

THE UNIVERSITY OF MINNESOTA
AGRICULTURAL EXPERIMENT STATION

WHEAT AND FLAX AS
COMBINATION CROPS

A. C. ARNY
DIVISION OF AGRONOMY AND FARM MANAGEMENT



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MINNESOTA.

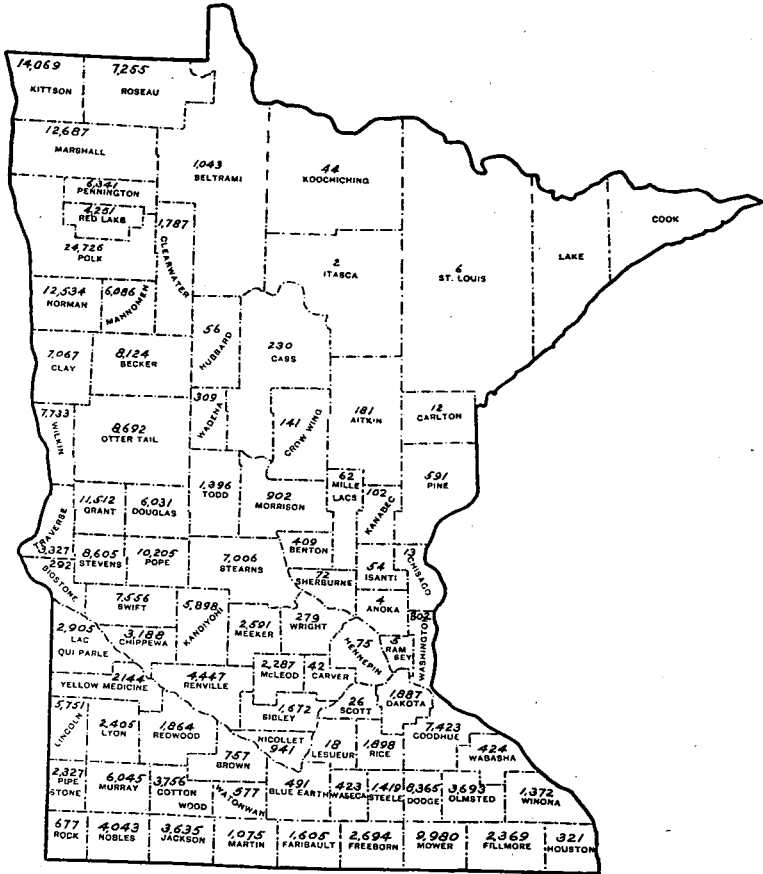


Fig. 1. Acreage of Flax Reported for Each County, 1919

WHEAT AND FLAX AS COMBINATION CROPS

By A. C. ARMY

FLAX ACREAGE AND PRODUCTION LOW

For the ten-year period ending in 1910 the average annual production of flax in the United States was nearly equal to the amount used. During the next ten years the acreage and production fell off very materially, so that the flax produced averaged only slightly more than half the amount needed, which is, approximately, twenty-six millions of bushels annually. In the principal flax producing states, North Dakota, Minnesota, and South Dakota, the production during the period 1911-20 decreased one half, while in Montana, owing to the suitability of flax as a pioneer crop on new land, the acreage and production increased rapidly. These changes in the acreage and production of flax during the periods 1902-10 and 1911-20 are shown in Table I.

The decreased production of flax in North Dakota, Minnesota, and South Dakota has been due very largely to: (1) The great demand for wheat during the war period and the consequent high price; (2) the gradual decrease in the acreage of new land brought under cultivation in the flax producing areas of these states; and (3) reduction in yields of flax because of wilt and other diseases, particularly when the crop has been grown more often than once in six or seven years on the same fields.

TABLE I
ACREAGE, TOTAL PRODUCTION, YIELD PER ACRE, PRICE PER BUSHEL AND VALUE PER ACRE ON
DECEMBER 1, OF FLAX FOR THE UNITED STATES AND THE FOUR LEADING
FLAX PRODUCING STATES, 1902-10 AND 1911-20

State	Acreage		Total production	
	9-year Av. 1902-10	10-year Av. 1911-20	9-year Av. 1902-10	10-year Av. 1911-20
	Acres	Acres	Bu.	Bu.
United States.....	2,778,700	1,941,200	24,362,000	14,831,000
North Dakota.....	1,516,400	899,200	14,370,000	6,767,000
Minnesota.....	492,233	320,000	5,906,796	2,976,000
South Dakota.....	482,800	293,500	4,969,000	2,271,300
Montana.....	18,600	385,000	224,000	2,557,900

State	Yield per acre		Price per bushel		Value per acre	
	1902-10	1911-20	1902-10	1911-20	1902-10	1911-20
	Bushels	Bushels				
United States.....	8.80	7.60	\$1.25	\$2.21	\$10.41	\$15.84
North Dakota.....	9.56	7.46	1.11	2.24	10.56	15.62
Minnesota.....	12.00	9.30	1.26	2.23	12.49	21.31
South Dakota.....	10.36	8.24	1.09	2.16	11.19	17.64
Montana.....	11.70	6.88	1.04	2.19	12.26	12.80

During the latter part of the ten-year period 1911-20 the December 1 farm value per acre of flax in Minnesota was somewhat higher than that of wheat, oats, and barley, so that as an average for the period flax, with a production cost slightly higher than the other crops, was a more profitable cash crop than the other small grains. This is shown in Table II. Approximately the same relative values prevailed in the other flax producing states. For the 1921 crop, as is shown in Table II, the acre value of flaxseed was slightly greater than that of wheat and considerably greater than that of barley. For the 1922 crop, the acre value of flax was greater than that of wheat, oats, or barley.

TABLE II
ACREAGE, TOTAL PRODUCTION, YIELD PER ACRE, PRICE PER BUSHEL AND VALUE PER ACRE, OF
WHEAT, OATS, BARLEY, AND FLAX, 1901-10 AND 1911-20

Crops and periods	Acreage	Yield per acre	Dec. 1 farm price per bushel	Value per acre on Dec. 1. Farm price
	Acres	Bu.		
Wheat				
Av. 1901-10	5 538,140	13.3	\$0.74	\$9.98
Av. 1911-20	3,907,500	13.5	1.38	18.49
1921	2,582,000	14.0*	0.97	13.58*
		9.7†		9.41†
1922	1,939,000	19.0*	1.01	19.19*
		13.7		13.84†
Oats				
Av. 1901-10	2,435,412	32.0	0.32	9.99
Av. 1911-20	3,154,600	34.3	0.44	15.00
1921	3,924,000	24.0	0.23	5.52
1922	4,021,000	35.5	0.32	11.36
Barley				
Av. 1901-10	1,128,894	25.5	0.44	11.00
Av. 1911-20	1,328,000	24.7	0.74	17.90
1921	886,000	20.0	0.34	6.80
1922	908,000	26.5	0.47	12.46
Flax				
Av. 1901-10	492,233	12.0	1.26	12.49
Av. 1911-20	320,000	9.3	2.23	21.39
1921	287,000	9.5	1.51	14.34
1922	377,000	10.0	2.18	21.80

* Winter. † Spring.

These figures are given to show the trend of production and prices of flax seed. No prediction can be made as to probable prices of flax seed in the future. However, the following facts are to be considered.

Since September, 1922, there has been a duty of 40 cents per bushel on all flax imported. As long as this duty remains in effect, growers in the United States can more nearly meet the competition of foreign flax. The bulk of the imported flax comes from South America. The flax harvest there comes during our winter, and therefore it is possible for growers in the United States to learn the size of the South American crop, the price, and the probable carry-over, if any, before seeding time. The extent of the acreage in the United States can well be governed

to a considerable extent by the size of the South American crop, which is a very decided factor as far as the supply of flax seed is concerned. Relative prices of the various grain crops should also be taken into consideration in deciding whether or not to grow flax and the amount to grow.

READY MARKET FOR CLEAR FLAX STRAW

Several well established industries utilizing flax straw are located at various points in Minnesota. These industries use approximately 150,000 tons of clear flax straw annually. The 1922 price per ton of baled clear flax straw including freight to Twin City points is \$12. This straw is now obtained to a considerable extent within a radius of 150 miles from the Twin Cities and the present freight charge per ton in car lots for this distance is approximately \$3. Any marked decrease in the flax acreage within the radius mentioned would result in reaching out farther for the supply with a higher freight charge against it. The baling cost averages approximately \$3 per ton and the cost of hauling to the freight station \$3 per ton. This leaves a farm value of flax straw in the stack at the present time of approximately \$3 per ton. On many farms part of the baling and all of the hauling charge goes to the farmer as wages during the dull season.

The farm value of flax straw will undoubtedly vary in the future along with other products. However, the fact that there is an established industry that needs large amounts of flax straw each year makes a ready market for it. This fact should be considered when flax as a cash crop is being compared with other crops grown for this purpose.

HISTORY OF THE GROWING OF WHEAT AND FLAX TOGETHER

Spring wheat and flax have been grown as combination cash crops on Minnesota farms for at least forty years. How much longer and when the practice was first begun, careful inquiry has not revealed.

Growing the two crops together was practiced over forty years ago on several farms in Washington county, very largely in order to reduce the injury to wheat by chinch bugs. In Goodhue County the practice of growing the two crops together has been passed down from father to son. The number of farms producing the mixed crop in the county has increased steadily. In 1919 the acreage devoted to flax in Goodhue County is reported as 7423, largely wheat and flax grown together. This acreage compares favorably with that devoted to flax growing in many of the counties in the western half of the state where much of the land has been brought under cultivation much more recently. Average yields reported by Goodhue County growers are given on page 17.

Farmers in the vicinity of New London, Ohio, in 1912 had been following for at least twenty years the practice of sowing 28 to 56 pounds per acre of flax very early in the spring in the fall-sown wheat fields, when the stands were thin as the result of winter-killing. The practice came to the attention of M. W. Evans, scientific assistant in the Bureau of Plant Industry, United States Department of Agriculture, who gave details regarding the methods they followed in an article entitled "Sowing Flax on Winter-Killed Wheat Fields," published in Bureau of Plant Industry Circular No. 114, 1913. From eight fields in 1912 the average yield of the combination crop was 7.2 bushels of flax and 3.2 bushels of wheat per acre. Yields on three additional farms averaged 11 bushels of flax and 9.5 of wheat per acre. From four of these fields an average of 1.3 bushels of timothy seed was secured in addition.

That wheat and flax mixtures were grown at Dickinson and Mandan in western North Dakota, in 1917 and 1918, is reported in the Oil, Paint, and Drug Reporter, for November 23, 1922, by A. C. Dillman, in charge of flax investigations, Bureau of Plant Industry, United States Department of Agriculture. The results were not satisfactory because of extreme drouth.

The growing of wheat and flax as combination crops has reached considerable proportions in Minnesota. For the purpose of finding out the advantages as well as the disadvantages of growing crops in combination as compared with growing them alone, carefully conducted trials have been made at University Farm for several years. The results of these trials and other available data regarding the combination crop have been included in this publication.

In 1913 the growing of wheat and flax in combination compared with growing each of the crops alone under carefully controlled conditions was begun at University Farm. In 1914 and 1915, two other combination crops, oats and flax, and barley and flax were grown.

CONDUCTING THE WORK AT UNIVERSITY FARM

The crops were grown in plots varying in size in the different years from one-twentieth to one-fortieth acre. From 1913 to 1916, inclusive, two plots were sown each year of each mixture and each crop alone. From 1911 to 1919, inclusive, three plots, and from 1920 to 1922 four plots of each seeding were made each year.

The seed for the combined crops was mixed in the desired proportions in the granary. The drill was regulated carefully to sow the desired amounts of the mixed seed and of the seed alone before the actual sowing was started. At seeding time the grain previously mixed was put into the drill box and sown as grains alone are usually sown.

All seed was drilled at a depth of approximately $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. The seeding was done each year at the regular time for seeding wheat alone.

The yields of the combined crop were computed in percentages based on the yields of the crops grown alone as 100. This was done by dividing the yield of wheat grown alone by the yield of flax grown alone and multiplying the yield of flax in each mixture by this factor. This reduced the yields of flax in the mixtures to a wheat basis. The two yields for each mixture were then added and the sums divided by the yield of the wheat grown alone. This gave the yields of the combined crops in percentage, with the yields of the crops grown alone as 100. Differences in yields of less than 5 per cent even in carefully conducted experimental work, can not be considered as meaning that one mixture is superior to the other or that a mixture yields higher than the crops grown alone.

The values of the combined crops and of the crops grown alone were computed annually, using the December 1 farm prices given in the Yearbooks of the United States Department of Agriculture. These prices are given in Table III.

The present values of clear flax straws are discussed on page 7.

TABLE III
FARM PRICES ON DECEMBER 1, FOR CORN, WHEAT, OATS, BARLEY, AND FLAX*

Crop	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913
Corn	\$0.56	\$0.31	\$0.51	\$1.20	\$1.11	\$1.10	\$0.80	\$0.62	\$0.52	\$0.53
Wheat	1.01	0.97	1.30	2.50	2.04	2.02	1.62	0.90	1.02	0.76
Oats	0.32	0.23	0.36	0.64	0.63	0.63	0.47	0.32	0.40	0.32
Barley	0.47	0.34	0.62	1.16	0.80	1.11	0.87	0.49	0.53	0.48
Flax	2.18	1.51	1.83	4.45	3.41	2.95	2.40	1.76	1.28	1.23

* From the Yearbook of the U. S. Department of Agriculture.

YIELDS OF WHEAT AND FLAX MIXTURES

In conducting the work, the aim was to use in the combination crops varieties in general use on farms in the state.

BLUESTEM WHEAT AND PRIMOST FLAX

In 1913 when the work was started, Bluestem wheat, Minn. No. 169, and Primost flax, Minn. No. 25, were used and continued in use for 4 years. For the 4-year period the wheat averaged 20 inches taller than the flax and matured a few days later. No loss resulted from letting the flax stand until the wheat matured.

The wheat and flax in the mixture was sown at the rates mentioned in Table IV. This is one half and three fourths of the full seeding rates for the crops grown alone, the proportion of wheat in pounds

being approximately two thirds and of flax one third. In the crops harvested the proportion of wheat was much greater and the proportion of flax much less than in the seed sown. The 4-year average yield of flax grown alone was 13.17 bushels and of wheat grown alone, 26.57 bushels. In the mixed crops the yields of wheat averaged somewhat lower. The flax yields in the mixed crops averaged 1.47 bushels and 2.60 bushels, or approximately 15.5 per cent of the crop grown alone. The difference in height between the Bluestem wheat and the flax and the comparative leafiness of the wheat caused undue shading, and undoubtedly accounts to a very large extent for the small proportion of flax in the crops harvested.

TABLE IV
AVERAGE YIELDS PER ACRE OF BLUESTEM WHEAT (MINN. NO. 169) AND PRIMOST FLAX (MINN. NO. 25) GROWN IN MIXTURES AND ALONE, TOGETHER WITH YIELDS OF THE MIXTURES IN PERCENTAGES BASED ON THE YIELDS OF THE CROPS GROWN ALONE AS 100, THE PERCENTAGES OF WHEAT AND FLAX IN THE MIXTURES HARVESTED, AND THE VALUE OF THE CROPS PER ACRE AT DECEMBER 1 FARM PRICES, 1913-16, INCLUSIVE.
UNIVERSITY FARM, ST. PAUL

Crops	Rate of seeding per acre	Proportion of each crop sown	Proportion of each crop harvested	4-year average yields per acre	Average yields per acre with yields of crops grown alone as 100	Value of crops per acre at December 1 farm prices
	Pounds	Per cent	Per cent	Bushels	Per cent	
Bluestem wheat	37.5	64.01	94.25	23.46	....	\$24.39
Primost flax	21.0	35.99	5.75	1.47	101.9	2.47
						26.86
Bluestem wheat	56.0	64.01	89.71	22.40	....	22.64
Primost flax	31.5	35.99	10.29	2.60	101.6	5.19
						27.83
Bluestem wheat alone	75.0	100.00	100.00	26.57	100.0	26.99
Primost flax alone	42.0	100.00	100.00	13.17	100.0	23.56

The yields of the combination crops were computed each year on the basis of the crops grown alone as 100 in the manner outlined under "Conducting the Work at University Farm," pages 8 and 9. Computed in this way as an average for the 4-year period the crop from the lighter seeding of wheat and flax yielded 101.9 and from the heavier seeding, 101.6 as compared with the crops grown alone as 100. From these results it is evident that for the 4-year period the mixed crops yielded neither higher nor lower than the crops grown alone. In the 4-year period, in only one season, 1916, did the mixed crops yield decidedly well, 110.2 and 112, as compared with the crops grown alone as 100.



Fig. 2. Wheat and Flax Grown Together as It Appears in the Field at Maturity
(Photo by W. L. Bakkela, Red Wing, Minn.)

In 1915 the mixture sown at the rate of 56 pounds of wheat and 31.5 pounds of flax per acre yielded at the rate of 111.5 as compared with the crops grown alone but the other mixture yielded at a rate less than 100.

In values per acre, the mixed crops and the crops grown alone computed on the December 1 prices as outlined under "Conducting the work at University Farm," page 8, the wheat-flax mixtures were of approximately the same value as the wheat grown alone. The value of the seed crop of the flax grown alone is lower than that of the mixed crop or wheat alone. However, the flax grown alone produced one ton

of straw per acre. A farm value of \$3 per acre for clear flax straw raises the total value of the flax crop grown alone to approximately the same figure secured from the mixtures. The straw from the mixed crop has no value at present for manufacturing purposes.

MARQUIS WHEAT AND PRIMOST FLAX

The work was continued in 1917 with some changes in the varieties used and in the rates of seeding. Marquis wheat was used instead of Bluestem. It averages approximately six inches shorter than Bluestem and matures a week earlier. The rates of seeding and the results for the 3-year period, 1917-19, inclusive, are given in Table V.

TABLE V
AVERAGE YIELDS PER ACRE OF MARQUIS WHEAT AND PRIMOST FLAX (MINN. NO. 25) GROWN IN MIXTURES AND ALONE, TOGETHER WITH YIELDS OF THE MIXTURES IN PERCENTAGES BASED ON THE YIELDS OF THE CROPS GROWN ALONE AS 100, THE PERCENTAGES OF WHEAT AND FLAX IN MIXTURES HARVESTED, AND THE VALUE OF THE CROPS PER ACRE AT DECEMBER 1 FARM PRICES, 1917-19, INCLUSIVE. UNIVERSITY FARM, ST. PAUL

Crop	Rate of seeding per acre	Proportion of each crop in mixtures sown	Proportion of each crop in mixtures harvested	3-year average yields per acre	Average yields per acre with yields of crops grown alone as 100	Value of crops per acre at December 1 farm prices
	Pounds	Per cent	Per cent	Bushels	Per cent	
Marquis wheat	45.0	62.50	91.27	31.21	....	9.99
Primost flax	28.0	37.50	8.73	2.68	105.1	9.99
						75.80
Marquis wheat	15.0	26.32	75.34	18.71	....	39.34
Primost flax	42.0	73.68	24.66	6.12	110.0	21.75
						61.09
Marquis wheat alone.....	90.0	100.00	100.00	41.98	100.0	90.30
Primost flax alone.....	42.0	100.00	100.00	9.14	100.0	31.69

As will be noted from the study of the results, the flax averaged somewhat better yields in the mixtures for the 3-year period, but four bushels less when sown alone than in the preceding 4-year period. The increased yields of flax were due in part to the use of Marquis wheat, which gives the flax a better opportunity to grow, and in part to the heavier rate of seeding of the flax. On the average there was more damage to the flax crop from wilt during this period than in the preceding one.

The combinations gave higher yields each year than the crops grown alone. In this period the seeding of 45 pounds of wheat and 28 pounds of flax yielded at the rate of 101.7, 101.8, and 111.8, with an average

of 105.1 as compared with the crops grown alone as 100. The seeding of 15 pounds of wheat and 42 of flax yielded 108.5, 105.2, and 116.2, with an average of 110 for the 3-year period as compared with the crops grown alone as 100.

The years 1917 and 1918 were exceptionally favorable for wheat at University Farm and prices were unusually high. Computed at December 1 prices, wheat sown alone had a higher cash value per acre than either of the mixtures, which in turn had a higher value than the flax grown alone, considering the value of the straw in addition to the value of the seed.

MARQUIS WHEAT AND NORTH DAKOTA RESISTANT FLAX

In the 1920-22 seedings, North Dakota Resistant No. 114 flax was used instead of Primost. This is a wilt resistant, high yielding variety developed at the North Dakota Experiment Station. The results for the 3-year period are given in Table VI.

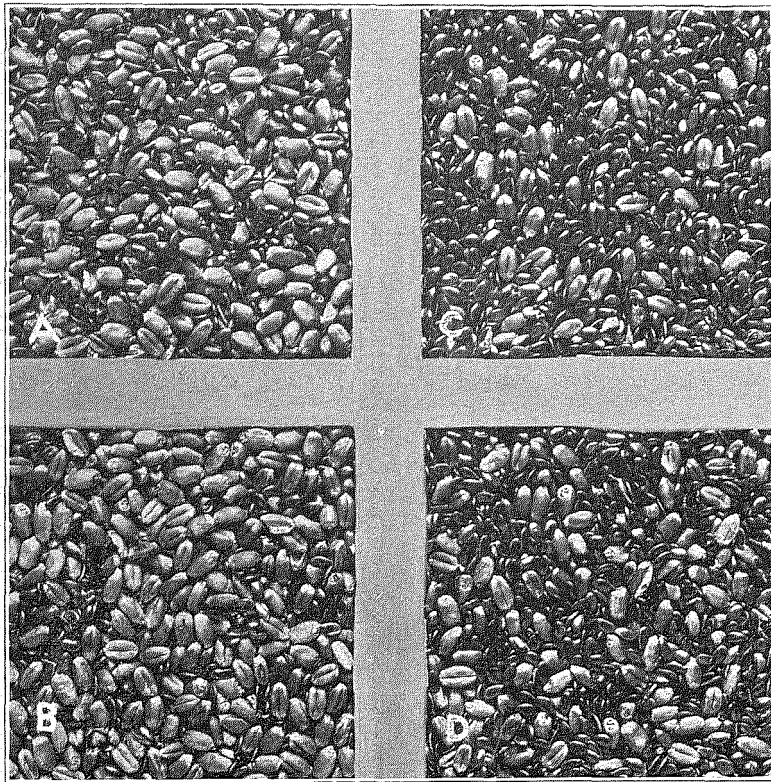


Fig. 3. Proportions of Wheat and Flax in Seed and in Crop

- As sown—45 pounds of wheat, 28 pounds of flax; 62.5 per cent wheat, 37.5 per cent flax
- As harvested—76.6 per cent wheat, 23.4 per cent flax
- As sown—15 pounds of wheat, 42 pounds of flax, 26.3 per cent wheat, 73.7 per cent flax
- As harvested—40.9 per cent wheat, 59.1 per cent flax.

TABLE VI

AVERAGE YIELDS PER ACRE OF MARQUIS WHEAT AND NORTH DAKOTA RESISTANT NO. 114 FLAX GROWN IN MIXTURES AND ALONE, TOGETHER WITH YIELDS OF THE MIXTURES IN PERCENTAGES BASED ON THE YIELDS OF THE CROPS GROWN ALONE AS 100, THE PERCENTAGES OF WHEAT AND FLAX IN THE MIXTURES HARVESTED, AND THE VALUE OF THE CROPS PER ACRE AT DECEMBER 1 FARM PRICES, 1920-22, INCLUSIVE. UNIVERSITY FARM, ST. PAUL

Crop	Rate of seeding per acre	Proportion of each crop in mixtures sown	Proportion of each crop in mixtures harvested	3-year average yields per acre	Average yields per acre with yields of crops grown alone as 100	Value of crops per acre at December 1 farm prices
	Pounds	Per cent	Per cent	Bushels	Per cent	
Marquis wheat	45.0	62.50	76.55	15.71	.....	\$17.31
N. D. Resistant flax.....	28.0	37.50	23.45	5.38	107.4	10.42
						27.73
Marquis wheat	15.0	26.32	40.86	6.47	.....	7.33
N. D. Resistant flax.....	42.0	73.68	59.14	9.84	102.5	18.51
						25.84
Marquis wheat alone.....	90.0	100.00	100.00	24.64	100.0	27.23
N. D. Resistant flax alone..	42.0	100.00	100.00	13.62	100.0	24.92

The yields of flax in the mixtures during this period were higher than during the previous periods and a good yield of flax alone was secured. In 1920 the yields from the mixtures were lower than from the crops grown alone and in 1921 they were equal. In 1922 the mixture of 45 pounds of wheat and 28 of flax per acre yielded at the rate of 120.1, and the 15 pounds of wheat and 42 of flax at the rate of 115 as compared with the crops grown alone as 100. The variation in the results for the 3-year period due to seasonal conditions is very marked. The average for the 3-year period is 107.4 for the mixture of 45 pounds of wheat and 42 of flax, and 102.5 for the mixture of 15 pounds of wheat and 42 of flax, as compared with the crops grown alone as 100.

In average value per acre of the seed for the 3-year period, the mixture sown at the rate of 45 pounds of wheat and 28 of flax and the wheat sown alone are practically equal, while the values of the crops from the other mixture and the flax alone are lower. The yield of straw from the flax grown alone averaged one ton per acre. This has a farm value of approximately \$3. Adding the value of the straw to the value of the grain, \$27.92 equals the value per acre of the crop from the combination of 48 pounds of wheat and 28 of flax.

YIELDS OF OATS-FLAX AND BARLEY-FLAX MIXTURES

Wheat is not grown regularly in some parts of Minnesota, therefore it appeared advisable to include in the trials mixtures of oats and barley with flax in order to learn the practicability of growing these crops in combination.

IMPROVED LIGOWA OATS AND PRIMOST FLAX

Improved Ligowa is a standard medium maturing variety of oats widely grown in the state. It matures at approximately the same time as Primost flax. Data from the oat-flax mixtures in 1914-15 as compared with growing the crops alone, are presented in Table VII.

TABLE VII

AVERAGE YIELDS PER ACRE OF IMPROVED LIGOWA OATS (MINN. NO. 281) AND PRIMOST FLAX (MINN. NO. 25) GROWN IN MIXTURES AND ALONE, TOGETHER WITH YIELDS OF THE MIXTURES IN PERCENTAGES BASED ON THE YIELDS OF THE CROPS GROWN ALONE AS 100, PERCENTAGES OF OATS AND FLAX IN THE MIXTURES HARVESTED, AND VALUE OF THE CROPS PER ACRE AT DECEMBER 1 FARM PRICES, 1914-15, UNIVERSITY FARM, ST. PAUL

Crop	Rate of seeding per acre	Proportion of each crop in mixtures sown	Proportion of each crop in mixtures harvested	Average yields per acre from three trials	Average yields per acre with yields of crops grown alone as 100	Value of crops per acre at December 1 farm prices
	Pounds	Per cent	Per cent	Bushels	Per cent	
Improved Ligowa oats ...	32.0	60.38	96.18	46.09	....	\$15.76
Primost flax	28.0	39.62	3.82	0.51	94.80	.87
						16.63
Improved Ligowa oats ...	48.0	60.38	98.15	49.85	....	17.03
Primost flax	31.5	39.62	1.85	0.28	99.30	.46
						17.49
Improved Ligowa oats alone	64.0	100.00	100.00	51.92	100.00	17.60
Primost flax alone	42.0	100.00	100.00	12.69	100.00	18.34

The data in Table VII shows very low proportions of flax in the oat-flax mixtures. In 1914, compared with the crops grown alone considered as 100, the mixture of 32 pounds of oats and 28 of flax yielded 103.8, and the seeding of 48 pounds of oats and 31.5 of flax yielded 110.5. In 1915, on land of medium productivity the 32 pounds of oats and 28 of flax yielded at the rate of 91.8; and the 48 pounds of oats and 31.5 of flax at the rate of 104.7, as compared with the crops grown alone considered as 100; while on very productive land both

mixtures yielded less than 100 on the same basis. The averages for the two mixtures for the three tests in the two years were 94.8 and 99.3.

Oat plants are more leafy than wheat plants and shade the flax plants more. The results indicate that the oat-flax mixture is not a desirable one from the standpoint of the flax. Somewhat better yields of flax might be expected in the mixed crop if the amount of oats were limited to 2 pounds or less with 28 of flax per acre.

MANCHURIA BARLEY AND PRIMOST FLAX

The standard variety of six-rowed barley in the state in 1914 and 1915 was Manchuria, Minn. No. 105. This variety has been replaced by Improved Manchuria, Minn. No. 184. Barley and flax were sown in combination at two rates per acre and both crops were sown alone at the full seeding rate. The rate of seeding and the average results for the 2-year period are given in Table VIII.

TABLE VIII
AVERAGE YIELDS PER ACRE OF MANCHURIA BARLEY (MINN. NO. 105) AND PRIMOST FLAX (MINN. NO. 25) GROWN IN MIXTURES AND ALONE, TOGETHER WITH YIELDS OF THE MIXTURES IN PERCENTAGES BASED ON THE YIELDS OF THE CROPS GROWN ALONE AS 100, PERCENTAGES OF BARLEY AND FLAX IN THE MIXTURES HARVESTED, AND VALUE OF THE CROPS PER ACRE AT DECEMBER 1 FARM PRICES, 1914-15, UNIVERSITY FARM, ST. PAUL

Crop	Rate of seeding per acre	Proportion of each crop in mixtures sown	Proportion of each crop in mixtures harvested	Average yields per acre from three trials	Average yields per acre with yields of crops grown alone as 100	Value of crops per acre at December 1 farm prices
	Pounds	Per cent	Per cent	Bushels	Per cent	
Manchuria barley	48.0	69.56	99.73	55.85	....	\$27.19
Primost flax	21.0	30.44	0.27	0.13	96.9	.20
						27.39
Manchuria barley	72.0	69.56	99.52	56.28	....	27.40
Primost flax	31.5	30.44	0.48	0.22	98.5	.39
						27.79
Manchuria barley alone ..	96.0	100.00	100.00	58.41	100.0	28.44
Primost flax alone	42.0	100.00	100.00	9.76	100.0	15.76

The yields of flax in the barley mixtures were so small in every instance that they are negligible. The yields of the mixtures averaged 96.9 and 98.5 as compared with the crops grown alone as 100. Barley is more leafy and lower growing than wheat and therefore does not make a desirable companion crop for flax. Six-rowed barley usually matures approximately two weeks earlier than flax. This makes the

mixture undesirable. Two-rowed barley matures more nearly at the same time as flax. A high-yielding two-rowed variety, such as Svan-sota, sown with flax at the rate of 16 pounds of barley and 28 of flax would be the more desirable mixture if the two crops were to be grown together.

SUMMARY OF RESULTS AT UNIVERSITY FARM

1. Mixtures of Manchuria barley and Improved Ligowa oats with Primost flax sown at the rates per acre of 48 pounds of barley and 21 of flax, 72 pounds of barley and 31.5 of flax, 32 pounds of oats and 28 of flax, and 48 pounds of oats and 31.5 of flax, as shown in Tables VII and VIII, produced very unsatisfactory yields of flax and on the average a lower total yield than either of the crops grown alone.

2. Mixtures of Bluestem wheat and Primost flax sown at the rates per acre of 37.5 pounds of wheat to 21 of flax and 56 pounds of wheat to 31.5 of flax, as given in Table IV, produced very moderate yields of flax and the total yields per acre were not significantly greater than the yields from the crops grown alone.

3. More satisfactory results were secured over the two 3-year periods from growing Marquis wheat and flax together. The highest increase, 20.1 per cent, from growing the crops in combination, was secured in 1922 from the mixture of 45 pounds of wheat and 28 of flax. In 1919 the combination crop sown at the same rate gave an increased yield of 11.8 per cent. For the 6-year period the average increased yield from each of the two combinations was 6.25 per cent. Two different mixtures of Marquis wheat and flax were grown for six years, making twelve separate tests during the period. In only one of these twelve tests did the yield of flax in a mixture equal the yield of flax grown alone under like conditions.

4. In values per acre figured on December 1 farm prices, except during the period 1917-19 when the price of wheat was very high as compared with that of flax, the mixed crops averaged somewhat higher than the flax grown alone when the seed yields alone are considered. When the farm value of the clear flax straw is considered, the flax crop had as high values per acre as the mixed crops.

YIELDS REPORTED BY GOODHUE COUNTY GROWERS

Marquis wheat is used in the mixtures almost exclusively in Goodhue County. The flax grown is of no particular variety, altho some North Dakota Resistant No. 52 has been brought in. This is a wilt-resistant strain developed in North Dakota.

Yields were reported by growers in 1919 and again in 1922. In 1919 six reports were received from fields sown at the rate of 30 pounds of wheat and 28 of flax per acre. The average yield was 5.16 bushels of wheat and 9.38 of flax. Three reports were received from fields sown at the rate of 15 pounds of wheat and 28 of flax. The average yield was 7.33 bushels of flax and 7.66 of wheat per acre.

In 1922 reports were received on twenty-two fields sown to 30 pounds of wheat and 28 of flax per acre. The average yield was 6.25 bushels of wheat and 9.9 of flax. The yields varied from no wheat and 10 bushels of flax per acre to 9 bushels of wheat and 13 of flax. Eleven reports were received from fields sown to 15 pounds of wheat and 28 of flax. The average yields were 4.09 bushels of wheat and 13.36 of flax per acre. The yields varied from one bushel of wheat and 19 of flax to 8 bushels of wheat and 12 of flax per acre.

Four reports were received from fields sown to from 45 to 60 pounds of wheat and 28 of flax per acre. These averaged 9 bushels of wheat and 10.37 of flax, with a range from 5 bushels of wheat and 8 of flax to 13 bushels of each per acre.

In considering these data it is necessary to keep in mind that, while the mixed crop has been grown for several years the reports cover only two years and that wheat and flax grown alone on the same fields were not available for comparison.

ADVANTAGES OF GROWING THE MIXED CROP

1. Increased seed yields per acre on the average result from growing the mixed crop. The carefully conducted experiments at University Farm show that in some years the increase in yield may be as high as 15 or 20 per cent, while in other years there is no increase. On the average, over a period of years, from 5 to 10 per cent increase may be expected from the mixed crop as compared with either crop alone. While there may be instances in which the flax in the mixed crop yields as much as flax grown alone under the same conditions, the indications are that this is comparatively rare. The increased yields are due, in part at least, to the following:

a. Early planting, when sown with the wheat. It is definitely known that flax planted early is less subject to wilt and other diseases than flax planted late in the season. Flax alone may be planted early but is less likely to be than when sown with wheat.

b. Marquis wheat appears to be somewhat less affected by disease, particularly black stem rust, when it is grown in the mixtures than when grown alone. However, where epidemics of black stem rust are general, very marked reductions in yield of Marquis or any rust susceptible wheat grown in combination with flax may be expected.

c. Weeds are not so much a factor in the mixed crop as in flax grown alone. The wheat in the mixed planting grows taller than the flax and crowds out and reduces by partial shading many of the common weeds which would grow in flax planted alone. Wild oats make as vigorous a growth in the mixed crop as in either alone.

2. The values per acre of the mixed crops as compared with the crops grown alone depend on the relative prices per bushel of the wheat and flax. Where the flax straw can be sold for manufacturing purposes, this additional revenue must be credited to flax grown alone.

3. Each operation in handling the mixed crop can be accomplished with greater ease and satisfaction than when the flax crop is grown alone. The binder cuts, elevates, and binds the mixed crop more easily, and better bundles are made. The greater length of the bundles due to the presence of the wheat and the taper toward the top, makes it possible to build better shocks and stacks of the mixed crop than of flax alone. The mixed crop goes through the thresher more satisfactorily than clear flax. Adjustment of the sieves and the wind blast in threshing the mixed crop is no more difficult than for either crop alone.

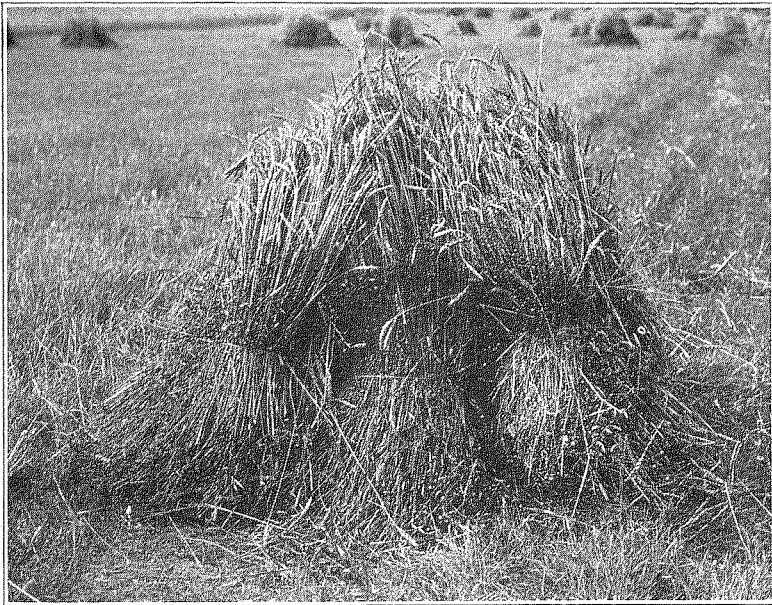


Fig. 4. Shock of Wheat—Flax Mixture

The bundles taper to the top and are as easily shocked and stacked as bundle of wheat alone.

DISADVANTAGES OF THE MIXED CROP

1. In the territory where there is a ready market for clear flax straw, on the average the value of the straw from the flax crop grown alone offsets the value of the increases in seed yields obtained by growing the mixtures. Mixed wheat and flax straw is not used by the industries utilizing clear flax straw. Therefore growers of the mixed crop can not look forward to an income from the sale of straw for manufacturing purposes.

2. The mixed crop must be separated before it is marketed. This may be done easily and rapidly at times when other work is not pressing by using an ordinary fanning mill properly adjusted. Write to the Division of Farm Engineering, University Farm, St. Paul, for plans for a homemade mill.

GROWING THE WHEAT-FLAX CROP

In the rotation the mixed crop should usually follow meadow and pasture crops or corn that has been kept clean. Flax is an ideal crop on fall plowed meadow and pasture lands. There are indications that corn is a better crop than wheat to follow meadows and pastures.

If wilt-resistant flax is used, the mixed crop may be one of the regular grain crops in a 3-, 4-, or 5-year rotation.

Fall plowing is necessary in order that the seedbed may be prepared and the crop sown at wheat seeding time. Careful tests conducted at University Farm, where wheat was sown at the usual time and at ten-day intervals thereafter, show on the average for a 3-year period a reduction in yield of approximately five bushels per acre for each ten days' delay in seeding.

Marquis wheat has proved fairly satisfactory in the mixtures. A rust-resistant variety with the milling qualities of Marquis would be still better. Where epidemics of black stem rust are general, the yields of Marquis wheat in the mixtures will be materially reduced.

As far as possible wilt-resistant varieties of flax should be used in the mixtures. Seed of North Dakota Resistant No. 114 has been available for some time. For several years the demand for good seed of the best wilt-resistant varieties has been greater than the supply.

The amount of wheat and flax seed in the mixtures sown should be governed somewhat by the relative market prices of the two crops. The extent of the damage to wheat by black stem rust and to flax by wilt and other diseases, and the character of the season influence the percentages of each in the crops harvested. Mixtures of 15 pounds of wheat and .28 of flax per acre result, on the average, in more flax than

wheat. The result from 30 to 45 pounds of wheat and 28 of flax per acre is, on the average, as many bushels of wheat per acre as of flax, or more.

The wheat and flax seed should be combined in the desired proportions and mixed thoroly in the granary. This mixed seed is then drilled at a depth of from 1 to 1½ inches at the usual time for seeding wheat, or a few days later. No injury to the flax crop from frost, due to seeding the mixtures as early as wheat, has resulted at University Farm during the last ten years. Where hard frosts are frequent for a considerable period after the usual wheat seeding time, this fact should be taken into consideration in planting the combination crop. When the mixed crop is sown several weeks or more later than the usual time for seeding wheat, lower yields of both wheat and flax must be expected.

MIXED CROP MAY BE EXTENDED IN SOUTHEASTERN MINNESOTA

The wheat-flax combination crop is grown successfully and extensively in good rotations in Goodhue County and, to some extent, in adjacent counties. The mixed crop should give similar results when grown in all the counties in southeastern Minnesota where the climatic and soil conditions are similar to the conditions in Goodhue County. When grown in good rotations, the mixed crop should be satisfactory also in the south central part of the state. The mixed crop should not replace the clear flax acreage in that region but should take the place to some extent of other cash crops, particularly oats, which at present prices are relatively unprofitable. Farmers should not be encouraged to grow the mixed crop in localities where a satisfactory and reliable market for flax straw has been established. What results may be secured from the mixed crop in the central and western parts of the state where the rainfall averages less and soil conditions are different, can only be found by trial.