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Research in Crops and Soils: A Progress Report

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RESEARCH IN CROPS AND SOILS

A Progress Report

AGRONOMY DEPARTMENT
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE, BROOKINGS

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A PROGRESS REPORT

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The Experiment Station Agronomy Farm, located 1 mile east of Brookings, is representative of a large area of land in eastern South Dakota. It consists of 160 acres which are laid out in various soil and crop experiments. The soil, commonly called "loam" and classified as Vienna loam, is in a good state of fertility.

Results of the experiments on this farm will indicate 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 in progress on this farm. The information in this circular is a progress report on 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 variety tests of small grains soybeans, corn, and sorghum are rotated on nine ranges of approximately 4 acres each. The fertility is maintained by applying 300 pounds of 10-20-0 and 3 tons of manure per acre for each 3-year period.

Spring wheat variety tests. The results of spring wheat variety trials are given in table 1.

The variety Selkirk, introduced from Canada because of its resistance to stem rust, has the best 5-

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What Least Significant Difference Means

Least significant difference (**L.S.D.**) is the minimum amount two varieties must differ in yield for that difference to be considered statistically significant.

year yield record. In 1955 stem rust was very light and climatic conditions favored very high yields in wheat, both bread and durum types. Both 1955 and 1956 favored early wheats; in 1956 stem rust and scab were yield influencing factors that hurt yields of Mida and Rival. The over-all performance of Rushmore and Lee bread wheats has been very satisfactory.

In 1956 rust was noted on the new durum wheats Ramsey and Tower. Yuma maintained a very high level of resistance.

Barley variety tests. The recent release of the new barley varieties Traill and Liberty has made available to the farmer types with improved straw strength, good disease resistance, and excellent yield records. The yield and performance of these and other varieties is presented in table 2. Early varieties in the Plains maturity class have continued to show some advantages to the producer of feed grains. Kindred remains the only malting barley which is recognized for the production of this commodity.

Table 1. Results of Spring Wheat Variety Tests, 1952-56

Variety	Average Yield, Bu./A. 1955	1956	1952–56	Test Wt. 1956	Date Headed 1956	Height, Ins. 1956	Scab* Rating 1956	Stem* Rust 1956	Lodging* Score 1955
Hard Red Spring									
Rushmore	38.1	19.4	19.5	60	6–14	23	4	5	0
Lee	38.0	20.0	21.6	61	13	26	5	3	2
Selkirk	35.1	17.9	27.4	57	17	23	5	T	0
Conley	30.4	14.5	—	59	19	28	3	T	0
Mida	39.5	15.3	16.1	62	16	30	3	9	1
Rival	27.6	13.8	14.7	60	17	30	3	15	2
Pilot	32.1	17.7	16.0	61	17	31	3	6	4
Thatcher	36.3	18.4	17.9	60	16	25	3	8	0
Cadet	32.1	14.3	17.9	59	19	29	3	2	0
Ceres	37.5	17.3	16.3	61	17	29	4	14	2
Spinkota	34.9	19.3	—	63	17	31	1	9	2
Marquis	26.4	16.1	—	61	18	30	1	22	0
N. D. 3	33.1	15.5	—	59	17	29	3	1	0
Ellar	38.7	16.9	—	62	17	27	4	3	1
R. H. 1935	32.4	20.6	—	60	13	24	1	2	0
Durum									
Stewart	32.6	10.8	13.5†	62	19	34	1	12	2
Mindum	30.1	14.1	13.2†	63	17	38	2	28	2
Vernum	33.8	10.6	15.4†	61	16	36	2	8	4
Nugget	35.2	16.9	15.5†	60	13	25	5	9	5
Sentry	35.1	14.7	17.6†	62	15	25	4	4	2
Yuma	21.7	12.0	18.8†	59	16	28	1	0	2
Ramsey	34.0	12.0	25.6†	60	16	30	2	12	2
Langdon	40.4	16.7	26.8†	61	16	27	2	1	2
Towner	31.8	8.4	20.4†	60	17	34	1	15	2
L.S.D.‡	5.3	3.7	1.1						

*Stem rust in percent, lodging score and scab rating on 1-10 scale.

†4-year average.

‡L.S.D.—least significant difference.

Oat variety tests. Performance of oat varieties plots at Brookings is summarized in table 3.

The 5-year, as well as the individual year's data, indicate the superiority of Mo. 0-205 in the intermediate maturity group and Garry for the late maturity variety. Rust resistance and lodging have not been a problem in the last 2 years.

Flax variety tests. The data for flax are reported in table 4. Varieties of flax having rust resistance and full season growth yielded best. Redwood, a full season flax, has maintained a yield advantage over other common varieties. The absence of rust during this period has resulted in good yields even on rust susceptible types.

Rye variety tests. Table 5 shows that Pierre and Emerald have excellent long-time yield records, while Caribou and Antelope have been satisfactory for yield in the years tested. All four of these have adequate winter hardiness. Tetra Petkus has not been sufficiently hardy for satisfactory winter survival in 1955 and 1956.

Winter wheat variety tests. The summarized performance of varieties shown in table 6 indicate that winter wheat can be grown as far north as Brookings, provided that proper selection of winter hardy varieties is practiced. The recommended variety Minter has been satisfactory for yield, quality, and winter hardiness. The maturity class of Minter tends to reduce scab

Table 2. Results of Barley Variety Tests, 1952-56

Variety	Yield, Bu./A. 1955	1956	1952-56	Test Wt. 1956	1955 Date Headed	1955 Stem Rust*	1955 Shattering, %*
Plains	55.8	31.7	43.8	49	6–1	—	—
Feebar	57.8	22.1	38.8	43	6–5	—	—
Velvon 11	51.8	27.4	40.0	47	6–6	20	—
Kindred†	52.5	25.3	39.1	50	6–5	—	—
Spartan	55.6	22.3	40.6	50	6–2	30	—
Odessa	59.5	31.2	44.7	49	6–9	15	—
Tregal	63.4	23.0	38.8	48	6–13	15	—
Mars	55.1	31.6	39.2 (4)‡	49	6–2	—	—
Custer	49.8	32.7	41.0	46	6–2	15	—
Traill	52.5	26.1	44.6	50	6–5	—	—
Wisconsin 38	48.1	20.6	37.9	46	6–15	15	10
Manchuria	55.6	21.0	44.4	49	6–7	12	—
Fox	57.2	22.3	38.4 (4)	48	6–7	—	10
Parkland	52.0	24.2	—	49	6–6	—	—
Liberty	63.7	31.5	49.0	50	6–6	—	—
C.I. 9187	56.1	17.3	39.5	50	6–8	—	10
L.S.D.§	8.6	7.9					

*Percent.
†Acceptable malting type.
‡Number of years averaged when less than five.
§L.S.D.—least significant difference.

Table 3. Results of Oat Variety Tests, 1952-56

Variety	Average Yield, Bu./A. 1955	1956	1952-56	Test Wt. 1956	Date Headed 1955	Height, Ins. 1955	Stem Rust, % 1956
Vikota	85.8	35.1	73.5	35	6–6	27	3
Andrew	77.2	36.8	73.1	35	–1	31	12
Dupree	82.1	38.8	68.5	36	–1	27	25
Cherokee	65.9	27.7	62.1	37	–1	29	20
Nemaha	62.4	28.0	61.1	36	–1	26	25
Clinton	67.2	25.9	60.2	38	–4	29	40
James	68.9	29.4	55.9	48	–4	34	35
Marion	80.2	34.6	71.7	35	–6	33	12
Branch	87.2	45.5	74.2	33	–14	37	6
Ajax	81.2	38.0	76.7	34	–14	36	8
Waubay	73.4	34.8	66.2	38	–8	29	18
Ransom	76.6	30.7	69.9	37	–1	28	T
Mo. 0-205	86.0	43.6	82.3	38	–3	32	8
Sauk	81.5	41.2	—	38	–12	32	9
Rodney	77.3	47.9	—	36	–16	30	T
Simcoe	81.7	28.1	—	36	–9	36	5
Minland	69.5	32.7	—	32	–1	32	2
Newton	70.2	17.2	—	35	–3	28	6
Garry	90.0	42.5	—	38	–13	34	1
Jackson	82.2	37.0	—	39	–7	32	8
Clarion	75.9	33.7	69.6	39	–5	30	18
Richland	81.8	39.2	75.7	35	–7	27	8
Brunker	71.3	28.5	61.2	36	5–31	27	28
Osage	85.8	37.3	71.0*	33	6–1	26	10
Trojan	85.1	37.8	66.9*	35	–2	30	15
Burnett	—	42.6	—	41	–1	34	T
C.I. 6913	—	42.8	—	36	–2	34	T
L.S.D.†	7.9	10.3	4.3				

*4-year average.

†L.S.D.—least significant difference.

Table 4. Results of Flax Variety Tests, 1952-56

Variety	Yield, Bu./A. 1955	1956	1952-56	Test Wt. 1956	1956 Date of First Bloom	1956 Height, Ins.	1956 Flax* Rust	1956 Pasmo†
Marine	11.7	15.9	17.6	54	6–16	19	R	1
Sheyenne	10.7	17.4	17.5	55	6–18	20	R	3
Redwood	10.7	16.2	18.7	55	6–20	20	R	3
B-5128	6.3	17.6	17.1	54	6–20	21	R	4
Redwing	12.0	14.7	15.5	56	6–16	19	S	2
Dakota	11.7	17.1	17.2	55	6–16	19	S	4
Rocket	7.8	15.3	17.7	53	6–19	20	S	5
Norland	7.3	14.2	17.7	55	6–20	21	R	4
Royal	11.1	15.0	16.6	55	6–19	21	S	3
Crystal	6.5	16.0	16.1	53	6–21	23	R	3
Bison	11.7	16.4	12.9	54	6–19	21	S	2
Linda	11.0	16.4	—	52	6–18	20	R	4
Raja	11.6	15.4	—	54	6–14	18	R	5
C.I. 1478	—	14.8	—	53	6–18	21	R	3
L.S.D.‡	1.7	N.S.§						

*1=excellent resistance, 9=no resistance.
†R—resistant, S—susceptible.
‡L.S.D.—least significant difference
§N.S.—not significant.

Table 5. Results of Rye Variety Tests, 1952-56

Variety	Average Yield, Bu./A. 1955	1956	1952-56*	Survival % 1956	Test Wt. 1956	Leaf Rust 1955	Date Headed 1955
Pierre	35.0	41.0	37.9	95	54	20	5–18
Antelope	36.4	40.5	—	98	53	15	–20
Caribou	37.5	42.7	—	98	53	20	–23
White Soviet	32.4	42.2	36.0	58	54	40	–21
Tetra Petkus	10.8	0	10.4†	0	—	60	–31
Emerald	38.0	42.5	39.6	81	55	25	–20
Adams	33.1	38.0	—	80	52	30	–22
Horton	29.1	35.3	—	90	53	25	–17
L.S.D.‡	3.9	2.6	2.3				

*No crop in 1954 due to fall drouth, 1953. †3-year average. ‡L.S.D.—least significant difference.

Table 6. Results of Winter Wheat Variety Tests, 1952-56

Variety	Average Yield, Bu./A. 1955	1956	1952-56	Test Wt. 1956	Winter Survival, % 1955	1956	Date Headed 1956	Stem Rust* 1956	Leaf Rust* 1956	Scab Rating* 1956
Nebred	22.2	26.0	27.0	59	25	43	6–16	50	22	4
Minter	24.8	25.3	28.9	59	52	55	–20	45	12	2
Pawnee	16.1	9.6	21.6	54	12	13	–16	55	18	4
Minturki	21.9	24.5	26.1	56	48	58	–21	65	25	1
Marmin	25.1	29.1	29.2	57	65	65	–18	70	40	4
Sioux	16.9	14.8	—	53	27	13	–16	70	20	3
Wichita	14.1	14.3	—	56	22	8	–15	75	8	4
Yogo	—	21.7	—	52	—	60	–23	70	40	2
Kharkof MC22	—	12.3	—	45	—	70	–21	80	15	1
Cheyenne	—	19.0	—	57	—	33	–19	80	25	5
Concho	—	7.4	—	52	—	6	–14	65	10	6
Triumph	—	6.8	—	59	—	3	–13	65	10	5
Mint. x Tim-Vulg[2]	17.0	14.8	—	56	35	62	–28	60	8	2
L.S.D.†	5.1	7.5	2.4							

*Stem rust, leaf rust readings in percent; scab rating on 1-10 scale of increasing severity.
†L.S.D.—least significant difference.

injury, while the Hope resistance to rust is still of some value when incidence of stem and leaf rust is heavy.

Soybean variety tests. The results of soybean variety tests are given in table 7.

Chippewa, a new release, is about 5 to 6 days earlier than Blackhawk and has good yielding potentials. Chippewa, Blackhawk, and Ottawa Mandarin stand better than Earlyana and Monroe.

Table 7. Results of Soybean Variety Tests 1949-56*

Variety	Relative† Maturity	Lodging‡ Rating	Oil, % 1949-55	1956 Yield	Av. Bu./A.
Chippewa	0	1.5	20.4	20.3	21.3
Blackhawk	+5.5	1.9	20.6	15.5	21.2
Ottawa Mandarin	—2.9	1.3	19.6	15.5	20.5
Earlyana	+7.1	3.0	19.8	15.6	19.8
Monroe	+3.3	2.9	19.7	16.8	19.2

*Conducted in cooperation with Field Crops Research Branch, ARS, USDA.
†Days maturity from Chippewa.
‡Lodging score, 1=excellent; 5=poor.

Table 8. Results of Corn Performance Tests, 1952-56

Variety	1956			2-Yr. Av.			3-Yr. Av.			4-Yr. Av.			5-Yr. Av.		
	Yield, Bu./A.	Moisture, %	Root Lodging, %	Yield, Bu./A.	Moisture, %	Root Lodging, %	Yield, Bu./A.	Moisture, %	Root Lodging, %	Yield, Bu./A.	Moisture, %	Root Lodging, %	Yield, Bu./A.	Moisture, %	Root Lodging, %
S. D. 220	81.2	11.6	0.4	63.7	12.2	3.6	65.7	16.1	2.4	66.1	16.8	2.4	65.3	17.4	3.4
S. D. 250	87.1	12.5	8.6	64.5	14.9	4.5	70.0	19.7	4.0	73.8	19.7	3.4	74.3	20.7	3.9
S. D. 262	91.4	11.4	28.3	66.6	15.9	15.9	70.7	20.8	15.1	74.7	21.7	15.9	73.8	22.1	17.7
S. D. 270	90.1	13.3	8.4	62.5	17.7	4.7	68.1	22.8	8.1	73.4	23.7	8.1	73.9	23.6	8.1
S. D. 400	87.4	14.3	6.8	61.0	18.2	3.4	66.3	23.2	6.7	72.4	23.7	6.4	69.2	24.7	7.6
S. D. Exptl. 22	91.9	17.2	0.0	—	—	—	—	—	—	—	—	—	—	—	—

Corn performance tests. Corn work on the Agronomy Farm consists of yield testing of existing commercial hybrids and the development of new varieties specifically adapted for South Dakota. Experimental hybrids are tested extensively against each other and the better commercial hybrids. Those experimentals competing favorably are numbered and released.

The performance records of one experimental number and of those S.D. hybrids which have already been released are presented in table 8. Results from five years of testing indicate that S.D. 220 is early for the Brookings area while S.D. 400 is quite late. As a result both have yielded less in these tests than have the other three, better adapted, hybrids.

A circular, "South Dakota Corn Performance Tests," is published annually and presents performance of the commercial hybrids tested, not only at Brookings, but also at other locations in the state. This circular can be obtained at county extension agent offices or by writing the Bulletin Room, Agricultural Experiment Station, College Station, Brookings, South Dakota.

Grain and forage sorghums and sudan grass variety tests. The grain and forage sorghum and sudan grass data are reported in table 9. Reliance and Norghum are adapted early grain varieties. Rancher and 39-30-S are early maturing, low prussic acid forage sorghums. Piper is a low prussic acid sudan grass adapted for pasture, hay, and fodder.

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

Table 9. Results of Sorghum and Sudan Grass Variety Tests

Variety	Cured Forage, Lbs./A.	Yield, Bu./A. 8 Yrs.	Yield, Bu./A. 1956	Date Pollinated	Height, Ins.
Grain Sorghums, 8-Yr. Av. (1949-56)					
Reliance		60.6	67.3	7/25	42
Norghum		62.4	56.2	7/24	46
Martin		38.5	56.2	8/8	42
Midland		37.9	46.7	8/6	43
RS-501			76.6	7/29	51
Forage Sorghum and Sudan Grass, 5-Yr. Av. (1948-52)					
Rancher	14,653	38.1		7/30	72
39-30-S	14,154	42.3		7/29	71
Rox Orange	18,633	19.5		8/18	79
Axtel*	19,636	33.1		8/18	80
Norkan	18,701	44.7		8/14	76
Leoti Red	18,216	27.5		8/21	80
Commercial Sudan	6,114	20.4†		7/22	70
Sweet Sudan	6,959	20.2†		7/24	66
Piper Sudan	6,969	11.7†		7/24	71

*1948 and 1949 Atlas. †4-year average, 1949 sudan grass seed shattered 60 percent before harvesting.

Table 10. Results of Recent Alfalfa Variety Trials

Variety or Strain	1951 1st Cut August	1952 1st Cut July 2	1952 2nd Cut August	1953 1st Cut June	1954 1st Cut June	Cumulative Av. 1st Cut	Cumulative Av. 2nd Cut	Av. Seasonal Total
Ladak	0.97	2.91	0.95	2.00	1.73	2.21	0.96	3.17
Ranger	0.75	2.36	1.03	1.92	1.40	1.89	0.89	2.78
S. D. Common	0.74	2.50	1.19	2.07	1.62	2.06	0.96	3.02
Sevelra	0.77	2.25	1.10	2.10	1.51	1.95	0.93	2.88
Nomad	0.79	2.12	0.80	1.87	1.40	1.80	0.80	2.60
Wisc. Syn C*	0.85	2.58	1.18	1.94	1.56	2.03	1.02	3.05
Atlantic	0.78	2.40	1.14	2.07	1.47	1.98	0.96	2.94
Du Puits	0.70	2.27	1.21	1.74	1.38	1.80	0.95	2.75
Talent	0.63	2.00	1.06	1.81	1.11	1.64	0.85	2.49
Williamsburg	0.72	2.26	1.13	1.95	1.48	1.90	0.93	2.83
Narragansett	0.84	2.52	1.19	1.98	1.48	1.99	1.02	3.01
A226	0.78	2.49	1.26	1.99	1.54	2.01	1.02	3.03
A228	0.94	2.86	1.09	1.94	1.63	2.14	1.02	3.16
A227	0.90	2.58	1.16	1.74	1.62	1.98	1.03	3.01
A229	0.91	2.67	1.14	2.25	1.64	2.19	1.03	3.22
Average	**0.80**	**2.45**	**1.11**	**1.96**	**1.50**	**1.97**	**0.96**	**2.93**

*A sister selection to Vernal.

sufficient cold resistance to be grown safely here.

Bacterial wilt may infect alfalfa when grown in the eastern one-fourth of the state. Infection usually does not influence stand or plot yields until the third or fourth harvest year; the second cutting will be more affected than the earlier cutting. In the fifth and succeeding seasons the stands become noticeably thinned and yields markedly depressed. Ranger and Vernal are the only varieties available at present which are resistant in 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.

In recent years several new strains of alfalfa have been introduced for general use either as forage or as green manure or both. Their suitability with respect to these purposes in South Dakota is related to their inherent cold resistance.

From the data presented in table 11, it may be seen that Certified S.D. Ladak, the standard cold resistant variety in these tests, is equalled or exceeded in cold resistance by S.D. Synthetic (exp.), Vernal and Semipalatinsk. Several other new varieties appear at present to be somewhat susceptible to cold and their wide use in South Dakota is to be discouraged. African, Terre Verde, and Arizona Chilean are inherently nonhardy strains or bulks often grown for green manure in the northern U. S.

Table 11. Relative Cold Resistance of Some Selected Alfalfa Strains Field Grown at Brookings, S. D.

Variety or Strain	Amount of Regrowth in Grams of Comparative Plant Samples Following a Freezing Test	
	March 1955	March 1956
Certified S. D. Ladak	15.62	12.52
Non-certified Ladak (1)	7.09	—
Non-certified Ladak (2)	7.14	—
Talent	6.60	11.12
Ranger (1)	4.44	6.00
Ranger (2)	4.03	—
Narragansett	2.61	2.60
Nomad	2.28	1.20
Williamsburg	1.56	—
Du Puits	1.23	—
African	0.84	0.00
Semipalatinsk	—	16.20
S. D. Synthetic (exp.)	—	18.40
Vernal	—	14.88
Rhizoma	—	4.56
Terre Verde	—	2.84
Arizona Chilean	—	0.00

Red clover variety tests. Data for red clover varieties are given in table 12. 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. Dollard is definitely superior on plots where it is carried over to the second harvest year, although all strains are appreciably less productive.

Birdsfoot trefoil variety tests. The strains of birdsfoot trefoil listed in table 13 were established in 1951. Birdsfoot trefoil strains are either

of the narrowleaf or broadleaf form. The narrowleaf form is not grown commonly in the Corn Belt because of insufficient vigor and hardiness. Among the broadleaf forms listed, only Empire and Mandan 1116 are of the domestic type. Differences in flower production and dormancy after cutting are striking and signficant. The narrowleaf forms failed to survive the winter of 1952-53, and during the following winter of 1953-54 all of the European broadleaf types succumbed to winter hazards.

On the basis of these observations we must conclude that (a) birdsfoot trefoil strains yield on the average about two-thirds as much hay in a season as alfalfa (b) critical comparisons of trefoil strains should be made under pasture conditions (c) only domestic strains of or related to the Empire type are at present well enough adapted in South Dakota to be used safely.

Table 12. Yield Performance of Red Clover Varieties

Variety	Test of Dry Matter per Acre 1951 1st Cut August	1952 1st Cut July 2	1952 2nd Cut August	1952 Total	1952 Nursery, Harvested in 1953—the 2nd Harvest Yr.
Emerson	1.84	2.24	1.33	3.57	0.95
Kenland	2.07	2.32	1.18	3.50	0.73
Dollard	2.29	2.16	1.11	3.27	1.56
Libel	2.04	1.89	1.21	3.10	1.26
Mammoth		2.77	0.48	3.25	1.19
Rahn	1.79	2.06	1.33	3.39	0.97
Van Fossen	1.99	2.42	1.09	3.51	0.79
Wegener	1.82	2.14	1.03	3.17	1.11
Ottawa	1.89	2.43	1.09	3.52	1.08
Midland	2.10	2.26	1.02	3.28	0.90
Pennscott	1.67	2.33	0.85	3.18	0.65
Average	**1.95**	**2.27**	**1.07**	**3.34**	**1.01**

Table 13. Results of Birdsfoot Trefoil Variety Tests

Variety or Strain	Stand Percent Nov. 1951	Stand Percent May 1952	Vigor* Nov. 1951	Vigor* May 1952	Percent Flower Production	Recovery In Inches After Cutting July 18	Recovery In Inches After Cutting Aug. 14	1925 Yield T./A. (1 cutting)	1953	1954
Cascade (Wash.)	82	78	2.3	1.3	22	4.0	9.7	1.90	1.49	....†
Granger (Ore.)	82	75	2.3	1.0	27	3.7	9.3	1.90	1.54	....†
Viking (N. Y.)	78	73	2.7	1.7	10	3.0	9.0	2.01	1.91	....†
P.I. 188101 (Italy)	62	73	4.1	1.3	12	4.0	9.0	1.96	1.46	....†
P.I. 188867 (Italy)	45	60	6.0	1.7	27	3.0	9.7	1.64	1.44	....†
Empire (N. Y.)	82	73	2.3	2.7	2	1.0	4.7	2.66	1.73	2.00
Mandan (1116)	70	75	3.5	2.0	2.7	1.0	4.7	2.36	1.36	1.70
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	....†	....†
S. D. Source (Empire Type)										1.80
Average								**1.89**	**1.56**	**1.83**

*Score 1=excellent; 10= poor.
†Severe winterkilling—stands less than 10% of initial.

Table 14. Performance of Sweet Clover Varieties

Variety or Strain	Growth Characteristics	Yield in Tons Dry Matter 4-Yr.Av.	Yield of First Year Growth, 1954				Yield of Dry Matter at Two Dates in 1955			
			Dry Matter		Nitrogen		May 5, 1955		June 16, 1955	
			Roots Lbs./A.	Tops Lbs./A.	Roots Lbs./A.	Tops Lbs./A.	Roots Lbs./A.	Tops Lbs./A.	Roots Lbs./A.	Tops Lbs./A.
Spanish	Tall, coarse, white flower, maturity later than common white	2.72	2,929	4,560	87.6	136.3	480.2	828.3	2,040.7	5,653.9
Willamette	Tall, coarse	2.46*	1,861	3,580	51.6	98.5	1,272.4	822.3	1,746.6	4,219.4
Alpha	Mid-tall, fine stem, white flower	0.66*	-----	-----	----	----	-----	-----	----	----
Common White	Tall, coarse, white flower	2.39	2,377	1,620	72.3	50.7	1,602.5	1,320.4	1,824.6	3,283.1
Common Yellow	Tall, coarse, yellow flower	2.75	2,671	1,940	71.8	59.9	2,586.9	1,776.6	2,700.9	5,419.8
Common Yellow Selection	Similar to parent strain	2.45*	2,443	2,640	67.4	75.2	2,022.7	1,560.5	1,668.6	4,909.6
Artic	Mid-tall, coarse, white flower, early	2.33*	-----	-----	----	-----	----	----	----	----
Madrid	Tall, coarse, yellow flower, maturity similar to common yellow	2.27	2,533	3,400	62.8	99.6	1,500.5	780.3	1,686.6	4,003.3
Brandon Dwarf	Short, branching fine stem, white flower, slightly earlier than common white	2.67*	----	----	----	----	----	----	----	----
Evergreen	Tall, coarse, white flower, late	2.59	2,604	3,360	74.5	96.4	1,656.5	708.2	2,808.9	4,033.3
Wisc. Int. I	Tall, coarse, white flower, late	1.16*	----	----	----	----	----	----	----	----

Wisc. A-46	Tall, coarse, yellow flower, later than common yellow	3.13*	2,605	2,960	67.2	80.2	1,182.4	696.2	2,911.0	4,867.6
N-1	Mid-tall, branching, fine stem, white flower, late	2.40	1,627	3,140	49.1	94.8	1,374.5	636.2	1,152.4	1,944.6
N-7	Biennial type grown for first time in 1954	0.54*	1,560	3,020	49.0	93.3	846.3	144.0	642.2	1,080.4
N-9	Biennial type grown for first time in 1954	0.66*	1,597	2,600	50.2	77.5	1,128.4	444.1	1,152.4	1,320.4
Melilotus wolgica	(Biennial species)	2.02*	984	2,240	26.5	75.9	522.2	702.2	1,716.6	4,033.3
Melilotus taurica	(Biennial species)	0.92*	798	1,040	24.6	30.9	678.2	654.2	1,134.4	1,842.6
Israel	Annual, tall, coarse, white flower, late	.....	1,200	4,820	12.2	119.5	.....	.....	.....	.....
Hubam	Annual, mid-tall, coarse, white flower	.....	480	3,600	3.1	95.0	.....	.....	.....	.....

*Based on results of less than 4 years.

Sweet clover variety tests. Although sweet clover in South Dakota is grown primarily for green manure, a considerable portion of the acreage is pastured during a part of the growing period, and many fields are used for seed production. A simple evaluation based on hay yields, therefore, does not adequately appraise the different strains for these varying purposes.

A test based on root weights as well as top weights would appear to be more valuable from the green manure standpoint; two of the columns of table 14 indicate the dry root weights in the upper 8 inches of soil and the dry top yields produced by first-year sweet clover. On these bases, the annual Hubam appears definitely inferior for green manure purposes. Annual Israel appears more promising, but some of the biennials produced over a ton of roots per acre in the first season and in addition produced over a ton and a half of tops.

Table 15. Hay Yields of Bromegrass Varieties in Tons per Acre at Brookings

	1951	1952	1953	1954	1955	1956	6-Yr. Av.
Elsberry	3.85	2.28	2.05	.85	.91	1.41	1.89
Achenbach	3.73	2.42	2.29	.99	.84	1.39	1.94
Lincoln	3.96	2.28	1.76	.94	.85	1.52	1.88
Fischer	4.29	2.30	2.03	1.07	.92	1.44	2.01
Lyons	3.57	2.12	1.78	1.20	.82	1.60	1.85
Lancaster	4.21	2.55	1.78	1.05	.81	1.51	1.98
Bineimis 12	3.89	2.12	2.01	1.05	.75	1.63	1.98
Martin	3.30	2.50	2.18	.99	.70	1.39	1.84
Manchar	3.55	2.72	2.26	.92	.79	1.38	1.94
Mandan 404	3.88	2.20	2.29	.85	.62	1.18	1.84
Canadian	4.10	2.45	1.78	.74	.59	1.24	1.82
Homesteader	4.10	2.58	2.54	.95	.77	1.53	2.09
Storley	3.76	2.50	2.32	.81	.61	1.17	1.86

Table 16. Hay Yields of Wheatgrass Varieties in Tons per Acre

Intermediate Wheatgrass	3-Yr. Av.* 1950-53	Vigor† Notes 1954	1955	1956	Av. 1955-56
Ree	1.80	2.7	1.29	1.39	1.34
Neb. 50	1.66	3.3	1.25	1.33	1.29
S. D. 1	----	----	1.17	1.25	1.21
S. D. 4	1.65	----	----	----	----
S. D. 11	1.47	----	----	----	----
M-10820-52	----	7.0	1.18	1.48	1.33
A 12496	----	3.8	1.21	1.28	1.24
Pubescent Wheatgrass	1.22	7.3	----	----	----
Tall Wheatgrass	1.33	----	----	----	----

*Excluding 1951.
†Notes taken on basis of 1-9, 1 being the most vigorous.

Bromegrass variety tests. Yield tests over the past years have shown that the species smooth bromegrass, intermediate wheatgrass, and crested wheatgrass are the best adapted and highest yielding grasses. In table 15, hay yields of varieties of smooth bromegrass indicate that Homesteader, a variety originating from this station, is the highest yielding. The high yield and limited range between lowest and highest yielding varieties indicate the high degree of adaptability of this grass.

Intermediate wheatgrass variety tests. Different varieties of intermediate wheatgrass have been tested to determine their ability to yield both hay and seed (tables 16 and 17). Ree wheatgrass yields slightly more hay than the other varieties of intermediate wheatgrass and also more than the two species, pubescent wheatgrass and tall wheatgrass.

Seed yields of different intermediate wheatgrass varieties indicate wide differences. S.D. 2 has, on the average, yielded more seed than

Table 17. Seed Yields of Wheatgrass Varieties in Pounds per Acre in 1955 and 1956

	1955	1956	2 Yr. Av.
Intermediate Wheatgrass			
Ree	328	238	283
S. D. 1	370	244	307
S. D. 2	466	343	404
S. D. 1A	368	219	294
A 12496	282	185	233
$M_2$10820-52	386	348	367
Pubescent Wheatgrass			
759	400	305	352

any other variety and yields 43 percent more seed than Ree wheatgrass from which it was selected.

Crested wheatgrass variety tests. Both Fairway and standard crested wheatgrass varieties were tested (table 18). Fairway varieties, which as a type are somewhat shorter and leafier than the standard, yield slightly less than the standard varieties. Nordan, a new variety, yields higher than the common but slightly less than Summit. Nordan has very good seedling vigor and its seed has a much shorter awn than the common, making it more easily harvested and seeded.

Table 18. Hay Yields of Crested Wheatgrass Varieties in Tons per Acre

Crested Wheatgrass	Av. 1950-53	1955	1956	Av. 1955-56
Fairway Type				
A1770		.91	1.28	1.10
S-31-3-1	1.49			
Standard Type				
Nordan		1.20	1.40	1.30
Summit	1.54	1.26	1.49	1.38
42-1		1.17	1.28	1.22
P-27		1.20	1.44	1.31
Neb. 10		1.28	0.88	1.08
S. D. 3	1.36			
Common	1.38			

Crop Cultural Tests

Soil moisture utilization by crops. The purpose of this investigation was to determine the amount of water used and the period of use of water by the major crops. The results of the water use by these crops is shown in table 19.

Alfalfa used the most water of all crops studied during 1956. It began using water early in the growing season and continued use until frost. Corn used 17.9 inches of water and had its maximum use during August and September. Flax and sweet clover used 17.4 inches of water and had their peak use during June and July. Oats used the least amount of water and had its maximum use during May.

Soil structure. Soil structure was investigated on the tillage and crop residue experiment. The effect of tillage and crop residues on soil structure is shown in table 20.

Subsurface tillage does not break up the soil aggregates as readily as plowing. The return of crop residues give a better aggregation of the soil than the removal of these residues on both methods of tillage. The best aggregation of the soil was

Table 19. Soil Moisture Utilization by Different Crops

Dates of Sampling	Rainfall Between Dates (Ins.)	Inches of Available Soil Moisture Under Crops Indicated and Water Use by Crops							
		Alfalfa		Flax & Sw. Cl.		Oats		Corn	
		Soil Moisture	Use	Soil Moisture	Use	Soil Moisture	Use	Soil Moisture	Use
5/2/56		2.9		3.5		3.5		3.5	
	4.6		5.5		3.4		5.3		3.8
6/8/56		2.0		4.7		2.8		4.3	
	2.4		3.9		5.0		3.1		3.0
7/3/56		0.5		2.1		2.1		3.7	
	6.9		5.0		5.2		5.0		4.9
8/6/56		2.4		3.8		4.0		5.7	
	3.0		4.8		3.8		3.6		6.2
9/22/56		0.6		3.0		3.4		2.5	
Total Use			**19.2**		**17.4**		**17.0**		**17.9**

Table 20. Effect of Tillage and Crop Residue on Soil Structure

Treatment	Log G.M. Diameter*	Av. Yield, Bu./A.
Plowing	.124	60.8
Plowing with residue	.138	66.0
Subsurface	.148	60.9
Subsurface with residue	.166	64.4
Subsurface with residue and manure	.194	83.0
Subsurface with residue and nitrogen	.151	66.9
Subsurface with residue and phosphorus	.180	65.2
Subsurface with residue, nitrogen and phosphorus	.144	71.0

*Logarithm of the diameter of the 50% size particle.

obtained with the return of crop residues plus the addition of manure. The corn yields were also highest with the addition of residues and manure to the soil.

Dates of planting sorghums. Three sorghum varieties were planted at weekly intervals from May 10 to June 14. The results are given in table 21. Reliance yields were uniformly high on all except the last date of planting. Norghum out-yielded Reliance on the first two dates of planting. It is advisable to delay planting until the latter part of May and kill as many weeds as possible before planting. The best time to plant sorghums is from May 20 to June 1.

Table 21. Yields in Bushel Per Acre of Sorghums on Six Dates 1950-53

Variety	Dates of Planting					
	May 10	May 17	May 24	May 31	June 7	June 14
Reliance	55.8	52.2	53.3	49.4	52.4	30.3
Norghum	61.8	57.9	49.4	46.1	44.4	28.0
Sooner Milo	43.7	42.4	34.4	34.2	25.3	12.4

Soil Experiments

Crop yields on fertility plots. The object of these trials is 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 (60 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). Fertility of the soil on the farm had been maintained at a high level previous to the establishment of the fertilizer trials in 1942. Results of the fertilizer trials for the period 1942-52 and for the individual years 1953, 1954, 1955, 1956 are shown in tables 21, 22, 23, and 24. The rotation used on the fertilizer plots is corn-oats-wheat.

Corn is most responsive to nitrogen and phosphorus fertilizer, (table 22). Oats is very responsive to nitrogen fertilizer (table 23). Including phosphorus with the nitrogen usually results in the largest

Table 22. Corn Yields on Fertility Plots

Treatment*	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
None	46.2	64.2	52.2	39.6	59.4
Nitrogen	48.2	72.3	51.8	39.2	56.4
Phosphorus	48.7	67.0	51.0	40.5	56.1
Potassium	50.1	64.1	55.1	41.9	56.3
Nitrogen+phosphorus	52.1	79.9	55.8	42.9	68.0
Nitrogen+potassium	50.5	73.3	54.7	40.7	54.2
Phosphorus+potassium	52.2	72.7	53.4	41.3	46.4
Nitrogen+phosphorus+potassium	49.0	67.8	48.8	38.0	48.1

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

Table 23. Oat Yields on Fertilizer Plots

Treatment*	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
None	63.9	38.1	38.1	53.7	42.0
Nitrogen	68.5	68.1	58.1	48.0	43.4
Phosphorus	64.8	43.8	38.6	54.2	42.1
Potassium	62.2	41.0	34.3	49.9	37.6
Nitrogen+phosphorus	72.9	65.8	66.5	62.3	64.7
Nitrogen+potassium	71.3	59.6	53.2	53.6	44.5
Phosphorus+potassium	65.2	40.6	40.0	47.8	50.4
Nitrogen+phosphorus+potassium	71.2	73.4	51.5	54.9	41.5

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

Table 24. Wheat Yields on Fertilizer Plots

Treatment*	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
None	19.8	10.4	12.1	23.7	14.6
Nitrogen	22.6	12.7	9.2	18.8	8.3
Phosphorus	19.9	9.8	14.1	21.5	11.6
Potassium	20.3	11.4	12.0	21.4	14.3
Nitrogen+phosphorus	26.1	16.0	14.9	24.7	10.4
Nitrogen+potassium	23.6	14.3	12.0	22.5	8.3
Phosphorus+potassium	21.6	10.1	16.4	20.9	10.3
Nitrogen+phosphorus+potassium	24.8	14.3	13.2	25.4	6.8

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

Table 25. Effect of Various Rates of Fertilizers on Crop Yields

Treatments*	Average Yield in Bushels Per Acre for the Periods Indicated					
	Corn		Oats		Wheat	
	1944-52	1953-56	1944-52	1953-56	1944-52	1953-56
2 Nitrogen—Phosphorus—Potassium†	50.8	52.8	77.6	58.0	25.6	19.7
Nitrogen—2 Phosphorus—Potassium	50.3	49.4	72.8	56.0	24.6	19.7
Nitrogen—Phosphorus—2 Potassium	51.1	49.9	72.5	54.7	25.4	17.1
2 Nitrogen—2 Phosphorus—2 Potassium	49.1	50.8	77.9	60.9	26.7	19.3
Nitrogen—Phosphorus—Potassium	50.3	50.6	71.2	55.3	24.8	14.9
Nitrogen—Phosphorus	53.5	59.4	74.7	60.4	27.9	16.4
None	46.5	53.9	63.3	42.9	19.5	14.6

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

Table 26. Corn Yields on Tillage and Residue Plots

Treatment	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
Plowing	48.8	59.3	50.6	42.0	60.8
Plowing with residue	51.4	64.6	59.3	39.9	66.0
Subsurface	47.9	46.9	51.6	46.9	60.9
Subsurface with residue	48.4	43.7	53.0	48.7	64.4
Subsurface with residue and manure	50.0	54.7	61.1	45.0	83.0
Subsurface with residue and nitrogen	47.1	44.5	56.5	47.2	66.9
Subsurface with residue and phosphorus	47.7	44.7	55.4	52.3	65.2
Subsurface with residue, nitrogen, and phosphorus	46.6	51.4	58.6	47.7	71.0

yield for oats. The influence of fertilizer on the yield of oats was more pronounced in 1953 and 1954 than for the earlier period from 1942-52. This is probably due to the effects of declining soil fertility. The yield of oats was increased by every fertilizer treatment that included nitrogen. The response of both corn and oats to fertilizer treatment for the 1955 and 1956 period was adversely affected by drought.

The data in table 24 indicate that a combination of nitrogen and phosphate fertilizer is the most effective fertilizer treatment for increasing wheat yields. For the years 1953-56, yields of wheat in the experimental plots were affected by diseases and drought, so consequently the effects of fertilizer treatment were reduced. Table 25 summarizes the effect of nitrogen, phosphorus, and potassium fertilizer applied at two rates to a corn-oats-wheat rotation. It may be noted that the lower rates of application are as effective for increasing crop yields as the double rate. Potassium had no beneficial effect.

Tillage and crop residue experiments. The purpose of this trial was to determine the effect of tillage, crop residues, and fertilizer applied with residues on the yields of corn, oats, and wheat in a 3-year rotation. The average crop yields from 1942 through 1952 and the yields for the individual years for the period 1953 through 1956 are given in tables 26, 27, and 28.

Table 27. Oat Yields on Tillage and Residue Plots

Treatment	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
Plowing	57.3	40.4	34.2	48.2	30.6
Plowing with residue	61.4	45.5	42.4	56.7	38.2
Subsurface	58.4	42.2	37.1	50.2	31.4
Subsurface with residue	61.6	56.6	36.6	49.8	38.6
Subsurface with residue and manure	63.3	61.5	59.9	53.7	51.7
Subsurface with residue and nitrogen	63.4	64.5	49.1	50.1	39.3
Subsurface with residue and phosphorus	64.2	50.8	38.2	56.2	45.4
Subsurface with residue, nitrogen, and phosphorus	64.6	69.0	52.7	55.7	43.6

Table 28. Wheat Yields on Tillage and Residue Plots

Treatment	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
Plowing	18.8	7.1	4.9	17.1	8.7
Plowing with residue	20.6	11.8	6.1	18.4	10.6
Subsurface	18.1	7.3	4.3	19.1	9.6
Subsurface with residue	18.0	8.7	5.3	20.9	11.3
Subsurface with residue and manure	22.0	12.2	7.6	25.3	15.3
Subsurface with residue and nitrogen	22.5	12.5	6.7	20.4	11.1
Subsurface with residue and phosphorus	20.9	8.9	6.3	21.5	13.7
Subsurface with residue, nitrogen, and phosphorus	24.7	14.8	7.6	24.4	13.9

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. In 1956 the yields of corn, oats, and wheat on the tillage and crop residue plots were increased by the application of manure, crop residues, and nitrogen or nitrogen and phosphorus fertilizer.

Method 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 tables 29, 30, and 31. In this trial none of the crop residues were returned to the soil and no fertilizer was used. A comparison of the four methods of seedbed preparation shows that plowing has consistently produced the higher yields of wheat.

Table 29. Corn Yields on Tillage Plots

Treatment	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
Plow 4"	46.5	59.6	54.9	41.8	51.2
Plow 7"	48.1	63.5	53.5	46.4	57.4
Plow 10"	47.0	62.8	53.7	38.0	52.2
Subsurface	44.8	48.0	47.1	48.4	54.4
One-way	45.2	52.0	47.7	40.9	50.8
Double disc	42.1	49.2	43.3	42.8	49.2

Table 30. Oats Yields on Tillage Plots

Treatment	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
Plow 4"	65.5	44.3	40.5	58.0	35.3
Plow 7"	61.0	34.0	39.4	55.8	34.6
Plow 10"	66.1	45.9	44.4	56.5	42.4
Subsurface	59.5	46.8	34.0	51.5	35.6
One-way	60.0	41.3	30.5	52.3	34.1
Double disc	58.2	40.5	30.6	52.5	40.2

Table 31. Wheat Yields on Tillage Plots

Treatment	Average Yield in Bushels Per Acre				
	1942-52	1953	1954	1955	1956
Plow 4"	19.5	10.2	8.7	18.0	11.4
Plow 7"	19.0	9.2	6.9	18.5	15.5
Plow 10"	20.6	10.3	7.4	18.4	14.3
Subsurface	17.3	6.0	7.9	19.0	14.8
One-way	18.1	7.8	6.4	16.7	10.0
Double disc	16.3	6.7	6.0	16.5	9.9

Method 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 32. The sweet clover was seeded with the wheat crop and the following year was plowed under for green manure. It was either plowed under in June or mowed and allowed to grow until August and then plowed under. The wheat yields from 1944-52 have been substantially higher in the sweet clover rotation than in the corn-oat-wheat rotation. For the year 1955 and 1956 the effect of the sweet clover rotation on wheat yields was reduced by drought.

Legume nitrogen or commercial nitrogen. New rotations are under way on the Agronomy Farm comparing legumes as a source of nitrogen with nitrogen fertilizer. The results for corn for the years 1955 and 1956 and oats for 1956 are given in tables 33 and 34. The rotations in these experiments are corn-oats-flax-wheat or legume, alfalfa-alfalfa-corn-flax, and corn-flax-corn-oats. Nitrogen is applied at three levels, 20, 40, and 60 pounds per

Table 32. Effect of Sweet Clover Rotations on Crop Yields

Treatment	Av. 1944-53, Bu./A.*		Av. 1953-54, Bu./A.*		Av. 1955, Bu./A.		Av. 1956, Bu./A.	
	Corn	Wheat	Corn	Wheat	Corn	Wheat	Corn	Wheat
Sweet clover plowed June 15	49.1	26.4	60.6	14.1	35.9	26.1	61.6	17.1
Sweet clover plowed June 15 with phosphorus fertilizers	50.3	29.2	63.2	15.3	34.7	25.6	64.0	18.2
Sweet clover plowed August 1	52.6	28.2	66.9	15.6	31.0	25.0	70.5	22.7
Sweet clover plowed August 1 with phosphate fertilizers	53.3	28.9	66.2	15.9	32.1	28.9	64.6	21.9
No legume—corn—oats—wheat rotation	46.0	18.4	58.2	11.2	31.5	23.5	63.3	19.5
Continuous corn or wheat	44.9	19.5	51.3	11.1	36.9	22.0	61.8	11.5

*Years are inclusive.

Table 33. Effect of Sweet Clover Rotations and Nitrogen Fertilizer on Crop Yields

Soil Treatment	Corn, Bu./A. 1955	Corn, Bu./A. 1956	Oats, Bu./A. 1956
Corn—Oats—Flax—Wheat—No legume or nitrogen fertilizer	31.7	62.5	33.6
Corn—Oats—Flax—Sweet clover	22.9	61.7	27.6
Corn—Oats—Flax—Mature sweet clover	15.9	67.4	28.5
Corn—Oats—Flax—Sweet clover+30 pounds nitrogen per acre	33.2	62.6	41.2
Corn—Oats—Flax—Wheat+20 pounds nitrogen per acre	39.8	63.2	45.3
Corn—Oats—Flax—Wheat+40 pounds nitrogen per acre	35.8	62.3	38.3
Corn—Oats—Flax—Wheat+60 pounds nitrogen per acre	32.9	60.8	30.8

*Nitrogen applied in the form of ammonium nitrate.

acre, to the rotations which do not have a legume. Phosphorus is added at the rate of 20 pounds of phosphoric acid to all plots except the check plots.

In 1955 the yield of corn on the sweet clover plots was depressed below that of other soil treatments except where 30 pounds of nitrogen was added to the sweet clover rotation. This reduction in yield was probably due to the July drought. In 1956 oats yields were highest on the sweet clover rotation which received 30 pounds of nitrogen or where 20 pounds of nitrogen was added to the nonlegume rotation. In 1956 the highest yield of corn in the sweet clover rotation was obtained where the sweet clover was plowed under in the mature stage.

The corn yields in the alfalfa rotations were not influenced by soil treatment in 1956. The midsummer moisture supply placed a ceiling on corn yields for this experiment.

Table 34. Effect of Alfalfa Rotation and Nitrogen Fertilizer on Yield of Corn 1956

Soil Treatment	Corn, Bu./A. 1956
Alfalfa—Alfalfa—Corn—Flax rotation	67.0
Corn—Flax—Corn—Oats+40 pounds of nitrogen per acre	68.6
Corn—Flax—Corn—Oats rotation	69.0

Effect on yields of growing crops continually. What happens to yields when crops are grown continually without the use of soil improvement practices is shown in table 35.

Table 35. Effects of Continuous Cropping on Yields

	Av. 1942-47, Bu./A.*	Av. 1948-52, Bu./A.*	Av. 1953-54, Bu./A.*	Av. 1955-56, Bu./A.*
Corn	47.9	42.4	52.3	49.3
Barley	37.1	34.8	31.8	30.2
Oats	58.6	46.2	44.9	39.2
Rye	29.8	26.0	26.2	22.3
Wheat	21.4	17.3	11.2	16.7

*Years are inclusive.

The data in this table show that the crop yields for the first 6-year period are higher than for the second 5-year period. The yields of barley and oats for the 1953-54 period are lower than the previous periods. The small grain yields for the 1955-56 years are below those of all previous years. Corn yields have remained relatively constant. The fluctuations in yields of crops in this experiment are the result of both declining soil fertility and climatic conditions. Plant diseases have also been a factor in influencing yields. Chemical analysis of the soils on the continuous plot show that these soils are undergoing a constant decline in soil nitrogen and organic matter.

1957 RECOMMENDED VARIETIES

Spring Wheat
- Conley
- Lee
- Rushmore
- Selkirk

Durum Wheat
- Langdon
- Ramsey
- Yuma

Winter Wheat
- Cheyenne
- Minter
- Nebred

Oats
- Andrew
- Brunker
- Cherokee
- Dupree
- Garry
- Marion
- Mo.-0-205
- Nemaha
- Newton
- Osage
- Ransom
- Waubay

Rye
- Antelope
- Caribou
- Pierre

Flax
- Marine
- Redwood
- Sheyenne
- B-5128

Grain Sorghum
- Norghum
- Reliance
- R.S.501

Forage Sorghum
- Piper Sudan
- Rancher
- 39-30-S

Soybeans
- Blackhawk
- Capital
- Chippewa
- Grant
- Harosoy
- Ottawa Mandarin

Barley
- Custer
- Feebar
- Kindred
- Plains
- Spartan
- Traill
- Velvon-11
- Liberty

Red Clover
- Dollard

Alfalfa
- Cossack
- Grimm
- Ladak
- Narragansett
- Ranger
- Rhizoma
- Vernal

Sweet Clover
- Gold Top
- Madrid

Birdsfoot Trefoil
- Empire

Grasses
- Fairway Crested Wheatgrass
- Homesteader Bromegrass
- Lincoln Bromegrass
- Nordan Crested Wheatgrass
- Ree Wheatgrass
- Tall Wheatgrass

Trees
- Chinkota Elm
- Harbin Pear
- Siouxland Cottonwood

Tomatoes
- Siouxann
- State Fair

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