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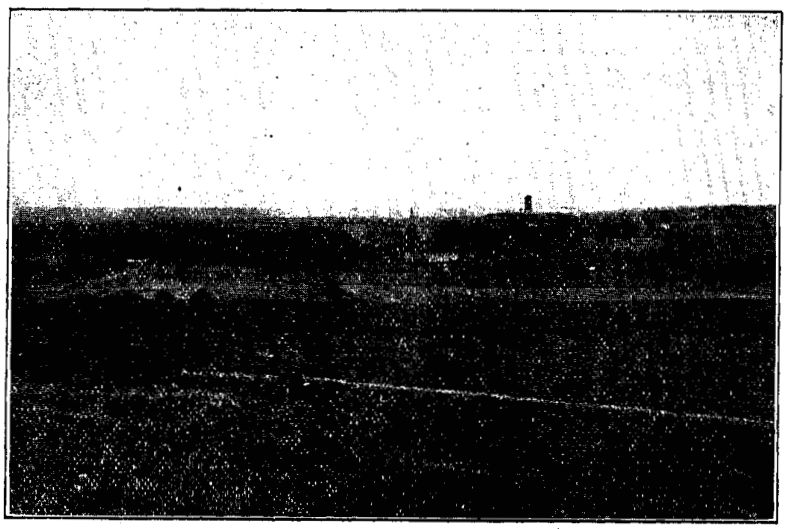
Agricultural Experiment Station

Small Grain Crops



Experimental plots; College Buildings in Background.

BY

A. M. Ten Eyck and V. M. Shoesmith

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Small Grain Crops

By A. M. TenEyck and V. M. Shoesmith

A report of crop experiments conducted in 1903 was published in Bulletin No. 123. This bulletin gives the results of experiments conducted with small grains in 1904, 1905, and 1906, and when the same tests were made in 1903 the average yields are given for the four years. Practically all of the crop experiments begun in 1903 have been continued during the past three years. In the variety trials, undesirable varieties have been discarded as soon as their qualities have been sufficiently tested, but on account of the many new varieties received this work has become much greater in amount than in 1903.

Although a relatively small amount of rainfall was received during the late falls and winters of 1903-'04, and 1904-'05, the growing seasons of 1904 and 1905 were favorable for crop production. The rainfall was not so great during the cropping seasons of 1904 and 1905 as in 1903. In 1906 the spring was very dry, which resulted in very small yields of spring grains, and the corn crop was somewhat injured by the hot, dry weather during the latter part of the summer. Otherwise, the season of 1906 was very favorable for crop production.

A summary of the weather, crop, and soil conditions which prevailed during each of the several cropping seasons are reported in tables I, II, III, and IV.

Winter Grains

A TRIAL OF VARIETIES OF WINTER WHEAT

The variety test of winter wheat in 1904 was conducted in a field having a western slope and a rather heavy, clay-loam soil, in which cow-peas had been grown in 1901, soy-beans in 1902, and varieties of spring grains in 1903. The field had been cultivated well in previous years and was exceptionally free from weeds. No experiments were conducted in this field previous to 1903, and the plots in the 1904 test extended north and south, crossing those of the former experiment, so that fairly uniform soil conditions were secured; but because of the length of the series of plots and the

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TABLE I.—Trimonthly and monthly weather and crop report, March 1 to November 1, 1903.

MONTH—DAYS, 1903.	Average temperature.			Weather.*				Rainfall, in inches.	Condition of soil.	Progress of the work and condition of crops.
	Maximum.	Minimum.	Mean.	Clear days.	Part cloudy.	Cloudy	Prevailing winds.			
March 1–10	50.0	29.0	39.5	4	2	4	S.W. and N.W.	.30	Wet	Cold and wet; soil not workable.
" 11–20	64.0	36.0	50 0	1	6	3	N.W. and S. E.	.50	Favorable	Began plowing and other spring work.
" 21–31	61.0	29.0	45.0	7	4	0	S.W. and N.E.	.50	"	Sowed varieties of early grain.
Monthly totals and aver.	58.4	31.2	44.8	12	12	7	S.W. and N.W.	1.30	"	Spring backw'd, but favorable for sowing at close of month.
April 1–10	74.0	41.0	57.5	6	3	1	S.W. and N.W.	.75	Favorable	Plowing for corn.
" 11–20	79.0	44.0	61.5	4	5	1	N.W. and S. E.	1.10	"	Plowing for corn; preparing seed-bed.
" 21–30	72.0	42.0	57.0	6	1	3	N. and S.	1.20	"	Commenced planting corn.
Monthly totals and aver.	75.0	42.3	58.6	16	9	5	N.W. and S.W.	3.05	"	Early crops growing well.
May 1–10	82.0	45.0	63.5	4	5	1	S. E. and S.W.	.85	Favorable	Finished planting early corn.
" 11–20	78.0	56.0	67.0	3	2	5	S. and S.W.	2.75	Wet & fav.	Harrowed corn; soil mostly too wet to work.
" 21–31	83.0	60.0	71.5	1	2	8	S. and S.W.	9.37	Wet	Too wet to cultivate; crops backward, weedy.
Monthly totals and aver.	81.0	53.8	67.6	8	9	1[illegible]	S. and S.W.	12.97	"	Crops injured by floods, excessive moisture. Soil compact.
June 1–10	77.0	55.0	66.0	6	2	2	N.W. and N.	.39	Wet & fav.	Corn cultivated.
" 11–20	55.0	54.0	69.5	6	4	0	N., S., W.	.02	Favorable	Late crops planted.
" 21–30	88.0	60.0	74.0	7	3	0	S.W. and N.W.	1.10	"	All crops cultivated: small grains ripening.
Monthly totals and aver.	73.8	56.4	69.9	19	9	2	N.W. and N.	1.51	"	Cultivated crops growing well; grain crop promising.
July 1–10	95.0	67.0	81.0	5	4	1	S.W. and S. E.	.65	Favorable	Harvested varieties of small grain.
" 11–20	94.0	67.0	80.5	3	4	3	N. E. and E.	1.67	"	Cultivated late crops.
" 21–31	92.0	66.0	79.0	5	5	1	S. and E.	1.48	Dry	Thrashed varieties of grain.
Monthly totals and aver.	93.6	66.6	80.1	13	13	5	S., S. E., S.W.	3.80	Favorable	Late crops grow'g well; corn promising crop.
August 1–10	91.0	66.0	78.5	4	6	0	S. and S.W.	3.72	Favorable	Plowing for fall seeding; cultivating.
" 11–20	87.0	62.0	74.5	7	3	0	E. and S. E.	2.45	Wet & fav.	Plowing for fall seeding; cultivating.
" 21–31	82.0	64.0	73.0	9	2	0	S.W. and N.	.00	Favorable	Hauled manure; pulled and cut weeds.
Monthly totals and aver.	86.5	64.0	74.9	20	11	0	S.W., S., S. E.	6.17	"	Crops look well; weeds made great growth.
September 1–10	89.0	60.0	74.5	5	4	1	S.	.96	Dry	Harvested silage corn; too dry to plow.
" 11–20	78.0	52.0	65.0	6	3	1	N and S.W.	.97	Favorable	Harvested corn and soy-beans.
" 21–30	80.0	53.0	66.5	5	4	1	S.W. and N.	1.05	Dry	Harvested cane and Kafir-corn.
Monthly totals and aver.	82.3	55.0	68.6	16	11	3	N., S.W., S.	2.98	"	Good yld. forage crops; corn cut and in shock.
October 1–10	77.0	51.0	64.0	7	3	0	N.	.05	Favorable	Sowed varieties of winter wheat.
" 11–20	67.0	37.0	52.0	5	2	3	N. and N. E.	2.25	Wet	Harvested cow-peas, late corn, etc.
" 21–31	69.0	39.0	54.0	9	0	2	S.W.	1.60	Favorable	Thrashed soy-beans.
Monthly totals and aver.	70.9	42.0	56.5	21	5	5	N. and S.W.	3.90	"	Harvest finished.
Totals and averages for season	77.7	53.1	65.1	125	79	41		35.68		A favorable season, except in May, and good average crops.

*Light frosts, April 22 and May 3, September 17, 24, 28, and October 8; killing frosts, April 30, May 1 and 2, October 15, 16, 18, 23, and 24.

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TABLE II.—Trimonthly and monthly weather and crop report, March 1 to November 1, 1904.

MONTH—DAYS, 1904.	Average temperature.			Weather.*				Rainfall, in inches.	Condition of soil.	Progress of the work and condition of crops.
	Maximum.	Minimum.	Mean.	Clear days.	Part cloudy.	Cloudy	Prevailing winds.			
March 1-10	59.6	26.3	43.0	8	2	0	N.W.	.22	Dry	Soil dry & loose at surface; sprg. wrk. begun.
" 11-20	53.6	33.2	43.4	4	4	2	N.	.68	Favorable..	Win. gr. start'g well; began seed'g sprg. gr.
" 21-31	58.3	37.6	48.0	5	4	2	N.W. and S.W.	1.25	" ..	Plowing for corn. [much warm weather.
Monthly totals and aver.	57.2	32.4	44.8	17	10	4	N.W.	2.15	" ..	Favorable for spring work; spring opened early but not
April 1-10	59.2	33.9	46.5	5	2	3	N.W.	.65	Favorable..	Plowing for corn.
" 11-20	60.7	35.0	47.9	8	0	2	N. E. and N.W.	1.20	" ..	Plowing and preparing seed-bed for corn.
" 21-30	69.9	42.5	56.2	6	0	4	E.	2.71	" ..	Planting corn. [crops.
Monthly totals and aver..	63.2	37.1	50.2	19	2	9	N.W. and N. E.	4.56	" ..	Soil in good condition; fav. for plant'g sprg.
May 1-10	75.9	51.1	63.5	4	3	3	S. E.	2.02	Favorable..	Finished planting early corn. [favorable.
" 11-20	71.4	46.1	58.8	5	2	3	N.W. and S.W.	1.40	" ..	Harrowed corn; weather and soil conditions
" 21-31	78.0	62.1	70.1	3	5	3	S.W. and N. E.	2.25	" ..	Cultivating corn [doing well.
Monthly totals and aver..	75.1	53.1	64.1	12	10	9	S.W. and S. E..	5.67	" ..	Weather and soil conditions favorable; crops
June 1-10	80.8	58.4	69.6	4	3	3	W. and E.	1.92	Wet & fav..	Cultiv. corn; plant'g soy-beans, cow-peas, cane & Kafir-corn.
" 11-20	86.5	62.8	74.7	2	8	0	S.W.	1.01	Favorable..	Rather wet; cultivated crops weedy.
" 21-30	84.6	60.9	72.8	2	5	3	S.W.	3.38	" ..	Harvested most of the small grain.
Monthly totals and aver..	83.6	60.7	72.1	8	16	6	S.W.	6.31	" ..	Cultivated crops growing well.
July 1-10	86.2	64.2	75.2	3	5	2	S.W.	5.24	Wet	Too wet for field work except July 1 and 2.
" 11-20	91.0	68.5	79.8	8	2	0	S.	.74	Favorable..	Finished harvest'g and threshed small grain.
" 21-31	82.8	62.2	72.5	4	5	2	S. E. and N.	.67	" ..	Cultivating late crops. [cult. flds. weedy.
Monthly totals and aver..	86.6	65.0	75.8	15	12	4	S.	6.65	Wet & fav..	Too wet during first of month; difficult to harvest gr. crp.;
August 1-10	84.4	61.7	73.1	4	6	0	N. E. and S. E.	.00	Rather dry.	Cultiv. late crps; need'g rain, tho crps. don't seemed to have
" 11-20	88.5	65.3	76.9	5	4	1	S.	.86	Dry & fav..	Plowing for fall seeding. [suffered much.
" 21-31	84.5	66.5	74.8	5	5	1	N. E. and S. E.	1.03	Favorable..	Plowing for fall seeding.
Monthly totals and aver..	85.8	64.5	75.2	14	15	2	N. E. and S. E.	1.89	Dry & fav..	Corn & late crops, well cultiv., are promising.
September 1-10	85.7	56.3	71.0	8	1	1	S.	.00	Favorable..	Plowing and harrowing for fall seeding.
" 11-20	83.2	51.8	67.5	8	0	2	N.W. and S.W.	.57	" ..	Harvested silage corn.
" 21-30	83.0	64.8	73.9	1	4	5	S.	3.54	" ..	Harvesting corn; began sowing fall grain.
Monthly totals and aver..	84.0	57.6	70.8	17	5	8	S.	4.11	" ..	Good yields of forage crops.
October 1-10	78.2	55.0	66.6	5	4	1	N.W. and S.W.	.30	Favorable..	Finish'd seed'g small gr. Thresh'd soy-beans.
" 11-20	78.4	49.3	63.9	6	2	2	S. E. and S.W.	.69	" ..	Husking corn; plowing for spring crops.
" 21-31	69.0	32.0	50.5	10	0	1	N.W.	.00	" ..	Harvesting Kafir-corn; plow'g for sprg. crps.
Monthly totals and aver..	75.2	45.3	60.3	21	6	4	N.W. and S.W.	.99	" ..	Weather favorable for harvest'g late crops.
Totals and averages for season	77.6	52.0	64.8	123	76	46	S.W. and S. E.	32.33	Favorable..	A favorable season except too wet in grain harvest; good crops except oats & barley.

*Killing frosts, October 22, 23, and 25.

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TABLE III.—Trimonthly and Monthly Weather and Crop Report, March 1, to November 1, 1905.

MONTH—DAYS, 1905.	Average temperature			Weather.*				Rainfall, in inches.	Condition of soil.	Progress of work and condition of crops.
	Maximum.	Minimum.	Mean.	Clear days.	Part cloudy.	Cloudy	Prevailing winds.			
March 1-10	62.3	34.2	48.2	6	1	3	S. W. and N.	.00	Wet	Soil wet until Mar. 6, when plg. and other spr. wk. was begun.
" 11-20	56.7	38.7	47.7	0	1	9	S. W. and E.	2.23	Wet	Soil in good condition, began seeding small grains.
" 21-31	68.9	44.5	56.7	4	5	2	S. W. and N. W.	.20	Favorable.	Seeded varieties of small grains.
Monthly totals and aver.	62.7	39.0	50.8	10	7	14	S. W. and N.	2.43	Wet & fav.	Soil and weather cond's fab'le for seeding.
April 1-10	73.4	41.3	57.4	5	4	1	N. W. and S. W.	.55	Favorable.	Preparing for the planting of corn.
" 11-20	64.9	34.4	49.6	3	3	4	N. and W	.00	"	Preparing for the planting of corn.
" 21-30	73.0	46.7	59.8	7	1	2	N. W. and S. W.	1.15	"	Sowed flax and commenced planting corn.
Monthly totals and aver.	70.6	40.8	55.6	15	8	7	N. W. and S. W.	1.70	"	Early crops growing well.
May 1-10	79.5	51.7	65.6	5	3	2	S. W	.58	Favorable.	Finished planting corn.
" 11-20	76.9	51.4	64.1	5	4	1	W. and N. W.	.55	"	Began cultivating corn.
" 21-31	77.6	54.9	66.2	5	2	4	S. W. and E.	4.88	"	Cultivating corn; cutting first crop of alfalfa.
Monthly totals and aver.	78.0	52.6	65.3	15	9	7	S. W. and N. W.	6.01	"	Small grains and corn growing well.
June 1-10	92.2	68.3	80.2	9	1	0	S. and S. E.	.00	Favorable.	Planted late crops.
" 11-20	92.0	63.3	77.6	6	4	0	S. W. and N. W.	1.32	"	Harvested most of wheat.
" 21-30	89.5	63.9	76.7	4	5	1	W. and N. E.	2.57	"	Harvested small grain. [well.
Monthly totals and aver.	90.6	65.2	78.2	19	10	1	S. W. and N. W.	3.89	"	Good grain crops secured; late crops growing
July 1-10	83.0	59.9	71.4	6	3	1	N. W. and W.	1.92	Favorable.	Cultivating late crops.
" 11-20	95.7	66.8	81.2	10	0	0	S. and N.	.00	"	Threshed small grains.
" 21-31	85.8	65.2	75.5	4	4	3	N. E. and N. W.	3.03	"	Cultiv'ting late crops; pl'wing for fall seeding.
Monthly totals and aver.	88.2	63.6	76.0	20	7	4	N. W. and S.	4.95	"	Corn promises good crops.
August 1-10	91.6	65.2	78.4	5	3	2	S. W. and N. E.	.78	Favorable.	Plow'g for fall seeding; soil in fair condition.
" 11-20	92.1	66.5	79.3	6	4	0	S. E. and S.	.72	"	Plowing for fall seeding; weather very hot.
" 21-31	95.7	67.1	81.4	8	2	1	S. and E.	.00	Little Dry.	Plowing, but soil getting hard and dry.
Monthly totals and aver.	93.1	66.2	79.7	19	9	3	S. and S. E.	1.50	Favorable.	Corn injured considerable by hot weather.
September 1-10	79.1	57.8	68.4	2	3	5	N. and W	2.28	Favorable.	Preparing for seeding of winter grains.
" 11-20	84.4	60.9	72.6	4	5	1	S. W. and E.	2.02	Wet & fav.	Harvested ensilage corn. [able.
" 21-30	90.0	60.4	75.2	7	3	0	S. W.	.02	Favorable.	Seeding winter grain; soil conditions favor-
Monthly totals and aver.	84.5	59.7	72.1	13	11	6	S. W. and S. E.	4.32	"	Good y'lds of f'ge crps, exc't corn which is fair.
October 1-10	80.9	51.2	66.0	9	0	1	S. and N.	.33	Favorable.	Seeding winter grain.
" 11-20	65.3	39.1	52.2	4	2	4	N. and S. W.	.37	"	Harvesting Kafir-corn and other late crops.
" 21-31	56.6	33.6	45.1	5	0	6	N. and S. W.	1.49	"	Husking corn; plowing for spring crops.
Monthly totals and aver.	67.6	41.3	54.4	18	2	11	N. and S. W.	2.19	"	Harvest practically finished.
Totals and averages for season	79.4	53.5	66.5	129	63	53	S. W. and N.	28.77	Favorable.	A fav'ble season ex'pt we'th'r too hot and dry for corn in Aug.; corn fair, other crps. good.

*Killing frost, October 11.

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TABLE IV.—Trimonthly and monthly weather and crop report, March 1 to November 1, 1906.

MONTH—DAYS, 1906.	Average temperature.			Weather.*				Rainfall, in inches.	Condition of soil.	Progress of the work and condition of crops.
	Maximum.	Minimum.	Mean.	Clear days.	Part cloudy.	Cloudy	Prevailing winds.			
March 1-10	43.9	25.1	34.5	3	2	5	S.W. and N. E.	1.14	Wet	Too wet and cold for field work.
" 11-20	30.0	12.5	21.2	4	1	5	N.W. and N. E.	.52	"	Too wet and cold for field work.
" 21-31	50.4	31.2	40.8	4	1	6	N.W. and N. E.	.36	"	Too wet and cold for field work.
Monthly totals and aver.	41.4	22.9	32.1	11	4	16	N. E. and N.W.	2.02	"	Winter was mild, but spring backward.
April 1-10	67.8	40.6	54.2	5	0	5	N.W. and S. E.	1.20	Favorable	Seeding spring grain.
" 11-20	72.5	46.0	59.2	6	2	2	E. and N.W.	.43	"	Plowing for corn. Seeding flax.
" 21-30	81.0	50.0	65.5	6	1	3	E. and S.W.	1.13	"	Planting corn.
Monthly totals and aver.	73.7	45.5	59.6	17	3	10	E. and N.W.	2.76	"	Winter wheat doing well.
May 1-10	74.0	43.6	58.8	7	1	2	S.W. and N.W.	.51	A little dry.	Planting corn. [late crops.
" 11-20	84.4	59.7	72.0	4	3	3	S. and S.W.	1.10	Dry	Preparing seed-bed for Kafir-corn and other
" 21-31	82.3	55.4	68.8	3	2	6	S. E. and S.W.	1.39	Favorable	Cult. corn, pltg. Kafir-c. & other late crps.
Monthly totals and aver.	80.2	52.9	66.5	14	6	11	S.W.	2.00	Dry	Sprg. gr. not doing well acct. dry weather.
June 1-10	89.8	57.6	73.7	5	5	0	S.W. and N.W.	.05	Favorable	Cultivating corn.
" 11-20	89.6	56.7	73.1	6	3	1	S.W. and N.W.	1.33	"	Cultivating corn and other crops.
" 21-30	91.7	63.2	77.4	6	1	3	S.W	5.35	"	Harvesting small grains.
Monthly totals and aver.	90.3	59.1	74.7	17	9	4	S.W. and N.W.	6.73	"	All cultivated crops doing well.
July 1-10	87.4	60.9	74.1	10	0	0	E. and N.W.	.45	Favorable	Harvesting small grain and threshing.
" 11-20	88.7	63.3	76.0	6	0	4	S. and N. E.	3.35	Wet & fav.	Disking grain fields and seeding catch crops.
" 21-31	90.4	63.1	76.7	9	0	2	N. and W.	1.48	Favorable	Disking grain fields and seeding catch crops.
Monthly totals and aver.	88.8	62.4	75.6	25	0	6	N.W. and E.	5.28	"	Corn and other late crps. promise large ylds.
August 1-10	89.2	65.5	77.3	4	4	2	S.W. and S.	5.22	Favorable	Spreading manure & plow'g for fall seeding.
" 11-20	95.2	68.2	81.7	10	0	0	S.W. and S.	0.00	"	Spreading manure & plow'g for fall seeding.
" 21-31	88.2	64.4	76.3	8	3	0	S.	1.15	"	Spreading manure & plow'g for fall seeding.
Monthly totals and aver.	90.8	66.0	78.4	22	7	2	S. and S.W.	6.37		Weather fav. for late crps, ex. latter part mo. when too dry.
September 1-10	92.7	63.4	78.0	8	2	0	S.W. and S.	0.00	A little dry.	Preparing for fall seeding.
" 11-20	83.2	60.8	72.0	4	3	3	N.W. and S.W.	4.62	Favorable	Filling silo.
" 21-30	80.2	50.9	65.5	10	0	0	S. and N.W.	0.00	"	Seeding fall grain and cutting corn. [good.
Monthly totals and aver.	85.3	58.3	71.8	22	5	3	S.W. and N.W.	4.62	"	Corn inj. some by hot, dry weath'r. Oth'r crps.
October 1-10	76.4	41.9	59.1	9	0	1	N.W.	0.00	Favorable	Seeding fall grain.
" 11-20	69.6	46.2	57.9	6	2	2	S.W. and E.	.45	"	Harvesting late crops.
" 21-31	61.4	40.1	50.7	7	2	2	S. and N.W.	.38	"	Harvesting late crops. [harv. at end mo.
Monthly totals and aver.	69.1	42.7	55.9	22	4	5	N.W. and S.W.	.83	"	Weather fav. for fall work but crops not all
Totals and averages for season	77.4	51.2	64.3	150	38	57	N.W. and S.W.	30.61	Fav. except in spring.	A fav. season ex. for sprg. grs. which were nearly a failure, acct. dry weather in sprg.

*Killing frost, October 10.

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difference in the slope of the land, one variety was seeded at four different locations in the series, as a check, to compare the productiveness of the soil in the several portions of the field. It was found that the yields from these check plots varied but little. However, the difference in the yields of the several check plots, compared to the average yield of all the check plots, has been added to or subtracted from the yields of those plots which should be compared to a certain check. Thus the yields of all the varieties are comparable, and this is true of all the variety trials. The land was plowed September 15 to 17, packed with a subsurface packer September 28, and harrowed with a smoothing harrow September 30. The soil was somewhat dry previous to September 19, when a rain of 1.25 inches was received, which made it possible to put the soil in excellent condition for seeding. The wheat was sown October 1 to 3, at the rate of five pecks per acre. A good stand was secured, and all varieties made a vigorous growth during the fall and throughout the following season.

The trial of varieties in 1905 was conducted in a field which was planted to ensilage corn, millet and flax in 1904, and to varieties of corn in 1903. The 1905 plots extended across the 1904 plots. The field was fairly uniform with the exception of one corner, where the soil is thinner and less fertile. This has somewhat reduced the yields of the first three varieties mentioned in table V, but it will be noticed that these were not among the highest yielding varieties in 1904. The flax and millet ground was plowed early in September and harrowed twice. The corn ground was disked three times (lapping half) directly after removing the corn on September 16, and was then harrowed twice. Later both of these plots were harrowed several times so that they were in good physical condition at thetime of seeding on September 28. The wheat was sown at the rate of five pecks per acre. One variety, Turkey No. 4, was seeded in several places, as a check upon the soil conditions.

The winter of 1904-'05 was extremely cold, being the most severe winter experienced in this locality in many years, but there was a light covering of snow on the ground during the cold weather, and all of the winter grain survived the winter better than usual and several spring grains seeded in the fall were found to be in good condition in the spring. The spring conditions being favorable, satisfactory yields were secured.

In the variety test of winter wheat in 1906 the hard wheats were seeded on a plot which grew a large crop of ensilage corn in 1905 and a good crop of spring grain in 1904, the seed-bed being pre-

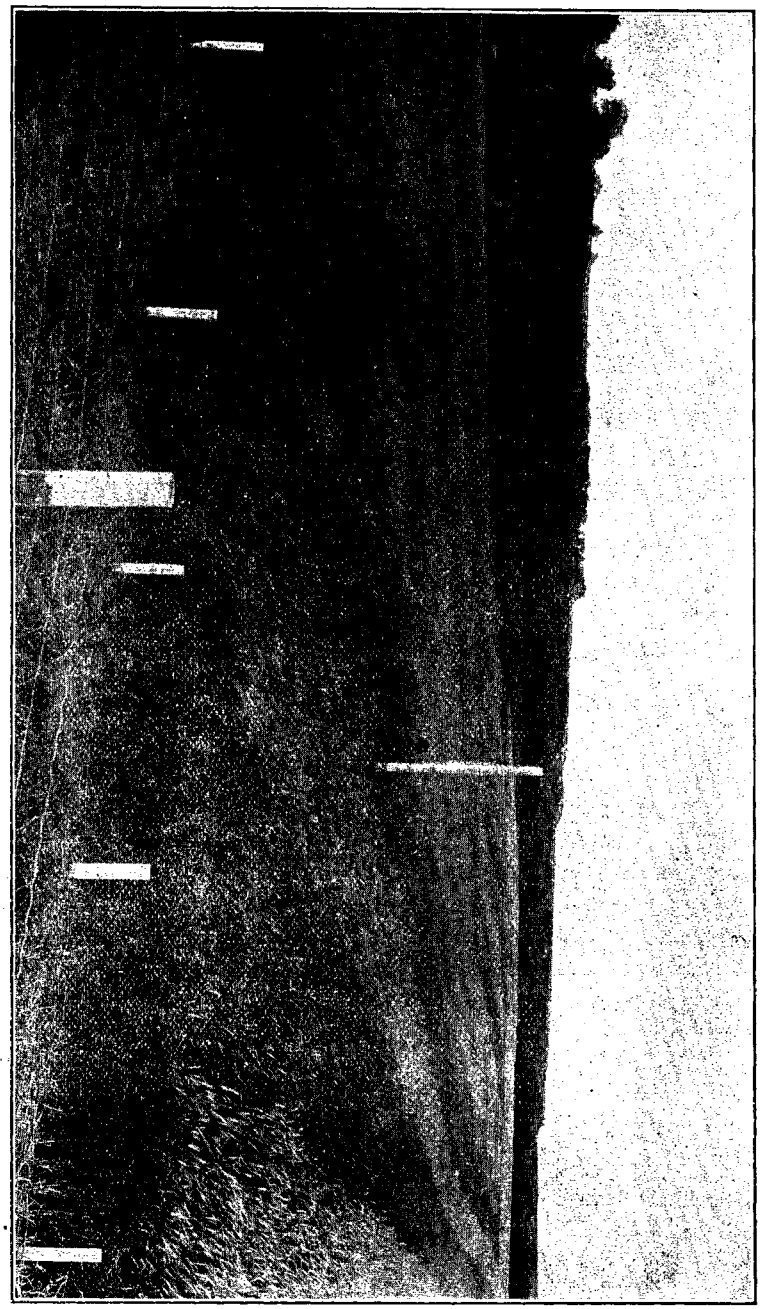

FIG. 1.—Plots of winter wheat; variety trial of 1906.

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pared by the use of the disk and smoothing harrows immediately after the crop of corn was removed. The soft wheats were seeded on another plot in the same field, which grew a large crop of flax in 1905 and a large crop of ensilage corn in 1904. This plot was plowed August 17 to 22, and was harrowed several times. The seeding was done September 29 and 30, good stands were secured, and all the varieties made a vigorous growth in the fall. The winter, though not nearly so cold as the previous one, was more severe on the wheat. The durum varieties, which the department has been trying to make hardy enough for fall seeding, were nearly all destroyed. The ordinary winter varieties survived the winter in good condition.

No smut was observed in the wheat in 1904 and 1905, and very little was found in 1906. All the varieties were badly infected with rust in 1904 and 1905, and slightly infected in 1906, the soft wheat being infected more than the hard wheat varieties. In 1904 the several varieties, with two exceptions, varied six days or less in date of maturity, while in 1905 the extreme variation was only five days, and in 1906, seven days. The date of ripening apparently had little or no effect upon the yield, though it is probable that other qualities being equal the earlier maturing varieties should be preferred, as they are more apt to escape the hot, unfavorable weather conditions that are sometimes experienced just before harvest.

YIELD VERSUS STOOLING

The number of tillers per plant, as given in table V, was determined by pulling up several plants of each variety (May 15) and counting the number of stalks. In 1904 most of the varieties stooled more than in 1905, the number of stalks per plant varying from three to eight, and the stooling seems to have been related to the yield. Those varieties which averaged six or more tillers per plant made an average yield of 28.45 bushels per acre, while those averaging less than six tillers per plant made a yield of 21.74 bushels per acre. Those varieties which yielded 27 bushels or more per acre averaged 6.6 tillers per plant, while those which yielded less than 27 bushels per acre averaged 4.85 tillers per plant. In 1905 the stooling seemed to have little or no effect on the yield.

In 1906 those varieties which averaged seven or more tillers per plant made an average yield of 43.62 bushels per acre, and those varieties which averaged less than seven tillers per plant made an average yield of 45.51 bushels per acre. In 1904 those varieties which tillered most made the larger yields, while in 1906 the re-

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verse was true, indicating that the yield depends upon the thickness of the stand, but that the proper thickness may vary with the season. Several of the best producing varieties grown by the Station stooled abundantly in 1904, but were among the varieties producing a relatively small number of tillers in 1906.

HARD AND SOFT WHEAT

The variety trial in 1904 included two varieties of soft wheat and the following varieties and types of hard wheat, viz, fifteen varieties of the smooth bearded type, two varieties of the smooth awnless type, and two varieties of the velvety awnless type. These groups of varieties may be compared by noticing the average yields of the types as given below:

Soft wheats, 27.2 bushels; hard wheats, smooth bearded type, 28 bushels; smooth awnless, 19.8 bushels, and awnless velvet chaff, 10.4 bushels per acre, respectively. All of the varieties included in the last two types named, with the exception of the Ghirka, were thought to be unworthy of further trial and were discarded in planting the 1905 test. Many of the varieties included in these experiments are the hard red Turkey or Russian type of wheat, and during the three years these varieties have made better yields than the varieties of other types of wheat. For description and yield of each variety, see tables V and VI.

The hard red type of winter wheat, imported from eastern Turkey and southern and eastern Russia and neighboring countries, has come to be recognized as the hardiest and best producing type of wheat grown in the great winter wheat belt of the West and Southwest, and is especially adapted for growing in the drier portion of the Western Plains region. This is doubtless due to the hardy characteristics acquired by these varieties of wheat in their native countries, where the rainfall is limited and the summers extremely hot.

The highest average yield for the three seasons, 41.70 bushels per acre, was made by the Bearded Fife, which is really a hard red Turkey wheat. Other varieties, tested for three years, which produced large average yields are the Defiance, Turkey No. 4, Turkey No. 9, Malakoff and Kharkof of the hard wheat varieties, and Zimmerman and Fultz of the soft wheat varieties.

The two varieties of soft wheat tested during the three years, 1904-'05-'06, made an average yield of 38.30 bushels per acre, as compared with 37.88 bushels, the average yield of the eleven hard wheats tested during the same period. This is a very favorable report for the soft wheats, since the tests have been conducted under soil conditions which are considered more favorable to the

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hard wheat varieties. The hard wheats are especially adapted to fairly dry or upland conditions and are much to be preferred for general seeding in the Western two-thirds of the State, and should also be used largely on the uplands in the Eastern part of the State. The soft wheats, however, should be used for seeding in eastern Kansas, on bottom lands, and in some sections on the lower uplands, also.

Among the varieties of wheat tested only one year (see table VI) the Red Winter made a yield of 52.92 bushels per acre, while Botany Department No. 230, Botany Department No. 415, Old Crimean, Pesterboden and Padi varieties also gave very satisfactory yields, comparing well with the best varieties tested for the longer period. Among the soft wheats tested for only one year the Fultzo-Mediterranean, Kentucky No. B 347, Harvest King and Poole made relatively large yields, comparing favorably with the soft wheats grown at the Station during the past three years.

WINTER DURUM WHEAT

In the fall of 1903 several varieties of durum wheat were seeded, including the Gharnovka, Velvet Don, and a variety from the Iowa Seed Company, DesMoines, Ia. This last was called simply "Macaroni" wheat and nothing further is known of the origin of the seed. This wheat has received the number "375" in our record book. Every plant of each of the first two varieties named winter-killed, but a few plants of No. 375 survived the winter. These plants made an excellent growth and produced large heads of plump, heavy grain. This wheat was carefully gathered and sown again in the fall of 1904. The following winter was colder than usual, but the ground was well covered with snow during the coldest weather and the winter durum wheat survived the winter, producing an excellent crop of 42.56 bushels per acre, as compared with 17.52 bushels per acre, the largest yield secured from the spring durum wheat.

A considerable acreage of the winter durum wheat was sown in the fall of 1905, but with unfavorable results. The wheat winter killed badly. Perhaps one-tenth of the plants survived, and these produced some very fine wheat, which was gathered and again seeded last fall, with the hope and expectation that it will now prove hardy and that we have succeeded in establishing a hardy winter variety of durum wheat. There is little question but that if a hardy winter variety of durum wheat can be produced that it will prove to be much more productive than the spring durum, and if the new strain retains the drought-resistent character of the old variety, it may be a more valuable wheat to grow

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TABLE V.—Varieties of wheat tested three years, 1904, 1905, and 1906.

Bulletin No.	Name of variety.	U. S. No.*	Type†	Where from.	Date of maturity	Av No. tillers per plant	Height at maturity, in.	Rust resistance, per cent.	Weight per bu., lbs.	Grade	Hard or soft, per cent.	Straw, 1905, yield per acre, tons.	Grain, 1905, yield per acre, bu.	Grain, 1904, yield per acre, bu.	Grain, 1906, yield per acre, bu.	Grain, 1904-'05-'06 average yield per acre, bu.
1	Ghirka	5637	A. S.	Ft. Hays Branch Station	6-17	3.0	28	75	61.0	No. 2H	88 hard	.....	25.35	19.43	.....	.....
2	Ulta	5638	B. S.	" " " "	6-17	2.5	28	70	61.0	No. 2H	94 "	.....	22.40	26.41	40.95	29.92
3	Imp. Turkey No. 3	.....	"	" " " "	6-17	2.5	29	70	60.8	No. 2H	88 "	1.25	26.53	31.70	.....	.....
4	Turkey (Neb)	.....	"	" " " "	6-17	2.0	31	75	61.0	No. 2H	92 "	1.51	38.63	34.94	46.91	40.16
5	Kharkof No. 4	7786	"	" " " "	6-17	2.5	29	75	61.5	No. 1H	93 "	1.65	32.61	30.93	47.13	36.89
6	Theiss	1561	"	" " " "	6-17	1 9	30	70	61.0	No. 2H	82 "	1.88	37.17	27.37	41.23	35.26
7	Malakoff	.....	"	Ratekin Seed House	6-17	2.4	31	70	60.5	No. 3H	60 "	2.04	42.43	30.02	46.42	39.62
8	Red Winter	.....	"	Bot. Dept. Kan. Exp. Station	6-17	2.4	31	75	61.0	No. 2H	90 "	1.95	40.08	28.05	48.09	38.74
9	Turkey	.....	"	Nebraska Experiment Station	6-16	2.7	30	70	61.5	No. 2H	90 "	1.96	41.74	27.23	50.17	39.71
10	Defiance	.....	"	Iowa Seed Co	6-17	2.0	30	70	61.3	No. 2H	88 "	1 65	38.28	35.44	48.81	40.84
11	Bearded Fife	.....	"	Nebraska Experiment Station	6-17	1.8	30	70	61.5	No. 3H	85 "	1.87	43.26	33.11	48.74	41.70
12	Minnesota No. 835	.....	"	Minnesota Experiment Station	6-19	2.1	34	75	60.0	No. 3H	80 "	1.90	38.97	24.75	.....	.....
13	Minnesota No. 529	.....	"	" " "	6-18	2.1	34	70	61.0	No. 3H	72 "	2.00	41.60	27.37	44.43	37.80
14	Banat	1560	"	Nebraska Experiment Station	6-18	2.8	36	70	60.5	No. 3H	80 "	1.93	39.25	23.18	.....	.....
15	Beloglina	7787	"	" " "	6-18	2 4	35	70	61.3	No. 2H	85 "	1.90	38.83	22.36	.....	.....
16	Weisenburg	1563	"	McPherson Branch Station	6-19	2.4	36	70	60.3	No. 3H	78 "	2.14	40.49	22.75	44.79	36.01
17	Ghirka	1438	A. S.	" " "	6-19	2.3	34	70	61.0	No. 3H	78 "	2.16	40.49	.....	32.76	.....
18	Turkey	1558	B. S.	" " "	6-18	2.9	34	75	61.0	No. 3H	80 "	2.41	47.57	.....	46.12	.....
19	Kharkof	1442	"	" " "	6-21	1.4	31	75	60.8	No. 2H	90 "	2.58	43.95	.....	44.98	.....
20	Crimean	1437	"	" " "	6-22	3.4	32	75	60.0	No. 2H	90 "	2.45	41.18	.....	41.58	.....
21	Crimean	1437	"	" " "	6-22	5.7	39	70	60.0	No. 2H	90 "	2.65	40.77	.....	.....	.....
22	Currell	.....	A. S.	" " "	6-15	3.2	32	70	60.0	No. 2S	90 soft	2.77	29.99	.....	48.28	.....
23	Fultz	.....	"	Kansas Experiment Station	6-15	2.2	33	70	60.5	No. 1S	95 "	2.26	44.91	25.49	48.91	39.77
24	Zimmerman	.....	"	" " "	6-14	2.8	38	70	62.0	No. 1S	82 "	2.01	43.53	28.91	38.05	36.83
25	Mull	.....	"	A. B. Mull, Iola, Kan	6-15	3.4	36	75	60.3	No. 2S	85 "	2.04	43.39	.....	27.60	.....

*U. S. No. is the number given this variety by the Bureau of Plant Industry, United States Department of Agriculture, from which the seed was originally obtained.

†A. S. = Awnless, smooth chaff. B. S. = Bearded, smooth chaff.

Descriptive data given for the 1905 crop.

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TABLE VI.—Varieties of wheat tested only one year—1906.

Bulletin No.	Name.	U. S. No.	Type.	Where from.	Date of maturity.	Av. No. tillers per plant.	Av. height at maturity, inches.	Rust resistance, per cent.	Weight per bu., lbs.	Grade.	Hard or soft, per cent.	Grain yield per acre, bu.
26..	United States No. 2034.....	2034	B. S.....	McPherson Branch Station.....	6-19	8	38	93	60	No.2 H.	90 H	43.51
27..	Torgova.....	1539	B. S.....	" " " "	6-19	5	38	95	60	No.2 H.	70 H	43.31
28..	United States No. 1532.....	1532	B. S.....	" " " "	6-19	8	37	95	61	No.2 H.	65 H	44.03
29..	United States No. 1555.....	1555	B. S.....	" " " "	6-19	6	37	93	59	No.2 H.	87 H	45.37
30..	United States No. 1656.....	1656	B. S.....	" " " "	6-19	9	37	93	60½	No.2 H.	65 H	46.64
31..	United States No. 13952.....	13952	B. S.....	" " " "	6-22	7	41	95	60	No.2 H.	80 H	46.57
32..	Old Crimean*.....	.....	B. S.....	S. O. Thompson, McPherson, Ks.	6-20	.....	37	94	60½	No.2 H.	76 H	49.25
33..	Bacska.....	1562	B. S.....	Ft. Hays Branch Station.....	6-20	.....	35	94	60	No.2 H.	80 H	46.18
34..	Pesterboden.....	1564	B. S.....	" " "	6-20	.....	38	94	60½	No.2 H.	72 H	48.67
35..	Padi.....	1582	B. S.....	" " "	6-20	.....	39	94	60	No.2 H.	75 H	47.50
36..	Red Winter.....	.....	B. S.....	Bot. Dept. Kan. Expt. Sta.....	6-19	.....	35	94	60½	No.2 H.	78 H	52.92
37..	Botanical Dept. No. 246.....	.....	B. S.....	" " " "	6-20	.....	37	94	.....	.....	.....	46.18
38..	Botanical Dept. No. 415.....	.....	B. S.....	" " " "	6-20	.....	38	94	60	No.2 H.	80 H	49.25
39..	Botanical Dept. No. 230.....	.....	B. S.....	" " " "	6-20	.....	36	94	61	No.2 H.	76 H	49.40
40..	Fultzo-Med.....	.....	A. S. club.	F. W. Topf, Leavenworth, Kan.	6-22	7	42	85	60	No.2 S.	90 S	48.89
41..	Harvest King.....	.....	A. S.....	" " " "	6-22	7	45	98	59	No.2 S.	90 S	47.97
42..	Poole.....	.....	A. S.....	Tennessee Experiment Station.	6-22	9	44	80	58	No.2 S.	85 S	46.18
43..	Niger.....	.....	B. S.....	" " "	6-25	7	46	85	58	No.2 S.	80 S	36.94
44..	Red May.....	.....	A. S. club.	" " "	6-25	8	42	85	.....	.....	.....	43.13
45..	Egyptian.....	.....	A. S.....	" " "	6-26	5	41	90	.....	.....	.....	40.12
46..	Mediterranean.....	.....	B. S.....	" " "	6-22	8	45	90	60½	No.2 S.	92 S	41.67
47..	Fulcaster.....	.....	B. S.....	" " "	6-22	9	46	85	60	No.2 S.	82 S	42.12
48..	Fulcaster.....	.....	B. S.....	Kentucky Experiment Station.	6-22	7	45	85	59	No.2 S.	90 S	43.68
49..	Gold Coin.....	.....	A. S. club.	" " "	6-25	9	46	85	59	No.3 S.	75 S	45.79
50..	Dawson's Golden Chaff.....	.....	B. S.....	" " "	6-25	9	46	85	57	No.3 S.	55 S	45.86
51..	Kentucky No. B-347.....	.....	A. S.....	" " "	6-25	8	46	85	57½	No.3 S.	60 S	48.74
52..	Harvest Queen.....	.....	A. S. club.	" " "	6-23	10	44	85	54	No.3 S.	65 S	36.23

*This wheat was originally imported from Crimea, but has been grown near McPherson, Kan., since 1897.

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on the dry lands of western Kansas than the hard red Turkey or Russian wheats which are at present the standard varieties.

DEPTH TO SOW WINTER WHEAT AND PREPARATION OF SEED-BED

The proper depth to sow wheat doubtless depends somewhat upon the season and the condition of the seed-bed, but when the soil is in a fairly good physical condition it is probably best, as indicated by this experiment, to plant the wheat in furrows two to two and one-half inches deep. A more shallow seeding may answer as well if the conditions are especially favorable, but is not to be recommended as a general practice.

Seeding deeper than two and one-half inches may be exhaustive of the strength of the young wheat plants, and is not to be recommended except when the seed-bed is dry at the surface and it is necessary to seed deeply in order to place the seed in moist soil.

This experiment has been carried on only one season—1906. The yields from seeding at the several depths were determined as follows:

Depth of seeding, inches.	Yield per acre, 1906, bushels.
1½	56.31
2	60.66
2½	59.84
3½	57.07
4	55.69

All of the wheat was ripe and was harvested June 19. The straw was rather short, averaging about three feet in height. The heads were heavy and well filled, and there was practically no difference in the grade and quality of the grain.

The double disk-drill with chain cover was used in this experiment, and the several depths of seeding were accomplished by placing the lever of the drill in different notches and measuring the depth of the furrow. For the deepest seeding the lever was placed in the top notch and a man rode on the disks. The wheat was really not covered at the depths given, but the figures simply mark the extreme depth of the furrows.

The shallowest sown wheat was barely covered with soil.

THE SEED-BED

It will be noticed that the yields given above are exceptionally large, and it may be of interest to know how this wheat was grown. The plots were located a short distance northeast of the College barn, in a field which is fairly high upland, and of only ordinary fertility. This field was recently purchased by the College, and the land had evidently received no manure for several years previous to 1905, when a light dressing of ten to twelve loads per acre

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was applied just before plowing for wheat. In 1904 a large crop of thickly planted ensilage corn was grown on this field, and in the spring of 1905 it was seeded to oats, which produced a good yield. The field was plowed August 3 to 7, about seven inches deep, and harrowed immediately after plowing. During the interval after plowing until seeding time the land was harrowed with the Acme and smoothing harrows at intervals of ten days to two weeks, or after each heavy rain, in order to conserve the soil moisture and keep the soil in a good physical condition. The variety Bearded Fife was used in this trial, and the wheat was seeded September 27 with a double-disk drill at the rate of one and one-fourth bushels per acre. A good stand was secured, the wheat made a vigorous growth in the fall, and, although the winter was not especially favorable, the wheat was observed to be in excellent condition in the spring,

Although the spring conditions were very favorable for the growth of wheat, the latter part of the season was rather too dry, but the excellent physical condition of the soil and the abundant supply of moisture and plant food in the soil caused the wheat to finish its growth and produce an exceptionally large yield. The trial plots considered above were one-tenth acre in area. A larger plot of about one-half acre in area yielded 59.09 bushels per acre, while a measured acre in this field produced 3,497.6 pounds, or 58.3 bushels of wheat.

These high yields have resulted largely from "good farming." The rotation of crops, the application of barn-yard manure in moderate quantities, the early plowing and frequent cultivation to conserve the soil moisture to develop the plant food and to put the soil in a good physical condition, seeding at a favorable time and the use of a well-bred variety of wheat which has been tested and is known to be a large producer and adapted to the local conditions, are all factors which must be considered by the farmer who would produce the largest and most profitable crops of wheat.

DATE TO SOW WINTER WHEAT

This experiment was conducted during the past season only. For discussion regarding the soil, preparation of seed-bed, etc., refer to description of "Depth to Sow Wheat." The dates of seeding and resulting yields are given as follows:

Date of seeding.	Yield per acre, 1906, bushels.
September 1	41.18
September 9	39.93
September 21	52.60
September 27	54.04
October 5	53.21
October 12	45.19
October 20	42.95
November 3	26.67

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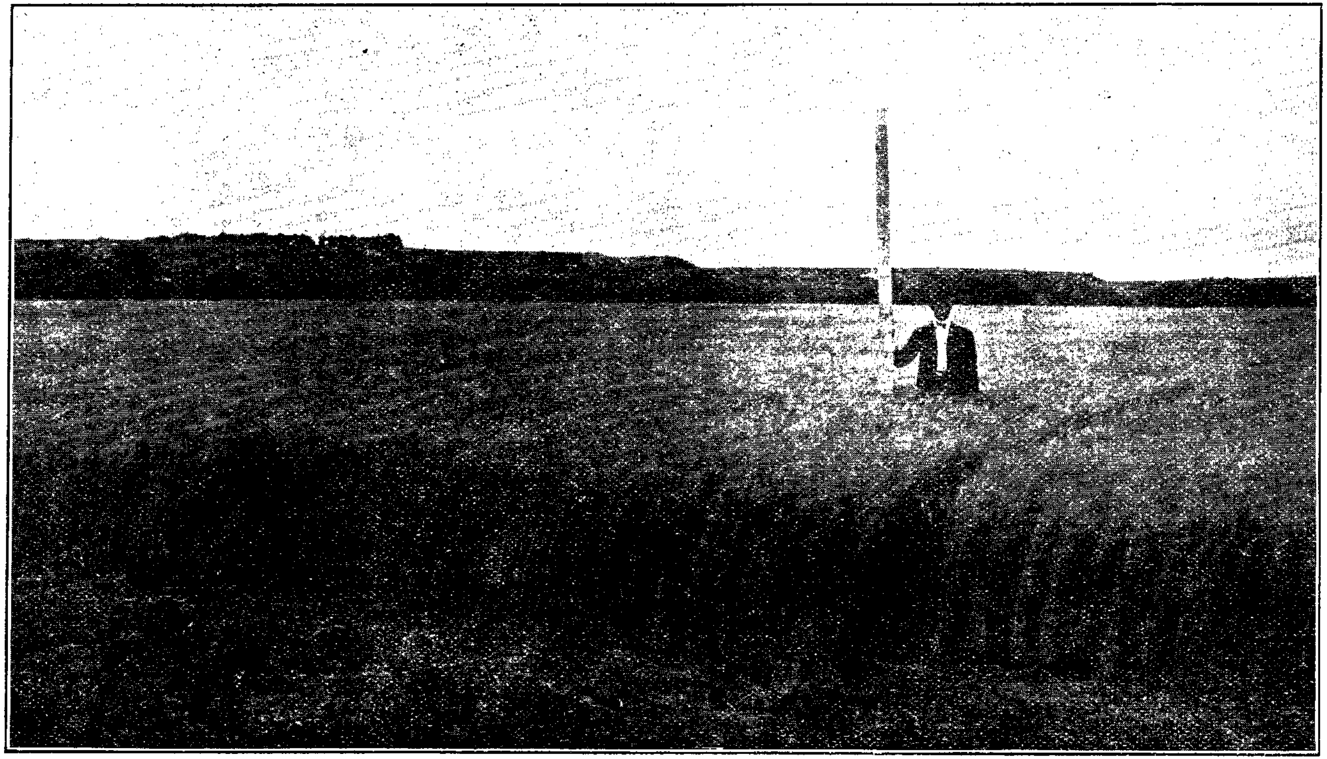

FIG. II.—A field of hard, red, winter wheat, grown on the Experiment Station farm in 1906; average yield, 58.3 bushels per acre.

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The Defiance wheat was used in this test. The largest yield, 54.04 bushels per acre, was secured by seeding September 27. Nearly as large yields were produced from seeding September 21 and October 5. All of the other plots referred to gave much smaller yields, indicating that winter wheat may best be seeded during the last week in September or the first week in October. The last seeding, November 3, made little growth in the fall and in the spring. The grain on this plot started slowly and did not stool much, thus making a thin stand. The crop from this late seeding would have doubtless been an entire failure if the season had not been especially favorable. The yields of grain from each seeding were closely related to the stand and growth of the wheat. The quality of the grain did not vary greatly.

Previous experiments in this line in 1893-'94-'95-'96-'97, carried on at this Station, as reported in Bulletin No. 71, gave results favoring earlier sowing, the largest yield being secured from seedings made near the middle of September. The advantage in sowing early is that the wheat makes a stronger fall growth, covers the ground better, and is not so apt to winter-kill as later sown wheat. Early sown wheat also furnishes more fall and winter pasture, and it is desirable to sow early when the purpose is to pasture the wheat. When the Hessian fly prevails, late seeding has the advantage of early seeding, since the fly does not usually work much in wheat sown after September 25. It is the usual practice at this Station to begin sowing wheat about September 25.

AMOUNT OF SEED-WHEAT TO SOW

This experiment was conducted in the same field as the experiment in "Depth to Sow Wheat," and the treatment given the land was the same as has already been described in discussing that experiment. The wheat was planted September 27, about two inches deep, at the rates mentioned in the following table, which also gives the resulting yields:

Rate of seeding per acre, pecks.	Yield per acre, 1906, bushels.
2	57.28
4	58.46
5	59.41
6	56.33
8	56.38

The wheat on all of the plots was mature and was harvested June 18. The thicker sown wheat appeared to be a little riper than the thinner sown wheat, all of the grain making a good stand, the wheat seeded at the rate of two pecks per acre appearing to be

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almost as thick as that seeded at the rate of six and eight pecks per acre. This was evidently due to the abundant stooling.

The largest yield was secured by seeding at the rate of five pecks per acre, and the second largest yield from seeding at the rate of four pecks per acre. There was little difference in the quality of the grain. Our usual practice is to sow from five to six pecks of winter wheat per acre. Previous tests at this Station, in 1892 and again in 1896, as reported in bulletin No. 59, gave average yields favoring thicker seeding — six to eight pecks per acre.

It is not possible to lay down or state any absolute rule with reference to the best amount of seed-wheat to sow per acre, since this will vary with the different conditions of seed, soil, and season. As a rule, less seed should be sown on light soils or in dry climates than on more fertile soil or in regions of abundant rainfall. Again an extremely fertile soil may require thick seeding in order to reduce the growth of straw and prevent the grain from lodging. In a well-prepared seed-bed, plentifully supplied with moisture, less seed is required to produce a good stand of grain than when sown under less favorable soil conditions. As a rule, less seed is required for early seeding than for late seeding, since the early sown wheat often starts more uniformly and has a better chance to stool than the later sown wheat. In a well-prepared seed-bed in soil of average fertility, four pecks of well-graded seed-wheat should be sufficient for seeding in eastern and central Kansas.

FERTILIZERS FOR WHEAT

Fertilizer experiments with wheat have been conducted only during the past season, 1906. The test was made in the same field as the 1905 fertilizer experiments with oats and barley,* the plots crossing those of the previous season. This field has been cropped perhaps forty years, mostly with corn and small grains. The soil is becoming exhausted in fertility and is especially deficient in humus. Table VII gives the rate of application of the various fertilizers and the yields secured. As with the oats and barley,* the barn-yard manure has proved to be the best fertilizer, the manured plots yielding over nine bushels per acre more than the unfertilized land, the second highest yield resulting from the application of sodium nitrate.

The station has not had any permanent system of plots to which certain applications of fertilizers have been made each year, and as some of the fertilizers, such as bone meal, are not readily available, greatly increased yields could not be expected the first sea-

*See page 182.

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TABLE VII.—Fertilizers for wheat.

NAME OF FERTILIZERS.	Fertilizer, amount per acre, bushels.	Wheat, yield per acre, bushels.
Special Grain Fertilizer*	102	30.97
Superphosphate	120	29.70
Pure Raw Bone Meal	98	30.05
Unfertilized	.....	30.35
Potassium Sulphate	83	28.05
Potassium Sulphate	120	29.48
Sodium Nitrate	127	34.30
Sulphate of Iron	73	32.65
Barn-yard Manure	22,126	39.47

*Manufactured by Swift & Co.

son. A continued application for several seasons might give more favorable results. Some of the yields represented in table VII are perhaps misleading, as it would seem improbable that any of the fertilizers used would cause a reduction in yield, although apparently their application had no beneficial effect on the single crop.

No definite conclusions should be drawn from the results of this single trial. However, this experiment and other fertilizer experiments with oats, barley and corn indicate that chemical fertilizers which are applied to "worn-out" land, deficient in humus and in bad physical condition, are practically thrown away. The first step towards renewing the fertility and increasing the productiveness of such land should be to supply humus and practice deep and thorough tillage in order to improve the physical condition of the soil. When such land has been put into a good condition of tilth, then the application of chemical fertilizers may give some benefit and a profitable increase in the yield of crops.

In all the fertilizer experiments with small grains conducted at this Station the application of barn-yard manure has resulted in the largest yields. Besides containing all the elements of plant food, manure increases the humus content of the soil, thus improving the texture of the soil and increasing its water-holding capacity. Manure can be applied also usually at less cost than commercial fertilizers, notwithstanding the labor and expense required in hauling and spreading manure. Except for the growing of special crops by the most intensive farming methods near large cities, the general use of commercial fertilizers in this State should not be recommended. The Kansas farmer can more economically increase and maintain the fertility of the soil on his farm by the rotation of crops, the growing of legumes and grasses, and by keeping and feeding more stock and applying the manure to the soil.

†See Station Bulletin No. 147, also page 182 of this Bulletin.

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GREEN MANURING FOR WHEAT

During the summer of 1903 an experiment to test the value of catch crops on land continuously cropped with wheat was commenced on the old College farm, one and a half miles west of the College campus. The soil on this farm is a tenacious clay-loam, rather deficient in fertility. It is also badly infected with bindweed and foxtail, which have not been very well held in check by the continuous cropping to wheat, so that this experiment has had abnormal conditions which doubtless accounts in part, at least, for the low yields and the small difference in the yields of the several plots. The following is the plan of the experiment:

Four plots one-fourth of an acre in area were laid out in the spring of 1903 and planted with barley. After the barley was harvested, each of the several plots was treated as follows: No. 1 was double disked, the disk harrow being lapped half. No. 2 was double disked and planted to cow-peas with the grain drill, in drill rows six inches apart No. 3 was left as a check and received no treatment. No. 4 was double disked and seeded to millet. The plots were plowed September 16 and 17 and seeded to Zimmerman wheat October 3, having been well harrowed at intervals between the plowing and seeding. In 1904 the treatment described above was repeated after wheat harvest, and again in 1905 and 1906. The results of the several trials are given in table VIII.

TABLE VIII.—Green manuring for wheat.

PLOT NO.	Treatment.	Yield per acre, 1904, bushels.	Yield per acre, 1905, bushels.	Yield per acre, 1906, bushels.	Average yield per acre for the three seasons, bushels.
1	Lap disked	14.01	15.10	16.82	15.31
2	Lap disked and cow-peas	14.49	16.53	15.54	15.52
3	Untreated	13.40	12.04	13.41	12.95
4	Lap disked and millet	14.15	15.37	15.81	15.11

The cow-peas have usually made a growth of twelve to sixteen inches in height, while the millet has made somewhat less growth than the cow-peas. The plot which was disked immediately after harvest and planted to cow-peas produced the highest average yield for the three seasons (15.52 bushels per acre). The check plot made an average yield for the three seasons of 12.95 bushels per acre, 2.16 bushels per acre less than any of the other plots.

The results secured indicate that in this experiment the difference in the yields has been caused mainly by the disking, which doubtless helped to save the moisture in the soil during the inter-

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val after harvest, before plowing. The weed growth in the unplanted plots has usually been nearly as large as the crop of cow-peas or millet; thus there has not been a great difference in the amount of vegetable matter turned under on the several plots. Weeds do not make a satisfactory catch crop or green manuring crop, however, as they are often too slow in making a covering for the soil and are apt to make an irregular stand; besides, the weeds may seed and propagate themselves and thus injure future crops.

The cow-peas make an excellent catch crop for planting after wheat harvest. It is one of our hardiest annual legumes, and superior to millet, sorghum, and rape, in that the cow-peas not only increase the humus of the soil, but actually increase the nitrogen supply, through the action of bacteria whichlive in the root tubercles, and are able to assimilate the free nitrogen of the air, transmitting it to the plant, which in the processes of growth stores the nitrogen in the stems, leaves, and roots, thus actually increasing the supply of this plant-food element in the soil. It is unsafe, however, to sow winter wheat after plowing under a catch crop of cow-peas. The ground is almost sure to be left too loose and dry to start the wheat well. Corn is a much better crop than wheat to follow cow-peas, plowed under in this way, and the experiments carried on at this Station indicate that the effect of green manuring with cow-peas is much more marked on corn than on wheat.*

EXPERIMENTS IN ROTATING WHEAT WITH OTHER CROPS

This is a two-year rotation, the crops alternating with wheat being wheat, oats, flax, millet, soy-beans, sorghum, Kafir-corn, and corn. The plots are one-fourth acre in area and are laid out in two series. Wheat is grown each season on one series of plots, after the several crops, and the several crops are also grown each season on the other series of plots, after wheat, the purpose being to determine which crops are best to precede wheat. The plots in each of the series are duplicated. Since the experiment was not commenced until the spring of 1903, barley was seeded in series one, in 1903, instead of wheat; but the yields of barley do not enter into the averages reported in table IX.

The soil upon which this experiment was conducted is a rather tenacious clay-loam, somewhat deficient in humus and difficult to keep in good physical condition. Previous to 1903 the field had been in alfalfa for four years and was plowed early in the spring of 1903. This is an old field which has been farmed many years,

*See discussion on "Green Manuring for Corn," Station Bulletin No. 147.

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and before it was seeded to alfalfa it was cropped largely with small grains and corn, with little or no application of manure or other fertilizer.

The crops of small grains have been removed sufficiently early so that a good seed-bed might be prepared for fall sowing of wheat, but the corn, Kafir-corn and sorghum cannot be harvested much before it is time to sow wheat, thus the seed-bed on these plots was often lacking in moisture and in poor physical condition. These facts, doubtless, help to explain why so much larger yields of wheat have been produced after millet, wheat, soybeans, oats, and flax. A continuation of the experiment may show more favorable results from seeding wheat after the later maturing crops. The value of the crops for the four-year period was greatest when the wheat was rotated with oats, the next greatest value in crops being secured from the land on which wheat was grown continuously.

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TABLE IX.—Rotation of crops with wheat, giving order of crops, and yields.

No. of Plots.	1903.		1904.		1905.		1906.	
	Crop.	Yield per acre.	Crop.	Yield per acre.	Crop.	Yield per acre.	Crop.	Yield per acre.
1 and 16	Barley	22.80 bu.	Kafir-corn	57.26 bu.	Wheat	22.97 bu.	Corn	54.14 bu.
2 and 15	Barley	22.80 "	Kafir-corn	39.75 "	Wheat	24.67 "	Kafir-corn	67.04 "
3 and 14	Barley	22.80 "	Sorghum(sowed)	8.27 tons	Wheat	19.07 "	Sorghum(sowed)	7.79 tons
4 and 13	Barley	22.80 "	Soy-beans	16.48 bu.	Wheat	26.54 "	Cow-peas	2.48 "
5 and 12	Barley	22.80 "	Millet	3.24 tons	Wheat	30.53 "	Millet	3.64 "
6 and 11	Barley	22.80 "	Flax	6.38 bu.	Wheat	28.23 "	Flax	7.54 bu.
7 and 10	Barley	22.80 "	Oats	19.32 "	Wheat	23.39 "	Oats	37.91 "
8 and 9	Barley	22.80 "	Wheat	20.10 "	Wheat	24.40 "	Wheat	36.20 "
17 and 31	Corn	50.34 "	Wheat	17.72 "	Corn	50.63 "	Wheat	18.11 "
18 and 30	Kafir-corn	22.40 "	Wheat	13.17 "	Kafir-corn	43.72 "	Wheat	13.85 "
19 and 29	Sorghum(sowed)	7.39 tons	Wheat	17.57 "	Sorghum(sowed)	6.20 tons	Wheat	15.70 "
20 and 28	Soy-beans	11.15 bu.	Wheat	21.10 "	Soy-beans	5.45 bu.	Wheat	31.10 "
21 and 27	Millet	3.28 tons	Wheat	20.80 "	Millet	2.02 tons	Wheat	35.45 "
22 and 26	Flax	10.29 bu.	Wheat	19.77 "	Flax	8.65 bu.	Wheat	29.09 "
23 and 25	Oats	36.41 "	Wheat	19.27 "	Oats	40.00 "	Wheat	34.73 "
24	Wheat	5.53 "	Wheat	17.13 "	Wheat	26.60 "	Wheat	40.40 "

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TABLE X.—Giving average yields of wheat and of various crops rotated with wheat.

CROPS IN THE ROTATIONS.	Average yield per acre, 1903-'04-'05, of various crops preceding wheat.	Estimated values (per bu. or ton) of crops in preceding column.	Average yield of wheat per acre, 1904-'05-'06, after various crops, bu.	Value per acre of crops produced in four seasons.
Wheat and corn.....	Corn .....52.74 bu.	$0.30	19.60	$29.15
Wheat and Kafir-corn..	Kafir-corn....35.29 bu.	0.30	17.23	22.30
Wheat and sorghum ...	Sorghum..... 7.29 T.	2.50	17.45	30.09
Wheat and soy-beans..	Soy-beans....11.09 bu.	0.65	26.25	25.06
Wheat and millet	Millet ..... 2.85 T.	3.50	28.93	29.65
Wheat and flax.....	Flax..... 8.44 bu.	0.90	25.70	25.07
Wheat and oats	Oats.....47.87 bu.	0.33	25.80	33.34
Wheat and wheat.....	Wheat.....17.41 bu.	0.68	27.31	30.41

Table IX gives the plan of rotation for each plot and the average yields per acre of duplicate plots for the several years during which this experiment has been conducted. Table X gives the average yields of the three crops of wheat which have been grown after each of the several crops used in the rotation, and also the average yield for three years, of each of the several crops, and the last column shows the total value per acre of the four crops produced in the four years, by each of the several methods of rotation.

The rotations described above are not considered ideal, the object being, as stated, to learn both the yearly and continued effect of certain crops on the production of wheat. A practical and scientific rotation of crops should include perennial grasses and legumes, and in a future Bulletin the writer hopes to discuss in further detail this important subject of crop rotation.

WINTER BARLEY—A TRIAL OF VARIETIES

In the fall of 1903 three samples of winter barley were planted in small plots. Two of these samples were secured from the Tennessee Experiment Station and one from the Ft. Hays Branch Station, the seed of which also originally came from the Tennessee Experiment Station. The barley was sown October 1 and 3, at the rate of two bushels per acre. These plots were adjacent to the winter wheat plots and the soil was the same in character and received the same preparation of the seed-bed before planting.

In this first trial, which was on soil rather poor in fertility, the yields were comparatively small, the largest being 34.18 bushels per acre, as given in table XI. Spring barley planted in the same field gave nearly as large a yield, 30.46 bushels per acre, while the best producing variety of winter wheat yielded 35.44 bushels per acre.

It appears that the winter barley was partly winter-killed. On

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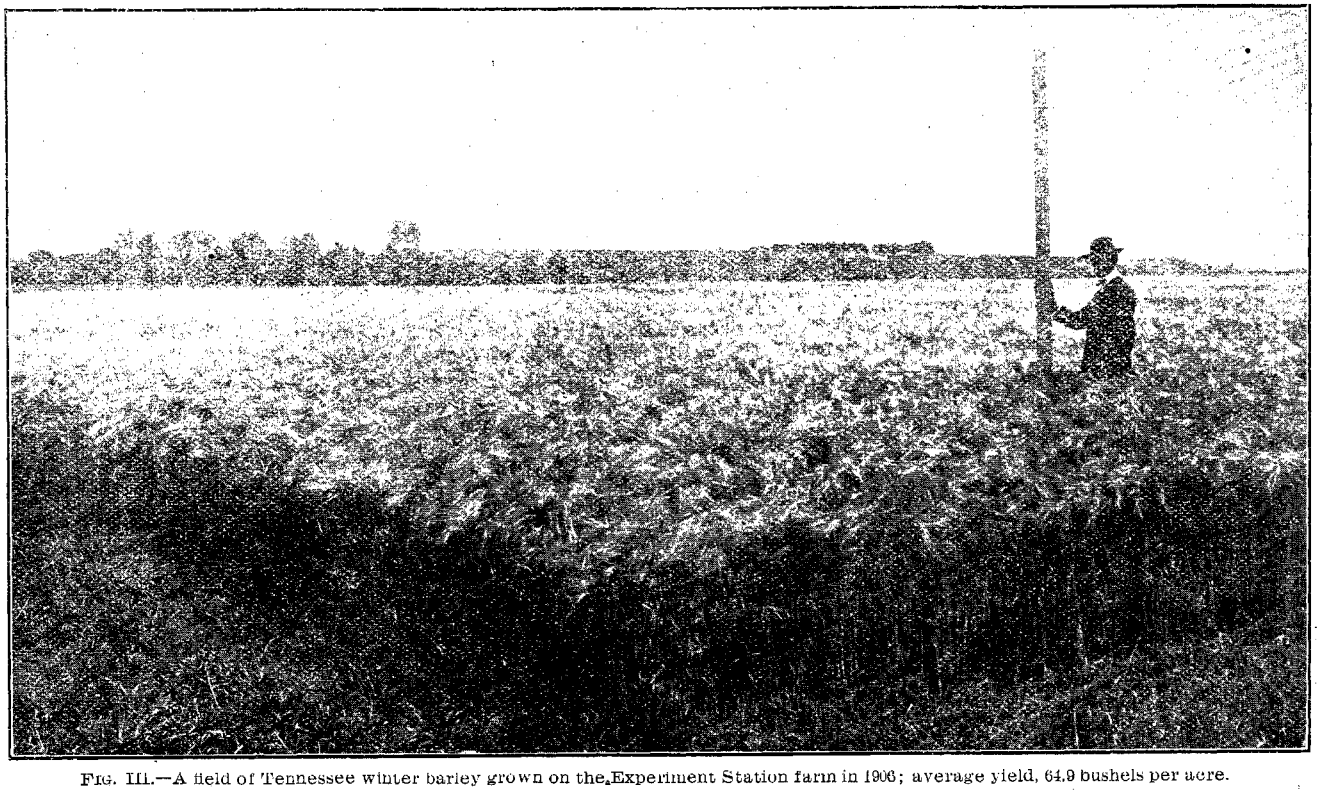

FIG. III.—A field of Tennessee winter barley grown on the Experiment Station farm in 1906; average yield, 64.9 bushels per acre.

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February 23 its condition was noted as "45 per cent." The leaves were practically all brown and very little green appeared at the above date, yet the stand at harvest time was noted as "good." The partial winter-killing, however, doubtless accounts in part for the comparatively low yield in 1904 as compared with the yield of other seasons.

In 1904 the winter barley was again planted along with the varieties of winter wheat. The crop withstood the winter better in 1904-05, and its condition noted early in the spring was "65 to 70 per cent." The soil upon which the test was made was more fertile than that used for the test in 1903-'04, and the barley made a remarkable yield, variety No. 3 producing at the rate of 81.19 bushels per acre. An increase plot, 2 1/8 acres in area, in another field, variety No. 4, yielded 67.86 bushels per acre.

The winter barley was mature and was harvested June 10 to 14. The winter wheat was harvested June 16 to 21, while the earliest maturing spring barley was ripe June 27, the winter barley maturing a week to ten days earlier than winter wheat and two weeks earlier than spring barley.

The winter barley was sown September 30, in the fall of 1905, in the same field and adjacent to the winter wheat. The barley made an excellent fall and winter growth and stood the winter well. The crop was ripe and was harvested June 10, while Turkey wheat was mature June 19, and Common Six-rowed barley was ripe June 22. An excellent crop was harvested, but the yields were not quite so large as in 1905, variety No. 3 again giving the largest yield—66.9 bushels per acre. A measured acre of this barley in another field yielded 3116 pounds of grain, or 64.92 bushels per acre.

The seed of each of the varieties tested came directly or indirectly from the Tennessee Experiment Station. The varieties are alike in type of plant and grain, and very similar to Common Six-rowed or Mansury spring barley. For the annual and average yields of the several varieties, see table XI.

TABLE XI.—Varieties of Winter Barley.

No.	Name of variety.	Yield per acre, 1904, bu.	Yield per acre, 1905, bu.	Yield per acre, 1906, bu.	Average yield per acre, 1904-'05-'06, bushels.
1...	Union Winter	20.83	65.30	60.29	48.81
2...	Tennessee Winter	25.93	69.77	57.88	51.21
3...	Tennessee Winter	34.18	81.19	66.90	60.76
4...	Tennessee Winter		61.50	64.10	

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It appears that No. 8, Tennessee Winter barley, seed of which was secured from the Ft. Hays Station, is somewhat superior to the other varieties, having produced the highest average yield for the three tests, namely, 60.76 bushels per acre.

WINTER BARLEY COMPARED WITH OTHER GRAINS

The average yields for three years, 1904-'05-'06, of the three best producing varieties of several standard grains is compared as follows:

Name of grain	Yield per acre, bu.
Winter barley	53.59
Spring "	28.72
Oats	40.56
*Rye	37.97
*Emmer	31.35
Winter wheat	40.90
*Spring "	12.56

Winter barley has yielded nearly **75** bushels more grain per acre in the three years than spring barley, and 40 bushels more grain than the best producing oats. The results of the three years' trials are very favorable to the winter barley, and there is little question, if the grain continues to prove hardy, but that it will be a much more profitable crop to grow than spring barley or oats. The early maturing character of winter barley counts to its advantage in that the crop may be harvested before the wheat harvest begins. Also, by this early maturing the crop often escapes hot weather, which may injure the wheat and later maturing spring barley and oats. The Tennessee winter barley is apparently the hardiest and best producing variety, and variety No. 3, which has been grown longest in this State, is the best producing strain which has been tested at this Station. Doubtless the winter barley cannot be so successfully grown in western Kansas as in the central and eastern parts of the State. In the tests at the Ft. Hays Branch Station the barley has been more severely injured by winter-killing than at this Station. We may expect, however, that the longer this barley is grown in our soil and climate the more hardy and productive it will become.

DATE TO SOW WINTER BARLEY

This experiment was conducted in a field which was seeded to spring barley in 1905 and to cow-peas in 1904. The field was plowed August 11 to 15, after receiving a light dressing of manure (eight to ten loads per acre). The harrow followed the plow and the field received several harrowings at intervals, the soil being kept in good seed-bed condition for each sowing. Tennessee win-

*Only one variety of each tested.

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ter barley was seeded at the rate of two bushels per acre. The dates of seeding, dates of maturing and yields per acre are given as follows :

DATE OF SEEDING.	Date of maturity.	Yield per acre, 1906, bu.
Sept. 1	June 2	50.10
Sept. 9	June 2	48.02
Sept. 21	June 4	78.21
Sept. 27	June 6	75.96
Oct. 5	June 8	63.79
Oct. 12	June 8	55.41
Oct. 20	June 10	36.94
Nov. 3		00.00

The barley sown November 3 was entirely winter-killed. The largest yield per acre, 78.21 bushels, was secured from seeding September 21, and the second largest yield, 75.96 bushels, from seeding September 27. All the plots seeded on earlier or later dates made much smaller yields. There was little difference in the quality of the grain. The weight of the grain per bushel was not determined. From observation of the crop, however, it appeared that the difference in yield may have been due largely to the difference in the stand and growth of the grain on the several plots, the later sown barley especially making a thinner stand and less growth than that sown earlier.

It appears that winter barley should be sown a week or so earlier than winter wheat. The crop is a little less hardy than wheat and needs to make a strong fall growth to withstand the winter. Also, the Hessian fly does not seem to trouble the barley, at least not to the extent that it does wheat.

RATE TO SOW WINTER BARLEY

This experiment has been carried on only one season. The barley was sown September 27 in the same field and adjacent to the plots which were used for the "Date to Seed Winter Barley" experiment. The preparation of the seed-bed has already been described in the discussion of that experiment. The Tennessee winter barley, No. 3, was used in this trial. The rates of seeding and corresponding yields are given as follows:

Drill set to sow, per acre, bushels.	Amount actually sown, per acre, lbs.	Yield per acre, bu.
1	39.3	54.15
1½	51.9	51.81
2	97.3	55.69
2½	125.4	50.91
3	138.4	43.43

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The weight of the grain sown on each plot was determined and the actual amount of grain sown per acre was calculated as given above. It will be observed that the drill usually seeded a little less than it was set to sow.

The largest yield was secured by setting the drill to sow at the rate of two bushels per acre, which really sowed a trifle over two bushels per acre. In a good seed-bed, in a favorable season, with earlier seeding, it would be preferable to sow a little less than two bushels of winter barley per acre rather than to sow more than this amount.

Winter Rye

A small plot of winter rye has been sown each fall during the past three seasons, along with the varieties of winter wheat. Only one variety, the Monster rye, seed of which was secured from the Iowa Seed Company, has been grown for the three successive seasons, and has given an average yield of 37.97 bushels per acre.

The Ivanof winter rye, a Russian variety, seed of which was secured from the United States Department of Agriculture, was planted in the fall of 1904 and again in the fall of 1905. This variety appears to be a little hardier and a stronger growing rye than the Monster. The average yields for the two seasons were about the same for each variety, namely, Monster, 41.28 bushels; Ivanof, 41.70 bushels per acre, respectively. The Ivanof rye has given good results also in Colorado, and it appears to be well adapted for growing in western Kansas.

Rye is not considered so profitable a crop for grain production as winter wheat. It has a special value, however, for fall and winter pasture, and on light soil may often give better returns than wheat in the production of grain.

Winter Oats

In the fall of 1903 several varieties of winter oats were seeded in the same field with the varieties of winter wheat. All of the seed was secured from the Tennessee Experiment Station, and included the following varieties: Winter Turf, Virginia Gray, Common Gray, and Culbertson. Every plant of each of these varieties entirely winter-killed, although the oats made a good stand in the fall. The Winter Turf oats seemed more hardy than the other varieties, and in the fall of 1904 two samples of this variety were sown along with the winter wheat. The seed of one sample was secured from Barteldes & Co., and the other from the Iowa Seed Company. These oats withstood the winter well, No. 1 yielding

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57.37 bushels per acre and No. 2 yielding 44.05 bushels per acre. In the same season, on another field, the Red Texas oats yielded 71.26 bushels per acre. It was found that the winter oats were badly mixed with chess. The oats were carefully cleaned and the chess largely removed, and a small plot of each of the varieties was seeded in the fall of 1905. These oats winter killed very badly, only a few plants in the two plots surviving the winter. These plants stooled very abundantly, forming very large bunches of oats, which matured and were harvested, and the seed was planted again last fall. It is possible that by this severe selection we may have secured a hardier strain of the Winter Turf oats than was the original sample.

The Winter Turf oats mature a little later than the best producing varieties of spring oats. In 1905, when the best crop was harvested, the Winter Turf oats was mature June 29, while the Red Texas oats was harvested June 28, and the Sixty-day oats, June 22. An early maturing variety of winter oats would be preferable. The Winter Turf oats stools abundantly and makes a rank growth of foliage, and when sown early in the fall will furnish an abundance of pasture in the late fall and early winter. The crop is probably more valuable for this purpose than winter wheat.

TABLE XII.—Varieties of Spring Wheat, 1903-'04 Crops.

BULLETIN No.	Name of Variety.	Type.	Yield per acre, 1904, bu.	Average yield per acre for two years, 1903,-'04, bu.
10	Gharnovka	durum	11.1	12.2
11	Velvet Don	durum	7.0	9.5
8	Grant	common (bearded)	3.6	4.9
3	Minnesota No. 285	common (fife)	4.9	7.3
1	Minnesota No. 163	common (fife)	5.3	7.5
7	Haynes' Blue Stem	common (velvet chaff)	6.1	6.6
6	Velvet Chaff	common (velvet chaff)	4.8	5.7
9	Preston	common (bearded)	1.9	4.5

Spring Grains

A TRIAL OF VARIETIES OF SPRING WHEAT

The tests of the varieties of spring wheat grown in 1903 were continued in 1904, after which trial most of these varieties were discarded. The yields of the several varieties for the two seasons are given in table XII.

In 1904 the spring wheat was seeded on March 11, the durum varieties at the rate of six pecks per acre, the other wheat at the rate of five pecks per acre. This wheat grew nicely in the early part of the season and made a rank growth of straw (3 feet and 9

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inches in height), but failed to fill well, producing light, shrunken grains. The best yielding durum wheat, Gharnovka, weighed 52 pounds per bushel. The common wheat weighed 42 pounds per bushel, and all of the wheat was graded "rejected."

In 1905 only one of the varieties of spring wheat formerly sown, Velvet Don, was planted. Three new varieties were included in the test. The names of varieties and yields per acre are given as follows:

BULLETIN No.	Name of variety.	Yield per acre, 1905, bu.
12	Early Java	13.56
13	Chlondovka	14.53
14	Oulka	14.98
11	Velvet Don	17.96

The seed of the Early Java wheat came from Iowa, where it is considered a good producing variety. The Oulka and Chlondovka are Russian varieties, seed of which was secured from Stavropol, Russia, through the experiment station located there. None of these new varieties were considered especially valuable and were not again planted. The Velvet Don was planted in 1906, with several new varieties, the results of the test being as follows:

BULLETIN No.	Name of variety.	Yield per acre, 1906, bu.
11	Velvet Don	12.75
15	Kubanka	17.59
16	Pellisser	9.83
17	United States No. 2246	19.67
18	United States No. 8230	17.52
19	Colorado No. 50	11.35

All of the above-named varieties were of the durum or macaroni type of wheat except No. 19, which was common spring wheat, one of the best producing varieties at the Colorado Experiment Station, from which the seed was secured. It appears that several of the new varieties of durum wheat tested are superior to the Velvet Don. The seed of varieties Nos. 17 and 18 was secured from the Hays Branch Station and originally came from Russia through the United States Department of Agriculture. These varieties have also proved to be among the best producing at the Hays Branch Station.

The tests indicate that spring wheat of all varieties is not adapted for growing in this section of the State. The durum wheat has

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yielded better than the common varieties, fife and blue-stem, and yet the yield of the durum wheat is very low as compared with the yield of winter wheat. As an average for the last four seasons the Velvet Don durum wheat has yielded only 14.24 bushels per acre, while the best producing variety of winter wheat has yielded 41.70 bushels per acre. The spring durum wheat is a dry-land wheat and is fairly well adapted for growing in the central and western portions of the State, but cannot be recommended for Eastern Kansas.

A TRIAL OF VARIETIES OF OATS

The variety trial of oats in 1904 was conducted in a field which had grown cow-peas and soy-beans in 1903. The field was plowed early in March, after a very dry winter, but a rain of 0.22 inches was received just before seeding time (March 10), and the seed-bed was put into fairly good condition. A Bement weeder was used on all the plots March 30, just before the oats came up. The thin stands secured were perhaps due in part to the soil conditions, but more largely to the heavy frosts of April 1 and 2, which apparently killed many of the young plants. No rain was received after seeding until April 25, and this fact, with the rather dry condition of the soil at the time of seeding, doubtless accounts for the small growth made and the small number of tillers produced. The yields secured of all varieties were very small, as shown in table XIII.

In 1905 this experiment was conducted upon a plot which had grown a large crop of ensilage corn in 1904, and a light coat of eight to ten loads of manure per acre was applied in the fall before plowing for the oats. The oats were seeded March 22 on a well-prepared seed-bed. Good stands were secured and all the varieties made a vigorous growth throughout the season.

In 1906 the varieties of oats were seeded on a plot which was planted to corn in 1904 and 1905. The land was not plowed, but prepared for seeding by the use of the disc and smoothing harrows. The oats were seeded March 31. Good stands were secured of all varieties, but as only 3.18 inches of rain (all in small showers) was received between April 17 and June 18 the oats did not make a satisfactory growth; the grain stooled poorly, the straw was very short, and the heads were small and not well filled. The results of these several trials are given in table XIII. The description is for the 1905 crop.

In 1904 and in 1906 the early maturing varieties of oats made larger yields than the late varieties, but in 1906, a season which was especially favorable for oats, the larger growing, later maturing varieties commonly grown in the Northern States produced

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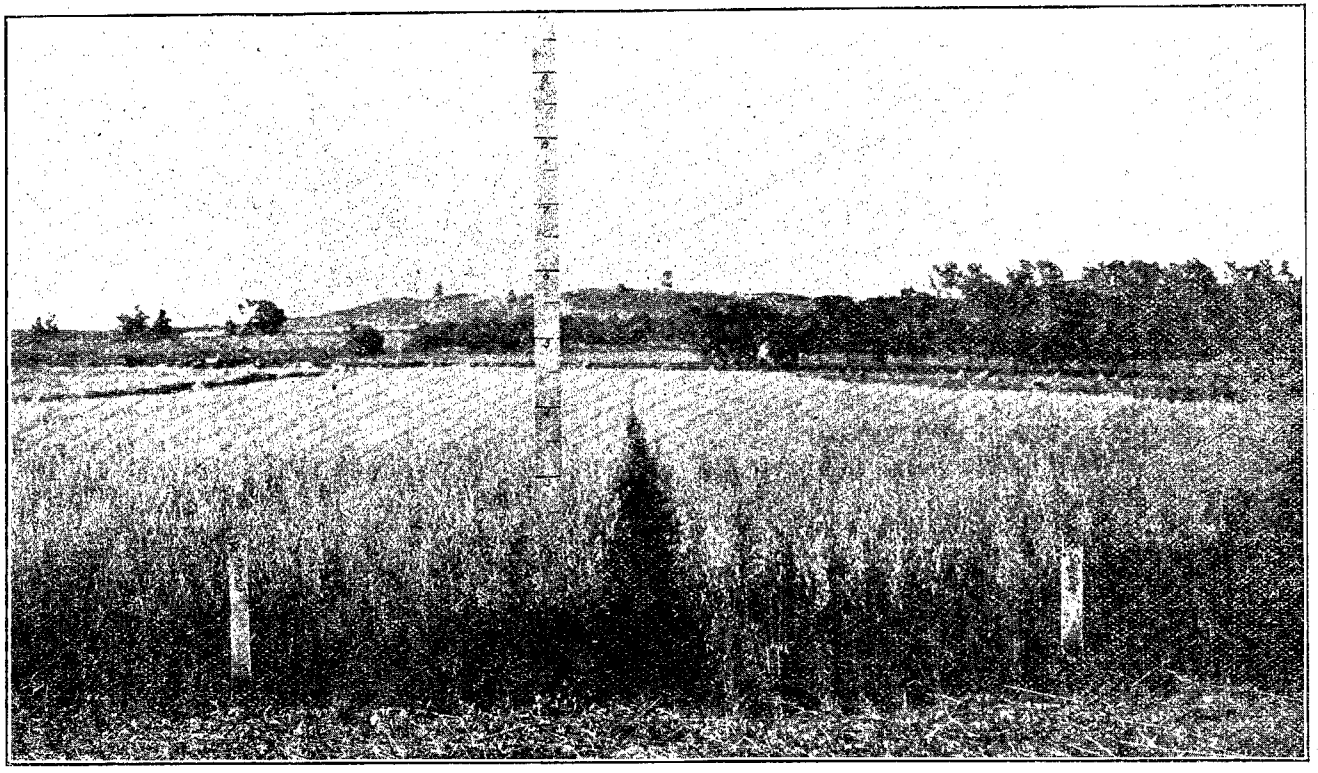

FIG. IV.—Field of Kherson and Sixty-day oats; crop of 1905.

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TABLE XIII.—Varieties of Oats.

Bulletin No.	Name.	Where from.	When received.	Days to mature.	Av. No. of tillers per plant.	Av. height at maturity, in.	Rust resistence, per cent.	Smut resistence, per cent.	Stiffness of straw, per cent.	Weight per bushel, lbs.	Grade	Straw, yield per acre, 1905, tons	Grain, yield per acre, 1905, bu.	Grain, yield per acre, 1904, bu.	Grain, yield per acre, 1903, bu.	Grain, av. yield per acre, '03, '04, '05, bu.
1	Sixty Day	North Dakota Expt. Station	1903	92	0.6	34	85	70	93	29.0	No. 2	0.86	60.87	25.96	32.63	43.24
3	Minnesota No. 202	North Dakota Expt. Station	1903	100	1.6	39	90	75	92	33.0	No. 1	1.53	55.71	13.98	37.42	33.70
5	Tartarian	North Dakota Expt. Station	1903	104	0.8	37	88	70	95	33.0	No. 1	1.16	47.94	19.13	32.86	32.46
8	Kherson	Nebraska Experiment Station	1903	94	0.8	31	88	70	95	32.0	No. 1	0.83	59.60	27.21	34.94	42.11
10	Red Texas	F. Barteldes & Co.	1903	97	1.2	30	85	98	93	33.5	No. 2	1.09	63.88	15.24	44.75	40.44
14	Early Champion	Iowa Seed Co.	1903	94	0.1	36	92	60	90	34.0	No. 1	0.98	40.94	22.81	27.94	30.97
15	Silvermine	Iowa Seed Co.	1903	98	0.1	38	83	75	85	36.5	No. 1	1.31	58.04	18.87	46.31	37.81
21	Burt	McPherson Branch Station	1904	85	1.5	31	94	95	95	29.0	No. 2	1.10	42.75	.....	30.10	.....
22	Irish Victor	Iowa Seed Co.	1904	98	0.5	38	88	78	75	33.0	No. 1	1.12	46.90	14.46	40.44	.....
23	White Russian	F. Barteldes & Co.	1904	103	0.8	38	90	70	88	34.5	No. 1	1.14	47.94	17.90	33.54	.....
24	Schoenen	F. Barteldes & Co.	1904	108	0.7	38	92	83	90	32.5	No. 1	1.22	49.49	17.90	23.90	.....
25	Swedish Select	D. A. Wallace, Mora, Minn.	1905	97	0.2	37	83	83	85	36.5	No. 1	1.27	52.89	.....	37.42	.....
26	Swedish Select	Hays Branch Station	1905	97	0.4	35	88	80	85	35.0	No. 1	1.00	45.66	.....	40.84	.....
27	Dun	United States Dept. of Ag.	1905	106	2.8	38	90	90	83	33.0	No. 1	1.22	47.94	.... .	20.91	.....
28	Black Tartar	United States Dept. of Ag.	1905	106	4.3	38	92	98	83	29.5	No. 2	2.30	58.45	.....	18 73	.....
29	Canadian	United States Dept. of Ag.	1905	94	0.2	41	88	85	85	33.0	No. 1	1.46	59.09	.....	33.28	.....
30	White Tartar	United States Dept. of Ag.	1905	107	0.6	41	90	93	85	33.0	No. 1	1.63	76.14	.....	27.80	.....
31	Sparrowbill	United States Dept. of Ag.	1905	98	0.2	41	92	92	85	34.0	No. 1	1.20	55.06	.....	29.30	.....
32	Danish	United States Dept. of Ag.	1905	98	0.6	39	90	87	85	33.0	No. 2	1.01	57.24	.....	40.21	.....
33	Lincoln	Oklahoma Experiment Station	1905	95	1.8	38	90	80	85	32.5	No. 1	0.60	50.53	.....	35.52	.....
34	Schatiloff	Stavropol Expt. Sta., Russia.	1905	97	0.7	37	88	72	82	36.0	No. 1	1.29	42.78	.....	28.26	.....
35	Stavropol	Stavropol Expt. Sta., Russia.	1905	97	1.0	37	98	72	90	32.0	No. 1	1.49	52.89	.....	33.43	.....

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slightly larger yields than the early maturing varieties. The season of 1905, however, was probably a more exceptional one than those of 1903,1904,and 1906, and the early maturing varieties of oats, as well as the practice of early seeding, should doubtless be recommended for Kansas conditions.

The highest average yield for the four years during which these varieties have been tested, 43.24 bushels per acre, was produced by the Sixty-day oats, and the second highest yield, 42.11 bushels per acre, by the Kherson oats, two of the earliest maturing varieties of oats grown at the Station. These varieties are very similar (if they were not originally the same) and were imported from Russia, the Kherson by the Nebraska Experiment Station in 1899 and the Sixty-day by the United States Department of Agriculture in 1900. The Red Texas oats commonly grown in the South and Southwest ranked third, with an average yield of 40.44 bushels per acre. Of the Northern-grown oats the Silvermine has given the largest average yield, 37.81 bushels per acre, ranking fourth in order of yields as compared with the other varieties.

As an average for two trials, 1905 and 1906, the varieties producing the highest yields were the Red Texas, 54.37 bushels; Silvermine, 52.18 bushels; White Tartar, 51.97 bushels; Danish, 48.03 bushels; Kherson, 47.27 bushels; Sixty-day, 46.75 bushels; Minnesota No. 202, 46.57 bushels; and Swedish Select, 45.16 bushels per acre, respectively. The season of 1905 was especially favorable for the production of oats.

This strain of the Red Texas oats which has given the largest yield for two seasons, and which stands third in order of yield for the four-years' trial, has been grown at the Station for four years and has seemed to improve rather than to deteriorate in quality and yield. Oats are not considered well adapted for growing in this State. It is the general experience that oats soon "run out" in Kansas, and farmers consider it necessary to secure new seed every two or three years. The trials at this Station, however, indicate that it is not only possible to maintain the quality and yield of oats, but also to even improve them by good culture and by sowing only the best grade of seed. In 1905, Red Texas Oats, secured directly from the Oklahoma Experiment Station, yielded 53.49 bushels, while our home-grown variety (No. 10) yielded 63.88 bushels per acre. Two other samples of the Red Texas oats were planted the same season, one being secured from the Fielding Seed Company, of Manhattan,the other from F. Barteldes & Co., Lawrence, Kan. These samples yielded 56.49 bushels and 61.15

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bushels per acre, respectively. It was true, also, in 1904 that the home-grown Red Texas oats outyielded the new seed of that variety which was secured from Barteldes. Some trials have been made, also, in comparing the yield of home grown seed of Kherson and Sixty-day oats with seed of these varieties secured from the Nebraska Experiment Station. The results of these tests, however, are conflicting, although the average yields for the two seasons, 1905 and 1906, slightly favor the home-grown seed.

Our methods of culture in growing these oats have already been described. The seed oats are fanned and graded and all the light oats are removed, so that only good, sound seed is sown from year to year. The fact that the oats have been gradually improved the longer we have grown them may be credited to the grading of the seed.

In table XIII the records are given only for those varieties which have been tested two years or more and which have proved worthy of further trial. A number of other varieties have been grown one or two years and discarded, because of low yields and inferior quality of grain. Among these varieties may be mentioned the following: Archangel, Black Beauty, Morganfeller, Siberian White, Black Tartarian, Calgary Gray, Michigan Wonder, Czar of Russia, Canadian Giant, European Hulless, and North Finnish Black. Several of these varieties were grown in 1903 and their yields are reported in bulletin No. 123. The varieties grown for the first time in 1906 were the Sensation, Moyer, Leonard and Hennessy varieties. None of these varieties appear to be extra yielders.

A TRIAL OF VARIETIES OF BARLEY

The variety tests of barley in 1904 and in 1906 were conducted on the same plots as the variety tests of oats, and the previous cropping, preparation of seed-bed and other conditions were the same as already described for oats. In 1905 this experiment was conducted on a plot which had been planted to cow-peas in 1903 and 1904. The land was fall plowed and a good seed-bed was prepared in the spring by the use of the Acme and smoothing harrows. The barley was seeded March 24. Good stands were secured of all varieties, but the season did not appear to be as favorable for the barley as for the oats, and only medium yields were secured.

During the four seasons in which these varieties have been tested the Common Six-rowed barley made the largest average yield, 30.94 bushels per acre, the Bonanza and the Mansury ranking second and third, with yields of 28.97 and 28.80 bushels per

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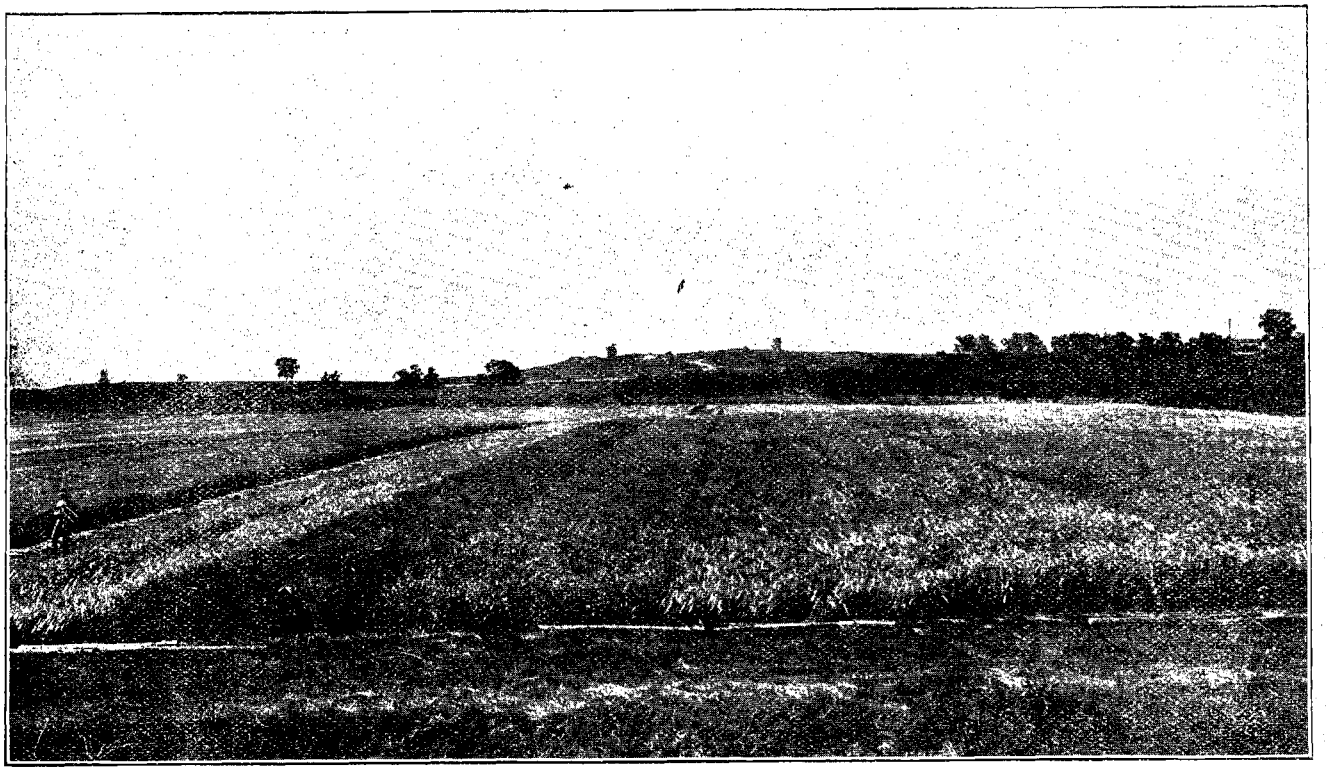

FIG. V.—Variety test of barley; crop of 1905.

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TABLE XIV.—Varieties of Barley.

Bulletin No.	Name of variety.	Type.	Where from.	Date received.	Days to mature.	Av. No. of tillers per plant.	Av. height at maturity, inches.	Rust resistance, per cent.	Smut resistance, per cent.	Stiffness of straw, per cent.	Weight per bushel, lbs.	Straw, yield per acre, 1905, tons.	Grain, yield per acre, 1905, bu.	Grain, yield per acre, 1904, bu.	Grain, yield per acre, 1906, bu.	Grain, av. yield per acre, 1903, '04, '05, '06, bu.
1	Mansury	B. 6-rowed	F. Barteldes & Co.	1903	90	0.0	33	90	90	90	43.0	1.27	42.32	30.46	12.93	28.80
2	Mandscheuri	B. 6-rowed	North Dakota Expt. Station	1903	90	0.0	32	90	90	87	44.0	1.28	38.74	25.75	12.71	27.30
4	2 Rowed Mandscheuri	B. 2-rowed	North Dakota Expt. Station	1903	95	2.5	33	88	100	88	45.0	1 66	30.42	14.84	10.26	20.88
5	Common	B. 6-rowed	F. Barteldes & Co.	1903	90	0.5	31	90	100	85	40.0	1.06	46.55	26.92	16.39	30.94
6	Bonanza	B. 6-rowed	Hammond Seed Co.	1903	91	0.0	22	88	80	87	44.0	1.13	42.80	27.43	12.56	28.97
7	Black Hulless	B. H. 6-rowed	Farmer Seed Co.	1903	90	0.5	31	92	100	85	60.5	1.05	32.75	19.89	14.40	22.26
8	Success Beardless	A. 6-rowed	Farmer Seed Co.	1903	91	0.0	38	85	100	95	41.0	1.19	35.22	28.28	14.16	26.42
10	White Hulless	A. H. 6-rowed	F. Barteldes & Co.	1903	90	0.5	30	95	90	75	58.0	1.14	33.92	9.56	10.63	18.00
13	6 Rowed Ellis	B. 6-rowed	Hays Branch Station	1905	91	1.8	29	92	70	90	41.0	1.10	43.06	.....	13.63	.....
14	Hanna	B. 6-rowed	Hays Branch Station	1905	93	2.7	28	95	82	90	45.0	1.03	34.25	.....	11.18	.....
15	White, U. S. No. 195	B. 6-rowed	Hays Branch Station	1905	90	1.5	22	90	100	80	46.5	0.91	39.57	.....	15.32	.....
16	U. S. No. 7969	B. 6-rowed	McPherson Branch Station	1905	90	1.0	25	92	98	85	47.5	1.01	47.72	.....	15.92	.....
17	Stavropol	B. 6-rowed	Stavropol Expt. Sta., Russia	1905	90	0.3	34	92	100	78	45.0	1.25	37.54	.....	18.68	.....

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acre, respectively. The beardless varieties of barley, which are often demanded by the farmers on account of the beardless character, have made smaller yields with a poorer grade of grain than the above-mentioned varieties which belong to the six-rowed bearded type. It is possible that the yield and quality of the beardless barley may be improved by breeding, but for the present some of the best producing of the six-rowed beardless varieties should be used for planting in this State.

The hulless barley, though it may have some advantages over other types in feeding value, has produced such relatively low yields that it cannot be recommended for general planting. Although the grain of hulless barley weighs 60 pounds to the bushel, the yields as reported in table XIV have been figured upon a basis of 48 pounds to the bushel, to make them more readily comparable to the yields of other varieties.

Several varieties of the beardless and hulless types of barley have been tested, but the yields of only the better producing varieties are reported in table XIV. Varieties which have been tested and discarded are: McEwan's Hulless, Hammond's Colossal Champion Beardless, Beldi (U. S. No. 190), Telli (U. S. No. 194), U. S. No. 265 and U. S. No. 264.

RATE TO SOW BARLEY AND OATS

This is the report of a single trial which was conducted in 1904. The land used for the experiment had previously been cropped to corn, alfalfa, and Bromus inermus. The alfalfa and Bromus inermus sod was broken in the fall of 1903. The corn ground was not plowed, but was cultivated with the disk harrow. The sod was also well disked, and was in good condition when seeded, March 23. This land was in an excellent state of fertility, the corn land having received a heavy coat of manure in the spring of 1903. The grain was seeded crosswise of the plots of the previous season. Duplicate plots of barley were seeded, but the oats were sown in single plots. Each plot consisted of two drill widths, 404 feet long, or about one-eighth of an acre in area. The grain made a rapid, rank growth early in the season; in fact, the growth of straw on the alfalfa ground was so great that the oats lodged, grew up, and lodged again, and produced practically no grain. The barley lodged also, but not so badly but that it could be harvested.

It was observed at harvest time that there was a great difference in the growth of the grain on the several kinds of land, and each of the several plots was divided and harvested separately, and in table XV the yields of barley are given on the corn, alfalfa

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and grass land, as well as for the whole of each plot. The yield of oats was determined on the corn ground only. There was little difference in the date of maturity of the grain on the several plots. The barley was harvested July 3 and the oats a few days later. The Red Texas oats and the Common Six-rowed barley were used in this experiment. The rates of seeding with the resulting yields are given in tables XV and XVI.

TABLE XV.—Rate to sow Barley.

RATE OF SEEDING PER ACRE, BU.	Yield per acre on corn ground, bu.	Yield per acre on Brome sod, bu.	Yield per acre on alfalfa sod, bu.	Average yield per acre, bu.
1	44.92	56.84	27.50	43.08
1½	46.55	62.00	33.79	47.45
1¾	46.55	60.72	38.48	48.58
2	48.88	57.84	34.77	47.14
2½	52.41	58.48	36.56	49.15
Averages	47.85	59.17	34.22	47.08

TABLE XVI.—Rate to sow Oats.

Rate of seeding, per acre, bushels.	Yield per acre, on corn ground, bu.
1½	31.64
2	37.48
2¼	37.96
2½	41.37
3	40.40

In this test the thicker seedings of both barley and oats gave the larger yields, the largest yield in each trial resulting from seeding 2½ bushels of seed-grain per acre. By referring to table XV, however, it will be observed that the yields of grain on the Brome sod land were not only larger, but differed from the yields produced from corn ground and alfalfa land in that the largest crop was secured from sowing 1½ bushels of seed barley per acre. The results may be explained in this way, that on the more fertile soil the grain on the plots having the thicker stand lodged less than the grain on the plots having a thinner stand, due to the fact that where the grain was very thick the straw did not grow so rank and tall, hence did not lodge so badly. The Brome sod land, although in a good state of fertility, was not too fertile to produce a good crop of barley, and the thinner stand, producing the larger, stronger growth, gave also the larger yield.

It has usually been recommended to use less seed on fertile land, but this experiment would indicate that on extremely fertile land it is better to sow more seed than on land of average fertility.

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The usual practice at this Station is to sow about two bushels of barley per acre.

It is interesting to observe that the Brome sod land produced the largest average yield of barley, nearly 25 bushels more per acre than was produced on the alfalfa land and 11.3 bushels more per acre than was produced on the corn ground. This result is largely due to the lodging of the grain on the alfalfa and corn ground as stated above.

DATE TO SEED BARLEY AND OATS

Two trials have recently been made to determine which are the best dates for sowing barley and oats. In 1905 the yields of each kind of grain, seeded at different dates, was determined as follows :

TABLE XVII.—Date to sow Oats and Barley.

Date of seeding.	Oats, yield per acre, bu.	Barley, yield per acre, bu.
Mar. 10	40.79	.....
Mar. 14	40.14	21.20
Mar. 30	45.92	25.69
Apr. 13	42.72	16.91
Apr. 20	41.11	24.82
Apr. 27	14.77	7.94
May 6	.....	14.56
May 12	.....	6.64

Mandscheuri barley No. 2 and Red Texas oats were seeded in this trial, the barley at the rate of two bushels per acre and the oats at the rate of two and one-half bushels per acre. The trial was made on old land, which had previously been cropped with corn and sorghum, and which was given a light dressing of manure in the spring of 1905, previous to plowing for oats and barley. A great deal of volunteer sorghum started in the grain, especially in the early seeded plots, and this no doubt tended to decrease the yield of grain and interfered somewhat with the accuracy of the experiment.

The seedings made March 30 have given the largest yields of both barley and oats. Seedings were also made April 6, but the yields from these plots were not determined. No barley was sown on March 10, and the last seeding of oats, May 6, produced no grain and a very dwarf growth of straw, although the barley sown on this date produced a fair yield of grain.

This experiment was continued in 1906, the first sowings being made in February, during a period of warm weather when there was no frost in the ground. The weather and soil conditions were so favorable for growth that the grain sown February 1

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started and came up. During the last week of February and the first two weeks of March the weather was cold and the ground froze to the depth of several inches, but a light snow previous to the freeze covered the grain and it was apparently uninjured by the cold weather. This experiment was conducted with more care than the former one, and more notes were taken. The results are given in Table XVIII.

TABLE XVIII.—Date to sow Barley and Oats, 1906.

Date of Seeding.	Date of maturity.		Average height of grain.		Weight per bu.		Yield per acre.	
	Barley.	Oats.	Barley, in.	Oats, in.	Barley, lbs.	Oats, lbs.	Barley, bu.	Oats, bu.
Feb. 1	June 15	June 19	22	27	34	27	36.55	29.69
Feb. 19	June 15	June 19	23	26	35	27	30.21	36.25
Mar. 29	June 15	June 19	25	21	28¾	25½	18.54	43.75
Apr. 10	June 28	June 28	20	20	22	27	18.75	42.97
Apr. 21	July 18	July 18	20	18	25	32	11.25	23.75
Apr. 28	July 18	July 18	22	19	29½	29½	18.33	17.55
May 11	July 20	July 20	20	24	.....	25½	5.83	31.25

It appears that the winter-seeded oats have not yielded so well as the oats which were sown after the spring opened, the largest yield being secured from the seeding made March 29. With the barley, however, the winter seeding seems to have given the best results, and the largest yield, 36.55 bushels per acre, was produced by seeding February 1. The winter-seeded barley also graded better than the barley produced from the spring seedings. The heaviest oats, however, were produced by rather late spring seeding, made April 21 and 28. However, the yield of grain from these plots was relatively low. It appears that the late sown grain made a thin stand and a dwarf growth of straw, although the heads developed fairly well and contained some plump, sound grain. This seems to be more true of oats than barley.

From the results of the several trials it appears that there is a best date for seeding oats at this Station, and this date seems to be the last days of March or the first days of April, depending somewhat upon the season. With barley, however, there seems to be a greater range in time when this grain may be seeded with a prospect of producing a good crop. It will be observed that as an average, the earlier seedings of barley and also the later seedings of barley produced relatively larger yields than the corresponding seedings of oats. It should be observed, also, that while the season of 1905 was favorable to the growth of small grains, the season of 1906 was too dry in the early part of the year to produce a good growth of barley or oats, and all of the plots sown on the Collegefarm produced relatively low yields.

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WINTER SEEDING OF SMALL GRAINS

Advantage was taken of the warm weather in February, 1906, to make a seeding trial of a number of varieties of small grains. Winter seedings were made February 1 and February 19. Table XIX gives the yields secured from these seedings and also the yields secured by seeding the same varieties of grain at the ordinary season of the year.

TABLE XIX.—Winter seeding of small grains.

BULLETIN No.	Kind of grain.	Variety.	Seeded Feb. 1, yield per acre, bu.	Seeded Feb. 19, yield per acre, bu.	Seeded at ordinary season, yield per acre, bu.
7	Winter wheat	Malakoff	18.50	.....	45.07
2	Winter rye	Ivanof	18.16	.....	42.68
12	Common spring wheat	Early Java	.....	19.58	11.35*
11	Durum spring wheat	Velvet Don	19.50	.....	12.75
2	Emmer	Common	25.11	31.26	22.22
5	Barley	Common Six-rowed	36.56	30.21	18.54
2	Oats	Sixty-day	29.69	36.25	43.75

*Colorado No. 50, yield in regular test.

With the exception of the winter wheat, spring wheat, and winter rye, all of the yields given in the last column of table XIX were made on the same field. The spring wheat, emmer and barley gave decidedly larger yields from the winter seeding. Oats yielded best when sown at the ordinary season, as did also winter wheat and winter rye. Winter seeding of any kind of grain is doubtless uncertain as to results, but with spring wheat it may be preferable to sow very early in the spring, or even in the winter, if soil conditions are favorable. Spring wheat sown at the ordinary season usually makes an unprofitable crop at this Station.

FERTILIZERS FOR OATS AND BARLEY

Sodium Nitrate.-The fertilizer tests with oats and barley in 1903 and 1904 were conducted on an upland field of the Station farm upon which no manure had been applied for many years. In 1903 the only fertilizer used was sodium nitrate, which was applied at the time of seeding, at the rate of 180 pounds per acre on the oats and 210 pounds per acre on the barley. The oats on both the fertilized and unfertilized plots lodged badly. The varieties used were the Red Texas oats and the Common Six-rowed barley. The yields were as follows: Fertilized oats, 19.5 bushels of grain and 1512 pounds of straw per acre; unfertilized oats, 24.4 bushels of grain and 1649 pounds of straw per acre; fertilized barley, 20.0 bushels of grain and 2234 pounds of straw per acre; unfertilized barley, 16.2bushels of grain and 1640 pounds of straw per acre.

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In 1904 the experiment with the sodium nitrate was repeated, and the fertilizer was applied on both oats and barley at the rate of 186 pounds per acre. The fertilized oats started well, making a better stand and somewhat ranker growth than the grain on the plot receiving no fertilizer. It was observed that the fertilized oats lodged and crinkled down much worse than the unfertilized oats. The fertilized barley showed a more vigorous growth than the unfertilized and produced about twice as much grain and straw. The yields were determined as follows: Fertilized oats, 24.17 bushels of grain and 1637 pounds of straw per acre; unfertilized oats; 86.27 bushels of grain and 1602 pounds of straw per acre; fertilized barley, 35.21 bushels of grain and 1594 pounds of straw per acre; unfertilized barley, 17.69 bushels of grain and 819 pounds of straw per acre.

Commercial Fertilizers.-The fertilizer tests of 1905 and 1906 were conducted upon rented fields, which had been cropped for years without the application of barn-yard manure or commercial fertilizers and the soil was in a very low state of fertility. These fields were adjacent to each other and were similar in character of soil and in fertility. It is thus apparent that seasons have much more effect on crops than fertilizers. The yields of the 1905 crops were from four to five times larger than those of 1906.

In 1905 and 1906 the application of sodium nitrate gave reverse results with oats to those secured in 1903 and 1904, due in part, perhaps, to the fact that smaller applications were made, averaging 76 pounds per acre. Oats, when abundantly supplied with nitrogen, are apt to make a vigorous growth of straw, but produce scantily in grain. As an average for the two seasons, the plots fertilized with nitrate of soda yield 38.76 bushels per acre, or 5.46 bushels more than the unfertilized land. In each of the trials the other commercial fertilizers used apparently failed to cause any increase in the yield of oats, but the application of twenty-four loads of barn-yard manure per acre in 1906 resulted in a yield of 19.11 bushels of oats per acre, the highest yield secured in that season from any of the plots.

In the test of commercial fertilizers as an average for the two seasons, the application of sodium nitrate has resulted in the highest yield, while the unfertilized plots produced more oats than either the phosphate or potassium fertilized plots. The average yield of oats for four years, produced by the lands fertilized with sodium nitrate, was 30.42 bushels per acre as compared with 22.55 bushels per acre from the unfertilized plots. Sixty-day oats and Mandscheuri barley were used for these trials in 1905, and Kher-

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son oats and Bonanza barley in 1906. The tabulated results of these experiments are given in tables XX and XXI.

TABLE XX.—Fertilizer for Oats.

NAME OF FERTILIZER.	1905.		1906.		1905 and 1906.	
	Fertilizer, amount per acre, lbs.	Oats, yield per acre, bu.	Fertilizer, amount per acre, lbs.	Oats, yield per acre, bu.	Fertilizer, average amount per acre, lbs.	Oats, average yield per acre, bu.
Special grain fertilizer	.....	.....	75	7.64	.....	.....
Superphosphate	110	46.09	93	12.04	102	29.07
Pure Raw Bone Meal	.....	.....	106	9.08	.....	.....
(Unfertilized)	.....	54.48	.....	12.12	.....	33.30
Potassium Sulphate	110	51.39	82	11.54	96	31.47
Sodium Nitrate	82	59.85	70	17.66	76	38.76
Sulphate of Iron	.....	.....	58	9.10	.....	.....
Barn-yard Manure	.....	.....	48,235	19.11	.....	.....

TABLE XXI.—Fertilizer for Barley.

NAME OF FERTILIZER.	1905.		1906.		1905 and 1906.	
	Fertilizer, amount per acre, lbs.	Barley, yield per acre, bu.	Fertilizer, amount per acre, lbs.	Barley, yield per acre, bu.	Fertilizer, average amount per acre, lbs.	Barley, average yield per acre, bu.
Special grain fertilizer	.....	.....	130	14.58	.....	.....
Superphosphate	73	36.84	110	16.85	92	26.85
Pure Raw Bone Meal	.....	.....	122	14.56	.....	.....
(Unfertilized)	.....	45.34	.....	10.97	.....	28.16
Potassium Sulphate	125	35.14	63	8.94	94	22.04
Sodium Nitrate	73	32.59	137	11.23	105	21.91
Sulphate of Iron	.....	.....	66	3.75	.....	.....
Barn-yard Manure	.....	.....	48,235	18.64	.....	.....

COMBINATIONS OF FERTILIZERS

Combinations of the commercial fertilizers used in the experiments reported above were applied on adjacent plots in the same field which were planted to another variety of barley. No check plot was seeded in this series, so that a comparison between the fertilized and the unfertilized land cannot be made. A combination of 6 pounds of sodium nitrate, 8 pounds of potassium sulphate, and 11 pounds of raw bone-meal, applied at the rate of 130 pounds of the mixture per acre, gave a yield of 14.42 bushels of barley, while a combination of 9 pounds of potassium sulphate and 18 pounds of raw bone-meal, applied at the rate of 164 pounds of the mixture per acre, gave a yield of 14.42 bushels of barley per acre. The check plot of Bonanza barley in the regular series yielded 10.97 bushels per acre.

It appears that the application of a combination of fertilizers has given practically no better results than the application of each

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of the fertilizers on separate plots. There is little question, however, but that in a more favorable season, land in better physical condition, and not so badly depleted in fertility as the land on which this trial was made, should respond with better effect to the application of a proper combination of chemical fertilizers. This is indicated in an experiment conducted on small plots by one of our students of the College, W. B. Gernert. This experiment was made on a more moist and fertile soil than the regular experiments quoted above, and Mr. Gernert secured yields of both oats and barley, favoring the application of a combination of nitrate, potash and phosphate compared with the application of a single one of these fertilizers to separate plots.

FERTILIZERS VERSUS COW-PEAS

An interesting experiment was made with the Kherson oats in another portion of the same field in which the regular fertilizer test with oats was made, as reported in table XX. A plot of cow-peas had been planted on part of this land in 1905. Chemical fertilizers were also applied to two adjacent plots, and another strip of unfertilized land was used as a check plot. The results of the trial are given as follows:

KIND OF FERTILIZER.	Fertilizer, amount per acre, lbs.	Oats, yield per acre, bu.
Unfertilized	.....	7.64
Cow-peas in 1905	.....	20.08
Special Grain Fertilizer	102	12.65
Equal parts of Raw Bone Meal and Sulphate of Potash	121	9.24

The effect on the yield of oats by the growing of a single crop of cow-peas is remarkable. These cow-peas were grown and cultivated in rows, and the crop was harvested and removed. If the peas had been turned under for green manure, doubtless the fertilizing effect would have been still greater.

FERTILIZERS APPLIED AT DIFFERENT RATES

In connection with the last experiment described, tests were made in applying the special grain fertilizer and a combination of bone meal and potash at different rates per acre, namely, the special grain fertilizer was applied at four different rates, varying from 76 to 114 pounds of the fertilizer per acre. There was practically no difference, however, in the resulting yields from the several plots. With the combination of potash and bone meal, the amount applied on four separate plots varied from 50 to 220 pounds per acre. The yield from the plot receiving the 50 pounds of

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fertilizer per acre was a little larger than that from any of the other plots. All of these trials indicate that the chemical fertilizers; whether applied in small or great quantities, apparently have very little effect in increasing the crops of grain on the poor upland soil, such as was used for these experiments.

Emmer and Speltz

Varieties of Emmer. — During the past three years two varieties of spring emmer, *Triticum dicoccum* (sometimes erroneously called speltz), have been tested at this Station. No. 1, received from F. Barteldes & Co., made an average yield for the three seasons of 28.46 bushels per acre, while No. 2, received from the North Dakota Experiment Station, produced an average yield of 31.35 bushels per acre. Forty-five pounds is usually considered a standard bushel of emmer. The highest average yield per acre of barley during the same period was 29.95 bushels, and the highest average yield per acre of any of the varieties of oats was 40.58 bushels per acre. According to the analyses made by Shepard, Ladd and Snyder, as reported in the United States Department of Agriculture, Farmers' Bulletin, No. 139, it would seem that the total amount of protein, carbohydrates and fat in the yields of the three crops, as mentioned above, would be approximately equal. On account of the large percentage of hulls, however, the emmer contains less digestible nutrients than either the oats or barley, and the above-mentioned crops of oats or barley would doubtless be more profitable than emmer yielding at the rate of 31.35 bushels per acre. Reports from the North Dakota and other experiment stations, and from farmers in the Great Plains region, indicate that emmer resists drought fairly well, but at the Ft. Hays Branch Station, in Ellis county, emmer has not proved more drought resistant than barley or oats, and it is probable that this crop should not be strongly recommended for semi-arid conditions until its merits are further determined.

Fall Seeding Emmer. — The experiments in sowing emmer in the fall with the purpose of producing a winter variety have not been very successful. Emmer sown in the fall of 1903 was entirely winter-killed. That planted in the fall of 1904 survived the winter, yielding 43.85 bushels per acre, while spring emmer yielded only 31.06 bushels per acre. However, the seed of this fall seeded crop, sown again in the fall of 1905, almost entirely winter-killed; only a few plants survived and a small quantity of seed was secured and sown again last fall, 1906. There is little question but that if a winter variety can be established it will far out-yield the spring emmer and perhaps produce a better quality of grain.

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Rate to Sow Emmer. —In 1904 an experiment was made to determine how much emmer seed should be sown per acre. The plot of ground used had previously been in grass (Bromus inermis) and was broken in the fall of 1903. The sod was well disked in the fall and again in the spring. Emmer No. 1, referred to in the discussion of the test of varieties, was seeded with the Dowagiac double-disk drill. The rates of seeding and resulting yields are given as follows :

Drill set to sow barley per acre, bu.	Actual amount of emmer seeded per acre, lbs.	Yield per acre, bu.
3	89	31.82
2½	84	33.40
2¼	75	33.06
2	70	32.04
1½	56	32.72

From these tests we may conclude that the ordinary grain drill should be set to sow nine or ten pecks of barley per acre in order to seed the right amount of emmer, since the seeding at the rate of 2½ bushels of barley per acre, which actually seeded 1.87 bushels of emmer, gave the largest yield, 33.40 bushels per acre, while the plot which received a peck less seed per acre gave nearly as large a yield. It would appear from this trial that six to eight pecks of emmer seed per acre is the proper amount to sow at this Station.

Varieties of Speltz.-Two varieties of the true speltz *Triticum sativum Spelta,* which differ in appearance from the emmer in having the spikelets of the head placed farther apart and in having shorter beards or no beards at all, were seeded in the fall of 1905. These varieties did not prove to be as hardy as the winter wheats, about 20 per cent more of the plants being winterkilled. The speltz, however, stooled more than the wheat and made a fairly good stand before the grain was headed. It was very free from rust and smut and made a vigorous growth, attaining a height of 3 feet and 5 inches. It was headed by May 26 and matured by June 24. The better of the two varieties, which was received from the McPherson Branch Station, made a yield of 2571 pounds per acre. No date is at present available to the writer on the feeding value of this grain. Speltz is a very ancient grain and is still cultivated in certain parts of the old continent, but aside from the tests made at several experiment stations it is little grown in this country. It is perhaps best adapted to semi-arid conditions or poor soils.

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Flax

TRIAL OF VARIETIES

The Agronomy Department of this Station has carried on experiments with flax during the past four seasons. In 1903 several varieties of flax were sown in small plots, on April 17. The seed was sown with a disk grain drill, in drill rows eight inches apart, at the rate of three pecks per acre. The flax came up nicely and made a very satisfactory growth, blooming freely and producing many bolls, which, however, failed to produce perfect seed. The largest yield was only 4.7 bushels per acre in the variety trial, but in another field a half-acre of flax which was protected by timber on the south and east sides yielded 10.3 bushels of flax seed per acre. This flax was planted on alfalfa ground, which was plowed early in the spring. It was evident that the crop was injured by hot, dry weather early in July, and largely because of the protection afforded by the timber the plot on the alfalfa ground gave a larger yield than the flax sown in the open field in the variety trial.

In the trial of varieties in 1904, the common flax, Kansas grown seed, yielded best, *i. e.,* 9.3 bushels per acre. This flax was seeded on March 28 on new land, prairie sod, plowed in the fall of 1903.

On May 3, twenty-four varieties of flax, received from the United States Department of Agriculture, were seeded on old land which had produced corn the previous season and which had been well manured in the winter of 1902-'03. None of these varieties yielded sufficient seed to pay for the threshing. Most of the varieties started well and made a vigorous growth until about the middle of July, when the flax lodged badly and failed to produce much seed. Several of the varieties were discarded, and those that were harvested produced such small yields of light-weight seed that the test was considered entirely unreliable and has not been reported in tabular form.

The seed of these varieties of flax was secured from Russia, and perhaps the poor yield was largely due to the imported seed, since Kansas-grown flax sown on May 7 yielded 8.3 bushels of good seed per acre. The last-named variety was seeded on sod land, which may account somewhat for its better yield, since it appears that the manured corn land was too fertile to produce the best flax, causing a large growth of straw, which lodged, resulting in light bolls and light seed.

In 1905 the varieties of flax were planted April 29 on a piece of new breaking, prairie sod broken in the fall of 1904. The sod was

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disked March 28, Acme harrowed April 22, and harrowed with the smoothing harrow just previous to seeding. The flax was sown at the rate of three pecks per acre with the Dowagiac disk drill. All varieties of flax made a good stand and a fair growth, averaging 16 to 24 inches in height at maturity. Most of the flax was harvested August 8, upon which date it was noted that some of the flax was "over ripe."

The test of varieties of flax was made on old land in 1906, a field which has been farmed many years, and which had been planted to forage crops (sorghum, cow-peas, corn, etc.) in 1905. Part of the land was fall plowed and part of it was spring plowed, the plots crossing the strips of plowing, as well as the plots of the previous season. This land was put into good condition and the flax was sown April 17, at the rate of two pecks per acre. The season of 1906 was, quite favorable for flax. A good stand and growth was secured on all plots. The descriptive data given in table XXII is for the 1906 crop.

TABLE XXII.—Varieties of Flax, Crops of 1905 and 1906.

Bulletin No.	Name of variety.	Where from.	Height at maturity, inches.	Days to mature.	Yield of seed per acre, '06, bushels.	Yield of seed per acre, '05, bushels.	Av. yield of seed per acre, 1905 and 1906, bu.
1..	Common.....	Kansas Experiment Station.....	23	105	7.98	7.36	7.67
4..	N. D. No. 155.....	N. Dakota Experiment Station.....	20	105	10.60	8.96	9.78
5..	N. D. No. 709.....	N. Dakota Experiment Station	20	105	9.14	9.16	9.15
6..	N. D. No. 969.....	N Dakota Experiment Station.....	30	105	5.36	4.23	4.80
7..	U. S. No. 9950....	U. S. Dept. of Agriculture.....	21	105	9.29	4.89	7.09
8..	U. S. No. 9981....	U. S. Dept. of Agriculture.....	30	105	4.80	2.26	3.52
9..	U. S. No. 9982....	U. S. Dept. of Agriculture.....	22	105	10.72	10.92	10.82
10..	U. S. No. 9967....	U. S. Dept. of Agriculture.....	24	105	9.43	6.61	8.02
11..	U. S. No. 10017...	U. S. Dept. of Agriculture.....	22	105	9.00	6.14	7.57
12..	Stavropol.....	Stavropol Ex. Station, Russia.....	20	105	8.86	7.56	8.21
13..	Cicilian.....	Stavropol Ex. Station, Russia.....	21	105	7.55	.....	.....
14..	Common.	Northrup, King & Co.....	22	105	12.05	10.11	11.58

The varieties producing the largest average yields in 1905 and 1906 were the Common flax, No. 14, 11.56 bushels per acre; United States Department of Agriculture No. 9982, 10.82 bushels per acre; North Dakota No. 155, 9.78 bushels per acre; and North Dakota No. 709 9.15 bushels per acre. The United States No. 9981 is a fiber flax, which probably accounts for its low yield of seed.

RATE TO SOW AND DATE TO SOW FLAX

In 1904 these tests were begun and were conducted on native sod land. The seed-bed was prepared by fall plowing and by the use of the disk and Acme harrows in the spring. In 1905 the flax was sown on old land (fall plowed), which had grown a large crop of ensilage corn in 1904, and had previously been in alfalfa, and in

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1906, in a field which had grown soy-beans in 1905, but which had been cropped continuously for many years largely with small grains. Dates of seeding the rate tests were: April 12, 1904, March 30, 1905, and April 17,1906.

In 1904 the flax plots crossed a piece of land which had previously grown alfalfa. On this land the flax made a very rank growth of straw, lodging badly, and did not yield so well or produce so good a quality of seed as on the sod land. The yields given in table X were made on the sod land.

The early sown flax was not injured apparently by hot winds or unfavorable weather in the season of 1904, but the later seedings in the latter part of May and the first part of June gave relatively low yields compared with the flax sown early. In 1905 the early seeded flax matured in 102 days, the flax sown April 12 matured in 96 days, while that sown May 6 was mature August 10, 95 days after planting.

TABLE XXIII.—Rate to sow Flax.

RATE OF SEEDING PER ACRE, PECKS.	Yield per acre, 1904, bu.	Yield per acre, 1905, bu.	Yield per acre, 1906, bu.	Average yield per acre, 1904-'05-'06, bushels.
1	7.72	11.83	12.34	10.63
2	8.14	13.32	12.05	11.71
3	8.98	12.87	12.05	11.30
4	7.92	12.28	11.91	10.70
5	.....	12.73	10.01	.....

TABLE XXIV. - Date to sow Flax.

DATE OF SEEDING.	Yield per acre, 1904, bu.	Yield per acre, 1905, bu.	Yield per acre, 1906, bu.	Average yield per acre, 1904-'05-'06, bushels.
Mar. 28	8.98	14.35	.....	.....
Apr. 16	8.84	12.87	12.05	11.25
Apr. 27	8.44	12 28	12.77	11.36
May 6	8.31	10.08	.....	.....
May 12	.....	8.66	13.98	.....
May 19	6.99	5.10	10.45	7.51
May 26	.....	0.66	11.60	.....
June 6	2.11	.....	6.09	.....

In the 1905 trial the yield of straw was determined for the flax which was seeded at different rates. The thickest sown flax, seeded at the rate of five pecks of seed per acre, produced 4723 pounds of straw per acre; the next largest yield was 4638 pounds, secured from the plots seeded at the rate of three pecks per acre.

The highest average yield of flax in the rate test, 11.30 bushels per acre, was secured by seeding three pecks per acre, although the plots seeded at the rate of two pecks per acre have produced nearly as large an average yield. The seeding of more than three

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pecks of flax seed per acre appears to give too thick a stand, which has resulted in a reduced yield.

The results secured in the date test for seeding flax indicate that fairly early seeding is to be preferred to the later seeding. In 1904 and 1905 the largest yields were secured from seeding March 29, and a careful study of the yields reported in table XXIV, and of yields from other early seedings not here reported, would indicate that the most favorable time for sowing flax in this section of the State is during the last few days of March or the first week in April, or about as early as a proper seed-bed can be prepared.

FLAX CULTURE IN KANSAS

Flax should not be grown continuously on the same land, since by the continuous growing of flax the land may become infected with the "flax-wilt" disease, which will injure or destroy the crop. Flax follows corn very successfully. The writer recommends not to plow corn land for flax, but to cut the stalks with a stalk cutter, if the stalks have not been removed from the ground, and disk and harrow thoroughly to prepare a seed-bed.

As shown by the results of the trials at this Station, early seeding is desirable. Sow two to three pecks of good seed per acre. Any ordinary grain drill may be used, care being taken not to plant the flax too deep. In a good seed-bed with favorably moist weather, if the seed is barely covered it will start best; in a drier seed-bed it is best to cover the seed with an inch or two of mellow soil. A proper seed bed may also be prepared by plowing grain stubble land either in the fall or early in the spring, cultivating the soil sufficiently to pulverize and firm it previous to seeding the flax.

Flax is grown quite extensively and successfully in southeastern Kansas. The writer is interested in introducing flax as a more general crop throughout this State, and sees no reason why flax should not he a profitable crop to grow throughout central and western Kansas, as well as in the southeastern portion of the State. Experiments in the growing of flax have been undertaken at the Ft. Hays Branch Experiment Station, in Ellis county, and the Agronomy Department is cooperating with farmers in different sections of the State in carrying on experiments with flax and other grains.

The crop is one which is worthy of general trial and more extensive growing throughout the State. The yields of flax secured at this Station are not so large as the crops grown in the Northwestern states; perhaps we have not yet learned the best methods

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of culture, and it is possible that varieties may be introduced or bred which may be better adapted for growing in this State than those which are at present being grown. The Agronomy Department has for sale and distribution a limited supply of seed of several of the best producing varieties. Some breeding experiments with flax are also being undertaken.

Breeding and Distributing Seed Grain

The results of the variety tests indicate that all varieties are not equally well adapted for growing in our soil and climate. Some varieties are certainly hardier and more productive than other varieties, and in a series of years it will make considerable difference in the income of a farmer whether he is growing a large yielding variety or a variety which is only capable of producing medium or relatively low yields. For instance, with oats, the Early Champion oats, which is a standard variety in Iowa and Illinois, has yielded nearly 50 bushels less grain per acre in four years than the Sixty-day oats, which at thirty cents per bushel (allowing for extra threshing) would mean an actual net loss in profit of $15 per acre to the farmer who grew the low-yielding variety. Again, with wheat, the variety known as Bearded Fife has produced a little over 38 bushels more grain in three years than the Ulta variety, notwithstanding that both of these varieties are the hard, red type of winter wheat. At 60 cents per bushel the farmer who grew the high-yielding wheat, compared with the farmer who grew the low-yielding variety, would have made a clear profit, after deducting the extra cost of threshing, of over $20 per acre in three years. The variety tests with barley and corn have shown similar results.

There is little to be gained in simply testing varieties to prove their hardiness and productiveness unless the better producing varieties are introduced for general culture in the regions where they are adapted for growing. Following this plan, a considerable part of the work of this department consists in selecting and propagating, for seed production, the best producing varieties of the several standard grains. (Similar and more extensive work is also being carried on with corn, Kafir-corn, sorghum, and other crops, and this work is rapidly increasing in amount and importance.)*

Thus far the work with small grains has included little more than variety testing and the planting of some varieties in larger areas to secure seed of the best producing sorts for distribution.

*See Station Bulletin No. 147.

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During the past two years the department has sold and distributed to the farmers of Kansas some 1500 bushels of good seed-wheat of the best producing varieties and several hundred bushels of seed-oats, barley, flax, rye, and emmer. Our work in breeding, growing and distributing well-bred seed-corn has been even greater, and there is little question but that the growing, breeding and distributing of well-bred seed of the best producing varieties of wheat and corn has had a marked effect toward increasing the average yields per acre and total production of these crops in this State. It is not only possible but probable that several million bushels was added to both the wheat and the corn crops of the State in 1906 by the factor of better seed alone.

The work in grain breeding and seed distribution is being enlarged and perfected. In 1905 the seed from selected heads of the better producing varieties was planted in separate plots in order to secure a purer type and perhaps a better producing strain of the variety. In 1906 the department began breeding small grains by the "head-row" method, similar to the "ear-row" method of breeding corn. In this way we shall not only secure a purer type of the variety but hope to secure hardier and better producing strains by discovering the great individuals which may be made the foundation stock for an improved pedigreed variety. (This breeding work with grains is independent of the work of the Botanical Department of this Station, which is carrying on extensive plant-breeding experiments with the purpose of improving the quality and yield in wheat and corn by originating and establishing *new* varieties, through crossing and selection.)

NOTE.-We wish to acknowledge the faithful work of Mr. D. H. Zuck, farm foreman, who has had charge of much of the field work discussed in this bulletin.