Table 10. Effect of NutraLime on soil pH, soluble salts, Bray P1, Olsen P, ammonium acetate extractable cations and DTPA extractable metals - Washington County.

						NH4OAc Extractable				DTPA Extractable							
Depth	Trmt	pH	Soluble Salts	Bray P	Olsen P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu	Pb	Ni	Cd	Cr
			mmhos/cm	ppm													
0 - 6"	0	5.3	0.20	67	43	236	1766	250	5.7	125	32.3	2.1	1.0	1.9	2.1	0.12	<0.03
	0.5x	7.0	0.47	133	77	258	3575	342	7.4	65	8.9	2.7	2.9	1.4	1.4	0.18	<0.03
	1.0x	7.4	0.43	151	91	243	4874	379	8.6	48	5.6	2.3	4.4	1.4	1.0	0.21	<0.03
	2.0x	7.6	0.33	209	105	293	5477	467	10.4	44	4.3	3.0	6.9	1.7	0.9	0.24	0.04
Significance		**	*	**	**	NS	**	**	**	**	**	*	**	NS	**	**	--
BLSD (5%)		0.5	0.14	26	31	--	647	61	1.2	35	9.0	0.6	0.9	--	0.5	0.02	--
Contrasts																	
Linear		**	NS	**	**	NS	**	**	**	**	**	*	**	NS	**	**	--
Quadratic		**	**	NS	NS	NS	**	NS	NS	*	**	NS	NS	*	*	**	--
6 - 12"	0	5.3	0.20	43	30	153	1966	285	6.7	111	24.0	1.5	0.9	1.5	2.0	0.09	<0.03
	0.5x	6.2	0.37	64	40	158	2690	341	8.5	87	13.3	1.9	1.5	1.3	1.8	0.11	<0.03
	1.0x	6.8	0.57	84	37	154	3437	372	9.7	73	8.2	1.5	2.1	1.1	1.5	0.11	0.03
	2.0x	6.6	0.30	90	45	172	3079	399	11.0	81	10.7	2.0	2.0	1.2	1.4	0.11	0.04
Significance		**	*	NS	NS	NS	*	NS	**	NS	*	NS	NS	NS	NS	NS	--
BLSD (5%)		0.7	0.22	--	--	--	1066	--	1.0	--	10.2	--	--	--	--	--	--
Contrasts																	
Linear		**	NS	NS	*	NS	*	*	**	NS	*	NS	NS	NS	*	NS	--
Quadratic		*	**	NS	NS	NS	*	NS	*	NS	*	NS	NS	NS	NS	NS	--
12 - 24"	0	5.8	0.20	10	8	99	2133	399	8.9	49	4.3	0.4	1.0	0.6	0.9	<0.02	0.04
	0.5x	6.0	0.20	10	8	90	2180	383	9.8	51	3.0	0.3	0.8	0.6	1.1	0.02	0.04
	1.0x	6.0	0.20	8	7	86	2154	379	10.9	46	2.9	0.2	0.7	0.6	1.0	0.02	0.04
	2.0x	6.1	0.23	16	12	109	2347	422	12.1	59	4.1	0.5	1.0	0.6	1.0	<0.03	0.04
Significance		NS	NS	*	NS	*	NS	NS	**	NS	NS	NS	NS	NS	NS	--	NS
BLSD (5%)		--	--	5	--	16	--	--	1.1	--	--	--	--	--	--	--	--
Contrasts																	
Linear		NS	NS	*	*	NS	NS	NS	**	NS	NS	NS	NS	NS	NS	--	NS
Quadratic		NS	NS	*	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	NS

NS = not significant, * = significant at 5%, ** = significant at 1%.

Table 11. Effect of NutraLime on nitric acid extractable elements - Dakota County.

DEPTH	Treatment	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Si	Na	Sr	S	Ti	V	Zn
		1 N Nitric Acid Extractable																									
		ppm																									
0 - 6 inches	0	1403	1.5	107	0.4	1.1	0.3	2696	1.1	0.8	4	593	9	<0.20	629	111	0.44	2.9	198	235	333	8	10	12	8	2.6	5
	0.5x	1904	2.0	122	0.4	1.6	0.8	5456	3.4	1.1	30	862	15	<0.20	899	191	0.67	3.2	921	263	610	22	14	20	13	3.8	12
	1.0x	2367	2.6	139	0.4	2.1	1.2	7694	5.4	1.2	55	1078	21	0.26	898	259	0.90	3.8	1639	284	797	41	18	29	17	4.4	19
	2.0x	2491	2.7	142	0.3	2.2	1.4	8767	6.2	1.3	65	1132	24	0.28	962	284	0.97	4.0	1916	312	847	45	20	31	19	4.5	22
Significance		**	**	**	NS	**	**	**	**	**	**	**	**	--	NS	**	**	NS	**	NS	**	**	**	**	**	**	**
BLSD (5%)		217	0.2	11	--	0.2	0.1	774	0.6	0.1	6	137	3	--	--	27	0.08	--	191	--	81	7	2	3	2	0.4	2
Contrasts																											
Linear		**	**	**	NS	**	**	**	**	**	**	**	**	--	*	**	**	*	**	*	**	**	**	**	**	**	**
Quadratic		**	**	*	NS	**	**	**	**	**	**	**	**	--	NS	**	**	NS	**	NS	**	**	**	**	**	**	**
6 - 12 inches	0	1447	1.4	98	0.3	0.8	0.2	1984	1.1	0.4	2	545	6	<0.21	502	47	0.43	2.0	49	82	375	9	11	12	10	2.3	4
	0.5x	1467	1.4	101	0.4	0.9	0.2	2280	1.1	0.5	4	566	10	<0.20	529	60	0.45	2.0	94	92	370	11	11	15	9	2.4	4
	1.0x	1511	1.5	105	0.4	0.9	0.2	2122	1.2	0.4	3	613	7	<0.22	511	55	0.46	2.1	95	82	389	13	11	19	11	2.5	4
	2.0x	1474	1.4	99	0.3	0.9	0.2	2235	1.2	0.4	4	557	8	<0.21	528	55	0.45	2.0	93	94	372	13	11	18	9	2.4	4
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	**	NS	*	NS	NS	NS
BLSD (5%)		--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	2	--	4	--	--	--
Contrasts																											
Linear		NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	**	NS	**	NS	NS	NS
Quadratic		NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
12 - 24 inches	0	702	0.8	40	0.1	<0.3	<0.1	1028	0.6	<0.1	2	389	2	<0.20	232	15	0.22	0.7	100	36	237	7	6	6	10	1.3	2
	0.5x	822	0.9	47	0.1	0.4	0.1	1174	0.7	<0.1	2	412	3	<0.20	282	15	0.25	0.6	84	42	250	9	7	8	11	1.6	2
	1.0x	790	0.9	47	0.1	0.3	0.1	1149	0.7	<0.1	2	426	3	<0.20	271	14	0.24	0.5	95	39	257	9	7	12	12	1.6	2
	2.0x	800	0.9	44	0.1	<0.4	0.1	1178	0.7	<0.1	2	416	3	<0.20	268	15	0.25	0.6	93	39	259	9	7	10	11	1.5	2
Significance		NS	NS	NS	NS	--	--	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD (5%)		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Contrasts																											
Linear		NS	NS	NS	NS	--	--	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Quadratic		NS	NS	NS	NS	--	--	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = not significant; * = significant at 5%, ** = significant at 1%.

Table 12. Effect of NutraLime on nitric acid extractable elements - Isanti County.

DEPTH	Treatment	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Si	Na	Sr	S	Ti	V	Zn
		1 N Nitric Acid Extractable																									
		ppm																									
0 - 6 inches	0	743	1.1	43	0.1	0.6	0.3	1178	0.7	<0.4	2	813	5	<0.20	124	133	0.26	2.1	97	337	155	8	4	10	12	2.6	4
	Lime	833	1.5	45	0.2	0.8	0.3	6332	0.9	0.5	3	947	6	<0.20	391	174	0.27	1.8	119	262	243	10	7	19	14	3.3	5
	0.5x	976	1.5	51	0.1	0.9	0.7	3235	2.2	0.6	20	951	9	<0.20	259	198	0.36	2.2	504	312	330	17	6	14	18	3.2	10
	1.0x	1133	1.8	56	0.1	1.1	0.9	4327	3.0	0.6	28	1031	11	<0.20	334	218	0.43	2.5	704	282	392	21	8	17	20	3.4	13
	2.0x	1244	2.0	61	0.2	1.2	1.0	4935	3.3	0.5	32	1186	12	<0.21	389	231	0.49	2.7	800	289	435	25	9	19	22	3.9	15
Significance		**	**	NS	NS	**	**	**	**	--	**	NS	**	--	**	**	**	*	**	NS	**	**	**	**	**	NS	**
BLSD (5%)		126	0.4	--	--	0.2	0.2	1440	0.5	--	7	--	1	--	88	29	0.06	0.5	149	--	50	4	2	4	2	--	2
Contrasts																											
Linear		**	**	*	NS	**	**	**	**	--	**	NS	**	--	**	**	**	**	**	NS	**	**	**	**	**	*	**
Quadratic		*	NS	NS	NS	*	**	*	**	--	**	NS	**	--	*	**	*	NS	**	NS	**	*	*	NS	**	NS	**
Lime vs 2.0x		**	*	*	NS	**	**	NS	**	--	**	NS	**	--	NS	**	**	**	**	NS	**	**	**	NS	**	NS	**
6 - 12 inches	0	753	1.0	31	0.1	0.4	0.2	1082	1.0	<0.2	1	802	4	<0.23	218	60	0.25	1.2	56	153	234	10	4	6	16	2.8	3
	Lime	760	1.1	33	0.1	0.5	0.2	1156	1.0	<0.2	2	1023	4	<0.20	179	85	0.26	1.5	96	149	209	9	4	7	17	3.3	3
	0.5x	880	1.2	37	0.1	0.6	0.4	1891	1.4	<0.3	7	901	6	<0.23	280	94	0.31	1.6	183	157	300	14	5	9	18	3.2	5
	1.0x	827	1.2	38	0.1	0.6	0.4	1985	1.4	<0.2	8	841	6	<0.21	249	100	0.33	1.7	210	146	263	14	5	9	17	2.9	5
	2.0x	811	1.2	38	0.1	0.6	0.3	1727	1.2	<0.2	6	876	5	<0.20	239	87	0.28	1.6	154	129	242	14	5	10	17	3.0	5
Significance		NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
BLSD (5%)		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--
Contrasts																											
Linear		NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	*	NS	*	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	*	*	--	*	NS	NS	--	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS
Lime vs 2.0x		NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
12 - 24 inches	0	1201	1.5	36	0.2	0.5	0.2	1728	1.8	<0.1	2	1264	4	0.49	577	25	0.39	1.8	115	149	552	18	6	7	27	4.3	4
	Lime	1161	1.5	34	0.2	0.5	0.3	1819	2.0	<0.1	2	1415	4	0.49	557	28	0.39	1.9	144	116	547	15	6	6	25	4.8	4
	0.5x	1233	1.5	34	0.2	0.6	0.2	1829	1.9	<0.1	3	1264	4	0.58	647	32	0.41	2.0	128	113	630	21	6	9	28	4.3	5
	1.0x	1081	1.3	32	0.2	0.5	0.2	1601	1.6	<0.1	2	988	4	0.42	495	26	0.36	1.7	90	106	463	16	6	10	25	3.6	3
	2.0x	1121	1.3	33	0.2	0.5	0.2	1691	1.7	<0.1	2	1144	4	<0.43	526	23	0.37	1.5	86	104	488	18	6	11	26	4.1	4
Significance		NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS
BLSD (5%)		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--
Contrasts																											
Linear		NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Lime vs 2.0x		NS	NS	NS	NS	NS	NS	NS	*	--	NS	NS	NS	--	NS	NS	NS	NS	*	NS	NS	NS	NS	**	NS	NS	NS

NS = not significant, * = significant at 5%, ** = significant at 1%.

Table 13. Effect of NutraLime on nitric acid extractable elements - Washington County.

DEPTH	Treatment	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni	P	K	Si	Na	Sr	S	Ti	V	Zn
		1 N Nitric Acid Extractable																									
		ppm																									
0 - 6 inches	0	1343	1.3	105	0.39	1.1	0.3	2357	0.8	0.6	4	506	8	<0.20	331	92	0.43	3.8	109	257	264	6	12	10	6	2.2	6
	0.5x	1523	1.7	123	0.39	1.7	0.8	5503	2.4	0.8	21	614	12	<0.20	518	154	0.52	4.4	566	298	492	14	17	14	8	3.3	13
	1.0x	1869	2.2	127	0.39	1.9	1.3	8271	4.3	1.1	39	765	15	<0.21	709	195	0.67	4.7	967	294	668	24	19	19	10	3.8	18
	2.0x	2368	2.8	141	0.39	2.5	2.0	11601	6.4	1.3	70	999	22	0.29	957	250	0.89	5.5	1740	379	886	42	24	27	14	4.6	29
Significance		**	**	**	NS	**	**	**	**	**	**	**	**	--	**	**	**	**	**	*	**	**	**	**	**	**	**
BLSD (5%)		164	0.2	16	--	0.2	0.2	1480	0.6	0.1	7	59	1	--	105	15	0.06	0.6	192	78	79	3	3	6	2	0.4	2
Contrasts																											
Linear		**	**	**	NS	**	**	**	**	**	**	**	**	--	**	**	**	**	**	**	**	**	**	**	**	**	**
Quadratic		NS	NS	NS	NS	*	NS	*	*	*	NS	NS	NS	--	NS	**	NS	NS	NS	NS	*	NS	NS	NS	NS	**	NS
6 - 12 inches	0	1418	1.4	107	0.40	1.0	0.3	2526	0.9	0.4	4	534	7	<0.21	408	69	0.45	3.8	73	168	343	7	13	9	8	2.3	5
	0.5x	1390	1.4	115	0.40	1.2	0.4	3658	1.3	0.5	9	536	8	<0.21	486	82	0.46	4.2	191	175	397	11	15	11	8	2.7	8
	1.0x	1591	1.7	116	0.40	1.3	0.6	4908	2.1	0.5	17	614	9	<0.24	609	96	0.53	4.1	375	177	495	16	16	16	10	3.0	10
	2.0x	1601	1.7	114	0.39	1.4	0.6	4508	1.9	0.6	16	624	10	<0.22	587	100	0.55	3.8	378	201	470	18	16	16	10	3.0	10
Significance		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	*	*	NS
BLSD (5%)		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8	--	--	2	0.5	--
Contrasts																											
Linear		NS	*	NS	NS	NS	NS	*	NS	*	NS	NS	*	--	*	NS	*	NS	NS	NS	*	*	NS	*	*	*	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
12 - 24 inches	0	1515	1.4	91	0.34	0.7	0.2	2434	1.1	<0.2	3	676	6	0.34	628	26	0.48	2.1	24	104	528	10	15	5	16	2.9	5
	0.5x	1391	1.3	95	0.35	0.8	0.2	2520	1.1	0.2	3	605	5	0.30	588	24	0.45	2.6	19	92	483	11	15	6	16	2.7	5
	1.0x	1403	1.3	95	0.34	0.8	0.2	2515	1.1	0.2	4	677	5	0.34	619	24	0.46	2.4	24	89	529	12	15	8	18	2.9	5
	2.0x	1557	1.5	99	0.34	0.9	0.2	2961	1.2	0.2	5	649	6	0.31	639	34	0.50	2.5	72	117	501	14	16	12	14	2.9	5
Significance		*	*	NS	NS	NS	NS	NS	NS	--	*	NS	NS	NS	NS	NS	NS	NS	*	*	NS	*	NS	*	NS	NS	NS
BLSD (5%)		109	0.1	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	29	19	--	1	--	4	--	--	--
Contrasts																											
Linear		NS	*	NS	NS	NS	*	NS	NS	--	**	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	**	NS	**	NS	NS	NS
Quadratic		**	**	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	NS	NS	*	NS	*	*	NS	NS	NS	NS	NS	NS	NS

NS = not significant; * = significant at 5%, ** = significant at 1%.

Table 14. Effect of NutraLime on the elemental composition of seed corn whole plant samples, July 20, 1993 - Dakota Co.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	2.90	0.36	2.85	0.41	0.46	60	104	11	38	22.6	5.8	6.5	2.17	1.23	1.39	0.25	0.67
0.5x	2.82	0.37	2.36	0.47	0.48	76	125	11	45	22.1	6.6	6.7	2.10	1.52	1.86	0.25	3.50
1.0x	2.84	0.35	2.45	0.48	0.52	78	122	13	32	22.5	6.9	6.2	2.15	1.44	1.76	0.27	4.35
2.0x	3.14	0.39	2.86	0.44	0.44	67	124	12	37	24.8	7.1	6.6	2.04	1.19	1.45	0.25	4.58
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.43
Contrasts																	
Linear	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**
Quadratic	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 15. Effect of NutraLime on the elemental composition of seed corn ear leaf samples, August 6, 1993 - Dakota Co.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	3.19	0.38	1.53	0.65	0.50	38	134	<4	40	18.6	5.4	7.8	<1.68	0.64	0.82	<0.13	0.90
0.5x	3.07	0.39	1.40	0.73	0.59	38	140	<4	32	17.1	6.6	7.1	<1.68	0.66	0.83	0.13	4.82
1.0x	3.17	0.39	1.44	0.73	0.57	29	128	<4	27	18.7	7.0	7.8	<1.68	0.63	0.78	0.13	6.13
2.0x	3.28	0.39	1.52	0.69	0.53	32	122	<6	35	19.0	7.5	7.9	<1.68	0.63	0.80	0.15	7.83
Significance	NS	NS	NS	NS	NS	NS	*	--	NS	NS	NS	NS	--	NS	NS	--	**
BLSD (5%)	--	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--	1.73
Contrasts																	
Linear	NS	NS	NS	NS	NS	NS	**	--	NS	NS	*	NS	--	NS	NS	--	**
Quadratic	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	--	NS	NS	--	*

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 16. Effect of NutraLime on the elemental composition of seed corn stover samples, September 1, 1993 - Dakota Co.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	1.67	0.27	1.19	0.35	0.39	68	139	6	37	16.0	4.3	6.4	<1.68	0.66	0.83	0.14	0.58
0.5x	1.46	0.23	0.93	0.35	0.42	54	98	<7	26	13.2	3.9	6.0	<1.68	0.65	0.82	<0.13	1.90
1.0x	1.73	0.26	1.06	0.41	0.44	77	122	<6	26	15.1	4.3	6.9	<1.68	0.73	0.92	0.14	3.55
2.0x	1.65	0.26	1.04	0.32	0.37	72	126	6	23	15.4	4.5	6.9	<1.68	0.73	0.92	<0.16	3.35
Significance	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	--	NS	NS	--	**
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.56
Contrasts																	
Linear	NS	NS	NS	NS	NS	NS	NS	--	*	NS	NS	NS	--	NS	NS	--	**
Quadratic	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS	--	NS	NS	--	**

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 17. Effect of NutraLime on the elemental composition of seed corn cob samples, September 1, 1993 - Dakota Co.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	0.84	0.16	0.87	0.02	0.11	<4	23	<5	12	25.5	3.5	3.9	<1.68	0.93	0.87	<0.12	0.29
0.5x	1.12	0.22	1.08	0.03	0.14	5	25	<4	13	30.0	4.4	4.8	<1.68	0.80	0.78	<0.12	0.66
1.0x	1.09	0.22	1.03	0.03	0.14	5	29	<4	13	31.1	4.4	4.8	<1.68	0.98	0.90	<0.12	0.80
2.0x	0.96	0.20	0.91	0.02	0.12	<4	23	<4	10	28.6	3.9	4.0	<1.68	0.89	0.82	<0.12	0.77
Significance	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	NS	--	**
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.24
Contrasts																	
Linear	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	NS	--	**
Quadratic	NS	NS	*	*	*	--	*	--	NS	NS	*	*	--	NS	NS	--	**

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 18. Effect of NutraLime on the elemental composition of seed corn kernel samples, September 1, 1993 - Dakota Co.

Treatment	N	P	K	Mg	Ca	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%				ppm												
0	1.93	0.64	0.80	0.25	78	<4	39	<4	13	30.7	1.5	4.5	<1.68	0.69	0.54	<0.12	0.31
0.5x	1.92	0.61	0.76	0.24	77	<4	37	<4	12	29.9	1.7	4.4	<1.68	0.60	0.53	<0.12	0.69
1.0x	2.02	0.55	0.75	0.22	82	<4	34	<4	11	27.5	1.6	4.1	<1.68	0.70	0.54	<0.12	0.70
2.0x	2.04	0.77	0.94	0.32	93	<4	46	<4	16	39.1	1.8	5.3	<1.68	0.56	0.53	<0.12	0.81
Significance	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	NS	--	**
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.22
Contrasts																	
Linear	*	NS	NS	NS	NS	--	NS	--	NS	*	NS	NS	--	NS	NS	--	**
Quadratic	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	NS	--	*

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 19. Effect of NutraLime on the elemental composition of corn whole plant samples, July 6, 1993 - Washington county.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%			ppm													
0	3.61	0.41	4.98	5339	2464	113	152	14	77	48.0	7.1	6.3	<1.84	1.78	1.86	0.33	0.58
0.5x	3.51	0.43	4.72	6604	2872	87	131	13	70	44.3	7.6	6.5	<1.97	1.41	1.49	0.36	3.83
1.0x	3.36	0.43	4.75	6422	3032	77	125	10	57	34.8	7.6	6.5	<1.81	1.78	1.94	0.37	5.78
2.0x	3.28	0.45	4.91	6011	2842	76	119	10	50	36.0	7.4	6.5	<1.86	1.46	1.52	0.36	8.65
Significance	*	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	--	NS	NS	NS	**
BLSD (5%)	0.22	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	3.45
Contrasts																	
Linear	**	NS	NS	NS	NS	NS	*	NS	**	*	NS	NS	--	NS	NS	NS	**
Quadratic	NS	NS	NS	*	*	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 20. Effect of NutraLime on the elemental composition of corn ear leaf samples, August 6, 1993 - Washington county.

Treatment	N	P	K	Ca	Mg	S	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%						ppm											
0	2.93	0.34	2.73	0.60	0.22	0.27	19	98	12	74	31.1	6.2	4.6	<1.68	0.48	0.62	<0.14	0.47
0.5x	3.06	0.35	3.11	0.71	0.24	0.27	23	95	20	51	28.2	7.4	5.0	<1.68	<0.46	0.63	0.16	4.35
1.0x	2.84	0.35	2.93	0.74	0.23	0.26	24	96	13	54	28.2	7.8	5.0	<1.68	0.52	0.70	0.19	5.99
2.0x	3.06	0.37	3.08	0.69	0.22	0.28	26	101	18	48	25.9	7.7	5.2	<1.68	0.55	0.75	0.17	9.17
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	--	*	--	**
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.08	--	3.31
Contrasts																		
Linear	NS	*	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	--	--	**	--	**
Quadratic	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	--	NS	--	NS

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 21. Effect of NutraLime on the elemental composition of corn stover samples, October 12, 1993 - Washington county.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	0.85	0.07	1.86	0.37	0.17	128	129	10	55	10.8	3.6	3.9	<1.86	0.67	0.79	0.17	<0.33
0.5x	0.95	0.11	2.27	0.48	0.18	231	212	21	40	9.8	4.5	4.5	<1.98	0.90	1.06	0.19	2.64
1.0x	1.00	0.09	2.04	0.52	0.20	133	137	11	46	9.9	4.5	4.4	2.02	0.79	0.85	0.22	3.35
2.0x	1.06	0.10	2.14	0.51	0.20	226	210	17	38	9.6	5.1	4.9	<2.14	1.07	1.32	0.24	5.06
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	*	--	NS	NS	NS	**
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	0.7	0.5	--	--	--	--	1.80
Contrasts																	
Linear	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	**	--	NS	NS	*	**
Quadratic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	NS	NS

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 22. Effect of NutraLime on the elemental composition of corn cob samples, October 12, 1993 - Washington county.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	0.49	0.04	1.22	0.02	0.02	<4	14	<4	11	15.9	2.5	2.1	<1.68	1.13	1.26	<0.12	<0.23
0.5x	0.49	0.04	1.18	0.02	0.01	<4	15	<4	7	10.9	2.3	2.0	<1.68	1.14	1.29	<0.12	0.38
1.0x	0.48	0.04	1.04	0.02	0.01	<4	14	<4	9	11.0	2.6	2.0	<1.68	1.07	1.21	<0.12	0.39
2.0x	0.45	0.05	1.22	0.02	0.01	<4	14	<4	7	8.6	2.3	1.9	<1.68	1.28	1.53	<0.12	0.56
Significance	NS	NS	NS	NS	NS	--	NS	--	*	**	NS	NS	--	NS	NS	--	**
BLSD (5%).	--	--	--	--	--	--	--	--	3	2.9	--	--	--	--	--	--	0.14
Contrasts																	
Linear	NS	NS	NS	NS	NS	--	NS	--	*	**	NS	NS	--	NS	NS	--	**
Quadratic	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	NS	--	NS

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 23. Effect of NutraLime on the elemental composition of corn kernel samples, October 12, 1993 - Washington county.

Treatment	N	P	K	Mg	Ca	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%				ppm												
0	1.35	0.28	0.44	0.12	56	<4	21	<4	8	22.0	1.5	1.7	<1.68	<0.55	<0.31	<0.12	<0.24
0.5x	1.42	0.29	0.42	0.12	50	<4	19	<4	6	18.0	1.3	1.4	<1.68	<0.50	<0.29	<0.12	0.39
1.0x	1.38	0.31	0.45	0.12	55	<4	19	<4	6	18.2	1.4	1.5	<1.68	<0.53	<0.52	<0.12	0.56
2.0x	1.41	0.31	0.45	0.12	56	<4	19	<4	6	18.2	1.7	1.6	<1.78	<0.53	<0.31	<0.12	0.55
Significance	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	--	--	*
BLSD (5%)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.19
Contrasts																	
Linear	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	--	--	**
Quadratic	NS	NS	NS	NS	NS	--	NS	--	NS	NS	NS	NS	--	NS	--	--	NS

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 24. Effect of NutraLime on the elemental composition of alfalfa samples, July 12, 1993 - Isanti county.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	1.92	0.28	2.47	1.29	0.17	40	63	38	62	31.1	8.2	32.4	<1.79	1.99	0.63	<0.22	<0.57
Lime	2.99	0.33	3.28	0.99	0.23	29	65	53	41	24.8	8.9	19.5	<1.69	1.05	0.62	<0.13	3.23
0.5x	3.25	0.34	3.05	1.27	0.17	24	63	54	34	22.4	8.3	25.0	<1.76	1.19	0.57	<0.14	9.66
1.0x	3.20	0.34	3.06	1.33	0.17	21	62	54	35	22.0	8.6	26.8	<1.68	1.07	0.55	<0.12	13.80
2.0x	2.98	0.32	2.89	1.17	0.15	19	54	60	28	19.6	7.9	24.0	<1.68	0.79	0.49	<0.12	14.05
Significance	**	*	**	NS	*	NS	NS	NS	*	*	NS	*	--	NS	NS	--	**
BLSD (5%)	0.44	0.04	0.26	--	0.04	--	--	--	20	6.5	--	6.0	--	--	--	--	2.67
Contrasts																	
Linear	**	NS	*	NS	NS	*	NS	*	**	**	NS	*	--	*	NS	--	**
Quadratic	**	**	**	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	NS	NS	--	**
Lime vs 2.0x	NS	NS	**	NS	**	NS	NS	NS	NS	NS	*	NS	--	NS	NS	--	**

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

Table 25. Effect of NutraLime on the elemental composition of alfalfa samples, August 26, 1993 - Isanti county.

Treatment	N	P	K	Ca	Mg	Al	Fe	Na	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd	Mo
	%					ppm											
0	3.62	0.34	3.24	1.17	0.19	41	102	68	76	37.7	10.3	29.0	<1.68	3.74	<0.35	<0.17	0.39
Lime	3.42	0.32	3.54	0.94	0.17	23	74	58	45	27.5	9.1	17.9	<1.68	1.58	<0.30	<0.12	1.59
0.5x	3.37	0.33	3.32	1.19	0.16	19	74	81	43	20.7	8.4	20.6	<1.68	2.17	<0.28	<0.12	4.90
1.0x	3.13	0.32	3.33	1.11	0.14	21	68	70	30	19.5	8.1	23.1	<1.68	1.60	<0.31	<0.12	7.49
2.0x	3.26	0.33	3.36	1.20	0.15	22	76	87	31	19.8	8.4	25.0	<1.68	1.80	<0.33	<0.12	9.01
Significance	**	NS	NS	**	NS	NS	NS	NS	*	**	**	*	--	*	--	--	**
BLSD (5%)	0.21	--	--	0.13	--	--	--	--	31	7.0	0.9	5.5	--	1.53	--	--	2.90
Contrasts																	
Linear	**	NS	NS	NS	*	NS	NS	NS	**	**	**	NS	--	*	--	--	**
Quadratic	**	NS	NS	NS	*	NS	*	NS	*	**	**	*	--	*	--	--	*
Lime vs 2.0x	NS	NS	NS	**	NS	NS	NS	**	NS	*	NS	*	--	NS	--	--	**

NS = nonsignificant, * = significant at 5%, ** = significant at 1%.

EFFECTS OF TILLAGE AND LIQUID DAIRY MANURE ON NITROGEN AVAILABILITY TO CORN AND INFILTRATION[1]

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Abstract: The study to determine the influence of tillage and manure application on corn production at the Dale Flueger farm in Goodhue county, MN was continued in 1993. Results from 1993 showed reduced yields and higher moisture contents than the long term average at this site. Annually applied manure produced the greatest yields (83 bu/A) and anhydrous ammonia applied at 180 lb N/A produced 59 bu/A. Biennially applied manure produced 74 bu/A of grain in the year of application and 64 bu/A of grain in the year following application. Triennially applied manure produced 88 bu/A the year of application, 71 bu/A the year after application, and 54 bu/A two years after application. The amount of surface residue left by the various tillage and N treatments and the corn population was similar to previous years. An unusually wet, cool summer, and the late planting date may have been responsible for the low yields.

Introduction

This study is being conducted to determine the long term impacts of tillage and frequency of manure application on corn yield and soil N levels. The Dale Flueger farm is located near Red Wing in Goodhue County, Minnesota. The research plots are on a Seaton silt loam soil. This study began in 1982.

The experimental design is a randomized complete block with tillage main plots (chisel plow and no till) with N source (commercial fertilizer and manure) and N frequency (annual, biennial, and triennially applied manure) subplots. Liquid dairy manure is injected each spring into the chisel plow and no till annual manure plots, and into the biennial manure plots that did not receive manure the previous year. Triennially applied manure plots only receive chisel plowing, and liquid dairy manure is injected at the same time into the plots that did not receive manure over the previous two years. Commercial fertilizer (anhydrous ammonia) was applied about two months after the manure injection. Zero N check treatments are also included in this study. Refer to table 1 for details on N treatments and other cultural practices.

From 1982 to 1986 the manure treatments were split with 0 and 200 lbs/A K_2O treatments, and the commercial fertilizer treatments were split with 0, 200, and 400 lbs/A K_2O treatments. These potassium additions were stopped in 1987, but some data in this report is split by K_2O treatment to check for residual effects of the added potassium.

Results and Discussion

Residue Cover and Corn Population. Residue and population counts were both taken on June 24, 1993. Residue was measured in duplicate in and between the rows for all plots. Population counts were made in duplicate for all plots. A table of significance of treatment effects on residue cover and population is provided in table 3. Residue cover between the row in the no till system resulted in about 62.4% residue cover (Table 2). Residue cover was reduced to 38% between the row in the no till system with the injection of liquid dairy manure. Chisel plowing reduced residue cover to around 20% between the rows for all plots. Plant population was at or near planting rate for all treatments. The row area is defined as the three inches on both sides of the corn plant, between the row is the remaining thirty-two inches.

Grain yields, Moisture, percent N, and N uptake: Biennial study.
The effects of the various annual and biennial treatments on corn grain yields, grain moisture, and grain percent N, can be found in Table 4. Grain yields were dramatically lower than in previous years. The trend of yields were as follows: annual manure>biennial manure in year of application>biennial manure in the year following application>commercial fertilizer. Grain moisture was about 33% lower in 1993 compared to 1992, most likely due to the delayed date of harvesting. Grain percent N was generally around 1.55%, except for biennial manure the year of application which contained only 1.17% N. Grain N uptake can also be found in Table 4, and was similar to grain percent N.

Grain yields, Moisture, and percent N: triennial study.
The effects of the various triennial treatments on corn grain yields, grain moisture, and grain percent N can be found in Table 5. Grain yields, as expected, decreased with each year after N was applied. Triennially applied manure in the year of application produced similar yields and held grain moisture to about the same level as annually applied manure.

[1] Support for this project in part was provided by a USDA-CSRS, LCMR, and the Soil Conservation Service. Their support is greatly appreciated.

[2] Research Assistant, Associate Professor, Professor, and Assistant Scientist respectively, at Soil Sci. Dept., University of Minnesota, St. Paul, MN 55108.

Rainfall Simulation.
Rainfall simulations were run on several plots from 7/6/93 to 8/3/93. The rainfall simulator consisted of a water tank, pump, and panels with hypodermic needles. The water was pumped into the panels at the rate of 100 mm/hour. The runoff and Sediment was collected from a bordered 152 x 90 cm plot into a large cylinder where runoff volume was measured and sediment samples were taken. The infiltration rate, sediment load, and time that runoff began can be found in table 6. Infiltration rate was significantly higher and sediment load was significantly lower for no till than chisel plow. Infiltration rate was also significantly higher for the annual manure treatment than for the annual fertilizer and the check plots. The time to the beginning of runoff showed no significant differences.

Infiltration rates, Organic carbon, and Bulk Density.
Saturated infiltration reading were taken using double ring infiltrometers from 9/23-10/9. Tension infiltrometers were used to take one dimensional tension infiltration readings at -3.5 cm and -7.0 cm tension during this same time period. Unlike the rainfall simulation, chisel plow and annual manure plots had significantly higher saturated infiltration rates than no till and annual fertilizer plots respectively. The difference is believed to be due to the increased formation of a surface crust on the chisel plow plots during rainfall simulation due to the lack of residue cover. Tension infiltrometer readings were not significantly different. Organic carbon samples were taken on 6/24/93 at 0-3 inches and 3-6 inches, and they showed no significant differences between treatments. Bulk density measurements were taken on 8/6/93 at 1-3 inches, 5-7 inches, and 9-11 inches, and they showed chisel plow and annual manure treatments were significantly lower than no till and annual fertilizer treatments respectively. These results can be seen in table 7.

Table 1. 1993 cultural practices at the Flueger farm in Goodhue County, MN.

Soil: Seaton silt loam (mixed, mesic, fine silty Typic hapludalf), well drained, 2 to 12% slope.

Cropping History:

1981-1988	Corn	Pioneer 3906
1989	Corn	Pioneer 3737
1990	Corn	Pioneer 3751
1991	Corn	NK 3624
1992-1993	Corn	Pioneer 3751

Manure Application and Analysis: Liquid dairy manure injected on May 20, 1993.

	1993 rate Mean
Manure (gal/A)	7675
Total N (lbs/A)	300
NH_4 N (lbs/A)	130
Solids (%)	9.0

Fertilizer:

Material	Tillage	N (lbs/A)	Date Applied	Application
82-0-0	Both	180	July 24,1993	Injected
5-14-42	Both	6	June 4,1993	As a starter

Planting and Harvest Information: A four row John Deere Maxi-Emerge planter with two inch fluted coulters was used to plant on June 4, 1993. Corn was harvested on Nov 27, 1993.

Insect control: 5.2 lbs/A Thimet 20G applied June 4, 1993.

Weed Control: .75 lbs/A Prowl and 1.2 lbs/A Bladex 90 DF applied on June 18, 1993.

Table 2. Surface residue cover and population as affected by tillage, N source, and row position at the Flueger farm in Goodhue Co., MN, measured on 6/24/93.

N source AND FREQUENCY	Row POSITION	RESIDUE (%) NO TILL	RESIDUE (%) CHISEL	Pop. (1000 plants/A) NO TILL	Pop. (1000 plants/A) CHISEL
Annual Manure	In	38.0	11.0	27.0	28.4
	Between	62.2	24.3		
Anhydrous Ammonia	In	67.4	12.1	27.9	28.1
	Between	84.2	22.5		
Biennial Manure	In	29.0	15.7	26.1	28.0
(yr. of application)	Between	26.3	18.0		
Biennial Manure	In	59.0	11.7	26.6	27.2
(yr after application)	Between	77.0	21.3		
			Average	**26.9**	**27.9**

Table 3. Significance table for surface residue cover and population at the Flueger Farm in Goodhue Co., MN.

	Till(T)	N treatment(N)	T*N	Row(R)	T*R	N*R	T*N*R
Residue	.000	.000	1.00	.000	.023	.065	1.00
Population	.255	.753	.814	----	----	----	----

Table 4. Grain yield, grain moisture, and grain N percentage as influenced by tillage, N source and frequency and potassium rates at the Flueger farm in Goodhue Co., MN.

N source & freq.	K_2O lbs/A	Grain Yield NoTill	Grain Yield Chsl	Grain Yield Mean	Grain Moisture NoTill	Grain Moisture Chsl	Grain Moisture Mean	Grain N NoTill	Grain N Chsl	Grain N Mean	Grain N uptake No Till	Grain N uptake Chisel	Grain N uptake Mean
		------bu/A------			--------%-------			-------%--------			--------lbs/A--------		
Annual	0	67	90	**79**	29.7	25.0	**27.4**	1.40	1.47	**1.44**	44.6	63.0	**53.8**
Manure	200	85	104	**95**	25.2	23.3	**24.3**	1.58	1.52	**1.55**	62.8	74.4	**68.6**
	Mean	**76**	**97**	**87**	**28.5**	**24.1**	**26.3**	**1.49**	**1.50**	**1.50**	**53.7**	**69.7**	**61.2**
Biennial	0	77	80	**79**	27.5	26.1	**26.8**	1.30	1.22	**1.26**	46.0	47.2	**46.6**
Manure	200	51	88	**70**	29.7	21.5	**25.6**	1.14	1.02	**1.08**	27.3	43.0	**35.2**
(yr of)	**Mean**	**64**	**84**	**74**	**28.6**	**23.8**	**26.2**	**1.22**	**1.12**	**1.17**	**36.7**	**45.1**	**40.9**
Biennial	0	57	78	**68**	33.2	26.1	**29.7**	1.54	1.53	**1.54**	41.6	56.7	**49.2**
Manure	200	54	72	**63**	31.7	21.5	**26.6**	1.62	1.38	**1.50**	41.6	47.0	**44.3**
(yr after)	**Mean**	**56**	**75**	**66**	**32.5**	**24.2**	**28.3**	**1.58**	**1.46**	**1.52**	**41.6**	**51.9**	**46.7**
Anhydrous	0	41	72	**57**	33.2	22.6	27.9	1.55	1.57	**1.56**	30.9	53.6	**42.3**
Ammonia	200	51	67	**59**	28.8	25.3	**27.1**	1.61	1.63	**1.62**	38.9	51.4	**45.2**
	400	51	75	**63**	29.7	21.9	**25.8**	1.63	1.60	**1.62**	38.7	56.7	**47.7**
	Mean	**48**	**71**	**60**	**30.6**	**23.3**	**27.0**	**1.60**	**1.60**	**1.60**	**36.2**	**53.9**	**45.1**
Overall Mean		**61**	**82**	**72**	**30.1**	**23.9**	**27.0**	**1.47**	**1.42**	**1.45**	**42.1**	**55.2**	**48.6**
Check (0 N)[1]		37	55	**46**	31.5	27.3	**29.4**	1.21	1.21	**1.21**	20.8	31.2	**26.0**

	Till(T)	N source(N)	T*N	K rate(K)	K*T	K*N	K*N*T
Grain Yield	.076	.001	.900	.687	.851	.375	.333
Grain Moisture	.122	.385	.757	.357	.860	.880	.299
Grain N %	.492	.000	.469	.727	.250	.017	.609
N uptake	.167	.000	.339	.703	.986	.129	.670

[1] Check plots not included in the statistical analysis.

Table 5. Grain yields, percent moisture, and N percentage at harvest for triennially applied manure with chisel plowing system at the Flueger farm in Goodhue Co., MN.

Year of manure Application	K_2O lbs/A	Grain Yield ---bu/A----	Grain Moisture ------%-----	Grain N ---%---	N Uptake --lbs/a--
First Year	0	88	24.8	1.09	45.4
	200	88	22.8	1.09	45.4
	Mean	**88**	**23.8**	**1.09**	**45.4**
Second Year	0	73	24.7	1.43	49.4
	200	69	23.6	1.35	44.1
	Mean	**71**	**24.2**	**1.39**	**46.7**
Third Year	0	60	27.7	1.28	36.3
	200	49	28.0	1.15	26.7
	Mean	**55**	**27.9**	**1.22**	**31.8**

Table 6. Infiltration rates, sediments, and time to beginning of runoff for rainfall simulation at the Flueger farm in Goodhue, Co., MN, measured 7/6/93 through 8/3/93.

Nsource	Inf. rate			Sediments			Time to runoff		
	Notill	Chisel	Mean	Notill	Chisel	Mean	Notill	Chisel	Mean
	--------mm/hr-----			-------T/ha-------			--------min-------		
Annual manure	58.0	20.3	**39.2**	2.6	15.4	**9.0**	16.2	11.2	**13.7**
Fertilizer	33.9	11.3	**22.6**	.8	11.2	**6.0**	12.5	5.8	**9.2**
Check	20.3	19.9	**20.1**	5.9	6.8	**6.4**	9.0	6.2	**7.6**
Mean	**37.4**	**17.2**	**27.3**	**3.1**	**11.1**	**7.1**	**12.6**	**7.7**	**10.2**

	Till(T)	Nsource(N)	T*N
Inf. Rate	.031	.073	.337
Sediments	.035	.672	.267
Time to Runoff	.132	.176	.267

Table 7. Infiltration rates (taken 9/23 through 10/9), organic carbon (taken 6/24), and bulk density measurements (taken 8/6) at the Flueger farm in Goodhue Co., MN.

Nsource & freq.	Inf. Rate									Organic Carbon					
	SAT			-3.5			-7.0			0-3 in			3-6 in		
	Notil	Chsl	Mean	Notil	Chsl	Mean	Notil	Chsl	Mean	Notil	Chsl	Mean	Notil	Chsl	Mean
	mm/hr									%					
Annual manure	293	587	**440**	61	137	**99**	31	12	**22**	1.47	1.67	**1.57**	1.20	1.33	**1.27**
Fertilizer	139	293	**216**	25	84	**55**	8	18	**13**	1.57	1.57	**1.57**	1.43	1.30	**1.37**
Check	180	392	**286**	49	28	**39**	6	19	**13**	1.37	1.27	**1.32**	1.00	1.17	**1.09**
Mean	**204**	**424**	**314**	**45**	**83**	**64**	**15**	**16**	**16**	**1.47**	**1.50**	**1.49**	**1.21**	**1.27**	**1.24**

	Bulk Density											
	1-3 in			5-7 in			9-11 in			1-11 in		
	Notil	Chsl	Mean	Notil	Chsl	Mean	Notil	Chsl	Mean	Notil	Chsl	Mean
	Mg/m^3											
Annual manure	1.32	1.41	**1.37**	1.44	1.32	**1.38**	1.53	1.46	**1.50**	1.43	1.39	**1.41**
Fertilizer	1.59	1.28	**1.44**	1.49	1.40	**1.45**	1.57	1.50	**1.54**	1.55	1.39	**1.47**
Check	1.47	1.41	**1.44**	1.46	1.33	**1.40**	1.54	1.51	**1.53**	1.49	1.42	**1.46**
Mean	**1.46**	**1.37**	**1.42**	**1.46**	**1.35**	**1.41**	**1.55**	**1.49**	**1.52**	**1.49**	**1.40**	**1.45**

	Till(T)	Nsource(N)	T*N	Depth(D)	D*T	D*N	D*T*N
Saturated	.057	.042	.652	----	---	---	----
-3.5 cm	.305	.144	.241	----	---	---	----
-7.0 cm	.794	.500	.171	----	---	---	----
Organic C.	.661	.108	.621	.002	.864	.811	.415
Bulk Density	.039	.053	.001	.000	.449	.756	.009

TILLAGE COMPARISON AT ROSEMOUNT, 1993[1]

T.L Hansmeyer, D.R. Linden, K.L. Walters,
R.H. Dowdy, R.R. Allmaras and C.E. Clapp[2]

ABSTRACT: A long term tillage system study was initiated at Rosemount in 1991. Four tillage systems including Conventional Tillage, Conservation Tillage, Ridge Tillage, and Minimum Tillage are used in a continuous corn and corn/soybean rotation. Nitrogen inputs remained constant across all plots planted to corn with no nitrogen applied to plots in soybeans. The objectives of the study are to determine the long term effects of various cropping systems on herbicide movement, earthworm activity, grain yield, nutrient availability and nutrient uptake. Though it is too early in the study to examine the differences in many of the objectives, grain yields and surface residue have proven to be significantly different in various tillage and rotation comparisons.

Site An 18 acre site at the Rosemount Agricultural Experiment Station was chosen for study. The dominant soil type is a Waukegon silt loam (Typic Hapludoll) which has 20 to 32 inches of silt loam overlying calcareous sand and gravel with a slope of less than 2%. The site was grid sampled for elevations and depth to gravel prior to plot layout.

Experimental Procedure The site was separated into 36 plots of 0.4 acre each. A continuous corn (CC),corn/soybean (CS) [corn 1993], and soybean/corn (SC) [soybean 1993] rotations were planted into four tillage systems in a randomized complete block design with three replications. The four tillage systems are described as follows:

CONVENTIONAL (T1):
Fall moldboard plow following corn and fall chisel plow following soybeans. Disk or field cultivate to prepare seedbed. One or two cultivations after planting as needed.

CONSERVATION (T2):
Fall chisel plow following corn with no fall tillage following soybeans. Disk and/or field cultivate to prepare seedbed for soybean. Corn is no-tilled into soybean stubble. One or two cultivations after planting as needed.

RIDGE-TILL (T3):
No fall tillage following corn or soybeans (stalks chopped in the fall following corn harvest). Planting done in ridges formed by previous cultivation. Two cultivations following planting to control weeds and reestablish ridges.

MINIMIZED (TACTICAL) TILLAGE (T4):
Generally, no primary or secondary tillage is prescheduled. Tillage will be performed only when soil or weed conditions require attention. Cultivation performed only when determined necessary.

Prepared seedbed by discing all Conventional and the CC and SC rotations of Conservation tillage plots. Corn (Pioneer 3751) was planted in the CC and CS plots across all tillage systems on May 14. The seeds were planted at a population of 26,000 seeds/acre. Force insecticide was banded over the row at a rate of 9 oz./1000 ft of row. Corn and soybean emergence was counted from two 20' sections of row of each plot periodically throughout the first 5 weeks after planting. Alachlor (Lasso) was broadcast at a rate of 2 qt product/acre on all CC and CS plots May 16. Soybeans (Hodgsen 78) were planted into the SC plots on June 4. All soybeans were planted at the rate of 60 lbs/acre. Alachlor (Lasso) was broadcast at the rate of 2 qt product/ac on all SC plots June 11. A photo slide of the surface residue was taken directly after planting. The developed slide is then projected onto a grid. Residue intersecting the grid lines are counted toward the percent residue coverage. Rotary hoed all T1 and T3 corn plots and the CC rotation of T2 tillage plots on June 12. Applied 2 pt product/acre of bentazon (Basagran) to all corn plots June 15. All soybean plots received 4 oz. product/acre of imazethapyr (Pursuit). A 28% solution of Nitrogen at 150 lbs N/acre was applied during the first cultivation on all CC and CS plots June 25. All CC and CS plots were cultivated and ridged in the T4 tillage treatment July 15. Cultivated all SC plots in the T4 tillage system July 15. Cultivated all soybean plots including T4 on July 27. Created ridges in all ridge-till (T3) plots planted to soybeans on August 2. Observed and recorded stands during the season and recorded final plant populations in all plots on Oct. 8.

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[1]This project was supported by the University of Minnesota Agricultural Experiment Station at Rosemount and the USDA-ARS Soil and Water Unit in St. Paul.

[2] T.L. Hansmeyer, D.R. Linden, R.H. Dowdy, R.R. Allmaras and C.E. Clapp are Ag. Research Technician, Soil Scientist, Soil Scientist, Soil Scientist and Research Chemist of the USDA-ARS, St. Paul MN. K.L. Walters is Director of the Agriculture Experiment Station at Rosemount.

Harvested (by combine) 8 center rows in all soybean plots Oct. 13. Harvested (by combine) 12 center rows in all corn plots Nov. 3. Corn stalks chopped and fall tillage performed Nov. 13-16.

RESULTS

Yield Grain yields and moistures from all tillages and rotations are given in figures 1-3 and table 1.

Within the continuous corn system, grain yields from the conventional till plots out-yielded all other tillages followed by ridge-till, conservation and minimum-till in that order. Statistically, the yields were not significantly different between any of the tillages (fig. 1). The two year average yields under the continuous corn rotation are also presented in table 1. The two year average yield puts ridge-till ahead of all other tillage systems followed by Conventional, Conservation and Minimum-till, respectively.

As with the yields under continuous corn, the corn/soybean rotation created the same yield rank when comparing the 4 tillage systems in 1993 and the two year average. Conventional tillage yielded the highest followed by Ridge-till, Conservation and then Minimum-till. Corn grain yields under these tillage systems for the Soybean/Corn rotation were not significantly different (Fig 2). The 1993 soybean yields in the corn/soybean rotation created a different yield rank with Conventional having the highest yield followed by Conservation, Ridge-till and Minimum-till, respectively (Fig 3). For soybeans, as with the previous cropping systems, no significant yield difference exists between tillages. The two year average shows the same yield rank as 1993.

The mean yield (which includes both crops) for each tillage indicates that Conventional tillage produced the highest yield followed by ridge-till, conservation and minimum-till, respectively. The grain yields from both ridge and conventional tillage systems are significantly higher than the yields from minimum-till (fig. 5). Also, the mean corn grain yields in 1993 indicate that the corn/soybean rotation with a mean yield of 110 bu/ac had a higher yield than continuous corn (CC) at 100 bu/ac (fig. 4).

Residue Residue cover after planting is shown in fig. 5. As expected, both Conservation and Minimum-till provide sufficient corn and soybean residue to qualify for the requirements for erosion control, where residue must provide at least 30% coverage after planting. It must be noted that in the conservation tillage plots, corn is no-tilled into the previous years soybean stubble, leaving the soybean stubble on the surface. Ridge-till provided sufficient residue to qualify under the continuous corn rotation, but only produced 28% residue cover under the corn/soybean rotation. Ridge-till buried a majority of the soybean stubble under the soybean/corn rotation leaving only 21% surface residue. A conventional tillage system did not provide enough surface residue to qualify for the residue requirements. Since the soybean plots in conventional tillage are chisel plowed in the fall, one might expect at least 30% residue cover. However, the fall chisel plowed soybean plots only produced 12% residue cover at planting.

Emergence Corn seed emergence varied in the cropping systems presumably due to spring soil moisture and temperatures. Figure 6 depicts three types of corn emergence trends. Conventional (CC), Conventional (CS) and Ridge-till (CS) cropping systems favored quick emergence of the corn seedlings with 50% of the total number of seeds emerging within 14 days (Type 1 Fig. 6). Conservation (CC), Conservation (CS), Ridge-till (CC) and Minimum-till (CS) cropping systems had 10 to 20% of the corn seeds emerged at day 14 (Type 2 Fig. 6). The third trend, represented by Minimum-till had the slowest emergence. After 14 days only 5% of the seeds had emerged. After 18 days and 70% emergence all trends begin to merge except for Minimum-till (CC) which lagged behind at 15% emergence.

The large difference in emergence found for corn does not exist under the soybean cropping systems (Fig. 7). Conventional and Conservation tillages have similar soybean seed emergence of 67-69% after 10 days. Seed emergence in Minimum-till equaled 60% after 10 days. The emergence under ridge-till was the lowest at 45% at 10 days. All soybean emergence trends begin to merge at day 14.

Weeds Weed populations in all corn plots except those planted no-till were compared between rotary hoeing and no rotary hoe (Fig. 8). The plots were randomly split with half receiving one pass with a rotary hoe and the other half receiving no rotary hoe. Rotary hoeing was most successful under Conventional (CC) Conventional (CS) and Conservation (CC) tillage treatments reducing the total weed population by 35ft^2, 23ft^2, and 74ft^2 respectively.

Fig. 1

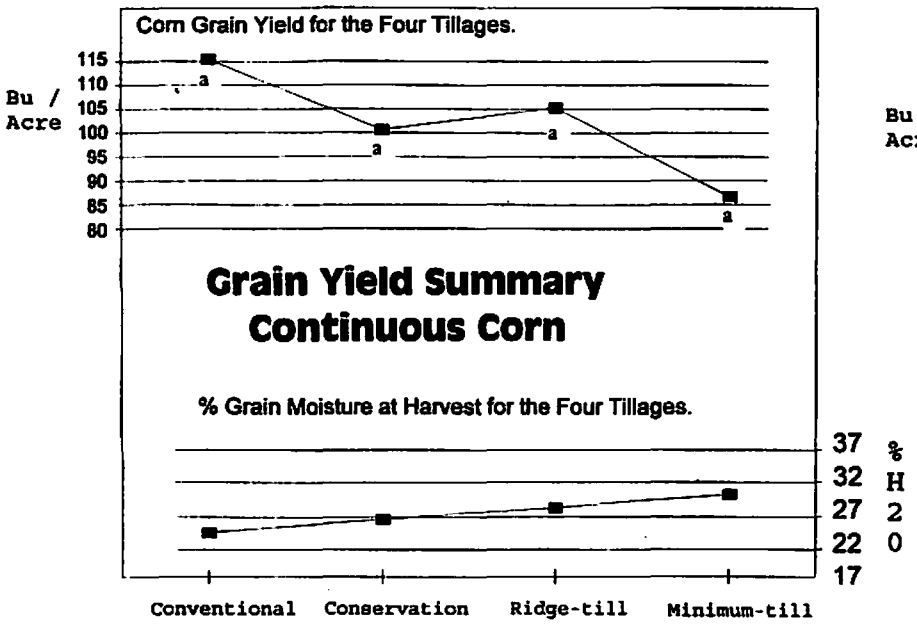


Fig. 2

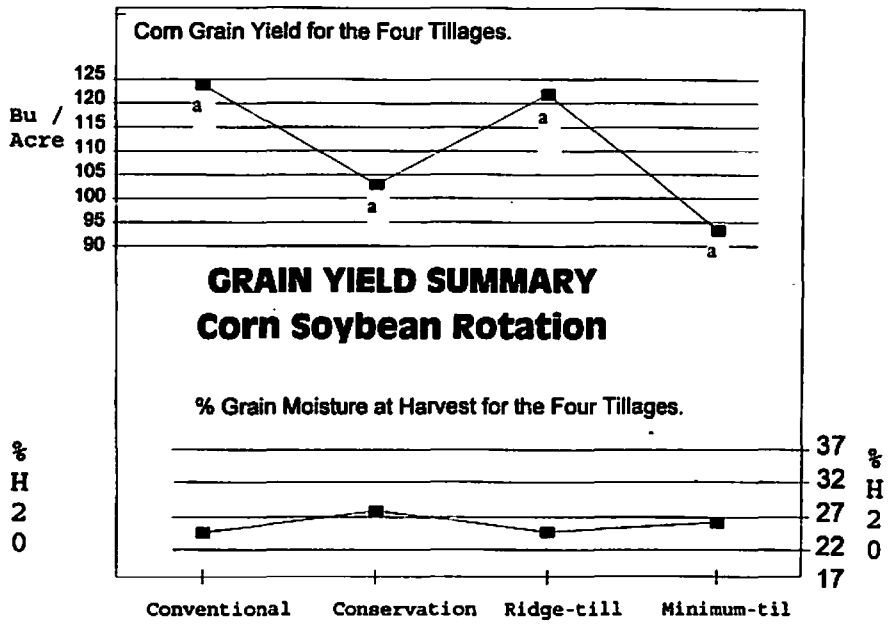
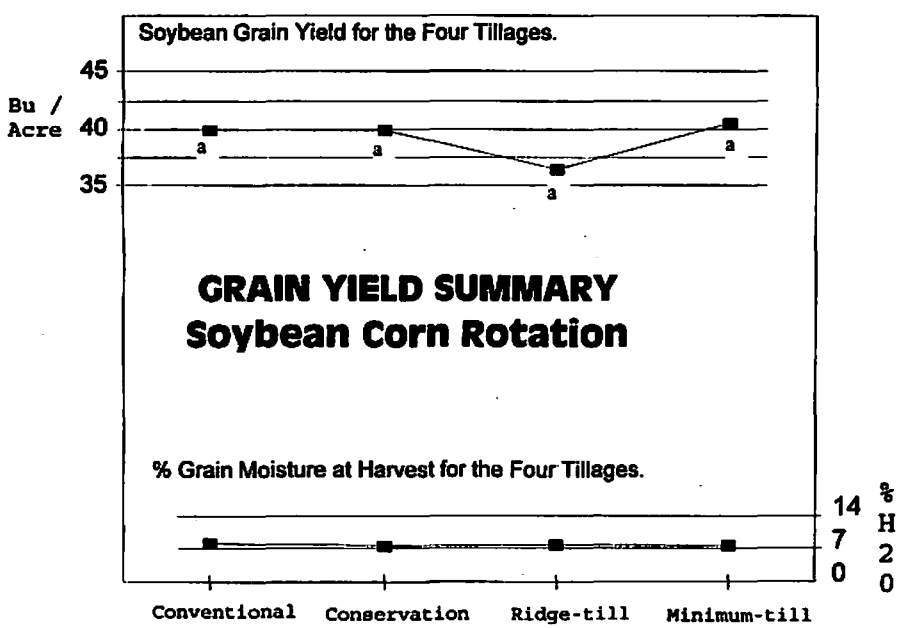
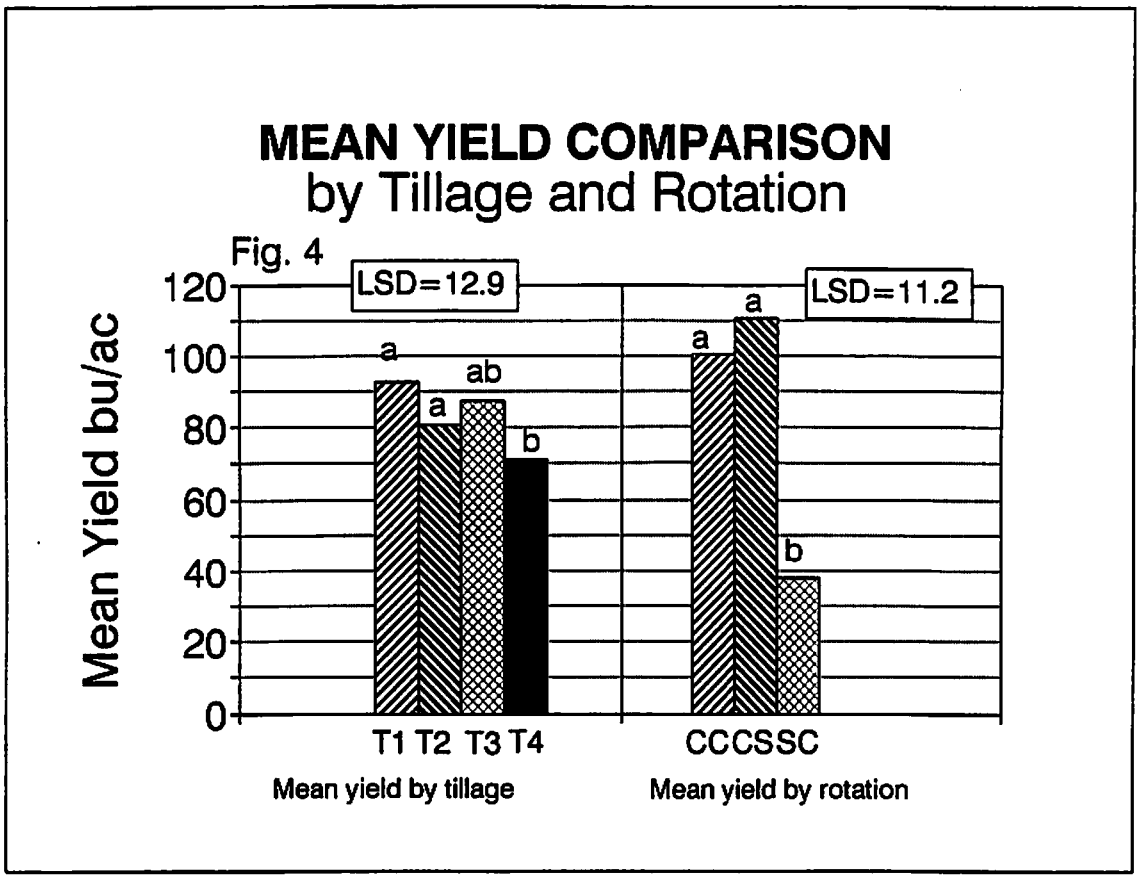
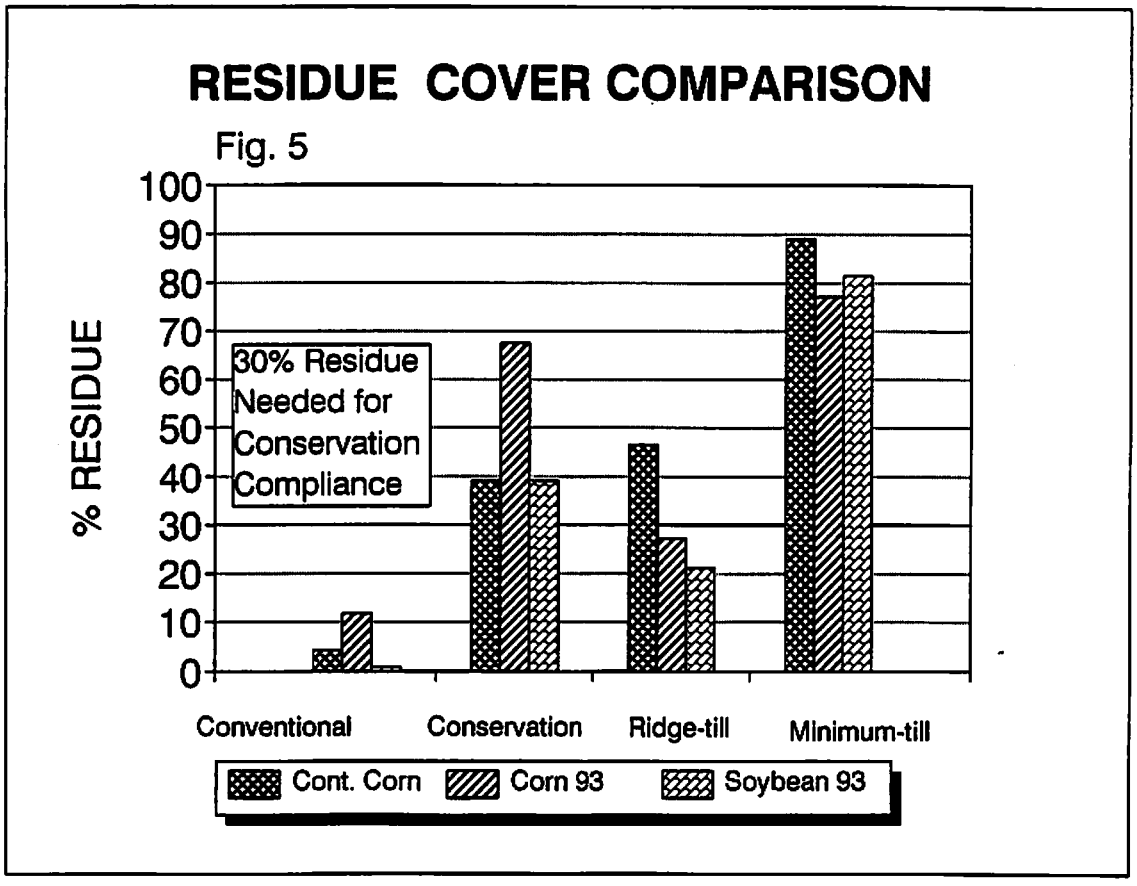


Fig. 3




MEAN YIELD COMPARISON
by Tillage and Rotation
Fig. 4
LSD=12.9
LSD=11.2
Mean Yield bu/ac
120
100
80
60
40
20
0
a
a
ab
b
a
a
b
T1 T2 T3 T4
CCCSSC
Mean yield by tillage
Mean yield by rotation


RESIDUE COVER COMPARISON
Fig. 5
% RESIDUE
100
90
80
70
60
50
40
30
20
10
0
30% Residue
Needed for
Conservation
Compliance
Conventional
Conservation
Ridge-till
Minimum-till
Cont. Corn
Corn 93
Soybean 93

1993 Corn Emergence

Tillage and Rotation Comparison

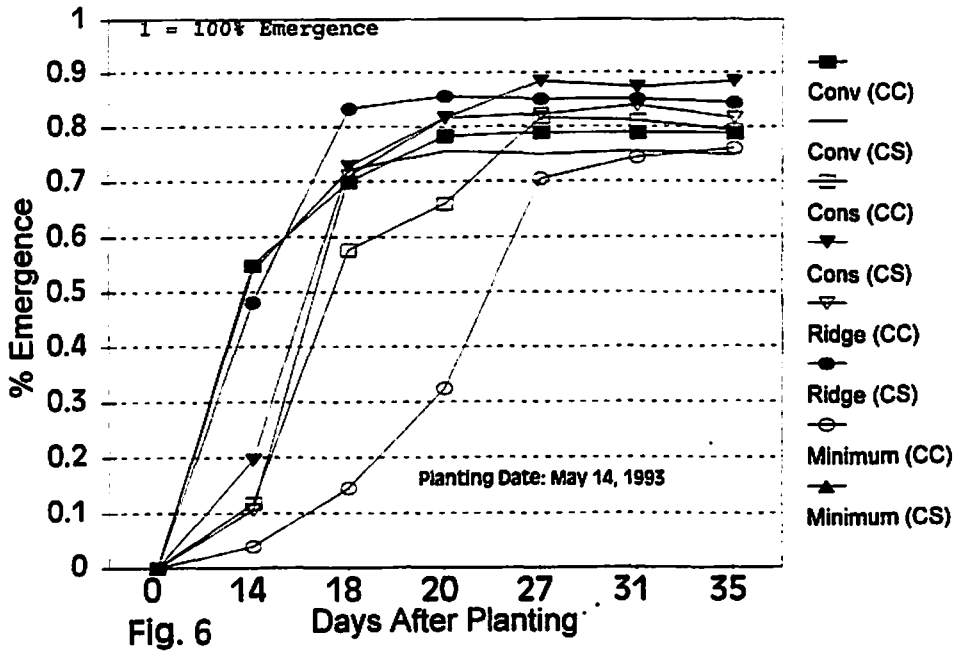


Fig. 6

1993 Soybean Emergence

Tillage and Rotation Comparison

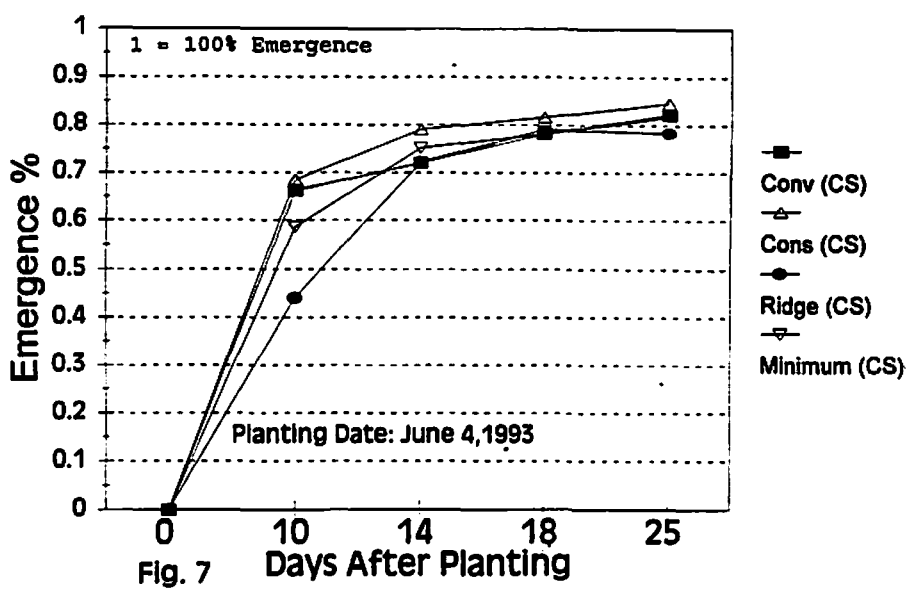


Fig. 7

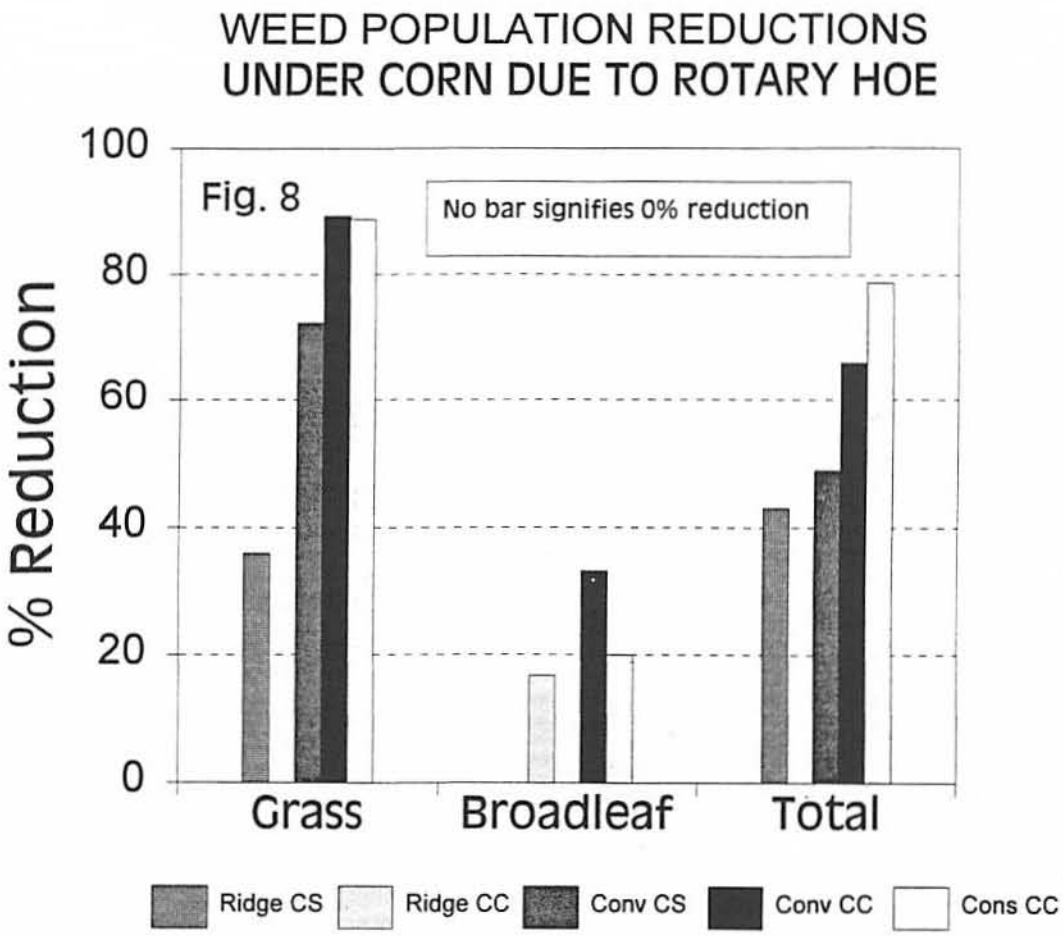


Table 1 Grain yields for the tillage study at Rosemount Study, 1993.

Treatment		Grain Yield			
Tillage	Rotation	1993		92/93 avg.	
		bu/ac	mt/ha	bu/ac	mt/ha
Conventional (T1)	Cont.Corn	114.2	6.05	118.1	6.27
	Corn/Soy	123.9	6.57	138.0	7.33
	Soy/Corn	39.9	2.33	40.5	2.36
Conservation (T2)	Cont.Corn	99.2	5.26	102.6	5.44
	Corn/Soy	102.8	5.45	122.9	6.52
	Soy/Corn	39.9	2.33	40.5	2.36
Ridge-Till (T3)	Cont.Corn	104.0	5.51	121.0	6.42
	Corn/Soy	121.9	6.46	137.5	7.30
	Soy/Corn	36.4	2.13	37.2	2.18
Minimum-Till (T4)	Cont.Corn	85.1	4.51	93.1	4.93
	Corn/Soy	93.2	5.67	119.1	6.68
	Soy/Corn	40.5	2.37	38.8	2.28

THE EFFECT OF TILLAGE SYSTEM AND SOIL TYPE ON THE YIELD OF CORN AND SOYBEANS ON SOILS DEVELOPED IN GLACIAL TILL[1].

J.F. Moncrief, D.D. Breitbach, T.M. Coffman
J.R. Jirik, M.F. Taylor, D.F. Preisler, and P.M. Bongard[2]

Four tillage systems (moldboard and chisel plowing, subsoiling, and no till systems) were evaluated for corn and soybean production from 1989 to 1993 on poorly drained soils developed in glacial till. Corn yields were reduced in one year out of three when grown under no till conditions. Other systems resulted in similar corn grain yields. Soybean yields were reduced with crop residue management systems in both years (1990 and 1992) of the study. There was no interaction between soil type and tillage on corn grain yields in 1993.

A tillage demonstration was initiated in Rice County, MN in 1989 to evaluate the effect of tillage (moldboard and chisel plowing, subsoiling, and no till systems) on the yield of corn and soybeans. Plots were 12 rows wide and about 400 feet long. The plots were located on a side slope with the Kilkenny B slope soil near the top, the Kilkenny C slope soil in the middle, and the Hamel A slope soil at the bottom. The crop sequence is a corn-soybean rotation. Moldboard and chisel plowing as well as subsoiling was done in the fall. The planter was equipped with rolling spiked wheel type row cleaners.

Average soil cover estimates are shown in table 1. Cover with soybean residue is marginal for erosion control with all tillage systems except the no till. Soil cover with corn residue was adequate with all systems except the moldboard.

Corn yield was estimated be taking the center six rows of each plot with a combine. Corn yields were similar in 1989 and 1993 (table 3). In 1991 they were reduced 20 bushels per acre when grown with no tillage. This resulted in an average reduction of 5 bushels per acre with the no till system over the three year study period. The other tillage systems evaluated resulted in similar corn grain yields.

Soybean yields are shown in table 3. In both soybean years of the study moldboard plowing resulted in significantly higher yields than the other systems evaluated (on average, from 6 to 11 bushels per acre higher. Soybeans grown under no till conditions were lower than other systems evaluated. This is in contrast to the performance of no till grown soybeans in dryer years.

In 1994 corn yields were estimated by hand picking two 20 ft. rows in each soil type within each tillage plot to evaluate the possible interaction of tillage and soil type. There was no interaction between tillage and soil type in 1993 for corn grain moisture or yields (table 5). Soil type did affect corn grain yields. The Hammel and Kilkenny C slope soils resulted in a 20 to 30 bushel lower grain yields than the Kilkenny B slope soil. Consistent with the combine yield estimates there was no effect of tillage on grain yields due to tillage. Hand picked corn yields were about 10 percent higher than the combine estimates.

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[1] This project was jointly supported by the Soil Conservation Service and the Minnesota Extension Service.

[2] J.F. Moncrief is an Extension Specialist in the Soil Science Department at the University of MN, St. Paul, MN. D.D. Breitbach, T.M. Coffman, J.R. Jirik, and M.F. Taylor are the State Agronomist, St. Paul, MN and District Conservationists in Rice, Waseca, and Le Seur Counties, MN respectively. D.F. Preisler is the Extension Educator in Le Seur County, MN. P.M. Bongard is a free lance data processor.

Table 1. Cultural practices used at the tillage demonstration at the Dave Judd Farm, Rice County, MN, 1989 - 1993.

	1989	1990	1991
Primary tillage			
Moldboard	White 18"-7 bottom	J.D. 5 bottom	White 18"-5 bottom
Chisel plow	2"straight shank	9 shank Case coulter with 4" twists	Mohawk straight point
V-Rip	J.D. 5 shank 30" spacing	same	same
Date	10/18/88	10/10/89	10/5/90
Secondary tillage			
Field cultivator (John Deere)	May 10	April 19	June 8 (also disked)
Planting			
Date	May 11	May 8	June 8
Variety	Pioneer 3737	Hardin	Pioneer 3737
Rate	23,700 seeds/A	57 lb/A	26,200 seeds/A
Planter	12-row J.D.7100 MaxEmerge with trash whippers	same	
Fertilizer			
Anhydrous Amm.	160 lb. AA/A (April 21)	-	160 lb N/A with N-serve (November, 1990)
10-34-0	15 gal/A at planting	8 gal/A at planting	- -
9-23-30	-	-	200 lb/A at planting
Weed control			
Herbicide	Ranger (3 pt/A) (May 3) Tandem (1.5 pt/A) & Extrazine (2.2 lb/A) (May 23)	Basagran (1 pt/A) with 1 qt. COC & 1 qt. 28% (May 29)	Gramoxone (1.5 pt/A) (June 7) Banvel (1 pt/A) (June 18) Accent (.66 oz/A) (June 28 no-till only)
Cultivation	June 12	July 2	June 27 (except no-till)
Harvest			
Date	October 6	October 2	October 22
Rainfall	April-September	April-October	April-September
Inches	9.45	24.26	25.11

	1992	1993
Primary tillage		
Moldboard	J.D. 5 bottom	none
Chisel plow	13 ' J.D. 3" twisted shank	none
V-Rip	J.D. 5 shank	none
Date	10/31/91	-
Secondary tillage		
Field cultivator	May 8 (2x except no-till)	May 21 (except no-till)
Planting		
Date	May 8	May 21
Variety	Sturdy	Pioneer 3751
Rate	62 lb/A	29,700 seeds/A
Planter	12-row JD 7100	12-row JD 7100 w/ Yetter trash whippers
Fertilizer		
10-34-0	-	8 gal/A at planting
28% N	-	140 lb N/A (sidedressed June 28)
Weed control		
Herbicide	Pursuit (4 oz/A) w/ COC & 28% (June 6)	Dual (2.8 pt/A) & Marksman (3 pt/A) (May 26)
Cultivation	June 27	-
Harvest Date	October 15	November 4
Rainfall	April-October	April-October
Inches	20.83	26.4

Table 2. Effect of tillage on surface residue cover after planting at the Dave Judd Farm, Faribault.

Year	Crop	Previous Crop	Tillage[2] Mld	Ch	Sb	NT
			--% cover--			
1989	Corn	Soybeans	2	10	10	25
1990	Soybeans	Corn	5	31	31	72
1991	Corn	Soybeans	2	4	5	44
1992	Soybeans	Corn	12	43	44	85
1993[1]	Corn	Soybeans	16	28	27	54
Avg.	Corn	Soybeans	2	7	8	41
	Soybeans	Corn	8	37	38	78

1. No fall tillage performed in 1992; plots were field cultivated the following spring (except no-till plots).
2. Tillage: Mld-fall moldboard plowed, Ch-fall chisel plowed, fall Sb-subsoiled, NT-no till.

Table 3. Effect of tillage on corn yields at the Judd Farm, Faribault.

	1989	1991	1993	Avg.
	----------bu/A----------			
Moldboard	141.1a[1]	98.9a	107.6a	115.9
V-Rip	139.9a	97.4a	106.7a	114.7
Chisel	142.7a	97.2a	107.6a	115.8
No-till	141.5a	79.1b	108.2a	109.6
Pr>F	0.67	0.0002	0.77	

1. Yields followed by the same letter in the same group are not significantly different at the 0.10 level.

Table 4. Effect of tillage on soybean yields at the Judd Farm, Rice County, MN.

Tillage	1990	1992	Avg.
	---------bu/A---------		
Moldboard	47.0a[1]	53.1a	50.0
V-Rip	42.9b	45.6b	44.2
Chisel	40.2bc	45.2b	42.7
No-till	38.2c	39.7b	39.0
Pr>F	0.004	0.028	

1. Yields followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 5. Effect of tillage and soil type on hand-harvested corn yields at the Dave Judd demonstration site, Rice Co., November 4, 1993.

Tillage	Soil Type	Moisture	Yield
		---%---	--Bu/a--
Moldboard	Kilkenny B	38.8fg[1]	134.4a
	Kilkenny C	42.3cde	103.4cde
	Hamel	45.6a	82.1e
V-Rip	Kilkenny B	37.8g	129.6ab
	Kilkenny C	41.4def	122.1abcd
	Hamel	45.4ab	101.2de
Chisel	Kilkenny B	41.1ef	129.6ab
	Kilkenny C	44.2abc	102.9cde
	Hamel	43.4abcd	109.0bcd
No-till	Kilkenny B	40.2efg	126.7abc
	Kilkenny C	45.1ab	118.2abcd
	Hamel	42.8bcde	108.3bcd
Soil type			
Kilkenny B		39.5b	130.0a
Kilkenny C		43.3a	111.6b
Hamel		44.3a	100.1b
Tillage			
Moldboard		42.7	117.8
Chisel		41.5	117.6
V rip		42.9	113.8
No till		42.3	106.6
Pr>F Soil		0.0006	0.032
Tillage		0.63	0.22
Tillage*Soil type		0.12	0.76

1. Data followed by the same letter in the same column group are not significantly different at the .10 level.

INTEGRATION OF MANURE AND ALFALFA N SOURCES INTO RESIDUE MANAGEMENT SYSTEMS FOR KARST AREAS OF MN[1]

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N. R. Broadwater, C. R. Schwartau, T.L. Wagar,
B.J. Johnson, P M. Bongard, and C.G. Eide[2]

Seven studies on five farms in southeastern Minnesota were used to evaluate integration of manure into residue management systems. Aspect and timing of alfalfa kill dramatically affected no till corn growth and yield. There were relatively small differences in early growth and development of both corn and soybeans under high residue systems. The growth delay persisted through flowering and physiological maturity. Yield differences due to N source and tillage were variable.

This study was initiated in the spring of 1993 to evaluate manure utilization strategies within residue management systems in southeastern MN. Farmer cooperators were identified in five counties in the karst area of MN. Each demonstration was tailored to fit within the project guidelines and also address particular farmer interests. Residue management systems are the convention in this part of the state due to the erosive nature of the soils.

Daryl Highum Farm

Treatments at this site are tillage and N source. Tillage systems evaluated are chisel plowing followed by discing and a no till approach. Nitrogen sources are anhydrous ammonia and liquid hog manure. Manure application was made in the spring followed by tillage and planting. Anhydrous ammonia was applied side dress June 15. The results from this demonstration is presented in tables 1a-1g. Back ground information for is shown in table 1a.

The manure source at this site has a high concentration of N. As is characteristic of hog manure more of the nitrogen was in the ammonium form (60 vs 40% for mineral and organic respectively). Manure and anhydrous ammonia were applied at very similar rates.

Corn planted with only a fluted coulters resulted in a delay of the emergence rate and .3 leaves per plant in development (table 1b. Final stands were similar and at adequate levels. The delay in growth was the result of 3% vs 10% soil cover in the row with soybean residue (table 1c). Soil cover between the row was 6% and 20% for the chisel and no till systems respectively. Corn plants grown with the no till system tasseled and silked slightly later than with chisel plowing (table 1d).

Anhydrous ammonia resulted in higher levels of late season ammonium (table 1e). Total soil mineral N levels were similar between N sources and tillage, however. Soil nitrate was concentrated in the top foot of soil (table 1f). Soil mineral N in the row was inversely correlated with early growth (table 1g).
Although corn phenology was affected by tillage and N source, differences were small and grain moisture was not affected (table 1h). Yields were relatively high and there was no affect of tillage or N source on grain yields. Grain N concentrations were higher with chisel plowing and the anhydrous ammonia source. This is consistent with other research.

Dan Graskamp Farm

Two rates of N as liquid hog manure were compared to anhydrous ammonia. The design is a randomized complete block with split plots. Main plots at this site were nitrogen source and rate. Subplots were row cultivation. Corn following soybeans was the test crop.

N source did not affect corn stands (table 2b). Row cultivation reduced stands by about 1,000 plants per acre. Soil cover with soybean residue was low. Cultivation reduced soil cover.

The high rate of manure increased the development of corn by about .2 leaves per plant. This affect carried through to silk emergence (table 2c).

The dominant weed at this site was wirestem muhly followed by velvet leaf. Horse tail numbers were reduced with cultivation by other species were not affected (tables 1d and e).

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[1] This study is supported by the Legislative Commission on Minnesota Resources the Minnesota Extension Service, and the Soil Conservation Service. Their support is greatly appreciated.

[2] J.F. Moncrief and B.J. Johnson are Extension Soil Scientist and Assistant Scientist respectively; B.A. Christensen, J.A. Tesmer, N.R. Broadwater, C.R. Schwartau, T.L. Wagar, P.M. Bongard, are Extension Educators; C.G. Eide is an udergraduate research assistant.

Soil ammonium and nitrate were similar between the low rate of manure and anhydrous ammonia. The high rate of manure increased mineral nitrogen concentrations in the row slightly and doubled concentrations between the row (table 2f). As expected, anhydrous ammonia, although applied at two thirds of the ammonium rate of the low rate of manure resulted in higher concentrations of late season ammonium due to the self inhibition of nitrification of this N source.

The manure N source resulted in a small but statistically significant increase in grain yields (3-5 bu/acre, table 2h). The low rate of manure and anhydrous ammonia (158 and 80 lbs N/acre, respectively) resulted in similar grain N concentrations. The high rate of manure (358 lbs N/acre) increased grain N significantly (table 2i).

Tony and Walter Hammel Farm

At this site corn was grown following alfalfa with a no till system. The treatments evaluated include: fall vs spring killed alfalfa; and north and south aspect. The design is a randomized complete block with timing main plots and aspect subplots. Data from this site are presented in tables 3a-k.

The time of the year that alfalfa was killed with herbicides did not affect corn stands (table 3b). Aspect and timing did affect early corn growth however (.2 and .6 leaves respectively). Spring killed alfalfa and northern aspect reduced growth.

Before row cultivation spring killed alfalfa resulted in about a 10% increase in soil cover (table 3c). Soil cover was not affected by aspect. After row cultivation soil cover was much reduced and northern aspect had slightly lower soil cover.

There was an interaction between aspect and timing of alfalfa kill on phenology later in the season (tassel and silk emergence, table 3d). Aspect was more important on spring killed alfalfa than fall killed.

Treatments did not affect weeds present in the row (table 3e). Between the row there was more foxtail and alfalfa with the spring killed alfalfa treatment (table 3f).

There was no affect of treatments on late season soil mineral nitrogen (table 3h).

Soils ranged in thickness from 32 to >69 inches (table 3j). The surface texture is silt loam with argillic horizons below.

Aspect affected grain moisture 4.1% at harvest. Earlier differences in development were greater at harvest due to aspect. Time of alfalfa kill resulted in a difference in grain moisture at harvest of 2.7%. This trend was opposite of the earlier affects of aspect and timing.

Fall killed alfalfa sod resulted in a yield increase of 30 bushels per acre over the spring kill treatment. Northern aspect reduced grain yields about 20 bushels per acre. Grain N concentrations were higher with the spring killed alfalfa, likely the result of dilution.

Jim Holty Farm

At this site there are three studies. The first is looking at the effect of aspect on corn response in a spring discing tillage approach. The design is a randomized complete block with two replications. The second study is evaluation of no till corn into corn. The design is a randomized complete block with two replications. The third study is evaluation of no till, drilled soybeans into corn stalks. The design is a randomized complete block with two replications.

The results of the aspect study are presented in tables 4b to 4d. Aspect did not affect stand establishment, early growth, or yield.

The results of the demonstration contrasting a disc/plant system to a no till approach for corn after corn are shown in tables 5a to 5d. Stand and early growth were not affected by tillage system. Weeds were higher with the no till system. The predominant weed species present was foxtail.

Corn grown no till after corn resulted in statistically similar yields. There is a trend for reduced yields with the no till approach that appears to be related to weed control.

The study evaluating tillage effects on soybeans grown after corn is summarized in tables 6a to 6c. The tillage evaluated were no till and chisel plowing systems. There was no difference in soybean stand due to tillage (table 6a). Early growth was delayed .4 nodes per plant under no till conditions. This due to the high "in row" cover with the no till system and the cool growing season in 1993.

Soybean yields were statistically similar between tillage treatments (table 6c).

Francis and Paul Kottshade Farm

The tillage approach at this site is light field cultivation for corn following soybeans. The N sources evaluated were liquid hog manure, anhydrous ammonia, and an unfertilized check. The design is a randomized complete block.

Soybean residue levels were at modest levels after the spring field cultivation (table 7a). The N sources did not affect stand establishment. Early corn growth was reduced with nitrogen stress (table 7b).

Although corn yields and N uptake tended to be higher with both N sources there was no statistically significant differences (table 7d).

Table 1a. Cultural practices used in the demonstration at the Daryl Highum Farm, 1993.

Experimental Design
Treatments at this site are tillage and N source. Tillage systems evaluated are chisel plowing followed by discing and a no till approach. Nitrogen sources are anhydrous ammonia and liquid hog manure. Plots were arranged in a completely randomized design. Manure application was made in the spring followed by tillage and planting. Anhydrous ammonia was applied side dress June 15.

Tillage Equipment
Chisel plow Land All, 4" twisted shovels at 7.5" spacing, straight coulters at 15"
Disc 19' Ford with 20" discs

Cropping history
Previous crop Soybeans; planting date 4/30/93; hybrid Cargill 4327 (105 day); rate 35,500 in 30" rows
Planter Allis Chalmers with 2" fluted coulters

Manure applications
Hog manure (pit storage) 2500 gal/A
Total N 203 lb/A
NH_4-N 126 lb/A
Estimated Avail. N 153 lb/A
Application Broadcast 5/4/93 (worked in except on no-till plots)

Liquid Hog Manure Analysis

Sample	Solids	NH_4^+	NO_3^-	Tot.Min.-N	Org.N[1]	Total N	Est.Avail.N[2]	Est.Avl.N applied[3]
5/19/93	---%---	----------lbs/1000 gals.----------						--- lbs.N/a ---
1.	11.6	50.8	-	50.8	26.9	77.7	60.2	123
2.	6.6	50.3	-	50.3	34.5	84.8	62.3	
3.	10.4	50.8	-	50.8	31.6	81.4	61.9	
4.	12.5	49.9	-	49.9	32.6	82.6	61.4	
5.	8.6	51.1	-	51.1	30.5	81.6	61.8	
6.	8.6	50.4	-	50.4	29.1	79.5	60.5	
Avg.	**9.7**	**50.6**	**-**	**50.6**	**30.9**	**81.2**	**61.4**	

1.Organic nitrogen = Total nitrogen - Total mineral nitrogen (from laboratory analysis).
2.Estimated available nitrogen =(Org.-N x .35) + Tot.Min.-N. It is assumed that all of the mineral N and 30% of the Org.N is available during the first year of application
3.The rate of manure applied for plot area was 2,000 gal./acre from a pit. Broadcasted on 5/4/93 and worked in on chisel plots and broadcast only on no till plots.

Fertilizer
82-0-0 125 lb N/A side-dressed 6/15/93; 9-23-30 180 lb/A applied as starter

Soil type Recent Alluvium, loam to sandy loam texture.

Weed control
2,4-D 1 pt/A applied 5/14/93
Lasso (alachlor) 2 qt/A applied 5/14/93
Bladex (cyanazine) 2 qt/A applied 5/14/93

Table 1b. Effect of tillage and nitrogen source on early season corn population and leaf numbers at the Daryl Highum farm demonstration near Rushford in Fillmore County, 1993.

		stand			early growth		
		6/12	7/2	avg.	6/10	7/2	avg.
tillage	N source	---plt/Ax 1000---			-leaves/plant-		
No-till	AN. NH_3	29.2a[1]	30.7a	30.0	4.9b	7.7c	6.3
	Hog Manure	28.8a	30.3a	29.6	4.9b	8.0bc	6.4
Chisel	An. NH_3	30.8a	29.6a	30.2	5.0b	8.1b	6.6
Plow	Hog Manure	29.4a	29.6a	29.5	5.4a	8.4a	6.9
No-till		29.0b	30.5a	29.8	4.9b	7.9b	6.4
Chisel Plow		30.1a	29.6a	29.9	5.2a	8.2a	6.7
An. NH_3		30.0a	30.2a	30.1	4.9a	7.9b	6.4
Hog Manure		29.2a	30.0a	29.6	5.2a	8.2a	6.7
Pr>F tillage		<0.10	>>0.10		<0.10	<0.05	
N Source		>0.10	>>0.10		>0.10	<0.05	
tillagexN		>0.10	>>0.10		>0.10	>>0.10	

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 1c. Effect of tillage and nitrogen source on soybean residue at the Highum Farm demonstration, 1993.

		in row cover			between row cover		
		6/12	7/2	Avg.	6/10	7/2	Avg.
Tillage	N Source	----------			%		----------
No-till	an. NH_3	11.2a[1]	10.0a	10.6	21.7a	15.0a	18.4
	Hog Manure	7.5b	10.4a	9.0	18.3a	16.7a	17.5
Chisel	An. NH_3	3.3c	3.8b	3.6	7.1b	5.8b	6.4
Plow	Hog Manure	2.5c	3.8b	3.2	4.6b	5.8b	5.2
No-till		9.2a	10.2a	9.7	20.0a	15.8a	17.9
Chisel Plow		2.9b	3.8b	3.4	5.8b	5.8b	5.8
An. NH_3		7.0a	6.9a	7.0	14.4a	10.4a	12.4
Hog Manure		5.0b	7.1a	6.0	11.4b	11.2a	11.3
Pr>F Tillage		<0.01	<.05		<<.01	<0.01	
N Source		<0.10	>>0.10		<0.10	>>0.10	
tillagexN Source		>0.10	>>0.10		>>0.10	>>0.10	

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 1d. Effect of tillage and nitrogen source on percent of corn plants tasselling and silking at the Highum Farm demonstration, 1993.

		Tasselling		Silking	
		7/26	7/30	7/26	7/30
		----------	%	----------	
No-till	An. NH_3	66.9a[1]	92.2a	21.6b	71.2b
	Hog Manure	75.8a	95.1a	29.2b	92.3a
Chisel	An. NH_3	81.6a	91.6a	45.6a	82.0ab
Plow	Hog Manure	84.1a	97.2a	41.4a	94.2a
No-till		71.4a	93.6a	25.4b	81.8a
Chisel Plow		82.8a	94.4a	43.5a	88.1a
An. NH_3		74.2a	91.9a	33.6a	76.6b
Hog Manure		80.0a	96.2a	35.6a	93.2a
Pr>F Tillage		>0.10	>>0.10	<0.05	>0.10
N Source		>>0.10	>0.10	>0.10	<0.05
tillagexNwource		>>0.10	>>0.10	>0.10	>0.10

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 1e. Effect of tillage and nitrogen source on total inorganic soil nitrogen concentrations to a 3 foot depth at the Highum farm demonstration, August 27, 1993.

	NH_4^++NO_3^-	NH_4^+	NO_3^-
	--------lb/A--------		
No-till An. NH_3	130.4a[1]	70.3a	60.1a
Hog manure	83.1a	48.9c	32.9a
Chisel An. NH_3	105.9a	62.9ab	43.0a
plow Hog manure	96.8a	57.2bc	39.6a
No-till	106.8a	59.6a	46.5a
Chisel plow	101.4a	60.0a	41.3a
An. Ammonia	118.2a	66.6a	51.6a
Hog manure	90.0a	53.0a	36.2a
In-row	101.5a	59.9a	40.9a
Between-row	106.6a	59.7a	46.9a
Pr>F Treatment	0.24	0.04	0.47
Tillage	0.53	0.69	0.55
N Source	0.34	0.17	0.46
Row position	0.60	0.96	0.44
Treatment*Row	0.73	0.81	0.78

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 1f. Effect of tillage and nitrogen source on inorganic nitrogen concentrations at three soil depths at the Highum farm, August 27, 1993.

	depth	NH_4^++NO_3^-	NH_4^+	NO_3^-
		--------lb/A----------		
No-till An. NH_3	0-12"	50.8a	20.3bcd	30.5a
	12-24"	39.3bc	23.0abc	16.3bcd
	24-36"	40.3abc	27.0a	13.3cde
Hog manure	0-12"	38.1bc	13.3e	23.5ab
	12-24"	22.8d	18.0d	4.8e
	24-36"	22.2d	17.5d	4.7e
Chisel An. NH_3	0-12"	42.9ab	16.8de	26.1a
	12-24"	31.4cd	22.5bc	8.8de
	24-36"	31.7cd	23.6abc	8.1de
Hog manure	0-12"	34.1bc	13.5e	20.6bc
	12-24"	32.0bcd	19.7cd	12.3cde
	24-36"	30.7cd	24.0ab	6.6e
Treatment				
No-till An. NH_3		43.5a	23.4a	20.0a
Hog manure		27.7a	16.3c	11.0a
ChiselAn. NH_3		35.3a	21.0ab	14.3a
Hog manure		32.2a	19.1bc	13.2a
Row position				
In-row		33.8a	20.0a	13.6a
Between-row		35.5a	19.9a	15.6a
Depth				
0-12"		41.4a	16.0b	25.2a
12-24"		31.4b	20.8a	10.6b
24-36"		31.2b	23.0a	8.2b
Pr>F Treatment		0.242	0.038	0.471
Row position		0.606	0.956	0.441
Depth		0.001	0.0004	0.0001
TreatmentxRow position		0.732	0.810	0.776
TreatmentxDepth		0.665	0.822	0.813
Row positionxDepth		0.424	0.374	0.821
TrtmentxRowxDepth		0.840	0.577	0.944

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 1g. Correlation of inorganic soil nitrogen concentrations at the 0-12" depth with corn phenology and yields at the Highum farm, 1993.

	leaf numbers		Silking		
Row position	6/11	7/12	7/26	7/30	Yield
In-row soil N	-0.631	-0.089	-0.282	0.069	-0.065
Between soil N	-0.284	0.115	-0.313	-0.033	0.131
Pr>F In row N	0.011	0.752	0.309	0.806	0.817
Between row N	0.304	0.683	0.256	0.908	0.643

Table 1h. Effect of tillage and nitrogen source on corn grain yields, moisture and nitrogen content at the Highum farm, October 28, 1993.

	moisture	yield	nitrogen
	--%--	-bu/a-	--%--
No-till an. NH_3	21.1a[1]	171a	1.20a
Hog manure	20.1a	163a	1.11b
Chisel An. NH_3	19.8a	176a	1.21a
plow hog manure	19.5a	175a	1.17a
Tillage			
No-till	20.6a	167a	1.16b
Chisel plow	19.6a	176a	1.19a
N source			
An. NH_3	20.4a	174a	1.21a
Hog manure	19.8a	169a	1.14b
Pr>F Treatment	0.41	0.56	0.01
Tillage	0.27	0.32	0.03
N Source	0.26	0.56	0.07

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 2a. Cultural practices at the Dan Graskamp farm, 1993.

Tillage equipment
Field cultivator (21') 2" shanks at 6" spacing
Row cultivator 13' John Deere (4-38" row)
(6/27/93) 2-5" sweeps between rows

Cropping history
Previous crop Soybeans
Planting date 5/8/93
Variety McCurdies 5222 (110 day)
Planting population 28,500

Experimental Design

Two rates of N as liquid hog manure were compared to anhydrous ammonia. The design is a randomized complete block with split plots. Main plots at this site were nitrogen source and rate. Subplots were row cultivation.

Manure	High rate	Low rate
Hog manure	6300 gal/A	3145 gal/A
Total N	450 lb/A	226 lb/A
NH_4-N	243 lb/A	122 lb/A
Est. Avail. N	316 lb/A	158 lb/A

Application Broadcast 5/11/93 and worked in

Liquid Hog Manure Analysis

Sample	Solids	NH_4^+	NO_3^-	Tot.Min.-N	Org.N[1]	Total N	Est.Avail.N[2]	Est.Avl.N applied[3]
5/19/93	---%---	----------lbs/1000 gals.----------						--- lbs.N/a ---
1.	9.5	39.2	-	39.2	34.1	73.3	51.2	* Hi= 311
2.	8.5	43.6	-	43.6	28.7	72.3	53.6	* Lo= 156
3.	9.1	41.8	-	41.8	28.9	70.6	51.9	
4.	4.3	29.8	-	29.8	41.2	70.9	44.2	
Avg.	**10.4**	**38.6**	**-**	**38.6**	**33.2**	**71.8**	**50.2**	

1.Organic nitrogen = Total nitrogen - Total mineral nitrogen (from laboratory analysis).
2.Estimated available nitrogen =(Org.-N * .35) + Tot.Min.-N. It is assumed that all of the mineral N and 30% of the Org.N is available during the first year of application.
3.The rate of manure applied for plot area was 6,200 gal./acre for the Hi and 3,100 gal/acre for the Lo treatment. Storage was a pit, surface applied by broadcast on 5/11/93 and worked in.

Fertilizer 9-23-30 100 lb/A applied as starter; anhydrous 80 lb N/A

Soil Fayette silt loam 2-6% slope

Weed control
Prowl (3.3E)2.5 pt/A applied 5/17/93; Marksman2.5 pt/A applied 5/17/93; Bladex (4 F)1 lb/A applied 5/17/93

Table 2b. Effect of nitrogen source and cultivation (6/27/93) on early season plant population and soybean residue at the Dan Graskamp farm demonstration near Fountain in Fillmore County, 1993.

N source	N rate	cul[1]	stand 6/9	stand 6/29	in row 6/9	in row 6/29	between row 6/9	between row 6/29
	-lb/A-		--plt/A---		---------%----------			
An. NH_3	80	Yes	-	24.3A[1]	-	2.7B	-	3.3C
		No	-	25.4A	-	4.2AB	-	6.5AB
Hog manure	316	Yes	-	24.4A	-	5.8A	-	4.6BC
		No	-	26.0A	-	1.8B	-	8.8A
Hog manure	158	Yes	-	24.5A	-	4.0AB	-	4.4B
		No	-	26.2A	-	3.8AB	-	6.4AB
AA	80		24.6A	24.9A	7.9A	3.3A	12.9A	5.0A
Hog manure	316		25.4A	25.2A	9.0A	3.8A	13.8A	6.7A
Hog manure	158		24.3A	25.4A	7.6A	3.8A	13.8A	5.4A
Cultivation			-	24.4B	-	6.8A	-	4.1B
No cultivation			-	25.9A	-	6.8A	-	7.2A
Pr>F N Source			0.16	0.82	0.52	0.93	0.80	0.36
Cultivation			-	0.03	-	0.18	-	0.0002
NxCultivation			-	0.91	-	0.02	-	0.25

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 2c. Effect of nitrogen source and cultivation (6/27) on corn phenology at the Graskamp Farm, 1993.

N source		Cult	early growth 6/9	early growth 6/29	silking 8/13
	-lb/a-		-leaves/plant-		-score-
An. NH_3	80	Yes	-	6.7b[2]	1.5c
		No	-	6.8ab	1.6c
Hog manure	316	Yes	-	7.0a	2.6a
		No	-	6.9ab	2.4ab
Hog manure	158	Yes	-	6.8ab	2.0abc
		No	-	6.8ab	1.8bc
Aa	80		2.8a	6.7b	1.6b
Hog manure	316		2.8a	6.9a	2.5a
Hog manure	158		2.9a	6.8ab	1.9b
Cultivation			-	6.8a	2.0a
No cultivation			-	6.8a	1.9a
Pr>f n source			0.20	0.08	0.04
Cultivation			-	0.63	0.49
Nxcultivation			-	0.77	0.61

[1]Silking score based on color: 1=white or yellow (not pollinated) 5=brown (pollinated).
[2]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 2d. Effect of nitrogen source and cultivation (6/27) on weed counts and species composition **in the row** at the Graskamp farm, July 19, 1993.

		Cult	Count	Wirestem Muhly	Horse Tail	Quack-Grass
	-Lb/a-		#/Ft[2]	-------%-------		
AA. NH_3	80	Yes	1.1a[2]	91.7	8.3	-
		No	1.3a	54.3	45.7	-
Hog Manure	316	Yes	1.1a	67.5	27.5	5.0
		No	1.2a	86.6	13.4	-
Hog Manure	158	Yes	1.4a	95.8	4.2	-
		No	1.0a	94.5	5.6	-
AA	80		1.2a	73.0	27.0	-
Hog Manure	316		1.2a	77.1	20.4	2.5
Hog Manure	158		1.1a	95.1	4.9	-
Cultivation			1.2a	85.0	13.3	1.7
No Cultivation			1.2a	78.5	21.5	-
Pr>F N Source			0.97	0.11	0.33	
Cultivation			0.80	0.12	0.68	
NxCultivation			0.34	0.14	0.12	

[1]W.Muhly=Wirestem muhly; Vel.leaf=Velvetleaf.
[2]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 2e. Effect of nitrogen source and cultivation (6/27) on weed counts and species composition **between the row** at the Graskamp farm, July 19, 1993.

		Cult	count	Wirestem Muhly	Horse tail	Vel. leaf	Common lambs
	-lb/A-		#/Ft²	--------% cover---------			
An. NH_3	80	Yes	5.8a[2]	94.1ab	1.7b	0.8	3.3
		No	6.5a	85.7b	10.2a	1.4	2.8
Hog Manure	316	Yes	5.4a	91.8ab	4.0ab	3.9	0.4
		No	6.4a	84.7b	6.7ab	1.1	7.3
Hog Manure	158	Yes	5.6a	98.2a	1.5b	0.4	-
		No	3.4a	91.7ab	7.2ab	1.1	-
AA	80	-	6.1a	89.9a	5.9a	1.1	3.0
Hog Manure	316	-	5.9a	88.3a	5.4a	2.5	3.8
Hog Manure	158	-	4.5a	94.9a	4.3a	0.7	-
Cultivation			5.6a	94.7a	2.4a	1.7	1.2
No Cultivation			5.4a	87.4b	8.0b	1.2	3.3
Pr>F N Source			0.52	0.31	0.89	0.17	0.42
Cultivation			0.89	0.08	0.02	0.60	0.38
NxCultivation			0.38	0.97	0.52	0.17	0.38

[1]W.Muhly=Wirestem Muhly; H.tail=Horsetail; V.leaf=Velvetleaf; Common Lambsquarters
[2]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 2f. Effect of nitrogen source and cultivation (6/27) on total inorganic soil nitrogen concentrations to a 3 foot depth at the Graskamp farm, August 28, 1993[1].

			In-row			Between-row		
			NH_4^++NO_3^-	NH_4^+	NO_3^-	NH_4^++NO_3^-	NH_4^+	NO_3^-
		cult	----------lb/A----------					
Anhydrous	80	Yes	120	112	8.1	71	58.2	13.0
		No	121	104	16.5	101	91.0	10.3
Hog manure	316	Yes	147	113	33.6	147	102.0	44.9
(high rate)		No	183	132	50.8	218	159.0	58.5
Hog manure	158	Yes	91	73	17.7	85	57.7	27.2
(low rate)		No	163	152	11.4	74	58.1	15.6
Anhydrous	80		120	108	12.3	86	74.6	11.6
Hog manure	316		165	122	42.2	182	130.5	51.7
Hog manure	158		127	112	14.6	80	57.9	21.4
Cultivation			119	99	19.8	101	72.6	28.4
No Cultivation			156	129	26.2	131	102.7	28.1
In-row			138	114	23.0			
Between-row			116	88	28.2			

1. These data represent one replication which did not allow statistical analysis.

Table 2g. Effect of nitrogen source and cultivation (6/27) on inorganic soil nitrogen concentrations at three depths at the Graskamp farm, August 28, 1993.

			In-row			Between-row		
			NH_4^++NO_3^-	NH_4^+	NO_3^-	NH_4^++NO_3^-	NH_4^+	NO_3^-
N Source	Cult	Depth	----------lb/A----------					
Anhydrous	Yes	0-12"	83.1	77.9	5.26	45.6	35.6	10.01
		12-24"	36.9	34.1	2.82	25.6	22.6	3.03
		24-36"						
	No	0-12"	44.6	36.5	8.03	34.9	30.1	4.84
		12-24"	38.6	34.2	4.33	33.6	32.0	1.54
		24-36"	37.7	33.6	4.16	32.8	28.9	3.95
Hog manure	Yes	0-12"	65.2	52.2	13.02	47.1	31.7	15.42
(high rate)		12-24"	38.1	31.4	6.74	47.1	37.9	9.21
		24-36"	43.7	29.8	13.89	52.5	32.3	20.28
	No	0-12"	56.8	29.2	27.58	62.4	44.5	17.84
		12-24"	82.8	73.6	9.20	76.0	55.1	20.83
		24-36"	43.5	29.6	14.0	79.1	59.2	19.90
Hog manure	Yes	0-12"	32.2	23.8	8.42	44.2	27.5	16.70
(low rate)		12-24"	29.9	25.4	4.50	40.7	30.2	10.49
		24-36"	28.6	23.8	4.76	---		
	No	0-12"	73.7	69.1	4.60	35.2	25.0	10.20
		12-24"	51.0	49.5	1.44	7.0	6.0	0.91
		24-36"	38.6	33.3	5.36	31.6	27.1	4.45
Anhydrous			50.1	45.5	4.56	28.7	24.8	3.90
Hog manure (high rate)			55.0	40.9	14.07	60.7	43.4	17.25
Hog manure (low rate)			42.3	39.4	4.85	26.4	19.3	7.12
Cultivation			46.4	39.5	6.90	33.6	24.2	9.46
No Cultivation			51.9	43.2	8.74	43.6	34.2	9.38
0-12"			59.3	48.1	11.15	44.9	32.4	12.50
12-24"			46.2	41.3	4.84	38.3	30.6	7.67
24-36"			42.0	34.5	7.48	32.7	24.6	8.10
In-row			49.2	41.3	7.82			
Between-row sampling			38.6	29.2	9.42			

Table 2h. Effect of nitrogen source and cultivation (6/27) on corn grain yields, moisture contents, and nitrogen concentrations at the Graskamp farm, 1993.

	cult	moist.	yield	N
		--%---	-bu/A-	-%-
An. NH_3	Yes	25.4a[1]	114c	1.31a
	No	26.1a	115c	1.28b
Hog Manure	Yes	25.1a	119ab	1.34a
(High Rate)	No	25.1a	123a	1.34a
Hog Manure	Yes	24.9a	119ab	1.30a
(Low Rate)	No	25.4a	118bc	1.24b
An NH_3		25.8a	115b	1.30b
Hog Manure(high)		25.2a	121a	1.34a
Hog Manure(low)		25.2a	118a	1.27b
Cultivation		25.2a	117a	1.31a
No Cultivation		25.5a	119a	1.29b
Pr>F N Source		0.43	0.02	0.04
Cultivation		0.47	0.56	0.03
NxCultivation		0.50	0.29	0.17

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3a. Cultural practices used at the Hammel Farm demonstration, 1993.

Tillage equipment
Row cultivator Dakon 4-38" rows (late June) 5 Danish tine/row

Cropping history
Previous crop Alfalfa
Planting date 5/8/93
Variety DeKalb 451 (100 day)
Planting population 29,900 seeds/A
Planter New Idea with Kinsey planting units & 2" fluted coulters

Experimental Design
The treatments evaluated at this site include: fall vs spring killed alfalfa; and north and south aspect. The design is a randomized complete block with timing main plots and aspect subplots.

Fertilizer
Urea 50 lb N/A

Soils
Black Hammer-Southridge silty clay loam
Nodine-Rollingstone silty clay loam

Weed control
Ranger (alfalfa kill) 3 pt/A

Aspect	avg.	std.	range
North slope	13%	(1.6)	10-14
South slope	16%	(3.2)	12-20

Table 3b. Effect of alfalfa-kill timing and aspect on early season plant population and corn leaf numbers at the Tony and Walter Hammel Farm demonstration near Caledonia in Houston County, 1993.

		stand			early growth		
sod		6/21	7/10	avg.	6/21	7/10	avg.
kill	aspect	---plt/A x1000---			-leaves/plant-		
Fall	North	26.7a[1]	28.6a	27.6	5.4a	7.8a	6.6
	South	28.3a	29.3a	28.8	5.5a	8.0a	6.8
Spring	North	26.1a	24.9a	25.5	4.7a	6.8b	5.8
	South	25.4a	25.9a	25.6	4.9a	7.3ab	6.1
Sod Kill							
Fall		27.5a	29.0a	28.2	5.4a	7.8a	6.6
Spring		25.8a	25.4a	25.6	4.8a	7.1b	6.0
Aspect							
North		26.4a	26.8a	26.6	5.0b	7.3a	6.2
South		27.0a	27.7a	27.4	5.2a	7.6a	6.4
Pr>F	Sod kill	0.47	0.38		0.17	0.08	
	Aspect	0.82	0.30		0.06	0.26	
SdkillxAspect		0.59	0.84		0.70	0.70	

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3c. Effect of alfalfa-kill timing and aspect on alfalfa residue at the Hammel Farm, 1993[1].

		In Row			Between Row		
Sod		6/21	7/10	Avg.	6/21	7/10	Avg.
Kill	Aspect	--Plt/a X1000---			-------%---------		
Fall	North	14.6a[2]	4.2c	9.4	24.2c	2.6a	13.4
	South	20.4a	5.7bc	13.0	30.8bc	3.1a	17.0
Spring	North	23.3a	7.3ab	15.3	35.8ab	2.6a	19.2
	South	31.2a	8.3a	19.8	49.2a	5.2a	27.2
Sod Kill							
Fall		17.5b	5.0b	11.2	27.5b	2.9a	15.2
Spring		27.5a	7.5a	17.5	42.5a	3.9a	23.2
Aspect							
North		19.2a	5.8a	12.5	30.0a	2.6b	16.3
South		25.8a	7.0a	16.4	40.0a	4.2a	22.1
Pr>F							
Sodkill		0.00	0.04		0.03	0.69	
Aspect		0.32	0.14		0.16	0.05	
SodkillxAspect		0.86	0.73		0.57	0.13	

[1]Plots were cultivated between 6/21 and 7/10/93.
[2]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3d. Effect of sodkill and aspect on corn silking and tasselling at the Hammel Farm, 1993.

		Tasseling		Silking	
		7/30	8/4	7/30	8/4
Kill	Aspect	----------%----------			
Fall	North	89.0ab[1]	100.0a	67.2ab	97.4a
	South	92.4a	98.8a	70.6a	88.7a
Spring	North	55.9b	97.5a	5.0c	62.8b
	South	75.3ab	98.1a	42.0b	93.8a
Sodkill					
Fall		90.7a	99.4a	68.9a	93.0a
Spring		65.6b	97.8a	23.5b	78.3b
Aspect					
North		72.4a	98.8a	36.1a	80.1b
South		83.8a	98.4a	56.3a	91.2a
Pr>F	Sodkill	0.08	0.50	0.04	0.03
Aspect		0.31	0.42	0.13	0.08
SodkillxAspect		0.44	0.10	0.17	0.03

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3e. Effect of sodkill and aspect on weed counts and species composition in the row (cultivation late June) at the Hammel farm, July 9-12, 1993.

Sod Kill		Weed Count #/Ft[1]	Species Composition[1] Qg	Fxt.sp.	Dand.	Yns	Alf.	Rrpw	Vele
			%						
Fall	North	3.7a[2]	74.9a	20.7	3.4	-	-	1.1	-
	South	3.6a	66.0a	-	34.0	-	-	-	-
Spring	North	15.8a	39.4a	50.0	-	6.3	4.4	-	-
	South	6.9a	74.4a	-	1.8	-	17.3	4.8	1.8
Sod Kill									
Fall		3.6a	70.4a	10.4	18.7	-	-	0.6	-
Spring		11.4a	56.9a	25.0	0.9	3.1	10.8	2.4	0.9
Aspect									
North		9.8a	57.1a	35.4	1.7	3.2	2.2	0.6	-
South		5.2a	70.2a	-	17.9	-	8.7	2.4	0.9
Pr>F	Sod kill	0.24	0.82						
	Aspect	0.44	0.62						
SodkillxAspect		0.45	0.46						

[1]QG=Quackgrass; Fxt.sp=Foxtail sp.; Dand.=Dandelion; YNS=Yellow nutsedge; Alf.=Alfalfa; RRPW=Redroot pigweed; Vele=Velvetleaf.
[2]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3f. Effect of sodkill and aspect on weed counts and species composition between the row (cultivation late June) at the Hammel farm, July 9-12, 1993.

Kill	Aspect	Weed Count #/Ft[2]	Species Composition[1] Qg	Fxt.sp.	dand.	Yns	Alf.	Rrpw
			%					
Fall	North	2.1ab[2]	88.2a	-	9.3	-	-	2.5
	South	1.5b	71.4a	-	28.6	-	-	-
Spring	North	5.1a	39.8a	48.4	-	5.3	5.3	1.4
	Spring	3.5ab	81.5a	-	-	-	16.3	2.3
Sod Kill								
Fall		1.8b	79.8a	-	19.0	-	-	1.3
Spring		4.3a	60.6a	24.2	-	2.6	10.8	1.8
Aspect								
North		3.6a	64.0a	24.2	4.7	2.6	2.6	1.9
South		2.5a	76.4a	-	14.3	-	8.1	1.2
Pr>F	Sodkill	0.03	0.65					
	Aspect	0.40	0.65					
SodkillxAspect		0.69	0.34					

[1]QG=Quackgrass; Fxt.sp=Foxtail sp.; Dand.=Dandelion; YNS=Yellow nutsedge; Alf.=Alfalfa; RRPW=Redroot pigweed.
[2]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3g. Effect of sodkill and aspect on total soil N at 3-foot depth at the Hammel Farm, August 26, 1993.

Sod kill	aspect	NH_4^++NO_3^-	NH_4^+	NO_3^-
		lb/A		
Fall	North	141a[1]	88.2a	52.5a
	South	84a	69.8a	13.8a
Spring	North	134a	100.8a	32.2a
	South	144a	89.2a	54.5a
Fall		112a	79.0a	33.1a
Spring		139a	95.0a	43.4a
North		137a	94.5a	42.4a
South		113a	79.5a	34.1a
In-ro		129a	88.9a	40.4a
Between-row		121a	85.1a	36.1a
Pr>F	Sodkill	0.17	0.18	0.56
	Aspect	0.63	0.50	0.78
SodkillxAspect		0.50	0.87	0.36
Row position		0.52	0.72	0.34
Row pos.xSodkill		0.77	0.36	0.18
Row pos.xAspect		0.67	0.62	0.91
Rowpos*Sodkill*Aspect		0.46	0.79	0.16

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3h. Effect of sodkill, aspect, and depth on soil nitrogen concentrations at the one- and two-foot depths at the Hammel farm, August 26, 1993.

sod kill	aspect	depth	NH_4^++NO_3^-	NH_4^+	NO_3^-
			--------lb/A---------		
Fall	North	0-12"	48.2a[1]	27.5a	20.7ab
		12-24"	46.6a	28.1a	18.4ab
	South	0-12"	41.0a	29.8a	11.4ab
		12-24"	41.8a	39.7a	2.1b
Spring	North	0-12"	45.6a	28.1a	17.6ab
		12-24"	43.0a	35.1a	8.1ab
	South	0-12"	50.0a	27.1a	23.0a
		12-24"	45.6a	29.4a	16.2ab
Fall			44.4a	31.3a	13.1a
Spring			46.2a	29.9a	16.2a
North			46.0a	29.7a	16.2a
South			44.6a	31.5a	13.2a
0-12"			46.3a	28.1a	18.2a
12-24"			44.3a	33.1a	11.2b
In-row			44.9a	30.0a	13.6a
Between-row			45.7a	31.2a	15.6a
Pr>F	Sodkill		0.77	0.26	0.66
	Aspect		0.93	0.77	0.76
	SodkillxAspect		0.75	0.44	0.37
	Row position		0.81	0.64	0.76
	Depth		0.64	0.14	0.00
	DepthxSodkill		0.60	0.91	0.45
	DepthxAspect		0.96	0.68	0.50
	SodkillxAspectxDepth		0.72	0.26	0.17

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3i. Correlation of inorganic soil nitrogen concentrations at the 0-12" depth with corn phenology and yields at the Hammel farm, 1993.

	Leaf Numbers		Silking		
Row Position	6/21	7/10	7/30	8/4	Yield
In-row soil N	0.072	0.144	-.004	0.186	-0.245
Between-row soil N	-0.180	0.147	-0.042	0.087	-0.296
Pr>F					
In-row soil N	0.86	0.73	0.99	0.66	0.56
Between-row soil N	0.67	0.73	0.92	0.84	0.48

Table 3j. Soil core sampling data from the Hammel Farm, July 21, 1993.

Core	Sodkill	Aspect	Horizon	Depth	Soil Description
1	Spring	South	A	0-30"	Silt loam (Alluvium)
			B	30-55"	Si. clay loam, lt. brown (Argillic)
			C	55-69"	Mottled clay
				69"+	Rock
2	Spring	North	A	0-10"	Silt loam
			B_1	10-24"	Red clay (Argillic)
			B_2	24-38"	White clay
			C	38"+	Sandstone
3	Fall	North	A	0-8"	Silt loam
			B_1	8-30"	Brown clay
			B_2	30-42"	Clay (light color)
			C	42"+	Rock
4	Fall	South	A	0-8"	Silt loam
			B_1	8-20"	Silty clay loam
			B	20-42"	Brown clay
				42"+	Rock
5	Spring	South	A	0-8"	Silt loam
			B_1	8-15"	Fine sandy loam
			B_2	15-36"	Fine sand
			C	36"+	Sandstone
6	Spring	North	A	0-8"	Silt loam
				8-14"	Silt loam
			B	14-24"	Silty clay loam
				24-50"	Silt loam
			C	50-52"	Sand
				52"+	Sandstone

Table 3k. Effect of sodkill and aspect on corn grain yields, moisture contents, and nitrogen contents at the Hammel farm study.

Kill	Aspect	Moisture	Yield	Nitrogen
		--%---	--Bu/a--	--%--
Fall	North	27.2b[1]	160.8a	1.27a
	South	24.2d	177.7a	1.27a
Spring	North	30.6a	129.0b	1.33a
	South	25.5c	148.8ab	1.33a
Sodkill				
Fall		25.7a	169.2a	1.27b
Spring		28.0a	138.9b	1.33a
Aspect				
North		28.9a	144.9b	1.30a
South		24.8b	163.2a	1.30a
Pr>FSodkill		0.15	0.08	0.03
Aspect		0.01	0.04	0.98
SodkillxAspect		0.15	0.73	0.94

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 4a. Cultural practices used in the demonstrations at Jim Holty's Farm, 1993.

Experimental design

At this site there are three studies. The first is looking at the effect of aspect on corn response in a spring discing tillage approach. The design is a randomized complete block with two replications. The second study is evaluation of no till corn into corn. The design is a randomized complete block with two replications. The third study is evaluation of no till, drilled soybeans into corn stalks. The design is a randomized complete block with two replications.

	Corn Aspect	Corn No-till	Soybean No-till
Tillage equipment			
	Disc 14' Case International	none	none
Cropping history			
Previous crop	Corn	Corn	Corn
Planting date	5/10/93	5/13/93	5/22/93
Variety	Pioneer 3563 (103 day)	Pioneer 3702 (101 day)	
Planting pop.	28,500	28,500	
Planter	Case IH 800 with Yetter rolling finger trash wipers	Case IH 800Case	IH Grain drill
Fertilizer			
82-0-0	131 lb N/A	131 lb N/A	-
9-23-30	150 lb/A	150 lb/A	-
Beef manure	40 ton/A	-	-
Soil			
	Port Byron silt loam 3-6% slope at all three sites.		
Weed control	Confidence (2.08 lb/A) Atrazine (0.7 lb/A) Bladex (1.67 lb/A) May 17	Confidence (2.08 lb/A) Atrazine (0.7 lb/A) Marksman (1.3 qt/A) May 20	Pursuit (4 oz/A)
Insect control	Counter	Counter	-

Table 4b. Effect of aspect on early season plant population and crop residue, at the Richard and Jim Holty's Farm near Spring Grove in Houston County, 1993.

	Population			Cover with Corn Residue			
				In-row		Between Row	
	6/15	7/6	Avg.	6/15	7/6	6/15	7/6
Aspect	----1000s Plt/a----			----------%----------			
North Facing	25.3a[1]	23.2a	24.2	24.2a	29.2a	76.7a	81.2a
South Facing	24.8a	23.2a	24.0	27.5a	31.2a	81.2a	85.4a
Pr>F Aspect	0.82	0.98		0.84	0.75	0.50	0.50

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 4c. Effect of aspect on common stalk borer damage, corn leaf numbers and corn silking at the Holty Farm, 1993.

	Common Stalk Borer Damage	Leaf Numbers 6/15	7/6	Avg.	Silking[1] 8/13
Aspect	--%--	-Leaves/plant--			Score
North Facing	6.3a[2]	3.1a	6.4a	4.8	1.0a
South Facing	10.0a	3.0a	6.6a	4.8	1.2a
Pr>F Aspect	0.45	0.80	0.20		0.50

[1]Silking score based on color: 1=white or yellow (not pollinated), 5=brown (pollinated).
[2]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 4d. Effect of aspect on corn grain yield and moisture at the Holty farm, 1993.

Aspect	Grain Moisture	Corn Yield
Aspect	--%--	-Bu/a-
North	27.2a[1]	101a
South	26.5a	103a
Pr>F Aspect	0.96	0.46

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 5a. Effect of tillage on early season corn population and corn residue at the Holty Farm near Spring Grove in Houston County, 1993.

	Population			In-row		Between Row	
	6/15	7/6	Avg.	6/15	7/6	6/15	7/6
	----Plt/a(x1000)--			----------%----------			
No-till	27.6a[1]	27.3a	27.4	17.5a	12.9a	73.3a	66.7a
Disc/plant	27.0a	27.3a	27.2	10.0a	6.7a	22.5b	25.4b
Pr>F Tillage	0.66	1.0		0.55	0.50	0.08	0.03

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 5b. Effect of tillage on corn leaf numbers and silking at the Holty Farm, 1993.

	Leaf Numbers			Silking[1]
	6/15	7/6	Avg.	8/13
	--Leaves/plant--			Score
No-till	2.6a[2]	6.8a	4.7	1.5a
Disc/plant	2.8a	7.1a	5.0	1.5a
Pr>F Tillage	0.30	0.50		1.0

[1]Silking score based on color: 1=white or yellow (not pollinated) to 5=brown (pollinated).
[2]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 5c. Effect of tillage on weed counts and species composition in and between the rows at the Holty Farm, July 12, 1993.

	Weed Counts		Species Composition			
			Foxtail Sp.		Velvetleaf	
	In-row	Between	In-row	Between	In-row	Between
	---No./ft^2----		------% ground cover--------			
No-till	10.8a[1]	2.6a	92.2a	100.0a	7.8a	-
Disc/plant	7.2a	0.7b	83.1a	70.0a	17.0a	30.0
Pr>F Tillage	0.59	0.03	0.47	0.50	0.47	

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 5d. Effect of tillage on corn grain moisture, test weight, and yield, Holty Farm, 1993.

	tst.wt	moi.	yield
	lb/bu	-%-	bu/ac
No-till	47.2a	24.9a	89.6a
Disc/plant	47.5a	24.4a	96.8a
Pr>F	0.80	0.67	0.34

Table 6a. Effect of tillage on early soybean populations, node numbers and corn residue at the Holty Farm, Houston County, 1993.

	Soybean Population			Node Numbers		
	6/15	7/6	Avg.	6/15	7/6	Avg.
	---Plt/a(x1000)----			--Nodes/plant---		
No-till	165a[1]	179a	172	2.7a	5.3b	4.0
Chisel Plow	187a	201a	194	2.9a	5.8a	4.4
Pr>F Tillage	0.40	0.65		0.20	0.07	

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 6b. Effect of tillage on corn residue at the Holty Farm, Houston County, 1993.

	Corn Residue			
	In-row		Between Row	
	6/15	7/6	6/15	7/6
	----------%----------			
No-till	42.1a[1]	46.2a	40.8a	39.2a
Chisel Plow	17.5a	17.5b	20.4a	21.7a
Pr>F Tillage	0.22	0.10	0.15	0.20

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 6c. The effect of tillage on soybean test weight, moisture, and yield, Holty Farm, 1993.

	tst.wt	moi.	yield
	lb/bu	-%-	bu/ac
No-till	57.8a	11.2a	33.4a
chisel plow	57.5a	11.6a	38.4a
Pr>F	0.50	0.30	0.27

Table 7a. Cultural practices used at the Kottschade Farm, 1993.

Experimental Design

The tillage approach at this site is light field cultivation for corn following soybeans. The N sources evaluated are liquid hog manure, anhydrous ammonia, and an unfertilized check. The design is a randomized complete block.

Tillage equipment
Field cultivator International
Row cultivator International

Cropping history
Previous crop soybeans; planting date 5/18/93; variety Pioneer 3751 (97 day); planting population 27,800
Planter John Deere 7000 (6-30" rows) with 1" fluted coulters

Manure applications
Hog manure
(stored pit under slots) 3,825 gal/A
Total N 236 lb/A
NH_4-N 137 lb/A
Estimated Available N 170 lb/A
Application Injected 5/9/93

Liquid Hog Manure Analysis

Sample	Solids	NH_4	NO_3	Tot.Min.-N	Org.N	Total N	Est.Avail.N	Est.Avl.N applied[3]
5/19/93	---%---	----------lbs/1000 gals.----------						--- lbs.N/a ---
1.	7.8	37.3	-	37.3	24.3	61.6	44.6	170
2.	7.8	34.5	-	34.5	27.4	61.9	44.1	
Avg.	**7.8**	**35.9**	**-**	**35.9**	**25.8**	**61.8**	**44.4**	

1.Organic nitrogen = Total nitrogen - Total mineral nitrogen (from laboratory analysis).
2.Estimated available nitrogen =(Org.-N * .35) + Tot.Min.-N. It is assumed that all of the mineral N and 30% of the Org.N is available during the first year of application.
3.The rate of manure applied for plot area was 3,825 gal./acre on May 9,1993. Storage is a pit under slots and injected with 3 inch straight shovels.

Fertilizer
82-0-0 100 lb N/A; 11-30-20 105 lb/A applied with planter.

Soil Fayette silt loam

Weed control Lasso (alachlor) 2 qt/A applied 5/18/93; Hi-Depth 1 pt/A applied 7/3/93

Table 7b. Effect of nitrogen source on early season corn population and crop residue at a demonstration on Paul Kottschade's farm near Plainview in Wabasha County, 1993.

	Corn Population			Soybean Residue			
				In-row		Between-row	
	6/25	7/20	Avg.	6/25	7/20	6/25	7/20
	---Plt/a(x1000)----			----------%----------			
Check	28.7a[1]	25.8a	27.2	3.8a	2.1a	5.8a	3.3a
Anh.NH_3	27.1a	26.2a	26.6	5.4a	3.8a	5.8a	4.0a
Hog Man.	27.2a	25.3a	26.2	3.1a	1.2a	6.7a	1.9a
Pr>f N Source	0.91	0.95		0.18	0.43	0.90	0.53

[1]data Followed by the Same Letter in the Same Column Are Not Significantly Different at the 0.10 Level.

Table 7c. Effect of Nitrogen Source on Corn Leaf Numbers and Silking at the Kottschade Farm.

	Leaf Numbers			Silking[1]
	6/25	7/20	Avg.	8/20
	--Leaves/plant--			Score
Check	4.3a[2]	6.2b	5.2	2.5a
Anh.NH_3	4.4a	6.6a	5.5	2.7a
Hog Manure	4.2a	6.5a	5.4	2.8a
Pr>f N Source	0.50	0.04		0.90

[1]silking Score Based on Color: 1=white or Yellow (Not Pollinated) to 5=brown (Pollinated).
[2]data Followed by the Same Letter in the Same Column Are Not Significantly Different at the 0.10 Level.

Table 7d. Effect of nitrogen source on hand-harvested corn grain yields, moisture contents, and nitrogen concentrations at the Kottschade Farm, November 4, 1993.

	Moisture	Yield	Nitrogen
	--%---	bu/A	--%--
Check	20.4a[1]	117a	1.28a
Anhydrous	21.2a	134a	1.35a
Hog manure	21.4a	136a	1.36a

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

EVALUATION OF RESIDUE MANAGEMENT SYSTEMS FOR CORN, SOYBEANS, AND WHEAT PRODUCTION[1]

J.F. Moncrief, H.J. Stanislowski, B.J. Johnson, B.P. Peterson, and P.M. Bongard[2]

Soil cover in the row was variable between planter mounted tillage tools. When "in row" cover was high, early corn growth was delayed and in most cases persisted through the season. Corn yields were reduced in some instances. Tillage did not affect soybean or wheat yields.

This is the second year of a three year project to evaluate corn, soybean, and wheat production with residue management systems on highly erodible land in West Central Minnesota. These trials are replicated and plots range in size from 1 to 10 acres. Tillage treatments and grain yield estimates are accomplished with full size field equipment.

Julian and Dave Sjostrom Farm

This is the second year of corn following oats. Tillage systems evaluated are no till and chisel plowing. The planter is equipped with an "add on" yetter tool bar with a pair of ripple coulters one for dry fertilizer placement. The planter units have a set of concave clearing discs and down pressure spring kits installed. the Soil is a Chappett-Sisseton loam complex with a slope 12-20% slope with an average of about 15%. Liquid dairy manure was broadcast, spring applied before tillage both years of the study to meet the N needs of the corn.

Data is presented in tables 1a to 1e. Soil cover with corn residue, stand establishment, and early growth are shown in table 1b. The soil cover in the row and stands were similar between both tillage treatments. The chisel system resulted in a one leaf greater early growth.

Corn grown with the no till system had higher ear leaf P levels and lower K levels. Although the K is close, both are greater than critical levels (.25 and 1.8% respectively). There was no differences in micronutrients due to tillage.

There were no differences in grain test weight, moisture, or yield due to tillage. It is somewhat surprising that grain moisture differences do not reflect the early difference in growth.

Evert Gilbertson Farm

At this site no till and chisel plowing systems are being evaluated for corn grown in wheat residue. Data is presented in tables 2a to 2d. Soil cover with wheat residue was similar in the row with both systems. There was no difference in stand or early growth due to tillage.

Grain test weight and yield were lower with the no till system. Yields were very low at this site probably in part due to a volunteer wheat problem.

Dave Holt Farm

Two types of planter mounted tillage tools are being evaluated under no till and chisel plowing conditions for corn planted into wheat residue at this site. Data is presented in tables 3a to 3d. Soil cover with wheat residue was measured at two times. The rolling finger residue wheels were much more effective at clearing the row area of residue than the 1" fluted coulter. This difference had a great influence on stand and early growth. The differences in stand were due to row cleaners only. Early growth was affected by row cleaner type and tillage. The effect of row cleaners was on average 3 times greater than the tillage affect. The response was much greater with the no till system.

There was no difference in tissue levels of N, P, and K due to tillage.

At harvest the average row cleaner effect on grain moisture was 3% and the tillage affect 5%. The impact on row cleaner type on grain moisture was only present under no till conditions. Final grain yields were 3 and 12 bushels lower for the fluted coulter and no

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[1] This project is supported by a grant from the Minnesota Department of Agriculture's Energy and Sustainable Agriculture Program, the Minnesota Extension Service, the Soil Conservation Service, and the Ottertail Soil and Water Conservation District.

[2] J.F. Moncrief and B.J. Johnson are Extension Soil Specialist and Assistant Scientist in the Department of Soil Science at the University of Minnesota, H.J. Stanislowski and B.P. Peterson are an Extension Educator and Plot Coordinator, Ottertail County, MN, P.M. Bongard is a free lance data processor.

till treatments respectively.

Dan Jennen Farm

At this site a no till and chisel plowing system are evaluated for soybean production in corn residue. Data is presented in tables 4a and 4b. Plant stands are higher than necessary but there is no difference in stand or grain yields due to tillage system.

Tom Jennen Farm-soybeans

At this site two types of no till drills for soybeans planted into corn residue without tillage are being evaluated. Data is presented in tables 5a and 5b. Plant stands are much higher than necessary. There was a small but statistically significant difference in grain yield favoring the Hiniker sweep type unit.

Orland Ohe Farm

At this site a no till and chisel plowing system was evaluated for wheat production into soybean residue. Data is presented in tables 6a and 6b. There was no difference in wheat stand, test weight, protein, or yield due to tillage.

Tom Jennen Farm-wheat

This comparison contrasts chisel plowing and no till systems for wheat planted into soybean residue. Data is presented in tables 7a and 7b. Although there was a difference in plant stand due to tillage, there was no difference in test weight, protein, or yield.

Table 1a. Cultural practices used at the Sjostrom Farm, 1993.

Tillage
Chisel plow 4" shovels at 18" spacing 10/20/92
Field cultivator (20') 7" sweeps at 6" spacing

No till
Planter JD7000 4 row 36" spacing, equipped with concave disc row cleaners and yetter ripple coulters for dry starter fertilizer.

Experimental Design
Randomized complete block with three replications.

Crop history
Previous crop corn, planting date 5/5/93
Variety Sigco 1885 (85 day)
Planting rate 25,300 seeds/A

Fertilizer
30-10-10, 150 lb/A; Liquid manure 4000 gal/A, 1993

SJOSTROM LIQUID DAIRY MANURE ANALYSIS

6/15/92

	Solids									Est		
	Total	Vtl	Fxd	pH	Tl	Og	Mn	Am	Nit	Avl[2]	P_2O_5	K_2O
	--percent--				--Pounds per 1000 gals.----							
1.	7.84	81	19	6.6	32	17	16	15	.36	21	17	32
2.	11.38	83	17	6.9	39	22	17	17	.02	24	24	34
Avg.	9.61	82	18	6.8	36	19	16	16	.19	22	21	33

10/26/93

	Solids	NH_4^+	NO_3^-	Tl	Og	Tl	Est Avl
	---%---	-----lbs/1000 gals.-------					
1.	6.86	16	-	16	16	32	20
2.	6.97	19	-	19	13	32	23
3.	6.94	-	-	-	-	33	-
Avg.	6.92	17	-	17	14	32	22

1. Organic nitrogen = Total nitrogen - Total mineral nitrogen.
2. Estimated available nitrogen =(Org.-N * .30) + Tot.Min.-N
3. Rate of 4,000 gals./acre applied on Oct. 26, 1993. It is assumed that all of the mineral N and 30% of the Org.N is available during the first year of application.

Soil Chappett-Sisseton loam complex 100% of plot area with slope 12-20% with a 15% average.

Weed control
5/20/93 2,4-D (1/8 pt.) + Banvel (1/2 pt.)
6/2/93 2,4-D (1 pt) + Banvel (1/2 pt)
6/12/93 Accent (2/3 oz)

Table 1b. Effect of tillage on crop residue (5/17), corn populations (6/21) and leaf numbers (6/30) at the Julian Sjostrom Farm, 1993.

	residue			corn	early
	in	betw	across	stand	growth
tillage	---------%--------			-p/a-	-lvs/p-
chisel	24.6a[1]	44.9a	29.0b	22.9a	8.7
no-till	19.4a	71.0a	55.0a	22.9a	7.8
Pr>F	0.50	0.17	0.01	1.0	0.10

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 1c. Effect of tillage on ear leaf concentrations and harvest data at the Julian Sjostrom Farm, 1993.

	Ear leaf			grain		
	N	P	K	tst wt	moist	yield
tillage	---------%--------			lb/bu	--%--	-bu/A-
Chisel	3.06a	0.356a	1.96a	48.5a	33.8a	48.5a
No-till	2.96a	0.384b	1.91b	44.3a	33.9a	45.2a
Pr>F	0.27	0.06	0.06	0.42	0.93	0.15

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 1d. Effect of tillage on ear leaf concentrations at the Sjostrom farm, 1993.

	Ca	Mg	Na	Al	Fe	Mn	Zn
tillage	----------ppm----------						
Chisel	7772a[1]	2475a	13.3a	30.0a	115a	91.6a	20.4a
No-till	7832a	2568a	17.4a	33.0a	121a	94.3a	21.4a
Pr>F	.79	.52	.33	.71	.30	.73	.38

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 1e. Effect of tillage on ear leaf concentrations at the Sjostrom farm, 1993.

	B	Pb	Ni	Cr	Cd
	----------ppm----------				
Chisel	6.55a[1]	2.16a	0.927a	1.08a	0.159a
No-till	6.28a	2.16a	0.917a	1.12a	0.164a
Pr>F	0.76	1.00	0.91	0.76	0.37

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 2a. Cultural practices used at the Evert Gilbertson Farm.

Tillage
Disc (21') 10/5/92
Field cultivator (21') 7" sweeps at 4" spacing
Planter JD7000 6 row, 30" spacing, concave clearing disc

Experimental Design Randomized complete block with three replications.

Crop history
Previous crop Wheat
Planting date 5/14/93
Variety Cenex 232
Planting rate 26,000 seeds/A
planter equipped with row cleaners-fingers

Soil
Chappett loam 70% of plot area; slope 4%
Chappett-Sisseton loam complex 25% of plot area; slope 9%
Friberg Weetown loam complex 5% of plot area; slope 2%

Fertilizer
Urea 200 lb/A spring applied

Weed control
Herbicide
Dual (4.5 lb) in 14" bands-volunteer wheat problem
Accent (2/3 oz)
Banvel (1/2 pt)

Table 2b. Effect of tillage on wheat residue (5/26), plant populations (6/14), and leaf numbers (6/14) at the Everett Gilbertson Farm.

	Wheat residue			Corn	early
	in	between	across	stand	growth
	----------%---------			-p/a-	
Chisel	16.3a[1]	31.8b	23.1b	21.8a	10.4 a
No-till	23.4a	84.3a	65.3a	25.1a	9.8 a
Pr>F	0.16	<.001	0.008	0.31	0.17

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 2c. Effect of tillage on ear leaf concentrations (6/14) and harvest data at the Gilbertson Farm, 1993.

	Ear leaf			grain		
	N	P	K	weight	moist	yld
	----------%--------			lb/bu	%	bu/A
Chisel	1.88a	0.388a	1.52a	42.3a	28.9a	22.7a
No-till	1.84a	0.349a	1.43a	41.0b	29.8a	17.6b
Pr>F	0.57	0.30	0.24	0.057	0.48	0.034

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 2d. Effect of tillage on corn ear leaf concentrations at the Gilbertson farm, 1993.

	Ca	Mg	Na	Al	Fe	Mn	Zn	B	Cu	Cr
	----------ppm----------									
Chisel	5610a[1]	2570a	7.09a	23.0a	70.0a	36.4a	15.2a	4.87a	2.82a	0.617a
No-till	5441b	2656a	7.32a	26.3a	68.7a	37.1a	13.2a	4.64a	2.91a	0.553a
Pr>F	.0070	.52	0.83	0.52	0.76	0.94	0.21	0.72	0.85	0.30

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 3a. Cultural practices used at the Holt Farm, 1993.

Tillage
Disc/Chisel 3.5" twisted shovels at 12" spacings
Field Cultivator (40')
with drag 7" sweeps at 4" spacings
Planter JD7000 8 row 30" spacing, concave disc row cleaners.
Row Cleaners: coulter-1" fluted Fingers-spiked wheel residue managers

Experimental Design Randomized complete block with split plots (tillage main plots and row cleaners for subplots).

Crop history
Previous crop Wheat
Planting date 5/3/93
Variety DeKalb 421
Planting rate 26,000 seeds/A in 30" rows
Planter John Deere 7000 with finger row cleaners and coulters

Soil Sandberg loamy sand on 100% of the plot area; slope 4-9%

Fertilizer
15-38-10 110 lb/A applied as starter
Anhydrous Ammonia100 lb/A side-dressed at 10 leaf stage

Weed control
No-till strips 1.2 pt/A pre-plant
All plots Accent (2/3 pt) + Banvel (1/2 pt)

Table 3b. Effect of tillage on wheat residue (7/10), corn plant population (6/2), and leaf numbers (6/25) on the Holt farm, 1993.

		Wheat residue							
		in row		between row		across row			
		5/16	7/10	5/16	7/10	5/16	7/10	stand	growth
		%						-p/a-	-lvs/p-
Chisel	Coulters	23.3cd		47.0bc		28.0b		23.7bc	8.2b
	Fingers	4.3d		27.3cd		25.7b		26.4ab	9.3a
No-till	Coulters	81.7ab	95.7a	93.3a	91.3a	90.3a	92.7a	23.2c	7.6b
	Fingers	7.0d	61.0b	97.0a	88.0a	80.0a	82.7b	26.9a	9.0a
Chisel				25.5b[2]		26.8b		25.1a	8.7a
No-till				69.8a		85.2a		25.1a	8.3b
Coulters				61.3a		59.2a		23.5b	7.9b
Fingers				33.9b		52.8b		26.6a	9.1a
In row				29.1b					
Between Row				66.2a					
Pr>F	Tillage			0.06		0.06		1.0	0.060
	Cleaners	0.002	0.005	0.377		0.005	0.022	0.008	0.011
	tlgxcln	0.11		0.02				0.488	0.617
	tlgxpos	0.03							
	posxcln	0.005							
	tlgxposxcln	0.005							

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3c. Effect of tillage on corn ear leaf concentrations and harvest data (10/19) at the Dave Holt Farm, 1993.

		ear leaf			corn yield		
		%			lb/bu	-%-	bu/A
		N	P	K	ts wt	moist	yield
Chisel	Coulters	2.71a	0.309a	1.53a	41.3a	27.7c	55.2a
	Fingers	2.66a	0.314a	1.59a	40.7a	28.4bc	57.7a
No-till	Coulters	2.92a	0.334a	1.47a	39.0b	36.4a	42.6c
	Fingers	2.78a	0.324a	1.49a	41.3a	30.1b	47.2b
Chisel		2.68a	0.311a	1.56a	41.0a	28.0b	56.4a
No-till		2.85a	0.329a	1.48a	40.2b	33.2a	44.9b
Coulters		2.82a	0.321a	1.50a	40.2a	32.1a	48.9b
Fingers		2.72a	0.319a	1.54a	41.0a	29.2b	52.5a
Pr>F	tillage	0.165	0.147	0.476	0.010	0.013	0.014
row cleaners		0.410	0.742	0.620	0.137	0.020	0.063
tillagexcln		0.686	0.320	0.740	0.029	0.009	0.514

[1]Data followed by the same letter in the same column group are not significantly different at the 0.10 level.

Table 3d. Effect of tillage on corn ear leaf concentrations at the Holt Farm, 1993.

		ppm												
		Ca	Mg	Na	Al	Fe	Mn	Zn	Cu	B	Pb	Ni	Cr	Cd
Chisel	Coulter	6566a[1]	2845a	34.0a	24.8a	93.4a	114a	20.6a	6.84a	5.32b	1.75ab	0.595a	0.802a	0.136a
	Fingers	6008a	2909a	18.2a	24.2a	91.1a	101a	19.2a	7.78a	5.72a	1.68b	0.576a	0.835a	0.125a
No-till	Coulter	6808a	2740a	38.2a	20.8a	93.7a	115a	21.6a	6.25a	4.71c	1.86a	0.682a	0.911a	0.149a
	Fingers	6255a	2594a	21.8a	20.5a	91.4a	101a	21.8a	6.60a	5.57ab	1.80ab	0.555a	0.738a	0.127a
Chisel		6287a	2877a	26.1a	24.5a	92.2a	107a	19.9a	7.31a	5.52a	1.71b	0.585a	0.818a	0.130a
No-till		6532a	2667a	30.0a	20.7a	92.6a	108a	21.7a	6.42a	5.14b	1.83a	0.618a	0.825a	0.138a
Coulter		6687a	2793a	36.1a	22.8a	93.5a	114a	21.1a	6.54a	5.01b	1.80a	0.638a	0.856a	0.142a
Fingers		6132b	2752a	20.0a	22.4a	91.3a	101a	20.5a	7.19a	5.64a	1.74a	0.565a	0.787a	0.126a
Pr>F	tillage	0.610	0.584	0.425	0.170	0.925	0.94	0.42	0.40	0.001	0.002	0.18	0.72	0.39
row cleaners		0.026	0.770	0.146	0.586	0.519	0.19	0.41	0.39	0.03	0.32	0.21	0.40	0.11
tlgxclns		0.986	0.472	0.975	0.831	0.994	0.96	0.29	0.68	0.30	0.98	0.33	0.24	0.51

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 4a. Cultural practices used at the Dan Jennen Farm, 1993.

Tillage
Chisel plow 5/29/93
Field cultivator 7" sweep at 7" spacings
Multiweeded 4/22/93

Crop history
Previous crop Corn
Planting dates 5/29/93-Chisel plots
6/4/93-No-till plots (too wet on 5/29/93)
Variety Ozzie
Planting rate 110 lb/A

Soil Type Barnes-Langhi loam complex 80% of plot area; slope 6-12%
Langhi-Barnes loam complex 15% of plot area; slope 12-20%
Lake Park loam; 5% of plot area; slope 2%

Fertilizer
None

Weed control
No-till plots Roundup (2 pt) + 2,4-D (3/4 pt) 5/20/93 good weed control an all plots

Chisel plots Trust (trifluralin) (2 pt) 5/21/93
Storm (1.5 pt) 7/8/93

Table 4b. Effect of tillage on corn residue (6/5), soybean population (6/5), and harvest data (10/7) at the Dan Jennen Farm, 1993.

	Across Residue	Stand	Test	moist	yield
	--%--	plt/A	lb/bu	--%--	bu/A
Chisel	8.7b[1]	285.6a	59.0a	10.5a	27.1a
No-till	88.0a	264.3a	59.2a	10.2a	25.2a
Pr>F	0.001	0.280	0.874	0.490	0.353

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 5a. Cultural practices used in the soybean demonstration at Tom Jennen's Farm, 1993.

Tillage
None

Crop history
Previous crop Corn; planting date 5/17/93; variety Pioneer 9091; planting rate 100 lb/A
Planters John Deere 750 and Hiniker sweep or air seeder

Fertilizer
None

Weed control
Preplant Roundup (1 qt); Postemergence Pursuit (3 oz) + Fusion (8 oz); Spot spray Basagran (1 qt) on thistles

Table 5b. Effect of planter on corn residue (6/16), soybean population (6/14), and harvest data at the Tom Jennen Farm, 1993.

Tillage	across residue	stand	test	moist	yield
	--%--	plt/A	-lb/bu-	-%-	bu/A
Hinniker	86.9a	465a	55.7a	9.9a	22.4a
John Deere	86.3a	462a	56.0a	9.9a	20.8b
Pr>F	0.88	0.77	0.67	0.85	0.10

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 6a. Cultural practices used at the Ohe Farm, 1993.

Tillage
Chisel plow (fall) 4" twisted shovel at 15" spacings

Crop history
Previous crop Soybeans; planting date 5/4/93; variety Prospect; planting rate 2 bu/A
Drill Haybuster (7" rows) single smooth coulter preceding double disc openers

Soil

Formdale-Buse Udic Haploboroll-Udorthentic Haploboroll complex clay loam slope 2-6% avg 4% 60% of plot area
Formdale-Langhi clay loam Udic Haploboroll- complex slope 6-12% avg. 9% 20% of plot area
Aazdahl clay loam Aquic Haploboroll slope 0-3% avg. 1% 20% of plot area

Fertilizer
Urea 100 lb/A (4/30); 15-38-10 120 lb/A drill applied

Weed control
Herbicides: Tiller, 2,4-D (1/2 pt) & Banvel (1/8 pt)

Table 6b. Effect of tillage on soybean residue (5/3), wheat population (5/17), and harvest data (9/7) at the Orland Ohe Farm, 1993.

	Cover	Stand	test	moist	protein	yld
	--%--	plt/A	lb/bu	-----%-----		bu/A
Chisel	14.9b[1]	771a	53.2a	13.9a	15.3a	44.9a
No-till	56.0a	806a	53.8a	13.8a	14.4a	42.7a
Pr>F	0.002	0.44	0.21	0.97	0.21	0.21

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.

Table 7a. Cultural practices used in the wheat demonstration on Tom Jennen's Farm, 1993.

Tillage
Chisel plow 3" twisted shovels at 12" spacing
Cultivator 9" shovels at 6" spacing
Planter JD9350 6" row spacing (conventional drill)

Crop history
Previous crop Soybeans; planting date 4/20/93; Hybrid P2375; planting rate 2 bu/A

Fertilizer
18-46-0 150 lb/A
fall application anhydrous ammonia 100 lb/A
(fall applied with spike applicator)

Soil Type

Fordum fine sandy loam 30% of plot area
Sandbery loamy sand 30% of plot area
Langhei loam 40% of plot area

Weed control
Herbicide MCPA (3/4 pt/A)

Table 7a. Effect of tillage on residue (late April), wheat population (5/20), and harvest data (8/19) at Tom Jennen's farm, 1993.

	cover	stand	test	moist	protein	yld
	--%---	plt/A	lb/bu	-----%-----		bu/A
Chisel	17.6[1]a	1002a	56.2a	17.8a	14.0a	53.4a
No-till	21.3a	767b	56.0a	18.0a	13.8a	47.7a
Pr>F	0.39	0.007	0.81	0.87	0.42	0.30

[1]Data followed by the same letter in the same column are not significantly different at the 0.10 level.