A Report on Field Research in Soils

(A compilation of recent experimental results by personnel of the Department of Soil Science, Extension Specialists and Agronomists at the Branch Stations at Crookston, Duluth, Grand Rapids, Lamberton, Morris, Rosemount, and Waseca).

Department of Soil Science

University of Minnesota

February, 1965

Some of the results herein reported are from experiments carried on during 1964 only, and should not be regarded as the results obtained over a number of years. The investigations are those of a more practical nature, and do not include some of the more theoretical problems presently under study in greenhouse and in the laboratory. Because these are largely one year results they should not be considered as conclusive and the results are not for publication.

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"Climatological and Microclimatological Investigations of 1964" by Donald G. Baker, which is a summary of results obtained from (a) the Soil Moisture Survey and studies in (b) Solar and Net Radiation, (c) Soil Heat Budget and Soil Temperatures, (d) Air Temperature in the Microclimate and (e) the Climate of Minnesota: Its Temperature Characteristics is available upon request. Those interested may write for Soil Series 72 .

Subsoil Regeneration Study

Lamberton

Bulk Density

June 25, 1964

Data Book 23:43-63
G. R. Blake and W. W. Nelson

Depth in Inches	Corn				Alfalfa				Significance 1/	
	Packed		Not Packed		Packed		Not Packed			
	Irrig.	Not Irrig.	Irrig.	Not Irrig.	Irrig.	Not Irrig.	Irrig.	Not Irrig.	Crop	Packing
4- 8	1.23	1.27	1.26	1.22	1.40	1.37	1.34	1.41	***	NS
8-12	1.35	1.43	1.40	1.30	1.52	1.43	1.33	1.27	NS	***
12-16	1.56	1.48	1.36	13.7	1.50	15.1	1.29	1.36	NS	***
16-20	1.50	1.43	1.37	1.38	1.46	1.45	1.36	1.37	NS	**
20-24	1.51	1.45	1.38	1.37	1.40	1.40	1.36	1.34	NS	**
24-28	1.44	1.40	1.38	1.36	1.39	1.40	1.35	1.45	NS	NS
28-32	1.47	1.48	1.44	1.41	1.45	1.44	1.38	1.45	***	NS

1/ * = Significance at 10%, ** = Significance at 5%, *** = Significance at 1%, NS = Not Significant

Replication significant, 1%, at 16-20" and 28-32" depths. Irrigation was significantly higher at the 5% level at 8-12" depth. Irrigation x Packing and Irrigation x Crop were significant it 10% at 8-12" depth. Packing x Crop significant at 5% level at 8-12" depth.

Subsoil Regeneration Study

Lamberton

Soil Moisture Percentages

June 25, 1964

23:65-85
G. R. Blake and W. W. Nelson

Depth in Inches	Corn				Alfalfa				Significance 1/	
	Packed		Not Packed		Packed		Not Packed			
	Irrig.	Not Irrig.	Irrig.	Not Irrig.	Irrig.	Not Irrig.	Irrig.	Not Irrig.	Crop	Irrig. x crop.
4- 8	18.52	21.26	21.00	20.34	18.16	18.76	19.12	17.06	NS	*
8-12	20.60	21.80	21.36	20.78	16.70	17.82	16.90	16.26	***	NS
12-16	20.88	21.16	20.06	21.16	17.02	17.92	16.38	15.96	***	NS
16-20	20.70	20.40	19.80	20.82	16.68	16.70	16.74	16.14	***	NS
20-24	19.84	20.04	20.08	20.62	16.74	17.54	17.42	16.28	***	NS
24-28	19.38	20.14	20.50	20.76	17.36	18.06	18.62	15.80	***	NS
28-32	18.86	20.36	20.52	20.64	18.20	18.06	18.46	15.80	**	NS

1/ 10%, 5%, 1%, one, two and three stars respectively

Irrigation NS

Irrigation x Packing interaction (1%) and Irrigation x Crop interaction (10%) significant at 4-8" depth. Packing significant at 1% at 8-12" depth. Replication significant at 10% level at 12-16" depth and at 5% level at 16-20", 20-24", 24-28", 28-32" depths.

Subsoil Regeneration Study

Lamberton, 1964

Corn Grain Yield (bu./A. @15.5% water);

Percent Moisture in Grain,

Alfalfa Yield(lbs./A @20% water)
and Alfalfa Height
G. R. Blake and W. W. Nelson

	Date Harvested	Date Book Reference	Packed		Not Packed	
			Irrig.	Not irrig.	Irrig.	Not irrig.
Corn Yield	10/13/64	23:123-125	106.3	91.8	90.7	103.2
% Moisture	10/13/64	23:127-128	33.3	34.0	33.8	32.5
Alfalfa Yield	6/5/64	23: 91-93	5354	5499	5300	5590
Alfalfa Yield	7/7/64	23: 96-98	3249	3104	2977	2940
Alfalfa Yield	8/26/64	23:101-103	3285	3086	3539	2904
Alfalfa Height	6/5/64	23: 94-95	26.6	26.6	27.0	26.0
Alfalfa Height	7/7/64	23: 99-100	23.4	22.2	23.4	22.2
Alfalfa Height	8/26/64	23:104-105	19.6	19.6	20.4	18.4

Irrigation x packing interaction was significant at the 90% level in corn grain yield and in the percent moisture of the grain. Replication was significant at 90% level in percent moisture of the grain.

Replication was signficant in the alfalfa yield in the 1st cutting at the 95% level and in the 3rd cutting at the 90% level. Replication was significant in the alfalfa height in the 3rd cutting at the 95% level. Irrigation was significant in the alfalfa height in the 2nd cutting at the 95% level.

Corn after Fallow

Lamberton, 6/25/64

Soil Water Content, %

G. R. Blake, W. W. Nelson, and R. R. Allmaras

Depth inches	Fall Plow Not Packed	Fall Plow Packed	Fallow Summer, 1963
		Rep I	
0 -12"	16.17	22.83	25.63
12-24"	18.53	24.90	26.07
24-32"	16.95	24.60	19.30
		Rep II	
0 -12"	20.37	21.33	25.13
12-24"	28.77	20.60	25.80
24-32"	31.35	18.95	25.35

Differences not significant at any depth.

Corn after Fallow

Lamberton, 6/25/64

Soil Bulk Density

G. R. Blake, W. W. Nelson, and R. R. Allmaras

Depth inches	Fall Plow Not Packed	Fall Plow Packed	Fallow Summer, 1963
		Rep I	
0--12"	1.17	1.17	1.21
12-24"	1.45	1.46	1.41
24-32"	1.58	1.48	1.64
		Rep II	
0 -12"	1.13	1.15	1.22
12-24"	1.42	1.50	1.42
24-32"	1.41	1.62	1.45

Differences not significant at any depth.

Corn after Fallow

Lamberton, 1964

Soil Temperatures, 4" depth, °F.

Averages of 5 daily readings per week

G. R. Blake, W. W. Nelson, and R. R. Allmaras

Week Ending	Time[2/]	Fallow 1963	Fall Plowed, Packed	Fall Plowed, Not Packed
May 28[1/]	A.M.	60.6	60.7	60.3
	P.M.	69.1	68.1	67.3
June 5	A.M.	57.7	57.8	58.3
	P.M.	68.4	66.7	66.6
June 12	A.M.	64.2	64.4	64.5
	P.M.	70.0	69.4	69.2
June 19	A.M.	62.3	62.4	62.7
	P.M.	67.5	67.2	67.2
June 26	A.M.	67.1	67.1	67.1
	P.M.	75.2	74.5	74.9
July 3	A.M.	71.8	72.3	72.1
	P.M.	77.7	77.5	77.2
July 10	A.M.	73.5	73.6	73.2
	P.M.	81.0	80.5	80.1
July 21[3/]	P.M.	79.7	80.6	80.4

1/ 3 days only

2/ 8-9 A.M. 4-5 P.M.

3/ Single date

Structure - Nitrogen Study

Waseca, 1964

Soil Temperatures at 4" depth, °F.

Averages of 12 readings on 3 reps
G. R. Blake, J. M. MacGregor, and L. E. Ahlrichs

Week Ending		Air Temp.	Minimum Spring	Tillage, when plowed: Minimum Fall	Regular Fall	Field Cultivate
May 2	max	61.6	54.1	56.7	56.3	57.1
	min	46.4	49.1	51.2	51.1	51.8
	mean	54.0	51.6	54.0	53.7	54.5
May 9	max	73.8	62.2	63.6	62.9	64.9
	min	54.6	57.8	58.2	58.9	60.3
	mean	64.2	60.0	60.9	60.9	62.6
May 16	max	73.7	64.0	67.3	66.4	66.7
	min	46.5	54.7	55.8	56.4	56.3
	mean	60.1	59.6	61.6	61.4	61.5
May 23	max	82.3	70.5	71.8	72.0	72.6
	min	57.9	63.3	64.9	64.9	64.9
	mean	70.1	66.9	68.4	68.5	68.8
May 30	max	72.7	71.2	71.7	71.7	73.5
	min	49.8	62.9	63.6	63.5	64.6
	mean	61.3	67.1	67.7	67.6	69.1
June 6	max	74.8	73.7	75.4	75.1	76.3
	min	45.9	64.0	65.3	64.8	65.6
	mean	60.4	68.9	70.4	70.0	71.0
June 10	max	81.2	74.8	76.6	76.9	77.0
	min	60.2	68.4	69.8	69.5	70.0
	mean	70.7	71.6	73.2	73.2	74.5

Primary Tillage for Potatoes

R R Valley Potato Research Farm

Soil Analyses. Sampled 9/14/64
G. R. Blake and G. W. French

Year and Range	Sample No.	Plot and Rep.1/	Particle size analysis, % Sand	Silt	Clay	Course silt	Fine silt	pH	Organic Matter, % 2/ (a)	(b)
1961 4S	1	V & VI	3.9	65.7	30.4	54.7	11.0	7.8	9.38	5.8
	2	VII & VIII	3.6	69.5	26.9	57.2	12.3	8.0	9.07	6.8
	3	I & II	4.1	68.4	27.5	57.0	11.4	8.0	8.77	5.2
	4	III & IV	3.9	67.5	28.6	56.1	11.4	8.0	10.27	6.6
1962 2S	1	V & VI	2.6	66.9	30.5	54.4	12.5	7.6	7.54	6.1
	2	VII & VIII	3.2	64.7	32.1	53.0	11.7	7.6	9.37	6.9
	3	I & II	3.0	69.9	27.1	57.6	12.3	8.0	6.75	6.9
	4	III & IV	3.0	66.0	31.0	53.7	12.3	7.9	9.85	6.8
1963 6S	1	V & VI	4.7	---	---	56.6	---	7.9	7.60	6.4
	2	VII & VIII	4.7	68.5	26.8	56.4	12.1	7.8	7.95	7.0
	3	I & II	7.5	65.2	27.3	54.4	10.7	8.1	7.95	6.0
	4	III & IV	4.8	68.9	26.3	57.0	11.9	8.0	7.56	6.3

1/ Sample taken between reps indicated.

2/
(a) Values of carbon furnace include free carbonites with O.M.
(b) Dichromate method, Soil Testing Lab.

Soil Salinity and Crop Growth in Southern Minnesota

J. M. MacGregor, R. Munter, G. Holcomb and O. Gunderson

On several relatively lower lying soils of southern Minnesota, corn or soybeans have frequently not grown normally, and in some years have not survived after the first few weeks of growth. Since applications of fertilizers or of iron or zinc chelates to some of these soils failed to improve or promote normal plant growth, it was decided late in 1964 to sample a number of these areas to determine if soil pH and soluble salt content as measured by electrical conductivity of water extracts were related to the poor growth conditions. In addition, the calcium carbonate content, concentrations of soluble sodium and of sulfate were determined. From this information, the sodium absorption ratio, the sodium hazard, and the salinity hazard of these soils was determined. A total of 24 soil profiles were sampled in the locations shown on the accompanying map.

Since water soluble salts are a frequent cause of poor crop growth in western irrigated areas, a salinity scale has been developed showing the relation of the electrical conductance of saturation extracts of soils and crop growth on affected soils and this is shown below.

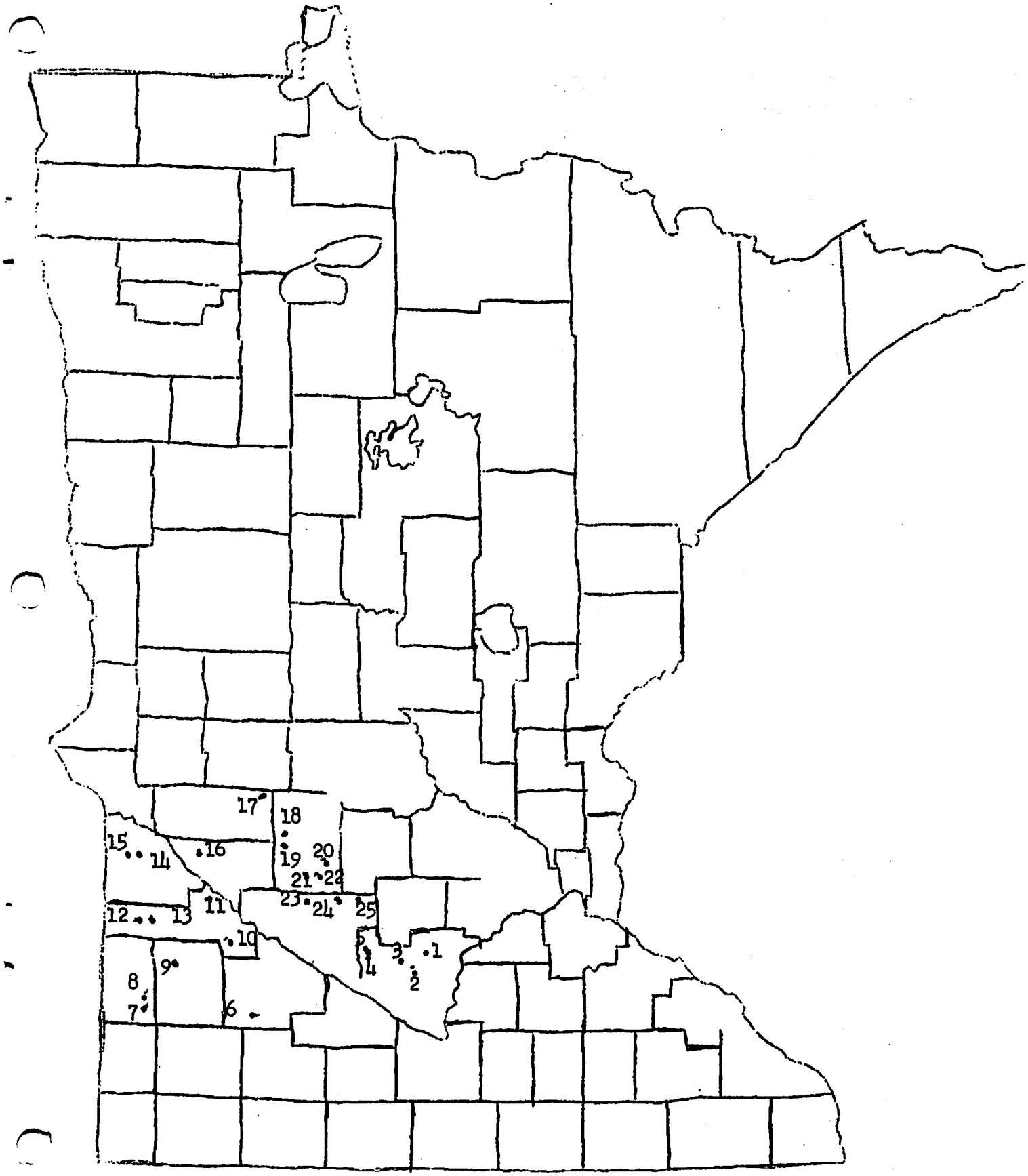
Salinity Scale Table

Specific conductance of the saturation extract of soil (mmillimhos per cm.)

0	2	4	8	16
Non-saline	Very slightly saline	Moderately saline	Strongly saline	Very strongly sal
Salinity affects mostly negligible	Yields of very sensitive crops may be stricted	Yields of many crops restricted. Alfalfa, cotton, sugarbeets, cereals and grain sorghums adapted.	Only tolerant crops yield satisfactorily. Bare spots appear because of injury to germination.	Only a few very tolerant crops yield satisfacto Only salt tolera grasses, herbacious plants, shrubs and tree grow.

Where the electrical conductivity of the saturation extract exceeds 2 millimhos per centimeter, the soluble salt content of the soil has an increasingly serious affect on several crops grown in Minnesota. The chemical analyses on the soil samples from the location sites on the preceding map are shown in the following tables.

Location of Soil Sample Sites



Map site no.	Cty, farm operator and soil type and crop symptoms	Soil depth (inches)	Soil pH	% $CaCO_3$ equivalent	Saturation extract Conductivity mmhos/cm.	Na meq/l	Ca + Mg meq/l	SO_4 (ppm)	SAR[a]	Na hazard	Salinity hazard
1	Sibley County	0- 6	7.2	17.4	1.15	1.0	15.9	45	1	L	H
	Elmer Battcher-Gaylord	6-12	7.4	17.8	0.86	0.8	12.2	45	1	L	H
	Harpster clay loam	12-24	7.1	20.5	0.92	0.7	12.4	45	1	L	H
	Soybean yellowing	24-36	7.5	19.0	1.04	0.9	14.2	2454	1	L	H
2	Sibley County	0- 6	7.6	4.5	0.80	0.4	12.2	45	1	L	H
	B. Weckworth-Gaylord	6-12	7.5	5.1	0.79	0.7	10.3	14	1	L	H
	Harpster silty clay loam	12-24	7.8	4.7	0.63	0.6	12.0	14	1	L	M
	Soybean yellowing	24-36	7.8	9.2	0.80	1.1	9.8	41	1	L	H
3	Sibley County	0- 6	7.5	14.0	1.01	1.1	16.2	113	1	L	H
	K. Turbitt - Gaylord	6-12	7.4	17.5	1.80	1.2	26.6	306	1	L	H
	Glencoe clay loam (Calc)	12-24	7.4	12.1	1.03	0.8	15.2	63	1	L	H
	Soybean yellowing	24-36	7.4	5.6	0.77	0.9	9.8	68	1	L	H
4	Sibley County	0- 6	7.4	22.8	1.01	1.7	13.5	41	1	L	H
	E. Bierman-Gaylord	6-12	7.6	27.8	0.81	0.9	11.7	45	1	L	H
	Webster silty C L (calc.)	12-24	7.9	30.4	0.83	1.0	11.1	18	1	L	H
	Soybeans yellow and die	24-36	7.7	26.0	1.29	2.0	15.9	18	1	L	H
5	Sibley County	0- 6	7.5	29.1	1.00	0.6	15.0	68	1	L	H
	E. Bierman-Gibbon	6-12	7.4	30.4	0.90	0.8	13.4	27	1	L	H
	Harpster silty clay loam	12-24	7.6	29.4	0.90	0.9	11.7	27	1	L	H
	Soybeans yellow and die	24-36	7.6	15.4	0.95	1.6	10.7	27	1.0	L	H
6	Redwood County	0- 6	7.7	20.8	3.30	3.2	45.4	519	1	L	VH
	G. Boelter-Lamberton	6-12	7.7	6.1	1.80	0.9	25.5	207	1	L	H
	Haprster silty clay loam	12-24	7.6	16.0	1.04	0.6	14.5	68	1	L	H
	Soybeans yellow	24-36	7.7	7.3	1.90	1.8	25.6	248	1	L	H
7	Lincoln County	0- 6	7.9	17.0	16.0	32.3	263	9225	2.8	L	VH
	John Wichern-Tyler	6-12	7.8	18.3	12.0	19.7	191	2925	1.9	L	VH
	Blue Earth silt loam	12-24	7.8	11.6	9.9	14.4	191	5259	1.4	L	VH
	Corn fails to grow	24-36	7.8	28.6	8.5	10.7	139	3870	1.3	L	VH

[a]SAR = sodium absorption ratio L = low, M = medium, H = high, VH = very high.

Map site no.	Cty, farm operator and soil type and crop symptoms	Soil depth (inches)	Soil pH	% $CaCO_3$ equivalent	Saturation extract Conductivity mmhos/cm	Na meq/l	Ca + Mg meq/l	SO_4 (ppm)	SAR[a]	Na hazard	Salt hazard
8	Lincoln County	0- 6	7.2	24.6	14.0	6.0	179	3690	1	L	VH
	John Wichern-Tyler	6-12	7.4	25.8	8.3	4.0	123	3375	1	L	VH
	Vallers silty clay loam	12-24	7.5	25.6	7.3	4.0	115	3714	1	L	VH
	Corn fails to grow	24-36	7.5	22.9	8.2	4.3	135	3690	1	L	VH
9	Lyon County	0- 6	7.6	25.6	6.8	27.2	61	4839	4.9	L	VH
	Maurice Regnier-Ghant	6-12	7.6	25.5	5.3	20.6	53	4770	4.1	L	VH
	Vallers silty clay loam	12-24	7.6	22.4	5.0	22.4	47	4050	4.6	L	VH
	Soybeans yellow and die	24-36	7.6	30.6	3.5	10.6	41	1356	2.3	L	VH
10	Yellow Medicine County	0- 6	7.7	16.0	5.0	10.6	71	6414	1.7	L	VH
	Marquardt	6-12	7.8	16.5	7.8	40.0	107	4974	5.4	L	VH
		12-18	7.7	16.5	5.3	21.4	73	4455	4.9	L	VH
		18-24	7.6	12.5	6.8	20.1	89	4613	3.1	L	VH
		24-36	7.6	14.2	5.5	15.2	75	3750	2.5	L	VH
11	Yellow Medicine County	0- 6	7.6	24.5	4.5	3.8	68	4995	1	L	VH
	Kermit Velde	6-12	7.6	18.6	4.2	3.4	71	5244	1	L	VH
	Vallers silty clay	12-24	7.6	29.9		7.1	118	1431	1	L	VH
	Corn fails to grow	24-36	7.6	26.2	5.8	4.4	87	654	1	L	VH
12	Yellow Medicine County	0- 6	8.0	16.0	7.0	34.4	71	5604	5.8	L	VH
	Nels Wollum-Porter	6-12	8.0	15.4	9.3	45.4	88	5064	6.8	L	VH
	Vallers clay loam	12-24	7.8	21.9	5.3	22.2	66	4659	3.9	L	VH
	Soybeans die										
13	Yellow Medicine County	0- 6	8.1	25.3	11.8	114	82	5775	17.8	M	VH
	Nels Wollum-Porter	6-12	8.1	24.6	11.0	84	65	6300	14.6	M	VH
	Vallers silty clay loam	12-24	8.0	21.4	9.8	81	63	6405	14.4	M	VH
	Soybeans die	24-36	7.8	18.5	7.3	46	65	4989	8.2	L	VH
14	Lac qui Parle County	0- 6	7.6	19.4	4.5	15.1	53	3939	2.9	L	VH
	J. Tollefson	6-12	7.6	7.2	5.0	16.3	55	3780	3.1	L	VH
	Sletten silty clay loam	12-18	7.5	7.9	2.9	8.8	28	284	2.4	L	VH
	Soybeans die at	18-24	7.5	11.5	2.3	6.9	25	158	2.0	L	VH
	6"	24-30	7.5	13.3	2.6	5.8	30	225	1.5	L	VH

Map site no.	Cty, farm operator and soil type and crop symptoms	Soil depth (inches)	Soil pH	% $CaCO_3$ equivalent	Saturation extract Conductivity mmhos/cm.	Na meq/l	Ca+Mg meq/l	SO_4 (ppm)	SAR[a]	Na hazard	Salt hazard
15	Lac qui Parle County										
		0- 6	7.5	5.6	3.5	2.9	52	1284	1	L	VH
	J. Tollefson	6-12	7.5	5.9	3.9	6.0	59	1230	1.1	L	VH
	Vallers silty clay loam										
		12-24	7.5	4.8	3.8	6.3	55	3825	1.2	L	VH
	Corn grows but	24-36	7.3	6.8	3.2	2.8	46	4410	1	L	VH
	very poor soybean growth	36-42	7.4	24.2	3.0	2.4	40	657	1	L	VH
16	Chippewa County	0- 6	7.7	18.9	1.3	0.7	14	50	1	L	H
	Ray Quam	6-12	7.8	29.1	1.0	1.2	12	36	1	L	H
		12-24	7.7	19.9	0.9	1.3	11	122	1	L	H
	Soybeans grow poorly	24-36	7.5	21.2	3.0	1.6	41	384	1	L	VH
17	Swift County	0-6	8.0	23.2	1.4	5.9	14	59	2.2	L	H
	E. Mitteniss	6-12	8.1	30.3	4.4	18.9	46	46	4.0	L	VH
	Borup silt loam	12-24	8.0	26.1	6.8	35.0	71	990	5.9	L	VH
	Corn is zinc	24-36	8.1	30.5	9.5	46.0	113	1035	6.1	L	VH
	deficient	36-43	8.0	28.5	8.3	39.6	108	1554	5.1	L	VH
18	Kandiyohi County	0- 6	7.9	30.6	2.5	3.1	29	369	1	L	VH
	Hauser	6-12	7.9	27.2	1.4	2.6	16	81	1	L	VH
	Calvin silty clay loam										
		12-24	7.9	30.2	0.9	1.7	10	41	1	L	H
	Soybeans grow	24-36	7.9	19.5	0.6	1.3	6	14	1	L	H
	poorly	36-42	8.0	17.9	0.8	1.4	8	14	1	L	H
19	Kandiyohi County	0- 6	7.6	51.8	2.3	3.7	28	348	1.0	L	VH
	Gilbertson-Pennock										
		6-12	7.9	55.2	1.6	2.7	19	135	1.0	L	H
	Calvin silt loam	12-24	7.7	26.4	1.3	2.3	16	113	1	L	H
	Soybeans yellow	24-36	7.5	30.4	2.8	2.0	40	180	1	L	VH
20	Kandiyohi County	0- 6	7.9	13.4	0.8	26.6	11	23	11.2	L	H
	C. H. Litch-Lake Lillian	6-12	8.0	8.3	1.3	3.9	14	14.4	1.5	L	H
	Unnamed silty clay loam										
		12-24	8.2	19.5	2.9	7.8	32	194	2.0	L	VH
	Zinc deficiency	24-36	8.0	18.4	3.0	9.5	37	360	2.2	L	VH
	in corn	36-44	8.1	18.9	3.1	9.3	35	468	2.2	L	VH
21	Kandiyohi County	0- 6	7.4	25.2	3.5	2.2	53	4500	1	L	VH
	G. Hopman, Lake Lillian	6-12	7.5	29.8	3.4	1.1	52	4458	1	L	VH
	Unnamed clay loam										
		12-24	7.3	24.7	2.9	1.5	43	4275	1	L	VH
	Yellow soybeans	24-36	7.4	28.3	3.0	1.6	46	4410	1	L	VH

Map site no.	Cty, farm operator and soil type and crop symptoms	Soil depth (inches)	Soil pH	% $CaCO_3$ equivalent	Saturation extract Conductivity mmhos/cm.	Na meq/l	Ca + Mg meq/l	SO_4 (ppm)	SAR[a]	Na hazard	Salt hazard
22	Kandiyohi County	0- 6	7.6	22.2	4.6	4.2	59	3465	1	L	VH
	Portinga, Lake	6-12	7.6	22.8	5.1	5.5	61	4164	1.0	L	VH
	Lillian Unnamed clay loam	12-24	7.4	21.4	4.6	8.9	56	2559	1.7	L	VH
	Soybeans yellow and die	24-36	7.4	21.6	5.9	9.0	66	4050	1.6	L	VH
23	Renville County	0- 6	7.4	29.5	0.50	0.4	9	50	1	L	M
	W. Benderhagen-Bird Island	6-12	7.5	28.8	2.95	1.0	45	1185	1	L	VH
	Biscay silt loam	12-24	7.4	28.3	1.60	0.8	21	186	1	L	H
	Yellowed soybeans	24-36	7.6	16.2	1.75	1.8	34	50	1	L	H
24	Renville County	0-6	7.5	51.1	1.5	1.0	21	261	1	L	H
	Novotny, Hector	6-12	7.5	20.6	2.1	1.3	30	396	1	L	H
	Harpster silty clay loam	12-24	7.5	42.6	2.0	1.1	29	270	1	L	H
	Yellowed soybeans	24-36	7.4	52.7	2.0	1.5	28	576	1	L	H
25	Renville County	0- 6	7.4	19.4	2.9	0.6	42	1431	1	L	VH
	J. Dascher-Buffalo Lake	6-12	7.4	25.5	1.9	0.6	29	684	1	L	H
	Harpster silty clay loam	12-24	7.4	22.0	3.2	2.3	45	252	1	L	VH
	Yellowed soybeans	24-36	7.5	12.8	2.2	1.3	32	189	1	L	H

Although the samples were all alkaline, only those of three profiles sites had a pH of 8.0 or above (site numbers 13, 17 and 20). The calcium carbonate equivalent varied widely from 4.5% (Site 2) to 55.2% (Site 19), the higher concentrations of which could contribute to the poor growth problem.

The conductivity values, which are largely to measure of water soluble salt content are generally very high with values above 8 millimhos per centimeter (strongly saline) in profile sites 7, 8, 13 and 17, and these concentrations would eliminate all but those plants most tolerant to salt injury. Six profiles had samples having conductivities of 4 to 8 (sites 5, 9, 10, 11, 12 and 14) and this would be sufficient to restrict crop growth. In addition Sites 6 and 15 showed conductivities in excess of 2 millimhos which would restrict yields of the more sensitive crops.

The analytical results from these problem soils indicate that moderate amounts of sodium are present and may contribute to crop damage, but it is more probable that the total content of water soluble salts is the main cause of poor or no crop growth, with the relatively less soluble calcium and magnesium carbonates having a lesser contributive effect.

Since the problem salts are comparatively readily leached from most soils, a more adequate drainage of these soil areas would solve the problem, although a period of at least five to ten years of good drainage would be essential.

Herbicide Residue Studies

Russell S. Adams, Jr.

During the summer of 1964, soil samples were taken from several fields in Minnesota where atrazine carry-over was reported. Only fields where atrazine had been broadcast were examined. Soil samples were taken from spots where injury was greatest (R or residue in Table 1), and where injury was least (N-R or no residue in Table 1). In addition to the usual soil tests the cation exchange capacity, caly, and water holding capacities of each soil sample was determined.

The object of this study was to determine if laboratory results could be confirmed by field observations. As was expected the most conspicuous difference between the extremes of atrazine carry-over in the fields examined was a difference in the organic matter content of the soil. That is, where injury from atrazine carry-over occurred the organic matter content of the soil was generally lower than where carry-over was slight or non-existent. Typically atrazine carry-over is observed first on the so called "clay knolls" in the field. In no case observed this summer was the clay content of these knolls higher than the surrounding soil. However, all were lower in organic matter. As seen in Table 1 marked differences in organic matter between "residue" and "no-residue" areas were reflected in more pronounced differences in cation exchange capacity.

The pH, available water, or exchangeable K could not be associated with differences in carry-over. However, in at least two locations (4 and 5 in Table 1) and possibly a third (3 in Table 1) the extractable phosphorus content of the soil was much higher where injury from carry-over occurred, and may have contriubted to injury. Laboratory and greenhouse experiments in this department indicated that high levels of phosphorus may increase injury from triazine herbicides. More detailed accounts of this work will be reported in the 1964 fall issue of the Minnesota Farm and Home Science and an issue of Weeds early in 1965.

That the level of phosphorus may be a factor in weed control is supported by a comparison of the degree of weed control and the amount of extractable-P found

in soil samples taken from Dr. Harley Otto's County Demonstration Weed Control Plots. These data are shown in Table 2. In both 1961 and 1962 the level of extractable-P was generally higher where weed control was good. However, this relationship was not apparent in 1963 and 1964. In those seasons extremes in rainfall over the state overshadowed the influence of other factors upon the activity of the herbicide. On the other hand the four year averages indicate a distinct increase in extractable-P at the highest levels of weed control.

Table 1. Soil characteristics where injury from atrazine residues occurred in several Minnesota locations in the summer of 1964.

Location	Exchange capa.		Clay		Organic Matter		Extractable P		Exchangeable K		pH		Available[1] water	
	R[2]	N-R[3]	R	N-R	R	N-R	R	N-R	R	N-R	R	N-R	R	N-R
	meq./100g		%		%		lbs/A		lbs/A				%	
1	34	35	21	19	4.0	5.1	6	12	155	135	7.2	7.4	11	10
2	21	30	41	41	6.6	8.0	7	9	270	230	7.6	7.8	14	14
3	16	17	29	30	3.7	4.5	110	52	520	380	7.1	6.4	17	15
4	22	21	33	34	5.4	5.5	140	56	310	390	5.9	5.6	14	13
5	17	19	30	29	5.3	4.5	60	35	230	240	7.2	6.9	16	16
6	17	18	28	29	5.1	5.4	45	48	400	500	6.5	6.7	13	14
7	17	18	32	32	5.1	5.7	27	33	230	340	6.5	6.3	17	14
8	17	16	27	27	3.8	5.0	32	52	210	190	7.0	7.2	15	15
9	24	30	48	43	4.0	6.3	9	32	240	300	8.0	6.7	10	10

[1] Available water is the difference between water holding capacities at field capacity and the wilting point (1/3 and 15 atmosphere tension respectively).

[2] R means severe carry-over occurred.

[3] N-R means carry-over was slight or non-existant.

Table 2. Comparison of weed control by 2 lbs/A of atrazine to Bray 1 extractable-P in County Demonstration Weed Control Plots.

Years and Weed Type	Evaluation of Weed control									
	Locations	50% control	Locations	50-75% control	Locations	75-85% control	Locations	85-95% control	Locations	95% control
1961	No.	lbs/A, P	No.	lbs/A, P	No.	lbs/A, P	No.	lbs/A, P	No.	lbs/A, P
Grass	18	38	15	33	12	39	5	111	8	55
Broad-leaf	10	37	8	29	4	27	8	62	23	57
1962										
Grass	1	35	7	36	11	27	16	56	4	86
Broad-leaf	0	--	6	39	5	31	6	45	17	59
1963										
Grass	2	29	6	31	12	55	8	51	5	33
Broad-leaf	0	--	2	45	6	53	5	49	18	42
1964										
Grass	21	48	13	33	9	50	4	25	0	--
Broad-leaf	11	36	8	39	6	26	11	66	6	28
Four year average										
Grass	42	40	41	33	44	43	33	59	17	55
Broad-leaf	21	36	24	33	21	35	30	60	64	50

Soil Productivity Study

R. H. Rust

The soil productivity study which began in 1956 is an attempt to gain reliable estimates of the productivity of major soil types in Minnesota. This productivity is estimated for the major crops under several generally specified soil managment programs. The estimates are incorporated in the soil survey reports published for the individual counties by the Soil Conservation Service, USDA, and the Experiment Station, cooperatively.

Since the project began 513 farm cooperators have furnished crop and soil management data on some 92 extensive soil types in the state. Currently 307 cooperators are enrolled in the project. The following kinds of data are recorded: date and rate of seeding; stand estimate; kind and amount of soil amendments used; moisture and temperature conditions during the growing season; weed and insect control measures; yields and losses of yield from harvesting or abnormal conditions; soil tests of pH, available P and K, organic matter.

Since it is planned that productivity estimates be based on multiple regression analysis and since there are a number of factors to be studied, a relatively large number of observations (generally more than 30) of each crop on each soil is necessary in order to establish reliability. In addition, the evaluation of yield variation associated with weather observations (chiefly rainfall and temperature) necessitates collection of data over several years.

In the following table the various soils included in the study are listed together with (1) number of fields, and (2) number of yields. Where 2 or more yields of a crop have been recorded, the crops, number of fields, and the average yields are given. On those soil series where data is available, yields are given according to the mapping phase, i.e., slope plus erosion. The reader may establish the location of the listed soils by reference to Soils of Minnesota, Ext. Bul. 278 (1963), or to the appropriate county soil report.

It should be noted that the average yields, particularly when only a few yields are included, do not necessarily reflect the relative productivity of the soils listed. They serve only to indicate the nature of yield levels attained in the last one to seven years by farmers who are in general using above average management. Many of the yields also reflect very favorable weather patterns as well as very unfavorable seasons. For those personnel concerned the data may serve to indicate where additional effort is needed.

Note: A-1 = 0-2 percent slopes, little or no erosion
B-1 = 2-6 percent slopes, little or no erosion
C-1 = 6-12 percent slopes, little or no erosion
B-2 = 2-6 percent slopes, one-third to two-thirds of surface eroded
D-2=12-18 percent slopes, one-third to two thirds of surface eroded

Where yields are given according to mapping unit (e.g., B-1), only the years 1960-63 are included.

Table 1. Soil series, number of fields, and number of yields included in soil productivity study to date. Average yields of selected crops given where two or more yields received. Yields of grain crops in bushels; hay, silage, and sugar beets, in tons; pasture, in cow-acre days.
* Number of fields on this series
** Number of yields on all crops

Lestad	(11)*	(43)**
Corn	13	53
Flax	6	12
Oats	6	57
Spring wheat	3	32
Barley	3	49
Alfalfa-brome-past.	3	136
Soybeans	3	25
Hay (other)	2	4.6
Pasture (other)	4	171
Anoka	(1)*	(1)**
Arlington	(1)	(5)
Oats	2	64
Alfalfa	2	3.4
Barnes	(16)	(82)
Corn	30	59
A-1	2	66
B-1	20	57
B-2	3	51
C-2	3	51
Oats	11	61
Flax	8	8
Soybeans	7	23
Alfalfa-brome	7	1.9
Barley	5	42
Alfalfa	5	1.9
Spring wheat	4	31
Corn silage	2	6.0
Bearden	(7)	(18)
Corn	4	56
Barley	4	53
Spring wheat	4	38
Sugar beets	3	11.6
Oats	2	58
Beltrami	(4)	(14)
Oats	3	66
Alfalfa	6	3.1
Alfalfa-brome-past.	2	76
Corn	2	66
Blue Earth	(3)	(11)
Corn silage	4	8.9
Corn	3	48
Soybeans	3	18
Oats	2	25
Alfalfa-brome	2	3.0
Borup	(1)	(1)
Braham	(2)	(2)
Brainerd	(5)	(14)
Oats	5	38
Corn	3	48
Corn silage	2	13.0
Hay (others)	2	2.8
Brickton	(4)	(6)
Alfalfa-brome	2	3.1
Buse-Barnes	(2)	(14)
Alfalfa-brome	3	1.6
Flax	2	9
Soybeans	3	15
Central	(4)	(5)
Chilgren	(5)	(29)
Oats	7	42
Barley	3	47
Flax	2	10
Spring wheat	3	18
Alfalfa	3	2.7
Alfalfa-tim.	3	2.4
Hay (other)	3	2.4
Corn silage	3	9.3
Wheat	4	33
Pasture (other)	2	243
Clarion	(37)	(240)
Corn	51	76
B-1	26	77
B-2	6	67
C-2	7	74
Oats	26	65
B-1	22	71
B-2	2	43
C-2	1	71
Soybeans	12	29
Spring wheat	8	31
Alfalfa-brome	13	3.1
Alfalfa	12	2.9
Mix. Leg. grass	3	5.0
Corn silage	3	14.5
Alfalfa-brome-past	3	228
Colvin	(6)	(15)
Alfalfa	4	3.6
Corn	6	68
Comfrey	(1)	(8)
Sorghum	4	8.1
Corn	2	60

Cormant	(4)	(15)
Oats	7	31
Alfalfa-brome	4	3.9
Downs	(3)	(13)
Corn	6	105
Oats	2	72
Alfalfa	3	3.4
Dubuque	(4)	(12)
Alfalfa-brome	3	4.5
Alfalfa	2	1.7
Enstrom		
Alfalfa-brome past.	2	222
Estelline	(1)	(3)
Esterville	(14)	(55)
Corn	18	60
A-1	10	61
B-2	1	72
Oats	12	45
Alfalfa-brome	9	2.2
Alfalfa	7	3.3
Corn silage	6	7.8
Fairhaven	(7)	(14)
Corn	7	62
Oats	4	63
Fargo	(20)	(69)
Spring wheat	17	37
Oats	8	41
Soybeans	3	23
Flax	6	12
Barley	7	30
Alfalfa-brome	6	1.5
Alfalfa	2	3.1
Sugar beets	9	13.5
Fayette	(7)	(36)
Corn	15	92
B-1	8	89
B-2	3	65
Oats	6	50
Alfalfa-brome	6	6.0
Alfalfa	3	3.0
Flom	(8)	(35)
Corn	12	73
Oats	6	56
Soybeans	3	17
Flax	5	19
Corn silage	3	15.0
Floyd	(5)	(20)
Corn	10	84
Soybeans	5	27
Oats	3	87
Fossum	(2)	(5)
Barley	2	49
Foxhome	(1)	(4)
Freer	(3)	(18)
Oats	5	66
Hay (other)	4	2.0
Corn silage	3	8.1
R.-Cl.-tim.	2	2.0
Freon	(6)	(11)
Oats	6	52
Glencoe	(1)	(1)
Greenbush	(3)	(8)
Corn silage	2	12.5
Hay (other)	2	1.5
Corn	2	65
Grimstad	(7)	(25)
Barley	4	44
Flax	3	10
Soybeans	3	15
Spring wheat	6	31
Oats	3	75
Grygla	(3)	(13)
Oats	4	36
Pasture (others)	2	112
Pasture (mix-leg-grass)	2	81
Alsike-tim.	2	1.3
Hamerly	(1)	(4)
Flax	2	15
Hantho	(1)	(3)
Harpster	(1)	(2)
Oats	2	34
Hayden	(23)	(89)
Corn	27	76
B-1	2[illegible]	101
B-2	3	98
C-1	1	66
D-2	2	86
D-3	4	77

Oats	15	55
Alfalfa	18	3.5
Alfalfa-brome	17	3.7
Alfalfa-brome-past.	8	301
Hegne	(7)	(17)
Spring wheat	6	34
Barley	3	47
Alfalfa	2	1.2
Potatoes	2	251
Hibbing	(4)	(6)
Alfalfa	2	3.1
Hubbard	(14)	(65)
Corn	26	62
A-1	13	67
B-2	4	29
Soybeans	11	21
Oats	8	42
Potatoes	5	425
Alfalfa	7	2.4
Alfalfa-brome	3	2.3
Corn silage	3	15.5
Kasson	(2)	(10)
Oats	2	65
Corn	2	83
Kato	(1)	(6)
Corn	2	72
Kenyon	(2)	(11)
Corn	4	86
Hay (other)	3	3.7
Alfalfa	3	2.7
Oats	2	66
Kingston	(3)	(15)
Corn	9	80
Soybeans	4	22
Kittson	(2)	(10)
Corn silage	2	4.9
Alfalfa	3	4.4
Kranzberg	(2)	(7)
Alfalfa-brome	3	2.3
Alfalfa	2	2.3
Lamoure	(2)	(13)
Corn	5	68
Soybeans	3	32
Sweet corn	3	7.0
Lerdal	(1)	(7)
Corn	4	82
Lester	(12)	(45)
Alfalfa	15	4.0
Corn	10	70
Oats	7	55
Alfalfa-brome	7	3.4
LeSueur	(9)	(38)
Corn	23	79
A-1	4	82
A-2	3	50
B-1	9	89
Soybeans	6	25
Oats	3	53
Barley	2	49
Litchfield	(2)	(15)
Corn	4	84
Soybeans	2	23
Oats	3	72
Potatoes	3	383
Alfalfa	3	4.0
Marcus	(1)	(1)
Marna	(6)	(18)
Corn	10	95
Soybeans	3	38
Alfalfa	2	5.1
Mavie	(1)	(2)
McDonaldsville	(1)	(3)
McIntosh	(3)	(18)
Oats	4	66
Spring wheat	6	35
Barley	3	64
Corn	2	70
Alfalfa	2	3.0
Menahga	(6)	(16)
Oats	3	38
Alfalfa-brome	6	3.0
Corn silage	4	9.4
Pasture (alfalfa brome)	3	147
Milaca	(8)	(30)
Oats	4	41
Corn	4	61
Hay (other)	6	2.6
Mix leg.-grass	4	2.0
Corn silage	5	11.4
Alfalfa	2	3.4
Alfalfa-brome	2	2.8
Moody	(2)	(6)
Corn	4	70

Mora	(4)	(16)
Corn	6	67
Oats	2	75
Mixed leg.-grass	3	3.1
Nebish	(7)	(34)
Oats	10	47
Alfalfa	6	1.6
Alfalfa-brome	7	4.4
Alfalfa-brome-past.	6	76
Nicollet	(21)	(100)
Corn	43	75
A-1	21	82
B-1	12	74
Oats	13	58
Soybeans	13	30
Spring wheat	4	32
Barley	2	94
Alfalfa	13	3.7
Alfalfa brome	4	4.0
Corn silage	4	7.9
Nokay	(5)	(13)
Corn	6	60
Oats	3	59
Corn silage	2	12.0
Nymore	(1)	(3)
Alfalfa	2	1.8
Onamia	(5)	(22)
Oats	5	63
Corn	5	69
Alfalfa	4	3.5
Alfalfa-brome	2	1.8
Pasture (brome)	2	200
Ostrander	(7)	(21)
Corn	7	83
Soybeans	3	27
Alfalfa	3	4.5
Parnell	(1)	(8)
Corn	5	47
Oats	2	75
Deep Peat	(6)	(22)
Corn	3	77
Soybeans	2	24
Timothy (seed)	3	334
Corn silage	2	6.5
Hay (other) past.	3	116
Leg,-grass past.	2	242
Shallow Peat	(5)	(7)
Soybeans	3	24
Barley	2	56
Pierce	(1)	(1)
Racine	(1)	(1)
Redby	(3)	(13)
Leg.-grass hay	3	1.5
Leg.-grass past.	4	81
*R. Cl-tim.	5	2.5
Oats	2	40
Rocksbury	(12)	(39)
Oats	10	60
Flax	5	8
Alfalfa	3	2.9
Hay (other)	6	1.5
Sweet corn-brome	2	1.7
Hay (other) past.	3	117
Wheat	3	23
Rockwell	(5)	(16)
Oats	3	52
Barley	3	23
Alfalfa	2	1.7
Corn silage	2	12.9
Wheat	2	29
Rothsay	(1)	(1)
Sioux	(4)	(11)
Oats	5	37
Soybeans	2	12
Alfalfa	2	0.8
Shcoks	(2)	(7)
Oats	3	42
Alfalfa	2	2.0
Skyberg	(3)	(12)
Corn	5	78
Oats	2	83
Leg.-grass past.	2	154
Sletton	(1)	(4)
Soybeans	3	30
Storden-Clarion	(1)	(7)
Oats	2	80
Alfalfa	5	2.9
Tama	(8)	(42)
Oats	11	65
Corn	14	91
A-1	6	87
B-1	4	97
B-2	2	106
C-1	1	43
C-2	1	43
Corn silage	3	14.2
Alfalfa	4	4.1
Alfalfa-brome	3	4.6

Leg.-grass hay	4	3.3
Alfalfa-brome past.	3	178
Taylor	(1)	(4)
Terrill	(1)	(2)
Todd	(2)	(7)
Alfalfa-brome	4	2.2
Corn silage	2	7.5
Truman	(3)	(10)
Corn	4	90
Ulen	(4)	(25)
Oats	9	48
Corn	6	52
Corn silage	2	15.5
Alfalfa	2	2.6
Vallers	(3)	(17)
Corn	4	55
Oats	2	63
Soybean	6	21
Varco	(1)	(6)
Corn	4	88
Alfalfa-brome	2	2.8
Vienna	(2)	(6)
Corn	3	63
Oats	2	60
Wabash	(1)	(4)
Corn	3	109
Wadena	(4)	(18)
Corn	7	76
Soybean	4	21
Oats	3	80
Waukegan	(9)	(36)
Corn	15	78
A-1	7	76
B-1	6	73
Oats	8	81
Alfalfa-brome	3	3.1
Alfalfa	3	2.2
Soybeans	2	33
Waukon	(10)	(38)
Corn	8	59
Oats	7	57
Barley	4	36
Spring wheat	3	30
Alfalfa	9	2.1
Mix. leg.-grass	3	4.1
Webster	(39)	(150)
Corn	69	88
Oats	26	62
Soybeans	16	20
Alfalfa	16	4.1
Alfalfa-brome	9	2.8
Corn silage	5	10.1
Alfalfa-brome past.	2	75
Mix-Leg grass	2	3.2
Webster Calc. Var.	(8)	(36)
Corn	12	89
Oats	3	85
Soybeans	10	34
Alfalfa	4	3.2
Wildwood	(2)	(6)
Oats	2	33
Winger	(4)	(21)
Oats	8	79
Barley	4	42
Spring wheat	4	29
Alfalfa	3	1.6
Zimmerman	(3)	(14)
Corn	3	62
Oats	2	57
Corn silage	3	11.0
Hay (other)	2	10.9

Grand total as of December 1964

No. Fields	No. Yields
530	2120

SOILS AND CROP MANAGEMENT SYSTEMS

Roy L. Thompson, Samuel D. Evans, and Lowell Hanson.

In 1960 an experiment was set up at the West Central Experiment Station to evaluate several crop management practices in combination with one another. Much work has been done on evaluating the individual factors such as fertilizers, varieties, and insect and disease control. It was the purpose of this experiment to apply these practices to different crops and to demonstrate the cumulative effect of the management practices and the economic feasibility of following them.

The experiment was divided into two parts; a management system designated as base which includes the recommended practices currently being used by farmers in the area and a management system designated as test which includes practices which may or may not have shown potentiality for increasing crop production and efficiency. These management systems are applied to continuous corn, soybeans, and alfalfa and to a rotation of oats, hay, soybeans, and corn.

The individual plots and treatments are as follows:

Continuous Soybeans:

Cultural Practice	Base Level	Test Level
Seeding rate	60 lbs./acre	90 lbs./acre
Weed control	3 cultivations	Amiben-Broadcast-3 lbs./
Fertilizer	None	0-45-0 100 pounds/acre
Row width	40 inches	20 inches
Variety	Merit	Merit

Continuous Corn:

Population, plants/acre	14,000-16,000	18,000-20,000
Row width	40 inches	20 inches
Soil insecticide	No	Yes
Fertilizer	8-32-16 80 lbs./acre Nitrogen 40 lbs./acre	8-32-16 160 lbs./acre Nitrogen 100 lbs./acre
Weed control	3 cultivations	Atrazine-Broadcast-3 lbs./acre

Variety	Various Minhybrids	Various Minhybrids
Continuous Alfalfa:	**Base Level**	**Test Level**
Variety and seeding rate	10 lbs. Vernal	10 lbs. Vernal
Fertilizer	0-45-0 100 lbs./acre	0-45-0 200 lbs./acre
Cuttings	2 or 3	2 or 3

The crop was initially established without a companion crop using 2,4-DB and Dalapon for weed control.

Rotation:

Oats (1960)	Base Level	Test Level
Variety and seeding rate	2½ bu. Minton	4 bu. Minton
	8 lbs. Vernal alfalfa	8 lbs. Vernal alfalfa
	3 lbs. Lincoln Brome	3 lbs. Lincoln Brome
Fertilizer	None	9-36-0 280 lbs./acre
		Nitrogen 50 lbs./acre

Harvest for determination of silage yield in addition to grain yield.

Hay (1960)		
Fertilizer	0-45-0 100 lbs./acre	0-45-0 100 lbs./acre

Harvest separate yields obtained from the plots where the oats was removed as silage as well as where oats was taken for grain yields.

Soybeans (1962) - Same treatments as the continuous soybean plots.

Corn (1963) - Same treatment as the continuous corn plots except for weed control. Weeds were hand hoed in the test plots.

Oats (1964) - The 1960 treatments were repeated with the following exceptions:

(1) Garland substituted for Minton

(2) No fertilizer on test plots other than carry-over from the previous crops.

Table 1. Five-Year Yields from Continuous Cropping Systems

	Continuous Soybeans		Continuous Corn		Continuous Alfalfa	
	Base	Test	Base	Test	Base	Test
	Bushels/Acre		Bu/A @ 15% Moisture		Tons/Acre	
1960	16.8	23.1	61.2	70.3	1.4	1.8

1961	20.7	28.4	62.0	65.5	2.2	2.0
1962	21.2	26.4	67.0	87.4	4.8	5.1
1963	23.4	36.7	72.7	73.1	4.9	4.9
1964	15.6	22.1	36.7	34.2	3.0	3.1
Average	19.5	27.3	59.9	66.7	3.3	3.4

Table 2. Five-Year Yields from Rotation Cropping Systems

	Rotation	Base	Test
1960	(Oats) Grain:	86.7 Bu/A	90.0 Bu/A
	Silage:	7.9 T/A (green wt.)	8.2 T/A (green wt.)
1961	(Hay) From grain plots:	1.87 T/A	1.79 T/A
	From silage plots:	2.44 T/A	2.19 T/A
1962	(Soybeans)	24.1 Bu/A	25.6 Bu/A
1963	(Corn)	86.4 Bu/A	113.9 Bu/A
1964	(Oats) Grain:	65.1 Bu/A	94.2 Bu/A
	Silage:	1.14 T/A (dry wt.)	1.76 T/A (dry wt.)

The results of this experiment show that soybeans, corn, and alfalfa have been grown continuously for five years with very few problems. The five-year averages show a 7.8 bushel per acre increase for soybeans grown under the test management system as compared to the base management system. This probably results from both the use of phosphate, narrower rows, and weed control. Soybeans on a different rotation plot on the station have shown an average response of 2.3 bushels per acre to 40 pounds of P_2O_5 over an eight-year period. It would appear that under the conditions of this experiment, there are factors which increased yeild in addition to the fertilizer response. This probably is due to the narrow rows.

Continuous corn grown under the test management system has yielded 6.2 bushels per acre more than under the base management system. The cost of the additional seed, fertilizer, and herbicide is substantial, so it appears that this combination of treatments is not economically feasible. However, this does not mean that one or more of these treatments would prove unprofitable when used alone. Atrazine has

worked fairly well on controlling the weeds in the 20-inch rows. For best results, some means of cultural weed control should also be available to supplement the effects of the chemicals when weather conditions are not favorable for the chemical. Fertilizer rates which are considerably in excess of soil test recommendations may give increased yields but the cost of these increases may exceed their value.

Continuous alfalfa has shown no yield increase under the more intensive test management. It appears that 45 pounds of phosphate is adequate to obtain maximum yields under western Minnesota soil and moisture conditions. The slightly lower yields from the test management alfalfa plots in 1961 may be accounted for by a difference in harvest dates. The first crop of hay was removed from the test plots six days before the base management system. The yield of protein and TDN would have been about equal from both plots because of a higher per cent of protein and TDN from earlier harvest.

Yields from the crops in the rotation have been very good. Comparisons between the continuous cropping system and the rotation system should be made using the yields for a particular year rather than using the five-year average yield for the continuous cropping system.

The oats yields in 1960 show only a slight advantage from the test management system. In 1964 the test system gave a 54 per cent increase in dry matter as silage and a 45 per cent increase in grain yields. It is rather doubtful that the higher seeding rate has as much effect on the yields as the fertility, especially where sufficient seed is used to get a satisfactory stand.

The rotation alfalfa yields in 1961 compared favorably with the continuous croppin system alfalfa. The same cutting dates were used for the rotation alfalfa as the continuous cropping system which may account for the reduced yield under the test system.

Removal of the oats as silage approximately ten days to two weeks before the small grain harvest in 1960 resulted in a considerable increase in hay yields from alfalfa in 1961. Similar results have been observed elsewhere from the early removal

of a companion crop on new alfalfa seedings.

The rotation corn yields in 1963 were extremely good on both the base and test management levels but the test level showed a 27.5 bushel advantage. The difference between the corn grown in the rotation and the continuous cropping corn is substantial. There was no obvious reason for this difference since the corn under either system appeared to be satisfactory. The comparison of corn between the two systems will have to be watched very carefully when they occur together again.

Soybean yields showed little difference between the rotation and continuous cropping systems.

In general there appeared to be little advantage to growing these crops in a rotation. This is true especially when the production is considered from an economic standpoint over the period of time needed to complete a rotation cycle.

No obvious difficulty was encountered due to diseases and insects. With the northward movement of corn rootworm and perhaps some root rots of soybeans, the use of rotations or alternating crops may be more essential. Where soil erosion is a problem, crop rotation with limited cultivated crops is one of the very effective means of control. However, it may be possible to leave the areas most subject to erosion in continuous sod crops while utilizing level land for continuous corn. Where continuous cropping of cultivated crops is followed, careful management to return crop residues should be practiced in order to maintain soil tilth.

The Nicollet County Plots
Soil Fertility and Crop Production Studies on the Webster Soils of Southern Minnesota

W. P. Martin, Fred Wetherill and Henry Kramer.

These long term fertility plots commenced in 1949 have now been conducted for fifteen years and were discontinued with the harvesting of the 1964 crop. The results were first reported in 1957 by C. O. Rost and H. W. Kramer in Minnesota Agricultural Experiment Station Bulletin 438 entitled "Soil Management Studies on the Webster Soils of Southern Minnesota." Later results have been annually reported in the Department of Soil Science "Blue Book" of 1960 through 1964.

Since a terminal report on the entire project will soon be available, the 1964 yields are not reported at this time.

High Fertility - Rosemount

W. P. Martin

Yield results 1964 (For experimental design and past years results see p. 47 in mimeographed "blue book", Feb., 1963 and p. 67, Jan., 1964).

Fertilizer Treatments*	Bu. Per Acre 19,500 Plants	16,500 Plants
1. Check	85.0	94.7
2. H*	98.5	101.0
3. H S1	110.0	103.5
4. H S_2	116.0	117.5
5. B1 H	96.5	96.7
6. B1 H S1	94.5	104.7
7. B1 H S2	99.0	104.7
8. B2 H	101.0	108.5
9. B2 H S1	96.5	106.3
10. B2 H S2	105.0	110.5

* H = 200# 10-20-10 banded starter
S1= 100# 33-0-0 sidedressed
S2= 200# 33-0-0 sidedressed
B1= 400# 6-12-24 broadcest
B2= 800# 6-12-24 broadcast

Killing frost on south one-half of field on August 13 was scattered over rest of plots. Very dry soil conditions were experienced during much of the 1964 growing season which seriously affected the yield data.

LAMBERTON MAXIMUM CORN AND SOYBEAN DEMONSTRATIONS

Wallace Nelson and Lowell Hanson

The 1964 yields of these two demonstrations were down markedly from the 1963 yields because of drought. 1963 Corn yields ranged from 88 to 116 bushels while the 1964 yields were from 43 to 65 bushels. The total May 15 to August 15 rainfall was only 6.6 inches at the Lamberton station.

While the narrow row, fertilized soybeans showed a 12 bushel advantage in 1963, results were considerably different in 1964. The Amiben herbicide treatment was not very effective on the narrow row plot in 1964. Actually, the average 21.7 bushel yield on this plot is surprising in spite of the weed competition and drought.

Corn Demonstration

Treatment	Plot	Yield	Plants/Acre
30,000 - planting rate 300# 8-24-12 500# 0-30-15 200# N	1	42.9	24,636
20,000 - planting rate same fertilizer as above	2	65.4	20,755
15,000 - planting rate No fertilizer	3	34.2	16,220
15,000 planting rate 125# 8-24-12	4	53.8	17,267
20,000 - planting rate Same fertilizer as above	5	44.1	21,017

Soybean Demonstration

Treatment	Yield, bushel/acre
40 inch row 60 lbs. seed per acre No fertilizer	22.0
18 inch row 120 lbs. seed per acre 200 lbs. 8-24-12, planter attach 200 lbs. 0-30-15, broadcast	21.7

Fertility Experiment on Alfalfa

Morrison Co. Pierz, Minn., 1964.

Merle Halverson, Lowell Hanson, Curtis Overdahl

Apparent effects of nitrogen, lime, phosphorus, and potassium on 1964 first and second cutting forage yields of Vernal alfalfa. Joe and Roderick Boser Farm, Pierz (Morrison County) Minnesota. The soil is Brainerd sandy loam, pH 6.4, P 19 (med), K 70 (low).

		Cuttings 1st	2nd	Both
Check yield, tons/acre forage at 20 percent moisture*		0.77	0.65	1.42
Forage yield inc. (tons/acre) due to:				
(a.) lime broadcast and disced in before seeding at:	2.5 tons/acre	0.15	0.09	0.24
	5.0 tons/acre	0.28	0.11	0.39
(b.) nitrogen topdressed spring '64	40 lb/acre	0.02	0.00	0.02
(c.) phosphorus broadcast and disced in before seeding at:	30 lb P_2O_5/acre	0.10	0.20	0.30
	60 lb P_2O_5/acre	0.24	0.21	0.45
(d.) Potassium broadcast and disced in before seeding at:	60 lb K_2O/acre	0.29	0.12	0.41
	120 lb K_2O/acre	0.32	0.15	0.47
	180 lb K_2O/acre	0.26	0.13	0.39
	240 lb K_2O/acre	0.40	0.31	0.71

* Entire area, including check, received 300 lb/acre gypsum and 4.5 lb/acre boron.

NPK - RATE STUDY WITH CORN ON SANDY SOILS - 1964

John Grava

Three corn fertilization trials were conducted in Anoka, Benton and Isanti Counties in 1964. Each experiment consisted of 12 treatments, replicated five times, for a total of 60 plots. The fertilizer treatments consisted of four nitrogen rates: 10, 60 110 and 160 lb./A. N, applied with 32 lb./A. P_2O_5 and 96 lb./A. K_2O. Base rate of 10 lb./A. N was applied in row, and the 50, 100 and 150 increments were broadcast and disked in prior to planting. Phosphorus rates included 0, 16, 32 and 64 lb./A. P_2O_5 used with 110 lb./A. N and 96 lb./A. K_2O. All phosphorus was row applied. Potassium treatments consisted of: 0, 24, 48, 96 and 192 lb./A. K_2O used with 110 lb./A. N and 32 lb./A. P_2O_5. All potassium, up to the 96 pound rate was applied in row, half of the potassium of the 192 pound rate was broadcast and disked in. The applications of starter fertilizer were made with a belt applicator and placed with a disk-type planter attachment, two inches below and two inches aside the seed. Each individual plot was 25 feet long and four-40 inch rows wide.

A 95-day corn variety was planted on May 21-23 by hill dropping. Atrazine was applied pre-emergence and the corn was cultivated once. The corn was thinned to a uniform stand of 16,000 plants per acre. The sixth corn leaf was randomly sampled from eight representative plants from the two border rows of each plot at silking time. Oven-dry leaf samples were ground and analyzed for total N, P and K. Yields were determined by harvesting ears from 40 plants from the two middle rows of each plot. Moisture in the ears at harvest was determined in five representative ears from each treatment after drying for seven days at 65° C.

Soil tests (Table 1) indicated low organic matter content, medium to very high phosphorus availability and very low to medium levels of potassium. The preceding crops in 1963 on experimental sites were as follows: Expt. 1, and old, grass and weed infested stand of alfalfa; Expt. 2, corn receiving 45 + 15 + 45 pounds per acre of nutrients and yielding about 70 Bu./A.; Expt. 3, soybeans fertilized with 90 lb./A. of K_2O and yielding about 25 Bu./A.

Table 1. Soil Test Results.

Expt. No.	Location	Soil Type	pH	Organic Matter %	Extractable P lbs./A.	Exchangeable K lbs./A.
1	F. Carlson, Isanti Co.	Anoka lvfs	6.1	1.6	76	155
2	A. Sorteberg, Anoka Co.	Hubbard s	5.9	2.2	30	100
3	D. Stumvoll, Benton Co.	Milaca l	6.6	2.9	17	55

Corn growth was affected by drought at all three locations. Most severely stricken by drought were the experiments (2 and 3) in Anoka and Benton Counties. Available soil water and rainfall data are given in Table 2. Lack of moisture caused poor germination and development of corn in Expt. 3 in Benton County. Corn was only knee to waist high on July 27. A large portion of the corn plants were tasseled out but with no silks visible. Consequently, no ears were developed and the experiment was abandoned. The corn on Expt. 2 in Anoka County also suffered from drought, especially at tasseling and silking time. Corn plants in the 110 + 32 + 96 treatment plots had about 80% nubbins and yielded only 10 bushels per acre.

Table 2. Available soil water and rainfall data of experimental fields.

Expt. No.	County	Available Water in Soil at Planting[1] Inches	% of Maximum	Rainfall June and July Inches	% of Normal
1	Isanti	8.8	100	7.6[2]	93
2	Anoka	1.6	44	3.0	39
3	Benton	5.3	66	3.0	39

[1] In a 5-foot profile

[2] Including: 2.5 inches received on June 23 and
3.3 inches received on July 9

The moisture supply was adequate at planting time on experimental site No. 1 in Isanti County. About 7.5 inches of rainfall (93% of normal) were received at this location during June and July. However, 5.8 inches of that amount came down in two major downpours, and might have been partially lost by runoff. There was only a slight curling on corn leaves observed at silking time. However, yield measurements and nubbin counts at harvest time indicated that corn had been affected by lack of moisture even at this location. The damage was more serious in some replications than in others. For example, Replication 5, with the least damage, had only 10% nubbins and 81 Bu./A. average yield. In contrast, 48% of nubbins and only a 38 Bu./A. average yield were obtained in Replication 2.

The effects of fertilizer applications on corn yield, as well as the percentage of nubbins on the Anoka lvf sand in Isanti County, are shown in Tables 3, 4 and 5.

While nitrogen applications above the base rate of 10 lb./A. did result in more nubbins, the yield responses were slight and inconclusive. Potassium applied to this soil, with a 155 pound K test, had no effect on corn yields or the percentage of nubbins. The most striking effects in corn on the Anoka soil were obtained from phosphorus treatments. The application of 16 lb./A. P_2O_5 increased corn yield by 20 Bu./A. over the no phosphorus treatment. This rate also decreased the number of nubbins. However, higher phosphorus treatments, especially the 64 lb./A.

Table 3. Effect of nitrogen fertilization on the yield of corn. Anoka loamy very fine sand, Isanti County 1964.

Rate of Nitrogen[1] (N)	Shelled Corn[2] At 15.5% Moisture	Nubbins
Lb./A.	Bu./A.	%
10	60	16
60	50	34
110	60	25
160	53	37

[1] Base rate of fertilizer: 10 + 32 + 96 row; 50, 100 or 150 lb./A. N above base rate was broadcast.

[2] Averages of five replications.

Table 4. Effect of phosphorus fertilization on the yield of corn. Anoka loamy very fine loamy sand, Isanti County 1964.

Rate of Phosphorus (P_2O_5)	Shelled Corn At 15.5% Moisture	Nubbins
Lb./A.	Bu./A.	%
0	48	38
16	68	21
32	60	25
64	40	44

Base rate of fertilizer: 10 + 0 + 96 row
100 lb./A. N broadcast

Table 5. Effect of potassium fertilization on the yield of corn. Anoka loamy very fine sand, Isanti County 1964.

Rate of Potassium[1] K_2O	Shelled Corn At 15.5% Moisture	Nubbins
Lb./A.	Bu./A.	%
0	57	24
24	56	31
48	58	28
96	60	25
196	55	33

[1] Base rate of fertilizer: 10 + 32 + 0 row, and 100 lb./A. N broadcast. All potassium was row applied, except 96 lb./A. K_2O broadcast application in highest rate.

rate, increased the percentage of nubbins and resulted in substantially lower yields.

The effects of fertilization on chemical composition of corn leaves collected from the Isanti and Anoka County experiments are shown in Tables 6 and 7.

Table 6. Effect of fertilization on the N, P and K content of sixth corn leaf at silking time.
Anoka loamy very fine sand, Isanti County 1964.

Treatment No.	Nutrients Applied	N	P In Corn Leaf	K
	Lb./A.	%	%	%
1	110 + 32 + 0	2.82	.298	1.28
2	110 + 32 + 24	2.78	.309	1.89
3	110 + 32 + 48	2.88	.301	2.28
4	110 + 32 + 96	2.98	.320	2.30
5	110 + 32 + 192	3.10	.315	2.42
6	10 + 32 + 96	2.26	.255	2.75
7	60 + 32 + 96	2.77	.294	2.67
8	160 + 32 + 96	3.04	.291	2.42
9	110 + 0 + 96	3.09	.302	2.68
10	110 + 16 + 96	2.75	.309	2.46
11	110 + 64 + 96	2.86	.305	2.41
12	None	2.14	.258	2.12

The nitrogen content in the sixth corn leaf at silking time was increased by nitrogen treatments from 2.26 to 3.04 on Anoka loamy very fine sand and from 2.30 to 2.88% N on Hubbard sand. Nitrogen deficiencies in corn also were observed in 10 and 60 lb./A. N treatment plots on the Anoka soil. Deficiency symptoms were eliminated by the application of 110 lb./A. of N, the average N content in the sixth corn leaf of this latter treatment was 2.98%.

Corn leaves from no phosphorus treatments but with adequate nitrogen contained about 0.300% P. Additions of phosphorus increased the P content in corn leaf only slightly. However, fertilization with nitrogen had a most striking effect on the phosphorus content in corn leaf on Anoka soil (Table 6; Treatment No. 6, 7 and 4). Leaves from the 10, 60 and 110 lb./A. N treatments had P content of 0.255, 0.294 and 0.320, respectively. These data would indicate that applications of nitrogen increased the absorption of phosphorus by corn from the fertilizer source, and probably even more so from the soil.

Table 7. Effect of fertilization on the N, P and K content of sixth corn leaf at silking time.
Hubbard sand, Anoka County 1964.

Treatment No.	Nutrients Applied	N	P	K
		In Corn Leaf		
	Lb./A.	%	%	%
1	110 + 32 + 0	2.67	.281	1.12
2	110 + 32 + 24	2.77	.306	1.65
3	110 + 32 + 48	2.72	.314	2.12
4	110 + 32 + 96	2.73	.306	2.33
5	110 + 32 + 192	2.74	.313	2.26
6	10 + 32 + 96	2.30	.300	2.45
7	60 + 32 + 96	2.69	.304	2.40
8	160 + 32 + 96	2.88	.304	2.29
9	110 + 0 + 96	2.76	.298	2.22
10	110 + 16 + 96	2.78	.306	2.39
11	110 + 64 + 96	2.74	.317	2.31
12	None	2.33	.290	1.68

The potassium contents in corn leaf from no potassium treatments on the Hubbard and Anoka soils were 1.12 and 1.28% K, respectively. Fertilization with 48 lb./A. K_2O increased the content of leaf K to 2.12 on the Hubbard sand and to 2.28% on the Anoka soil.

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ROSEMOUNT SOILS FARM
Rosemount Agricultural Experiment Station
1964
Paul M. Burson and E. G. Bonnell

It was thought that 1963 had the most extreme and critical moisture conditions in the history of the Rosemount station. However, 1964 was much more critical than 1963. During May of 1964 there was a total of 5.22 inches of rain. In the early part of June there was another 2.84 inches but these rains came with such high intensity that resulted in such excessive runoff that they were of little value.

For example, on June 19th there was .90 inches in 20 minutes and again on June 22 there was .35 inches in 10 minutes with the same amount again on June 23.

Because of these high intensity rains at no time since the soils farm was established has the erosion been so severe. The severe drought conditions actually started June 24th. From June 24th to July 24th there was only 1.17 inches of rainfall. From July 24th to August 20th there was another .51 inches making a total of only 1.68 inches from June 24th to August 20th. Because of these drought conditions trial results were very poor. A number of trial plots did not produce enough to harvest. It was of interest to observe that the fields that had the most top soil remaining were not so severely injured from the dry weather as those areas where all or most of the top soil had been eroded away before the Rosemount Experiment Station was established. Much less drought damage occurred on the finer textured soils higher in clay content as compared to the more upland soils of medium texture that had been subjected to erosion years before. It was generally observed in 1964 that where a consistant fertilizer program was in existance the hazards of drought were greatly reduced as reflected in the crop yields of the check as compared to the fertilized yields. Many barren corn stalks were universal in 1964.

The Effect of Pasture Fertility and Management on Beef Production
1964
P. M. Burson, Soils; A. R. Schmid, Agronomy;
A. L. Harvey, and O. E. Kolari; Animal Husbandry.

On May 13, 1964, light weight "good to choice" Angus steer calves were lotted as uniformly as possible and turned onto pasture. Pasture E was renovated and seeded in 1962. Prior to 1962 one-half of each pasture was fertilized and the other one-half not fertilized. Beginning in 1962 all of the pasture area was fertilized except for a 2 rod strip adjacent to the center fence in the original unfertilized area. On this area a basic treatment of 500 lbs. per acre of 0-20-20, according to soil test, was applied at the time of renovation. No other treatment will be made until it is renovated again. On the original fertilized area the usual annual application of 200 lbs. per acre of 0-20-20 was made.

Because of the severe drought the 1964 pasture season was only 79 days long as compared to 112 days in 1963. However, the smaller Angus steer calves produced almost as much beef in the shorter grazing period as compared to the heavier Holstein steers in 1963. In 1963 the Holstein steers produced 354 lbs. of beef in 112 days while the Angus steers produced 342 lbs. in only 79 days. However, the total steer-days were 1207 in 1964 compared to 1057 in 1963. In terms of steer-days per acre it was 155 days in 1964 and only 136 days in 1963.

A 4 pasture rotation grazing system was used in 1964 with 1.9 acres in each pasture. The gross value of beef produced per acre was $71.82 in 1964 as compared to $63.72 per acre in 1963. Often the costs for lime, fertilizer, seed and tillage changes were deducted the net value of beef was $59.93 or $8.10 per acre more than in 1963. In 1964 the beef produced per acre was $37.04 on the check or $22.89 more beef produced per acre on the fertilized pastures. See annual report September 24, 1964.

Beef Production from Renovated and Fertilized Grass Pastures. 1964

A. R. Schmid, Agronomy; P. M. Burson, Soils; A. L. Harvey and O. E. Kolari, Animal Husbandry

Four types of pastures were compared on G pastures consisting of grass with no fertilizer, grass with 8 tons of manure per acre applied annually the fall before, grass with 80 lbs. of N per acre applied in early spring and early June and in split applications in April or June and July and renovated pastures. All pastures except the check received an annual spring application of 0-40-40. In 1964 after all costs for lime, fertilizer, seed and tillage costs were deducted the net return in term of beef was highest for manure of $59.01 per acre, nitrogen $54.81 per acre, renovated $49.22 per acre and the check $37.04 per acre.

The three year average not return per acre for 1962, 1963 and 1964 is as follows: check $43.03, manure $60.92, N $61.92 and renovation $62.47.

Plowing Vs Field Cultivator in Preparation of Soybean Land for Corn. 1964

Paul M. Burson and E. G. Bonnell

The problem has been raised by farmers in southern and western Minnesota about the blowing and washing of land that the previous year had grown soybeans. A common cropping system is the alternating from year to year of corn and soybeans. Some farmers claim they are eliminating this erosion problem by preparing the soybean land for corn with a field cultivator instead of plowing. This type of cropping system is being used on some fields on the soils farm at Rosemount. In 1964 plowing and field cultivating seedbeds were compared for corn following the growing of soybeans in 1963. The field cultivation consisted of three trips over the field tilled about 10 to 12 inches deep. The three trips over the field were about equal in time to a single operation of plowing. The 1964 corn yields are as follows:

Fertilizer Treatments	Bushels per acre Plowing	Field cultivator
Check	83.0	80.0
Residual starter (RS)	72.0	76.0
RS + starter(1)	72.5	72.5
RS + starter + 80#N(2)	90.0	92.5

(1) 4-12-24 banded
(2) 80# N sidedressed at 1st cultivation
Final stand 18,000 plants per acre