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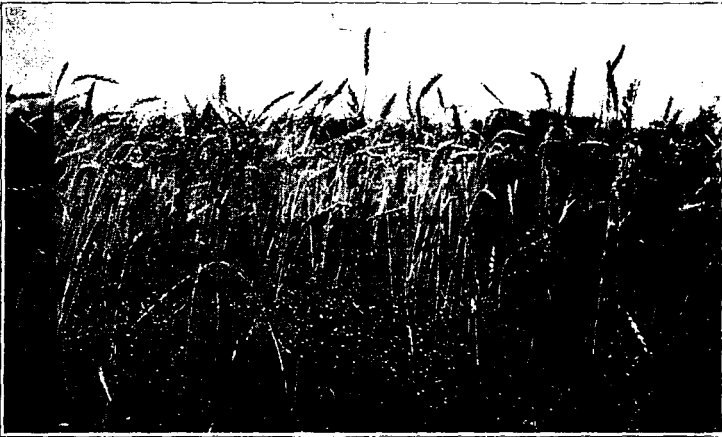
WHEAT AND FLAX AS COMBINATION CROPS

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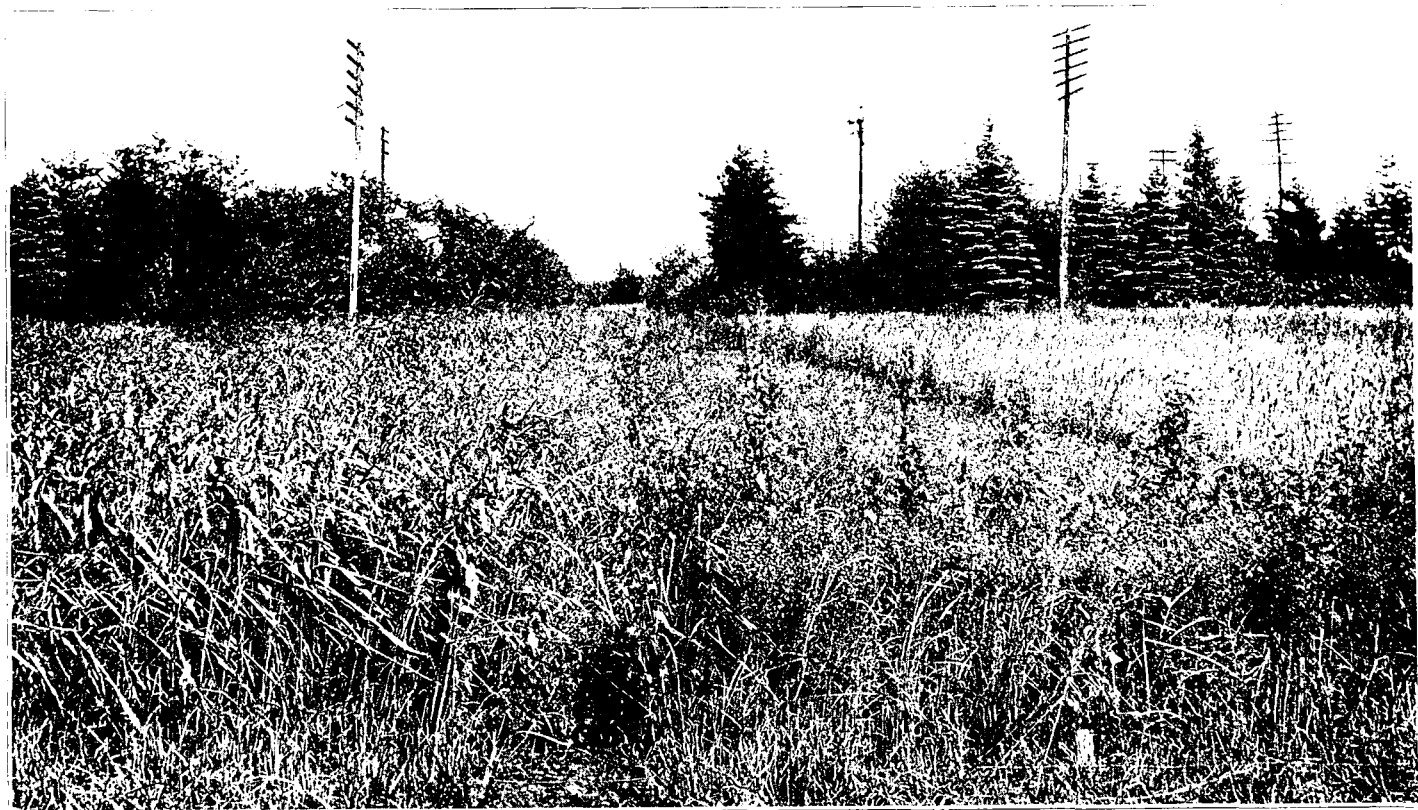


Fig. 1. Wheat and Flax Combination Crop

At extreme right the crop is practically free from weeds. In the center the flax alone was sown at the same time. It shows a good many weeds. At extreme left, flax sown ten days later than that in the center was practically choked out by weeds.

WHEAT AND FLAX AS COMBINATION CROPS

By A. C. ARNY

The demand for linseed oil in the United States is such that the crushers require approximately thirty million bushels of flax seed a year. A decided change in conditions in the United States, which is improbable; or a marked change in the tariff of 40 cents a bushel on flax or 35 cents a pound on oil, might result in a lower demand for linseed oil or in its direct import. Either of these conditions might lower the demand for flax seed.

In 1923, in the United States, 17,500,000 bushels of flax seed were produced. This leaves approximately fifteen million bushels for crushing after the amount needed for seeding in 1924 is taken out. From 15,000,000 to 20,000,000 bushels must be imported from Argentina this year to make up the deficiency in the crop produced in this country.

An increase of approximately one million acres in the land planted to flax in the United States in 1924, with an average yield of 9 bushels per acre, will still leave a considerable need for imported flax seed. Farmers in Minnesota can with profit to themselves increase the acreage in the state from 40 to 50 per cent over that of 1923. Any method that will extend the flax acreage beyond that suited to growing flax alone is well worth serious consideration.

In Bulletin 204 of the Minnesota Agricultural Experiment Station series are given the results of growing wheat and flax as a combination crop since 1913. Before wilt-resistant varieties of flax were available, the combination crop had practically no advantage in yield over flax grown alone. However, with the introduction of wilt-resistant flax, the combination crop yielded on the average from 2.5 to 10 per cent more than the flax grown alone over two periods of three years each. These results are given in Table I.

Throughout the first three-year period the price of wheat was very high as compared to the price of flax, and wheat alone was the most profitable crop. In the next three-year period the acre values of the combination crops were greater than that of flax alone. Of one combination the acre value was greater and of the other less than of wheat grown alone. The showing for the combination crop was very favorable in the second three-year period.

TABLE I

Average yields per acre of Marquis wheat and 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 mixtures harvested, and the value of the crops per acre at December 1 farm prices. 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	Bu.	Per cent	
3-year average, 1917-19						
Marquis wheat.....	45.0	62.50	91.27	31.21	....	\$65.81
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
3-year average, 1920-23—						
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	19.84	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

RESULTS WITH THE COMBINATION CROP IN 1923

Carefully conducted tests were made at several points in the state in 1923. Arrangements were made through the county agents for co-operative work on farms. The names of the co-operators, the county agents, and the counties are tabulated.

Co-operator	County Agent	County
Henry Schwartau	V. H. Kingsbury	Goodhue
Henry Heinrichs	V. H. Kingsbury	Goodhue
Tobias Peterson	F. E. Krause	Faribault
A. R. Wolfe	F. C. Hathaway	Renville
R. F. Nash	L. S. Stallings	Wilkin
F. W. McGinnis	.....	Clay

The combination crops were also grown at the West Central and Northwest Experiment Stations, at Morris and Crookston, respectively, in co-operation. The results at each of these places are included in the annual reports of the stations.

Seed of Marquis or Kota wheat was combined with that of wilt-resistant flax in the proper proportions at University Farm for each of the seedings, and sent to the co-operators together with seed for each crop alone. Each of the drills was carefully calibrated and the seedings were made according to the plan previously prepared. This was necessary in order that the seedings at the various locations be as nearly the same in every respect as careful work could make them.

The plots were 8 rods long and $8\frac{1}{4}$ feet wide with 18-inch alleys between each two. The drill rows were 6 inches apart. Each rate of seeding of each combination crop and of the crops grown alone was made in triplicate. In addition to the six carefully controlled trials on farms and the three at the stations, co-operative work was done according to another plan in which each farmer did the seeding himself.

When the crop was mature, six square yard areas of standing grain were carefully removed from each plot, bagged, and shipped to University Farm for threshing and cleaning. Neither wheat nor flax shatters easily on maturing, hence there was no loss from that source.

The wheat and flax crops were grown alone side by side with the combination crop. Under these conditions with wheat averaging 14.46 bushels and flax 10.77 bushels per acre, the flax alone yielded 0.755 as many bushels as the wheat alone. Multiplying, then, the yield of wheat in the combination by the factor derived in this way for each test reduces them to a flax equivalent. Adding the flax equivalent of the wheat in each combination to the flax yield gives the yield per acre on a flax basis. Dividing then by the yield of flax alone gives the percentage increase or decrease in yield as compared with flax grown alone. Computing the wheat equivalent of the flax would serve the same purpose.

In the interpretation of the results, differences in yield of less than 10 per cent are not considered significant. Increases of less than 10 per cent occurring continually in trials over several years would indicate real increases in yields. The value of the crops grown alone and in combination was computed on the December 1 farm prices given in the yearbooks of the United States Department of Agriculture.

In considering the yields of the 1923 crops it is necessary to bear in mind that for any one location the single trial is not conclusive. With a background of similar work previously done, the results from the large number of trials form a good basis for several general conclusions and recommendations.

The summarized data for all locations, in 1923, are given in Table II. They are based on the consideration of all the data.

Space does not permit the inclusion of the detail tables showing the results at each location. The average results for all locations are shown in Table II. The summary based on all the data is given below.

SUMMARY OF RESULTS FOR 1923

1. For the year, combination crops were found to do well in eight out of nine counties where trials were conducted. In Faribault County, owing to excessive rain in the spring and practically no rain in July, the combination seedings yielded less than the crops sown alone.

2. Out of 45 carefully controlled trial seedings at various rates, 29 gave some increase in yield due to growing wheat and flax in combination as compared with growing either alone. For 10 seedings the increases were over 10 per cent.

3. The seeding of 45 pounds of wheat and 42 pounds of flax per acre averaged the highest increase in yield per acre, followed by the seedings at the rate of 45 pounds of wheat and 28 pounds of flax, and 30 pounds of wheat and 28 pounds of flax, respectively. Forty-two pounds of flax per acre in the combination crop gives higher yields than 28 pounds.

4. In the seedings of flax alone the average advantage in favor of sowing 42 pounds per acre was one-half bushel increase in the trials on farms and nearly one-half bushel at the stations. The fact that in the majority of the trials the yields were somewhat greater for the heavier seeding rate makes it appear advisable until further data are available to use the 42 pound rate of seeding.

5. In the southern part of the state flax straw yields were approximately two tons per acre. In central and northern parts of the state approximately one ton.

6. The proportion of wheat and flax in the crops harvested from the 30 pound wheat and 28 pound flax seeding was maintained approximately. With lower seeding rates of wheat, the percentage of flax increased in the crop harvested.

7. The cash value of the combination crops exceeded that of wheat grown alone with only two exceptions. The average increase in value in favor of the combination crop as compared with wheat alone was \$5.46 in the trials on farms and \$7.03 in the trials at the stations.

As compared with the cash values per acre of flax grown alone the combination crops averaged \$2.86 per acre less.

ADVANTAGES OF GROWING THE COMBINATION CROP

Except in southwestern Minnesota, the results for the year indicate that the combination crop may be grown in the state with the probability of securing increased total yields in many instances. Differences in habits of plant growth both above and below ground probably account to some extent for these increases. Other factors are as follows:

1. Early planting of flax when grown with wheat results in larger flax yields. Even resistant varieties of flax are less injured by diseases when planted early than when planted late. Flax grown alone should be planted early but is less likely to be planted early than when planted with wheat.

2. Sowing 45 and 30 pounds of wheat in the combination crop definitely controls weeds with the exception of wild oats. Fifteen pounds of wheat in the combination will not control weeds. The use of the combination crop permits the growing of some flax successfully on land too weedy for flax alone and makes for a more extensive flax acreage. It is not recommended that flax be grown on land known to be particularly weedy.

3. With the combination crop there is less danger of serious crop failure due to black stem rust of wheat and flax wilt than with either crop grown alone.

4. The combination crop is easier to handle than flax alone. In every necessary operation it is as easily handled as wheat grown alone. This fact should tend to extend the flax acreage on farms where growers dislike to handle clear flax.

5. Flax and Marquis wheat lodge less on highly productive soil than flax grown alone.

6. Separation of the seed is accomplished easily by an ordinary fanning mill properly adjusted. Plans for a home-made mill of larger capacity can be obtained from the Division of Farm Engineering, University Farm, St. Paul, Minn.



Fig. 2. Harvested Grain and Flax from Different Plots

At left, bundle from clear wheat seeding. Practically no weeds present. In center, bundle from 45 pounds wheat and 30 pounds flax seeding. Practically no weeds present. At right, bundle from 15 pounds wheat and 30 pounds flax seeding. Large weeds and foxtail very abundant.

DISADVANTAGES OF GROWING COMBINATION CROPS

Clear flax straw has a farm value of approximately \$3 per ton in the territory where there is a ready market for it. In addition the baling and hauling of the straw offers employment at fair wages during the dull season. Mixed flax and wheat straw can not be used in manufacturing operations.

GROWING THE COMBINATION CROP

In rotations the best place for the combination crops is following corn that has been kept clean or on timothy and clover sod. Poor results with the wheat in the combination will usually result on old pastures. Land that has been in timothy without clover is better suited to corn if manure can be applied, than to the combination crop or flax alone.

Wilt-resistant varieties of flax must be used when the crop is grown in rotation.

Fall plowing is necessary in order that the crop may be sown early. Any clear wheat that is to be sown should be put in first and following that the combination crop may be sown immediately. At University Farm injury by frost has not occurred to early sown flax in the last ten years. On peat lands there is more danger of frost injury than on mineral soils. After the flax plants have passed the two-leaf stage, they are much more resistant to cold and, unless frosts are very severe, there is not much danger. Before the plants are up there is little danger of frost injury.

The seed should be mixed in the granary in the proportions of 30 to 45 pounds of wheat to 42 pounds of flax and sown with the ordinary drill at the rate of 75 to 87 pounds per acre, depending on the combination used. Drills are so variable in the amount they sow per acre in relation to the adjustment that no rule can be given for setting. It is necessary to try out each drill in order to properly adjust it. Plant at a depth of from one to one and one-half inches. Where grass and clover seed is usually sown with grain, the combination crop can be used for that purpose to good advantage.