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Progress Report of Research in Crops and Soils

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In Crops and Soils

AGRONOMY DEPARTMENT
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE
BROOKINGS

Table of Contents

Explanation of Terms

Least significant difference. The minimum amount by which two varieties must differ in yield in order for that difference to be considered statistically significant.

Cover: Victor A. Dirks, assistant agronomist, explaining the work of developing new crop varieties to one of the groups at Agronomy Field Day.

Progress Report of Research In Crops and Soils

By W. W. Worzella, L. F. Puhr, J. E. Grafius, C. J. Franzke, D. B. Shank, V. A. Dirks, J. G. Ross, M. W. Adams, and A. N. Hume[1]

The Experiment Station Agronomy Farm, located one mile east of Brookings, is representative of a large area of land in eastern South Dakota. It consists of 160 acres, of which about 130 acres are now laid out in various soil and crop experiments. The soil, commonly called "loam" and classified as Barnes Loam, is in a good state of fertility.

Results of the experiments on this farm will indicate closely what may be expected from similar soil management, cropping systems and crop varieties on the same type of soil and under comparable climatic conditions.

Numerous experiments are now in progress on this farm. The information given in this circular represents a progress report on only those experiments for which results can now be evaluated. Further results will be published at intervals as the experiments progress.

Crop Variety Tests

The annual tests of varieties of small grains, soybeans, corn and sorghum are rotated on nine ranges of approximately four acres each. Small grain data, except those for yield, are for 1952.

Spring Wheat Variety Tests. The results of spring wheat variety trials are given in Table 1.

The varieties Lee and Rushmore have been superior among the bread wheats, despite heavy scab injury to Lee in three of the five years and leaf rust injury on Rushmore every year. Both varieties appear to be more tolerant to Race 15B of stem rust than Mida and Rival. The durum yields reflect the degree of stem rust injury in 1952; Vernum has the best yield record under these conditions.

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Table 1. Results of Spring Wheat Variety Tests, 1948-52

Variety	Yield in Bushels per Acre						1952						
	1948	1949	1950	1951	1952	Average 1948-52	Test Weight Lbs./Bu.	Date Headed June	Height Inches	Stem Rust Percent*	Leaf Rust Percent*	Scab Rating†	Lodging Degree
Rival	31.0	25.0	28.1	32.4	15.8	26.5	54.6	19	36	50	80	4	22
Pilot	31.4	22.0	25.4	33.6	16.6	25.8	54.2	19	35	30	75	6	18
Mida	28.8	24.6	30.8	35.2	14.4	26.8	55.0	18	36	50	75	7+	15
Rushmore	32.1	24.2	27.7	35.6	18.6	27.6	57.4	16	32	25	80	4	T
Thatcher	31.9	19.6	26.9	29.8	17.2	25.1	55.6	17	33	30	80	7	8
Cadet	29.2	17.8	25.4	28.2	15.4	23.2	52.4	21	35	20	80	5	22
Ceres	29.4	22.2	26.5	33.2	16.2	25.5	53.9	18	34	45	80	7+	18
Lee	30.4	26.8	32.8	39.0	20.1	29.8	58.4	16	31	35	15	7+	20
Tri. x That. 630‡	27.9	26.1	31.6	40.9	21.8	29.7	60.4	16	33	8	20	5	18
Ns. 2211‡			29.3	46.6	19.8		55.4	15	33	80	18	2	15
Rush[2] x Surp. 36‡					26.2		61.4	18	34	5	0	2	12
Rush[3] x Surp. 114‡					26.4		61.2	18	36	8	0	2	10
Rushmore x Java 112‡					26.5		61.8	17	33	15	0	2	10
Rushmore x Java 8‡					27.4		62.0	18	34	10	0	2	5
Durum													
Stewart	34.9	20.8	25.4	33.5	5.2	24.0	50.0	23	38	80	5	2	15
Vernum	30.6	23.0	32.4	35.8	12.0	26.8	51.0	19	36	50	5	6	45
Mindum	32.4	23.2	28.9	36.6	7.0	25.6	49.6	21	39	60	15	4	25
Nugget			29.3	39.4	3.4		41.5	19	31	100	18	10	40
L.S.D.§	2.2	1.8	2.3	3.6	2.1	1.1							

*Percent infection.
†Score 1=excellent; 10=poor.
‡Experimental numbers not named and not available for distribution.
§L.S.D.=Least significant difference.

Barley Variety Tests. The results of the variety tests of barley are reported in Table 2.

It will be noted that the feed varieties, as a group, have a yield advantage over the malting types. Velvon 11 has been outstanding. The yield of Odessa, a malting type, has been reduced by lodging in three out of the past five years. The greatest barley acreage is in Kindred, which is low in yielding ability.

Table 2. Results of Barley Variety Tests, 1948-52

Variety	Yield in Bushels per Acre						1952							
	1948	1949	1950	1951	1952	Average 1948-52	Test Weight Lbs./Bu.	Date Headed June	Height Inches	Stem Rust Percent*	Septoria Rating†	Spot Blotch‡ Rating†	Lodging Percent	Lodging Degree
Odessa§	37.9	57.2	56.4	37.9	52.6	48.4	45.0	20	26.5	10	3	2+	80	45
Spartan	40.1	62.8	50.0	45.0	47.7	47.1	49.0	16	23.3	10	3	4	0	0
Wisc. 38§	35.3	64.2	57.1	47.9	50.7	51.0	46.0	22	29.7	5	3	1	100	30
Feebar	40.5	58.6	55.9	56.7	46.8	51.7	45.0	20	20.7	0	3	3	0	0
Plains	38.9	77.4	45.8	49.2	51.2	52.5	47.0	14	20.5	0	3+	4	0	0
Tregal	44.1	65.6	64.2	50.4	49.8	54.8	45.0	20	24.3	20	3	4	T¶	T
Mars	34.0	58.6	46.3	43.7	39.3	44.4	48.0	17	19.8	0	4	3	0	0
Velvon 11	44.1	71.7	59.1	52.0	52.6	55.9	44.0	21	24.0	20	3	4	100	30
Kindred§	33.1	59.5	51.3	44.6	45.6	46.8	46.0	18	25.3	0	4	3	100	20
Montcalm§	41.5	62.8	50.4	52.5	54.4	52.3	44.0	21	27.7	20	4	3	100	20
Manchuria§	35.7	62.4	57.8	46.7	53.5	51.2	45.0	19	26.0	5	4	3	T	T
L.S.D.‖	3.7	8.0	4.8	4.3	7.2	2.6								

*Percent infection.
†Score 1=excellent; 4=poor.
‡*Helminthosporium sativum* on nodes.
§Acceptable malting types.
‖L.S.D.=Least significant difference.
¶T=Trace.

Oat Variety Tests. Table 3 summarizes the results of five years of plot tests on oat varieties.

The hulless variety, James, has excelled over the entire period. The varieties that came close to it in yielding ability, namely Richland, Vikota and Andrews, are all remarkable in their similarity of plant type, reflecting adaptation to South Dakota conditions.

Table 3. Results of Oat Variety Tests, 1948-52

	Yield in Bushels per Acre						1952							
Variety	1948	1949	1950	1951	1952	Average 1948-52	Test Weight Lbs./Bu.	Date Headed June	Height Inches	Lodging*	Halo Blight Rating*	Stem Rust Percent†	Leaf Rust Percent†	Septoria Rating*	Lodging Percent
Richland	73.2	68.0	79.8	116.4	94.6	86.4	33.4	20	34	2	4	Tr	22	4	22
Vikota	67.4	70.9	76.8	113.6	89.9	83.5	35.2	21	34	2	4	T	0	3	70
Brunker	59.9	81.5	68.8	100.2	77.0	77.5	35.4	16	33	2	3	12	2	3	75
Clinton	64.4	71.6	73.2	110.8	83.0	80.6	35.4	20	36	3	3	4	15	3	12
Mindo	72.0	73.0	73.9	111.8	82.6	82.7	35.6	18	33	3	5	1	17	3	30
Bonda	67.4	64.5	68.1	101.6	77.0	75.7	36.9	19	40	7	4	1	14	3	37
Cherokee	77.0	69.4	69.5	109.2	80.5	81.1	36.0	18	35	4	7	1	17	5	25
Nemaha	72.8	66.3	64.4	109.0	78.0	78.1	35.5	18	34	4	5	1	15	4	70
James§	80.7	79.5	84.8	109.2	89.2	86.7	45.4	19	35	4	4	2	17	4	60
Andrew	77.0	73.0	79.0	100.5	90.0	83.9	34.5	18	36	5	3	T	20	4	27
Shelby	74.8	70.6	81.3	103.7	75.2	81.1	36.8	24	38	4	7	3	22	4	45
41115-1111 (AxB)	74.3	80.1	86.4	95.6	74.4	82.2	31.6	20	34	2	6	1	16	4	50
(RxF)4672			79.0	100.2	80.4		34.3	18	34	3	3	T	7	2	50
Marion				101.4	90.0		34.0	20	36	4	7	T	22	5	52
Clintafe					90.0		36.4	22	36	4	2	3	T	2	12
Ajax					97.8		35.6	24	38	5	5	5	15	3	32
L.S.D.‖	5.2	10.0	6.4	11.8	7.8	3.8									

*Score 1=excellent; 10=poor.
†Percent infection.
‡T=Trace.
§Hulless, yield adjusted.
‖L.S.D.=Least significant difference.

Flax Variety Tests. Rust resistance has been a major factor in determining the yields of flax varieties, as seen in Table 4. The performance of Redwood is superior to that of any other variety.

Table 4. Results of Flax Variety Tests, 1948-52

	Yield in Bushels per Acre						1952							
Variety	1948	1949	1950	1951	1952	Average 1948-52	Test Weight Lbs./Bu.	Date Full Bloom June	Date Ripe August	Height Inches	Rust Rating*	Pasmo Rating*	Second Growth*	Lodging Percent
Redwing	18.4	12.6	18.8	14.6	13.0	15.5	54.4	15	1	21	8	5	5	23.5
Sheyenne	20.0	13.8	21.3	18.6	25.5	19.8	55.2	17	4	22	—	7	4	10.3
Marine	19.0	16.6	23.0	26.3	25.9	22.2	54.6	17	3	22	—	2	6	15.5
Koto	20.0	13.4	20.5	15.8	17.1	17.4	55.0	19	6	24	7	6	3	11.8
Dakota	20.4	16.6	21.7	21.1	18.6	19.7	54.6	19	6	25	6	5	5	16.8
Arrow	20.6	15.8	25.5	20.7	17.1	19.9	54.6	19	6	24	6	5	6	6.8
Bison	20.4	13.0	18.8	9.7	6.9	13.8	54.2	18	1	24	9	5	4	40.0
Redwood	22.4	17.4	26.3	23.9	30.1	24.0	55.2	21	7	25	—	3	1	6.5
Royal	21.8	15.2	25.9	19.2	19.2	20.3	54.5	21	8	25	4	5	6	13.2
B-5128	21.5	16.2	27.2	21.5	24.5	22.2	54.4	20	8	26	1	5	2	10.7
Minerva	20.5	15.0	24.7	25.5	21.5	21.4	54.4	21	6	24	4	3	2	17.6
Crystal	17.1	15.8	25.1	28.0	24.5	22.1	54.4	23	9	28	—	1	2	12.0
Rocket				26.7	28.6		54.2	21	7	25	—	3	2	8.1
Victory Sel.					27.6		54.5	22	8	30	—	9	1	9.6
L.S.D.†	1.8	1.4	1.6	3.4	3.9	1.2								

*Score 1=excellent; 10=poor.
†L.S.D.=Least significant difference.

Rye Variety Tests. Table 5 shows that all four varieties have given almost identical 5-year average yields. Tests at Eureka have shown that Pierre is more winter hardy than Emerald, and in years where winter killing is a factor, Pierre may be expected to outyield Emerald.

Table 5. Results of Winter Rye Variety Tests, 1948-52

Variety	Yield in Bushels per Acre						1952	
	1948	1949	1950	1951	1952	Average 1948-52	Winter Survival Percent	Test Wt. Lbs./Bu.
Dakold	40.6	34.6	44.6	35.0	39.9	38.9	100	54.9
Pierre	44.8	34.3	43.2	40.4	37.5	40.1	100	55.7
Emerald	43.3	36.2	47.1	31.1	42.3	40.0	100	55.1
White Soviet	42.6	31.5	48.9	36.1	40.3	39.9	100	53.6
L.S.D.*	1.7	2.9	4.5	3.0	7.6	2.0		

*L.S.D. = Least significant difference.

Winter Wheat Variety Tests. The results in Table 6 show that Minter and Nebred have given excellent yields. Winter wheat can be raised successfully as far north as Brookings. Only one crop has been lost due to winter killing in 10 years. Minter is our most winter-hardy variety and is recommended for this area.

Table 6. Results of Winter Wheat Variety Tests, 1948-52

Variety	Yield in Bushels per Acre*					1952			
	1948	1949	1950	1952	Average 1948-52	Winter Survival Percent	Test Wt. Lbs./Bu.	Date Headed June	Stem Rust Percent†
Nebred	30.3	31.3	39.3	30.5	32.8	100	58	10	80
Minter	34.9	29.6	31.7	31.3	31.9	100	59	10	60
Minturki	33.4	20.2	26.6	31.3	27.9	100	57	13	60
Pawnee	0.0	21.7	16.0	28.7	16.6	80	58	8	50
Iowin	25.0	25.2	27.5	32.4	27.5	100	58	10	80
Marmin	46.3	27.5	31.5	30.2	31.4	100	59	12	30
Iohardi		21.9	30.8	29.4	27.4	100	60	10	80
L.S.D.‡	5.0	6.0	1.8	3.1	2.2				

*Crop winter killed in 1951.
†Percent infection.
‡L.S.D. = Least significant difference.

Soybean Variety Tests. The results of soybean variety tests are reported in Table 7. In three years out of the past four, Ottawa Mandarin has matured more than 10 days before frost. Considering the extremes in growing conditions experienced in this area during the past four years, Ottawa Mandarin has been a very reliable variety. Blackhawk has a higher yielding potential and, in somewhat less variable seasons, is expected to yield more than an earlier variety.

Table 7. Results of Soybean Variety Tests, 1949-52*

Variety	Relative Maturity†	Lodging Rating‡	Percent Oil (2-Yr. Av.)	1952 Yield Bu. A.	4-Yr. Av. (1949-52) Bu./A.
Blackhawk	+7.0	2.2	20.80	28.2	20.1
Earlyana	+6.7	2.6	19.75	29.0	18.8
Habaro	+5.3	1.9	18.85	26.4	17.4
Mandarin (Ottawa)	0.0	1.4	19.50	25.8	19.8
Monroe	+4.3	2.0	20.05	24.7	17.3

*Conducted in cooperation with Bureau of Plant Industry, Soil and Agricultural Engineering, USDA.
†Days later than Ottawa Mandarin which matured on the average about September 12 of each year.
‡Score 1=excellent; 5=poor.

Corn Performance Tests. About eight yield trials are conducted each year on breeding material which has been developed in the corn nursery. In addition, a test is conducted in which about 30 of the more popular commercial hybrids sold in the Brookings area are included. Table 8 shows how the South Dakota hybrids performed. South Dakota 270 has shown itself to be well adapted to the Brookings area where soil fertility is good. It is, however, a full-season hybrid and under many conditions may be too late. South Dakota 220 has yielded well and is quite early. South Dakota 400 has consistently been too late for the Brookings area.

A circular is published annually which presents the performance of all the hybrids tested, not only at Brookings but also at other locations in the state. These circulars can be obtained at county agent's offices or by writing to the Agricultural Experiment Station, College Station, South Dakota.

Table 8. Results of Corn Performance Tests, 1948-52

Variety	1952		2-Yr. Av.		3-Yr. Av.		4-Yr. Av.		5-Yr. Av.	
	Yield Bu./A.	Moisture Percent	Yield Bu./A.	Moisture Percent	Yield Bu./A.	Moisture Percent	Yield Bu./A.	Moisture Percent	Yield Bu./A.	Moisture Percent
S. Dak. 220 (Expt. 10)	61.7	20.1	50.5	28.9						
S. Dak. 212*	59.9	23.8	47.5	32.4	50.2	33.7	44.5	32.9	49.8	31.7
S. Dak. 224*	62.6	22.2	49.3	33.6	53.7	34.1	47.7	32.9	53.9	31.1
S. Dak. 262*	70.2	23.8	51.4	38.0	55.8	37.9				
S. Dak. 270*	76.1	23.6	54.7	35.7	56.7	38.3	49.6	36.7		
S. Dak. 400*	56.8	28.7	44.8	41.4	50.4	41.1	43.8	40.2	53.0	38.1
S. Dak. Expt. 9	76.0	24.4	57.2	36.5	61.1	35.4	54.6	33.4		

*Seed used was tested and reported in the annual circulars as a Sokota hybrid of the same number.

Sorghum and Sudan Grass Variety Tests. The sorghum and sudan grass yields are reported in Table 9. Rancher and 39-30-S are early maturing, low prussic acid forage sorghums well adapted for South Dakota. Piper is a low prussic acid sudan grass.

Table 9. Results of Sorghum and Sudan Grass Variety Tests

Variety	Cured Forage Lbs./A.	Yield Bu./A.	Date Pollinated	Height Inches
Grain Sorghums—4-Yr. Av. (1949-52)				
Reliance		52.6	7/28	42
Norghum		57.8	7/27	44
Martin		33.6	8/13	42
Midland		38.9	8/10	41
Forage Sorghums and Sudan Grass—5-Yr. Av. (1948-52)				
Rancher	14653	38.1	7/30	72
39-30-S	14154	42.3	7/29	71
Rox Orange	11633	19.5	8/18	79
Axtel*	19636	33.1	8/18	80
Norkan	18701	44.7	8/14	76
Leote Red	18216	27.5	8/21	80
Commercial Sudan	6114	20.4†	7/22	70
Sweet Sudan	6959	20.2†	7/24	66
Piper Sudan	6969	11.7†	7/24	71

*1948 and 1949 Atlas.
†4-year average. 1949 Sudan grass seed shattered 35 to 60 percent before harvesting.

Alfalfa Variety Tests. The data reported in Table 10 are from a trial seeded in 1950. Previous studies at this station have proved that seed originating in Kansas, Oklahoma, Arizona, Chile, and Argentina lacks sufficient cold resistance to be grown safely here.

Bacterial wilt may infect alfalfa when grown in the eastern one-fourth of the state. Ranger is the only variety available at present which is resistant to a high degree to wilt. Ladak is still one of the highest yielding strains adapted to South Dakota and is recommended for all parts of the state except where wilt is known to be severe.

Table 10. Results of Recent Alfalfa Variety Trials

Variety or Strain	Yield of Hay in Tons per Acre			
	1951	1952		
	1st Cut August	1st Cut July 2	2nd Cut August	Total 1952
Ladak	0.97	2.91	0.95	3.86
Ranger	0.75	2.36	1.03	3.39
South Dakota Common	0.74	2.50	1.19	3.69
Sevelra	0.77	2.25	1.10	3.35
Nomad	0.79	2.12	.80	2.92
Wisc. Syn C	0.85	2.58	1.18	3.76
Atlantic	0.78	2.40	1.14	3.54
DuPuits	0.70	2.27	1.21	3.48
Talent	0.63	2.00	1.06	3.06
Williamsburg	0.72	2.26	1.13	3.39
Narragansett	0.84	2.52	1.19	3.71
A226	0.78	2.49	1.26	3.75
A228	0.94	2.86	1.09	3.95
A227	0.90	2.58	1.16	3.64
A229	0.91	2.67	1.14	3.81
Average	**0.80**	**2.45**	**1.11**	**3.56**

Red Clover Variety Tests. Data for red clover varieties are given in Table 11. The yield tests of a number of regional strains collected throughout the Corn Belt and eastern Canada show relatively small differences among strains. During years of severe northern anthracnose disease infection, the Canadian Dollard has been superior; otherwise locally grown seed is about as good as any of the tested strains for the South Dakota farmer.

Table 11. Yield Performance of Red Clover Varieties

	Tons of Dry Matter per Acre			
	1951	1952		
Variety	1st Cut August	1st Cut July 2	2nd Cut August	Total 1952
Emerson	1.84	2.24	1.33	3.57
Kenland	2.07	2.32	1.18	3.50
Dollard	2.29	2.16	1.11	3.27
Libel	2.04	1.89	1.21	3.10
Mammoth		2.77	0.48	3.25
Rahn	1.79	2.06	1.33	3.39
Van Fossen	1.99	2.42	1.09	3.51
Wegener	1.82	2.14	1.03	3.17
Ottawa	1.89	2.43	1.09	3.52
Midland	2.10	2.26	1.02	3.28
Pennscott	1.67	2.33	0.85	3.18
Average	**1.95**	**2.27**	**1.07**	**3.34**

Birdsfoot Trefoil Variety Tests. The varieties of birdsfoot trefoil listed in Table 12 were established in 1951. Since only one year's results are indicated, no recommendations can be made. Final appraisal of these strains should be made under pasture conditions.

Table 12. Results of Birdsfoot Trefoil Variety Tests

	Percent Stand		Vigor*			Recovery in Inches after Cutting		Yield
Variety or Strain	Nov. 1951	May 1952	Nov. 1951	May 1952	Percent Flower Production	July 18	Aug. 14	T./A. (1 Cutting)
Cascade (Wash.)	82	78	2.3	1.3	22	4.0	9.7	1.90
Granger (Oregon)	82	75	2.3	1.0	27	3.7	9.3	1.90
Viking (New York)	78	73	2.7	1.7	10	3.0	9.0	2.01
P.I. 188101 (Italy)	62	73	4.1	1.3	12	4.0	9.0	1.96
P.I. 188867 (Italy)	45	60	6.0	1.7	27	3.0	9.7	1.64
Empire (New York)	82	73	2.3	2.7	2	1.0	4.7	2.66
Mandan 1116	70	75	3.5	2.0	2.7	1.0	4.7	2.36
Oregon (narrowleaf)	82	42	2.3	3.0	20	0.6	1.7	1.35
New York (narrowleaf)	85	63	7.3	7.3	67	0.5	2.0	1.24
Average								**1.89**

*Score 1=excellent; 10=poor.

Sweet Clover Variety Tests. Although sweet clover is grown primarily for green manure, a considerable portion of the acreage is pastured during a part of the growing period and many plantings are used for seed production. A simple evaluation based on hay yields therefore does not adequately appraise the different strains for these varying purposes. However, since total plant vigor is positively related to soil building value and also to pasture yield, the data shown in Table 13 are of significance.

Table 13. Performance of Sweet Clover Varieties

Variety or Strain	Stand		Vigor*		Yield
	Fall Percent	Spring Percent	Fall Rating	Spring Rating	1952 T./A.
Spanish	92	82	3	6	2.29
Willamette	87	80	4.5	6	2.73
Redfield	15	1–2	9	—	0.00
Alpha	25	0	7	—	0.00
Common white	75	62	5	7	2.24
Common yellow	90	90	4	1	2.25
Artic	68	68	5	6	1.51
Madrid	92	85	3	5	1.85
Brandon dwarf	90	75	5	7	2.24
Evergreen	95	82	3	5	2.25
Wisc. Int. 1	96	30	1	9	0.50
Wisc. Int. 1A	85	15	2	5	—
Wisc. Int. 2	90	30	3	6	2.07
Wisc. A46	90	85	2	1	3.20
N—1	95	90	2	4	3.22

*Score 1=excellent; 10=poor.

Grass Species and Variety Tests. Hay yields of different species and strains of grass growing alone and with alfalfa are shown in Table 14. Ree wheatgrass and the bromegrasses are the high yielders. Little difference was found in the yielding ability of the different bromegrass strains. In the last two years the grass-legume mixtures, including the lower

Table 14. Yield of Grasses in Tons per Acre When Alone and with Alfalfa, 1949-52

	Grown Alone			Grown with Alfalfa		
	1951	1952*	4-Year Average	1951	1952*	4-Year Average
Homesteader bromegrass	2.29	1.18	2.25	3.47	1.98	3.03
Lyons bromegrass	3.06	.91	2.28	4.10	2.15	3.16
Lancaster bromegrass	2.47	.88	2.01	3.92	2.28	3.26
Lincoln bromegrass	2.73	1.02	2.26	3.82	2.09	3.12
Ree wheatgrass	2.85	1.18	2.37	3.83	2.36	3.26
Standard crested wheatgrass	2.50	1.03	1.67	3.51	2.24	3.00
Kentucky bluegrass	2.05	.74	1.43	3.47	2.05	2.79
Creeping red fescue	2.88	.83	1.72	3.15	2.04	2.86
Ranger alfalfa	3.42	1.68	2.55	—	—	—

*Only one cutting harvested.

yielding grasses such as Kentucky bluegrass, yielded less than those including the higher yielding grasses. Grass alone has not yielded so high as a mixture of grass and alfalfa. Alfalfa alone has not yielded as much as when grown in a mixture with the best grasses. Green Stipa-grass, slender wheatgrass, and Mandan wild-rye were invaded by bromegrass and Ree wheatgrass indicating their lack of aggressiveness.

Crop Cultural Tests

Rate of Planting Corn. Table 15 gives the corn yields and the number of plants per hill. Corn was planted thick and thinned as nearly as possible to two, three and four plants per hill. Hills were 42 inches apart in each direction. Three kinds of corn were used: early, medium, and full-season corn. Average results indicate that highest yields were secured from four plants per hill.

Table 15. Effect of Rate of Planting Corn on Yield, 1945-52*

Number of Plants per Hill	Planted May 1			Planted May 20		
	Early Corn	Medium Corn	Full-Season Corn	Early Corn	Medium Corn	Full-Season Corn
2	39.8	45.8	54.5	49.2	48.0	52.6
3	46.3	53.1	60.0	54.7	57.8	59.1
4	53.0	55.4	62.0	58.6	63.3	61.5

*Yields are in bushels per acre of shelled corn with 15 percent moisture.

Date of Planting Corn. The yields and moisture content of corn planted on two dates are given in Table 16. Three kinds of corn were used: an early corn, a corn with a medium growth period, and a full-season corn. The 8-year data indicate that with early and medium strains greater yields were obtained in the east-central area by planting corn May 20 than by planting it May 1. The full-season strain produced slightly higher yields when planted May 1. However, corn planted on May 20 contained more moisture than that planted earlier.

Table 16. Effect of Date of Planting Corn on Yield and Moisture Content, 1945-52*

Kind	Planted May 1		Planted May 20	
	Yield Bu.	Moisture Percent	Yield Bu.	Moisture Percent
Early corn	46.5	23.7	54.1	29.5
Corn with medium growth period	51.5	28.4	56.5	32.3
Full-season corn	58.5	32.2	57.7	36.4

*Yields are in bushels per acre of shelled corn with 15 percent moisture.

Date of Planting Sorghums. Three sorghum varieties were planted at weekly intervals from May 10 to June 14. Yields are given in Table 17. Norghum yielded the highest during the early May plantings, and Reliance yielded best during the optimum dates of planting. Sooner Milo, a mid-late variety, consistently yielded less after the first planting date. The best time to plant appears to be from May 20 to June 1.

Table 17. Yields in Bushels per Acre of Sorghums Planted on Six Dates, 1950-52

Variety	Dates of Planting					
	May 10	May 17	May 24	May 31	June 7	June 14
Reliance	51.9	49.7	51.3	51.6	50.2	33.1
Norghum	55.6	54.4	47.7	48.0	40.5	28.5
Sooner Milo	38.0	36.3	31.8	31.6	25.4	14.5

Soil Experiments

Crop Yields on Fertility Plots. The object of this trial was to determine the effects of various fertilizers, applied at various rates and combinations, on the yield of crops. The following fertilizers and rates per acre were used: 20 pounds of nitrogen applied as ammonium nitrate (or 66 pounds of 33-0-0), 20 pounds of phosphoric acid applied as treble superphosphate (47 pounds of 0-43-0) and 30 pounds of potassium oxide applied as muriate of potash (60 pounds of 0-0-60). The fertility of the soil on the farm had been maintained at a high level previous to the establishment of the fertilizer trials in 1942. For this reason the immediate effects of fertilizer treatment on crop yields have not been pronounced. The results obtained are shown in Table 18. The wheat crop has responded more than the corn or the oat crop. However, the effect of fertilizer treatment is becoming more evident as more crops are produced.

Table 18. Results of Fertility Trials 1942-52

Treatment*	Average Yield in Bushels per Acre		
	Corn	Oats	Wheat
None	46.2	63.9	19.8
Nitrogen	48.2	68.5	22.6
Phosphorus	48.7	64.8	19.9
Potassium	50.1	62.2	20.3
Nitrogen + phosphorus	52.1	72.9	26.1
Nitrogen + potassium	50.5	71.3	23.6
Phosphorus + potassium	52.2	65.2	21.6
Nitrogen + phosphorus + potassium	49.0	71.2	24.8

*Nitrogen was applied at the rate of 20 pounds per acre as 60 pounds ammonium nitrate; phosphorus at the rate of 20 pounds phosphoric acid per acre as 47 pounds of treble superphosphate; potassium at the rate of 30 pounds of potassium oxide as 60 pounds of muriate of potash.

Table 19 summarizes the effect of a nitrogen-phosphorus and potassium fertilizer applied at two rates to a corn-oats-wheat rotation. It may be noted the lower rates of application are as effective for increasing crop yields as the double rate. Potassium did not have any beneficial effect.

Table 19. Effect of Various Rates of Fertilizers on Crop Yields 1944-52

Treatment*	Crop Yields in Bushels per Acre		
	Corn	Oats	Wheat
2 Nitrogen-Phosphorus-Potassium	50.8	77.6	25.6
Nitrogen-2 Phosphorus-Potassium	50.3	72.8	24.6
Nitrogen-Phosphorus-2 Potassium	51.1	72.5	25.4
2 Nitrogen-2 Phosphorus-2 Potassium	49.1	77.9	26.7
Nitrogen-Phosphorus-Potassium	50.3	71.2	24.8
Nitrogen-Phosphorus	53.5	74.7	27.9
None	46.5	63.3	19.5

*Nitrogen was applied at the rate of 20 pounds per acre as 60 pounds of ammonium nitrate; phosphorus at the rate of 20 pounds of phosphoric acid as 47 pounds of treble superphosphate; potassium at the rate of 30 pounds of potassium oxide as 60 pounds of muriate of potash. The figure 2 before the fertilizer indicates the rate was doubled.

Tillage and Crop Residue Experiments. The purpose of this trial was to determine the effects of tillage, crop residues, and fertilizers applied with residues, on the yields of corn, oats and wheat in a 3-year rotation. The average crop yields from 1942 to 1952 are presented in Table 20.

Return of crop residues to the soil, with plowing as the tillage practice, tended to produce an upward trend in crop yields which is becoming more pronounced from year to year. Plowing and subsurface tillage without the return of the crop residues have given about the same crop yields.

Subsurface tillage with residue and manure increased the yields of corn, oats and wheat, in comparison to the yields obtained under subsurface tillage with residues alone. Application of nitrogen and phosphorus fertilizer to subsurface and residue tilled soil increased the yield of wheat in comparison to subsurface and residue tilled soil with no fer-

Table 20. Results of Tillage and Crop Residue Tests, 1942-52

Treatment	Average Yield in Bushels per Acre		
	Corn	Oats	Wheat
Plowing	48.8	57.3	18.8
Plowing with residue	51.4	61.4	20.6
Subsurface	47.9	58.4	18.1
Subsurface with residue	48.4	61.6	18.0
Subsurface with residue and manure	50.0	63.3	22.0
Subsurface with residue and nitrogen	47.1	63.4	22.5
Subsurface with residue and phosphorus	47.7	64.2	20.9
Subsurface with residue, nitrogen and phosphorus	46.6	64.6	24.7

tilizer. Corn and oats on subsurface tilled soil were not significantly influenced by fertilizer treatment. The rates of fertilizers applied were the same as for the fertility plots.

Methods of Soil Preparation. The influence of different methods of soil preparation on the yields of crops in a 3-year rotation, corn-oats-wheat, is shown in Table 21. These data indicate that plowing is the most effective method for seedbed preparation. In this trial, none of the crop residues were returned to the soil.

Table 21. Results of Soil Preparation Experiments, 1942-52

Treatment	Average Yield in Bushels per Acre		
	Corn	Oats	Wheat
Plow 4"	46.5	65.5	19.5
Plow 7"	48.1	61.0	19.0
Plow 10"	47.0	66.1	20.6
Subsurface	44.8	58.5	17.3
One-way	45.2	60.0	18.1
Double disc	42.1	58.2	16.3

Effect of Cultural Practices on Wheat Yields Following Sorghum. The purpose of this experiment is to determine the effect of tillage, residue treatments and nitrogen fertilizer on the yield of wheat following sorghum. The results of the various treatments are given in Table 22. The yields of wheat following sorghum were not significantly influenced by tillage, residues, or nitrogen fertilizer. It should be noted that the yields of sorghum forage are lower on the subsurface plots than on the plowed plots.

Table 22. Results of Cultural Practices on Wheat Yields following Sorghum, 1942-52

Treatment	Sorghum Forage Lbs./A.	Wheat Bu./A.
Plowing	7556	19.7
Plowing with residue	8288	20.4
Plowing with nitrogen	8870	21.8
Plowing with residue and nitrogen	8313	22.0
Subsurface	7140	21.5
Subsurface with residue	7293	21.3
Subsurface with nitrogen	7060	21.7
Subsurface with residue and nitrogen	8313	21.2

Methods of Managing Sweet Clover Rotation. Sweet clover was plowed under as a green manure crop at two different dates. Its effect on yields of corn and wheat, with and without phosphate fertilizer, is shown in Table 23.

The sweet clover was seeded with the wheat crop and in the following year was plowed under for a green manure crop. It was either

plowed under in June or mowed. The portion which was mowed was allowed to grow until August and then plowed under. The wheat and corn yields are slightly higher following the August plowing.

Table 23. Effect of Sweet Clover Rotation on Crop Yields, 1944-52

Treatment	Yield in Bushels per Acre	
	Corn	Wheat
Sweet clover plowed June 15	49.1	26.4
Sweet clover plowed June 15 with phosphorus fertilizer	50.3	29.2
Sweet clover plowed August 1	52.6	28.2
Sweet clover plowed August 1 with phosphate fertilizer	53.3	28.9
No legume, corn-oats-wheat rotation	46.0	18.4
Continuous corn or wheat	44.9	19.5

Effect of Grass on Crop Yields. The effect of grass rotations on the yields of corn and wheat is shown in Tables 24 and 25. The yields of corn and wheat following grass are higher than for a corn-oats-wheat rotation and also higher than the yields for continuous cropping.

Table 24. Effect of Four Years of Grass on Crop Yields

Rotation	Corn Average 1946 & 1948 Bu./A.	Wheat Average 1947 & 1949 Bu./A.
4 years bromegrass, 1 year corn and 1 year wheat	61.0	22.4
4 years Crested wheatgrass, 1 year corn and 1 year wheat	60.3	21.7
Corn-oats-wheat	56.9	15.0
Continuous corn or wheat	50.8	15.8

Table 25. Effect of Six Years of Grass on Crop Yields

Rotation	Corn Average 1948 & 1950 Bu./A.	Wheat Average 1949 & 1951 Bu./A.
6 years bromegrass, 1 year corn and 1 year wheat	62.2	24.9
6 years Crested wheatgrass, 1 year corn and 1 year wheat	67.0	24.1
Corn-oats-wheat	60.8	11.8
Continuous corn or wheat	52.6	15.3

Effect of Growing Grain Crops Continuously on Yields. What happens to yields when crops are grown continuously without the use of soil improvement practices is shown in Table 26. The data in this table show that the crop yields for the first 6-year period are higher than for the last 5-year period. The decline in yields is the result of diminishing soil fertility.

The yields in Table 26 compare closely with the average yields in

Brookings County for the same period. This would indicate that the decline in yields under continuous cropping was due more to diminishing soil fertility than to differences in weather conditions.

Table 26. Effects of Continuous Cropping on Yields

Crop	Average 1942—1947 Inclusive Bu./A.	Average 1948—1952 Inclusive Bu./A.
Corn	47.9	42.4
Barley	37.1	34.8
Oats	58.6	46.2
Rye	29.8	26.0
Wheat	21.4	17.3