Lab No.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg me/l	Ca me/l	Mg me/l	Na me/l	K me/l	Cl ppm	SO_4 ppm *
				More Normal Flax								
	(29)											
122	Carl Gunkle	0-6	0.9	8.3	22	3	3	-	3.0	0.2	3	36
123	Norman Co.	6-12	0.8	8.5	32	7	2	5	1.6	tr	3	32
124	Ada (8S, 2W)	12-24	2.6	8.7	35	20	3	17	14.8	0.1	4	41
125	Bearden silt loam	24-36	6.0	8.6	28	31	4	27	38.7	0.1	3	108
				Chlorotic Flax								
126	Glyndon silt loam	0-6	1.2	8.4	20	10	3	7	3.7	0.1	9	239
127		6-12	1.1	8.7	21	9	3	6	2.7	0.1	6	23
128		12-24	3.5	8.8	33	34	6	28	14.8	0.1	2	158
129		24-36	8.0	8.6	35	82	12	70	50.1	0.1	4	383
				More Normal Flax								
	(30)											
100	M. Skang	0-6	1.4	7.9	20	23	5	18	3.4	0.1	24	50
100A	W. Polk Co.	6-12	1.6	8.1	20	11	3	8	5.9	tr	12	480
101	Beltrami (2E, 1N)	12-24	2.2	8.4	26	23	4	19	11.7	tr	1	68
102	Glyndon silt loam	24-36	3.8	8.3	27	44	13	31	16.4	tr	3	113
				Chlorotic Flax								
103	Glyndon silt loam	0-6	1.1	8.1	16	12	3	9	2.5	0.2	2	32
104		6-12	0.9	8.2	18	8	3	5	4.1	tr	2	23
105		12-24	1.7	8.4	25	14	3	11	9.6	tr	3	32
106		24-36	1.7	8.4	17	11	2	9	12.6	tr	1	104
				Normal Flax								
	(31)											
92	Ole Ronningen	0-6	0.5	7.8	23	6	2	4	0.9	0.1	1	383
93	W. Polk Co.	6-12	0.4	8.1	34	6	1	5	1.2	tr	1	14
94	Beltrami (1S, 10W)	12-24	1.6	8.1	34	27	4	23	6.6	0.1	1	45
95	Bearden silty clay loam	24-36	3.6	8.2	25	53	16	37	10.3	0.1	1	567

Lab No.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg me/l	Ca me/l	Mg me/l	Na me/l	K me/l	Cl ppm	SO_4 ppm *
					Chlorotic Flax							
96	Hegne Silty	0-6	0.8	8.0	12	12	5	7	0.8	0.1	1	27
97	Clay	6-12	0.7	7.8	11	11	4	7	0.8	0.1	1	14
98		12-24	0.3	8.0	7	11	4	7	1.4	0.1	1	9
99		24-36	3.0	8.0	6	42	20	22	5.7	4.5	6	72
84	Penningroth Farm	0-6	1.0	7.7	3	13	3	10	2.3	0.2	15	312
85	W. Polk County	6-12	1.3	8.7	3	12	3	9	3.0	0.1	125	14
86	15 S.E. Crookston	12-24	1.8	7.9	24	18	8	10	4.8	tr	9	54
87	Kittson Loam	24-36	1.8	8.2	38	18	8	10	5.0	tr	4	113
					Chlorotic Flax							
88		0-6	1.4	8.0	12	15	6	10	6.2	0.2	6	32
89		6-12	2.5	8.3	23	25	6	19	11.9	tr	4	162
90		12-24	5.5	8.2	18	65	21	44	19.7	0.2	15	284
91		24-36	5.5	7.8	25	58	18	41	41.0	0.1	4	32
					Normal Soil							
164	Arnold Stonberg	0-6	3.2	7.7	13	34	26	8	2.7	0.6	46	525
165	Polk County	6-12	2.8	7.5	10	33	24	10	2.1	0.1	31	1695
166	Oklee (3E)	12-24	2.9	7.2	14	34	23	11	2.5	0.3	46	1125
167	Rocksbury	24-36	3.0	7.4	15	36	23	13	2.5	0.3	31	825
					Soluble Salt Condition							
168	Rocksbury	0-6	8.0	7.9	20	83	18	63	28.4	1.8	46	1080
169		6-12	6.0	8.0	24	75	19	56	20.9	0.3	31	675
170		12-24	6.3	7.8	24	74	16	58	23.6	0.3	31	428
171		24-36	6.0	7.8	21	62	15	47	24.5	0.5	31	248

Lab No.	Farm operator county & reference no	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg me/l	Ca me/l	Mg me/l	Na me/l	K me/l	Cl ppm	SO_4 ppm *
					Chlorotic Flax							
32	Richard Field	0-6	1.3	8.0	18	25	5	20	3.0	0.1	31	338
33	Marshall County	6-12	2.9	8.2	28	13	3	10	3.0	0.1	31	72
34	9NE of Stephan	12-24	4.0	7.9	24	38	4	34	7.1	0.1	60	167
35	Bearden Silt loam	24-36	3.8	8.0	33	60	10	50	8.7	0.3	96	324
					More Normal Flax							
36	Fargo	0-6	0.5	7.3	4	3	tr	3	2.5	0.2	12	27
37	Clay	6-12	0.3	7.5	6	2	tr	2	2.0	tr	15	36
38		12-24	0.7	7.8	7	5	1	4	7.3	tr	60	32
39		24-36	3.4	7.8	4	22	7	15	18.5	0.2	280	234
					Poor Potatoes							
24	Ole Johnson	0-6	6.0	8.1	6	74	29	45	27.2	0.2	330	743
25	Marshall County	6-12	8.5	8.3	8	94	29	64	38.5	0.2	500	900
26	11NE of Stephen	12-24	10.0	8.6	53	118	16	102	44.2	0.1	820	518
27	Bearden Silt Loam	24-36	15.0	8.6	41	144	17	127	56.3	0.1	920	675
					Good Potatoes							
28	Bearden	0-6	0.6	8.4	6	6	1	4	1.9	0.1	38	99
29	Silt Loam	6-12	0.7	8.4	8	7	1	5	2.5	0.1	45	45
30		12-24	1.4	8.6	27	11	1	11	11.7	tr	230	45
31		24-36	2.3	8.7	32	26	1	25	13.5	0.1	230	104
					Good Wheat Growth (Durum)							
40	Erlandson Bros	0-6	4.0	7.1	4	24	16	8	18.9	0.8	570	54
40A	Kittson County	6-12	5.8	7.6	4	30	8	22	33.9	1.3	820	113
41	4.5 SE of Kennedy	12-24	13.4	7.5	14	81	32	49	54.5	0.1	1320	540
42	Fargo Clay	24-36	14.0	7.7	10	89	36	53	56.3	0.1	2220	698

Lab No.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg me/l	Ca me/l	Mg me/l	Na me/l	K me/l	Cl ppm	SO4 ppm *
					Bare Spot in Wheat							
43	Fargo	0-6	21.0	7.1	5	182	100	82	66.3	1.0	3960	383
44	Clay	6-12	27.0	7.2	6	180	100	80	65.0	0.1	3960	270
45		12-24	21.0	7.6	11	144	76	68	65.1	0.1	3000	675
46		24-36	18.0	7.4	13	132	71	61	62.3	0.2	2760	216
					Bare Spot in Oat Field							
47	Kittson County Fargo-Clay	12-24	16.0	7.6	14	139	79	50	38.5	0.1	2000	234
					Normal Flax							
48	A. V. Hunt	0-6	0.5	7.3	3	4	1	3	0.9	0.1	19	18
49	Kittson County	6-12	0.2	7.4	2	3	1	2	0.9	0.1	15	14
50	3/4 NE of Hallock	12-24	0.3	7.7	2	2	1	1	2.5	tr	38	9
51	Fargo Clay	24-36	0.8	7.9	13	6	2	4	4.6	0.1	19	37
					Chlorotic Flax							
52	Hegne Clay	0-6	0.4	8.3	9	4	1	3	1.4	0.1	4	14
53		6-12	0.3	8.2	9	4	1	3	1.1	tr	12	14
54		12-24	0.4	8.5	21	3	1	2	3.9	tr	12	18
55		24-36	0.8	8.3	20	4	1	3	7.8	tr	31	36
					Good Wheat							
56	Bill Moore	Not Compacted	9.5	7.7	13	76	38	38	22.4	0.1	1000	119
57	Kittson County	6-12	2.5	7.7	9	17	4	13	11.6	tr	500	18
58	8 NW of Hallock Fargo-Clay	12-24	5.5	7.8	16	43	17	26	18.9	0.2	820	99

Lab. No.	Farm operator county & refrerence no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg me/l	Ca me/l	Mg me/l	Na me/l	K me/l	Cl ppm	SO_4* ppm
					Good Oats							
59	Fargo Clay	0-6	1.9	7.5	5	14	3	11	8.2	0.1	378	4
					Large Bare Spot							
60		0-6	8.0	7.6	5	70	41	29	16.9	0.3	1000	89
61		6-12	16.0	7.4	6	133	68	65	31.6	0.1	2460	225
62	Compacted	0-6	17.0	6.9	5	146	95	51	30.8	0.6	2760	135
63	Fargo Clay	6-12	17.0	7.4	5	145	92	53	34.4	1.3	2760	113
64		24-36	16.0	7.6	14	142	85	57	34.8	0.2	2760	90

*Sulphates determined on a 1:5 Soil Solution ratio all other elements were determined on saturation extracts

Site 1 Steffler Rock County	Salinity is not a problem on these sites. The soil where good growth occurs is actually acid.
Site 2 Leanus Nelson Watonwan Co.	Soluble salts are not a problem here, but where chlorosis occured the less soluble carbonates (20%) are high enough to be a problem.
Site 3 D. Jacoby Watonwan Co.	Soluble salts are not a problem on these sites. The level of carbonates (16%) found is apparently sufficient to induce chlorosis.
Site 4 M. Regnier Cottonwood Co. Mountain Lake	The soluble salts are low and not a problem here. The primary difference between the normal growth and the chlorotic sites, is in the level of carbonates. The normal site has a 4 to 7% $CaCO_3$ equivalent, whereas the chlorotic site has 20 to 26% $CaCO_3$ equivalent.
Site 5 Duane Smith Murray Co. Walnut Grove	The soluble salts on the site were the corn germinated but failed to grow are not high enough to kill established plants. Under certain moisture stress and at certain soil temperatures, conditions may have existed where such levels of salts were able to kill young seedlings. The salts may also have been at a higher concentration at the time of germination as compared to the time the soils were sampled. The soluble salts in the poor growth site for corn and alfalfa are only moderate (3%), but coupled with the carbonates present (16-22%) a situation exists where fertility problems may occur.
Site 6 Harvey Wahl Murray Co. Currie	The carbonate level on the poor growth site is 11 to 16% $CaCO_3$ equivalent and 2 to 10% on the good growth site. The conductivities for the poor growth site III are approaching a critical level, 3.6 mmhos, for sensitive crops. The problem here is most likely one of fertility caused by the higher carbonates.
Site 7 Ed Onken Murray Co. Lake Wilson	A reason for the corn not surviving in the fallow site cannot be found in the analysis. The possibility of disease or nematode infestation may exist.
Site 8 Bert Jacoby Redwood Co. Morgan	The dead and damaged soybean sites are both low in soluble salts, but the $CaCO_3$ equivalent is 16 to 21%. The normal soybean site has a somewhat lower carbonate level, but it seems doubtful if this small difference would cause the beans to die in one area and not the other. Soil moisture at time of sampling from the site of the dead soybeans was 90% wetter than where the normal beans were growing. The site that had damaged beans the previous year was 30% wetter than where normal growth occurred. It therefore appears that soil wetness was the contributing factor.

Site 9 Cyril Iffert Redwood Co. Belview	The concentration of soluble salts and the less soluble carbonates were twice as high on the short corn site. Soil moisture may also have had an influence. The soil from the short corn site was 35 to 63% wetter than the soil where growth was normal.
Site 10 K. Jacobson Redwood Co. Lamberton	The problem on this site is not due to soluble salts. Carbonates ordinarily do not cause much of a problem at the level found here (10%), but along with some other adverse physical or chemical factor its influence may be significant.
Site 11 Harold E. Cooper Lyon County Tracy	High soluble salts as reflected by the conductivities is likely the problem here. The conductivity is 4.6 to 10.5 mmhos on the problem site and less than 1 mmho where no problem exists. Carbonates are very low.
Site 12 J. Van Overbeke Lyon Co. Marshall	The poor growth of corn and oats can be attributed to the high level of soluble salts. The carbonate levels (11 to 15%) were about the same for the problem and non-problem sites.
Site 13 D. Fruechte Lincoln Co. Verdi	The problem is other than salinity. This soil is actually acid.
Site 14 Yel. Med. Co. Verdi	The carbonates are very high (20%+) on both the normal and poor corn sites. Although the conductivity is somewhat higher where poor growth occurred, it is unlikely that this difference alone would be the cause. There may be a fertility problem caused by the carbonates, and having a more pronounced effect on the one site.
Site 15 John Zimmer Chippewa Co. Clara City	The poor corn growth in site I compared to II appears to be a reflection of higher soluble salts. Sodium sulphates are very high in the 0-12" depth with magnesium sulphates the highest in the 12 to 24" depth. On site II the corn did well even in the presence of 30% $CaCO_3$ equivalent,but the high soluble salt concentration was at a lower depth which may account for the difference. In comparing site III against IV, site III showing poor growth was very high in carbonates, 36% $CaCO_3$ equivalent in the 6 to 12" depth. This level of carbonates along with the higher soluble salts is sufficient to be detrimental.
Site 16 M. Gustafson Chippewa Co.	It is suprising that soybeans were not affected at site II under the high soluble salt condition found (about 5 mmhos). The data for the site where the beans died and where they were normal is very similar. Soil moisture at 6 to 12" was 33% greater where poor growth occurred. The possibility of toxicity from an element such as boron cannot be ruled out.

Site 17 Bernie Bosch Chippewa Co. Montevideo	Why the soybeans died on one site and recovered completely on another having a similar salt level is puzzling. Again toxicity by an element like boron could be the cause of the dead beans. The soil moisture where the beans died was 26% greater than where they fully recovered. This may be in part due to the fact that transpirational losses of moisture are not occuring where the beans had died.
Site 18 Paul Wager Lac Qui Parle Co. Dawson	The poor growth of corn on this site is likely the result of the high level of soluble salts as reflected by the conductivities. Because the carbonates are low and sodium is high there may exist an undesirable level of exchangeable sodium. The result would be a dispersed and puddled soil with poor aeration and impeded drainage.
Site 19 Wayne Glasser Lac Qui Parle Co. Bellingham	Although the better growth site for corn is higher in carbonates than the poor site, the latter is very high in soluble salts. Where normal growth occurred, there is a very high amount of carbonates, 48% $CaCO_3$ equivalent, in the 24 to 36" depth. Why this high level of carbonates didn't affect growth may be because it occurs below the rooting depth, since this is a poorly drained soil with a high water table. The high level of sodium present in the poor growth site may also have resulted in deterioration of soil structure resulting in poor aeration and drainage.
Site 20 Dave Hughes Swift County Danvers	Similar high conductivities were found for site I and III having poor corn growth, and site IV having normal growth. If high soluble salts was the cause of poor growth on sites I and III, then why didn't similar concentrations affect site IV. It may be that a plant growing under these high levels of osmotic tension and high sodium is easily affected beneficially or detrimentally, by small changes in other chemical or environmental factors.
Site 21 J. Torgelson Swift Co. Danvers	The normal growth of soybeans occurred on a site that is at a critical level of soluble salts (4 to 5 mmhos) and carbonates (16%) for the development of chlorosis. The site where the soybeans died was higher in soluble salts as shown by the conductivities (6 to 6.5 mmhos). The large amount of sodium present where the beans died may also have an effect on soil aeration and drainage. All these factors together could be sufficient to kill the beans especially in the early growth stage.
Site 22 F. Kohler Big Stone Co. Ortonville	The situation here is similar to that on the J. Torgelson farm in Swift Co. Conductivities of 3 to 5 mmhos show an effect on the beans but when they went above 6 mmhos its influence was realized. The level of carbonates (10% or less) was about the same for all sites.

Site 23 G. Jacobs Traverse Co. Dumont	Total soluble salts as reflected by the conductivities are very high in the chlorotic sites, 9 - 17 mmhos compared to 2 - 4 mmhos in the non-chlorotic sites. Carbonates were very low in chlorotic site I and very high in the normal site II, but because this high level occurs below 12 inches the majority of the root may have remained above and therefore not affected by the carbonates.
Site 24 Verdi Stonburg Farm Grant Co. Herman	The relatively high conductivity of the soil on which the chlorotic soybeans were growing along with high sodium (Na) and sulfate (SO_4) content indicates that soluble salt concentrations are the probable cause of the unhealthy soybean growth. Even the more normally growing soybean growth is probably affected to some degree by soluble salts present.
Site 25 Fred Larson Farm Clay Co,3N,1E Glyndon	This farm soil was sampled in 1965 (Site 23, pp. 37,38 1966 Bluebook) and the results obtained were the reverse of the expected pattern. The soils of the 1966 sampling show the same results with the more normal flax growth showing a much higher conductivity (soluble salt content and higher sulfate (SO_4) content than the chlorotic flax of the other two profiles.) The analyses of all three profiles would indicate soluble salt problems precluding normal flax growth.
Site 26 Norman Co. 2 mi. W of Syre	The soluble salt content (indicated by electrical conductivity) is not especially high in either soil, but apparently soluble sodium (Na) is relatively high in the problem soil (especially in the subsoil) which would seriously affect soybean growth.
Site 27 Fred Krebs Farm Norman Co Borup	Here the more normally growing soybeans are growing in a soil higher in soluble salt content than the chlorotic soybeans. The analyses shown do not explain (as in Site 24) why soybeans were more chlorotic with lower soluble salts.
Site 28 Joe Torvestad Farm Norman Co.	The indicated soluble salt content (electrical conductivity) would suggest that both sets of soybeans would have difficulty in growing normally, since salts at this level would be limiting and soil water and aeration could cause differences in growth.
Site 29 Carl Gunkle Farm Norman Co.	The soluble salt content of both of these soils is moderate, but the Na content of both could contribute to poor growth - along with the higher sulfate content where the chlorotic flax is growing.
Site 30 M. Skang Farm W. Polk Co.	Here the more normal growing flax actually has a higher salt content in the soil than where the chlorotic flax was growing. It is evident that the soil analyses conducted do not show why chlorotic flax growth developed.

Site 31 Ole Romningen Farm W. Polk Co.	Here again the soluble salt content is not high, and the cause of chlorotic growth is not evident from the soil analyses.
Site 32 Penningroth Farm W. Polk Co.	On this farm the flax was extremely chlorotic, which could be attributed to the high soluble salt content as shown by conductivity, Na and SO_4 content, as well as by the high $CaCO_3$ equivalent.
Site 33 Arnold Stonberg Polk Co.	The soluble salt content of this soil is very high (especially Na salts) and could be expected to seriously affect plant growth.
Site 34 Richard Field Farm Marshall Co.	The soluble salts in the soil indicated by electrical conductivity and also the $CaCO_3$ content (equivalent) of the chlorotic growth area would normally cause growth problems of susceptible crops such as flax.
Site 35 Ole Johnson Farm Marshall Co.	The soluble salt content (indicated by the electrical conductivity) containing a high proportion of sodium (Na) and sulfate (SO_4) would be expected to seriously affect potato plant development.
Site 36 Erlandson Bros. Kittson Co.	These analyses indicate the high resistance of durum wheat to soluble salt effect in the soil. However, the extremely high conductivity of the bare soils in the wheat and oat fields would be expected with the high sodium (Na) chlorides (Cl) and sulfates (SO_4), with a relatively low lime ($CaCO_3$ equivalent) content.
Site 37 A.V. Hunt Farm Kittson Co.	There was little difference in the soluble salt content of these two soils and the chlorosis may have developed from the higher lime content ($CaCO_3$ equivalent) or aeration differences of the Hegne clay.
Site 38 Bill Moore Farm Kittson Co.	Small grains are relatively resistant to soluble salts in the soil as shown by the high conductivities (soluble salt indicator) of the wheat and oat fields. The bare and compacted areas apparently contain salts in sufficient concentrations to preclude even small grain production.

Seasonal Variations in Soil Salt Concentrations

A study was made of possible changes in soil salt concentrations during the 1966 growing seasons. Three known problem soils were selected (one near Ghent in Lyon county, one near Porter in Yellow Medicine county, and one east of Montevideo in Chippewa county--marked A, B, and C respectively on the accompanying map--and sampled about the 20th of each month, commencing in May. The analytical results including schematics (figure (A), (B) and (C)) of the electrical conductivities are shown on the following pages.

The two sites on the Maurice Regnier farm show contrasting patterns of salt movement (figure A). The salts in the surface of site I were at their highest concentration in the May sampling and continued to decrease through June and July followed by an increase in the subsurface in August. The salts in the surface of site II were at their lowest in May with a large increase in June and followed by a drop in July. The pattern of movement in the 24 to 36" depth was just the opposite of the surface. It therefore appears that during the time interval from May 20 to June 20, soluble salts moved from the lower depths to the surface. Between the June and July samplings the salts moved downward out of the surface to the lower depths. Another visit to these sites to determine their proximity to tile lines and position in the micro-relief may suggest reasons for the differing patterns.

The surface six inches in site I on the Wollum farm (Figure B) had a conductivity of 8 mmhos on May 20 and dropped to 7 mmhos by June 20 where it remained through the July and August samplings. The greatest changes at this site was a buildup of salts in July at the 6 to 18 inch depth with a maximum (9.5 mmhos) at 6 to 12 inches. This buildup in salts continued into August with the maximum (11.6 mmhos) now occurring at 18 to 24 inches. The Wollum II site (figure B) behaved differently in that there was no buildup at the lower depths. The conductivities in the surface initially increased through June and then dropped off considerably by July 18. The levels of soluble salts on May and June 20 were dangerously high. Between June 20 and July 18 there was a considerable movement of salts out of the surface site sampled. Since there was no July buildup at the lower depths the salts must have moved out laterally. Another visit to these sites for further observations with these data in hand is recommended.

On the Gustafson farm only one site was sampled. At the May sampling the conductivities were highest at 12 to 24 inches followed by an increase at all depths by June. The June and July samplings were similar with soluble salts at the same level for every depth sampled. From July to August there was a tremendous increase in soluble salts at all depths below the surface six inches. At the September sampling the salts had returned to the earlier levels.

Seasonal Variation Study

Lab no.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg Me/L	Ca me/l	Mg Me/L	Na Me/L	K Me/L	Cl (ppm)	SO_4 (ppm)
					I							
140	Maurice Regnier	0-6	9.0	7.6	16	60	36	24	61.6	2.3	280	1410
141	Farm-Lyon County	6-12	6.5	7.6	14	49	21	28	36.6	1.2	125	1515
142	3 SW of Ghent	12-18	5.0	7.5	19	46	20	26	30.8	0.7	76	1455
143	May 20 sampling	18-24	4.0	7.4	24	40	21	19	17.3	0.8	46	900
144	Vallets silty clay loam	24-36	3.6	7.4	26	37	21	16	13.7	0.8	46	338
					II							
145		0-6	6.0	7.5	18	57	35	22	16.2	1.3	280	728
146		6-12	5.0	7.6	17	52	27	25	18.2	1.9	230	1440
147		12-18	4.5	7.4	15	47	24	23	17.8	1.3	125	1410
148		18-24	3.8	7.2	24	39	25	14	16.2	1.3	76	570
149		24-36	3.7	7.4	24	35	22	13	14.2	1.0	76	263
					I							
5	June sampling	0-6	7.0	7.4	19	67	53	14	24.5	2.0	350	2013
6		6-12	4.5	7.5	18	45	35	10	18.7	1.4	76	1980
7		12-18	3.8	7.3	10	41	36	5	16.2	1.1	31	1642
8		18-24	3.8	7.3	29	33	--	--	15.0	1.0	19	652
9		24-36	3.0	7.4	29	31	25	6	13.5	0.8	12	157
					II							
10		0-6	8.5	7.6	17	68	40	28	42.0	1.7	125	2070
11		6-12	6.0	7.6	15	45	32	13	37.9	1.8	58	1800
12		12-18	5.0	7.5	21	40	27	13	31.6	0.4	19	1035
13		18-24	3.8	7.4	21	38	28	10	20.6	0.4	19	405
14		24-36	1.7	7.4	18	10	7	3	12.5	0.1	15	157

Lab no.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg Me/L	Ca me/l	Mg Me/l	Na Me/l	K Me/l	Cl (ppm)	SO_4 (ppm)
					I							
229	Maurice Regnier	0-6	4.0	7.8	20	51	27	24	12.6	3.3	190	1695
230	July sampling	6-12	3.8	7.8	19	47	27	20	13.7	4.0	120	1980
231		12-18	3.8	7.9	13	44	24	20	12.8	2.4	3	1905
232		18-24	3.5	7.7	35	38	21	17	11.9	2.2	76	1965
233		24-36	3.2	8.0	30	32	17	15	10.6	1.1	190	247
					II							
234		0-6	6.5	7.9	18	53	23	30	44.6	3.5	280	2055
235		6-12	6.0	8.0	18	46	19	27	44.6	2.8	120	2139
236		12-18	5.0	7.9	24	39	16	23	33.3	1.0	76	1767
237		18-24	3.8	7.8	28	37	18	19	18.0	1.1	110	393
238		24-36	2.5	8.0	20	21	11	10	12.6	1.9	76	180
					I							
324	August sampling	0-6	4.2	7.6	18	60	18	42	6.2	0.3	5	1230
325		6-12	4.7	7.6	18	54	27	27	20.2	1.9	24	1575
326		12-18	5.2	7.6	19	62	24	38	15.9	2.2	58	1530
327		18-24	3.8	7.6	34	44	21	23	10.1	1.4	19	923
328		24-36	3.4	7.8	23	38	19	19	9.1	1.5	--	315

Lab. No.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg Me/l	Ca Me/l	Mg Me/l	Na Me/l	K Me/l	Cl (ppm)	SO_4 (ppm)
					I							
135	Nels Wollum Farm	0-6	8.0	7.9	15.6	64	25	39	61.6	2.0	190	1510
136	Yel. Med. County	6-12	5.5	7.7	12.7	54	29	25	32.6	1.0	46	1577
137	Porter	12-18	4.8	7.7	9.7	49	25	24	20.3	0.8	31	1042
138	May 20 sampling	18-24	4.0	7.7	9.8	55	27	48	19.1	0.8	31	840
139	Vallers silty clay loam	24-36	3.5	7.6	4.8	38	23	15	1.4	1.1	24	735
					II							
130		0-6	12.0	7.9	15.2	75	24	21	68.5	1.8	125	1530
131		6-12	6.0	7.6	10.4	62	28	35	34.4	1.2	24	1560
132		12-18	4.3	7.5	8.6	48	29	19	18.3	0.9	24	1650
133		18-24	3.6	7.5	12.4	41	27	14	13.6	0.9	19	713
134		24-36	3.7	7.4	7.2	44	29	15	13.6	8.4	24	255
					I							
15	June 20 sampling	0-6	7.0	7.8	14.9	57	29	28	40.5	1.0	76	2633
16		6-12	5.0	7.7	12.5	50	29	21	28.9	0.7	31	2318
17		12-18	4.5	7.6	9.5	48	33	15	18.7	0.5	12	1913
18		18-24	3.7	7.4	6.2	41	30	11	16.7	0.4	9	2228
19		24-36	3.5	7.4	1.9	37	28	9	15.1	0.5	19	180
					II							
20		0-6	14.0	8.1	13.9	90	35	45	88.5	0.8	378	3240
21		6-12	5.5	7.6	9.8	56	28	28	29.4	0.7	38	2250
22		12-18	4.3	7.5	8.9	47	28	19	19.7	0.5	15	1935
23		18-24	3.9	7.5	6.8	47	27	20	18.5	0.5	15	1620

Lab. No.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg Me/l	Ca Me/l	Mg Me/l	Na Me/l	K Me/l	Cl (ppm)	SO_4 (ppm)
					I							
244	Nels Wollum	0-6	7.0	8.1	16.2	62	24	38	60.0	1.6	280	2001
245	July 18 sampling	6-12	9.5	8.1	14.2	63	26	37	83.7	1.8	380	2475
246		12-18	7.0	8.0	13.8	57	28	29	55.7	1.2	500	1461
247		18-24	4.8	7.9	8.7	46	26	20	32.8	1.1	31	801
248		24-36	3.6	7.8	3.0	38	--	--	--	--	--	369
					II							
239		0-6	8.0	8.1	16.8	68	23	45	71.0	3.8	280	2100
240		6-12	5.0	8.0	13.7	59	26	33	22.8	2.5	96	2361
241		12-18	4.0	7.9	12.9	81	26	55	15.3	1.1	45	1965
242		18-24	3.6	8.0	3.5	39	22	17	13.4	0.8	45	345
243		24-36	2.9	8.1	1.8	28	14	14	12.0	0.8	45	2325
329	August sampling	0-6	7.1	7.9	16.4	65	22	43	47.8	2.0	24	1620
330		6-12	9.2	7.9	11.7	73	22	51	63.5	1.5	45	2160
331		12-18	9.3	7.8	13.6	74	25	49	61.5	1.4	58	1650
332		18-24	11.3	7.8	9.1	121	22	99	22.2	2.1	38	870
333		24-36	5.7	7.8	7.4	54	19	35	29.2	1.7	31	1230

Lab no.	Farm operator county & reference no.	Depth inches	Conductivity (mmhos/cm)	pH	% $CaCO_3$ equivalent	Ca + Mg Me/l	Ca Me/l	Mg Me/l	Na Me/l	K Me/l	Cl (ppm)	SO_4 (ppm)
156	Gustafson Farm	0-6	2.5	7.9	11	31	11	20	2.3	0.2	4	218
157	Chippewa Co.	6-12	3.5	-	15	46	20	26	2.3	0.1	6	1253
158	May 20 sampling	12-24	4.3	7.9	20	52	20	32	3.4	0.1	9	1005
159	Sletten silty clay loam	24-36	3.5	7.8	7	45	13	32	6.4	0.1	4	1155
160	June 20 sampling	0-6	5.0	7.4	11	59	23	36	5.8	0.1	9	735
161		6-12	5.0	7.8	11	62	19	43	7.3	0.1	4	1905
162		12-24	5.0	7.9	18	64	17	47	10.7	0.1	6	1800
163		24-36	5.1	7.9	19	38	18	20	13.5	0.2	6	1620
180	July 20 sampling	0-6	5.0	8.0	11	76	24	52	10.6	0.2	12	533
181		6-12	5.0	8.0	15	80	23	57	13.4	0.1	12	1388
182		12-24	5.5	7.9	20	86	23	63	17.0	0.1	12	1583
183		24-36	4.8	8.1	19	67	17	50	16.0	0.1	5	780
334	August sampling	0-6	4.3	7.9	12	67	22	45	4.9	0.2	5	270
335		6-12	8.7	7.7	17	157	24	133	63.7	1.0	12	578
336		12-24	9.4	7.9	39	156	27	129	22.0	1.3	--	458
337		24-36	10.1	7.8	23	154	25	129	31.8	1.6	9	630
370	Sept. sampling	0-6	--	7.6	12	69	20	49	5.3	0.5	--	675
371		6-12	4.1	7.6	12	60	16	44	5.1	0.3	9	2160
372		12-24	--	7.6	19	--	18	--	9.9	0.8	5	1710
373		24-36	5.2	7.8	20	72	15	57	12.5	0.5	3	1080

Seasonal Study of Electrical
Conductivities on Saturation Extracts

Figure A.

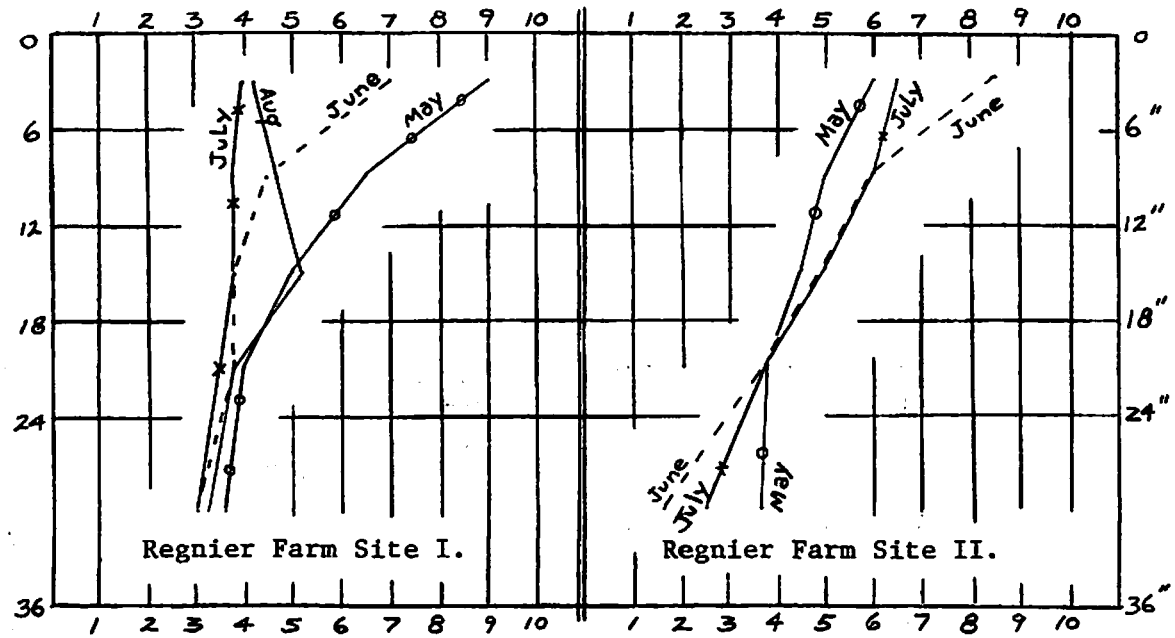
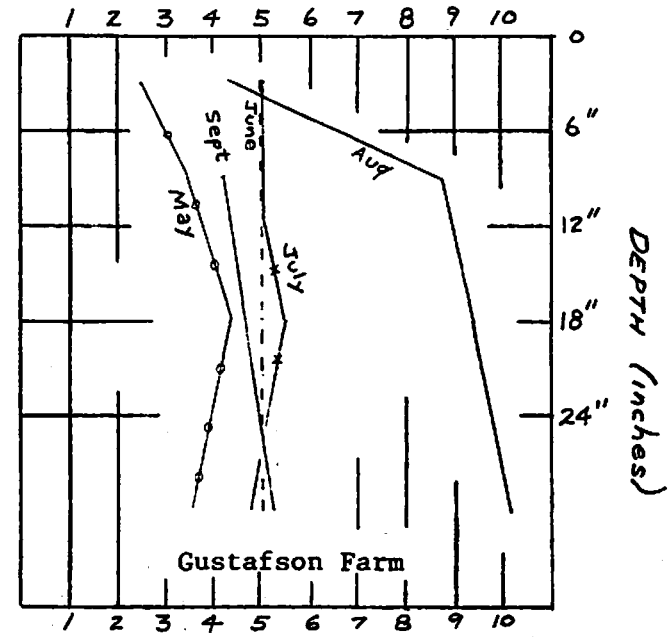


Figure C.



Electrical Conductivities mmhos/cm 25° C.(EC.)

(EC.)

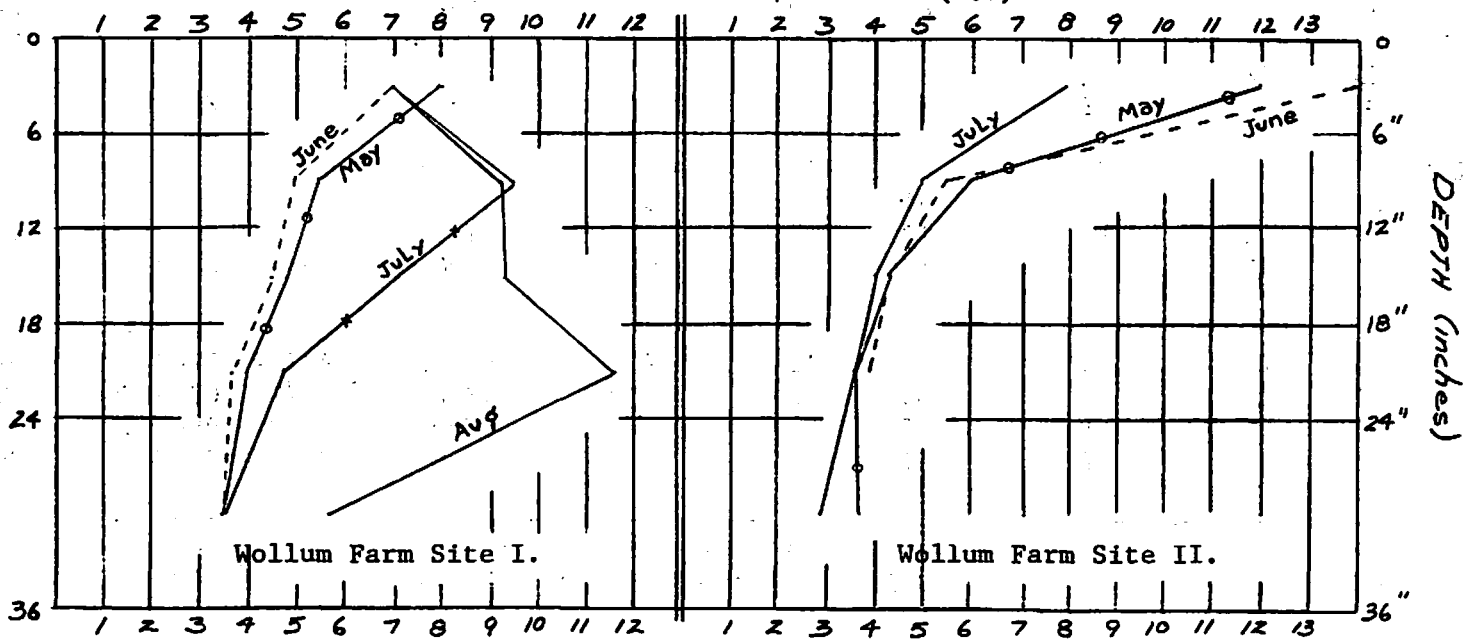


Figure B.

General Summary

As was reported last year, soybean chlorosis in southern Minnesota appears to be directly related to a high free lime content with essentially no soluble salts present. In western Minnesota it may occur from high concentrations of free lime, a high soluble salt content, or a combination of both. This years data showed that in general high soluble salts was the main factor in western Minnesota.

Corn, oats and potato growth appear to be affected more by high soluble salts than high carbonates. If growth was affected by carbonates, it was probably a fertility problem induced by carbonates through a lowering of solubilities and therefore availability.

Considering all of the data from the flax sites, there appears to be very little difference in the level of soluble salts or carbonates between the lesser chlorotic and the chlorotic sites. Apparently the plants, chlorotic or not, are under a critical level of stress from high levels of soluble salts. Under such conditions a small change in some environmental factor (temperature or moisture) or some chemical factor could result in the development of, or recovery from, chlorosis. It is recognized that temperature, through its effect on the physiology of the plant, and soil moisture may determine whether or not a plant develops chlorosis at a given soluble salt or carbonate level.

It is to be remembered that the conductivities, a reflection of soluble salt concentration, reported here are what they were at sampling time. Higher or lower levels may have existed prior to sampling and the physical appearance of the crop at the time of sampling may or may not be a reflection of an earlier circumstance.

The majority of the soils sampled are classified as poorly drained solonchalk soils developed on calcareous glacial till, or fine textured lacustrine sediments.

Soil Residue Studies

S. E. Nelson & R. S. Adams, Jr.

The soil residue plots initiated at Waseca in 1965 were continued in 1966 and expanded to Lamberton and Morris. In these plots atrazine was incorporated prior to planting to simulate residue conditions. The data is summarized in Table 1.

Oat stands at Lamberton and Morris were reduced by approximately 50% by 1/2 lb/A of "residual" atrazine. At Waseca 1 lb/A of "residual" atrazine was required to bring about similar stand reductions. The average stand reduction by 1/2 lb/A atrazine at the three locations was 42%; but produced no significant yield reduction. At Lamberton and Morris the 1 lb/A rate of atrazine reduced stand by approximately 70% but yields by only 10% at Morris and somewhat greater at Lamberton. At all locations 1 1/2 lb/A "residual" atrazine reduced stands by about 75% with a resulting reduction of greater than 50% in oat yield. These results were similar to those obtained at Waseca in 1965, indicating that considerable injury to the oat seedlings by residual atrazine may be overcome. The oats in the treated plots generally stooled better and bore a stiffer straw and plumper berry, with well filled heads.

Up to 1 lb/A of "residual" atrazine did not affect soybean yields adversely. At the 1 lb/A rate stand counts were reduced, on the average, by 10%, but yields were increased by 9%. The increase in yield was attributed to some weed control by the "residual" atrazine. This was particularly apparent at Morris where heavy weed infestation occurred. With the 1 lb/A application of atrazine severe necrosis and leaf drop occurred early in the season. By the end of the season no effects of the atrazine on the soybeans could be visually observed.

A new field study was started in 1966, as a result of some growth chamber work indicating a favorable interaction between "residual" atrazine and amiben or trifluralin. In these plots atrazine was incorporated at rates of 0, 1/4, 1/2 and 1 lb/A across other plots treated with no chemical, linuron, CDAA, amiben or trifluralin. The latter chemicals were applied at customary field rates (linuron, 2 1/2 lb/A; CDAA, 5 lb/A; amiben 3 lb/A; and trifluralin, 1 lb/A). The experiment was replicated four times giving a 4 x 4 x 5 experiment. The soybeans were cultivated as needed. Data is summarized in Table 2.

During the summer and at harvest the soybeans in the plots treated with 1 lb/A of atrazine and linuron or amiben appeared to be retarded in growth at all three locations. Early in the season necrosis and leaf drop was most severe in these plots. A slightly greater reduction in stand occurred in these plots than with 1 lb/A atrazine alone. However, effects of yield were not as pronounced. Only at Morris was the yield significantly reduced by the combination of 1 lb/A atrazine and linuron as compared to the linuron treatment alone.

Weed infestations were severe at Morris, even though the soybeans were cultivated, considerable increase in yield was realized by the addition of weed control chemicals to the plots. The reduction in yield by the combination of 1 lb/A atrazine and linuron (compared to linuron alone) was not due to weed infestation as weed control was good in all linuron treated plots.

Table 1. Stand and yield of oats and soybeans when atrazine was incorporated at three locations. Averages of 4 replications.

Atrazine Treatment lbs/A	Lamberton Stand Count % Control	Lamberton Yield Bu/A	Morris Stand Count % Control	Morris Yield Bu/A	Waseca Stand Count % Control	Waseca Yield Bu/A
			Oats			
0	100	42.4	100	86.9	100	81.9
1/4	82	37.7	77	98.6	93	85.0
1/2	56	42.0	55	85.8	63	77.8
1	33	19.8	29	79.9	50	70.8
1 1/2	24	21.3	20	54.7	29	50.6
			Soybeans			
0	100	19.9	100	22.5	100	29.0
1/4	93	20.6	99	27.3	109	31.3
1/2	85	19.1	98	27.9	103	26.8
1	87	21.5	87	23.5	97	31.6

Table 2. Yield of soybeans as affected by herbicide chemical treatments at three locations. Averages of four replications.

"Residual" atrazine	No Chemical	Linuron	CDAA	Amiben	Trifluralin
lb/A	Bu/A				
		Lamberton			
0	19.9	19.0	22.8	23.0	21.4
1/4	20.6	21.4	21.5	22.1	19.8
1/2	19.1	20.5	24.6	23.3	22.0
1	21.5	19.4	22.5	23.8	22.1
		Morris			
0	22.5	35.6	29.9	32.4	34.6
1/4	27.3	35.4	33.8	35.0	36.5
1/2	27.9	34.8	30.5	32.3	35.5
1	23.5	25.1	33.3	32.6	33.1
		Waseca			
0	29.0	32.6	29.2	32.3	28.9
1/4	27.5	31.9	26.8	27.7	27.7
1/2	26.8	28.3	29.8	29.0	31.2
1	27.9	29.8	27.8	28.2	27.5

LIME PLOTS, LAMBERTON 1966

J. GRAVA, W.W. NELSON AND G.W. RANDALL

A field experiment was established in the fall of 1965 to study the effects of liming on crop yields, chemical composition of plants and chemical properties of soil. The crops grown are a) alfalfa, and b) corn and soybeans in a sequence. Dolomitic lime (89.1% C.C.E., 96.4% passing 8-Mesh Sieve, 42.3% passing 60-Mesh Sieve) was applied in the fall of 1965. The rates used were as follows: 0,3 and 6 tons per acre. The treatments were replicated five times. The plots are 20 feet wide and 40 feet long. A row width 30 inches is used on the corn-soybean plots.

Soil samples were collected from the plot area during August, 1965. The surface ph values ranged from 5.3 to 6.0 on alfalfa area (Series 4) and 6.0 to 6.3 on corn-soybean area (Series 5).

Table 1 shows ph values of two sampling areas.

Table 1. ph values of surface and subsoil, Lamberton lime plots, August 1965.

Depth of sampling, inches	Hole 4 Series 4	Hole 21 Series 5
	pH	pH
0-6	5.3	6.0
6-12	5.6	6.4
12-18	6.0	7.6
18-24	6.7	7.6
24-30	7.4	8.2

Alfalfa was seeded with oats as a companion crop. Table 2 shows yields of oats obtained in 1966.

Table 2. Yield of oats, Lamberton lime plots, 1966.

Rate of Lime to /acre	Yield of Oats, Bu./acre
0	100
3	103
6	101

Statistical evaluation of yield data showed that these differences were nonsignificant.

The yields and moisture content of corn obtained in 1966 are presented in table 3.

Table 3. Yield and moisture content of corn, Lamberton lime plots, 1966.

Rate of Lime to. /acre	Corn Yield bu./acre	Moisture %
0	63	35.2
3	80	35.2
6	68	34.9
C.V. (coefficient of variability)	23	5.0

Statistical evaluation of corn yield data indicated that these differences were nonsignificant because of extreme variability in plots.

Planting Date: May 2, Herbicide: Ramrod at recommended rate; all corn plots received 83+48+24 LB./A of plant nutrients, expressed as N, P_2O_5 and K_2O.

Chemical composition of sixth corn leaf is shown in table 4.

Table 4. Chemical composition of sixth corn leaf at silking. Lamberton lime plots-1966.

Lime treatment tons/acre	P	K	Ca	Mg	B	Cu	Zn	Mn	Mo	Al	Fe
	-----Percent-------				----------Parts per million----------						
0	.28	1.31	.78	.43	8	5	25	38	1.72	90	81
3	.26	1.22	.76	.48	8	5	23	34	2.04	82	80
6	.30	1.37	.76	.47	7	5	24	33	1.82	87	90

Soil Productivity Study

R. H. Rust, E. R. Gross

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 management 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 593 farm cooperators have furnished crop and soil management data on some 99 extensive soil types in the state. Currently 245 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.

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 sufficient 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 by farmers who are in general using above average management. The standard deviations of the yield figures have been included in most instances to give some idea of the range in yields obtained. Many of the yields 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
C-2 = 6-12 percent slopes, one-third to two thirds of surface eroded
D-2 = 12-18 percent slopes, one-third to two thirds of surface eroded

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
( ) Standard deviation of yields in parenthesis

Aastad	(11)*	(57)**
Corn	18	51 (21)
Flax	6	12 (6)
Oats	8	62 (23)
Spring wheat	4	23 (18)
Barley	4	48 (5)
Alfalfa-brome-past.	4	139 (21)
Soybeans	3	24 (5)
Hay (other)	4	4.3
Pasture (other)	4	196 (5)
Anoka	(1)*	(1)**
Antigo	(3)	(11)
Corn silage	4	12.5 (7.1)
Hay (other)	2	1.4
Corn	3	61 (9)
Barnes	(16)	(104)
Corn	(31)	55 (20)
A-1	5	68 (15)
B-1	16	53 (18)
B-2	7	54 (26)
C-2	3	50 (17)
Oats	19	54 (29)
B-1	9	56 (33)
C-2	7	47 (25)
Flax	9	9 (3)
Soybeans	11	20 (4)
Alfalfa-brome	12	2.2
B-1	9	56 (33)
C-2	7	47 (25)
Barley	4	35 (11)
Alfalfa	5	1.9
Spring wheat	6	28 (13)
Corn silage	4	5.8 (5.6)
Bearden	(9)	(32)
Corn	4	52 (20)
Barley	4	52 (10)
Spring wheat	4	39 (1)
Sugar beets	4	9.5 (5.7)
Oats	2	58 (11)
Soybeans	3	20 (0)
Beltrami	(4)	(20)
Oats	4	74 (29)
Alfalfa	8	2.2
Corn	2	66 (11)
Blue Earth	(3)	(15)
Corn silage	3	8.1 (2.5)
Corn	6	54 (31)
Alfalfa-brome	2	3.0
Borup	(1)	(2)
Braham	(4)	(4)
Brainerd	(5)	(20)
Oats	4	43 (25)
Corn	4	57 (20)
Corn silage	2	6.5 (9.1)
Alfalfa	3	3.6
Brickton	(4)	(4)
Alfalfa-brome	2	3.1
Buse-Barnes	(2)	(11)
Alfalfa-brome	3	1.2
Flax	4	11 (3)
Soybeans	3	15 (4)
Canisteo	(8)	(43)
Corn	16	87 (33)
Oats	4	81 (17)
Soybeans	8	31 (3)
Alfalfa	6	3.1
Chetek	(1)	(3)
Alfalfa-brome	2	1.9
Chilgren	(5)	(43)
Oats	9	35 (27)
Barley	3	46 (17)
Flax	2	3 (4)
Apring wheat	4	27 (23)
Alfalfa	4	2.5
Alfalfa-tim.	3	2.7
Hay (other)	3	2.4
Corn silage	3	9.3 (6.6)
Pasture (other)	2	243
Clarion	(37)	(159)
Corn	55	73 (21)
B-1	41	75 (23)
B-2	8	75 (10)
C-2	5	65 (11)
Oats	28	69 (22)
B-1	22	69 (24)
B-2	4	72 (8)
C-2	2	55 (21)

Soybeans	14	27 (10)
Spring wheat	9	35 (15)
Alfalfa-brome	12	2.9
Alfalfa	14	3.0
Mix. Leg. grass	5	4.8
Corn silage	3	11.5 (1.3)
Alfalfa-brome-past	6	246 (3)
Colvin	(6)	(16)
Alfalfa	4	3.4
Corn	6	71 (23)
Comfrey	(1)	(12)
Sorghum	5	8.6 (5.6)
Corn	2	60 (5.9)
Cordova		
Corn	3	79 (31)
Oats	2	64 (7)
Alfalfa	3	3 (38)
Cormant	(4)	(19)
Oats	5	30 (12)
Alfalfa-brome	4	4.0
Downs	(3)	(18)
Corn (B-1)	6	105 (22)
Oats	2	71 (21)
Alfalfa	3	3.4
Dubuque	(4)	(6)
Enstrom	(1)	(4)
Alfalfa-brome	2	1.5
Estelline	(1)	(8)
Esterville	(17)	(76)
Corn	22	61 (25)
A-1	18	63 (25)
B-2	6	51 (20)
Oats	15	41 (23)
A-1	11	35 (23)
B-2	3	50 (19)
Alfalfa-brome	11	2.2
Alfalfa	8	2.9
Corn silage	6	7.1 (2.9)
Soybeans	3	10
Fairhaven	(9)	(22)
Corn	8	60 (17)
Oats	4	63 (12)
Alfalfa	2	3.7
Fargo	(23)	(93)
Spring wheat	18	34 (11)
Oats	11	45 (27)
Soybeans	3	22 (9)
Flax	7	13 (4)
Barley	8	30 (13)
Alfalfa-brome	5	1.5
Alfalfa	2	3.0
Sugar beets	10	8.2 (6.5)
Durum wheat	4	42 (11)
Fayette	(7)	(38)
Corn	16	92 (25)
B-1	2	83 (4)
B-2	8	95 (26)
C-2	6	90 (29)
Oats	7	71 (28)
Alfalfa-brome	5	4.4
Alfalfa	3	3.7
Flom	(8)	(40)
Corn	13	71 (27)
Oats	6	55 (22)
Soybeans	3	17 (15)
Flax	6	17 (8)
Corn silage	2	14.5 (3.5)
Floyd	(5)	(28)
Corn	12	82 (18)
Soybeans	8	24 (7)
Oats	3	86 (23)
Fossum	(2)	(4)
Barley	2	49 (2)
Foxhome	(1)	(5)
Freer	(3)	(14)
Oats	3	54 (14)
R.-Cl.-tim.	2	2.0
Freon	(6)	(11)
Oats	5	53 (25)
Grimstad	(7)	(36)
Barley	8	35 (16)
Flax	3	10 (5)
Soybeans	4	15 (0)
Spring wheat	9	31 (7)
Oats	3	74 (12)
Grygla	(3)	(20)
Oats	4	38 (10)
Pasture (mix)	5	72
Alsike-tim.	2	1.1

Hamerly	(1)	(4)
Flax	2	15 (3)
Harpster	(1)	(2)
Oats	2	34 (12)
Hayden	(24)	(104)
Corn	29	84 (27)
B-1	11	84 (34)
B-2	4	104 (16)
C-2	10	82 (26)
D-2	2	86 (20)
D-3	2	73 (22)
Oats	14	53 (11)
Alfalfa	27	3.0
B-1	8	2.8
C-1	3	2.8
C-2	8	3.6
Alfalfa-brome	15	3.3
B-1	5	3.5
B-2	3	3.1
C-2	5	3.6
Alfalfa-brome-past	10	306 (29)
Hegne	(7)	(22)
Spring wheat	6	35 (5)
Barley	4	51 (15)
Alfalfa	2	1.2
Potatoes	2	313 (96)
Hibbing	(4)	(6)
Alfalfa	2	3.0
Holdingford	(1)	(2)
Hubbard	(14)	(85)
Corn	34	58 (29)
A-1	29	64 (30)
B-2	2	41 (15)
Soybeans	12	19 (6)
Oats	9	44 (15)
Potatoes (irrig)	5	373 (78)
Alfalfa	6	2.4
Alfalfa-brome	6	2
Corn silage	6	10.4 (5.8
Kasson	(2)	(12)
Oats	2	65 (21)
Corn	3	71 (19)
Kato	(1)	(6)
Corn	2	71 (21)

Kenyon	(2)	(11)
Corn	4	81 (7)
Hay (other)	2	3.5
Alfalfa	2	2.7
Oats	2	66 (22)
Kingston	(3)	(18)
Corn	10	80 (32)
Soybeans	5	23 (11)
Kingston, variant	(11)	(3)
Oats	2	26
Kittson	(2)	(10)
Corn silage	2	4.9 (1.9)
Alfalfa	3	4.4
Kranzberg	(2)	(15)
Alfalfa-brome	3	2.2
Alfalfa	2	2.2
Corn	4	57 (13)
Flax	5	12 (5)
Lamoure	(2)	(9)
Corn	4	55 (7)
Soybeans	3	32
Sweet corn	3	7.0
Alfalfa-brome	2	3.9
Lerdal	(1)	(7)
Corn	4	81 (4)
Lester	(12)	(54)
Alfalfa	14	3.6
B-1	4	3.3
B-2	5	4.2
C-2	5	3.2
Corn	14	70 (16)
A-1	2	87 (9)
B-1	3	56 (16)
B-2	3	64 (7)
C-2	8	67 (19)
Oats	9	50 (23)
B-2	4	40 (28)
C-2	3	56 (6)
Alfalfa-brome	8	3.3
LeSueur	(9)	(45)
Corn	23	71 (32)
A-1	12	67 (13)
A-2	4	37 (26)
B-1	7	97 (14)
Soybeans	10	20 (10)
Oats	1	25
Barley	2	49 (10)

Litchfield	(2)	(20)
Corn	4	84 (13)
Soybeans	1	26 (0)
Oats	3	72 (24)
Potatoes (irrig)	1	240 (0) cwt
Alfalfa	6	3.3
Maddock	(4)	(6)
Marcus	(1)	(1)
Marna	(6)	(23)
Corn	14	89 (24)
Soybeans	3	34 (6)
Alfalfa	2	5.1
Mavie	(2)	(3)
McDonaldsville	(1)	(3)
McIntosh	(3)	(20)
Corn	2	69 (0)
Oats	5	62 (10)
Spring wheat	7	33 (8)
Barley	4	71 (26)
Alfalfa	1	3.5
Alfalfa-brome		
A-1	5	1.3
B-1	3	1.6
C-1	3	3.6
Menahga	(6)	(30)
Oats	5	29 (20)
Alfalfa-brome	10	2.1
Corn silage	4	7.6 (2.5)
Pasture (alfalfa brome)	5	107 (1)
Milaca	(8)	(32)
Oats	4	31 (19)
Corn	5	60 (16)
Hay (other)	5	2.2
Mix. leg.-grass	3	1.8
Corn silage	4	10.2 (3.8)
Alfalfa	2	3.4
Alfalfa-brome	3	2.8
Moody	(2)	(6)
Corn	4	70 (19)
Mora	(4)	(21)
Corn	6	57 (34)
Oats	4	49 (37)
Mix. leg.-grass	1	3.2
Corn silage	3	8.3 (3.6)

Nebish	(7)	(47)
Oats	10	47 (21)
Alfalfa	8	1.9
A-1	3	2.3
B-1	5	1.7
Alfalfa-brome	12	3.5
B-1	5	3.0
C-1	6	3.5
Alfalfa-brome-past)	8	78 (36)
A-1	5	71 (41)
B-1	3	90 (30)
Nicollet	(21)	(118)
Corn	52	74 (30)
A-1	43	77 (32)
B-1	9	72 (25)
Oats	14	58 (19)
A-1	11	61 (20)
B-1	3	47 (13)
Soybeans	16	28 (8)
Spring wheat	4	40 (11)
Alfalfa	13	3.8
Alfalfa brome	5	3.9
Corn silage	5	11.9 (6.9)
Nokay	(5)	(18)
Corn	6	53 (19)
Oats	5	42 (24)
Corn silage	6	5.5 (2.8)
Nymore	(3)	(4)
Alfalfa	2	1.8
Onamia	(5)	(21)
Corn	6	70 (11)
Oats	4	64 (5)
Alfalfa	3	4.1
Alfalfa-brome	2	1.8
Pasture (brome)	2	200 (70)
Ostrander	(7)	(25)
Corn	9	85 (32)
Soybeans	4	25 (2)
Alfalfa	4	3.8
Parent	(1)	(1)
Parnell	(2)	(11)
Corn	6	52 (25)
Oats	3	76 (9)

Deep Peat	(6)	(34)
Corn	5	57 (34)
Soybeans	4	25 (2)
Timothy (seed)	3	333 (24)
Corn silage	3	9.6 (4.7)
Pasture (other)	7	118 (41)
Leg.-grass past.	2	242 (43)
Shallow Peat	(5)	(9)
Soybeans	3	24 (7)
Barley	3	56 (7)
Corn	2	93 (2)
Racine	(1)	(1)
Redby	(3)	(18)
Oats	3	58 (6)
Leg.-grass hay	3	4
Leg.-grass past	4	82 (52)
RCl-tim hay	3	2.3
Rocksbury	(12)	(45)
Oats	12	41 (28)
Flax	7	5 (5)
Alfalfa	1	4.1
Hay (other)	3	1.8
Pasture (other)	2	109 (1)
wheat	5	23 (11)
Rockwell	(5)	(17)
Oats	3	52 (22)
Barley	3	27 (11)
Wheat	2	28 (2)
Alfalfa	2	1.6
Corn silage	2	12.9 (12)
Sioux	(4)	(16)
Oats	7	32 (21)
Soybeans	2	11 (4)
Alfalfa	2	0.8
Shooks	(2)	(12)
Oats	4	47 (15)
Alfalfa	2	2.0
Skyberg	(3)	(14)
Corn	5	85 (20)
Oats	3	87 (10)
Leg.-grass past.	2	153 (37)
Sletton	(1)	(5)
Soybeans	2	30 (0)
Storden-Clarion	(1)	(7)
Oats	2	80 (11)
Alfalfa	5	2.9
Tama	(8)	(50)
Oats	14	70 (20)
A-1	3	83 (32)
B-1	4	63 (6)
B-2	3	60 (8)
C-2	4	76 (26)
Corn	14	86 (24)
A-1	4	80 (14)
B-1	6	98 (17)
B-2	2	106 (4)
C-2	2	43 (0)
Corn silage	2	14.2 (3.1)
Alfalfa	5	4.3
Alfalfa-brome	4	4.2
Leg.-grass hay	4	3.3
Alfalfa-brome past	3	177 (40)
Taylor	(1)	(5)
Oats	3	46 (12)
Alfalfa	1	1.5
Terrill	(1)	(3)
Todd	(2)	(12)
Alfalfa-brome	4	2.1
Corn silage	3	7.0 (1.7)
Oats	4	32 (11)
Truman	(3)	(10)
Corn	5	86 (19)
Soybean	2	27 (13)
Ulen	(4)	(35)
Corn	6	51 (19)
Oats	10	53 (17)
Corn silage	2	15.5 (3.5)
Alfalfa	2	2.6
Vallers	(3)	(20)
Corn	5	55 (17)
Soybeans	6	21
Varco	(1)	(8)
Corn	6	80 (17)
Alfalfa-brome	2	2.7
Vienna	(2)	(7)
Corn	3	63 (28)
Oats	2	60 (13)
Wabash	(1)	(6)
Corn	3	109 (14)
Wadena	(4)	(21)
Corn	8	73 (30)
Oats	3	79 (9)
Soybean	3	23 (7)

Waukegan		
Corn A-1	17	75 (17)
Oats	9	81 (14)
Soybeans	3	30 (5)
Alfalfa	3	1.8
Alfalfa-brome	3	3.5
Waukon	(10)	(47)
Corn	10	68 (19)
Oats	7	60 (21)
Barley	4	40 (21)
Spring wheat	4	26 (11)
Alfalfa	9	2.1
Mix. leg.-grass	3	4.1
Webster	(39)	(167)
Corn	71	76 (25)
Oats	27	61 (17)
Soybeans	24	22 (7)
Alfalfa	14	4.0
Alfalfa-brome	8	2.8
Corn silage	7	11.6 (4.8)
Mix.-Leg-grass	2	2.2
Wildwood	(2)	(11)
Oats	2	32 (14)
Barley	2	32 (14)
S. wheat	2	16 (5)
Winger	(4)	(31)
Oats	8	77 (18)
Barley	5	47 (14)
Spring wheat	3	34 (20)
Alfalfa	3	1.6
Zimmerman	(3)	(19)
Corn	3	62 (15)
Oats	2	56 (20)
Corn silage	4	9.7 (3.8)

Grand total as of December 1966-

No. Fields	No. Yields
545	2473

Soil and Crop Management Systems
West Central Experiment Station
Roy L. Thompson and Samuel D. Evans

This experiment was reviewed and a revised plan was prepared for the 1966 cropping season. For the 1960-65 treatments and yields see the February, 1965 and 1966 Blue Books. The 1966 treatments and yields are as follows:

Continuous Soybeans	Base	Test
Seeding rate	60-70 lbs/acre	70-120 lbs/acre
Row width	38 inches	6 inches
Weed control	3 cultivations	Treflan @ 1 lb/A
Fertilizer	None	0+45+45 + 10 Zinc
Variety	Chippewa	Chippewa
Planting date	May 20	May 16
YIELD	29.44 Bu/A	32.11 Bu/A
Continuous Corn		
Population, plants/acre	14,000 - 16,000	25,000 - 28,000
Row width	38 inches	19 inches
Insecticide	None	Diazinon
Fertilizer	46+26+13 Broadcast	200+100+100 + 15 Zinc Broadcast and 3+12+12 with seed
Weed control	3 cultivations	Atrazine @ 4 lbs/acre
Variety	UH127	UH127
Planting date	May 19	May 3
YIELD	61.52 Bu/A	46.43 Bu/A
Continuous Alfalfa		
Variety	Vernal	Vernal
Seeding rate	12 lbs/A	12 lbs/A
Fertilizer	0+46+0	0+90+90
YIELD	No yields in 1966 - new stand	

Soil and Crop Management Systems
(continued)

Rotation (oats, seeded down)	Base	Test
Variety	Lodi & Vernal	Lodi & Vernal
Seeding rates	3 Bu + 12 lbs.	3 Bu + 12 lbs.
Fertilizer	None	60+90+90
Oat Yields	55.42 Bu/A	73.56 Bu/A

This experiment was hurt severly by the dry weather in July, 1966. This was particularly true in the test plots of continuous corn. These plots started tasseling about July 13 when the soil was very dry and the plants were wilting and no substantial rain fell until July 26. No changes are planned for the 1967 season.

Continuous Corn Silage Experiment
West Central Experiment Station
Samuel D. Evans

In 1965 an experiment was initiated on McIntosh silt loam to determine the effect of removal of continuous corn silage and fertilizer application on corn grain and corn silage yields. Rates of fertilizer used were 74+48+48 and 148+96+96. All plots received a broadcast application of 10 lbs of zinc as zinc sulfate in the fall of 1965.

Silage Yields
Dry Matter, tons/acre

On plots harvested as grain in 1965 & 1966:

Low fertility (74+48+48) - 6.26

High fertility (148+96+96) - 6.50

On plots harvested as silage in 1965 & 1966:

Low fertility (74+48+48) - 6.24

High fertility (148+96+96) - 6.33

Grain Yields
Bushels/acre @ 15.5% Moisture

On plots harvested as grain in 1965 & 1966:

Low fertility (74+48+48) - 115.12

High fertility (148+96+96) - 115.03

In addition an unfertilized, unreplicated check adjacent to the experimental area yielded as follows:

Grain (0+0+0) - 79.01 Bu/acre

Silage (0+0+0) - 5.26 tons/acre

Summary -

Two years of continuous corn silage caused no reduction in silage yields. Additional fertilizer above the 74+48+48 did not increase grain or silage yields.

Continuous Corn - High Fertility Experiment
Rosemount Experiment Station
Established - 1953
W. P. Martin, P. M. Burson, and G. W. Randall

Yield results 1966 (For experimental design and past years results see p. 47 in the mimeographed "Bluebook", Feb. 1963; p. 67, Jan. 1964; p. 33, Feb. 1965 and p. 54, Feb. 1966.)

	Fertilizer Treatments*	1966 Yield Bu/acre		14 yr. Ave. Yield Bu/acre	
		16,500 plants	19,500 plants	16,500 plants	19,500 plants
1	Check	114.5	106.5	79.8	87.6
2	20+40+40	109.5	106.5	86.4	97.7
3	100+40+40	129.0	118.5	89.8	101.0
4	180+40+40	114.5	123.2	93.0	104.7
5	36+88+136	106.0	108.8	87.0	98.3
6	116+88+136	120.8	118.8	94.0	104.9
7	196+88+136	117.8	120.2	94.0	104.8
8	52+136+232	108.2	112.5	89.8	102.4
9	132+136+232	115.8	118.8	96.6	106.2
10	212+136+232	116.0	121.8	96.8	106.8

* Pounds of $N+P_2O_5+K_2O$ applied this year. These rates have been upgraded throughout the years, although the ratios have remained approximately the same.

The 1966 corn yields were generally quite good. Yields from the check treatment were very high and far above average for both populations. Small yield responses can be seen due to nitrogen fertilizer. The 14 year averages are also presented. These averages show the higher population to produce greater yields than the lighter population. Again, a small response to nitrogen fertilizer is shown.

Fertilizer Rotation Study at Waseca in 1966

Southern Minnesota School & Experiment Station
A. C. Caldwell, John Thompson and G. W. Randall

An NPK factorial experiment involving the three major fertilizer nutrient elements alone and in all combinations applied across a five-year rotation and continuous corn has been conducted at Waseca eleven years. The cropping sequence in the rotation is corn, corn, soybeans, oats, alfalfa, and continuous corn not in rotation.

Corn

First year corn yields at Waseca ranged from 104.7 to 128.7 bushels per acre. The fertilizer treatments did not produce any significant yield effects although potassium showed an 8 bushel increase.

Second year corn yields varied from 96.5 to 119.2 bushels per acre and were somewhat lower than the first year yields. Again no significant treatment effects were evident.

The continuous corn yields ranged from 62.2 to 115.1 bushels per acre. Nitrogen treatments caused significant yield increases amounting to 41 bushels per acre. The phosphate and potash treatments did not show any effect on the continuous corn yield.

Alfalfa

Total yields taken from three cuttings of alfalfa ranged from 3.23 to 4.36 tons per acre. Significant increases in yield occurred with phosphate and potash, with a significant decrease following nitrogen fertilization.

Oats

The oats yields, which were quite high, did not show any significant response to the fertilizer treatments. Most treatments decreased yield in comparison to the check treatment. A positive PK interaction of 10.1 bushels was found.

Soybeans

Excellent soybean yields were obtained during 1966. These ranged from 35.6 to 43.0 bushels per acre. Individual N, P, and K treatments resulted in decreased yields while the NPK treatment produced the largest increase over the check treatment yield. Again, a significant PK interaction of 3.0 bushels was found.

The following tables contain only the 1966 yields.

Table 1. Yield of first year corn

Treatment	$N-P_2O_5-K_2O$	Ave. Yield bu/a	Difference from untreated	Treatment Effect
Check	0+0+0	108.6a	--	--
N	40+0+0	104.7a	-3.9	+0.2
P	0+80+0	107.4a	-1.2	+0.1
K	0+0+80	118.6a	+10.0	+8.4
NP	40+80+0	110.4a	+1.8	+3.6
NK	40+0+80	115.8a	+7.2	+0.7
PK	0+80+80	112.8a	+4.2	-2.1
NPK	40+80+80	117.5a	+8.9	+0.2
NPK+	80+160+160	128.7a	+20.1	---

Table 2. Yield of second year corn

Treatment	lbs/A $N-P_2O_5-K_2O$	Ave. Yield bu/A	Difference from untreated	Treatment Effect
Check	0+0+0	103.9a	---	---
N	80+0+0	107.4a	+3.5	+3.7
P	0+80+0	110.7a	+6.8	+1.5
K	0+0+80	96.5a	-7.4	-6.3
NP	80+80+0	107.7a	+3.8	-2.9
NK	80+0+80	106.3a	+2.4	+3.5
PK	0+80+80	98.5a	-5.4	-2.0
NPK	80+80+80	103.2a	-0.7	+0.3
NPK+	160+160+160	119.2a	+15.3	---

Table 3. Yield of continuous corn

Treatment	$N-P_2O_5-K_2O$	Ave. Yield bu/A	Difference from untreated	Treatment Effect
Check	0+0+0	75.8bc	---	---
N	160+0+0	104.3ab	+18.5	+40.6**
P	0+160+0	73.8bc	-2.0	+5.1
K	0+0+160	62.2c	-13.6	-3.0
NP	160+160+0	115.1a	+39.3	+2.3
NK	160+0+160	110.5a	+34.7	+5.8
PK	0+160+160	69.9c	-5.9	+0.7
NPK	160+160+160	114.4a	+38.6	-4.2
NPK+	320+320+320	103.4ab	+27.6	---

Table 4. Yield of first cutting alfalfa.

Treatment	$N-P_2O_5-K_2O$	Ave. Yield T/A	Difference from Untreated	Treatment Effect
Check	0+0+0	1.57b	---	---
N	20+0+0	1.30b	-0.27	-0.17*
P	0+80+0	1.90a	+0.33	+0.44**
K	0+0+80	1.59b	+0.02	+0.23*
NP	20+80+0	1.51b	-0.06	+0.06
NK	20+0+80	1.40b	-0.17	+0.16*
PK	0+80+80	2.01a	+0.44	+0.17
NPK	20+80+80	2.19a	+0.62	+0.13
NPK+	20+160+160	1.43b	-0.14	---

Table 5. Yield of second cutting alfalfa.

Treatment	$N-P_2O_5-K_2O$	Ave. Yield T/A	Difference from Untreated	Treatment Effect
Check	0+0+0	1.02a	---	---
N	20+0+0	0.98a	-0.04	-0.11*
P	0+80+0	1.16a	+0.14	+0.07
K	0+0+80	1.18a	+0.16	+0.10
NP	20+80+0	0.98a	-0.04	---
NK	20+0+80	1.01a	-0.01	---
PK	0+80+80	1.19a	+0.17	---
NPK	20+80+80	1.14a	+0.12	+0.06
NPK+	20+160+160	1.19a	+0.17	---

Table 6. Yield of third cutting alfalfa.

Treatment	$N-P_2O_5-K_2O$	Ave. Yield T/A	Difference from Untreated	Treatment Effect
Check	0+0+0	0.90c	---	---
N	20+0+0	0.96bc	+0.06	-0.01
P	0+80+0	1.16a	+0.26	+0.14**
K	0+0+80	0.92c	+0.02	-0.01
NP	20+80+0	1.06abc	+0.16	-0.08
NK	20+0+80	0.99abc	+0.99	+0.01
PK	0+80+80	1.11ab	+0.21	-0.03
NPK	20+80+80	1.03abc	+0.13	---
NPK+	20+160+160	1.05abc	+0.15	---

Table 7. Total 1966 alfalfa yield.

Treatment	lbs/A $N-P_2O_5-K_2O$	Ave. Yield T/A	Difference from Untreated	Treatment Effect
Check	0+0+0	3.49b	---	---
N	20+0+0	3.23b	-0.26	-0.29*
P	0+80+0	4.22a	+0.73	+0.66**
K	0+0+80	3.69b	+0.20	+0.31*
NP	20+80+0	3.55b	+0.05	-0.02
NK	20+0+80	3.40b	-0.09	+0.18
PK	0+80+80	4.30a	+0.81	+0.13
NPK	20+80+80	4.36a	+0.87	+0.19
NPK+	20+160+160	3.66b	+0.17	---

Table 8. Yield of oats.

Treatment	lbs/A $N-P_2O_5-K_2O$	Ave. Yield bu/A	Difference from Untreated	Treatment Effect
Check	0+0+0	98.7a	---	---
N	80+0+0	87.1a	-11.6	-0.7
P	0+80+0	88.3a	-10.4	+3.3
K	0+0+80	87.0a	-11.7	+1.4
NP	80+80+0	83.9a	-14.8	+7.9
NK	80+0+80	81.4a	-17.3	+7.3
PK	0+80+80	88.2a	-10.5	+10.1*
NPK	80+80+80	106.9a	+8.2	---
NPK+	120+160+160	82.2a	-16.5	---

Table 9. Yields of soybeans.

Treatment	lbs/A $N-P_2O_5-K_2O$	Ave. Yield bu/A	Difference from Untreated	Treatment Effect
Check	0+0+0	39.1a	---	---
N	20+0+0	38.2a	-0.9	---
P	0+40+0	37.6a	-1.5	+0.9
K	0+0+40	37.7a	-1.4	+1.7
NP	20+40+0	35.6a	-3.5	+0.8
NK	20+0+40	36.9a	-2.2	+1.4
PK	0+40+40	39.5a	+0.4	+3.0*
NPK	20+40+40	43.0a	+3.9	+1.4
NPK+	40+80+80	42.4a	+3.3	---

Rosemount Soils Farm

Rosemount Agricultural Experiment Station
1966

Paul M. Burson

The year 1966 was a very satisfactory year with about normal weather and growing conditions. The rainfall distribution throughout the growing season was good with a total of 19.46 inches from May 1 through October 31. The continued use of good landuse, soil fertility and management is showing excellent yield results. Top yield of corn in 1966 was 178.0 bu. per acre. Top yields are the result of a good rotation, banded fertilizer at planting time, broadcast plow-down fertilizer and 80 to 100 lbs. of actual N sidedressed at the 1st cultivation. The check yields range from 60.0 to 109.0 bu. per acre, depending on the soil type conditions of fertility, management and topsoil remaining.

Corn in Rotation

The 1st year of corn following alfalfa, had a top yield of 176.0 bu. per acre with banded fertilizer at 300 lbs. per acre of 4-12-24, 80 lbs. of N sidedressed at 1st cultivation and 300 lbs. of 0-20-20 broadcast plow-down applied in 1960, 1963 and 1966. The check yield was 107.0 bu. per acre.

On the 2nd year corn following alfalfa with the same treatment of 80 lbs. of N was applied as sidedressing, the top yield was 158.0 bu. per acre with the check producing 93.0 bu. per acre.

With a green manure crop of alfalfa and with the same combination of treatments except 80 lbs. of N was applied as sidedressing, the top yield again was 178.0 bu. per acre with the check producing 103.0 bu. per acre.

These comparisons show the value of a legume crop followed by corn regardless if the legume is a green manure crop or was a hay crop.

Continuous Corn

There are 4 fields on the Soils Farm at Rosemount that have been in continuous corn from 6 to 14 years. These fields for 1966 have not produced as well as the fields that have been in a regular crop rotation system. The check yields have ranged from 59.0 to 103.0 bu. per acre. Banded fertilizer at 300 lbs. per acre of 4-12-24 produced from 93.0 to 134.0 bu. per acre while the band plus 140 lbs. of sidedressed N produced from 137.0 to 144.0 bu. per acre.

Throughout the years the corn in rotation with no fertilizer has out yielded the continuous corn with no fertilizer by about 20.0 bu. per acre. This indicates the difference in favor of a rotation on upland, rolling soils that have been previously eroded.

Lime and Fertilizer on Continuous Corn
1966

On one field of mainly Port Byron silt loam, upland soil, which has been in corn for 9 years and which was limed at 3 tons per acre in November 1964 produced the following bu. yields per acre.

Soil treatments	No lime	Lime
Check	97.0 bu.	97.0 bu.
Band(1)	91.0 "	104.0 "
Band + N(2)	142.0 "	148.0 "

(1) 4-12-24 at 300 lbs. per acre
(2) 140 lbs. N sidedressed at 1st cultivation

On another field having been in continuous corn for 14 years, limed at the same time and fertilized with manure and banded fertilizer, was the best combination of fertilizer treatments for 1966. Manure was applied annually at the rate of 10 tons per acre plow-down.

The banded fertilizer was 6-24-12 at the rate of 200 lbs. per acre. The soil types are Judson and Clyde silty clay loams, slow in drainage as was the case in 1966. The 1966 yield bu. yields per acre are as follows:

Soil treatments	No lime	Lime
Check	114.0	108.0 (wet)
Manure	109.0	138.0
Band + Manure	129.0	140.0
Band + Manure + N(1)	---	136.0

(1) 80 lbs. N sidedressed at 1st cultivation.

The lime response was the greatest when used with other soil treatments. Sidedressed N with this rate of manure annually has never given any response to sidedressed N and was again shown in the 1966 corn yields.

POP-UP (STARTER) FERTILIZER

Pop-up (starter) fertilizer for corn is not new. It is an old practice. If has been referred to as a step beckward. However, it is nothing more than starter fertilizer brought up to date with the modern methods of accuracy of application. Furthermore, this method of fertilizer application seems to have a place with the new custom spreading fall plow-down service now available to farmers by the fertilizer industry. Pop-up (starter) fertilizer has been used since fertilizer first came into being. Truck gardeners around the Twin City area have used starter solutions for certain crops for 35 to 40 years. The

splitboot attachment on the corn planter which came on the market many years ago was a partial pop-up (starter) fertilizer method of application. The splitboot placed the then low analysis fertilizer in no specific place in relation to the seed. Some was placed with the seed, some on the surface, some to the side and more in some places than in others. But no one knew how much actually went in with the seed. Everyone knew some went in with the seed and there was a starter benefit. With the use of this practice the remaining nutrients for the growing of the final corn crop had to come from the natural fertility of the soil. As new higher analysis material came into use and applied at higher rates per acre, too much was placed with the seed with the splitboot attachment and severe germination injury occurred. Here the band application was developed with the idea that all of the fertilizer needs could be applied at one time. This is not a truly starter fertilizer as compared to having a known amount of fertilizer placed with the seed as a specific starter. As the natural soil fertility went down these basic needs had to be supplied. This is where broadcasting came into existence and the availability of the custom fall plow-down. Present day fertilizer application practices are giving a new look at old practices. The principles of fertilization will not change to any degree but the application methods will.

The problem facing the corn farmer today is the rapidly increasing labor cost and time. This is brought about by a number of things such as - all fertilizer needs applied at planting time, higher rates per acre meaning more fertilizer to transport over the field, narrow row planting with flexi-unit planter instead of the now conventional planter, more rows per planter unit for narrow rows meaning more fertilizer material to transport and handle as compared to the conventional corn planter and the increasing need and use of herbicides and insecticides. Here is where the custom fall plow-down fertilizer service, now available by the industry, can relieve a big share of this spring labor problem for the farmer at planting time. Latest figures by the Minn. Dept. of Agri. indicate there are about 350 licensed fertilizer blenders, mixers and manufacturers at the present time. It is estimated that about 90% are able to provide some custom spreading service but in another year will further expand their present service as the demand occurs. It is further estimated that broadcast fall plow-down in 1966 is running about 150% greater than in the fall of 1965. Broadcasting fertilizer is not new but has been updated through custom service, with materials provided on a prescription basis, as determined by soil test, and applied on the corn crop as well as the other crops in the cropping system as it was years ago.

This is where pop-up (starter) at planting time could team-up with the fall plow-down and give a new look in fertilizer use and relieve the farmer of the increasing labor cost and time now occurring at corn planting time. At present most farmers trying pop-up (starter) are using it with the band application. At Rosemount we have used pop-up (starter) with both band and broadcast plow-down. The following tables indicate some of the results:

Table 1. Pop-up (starter) fertilizer with and without band and with and without broadcast plow-down for corn.

FIELD 30A

1966 - 6 years continuous corn

Fertilizer treatments	Yield bu. per acre no plow-down	Yield bu. per acre with plow-down[1]
1. Check	127.0	140.0
2. Check + N	128.0	140.0
3. P(st) L-7-21-7 (14#NK) + N	130.0	138.0
4. P(st) D-10-30-12 (14#NK) + N	135.0	148.0
5. P(st) D-12-24-12 (16#NK) + N	139.0	149.9
6. B 4-12-24 300# per acre + N	136.0	145.0
7. B 6-24-12 200# per acre + N	120.0	139.0
8. B 4-12-24 300# per acre + P(st) D-12-24-12 (16#NK) + N	129.0	144.0
9. B 4-12-24 300# per acre + P(st) L-7-21-7 (14# NK) + N	130.0	153.0
10. B 6-24-12 200# per acre + P(st) D-12-24-12 (16#NK) + N	134.0	149.0
11. B 6-24-12 200# per acre + P(st) L-7-21-7 (14#NK) + N	138.0	145.0
12. B 4-12-24 300# per acre + P(st) 10-30-12 (14#NK) + N	142.0	148.0
13. B 6-24-12 200# per acre + P(st) 10-30-12 (14#NK) + N	143.0	153.0

Planted May 25, 1966
Av. 4 replications split plot plow-down

B - Band 4-12-24 300# per acre
6-24-12 200# per acre
L - Liquid fertilizer
D - Dry fertilizer
P(st) - Pop-up starter fertilizer
N - Nitrogen plow-down 130# per acre

[1]Plow-down 4-12-24 800# per acre spring, 1966.

Soil test (Fall, 1966):	P	K
Plow-down	Very high	medium +
No plow-down	medium	medium

Atrazine broadcast after planting
Planting rate - 24,000 kernels - drilled
Final stand - check 19,000 plants per acre
all fertilizer 22,000 plants per acre

Maturity: Moisture content Oct. 25, 1966, was 2% +, less moisture on plow-down than on no plow-down.

Tasselling and denting pop-up (starter) + plow-down was 4 to 6 days in advance of check.

Table 2. Pop-up (starter) fertilizer with and without plow-down for corn.

FIELD 10
1966 - 11 years continuous corn

Fertilizer Treatments	Yield bu. per acre no plow-down	Yield bu. per acre with(1) plow-down
1. Check	60.0	80.5
2. B-4-12-24 300# per acre	85.0	122.5
3. B-4-12-24 300# per acre + N	116.0	145.6
4. P)st) L-7-21-7 (14#NK) + N	125.0	150.1
5. P(st) D-10-30-12 (14#NK) + N	126.0	151.3
6. B-4-12-24 300# per acre + P(st) L-7-21-7 (14#NK) + N	128.0	153.5
7. B-4-12-24 300# per acre + P(st) D-10-30-12 (14#NK) + N	137.0	151.8
8. B-4-12-24 300# per acre + P(st) D-12-24-12 (14#NK) + N	134.0	152.0

Planted May 26, 1966

B - Band placement
P(st) - Pop-up (starter) placement
L - Liquid fertilizer
D - Dry fertilizer
N - Nitrogen sidedressed 140# per acre at 1st cultivation.

(1) Plot 1-1959-62-65
" 2-1960-63-66
" 3-1961-64-

Every three years 0-20-20 was applied and plowed down at 300 and 600 lbs. per acre.

Soil test (Spring 1966):	P	K
plow-down	High	medium +
no plow-down	medium	medium

Atrazine banded at planting time
Planting rate - 24,000 kernels-drilled

Final stand:	
check	19,000 plants
Band	20,000 plants
B + P	22,000 plants

No rootworm injury on any treatment.

The plow-down 0-20-20 was applied on the basis of a soil test at the rates of 300 and 600 lbs. per acre. Plots were laid out across the 100 ft. field strip cropped field. In 1959 the first series was started with one additional series in 1960 and one again in 1961. Then the plow-down treatments were again repeated on the same plots so the repeated treatments were made every three years. With this arrangement it would be possible to determine the response the current year and the two following years as to any residual response and if there was any accumulative response.

Table 3. Pop-up (starter) fertilizer vs. Band vs. Band + pop-up (starter)

FIELD 30A
1965 - 5 years continuous corn

Fertilizer treatments	Yield bu. per acre
1. Check	99.5
2. P)st) D-0-45-0 (50#) + N	97.3
3. P(st) L-5-15-10 (14#NK) + N	124.0
4. B-5-15-10 (L) 300# per acre + P(st) L-5-15-10 (14#NK) + N	134.0
5. P(st) D-8-24-12 (15#NK) + N	131.5
6. B-8-24-12 (D) 200# per acre + P(st) D-8-24-12 (15#NK) + N	128.0
7. B-5-15-10 (L) 300# per acre + N	129.0
8. B-8-24-12 (D) 200# per acre + N	129.7

Planted May 19, 1965

B - Band placement
P - Pop-up (starter) placement
L - Liquid fertilizer - Furnished by T.V.A.
D - Dry fertilizer
N - Nitrogen 100# sidedressed 1st cultivation

4 replications

Atrazine broadcast at pre-emergence.

Maturity: 80% tasselling and denting
Pop-up 3 to 4 days over check
Pop-up (starter + band 7 to 8 days over check

Planting rate - 24,000 kernels per acre
Final stand - check 19,000 plants per acre
All fertilizer 21,000 plants per acre.
Root worm injury was serious on pop-up (starter) phosphate and check.

Table 4. Pop-up (starter) fertilizer with and without band and with and without plow-down on variable planting rates of soybeans.

FIELD 37
1966 - 4 years continuous row crops

Fertilizer treatments	Yield bu. per acre no plow-down	Yield bu. per acre with plow-down
Planting rate 60# per acre		
1. Check	28.0	28.3
2. P(st) L-7-21-7 (20#NK)	31.6	30.0
3. P(st) D-10-30-12 (20NK)	33.3	31.6
4. P(st) D-10-30-12 (14NK)	33.3	35.0
5. P(st) L-7-21-7 (14NK)	28.3	30.0
6. P(st) L-7-21-7 (7NK)	33.3	30.0
7. P(st) D-10-30-12 (7NK)	28.3	30.0
8. Band (D) 4-12-24 300# per acre	26.6	35.0
Planting rate 45# per acre		
1. Check	26.6	31.6
2. P(st) L-7-21-7 (20#NK)	26.6	33.3
3. P(st) D-10-30-12 (20#NK)	25.0	35.0
4. P(st) D-10-30-12 (14#NK)	28.3	36.6
5. P(st) L-7-21-7 (14#NK)	26.6	35.0
6. P(st) L-7-21-7 (7#NK)	26.6	33.3
7. P(st) D-10-30-12 (7#NK)	28.3	33.3
8. Band (D) 4-12-24 300# per acre	35.0	33.1

(1) Plow-down 4-12-24 800# per acre spring 1966
P(st)-Pop-up (starter) placement
L - Liquid fertilizer
D - Dry fertilizer
Planting date - June 9, 1966
Treflan broadcast for weed control

Soil test:	P	K
	High	very high

Maturity: Leaf drop on plow-down was 5 to 7 days in advance of no plow-down. Check was latest of all treatments.

Table 5. Pop-up (starter) fertilizer vs. pop-up (starter) plus band on stands of corn.

4 year average
1963-1966

Plants per acre (Final Stand)		
Check	(1) Pop-up (starter)	(1) Pop-up (starter + Band)
18,600	20,500	20,400

(1) 20 lbs. total or less of nitrogen and Potash

Planting rate 23,000 to 24,000 kernels

SUMMARY AND OBSERVATIONS

1. General fertility levels of fields 10, 30A and 37 are considered high because of regular annual fertilizer treatments. They are comparable to the soil fertility levels found with the good farmers of Minnesota.

2. The check areas of field 10 have never been fertilized while the check areas on fields 30A and 37 have had the normal band fertilization in previous years.

3. Broadcast plow-down fertilizer plus pop-up (starter) fertilizer on both corn and soybeans seems to about offset the results from band plus pop-up (starter).

4. Pop-up (starter) fertilizer apparently is an efficient means of getting nutrients into the plant, especially during the early stages of plant growth.

5. It did not seem to matter whether the fertilizer was liquid or dry.

6. No results were obtained in 1964 because of the very dry weather. All corn yields, regardless of treatments, were reduced over 50 percent.

7. Pop-up (starter) fertilizer alone is not sufficient. Additional fertilizer must be supplied especially with higher plant populations and narrower row spacing.

8. A fertilizer ratio of 1:2:1 or 1:3:1 or similar ratio high in phosphate and low in nitrogen and potash appears at present to be the better for pop-up (starter) fertilizer.

9. Different pop-up (starter) rates have been used but it appears now until different evidence is available that a total of 20 lbs. per acre of nitrogen and potash is the maximum amount. (Table 5. Plant Population)

10. If trace nutrients are needed it might be possible to add them in pop-up (starter) fertilizer. No work has been done in Minnesota on this practice.

11. The phosphate in the pop-up (starter) stimulates root growth and causes a rapid root proliferation. Previous root work has shown similar results.

12. Too much nitrogen and potash in contact with the seed will injure germination, delay emergence and reduce stand.

13. Potash appears to be more harmful than nitrogen regardless of moisture conditions. Seasonal differences in moisture and temperature shows up in a different response of each of the three major nutrients used in the pop-up (starter).
In 1963, a more normal season, all three nutrients were equally responsive. In 1964, which was very dry, the early phosphate response was most noticeable. However, in 1965 which was very wet and continued cold from early spring, the phosphate response was very poor but the nitrogen and potash gave the best response in growth with the nitrogen being the most responsive of all.

14. Pop-up (starter) fertilizer has increased emergence 3 to 5 days but the later the corn is planted and as the soil apparently becomes warmer this difference in emergences seems to diminish.

15. All basic fertilizer needs of nitrogen, phosphate and potash can be fall plow-down. Nitrogen may be expected on sandy soils.

16. Soil tests should be used to determine the basic fall plow-down fertilizer needs.

17. Broadcasting fertilizer is an old practice but has been brought up to date by custom fall plow-down offered by industry for the row crops.
It is now more universally used on all types of crops.

18. From 1959 through 1966 the broadcast plow-down of 300 and 600 lbs. of phosphate and potash as used in field 10 the 600 lbs. per acre was no better in response than the 300 lbs. per acre even though both rates were applied every 3rd year.

19. Only one years work (1966) with soybeans using pop-up (starter) with and without plow-down has been conducted. The maximum rate of a <u>total</u> of 20 lbs. of nitrogen and potash was not harmful to seed germination and growth. Lower rates of 14 and 7 lbs. per acre appeared about equal.

20. Soybeans were planted at two rates per acre, 60 and 45 lbs. per acre in 40 inch rows. The 45 lb. rate was generally higher in yield than the 60 lb. rate.

21. Nodulation and root proliferation on soybeans were both stimulated by the use of pop-up (starter) fertilizer.

22. Band fertilizer cost is cheaper than for custom plow-down because of the difference in amounts used per acre but in the case of the farmer the extra labor and time cost required in the spring for banding can offset the extra fertilizer cost for the custom fall plow-down. However, when considering costs and charges the most valuable period of a farmers time over the crop season probably is the period from April 15 to June 1 when he must figure his labor and time costs at a premium.

SOYBEAN FERTILIZATION

Questions have been raised about sidedressing soybeans with N the same as for corn. This practice was conducted on one field in 1966 with the following results. The rate of application was 80 lbs. of N applied on July 5 (1st cultivation) and another area sidedressed on July 29 (2nd cultivation). More work needs to be conducted. The later application of N gave 3.4 bushels increase over the earlier N sidedressed but no increase over the check. The residual fertilizer yield from the 1965 fertilized corn was the best with 26.6 bushels per acre. This is consistent with other years.

Fertilizer Treatment	Yield Bushel per acre
Check	25.0
Residual	26.6
Band (1)	21.6
Band + 80# N - July 5	21.6
Band + 80# N - July 29	25.0

(1) 300 lbs. per acre 4-12-24

POTASH PLACEMENT FOR ALFALFA HAY

Trials were continued in 1966 comparing plow-down potash and surface cultivation with field cultivator after plowing. This project was started in 1963. Yields were harvested in 1964, 1965 and 1966. In April 1966 all the treatments were repeated but were applied as topdressing with no cultivation. The total accumulative yields for the 3 years are as follows:

Total Tons per Acre Yield

2 cuttings per year

Check	0-60-0	0-120-0	0-0-120	0-0-240	0-60-0 0-0-120	0-60-0 0-0-240	0-120-0 0-0-120	0-120-0 0-0-240
Surface Cultivation								
9.06	9.55	11.33	6.62	9.20	11.79	13.88	12.26	15.08
Plow-down								
8.89	6.70*	7.10*	9.87	12.02	13.49	13.98	13.14	14.11

* 2 year yield. 1966 samples lost
Seeded April 25, 1963.
Variety - Vernal
Rate - 12 lbs. per acre with 1 bu. of oats per acre
Soil test: pH-7.0, P-low medium, K-medium
Limed - 3 tons per acre 1951.
Soil types - Port Byron S. L.-variable
Bold very fine sand loam - variable

These data indicate, in general, that the surface application is somewhat better than the plow-down. Potash alone was not effective. Phosphate appeared to be the main limiting nutrient. The higher rates of a combination of phosphate and potash produced the higher yields.

ALFALFA HAY YIELDS WITH PLOW-DOWN FERTILIZER 1966

Field trials of broadcast plow-down 0-20-20 fertilizer at two rates of 300 and 600 lbs. per acre were continued in 1966. The grade of fertilizer and the rates per acre were based on soil test. These treatments were repeated every three years on the same plots. The plots were established in 1959, 1960 and 1961. The yields of alfalfa in tons of hay per acre are as follows:

	Alfalfa Hay Yield in Tons per acre						
	Check	Plow-down (1) 1959-62-65		Plow-down (1) 1960-63-66		Plow-down (1) 1961-64-?	
Fertilizer rate (1)		300	600	300	600	300	600
Tons per acre	3.71	4.47	5.20	5.02	5.16	4.89	5.04

(1) 0-20-20 was plowed down on each plot every 3rd year at the rate of 300 and 600 lbs. per acre.

These data generally indicate there is little difference between the 300 and 600 lb. rate per acre of 0-20-20. The yield increase for the broadcast plow-down over the check ranged from .76 tons per acre of 300 lbs. per acre where the last treatment was made in 1965 to 1.49 tons per acre where the 600 lb. rate was made for the same year 1965.

BEEF PRODUCTION AND TIME OF FERTILIZER APPLICATION

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In 1951 a soil survey or a soil inventory was made on the Rosemount soils farm. This soil inventory gives the soil type, name, the percent slope and the seriousness of erosion or the amount of topsoil remaining. From this soil inventory information, landuse intensity was determined and established on the land as you see it today. Continuous row cropping is the most intensive use that can be applied on the level to undulating land while on the very rolling to steeper land permanent legume hay and pasture mixtures were established. Generally all land having an eight percent or more slope was established to permanent hay and pasture. On these rolling to steep slopes is where the Beef Cattle Grassland project is now located. Some of the slopes will run as high as 17 to 20 percent with little or no topsoil remaining. In some places gullies had to be filled before the permanent pasture and forage crops could be established.

To establish these permanent stands of pasture and hay forages lime and fertilizer must be applied. These needs should be determined by soil tests as the soil tests are the best guides we have to determine lime and fertilizer use. Besides the kind and amount of fertilizer to use the time and frequency are very important. This is not beginning to show in the production of beef per acre.