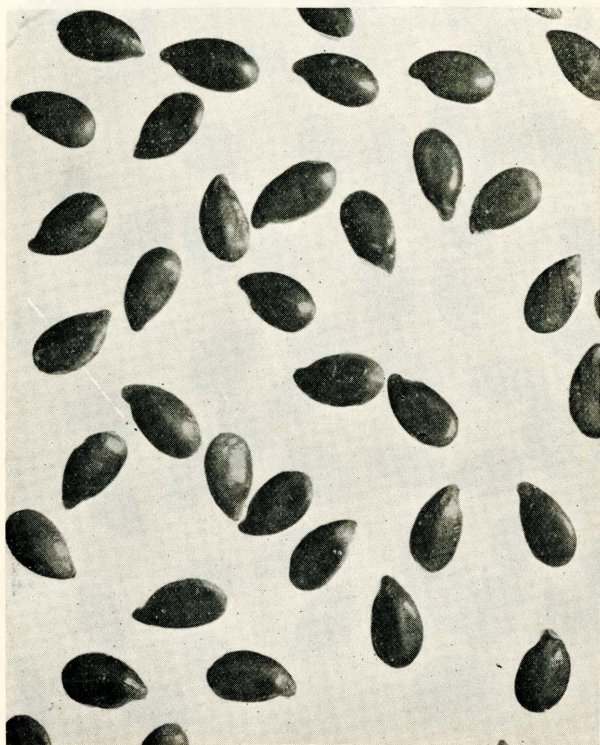


Fig. 3. Clean, plump flaxseed is necessary for best results.

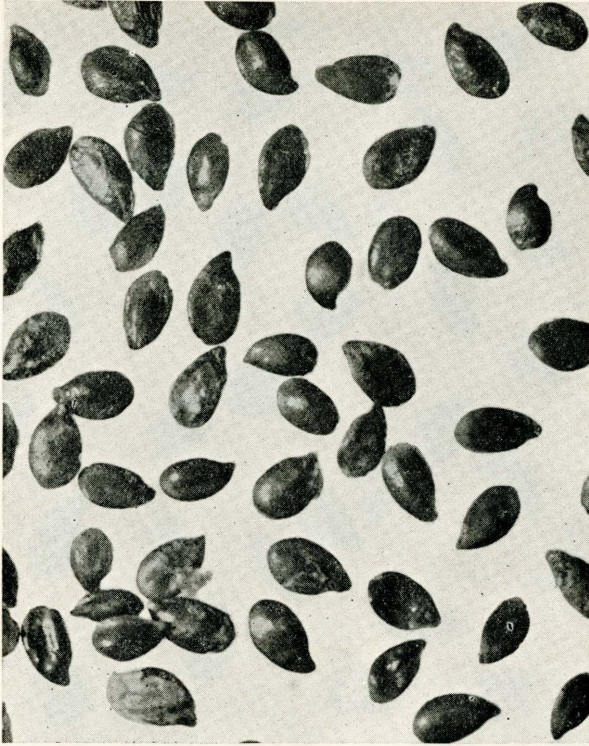


Fig. 4. Shriveled, diseased seed should be thoroughly eliminated by cleaning and grading.

SEED SELECTION

The most important factor in successful flax production is the use of clean, plump, healthy seed. Especially is this true in the older sections which are infected with flax diseases. The fanning mill is a valuable aid in this connection. With it one can remove the dirt, chaff, broken seed and the light, immature or shrunken seeds. In this way many of the seeds which are internally diseased are blown out.

It is well for the farmer to grow his flax for seed on his own farm. A part of the field of flax which shows the best vigor and the least evidence of disease should be staked off, while the crop is still growing. All weeds, the seeds of which can not be easily separated from flax by fanning, should be pulled from this patch. The crop from this plot must be harvested and threshed separately, care being taken to prevent the seed from becoming damp at any time.

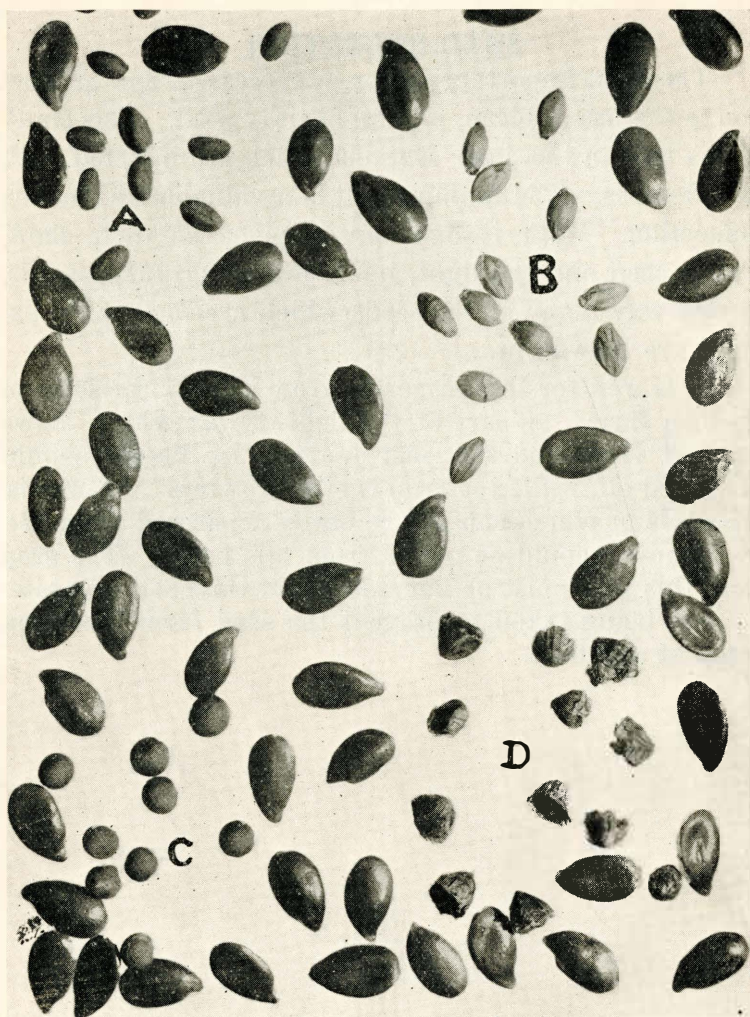


Fig. 5. Flaxseed is more difficult to clean than larger grain. Some common impurities are shown here, as follows:

- | | |
|---------------|--------------------|
| a. False flax | c. Dodder |
| b. Foxtail | d. Russian thistle |

The flaxseed for next season's crop should be grown on a special seed plot where weeds can be removed by hand.

Diseases

There are three common diseases of flax in South Dakota, viz. rust, wilt and canker. Rust is observed in the form of reddish-yellow clusters of spores on the leaves and stems of flax. The injury is not usually very serious. Wilt is evidenced by the yellowing, wilting and death of flax plants in various stages of growth, with much the same appearance as if the plants were in need of water. Canker causes the stem of the plant to rot or break off just above the surface of the soil. The appearance of the injury is much the same as would occur if the stem had been chewed apart by an insect.

Both wilt and canker are transmitted by the seed, and the diseases will remain in the soil for some years after being introduced. To avoid infected soil, flax should be grown only in long rotations with other crops or on new land. The chief means of controlling flax wilt and flax canker are by seed selection, as previously outlined, and seed treatment. The method of treatment is as follows:

Throw a pile of flax containing five to ten bushels upon a canvas, tight floor, or in a shallow box. Make up a solution of formalin, using 1 pound of the standard formalin to 40 gallons of water. The solution should be applied with any small handpower sprayer which delivers a fine misty spray. While one man sprays the solution over the flax, another should stir the pile constantly with a rake. The spraying should be continued until the surface of all of the seeds are moist but not wet. If too wet the flax seeds stick together. About one-half gallon of the solution is required to treat one bushel of flax. After being treated the flax may be covered

with a canvas for a few hours and later shoveled over a few times to assist in drying. Flax can be treated in a box or on a canvas out in the field and seeded almost immediately, while still damp. As moistened flax seed does not pass through the drill as rapidly as if dry, the drill should be adjusted to sow the correct amount. The formalin treatment kills the disease spores on the outside of the seeds, while cleaning with the fanning mill removes most of the seeds which are diseased internally.

SOIL PREPARATION.

Rotations.

When flax is grown on the same ground several years in succession, it is not uncommon for diseases to become so abundant that the yields of flax are too low to be profitable. This is the reason why flax is usually sown on new ground. Freshly broken prairie sod does not generally contain the diseases which attack flax plants. A period of five to seven years will usually cause the fungi of the flax diseases to die out; so flax can be grown on the same land which has produced the crop previously, if a six or eight year rotation is followed. Flax is not "hard on the land" as has frequently been claimed, i. e., it does not remove as large an amount of the elements of fertility as do wheat, oats, barley or corn. It is however a shallow-rooted crop, and may dry out the top layer of soil and temporarily reduce crop yields.

Flax is perhaps the best crop that can be grown on freshly-broken prairie sod and is often used as the first crop on new land. In the older farming sections flax succeeds well after pasture or meadow grasses and after corn or potatoes.

Rotations including flax on old land are on trial on the Cottonwood, Eureka and Highmore experiment farms. In these rotations flax is grown after potatoes because the potato ground can be kept absolutely free of weeds and the cultivation of the potatoes conserves moisture. In growing flax on old ground, the fact should be ever kept in mind that flax is not a good weed fighter and should therefore follow clean cultivated corn or potatoes or newly broken meadow or pasture.

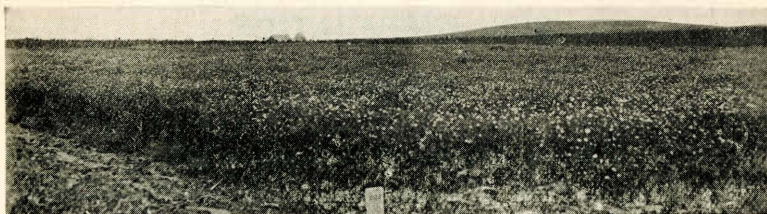


Fig. 6. Flax after potatoes, Eureka 1914. Flax following a cultivated crop gives good results if sown early.

The following rotations including flax are on trial at the various experiment farms as follows:

1. COTTONWOOD—Alfalfa 5 to 10 years, according to stand maintained, potatoes, flax, corn, wheat in three row cultivated groups, sweet clover sown in wheat stubble after wheat is removed to be plowed under the following summer, in preparation for potatoes. When it is desirable to renew the alfalfa field, the alfalfa is sown with the flax on potato ground and if a good stand is obtained the old field is plowed up early in the fall in preparation for corn. Then the rotation goes on as before.

2. EUREKA—Alfalfa 7 years, millet in cultivated double rows, oats, potatoes, flax, corn, wheat and sweet clover, sweet clover to be turned under for green manure.

3. HIGHMORE—Alfalfa 8 years, potatoes, flax, corn, sweet clover sown in fall in corn stubble, the first crop for hay and second for green manure, the one year crops to rotate twice around before renewing the alfalfa.

No wilt or canker has been observed in the flax in any of these rotations up to date. With similar long time rotations and clean disinfected seed, it is entirely possible to produce flax on old land.

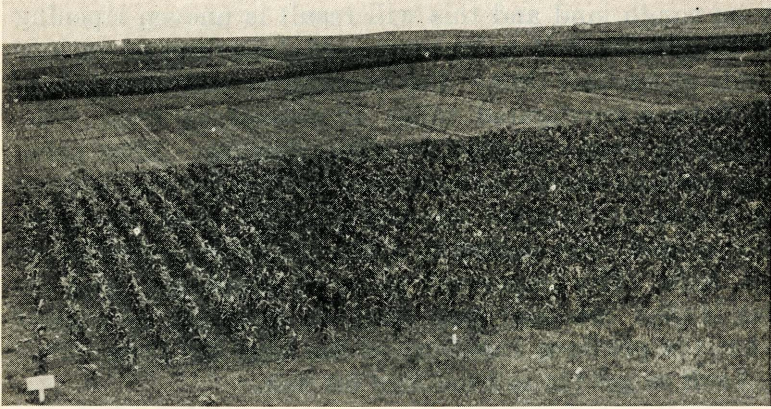


Fig. 7. Long rotations with flax following a cultivated crop or a grass crop are essential to success in growing flax on old ground.

Plowing.

Sod land, to be used for flax, should be broken to a depth of about four inches. The furrow slice must be turned flat, and in order to do this one must not attempt to cut too wide or too deep a furrow. Spring breaking is the usual practice and this should be done in May as June breaking makes the time of seeding too late. As a rule corn or potato ground which is to be seeded to flax should not be plowed. A compact seed bed is desired for flax and this would be difficult to secure if the cultivated land were to be plowed in the spring. Disking and harrowing of the corn stubble so as to level off and compact the soil is all that is necessary for flax.

Seedbed.

The most important operation in preparing a seedbed for flax from sod breaking is the packing. Each furrow slice should be laid well over and thoroughly packed so as to exclude all openings. Flax plants are likely to suffer from a lack of moisture or be severely attacked by disease if the roots are allowed to penetrate the layer of sod and then enter an open space between the sod and

the soil below. Further, the flax will not come up evenly on rough land and this will result in uneven ripening of the crop as well as breakage and difficulties of various kinds at harvest time. The packing is best accomplished with a corrugated roller of cement or iron. This should be done immediately after plowing. After packing, the land should be harrowed to level the seed bed, fill up cracks, and further compact the soil. If the disk harrow is used, care should be taken not to cut up or loosen the sods. The important point in preparing land for flax is that the seed bed must be compact, no matter what the previous condition of the land has been. It is difficult to get the soil too firm for flax.

SEEDING.**Date of Seeding.**

Flax has been considered a tender plant, and is not usually seeded until after all danger of frost is past. It is not uncommon for a farmer to seed flax as late as June 15th and even then get a good crop. This is possible, not because of the late seeding, but in spite of it. Futhermore, flax is not as tender as is commonly believed, and seeding as early as April 15th is not only possible but is very desirable. Flax plants are able to withstand a considerable degree of cold after they have passed the two-leaf stage.

Experiments to determine the best date of seeding of flax have been carried on at the Highmore, Eureka and Cottonwood substations and at the Experiment Farm at Newell. The results of the date of seeding test of flax at the Highmore substation are shown in the following table. The average yields are highest for the mid-April dates of seeding.

TABLE 4.

ANNUAL AND AVERAGE YIELDS OF TWO VARIETIES OF FLAX IN A DATE OF SEEDING TEST AT THE HIGHMORE SUBSTATION IN 1914 AND 1915. YIELDS FOR EACH YEAR ARE AVERAGES OF TWO VARIETIES, VIZ., PRIMOST, S. D. 25 AND SELECT RUSSIAN, S. D. 686.

Date Seeded	Yield per acre in bushels		
	1914	1915	average
April 1.....	9.6		
April 12 and 17.....	2.7	29.9	16.3
April 22 and May 1.....	6.3	23.2	14.7
May 7 and 15.....	2.3	26.8	14.5
June 2.....		

Table 5 shows the results of a date of seeding test of flax at the Eureka substation during the past three years. It will be seen that the highest average yield was obtained from the plats seeded earliest and the yield decreased directly as the date of seeding was postponed.

TABLE 5.

ANNUAL AND AVERAGE YIELDS OF PRIMOST S. D. 25 FLAX IN
A DATE OR SEEDING TEST OF FLAX AT THE EUREKA
SUBSTATION, 1913 TO 1915, INCLUSIVE.

Date Seeded	Yield per acre in bushels			
	1913	1914	1915	3 year average
April 15.....	0.4	11.6 (c)	18.5 (a)	10.1
May 1.....	2.0	9.3	11.4	7.5
May 15.....	2.1 (a)	5.0	8.6	5.2
June 1.....	2.7 (b)	4.5	6.4	4.5
June 15.....	0.2	1.0	4.6	1.9

(a) Average of two plats

(b) May 31

(c) April 23

The results of the date of seeding test of flax at the Cottonwood substation for the past three years are shown in Table 6. The yields are all rather low but the highest average yield was secured from the plats sown on April 15. In 1915 the latest seeded plats yielded the highest but in both of the previous years, the seeding of June 1st and June 15th were failures.

TABLE 6.

ANNUAL AND AVERAGE YIELDS OF PRIMOST S. D. 25 FLAX IN
A DATE OF SEEDING TEST AT THE COTTONWOOD
SUBSTATION, 1913 TO 1915, INCLUSIVE

Date Seeded	Yield per acre in bushels			
	1913	1914	1915	3 year average
April 15.....	1.7	1.6	8.4	3.9
May 1.....	0.8	1.4	7.1	3.1
May 15.....	0.0	1.5	5.9	2.4
June 1.....	0.0	0.0	8.9	2.9
June 15.....	0.0	0.0	10.9	3.6

The yields of flax in a date of seeding test for three years at the Belle Fourche Experiment Farm near Newell, are shown in Table 7. In 1912 and 1915, when moisture was abundant late in the season, the yields were slightly higher for later seeding. On the other hand the conditions in 1913 greatly favored early seeding. The

differences were greater in 1913 than during the other two years. The test is not conclusive but differences are so slight that no injury should be expected from early seeding, at any rate.

TABLE 7.

ANNUAL YIELDS OF PRIMOST S. D. 25 FLAX IN A DATE OF SEEDING TEST AT THE BELLE FOURCHE EXPERIMENT FARM, 1912, 1913, AND 1915:

Date Seeded	Yield per acre in bushels		
	1912	1913	1915
May 2.....		7.7	
May 8.....			20.0
May 15.....	8.3		
May 22.....			21.5
May 23.....		4.8	
June 1.....	10.6		Did not emerge
June 9.....		3.0	

Conclusions as to the Best Date of Seeding Flax.

A study of the tables given above will show that it is not only possible, but profitable as well, to seed flax much earlier than is commonly practiced. Perhaps the best rule would be to sow the flax as soon as the seeding of spring wheat, oats and barley is completed.

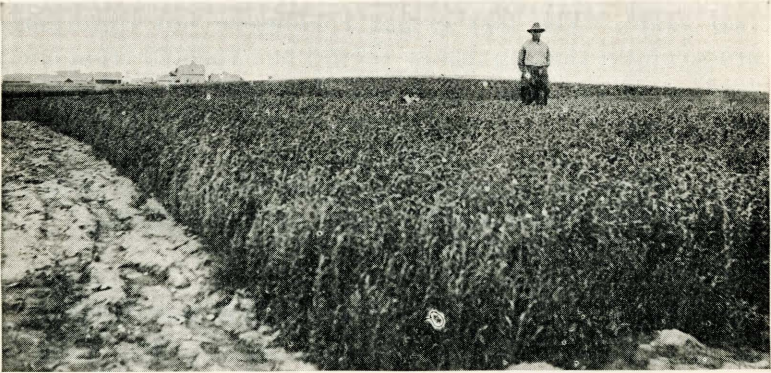


Fig. 8. Flax should be seeded as early as possible. This field of Resistant, N. D. 52 flax was seeded on potato ground April 15, 1916, at Eureka.



Fig. 9. Late seeded flax is much more likely to be injured by heat, drouth, disease, etc., than that which is seeded early. This field of Resistant N. D. 52 is the same variety and was seeded on the same preparation as that shown in Fig. 8 but was seeded June 1st instead of April 15th. Both pictures were taken June 28, 1916.

RATE OF SEEDING.

The common rule in regard to the rate of seeding of flax for seed production is to sow two pecks per acre. More recently, thinner seeding especially in the semi-arid section has been recommended. Flax, when seeded thin, tends to branch more freely and this is an undesirable condition. The bolls from these basal branches are often later in maturing, and thus uneven ripening on a plant is the result.

In a dry section, if the conditions for germination are very favorable, fifteen pounds of flax per acre may be sufficient. Until more definite information is established by long continued experiments, the safest rule appears to be to sow two pecks or slightly less per acre.

Depth of Seeding.

On account of the small size of the seed, flax should not be seeded as deep as wheat or oats. The young seedlings will be weakened or may even fail to come up if seed is sown too deep. The aim should be to place the seed about one inch below the surface for quick germination. When seeding with a drill, the levers which regulate the depth at which the furrow openers penetrate should be set about one notch higher than when seeding wheat. If the seed bed is compacted as thoroughly as it should be, the drill will not be likely to plant the seed too deep.

Method of Seeding.

On account of the greater uniformity, in depth, rate and spacing of flax seeds, drilling is always to be preferred to broadcasting. Also less seed is required and emergence is more uniform. This latter point is important as it is very desirable to have all of the flax bloom and ripen uniformly. The ordinary grain drill with a press wheel attachment is well adapted to the seeding of

flax. If the rate of seeding can not be adjusted low enough for seeding flax, wire or shell reducers should be inserted in the feed cups of the drill.

The method of seeding flax in groups of three drill rows with intertilled strips 30 inches wide between groups, has been tried at the Cottonwood substation. Flax has not responded to inter-tillage and the yields have been less with the three-row group method than with ordinary seeding.



Fig. 10. Flax has not responded to cultivation as have oats and barley under drouth conditions. This field of Primost, S. D. 25 flax at Cottonwood in 1914 illustrates the three-row group method of planting. Results to date have not justified recommending it for flax production.

Weed Prevention.

The flax plant is rather tender and slow growing during the cool spring weather, and weeds sometimes almost smother the crop. This indicates that it is not advisable to seed flax on weedy land. Sod land is usually not very weedy and corn or potato ground, if it has been properly cultivated, should be comparatively free from weeds. Well planned rotations will keep most of the weeds which are injurious to flax under control.

Early seeding will give the flax an even start with the weeds. When seeding is postponed until the weeds have started, it is a good practice to disk or harrow the

land so as to kill those weeds which are growing, and seed the flax immediately afterward.

Some weeds such as mustard can be controlled by spraying. The spray used is 100 pounds of iron sulphate dissolved in 52 gallons of water. This is best applied with a traction sprayer drawn by four horses. The spraying must be done before the flax is more than six inches high or the chemical will also injure the crop. It requires about one barrel (52 gallons) of the solution per acre. With a good sprayer and convenient water supply, from 25 to 40 acres can be covered in a day. The solution is not effective if applied in rainy weather.

The most common weeds which occur in flax fields of South Dakota are foxtail, Russian thistle and wild mustard.

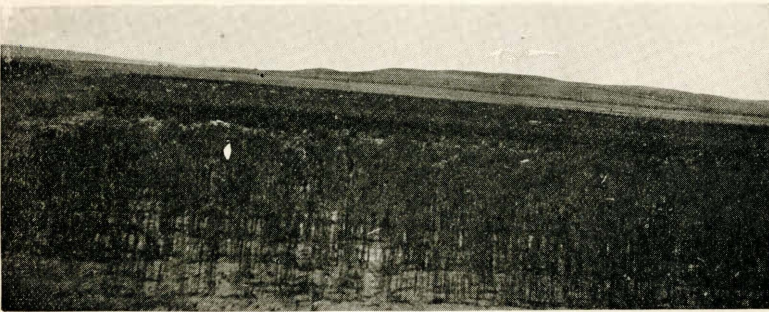


Fig. 11. A date of seeding test with flax at Cottonwood. This field is divided into plats seeded at fifteen day intervals from April 15th to June 15th inclusive. The early seeding is best. The soil of this field is strongly alkaline.

Flax Under Irrigation.

The above directions, except as noted, apply to flax as grown under the semi-arid or sub-humid conditions in South Dakota. Flax is destined to be of some importance as an irrigated crop. The cultural conditions under irrigation differ slightly from those in non-irrigated

sections. Greater care must be taken in smoothing and leveling the seed-bed. The rate of seeding should be at least two pecks per acre. Considerable care in controlling weeds is necessary. The amount of water to be applied varies largely with the season. Water should not be applied after flax is well in bloom, or late branching and blooming will result. One should aim to have the soil gradually dry out as the time of ripening flax is reached. Flax should never be over-irrigated nor water allowed to stand on the field for any length of time, as this seriously reduces the yield. It should also be remembered that wet conditions favor the development of flax wilt.

HARVESTING.

Time.

When flax is to be harvested with the header it must be thoroughly ripe so it can be stacked at once without danger of heating. This means that the stems must be dead and dried. When the flax is cut with the binder or reaper, so that it may stand in the field in shocks or bunches to dry out, the straw need not be dead ripe. Flax should not be cut until the bolls are brown and the seed well filled. Ripening may not be very uniform, especially on an uneven seed-bed or after late rains and blossoms often appear about the time that most of the seed is ripe but the crop should be harvested after most of the seeds are ripe.

Methods.

Flax is considered as a crop which is rather difficult to harvest. When the straw is short and uneven, and the field rough, this is certainly true, but if the seed-bed has been made uniformly smooth and compact, one should be able to cut the entire crop without loss. When the straw is long enough, that is from 18 to 24 inches, the ordinary self-binder can be used for harvesting flax. The bundles should be placed in long shocks until dry, when they may be stacked or threshed directly from the field. When the straw is too short to bind, the binding attachment can be replaced by a "buncher" and the same machine used for cutting the flax. Difficulty is sometimes encountered in cutting the flax especially if slightly green. Sickles must be kept sharp and clean. If necessary strips of linoleum are fastened on the slats of the reel or additional slats are put in.

The header is a good machine for harvesting large acreages of flax. The best method, when cutting with the header, is to let the flax get dead ripe and then haul directly from the header to the stack. An attachment is

sometimes used on the header which permits the flax to be deposited on the ground in large bunches instead of delivering it into a wagon. Stacks of flax must not be built too wide or heating is liable to occur.

Flax should be cut with a reaper only when other machines are not available, or the ground is very rough. There is considerable loss of seed when flax is deposited on the ground in small bunches, and there is a much greater injury in case of rain. The same or greater losses are experienced if flax is cut with a mower and buncher, or with a binder having neither the binding nor bunching attachment.

Threshing.

Flax is somewhat more difficult to thresh than most of the small grains. The tough, fibrous straw has a tendency to "ball up" on any revolving object. Unless carefully fed, the bunches of flax will pass through the separator with a "slug". It is almost impossible to do a good job of threshing if the flax is damp. This should never be attempted anyway, because the seed will "heat" easily if moist. At least six rows of concave teeth will be needed in the separator when threshing flax. Smaller screens to remove weed seeds are also necessary.

Uses.

The greater part of the flax seed produced in the United States is used in the manufacture of linseed oil; the chief use of the oil being as a constituent of paints and varnishes. Flax seed yields from 30 to 33 per cent of pure linseed oil. The residue left, after the oil has been extracted from the ground seeds, is known as oil-cake. This is usually ground, and sold on the market as oil meal. The oil meal has considerable value as a supplemental feed for livestock, especially to put "finish" or gloss on the animal.

Flax screenings have some value as feed for live-

stock but must be given rather sparingly. Flax straw can be used for coarse roughage and bedding.

It has been estimated by the Department of Agriculture that approximately 1,400,000 tons of flax straw are burned or wasted each year in the United States. A part of this at least could be manufactured into tow for upholstering, packing, paper and paper products. Where such a market exists or is created it would mean an additional revenue of over two dollars per acre from the sale of flax straw. Many such enterprises have been started in the United States and are now flourishing. Others have failed or have been abandoned because of the shifting area of flax production above mentioned. Since it has been found that flax can be grown successfully on old land, there is a good opportunity for farmers' cooperative companies to establish tow mills in connection with their elevators, each share holder agreeing to grow a definite amount of flax each year and bring in the straw. Flax straw can be used as bedding and returned to the land in the form of manure. It must not be spread on land on which it is intended to grow flax for a few years, because of the danger of introducing flax diseases.

Probable Returns.

The Yearbook of the U. S. Department of Agriculture shows that the average yield of flax seed in South Dakota during the past five years (1911 to 1915) is 7.9 bushels per acre, having a farm value of \$11.07 per acre. During the same period wheat in South Dakota yielded 10.6 bushels, valued at \$8.61 per acre. The return from an acre of flax was thus \$2.46 more than was received from an acre of wheat. The only item of expense, if any, which is higher for flax than for wheat is that of threshing. This difference in cost should not exceed fifty to seventy-five cents per acre, leaving a net increase of \$1.71

to \$1.96 per acre for flax above that received for wheat. The price of flax is now higher than it has been for several years. If the proper rotations, varieties, cultural methods and seed treatment as outlined above are followed, flax can be profitably grown on the older farming lands of South Dakota indefinitely.