

APPENDIX TABLES 1-36

Table A1. Mean chemical and physical characteristics of the Center tillage study from the 1987 access tube cores.[†]

Depth (cm)	Chemical					Physical				Texture
	pH	EC	Sat. %	SAR	Org. C	VFS [‡]	Sand	Silt	Clay	
0-15	7.8	0.7	45.1	0.3	2.0	17.3	44.5	39.2	16.3	Loam
15-30	7.8	0.7	44.5	0.3	1.8	16.1	44.9	38.5	16.6	
30-45	7.8	0.9	42.1	0.7	1.2	13.1	55.8	28.3	15.9	
45-60	7.8	0.9	40.6	0.8	0.8	10.5	62.4	23.1	14.5	
60-75	7.8	0.8	41.2	0.8	---	10.8	61.8	23.5	14.7	
75-90	7.8	1.1	41.0	0.8	---	10.7	61.7	23.7	14.6	
90-105	7.7	1.0	41.2	1.0	---	11.0	59.8	24.8	15.4	
105-120	7.7	1.1	42.1	2.0	---	14.1	57.6	26.9	15.5	
120-135	7.8	1.2	43.7	3.2	---	20.8	55.5	30.1	14.4	
135-150	7.9	0.8	43.0	2.2	---	23.0	58.0	27.6	14.4	

[†]Mean of 10 replications (materials from six cores were combined to make one replication).

[‡]Based on total sample weight.

Table A2. Mean chemical and physical characteristics of the Coteau tillage study from the 1987 access tube cores.[†]

Depth (cm)	Chemical					Physical				Texture
	pH	EC	Sat.%	SAR	Org. C	VFS [‡]	Sand	Silt	Clay	
0-15	7.4	0.8	47.6	0.4	1.6	10.0	30.1	47.7	22.2	Loam
15-30	7.4	0.8	51.6	0.4	1.5	8.2	30.1	46.8	23.1	Loam
30-45	7.6	1.2	49.1	1.0	1.1	9.3	36.9	40.6	22.5	Loam
45-60	7.8	1.4	46.4	1.5	0.6	10.0	47.4	31.6	21.0	Loam
60-75	7.9	1.5	47.4	1.6	---	10.6	47.4	31.2	21.4	Loam
75-90	7.9	1.3	47.8	1.5	---	10.2	48.4	30.7	20.9	Loam
90-105	7.9	2.0	50.7	2.7	---	9.9	43.8	33.1	23.1	Loam
105-120	7.8	3.7	59.9	6.0	---	9.9	35.9	37.0	27.1	Loam
120-135	7.8	5.5	76.9	12.9	---	9.6	24.7	42.3	33.0	Clay Loam
135-150	7.8	5.6	83.6	14.9	---	9.8	20.6	44.6	34.8	Clay Loam

[†]Mean of 10 replications (materials from six cores were combined to make one replication).

[‡]Based on total sample weight.

Table A3. Mean soil physical and chemical properties obtained in 1989 during tube installation at the Glenharold location.[†]

		Depth (m)				
		0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
Sand (%)	Mean	27	20	27	42	40
	Min/Max	24/31	11/29	18/43	10/61	18/60
Silt (%)	Mean	48	47	44	34	36
	Min/Max	45/51	41/33	31/48	22/51	24/51
Clay (%)	Mean	25	33	29	24	24
	Mix/Max	21/28	28/41	24/34	14/39	15/31
Texture [‡]		L	CL	CL	L	L
pH	Mean	7.8	8.0	8.0	8.0	8.0
	Min/Max	7.7/7.9	7.7/8.3	7.8/8.2	7.7/8.3	7.7/8.4
EC [§] (mmhos/cm)	Mean	1.4	2.8	3.0	4.0	3.9
	Min/Max	1.0/2.0	1.6/4.0	1.8/4.2	1.6/6.3	1.5/6.3
Saturation (%)	Mean	66	80	93	95	97
	Min/Max	60/87	64/100	65/114	81/108	81/114
SAR [¶]	Mean	2.5	9.8	13.0	22.2	23.3
	Min/Max	1.3/4.6	3.7/15.1	5.7/22.3	12.3/30.2	15.6/28.3

[†]12 replications per mean.

[‡]L = loam and CL = clay loam.

[§]Electrical conductivity.

[¶]Sodium adsorption ratio.

Table A4. Mean soil physical and chemical properties obtained in 1989 during tube installation at the Knife River location.⁺

		Depth (m)				
		0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
Sand (%)	Mean	65	61	52	52	38
	Min/Max	59/70	51/68	42/62	43/61	22/53
Silt (%)	Mean	20	22	27	27	34
	Min/Max	15/26	18/25	21/32	21/34	28/44
Clay (%)	Mean	15	17	21	21	28
	Mix/Max	10/20	12/24	15/28	17/29	19/39
Texture [#]		SL	SL	SCL	SCL	CL
pH	Mean	7.7	7.7	7.9	7.9	7.9
	Min/Max	7.5/8.0	7.5/8.0	7.7/8.1	7.8/8.1	7.6/8.2
EC [§] (mmhos/cm)	Mean	1.1	1.1	2.3	2.2	2.9
	Min/Max	0.8/1.4	0.8/1.6	1.4/3.1	1.1/3.9	1.1/4.8
Saturation (%)	Mean	38	41	51	53	59
	Min/Max	32/46	34/52	43/59	39/60	47/78
SAR [¶]	Mean	0.4	0.6	1.0	0.9	4.3
	Min/Max	0.4/0.5	0.4/1.1	0.5/3.3	0.5/1.8	0.5/12.4

⁺12 replications per mean.

[#]SL = sandy loam, SCL = sandy clay loam and CL = clay loam.

[§]Electrical conductivity.

[¶]Sodium adsorption ratio.

Table A5. Topsoil tillage effects with time on bulk density at Center and Coteau.

Data Year [†]	Tillage Treatment [‡]	Profile Depth (m) [§]			
		0-0.3	0.3-0.6	0-0.3	0.3-0.6
(Mg/m ³)					
		<u>Center</u>		<u>Coteau</u>	
1987C	CH	1.47	1.53	1.47	1.58
	DR	1.47	1.55	1.49	1.59
	GR	1.48	1.53	1.45	1.56
	LSD(0.10) [#]	NS	0.01	0.02	0.01
1989R	CH	1.56	1.70	1.42	1.61
	DR	1.48	1.58	1.44	1.57
	GR	1.50	1.66	1.50	1.62
	LSD(0.10)	0.04	0.06	0.06	NS
1990P	CH	1.50	1.66	1.41	1.62
	DR	1.49	1.66	1.42	1.65
	GR	1.49	1.69	1.43	1.62
	LSD(0.10)	NS	NS	NS	NS
1990R	CH	1.43	1.69	1.36	1.57
	DR	1.44	1.59	1.22	1.55
	GR	1.39	1.68	1.40	1.59
	LSD(0.10)	NS	0.04	0.12	NS
1991P	CH	1.42	1.70	1.31	1.59
	DR	1.35	1.63	1.34	1.58
	GR	1.41	1.71	1.35	1.63
	LSD(0.10)	0.05	0.04	NS	NS
1991R	CH	1.38	1.70	1.36	1.60
	DR	1.33	1.65	1.35	1.58
	GR	1.34	1.71	1.38	1.62
	LSD(0.10)	NS	NS	NS	NS
1992P	CH	1.36	1.72	ND ^{**}	ND
	DR	1.34	1.61	ND	ND
	GR	1.34	1.66	ND	ND
	LSD(0.10)	NS	0.08	---	---
1992R	CH	1.56	1.77	ND	ND
	DR	1.50	1.69	ND	ND
	GR	1.50	1.72	ND	ND
	LSD(0.10)	NS	NS	---	---
Yr x Top	LSD(0.10)	NS	NS	0.07	NS

[†]C = access tube installation, P = penetrometer sampling spring, and R = root sampling fall.

[‡]CH = chisel, DR = deep rip, and GR = grader rip.

[§]0.3-0.6 m depth averaged across subsoil tillage treatments.

[#]Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values.

^{**}Site discontinued in 1991 due to mining activities.

Table A6. Subsoil tillage effects with time on bulk density at Center and Coteau.

Date Year ⁺	Tillage Treatment ⁺	Profile Depth (m) ⁴					
		0.3-0.6	0.6-0.9	0.9-1.2	0.3-0.6	0.6-0.9	0.9-1.2
		(Mg/m ³)					
1987C	CH	1.55	1.56	1.57	1.57	1.61	1.60
	DL	1.50	1.54	1.55	1.57	1.62	1.59
	DR	1.54	1.55	1.57	1.60	1.61	1.59
	GR	1.54	1.56	1.55	1.58	1.62	1.60
	NT	1.54	1.57	1.56	1.56	1.58	1.56
	LSD(0.10) ⁶	0.03	NS	NS	NS	NS	0.02
1989R	CH	1.67	ND ⁷	ND	1.60	ND	ND
	DL	1.66	ND	ND	1.54	ND	ND
	DR	1.60	ND	ND	1.59	ND	ND
	GR	1.67	ND	ND	1.61	ND	ND
	NT	1.64	ND	ND	1.62	ND	ND
	LSD(0.10)	NS	---	---	NS	---	---
1990P	CH	1.68	ND	ND	1.57	1.55	1.62
	DL	1.62	1.47	1.66	1.64	1.57	1.59
	DR	1.64	1.52	1.84	1.66	1.69	1.57
	GR	1.70	1.86	1.80	1.62	1.65	1.67
	NT	1.71	1.60	1.82	1.64	1.69	1.80
	LSD(0.10)	NS	---	---	NS	NS	NS
1990R	CH	1.70	1.75	1.74	1.47	1.59	1.64
	DL	1.56	1.63	1.59	1.69	1.66	1.73
	DR	1.64	1.68	1.68	1.55	1.57	1.65
	GR	1.66	1.65	1.60	1.62	1.51	1.57
	NT	1.72	1.75	1.76	1.52	1.64	1.70
	LSD(0.10)	0.08	NS	NS	NS	NS	NS
1991P	CH	1.69	1.74	1.70	1.54	1.59	1.61
	DL	1.59	1.61	1.62	1.55	1.53	1.55
	DR	1.64	1.67	1.66	1.57	1.65	1.72
	GR	1.71	1.74	1.75	1.56	1.60	1.59
	NT	1.76	1.76	1.78	1.78	1.94	1.90
	LSD(0.10)	0.07	0.05	0.07	0.12	0.10	0.10
1991R	CH	1.72	ND	ND	1.58	1.56	1.78
	DL	1.62	1.62	1.73	1.63	1.51	1.52
	DR	1.62	1.67	1.60	1.64	1.67	ND
	GR	1.75	1.84	ND	1.52	1.58	ND
	NT	1.73	1.65	ND	1.63	1.67	ND
	LSD(0.10)	0.08	NS	---	NS	NS	---

Table A6 continued.

Date Year	Tillage Treatment	Profile Depth (m) ⁸					
		0.3-0.6	0.6-0.9	0.9-1.2	0.3-0.6	0.6-0.9	0.9-1.2
		(Mg/m ³)					
1992P	CH	1.70	1.80	1.78	ND	ND	ND
	DL	1.59	1.67	1.76	ND	ND	ND
	DR	1.66	1.61	1.71	ND	ND	ND
	GR	1.65	1.69	1.76	ND	ND	ND
	NT	1.72	1.66	1.81	ND	ND	ND
	LSD(0.10)	NS	NS	NS	---	---	---
1992R	CH	1.78	1.94	1.72	ND	ND	ND
	DL	1.65	1.62	1.55	ND	ND	ND
	DR	1.72	1.77	1.83	ND	ND	ND
	GR	1.69	1.62	1.77	ND	ND	ND
	NT	1.80	1.78	ND	ND	ND	ND
	LSD(0.10)	NS	NS	NS	---	---	---
Yr x Sub	LSD(0.10)	NS	0.10	NS	0.08	0.20	0.10

[†]C = access tube installation, P = penetrometer sampling, and R = root sampling.[‡]CH = chisel, DL = deep lift, DR = deep rip, GR = grader rip, and NT = no till.[§]Averaged across topsoil tillage treatments which may have penetrated one or more depth increments.^{*}Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values. --- indicates insufficient data for analysis.^{††}No data. Coteau discontinued after 1991 due to mining activities.

Table A7. Yearly changes in bulk density measured at the Center and Coteau locations.

Year of Data [†]	Profile Depth (m)			
	0-0.3	0.3-0.6	0.6-0.9	0.9-1.2
(Mg/m ³)				
<u>Center Location</u>				
1987C	1.47a [‡]	1.54a	1.56a	1.56a
1989R	1.52ab	1.65b	ND [§]	ND
1990P	1.49ac	1.67b	1.61a	1.75bcd
1990R	1.42d	1.66b	1.69b	1.67c
1991P	1.39de	1.68b	1.70b	1.70bc
1991R	1.35e	1.69b	1.69b	1.67bc
1992P	1.35e	1.66b	1.69b	1.76de
1992R	1.52bc	1.73c	1.69b	1.73be
<u>Coteau Location</u>				
1987C	1.47a	1.58a	1.60ab	1.59a
1989R	1.45ab	1.60ab	ND	ND
1990P	1.42b	1.63b	1.62b	1.63ab
1990R	1.33c	1.57a	1.59ac	1.65bc
1991P	1.33c	1.60ab	1.66d	1.67cd
1991R	1.36c	1.60ab	1.60bc	1.65abd

[†]Core data from access tube installation (C), penetrometer measurements (P) and root measurements (R).

[‡]Values within locations and depths followed by the same letter are not significantly different at the P = 0.10 level.

[§]No data.

Table A8. Selected mean cone index values by tillage depths with time at the Center tillage location.

		Profile Depth (cm)						
Year	Tillage ⁺		0-15	15-30	30-35 ⁺	35-50	50-65	65-100
	Topsoil	Subsoil	(MPa)					
<u>Year Effects</u>								
1990			2.44A [§]	5.73A	6.74A	7.86A	9.06A	6.91A
1991			4.00B	7.73B	9.70B	12.73B	14.88B	13.60A
1992			3.72B	6.91B	8.70B	12.20B	13.03B	10.86A
<u>Year x Topsoil Tillage Effects</u>								
1990	CH		2.20A	6.24A	8.03A	9.78A	10.01A	7.24AB
	DR		2.36A	4.87A	5.31A	6.04A	7.80A	7.00B
	GR		2.76A	6.06A	7.04A	8.16A	10.59A	6.08AB
	LSD(0.10)*		NS	NS	1.31	1.36	NS	---
1991	CH		3.86A	8.92A	12.14A	14.65A	14.46A	12.25A
	DR		3.56A	6.04A	6.78A	10.00A	12.76A	12.06A
	GR		4.63A	8.28A	10.39A	13.75A	17.82A	18.01C
	LSD(0.10)		0.73	1.70	2.60	2.40	NS	NS
1992	CH		4.07A	8.34A	11.71A	14.26A	13.97A	11.16A
	DR		3.46A	6.04A	6.43A	10.06A	12.29A	11.60A
	GR		3.64A	6.35A	8.16A	12.43A	13.05A	9.84A
	LSD(0.10)		NS	1.43	2.00	2.45	NS	NS
<u>Year x Subsoil Tillage Effects</u>								
1990	CH		2.39A	4.93A	5.54A	8.62A	11.28A	ND ⁺⁺
	DL		2.49A	6.67A	7.38A	7.76AB	8.46A	8.29A
	DR		1.94A	4.93A	7.30A	8.05AB	8.51A	8.48A
	GR		2.58A	6.14A	7.22A	7.93AB	10.15A	8.54A
	NT		2.78A	5.96A	6.34A	6.96B	8.37A	5.94A
	LSD(0.10)		0.42	0.98	1.33	NS	NS	---
1991	CH		3.80A	7.40A	10.54A	13.97CDE	16.10A	15.87A
	DL		4.90A	7.14A	7.12A	8.80AB	11.56A	10.99A
	DR		3.37A	7.47A	10.39A	12.44DFG	15.98A	12.01A
	GR		3.76A	9.61A	11.43A	15.37C	15.27A	17.91A
	NT		4.16A	7.25A	9.41A	13.68CEF	18.17A	ND
	LSD(0.10)		0.79	NS	NS	NS	NS	NS

Table A8 continued.

Year	Tillage		Profile Depth (cm)					
	Topsoil	Subsoil	0-15	15-30	30-35 ⁺	35-50	50-65	65-100
(MPa)								
1992	CH	4.13A	7.66A	9.57A	14.34CF	14.54A	13.14A	
	DL	3.03A	5.93A	6.81A	10.09AG	13.18A	12.02A	
	DR	3.70A	7.20A	9.43A	12.84CD	12.47A	7.89A	
	GR	3.25A	6.44A	7.97A	8.94AB	12.43A	9.89A	
	NT	4.51A	7.32A	9.81A	15.03C	12.41A	11.92A	
	LSD(0.10)	NS	NS	NS	2.03	NS	NS	

⁺CH = chisel, DL = deep lift, DR = deep rip between shank tracks, GR = grader rip, and NT = no till.

⁺Transition zone between topsoil and subsoil.

^aValues in columns by depth and effect followed by the same letter are not significantly different at the P = 0.10 level.

^bLeast significant difference at the P = 0.10 level for within year values. NS indicates no significant difference among mean values. --- indicates not enough data points for the ANOVA model.

⁺⁺No data.

Table A9. Selected mean cone index values by tillage depths with time at the Coteau tillage location.

Tillage [†]			Profile Depth (cm)					
Year	Topsoil	Subsoil	0-15	15-40	40-56 [‡]	56-73	73-85	85-100
(MPa)								
<u>Year Effects</u>								
1990			1.11A [§]	3.92A	7.68A	8.74A	7.72A	7.54A
1991			2.25B	6.33B	9.79B	12.48B	12.97B	10.11B
<u>Year x Topsoil Tillage Effects</u>								
1990	CH		1.02A	3.18A	7.48A	8.25A	7.31A	6.67A
	DR		1.01A	3.47A	7.24A	9.28A	8.48A	8.41A
	GR		1.29A	5.11A	8.33A	8.47A	7.31A	7.40A
	LSD(0.10) [#]		NS	0.90	NS	NS	NS	0.28
1991	CH		1.95A	5.48A	9.76A	12.40A	13.89A	10.46A
	DR		2.25A	5.58A	9.50A	12.60A	11.86A	10.47A
	GR		2.56A	7.93A	10.13A	12.43A	13.11A	9.49A
	LSD(0.10)		NS	1.24	NS	NS	NS	NS
<u>Year x Subsoil Tillage Effects</u>								
1990	CH		1.09A	3.90A	6.74A	7.95A	7.86A	6.82A
	DL		1.11A	4.07A	9.03A	8.89A	6.41A	7.02A
	DR		0.96A	3.42A	7.58A	9.15A	7.16A	8.38A
	GR		1.11A	3.85A	7.17A	8.88A	9.18A	7.22A
	NT		1.26A	4.37A	7.70A	9.01A	7.34A	9.22A
	LSD(0.10)		NS	NS	NS	NS	NS	1.30
1991	CH		2.00A	5.95A	8.09A	10.79A	11.52A	9.00A
	DL		3.13A	8.09A	11.39A	11.84A	12.35A	9.64A
	DR		2.12A	5.91A	8.27A	12.53A	13.67A	11.60A
	GR		2.31A	6.59A	11.79A	13.75A	12.72A	9.66A
	NT		1.71A	5.12A	9.44A	13.76A	15.25A	11.70A
	LSD(0.10)		NS	1.72	2.05	NS	NS	NS

[†]CH = chisel, DL = deep lift, DR = deep rip between shank tracks, GR = grader rip, and NT = no till.

[‡]Transition zone between topsoil and subsoil.

[§]Values in columns followed by the same letter by depth and effect are not significantly different at the P = 0.10 level.

[#]Least significant difference at the P = 0.10 level for within year values. NS indicates no significant difference among mean values.

Table A10. Selected mean cone index values with time from the deep rip topsoil tillage treatment at the Center location.

Year	Topsoil Tillage ⁺	Profile Depth (cm)		
		0-20	20-100	
(MPa)				
<u>Year Effects</u>				
1990		2.86A [†]	4.76A	
1991		3.98B	6.75B	
1992		3.94B	7.60C	
<u>Shank vs Nonshank Effects</u>				
	DR	3.66A	8.69A	
	DRSH	3.52A	4.05B	
<u>Year x Shank/Nonshank Effects</u>				
1990	DR	2.88A	5.98A	
	DRSH	2.83A	3.54B	
	LSD(0.10) [§]	NS	1.51	
1991	DR	4.05A	10.23C	
	DRSH	3.92A	3.28B	
	LSD(0.10)	NS	1.10	
1992	DR	4.05A	9.87C	
	DRSH	3.83A	5.33A	
	LSD(0.10)	NS	1.49	

[†]DR = between shank tracks and DRSH = within shank tracks.

[‡]Values within columns by depth and effect followed by the same letter are not significantly different at the P = 0.10 level.

[§]Least significant difference at the P = 0.10 level for within year values. NS indicates no significant difference between mean values.

Table A11. Selected mean cone index values from the deep rip topsoil tillage treatment with time at the Coteau location.

Year	Tillage [†]		Profile Depth (cm)		
	Topsoil	Subsoil	0-20	20-60	60-100
(MPa)					
				<u>Year Effects</u>	
1990			1.24A [‡]	4.81A	8.86A
1991			2.55B	7.10B	12.39B
				<u>Year x Topsoil Tillage Effects</u>	
1990	DR		1.19A	5.73A	9.24A
	DRSH		1.30A	3.89A	8.56A
		LSD(0.10) [§]	NS	0.92	NS
1991	DR		2.71A	8.04A	12.58A
	DRSH		2.38A	6.16A	12.20A
		LSD(0.10)	NS	1.32	NS
				<u>Year x Subsoil Tillage Effects</u>	
1990	CH		1.45A	3.92A	8.16A
	DL		1.12A	4.78A	8.60A
	DR		1.06A	4.25A	9.05A
	GR		1.25A	5.44A	8.82A
	NT		1.33A	5.66A	10.45A
	LSD(0.10)		NS	NS	NS
1991	CH		2.33A	5.30A	10.46A
	DL		3.15A	9.08A	12.85A
	DR		2.76A	6.69A	11.62A
	GR		2.78A	6.48A	11.54A
	NT		1.72A	7.93A	17.01A
	LSD(0.10)		NS	NS	NS

[†]DR = deep rip between shank tracks, DRSH = deep rip within shank, CH = chisel tracks, DL = deep lift, GR = grader rip, and NT = no till.

[‡]Values in columns by depth and effect followed by the same letter are not significantly different at the P = 0.10 level.

[§]Least significant difference at the P = 0.10 level for within year values. NS indicates no significant difference among mean values.

Table A12. Mean volumetric soil water percent for cone index cores at the Center and Coteau locations.[†]

Year	Profile Depth (cm)						
	0-15	15-30	30-45	45-60	60-75	75-90	90-105
(%)							
<u>Center Location</u>							
1990	11.8	11.7	11.0	12.8	10.6	12.8	15.1
1991	8.8	11.0	10.8	12.3	12.3	12.6	12.9
1992	8.0	11.2	11.6	13.2	14.7	14.9	15.7
LSD(0.10) [‡]	1.4	0.4	NS	NS	NS	NS	0.5
<u>Coteau Location</u>							
1990	19.0	20.1	15.1	14.0	14.0	15.9	17.0
1991	13.5	14.3	14.2	13.2	13.8	14.9	17.9
LSD(0.10)	1.6	0.3	0.3	NS	NS	NS	NS

[†]Averaged over tillage treatments.

[‡]Least significant differences at the P = 0.10 level. NS indicates no significant difference among mean values.

Table A13. Tillage influences on yearly forage yields at the Center and Coteau locations.

Tillage Treatment [†]		Location/Year of Data				
Topsoil	Subsoil	Center			Coteau	
		1990	1991	1992	1990	1991
(Mg/ha)						
CH		1.16	2.36	2.25	1.87	2.38
DR		1.05	2.19	1.94	2.09	2.37
GR		1.24	2.52	2.17	1.79	2.34
	LSD(0.10) [‡]	NS	0.23	NS	NS	NS
CH		0.99	2.56	2.33	1.83	2.45
DL		1.37	2.15	2.02	2.14	2.07
DR		1.34	2.43	2.26	2.22	2.56
GR		1.21	2.33	2.03	1.75	2.36
NT		0.83	2.30	1.96	1.64	2.38
	LSD(0.10)	NS	NS	NS	0.30	NS
CH	CH	0.89	2.11	2.13	1.90	2.52
	DL	1.37	2.30	2.41	1.64	2.08
	DR	1.08	2.33	2.14	2.21	2.58
	GR	1.72	2.75	2.28	1.98	2.33
	NT	0.72	2.30	2.30	1.62	2.38
DR	CH	0.69	2.40	2.18	1.79	2.53
	DL	1.17	1.87	1.51	2.95	2.24
	DR	1.76	2.49	2.55	2.45	2.47
	GR	0.88	2.04	1.96	1.74	2.44
	NT	0.75	2.14	1.49	1.53	2.18
GR	CH	1.40	3.16	2.68	1.80	2.31
	DL	1.58	2.28	2.13	1.83	1.90
	DR	1.17	2.46	2.08	1.99	2.62
	GR	1.04	2.20	1.86	1.52	2.30
	NT	1.03	2.48	2.10	1.78	2.56
	LSD(0.10)	NS	0.52	NS	NS	NS

[†]CH = chisel, DL = deep lift, DR = deep rip, GR = grader rip, and NT = no till.

[‡]Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values.

Table A14. Deep rip topsoil tillage influences on yearly forage yields at the Center and Coteau locations.

Tillage Treatment ⁺		Location/Year of Data					
		Center			Coteau		
Topsoil	Subsoil	1990	1991	1992	1990	1991	
(Mg/ha)							
DR DRSH	CH	1.05	2.19	1.94	2.09	2.37	
	DL	1.09	2.11	1.90	1.83	2.22	
	LSD(0.10)	NS	NS	NS	0.19	NS	
DR DRSH	CH	0.87	2.22	2.27	1.78	2.36	
	DL	1.13	1.94	1.58	2.44	2.13	
	DR	1.71	2.35	2.37	2.31	2.47	
	GR	0.88	2.13	1.88	1.62	2.28	
	NT	0.76	2.09	1.39	1.64	2.24	
	LSD(0.10)	0.37	NS	0.30	NS	NS	
DR DRSH	CH	0.69	2.40	2.18	1.79	2.53	
	DL	1.17	1.87	1.51	2.95	2.24	
	DR	1.76	2.49	2.55	2.45	2.47	
	GR	0.88	2.04	1.96	1.74	2.44	
	NT	0.75	2.14	1.49	1.53	2.18	
	LSD(0.10)	1.05	2.04	2.36	1.78	2.18	
DRSH	CH	1.09	2.02	1.66	1.94	2.02	
	DL	1.66	2.22	2.19	2.16	2.47	
	DR	0.89	2.22	1.99	1.51	2.13	
	GR	0.77	2.03	1.30	1.76	2.31	
	NT	NS	NS	NS	0.42	NS	

⁺CH = chisel, DL = deep lift, DR = deep rip, DRSH = deep rip shank track, grader rip, and NT = no till.

[†]Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values.

Table A15. Selected mean forage yields with time at Center and Coteau.

Tillage Treatment ⁺			Location	
Year	Topsoil	Subsoil	Center	Coteau
(Mg/ha)				
			<u>No DRSH Data</u>	
1990			1.15	1.92
1991			2.35	2.36
1992			2.12	---
		LSD(0.10) ⁺	0.18	0.27
	CH		1.92	2.12
	DR		1.72	2.33
	GR		1.98	2.06
		LSD(0.10)	0.16	NS
	CH		1.96	2.14
	DL		1.85	2.10
	DR		2.01	2.39
	GR		1.86	2.05
	NT		1.70	2.01
		LSD(0.10)	NS	0.20
<u>Topsoil DR vs DRSH Data</u>				
1990			1.07	1.96
1991			2.15	2.30
1992			1.92	---
		LSD(0.10)	0.19	NS
	DR		1.72	2.23
	DRSH		1.70	2.03
		LSD(0.10)	NS	0.12
	CH		1.79	2.07
	DL		1.55	2.29
	DR		2.14	2.39
	GR		1.66	1.95
	NT		1.41	1.94
		LSD(0.10)	0.21	NS

⁺CH = chisel, DL = deep lift, DR = deep rip between shank tracks, DRSH = deep rip shank track, GR = grader rip, and NT = no tillage.

⁺Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values.

Table A16. Mean alfalfa root length density by years as influenced by topsoil tillage treatments at the two topsoil/subsoil tillage locations.[†]

Year	Topsoil Tillage	Profile Depth (cm)										
		5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	
(cm/cm ³ x 10)												
<u>Center Location</u>												
1989	Chisel (CH)	19.8	11.8	7.1	0.6							
	Deep Rip (DR)	20.5	9.2	3.8	0.9							
	Grader Rip (GR)	21.9	12.4	8.3	0.0							
	LSD(0.10) [‡]	NS	NS	NS	NS							
1990	CH	24.7	13.4	5.9	1.2	0.6						
	DR	23.5	13.3	6.1	2.5	0.4						
	GR	24.2	14.7	5.6	0.6	0.3						
	LSD(0.10)	NS	NS	NS	NS	NS						
1991	CH	44.9	29.2	11.1	5.1	0.8	0.4	0.5	1.6			
	DR	39.8	19.7	14.2	4.5	0.8	0.7	0.3	0.1			
	GR	43.6	27.8	13.8	4.7	1.2	0.1	0.1	0.2			
	LSD(0.10)	NS	5.0	NS	NS	NS	0.4	NS	0.2			
1992	CH	86.6	51.3	31.7	5.8	3.0	3.7	3.9	1.1	13.6	0.0	
	DR	81.9	55.7	30.4	7.2	6.0	1.7	4.1	5.0	3.2	0.0	
	GR	92.4	46.8	35.5	12.4	3.6	0.3	0.2	1.3	2.0	7.6	
	LSD(0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Coleau Location</u>												
1989	CH	31.5	19.8	10.8	9.2							
	DR	24.4	12.5	9.0	2.3							
	GR	26.6	21.9	7.1	1.0							
	LSD(0.10)	NS	NS	NS	3.4							
1990	CH	29.8	16.4	7.0	3.4	1.3						
	DR	28.8	17.4	9.3	3.4	1.6						
	GR	28.9	15.4	7.4	2.8	0.0						
	LSD(0.10)	NS	NS	NS	NS	NS						
1991	CH	49.5	27.9	15.1	8.3	4.0	2.1	0.0	0.0			
	DR	53.2	30.9	22.4	5.6	4.9	2.5	0.4	0.8			
	GR	66.2	33.8	14.3	6.6	1.7	0.0	0.0	0.0			
	LSD(0.10)	12.0	NS	NS	NS	NS	NS	NS	NS			

[†]Banks indicate no roots found for those depth increments.

[‡]Least significant difference at the P = 0.10 level. NS indicates no significant differences among mean values.

Table A17. Mean alfalfa root length density by years as influenced by subsoil tillage treatments at the two topsoil/subsoil tillage locations.^t

Year	Subsoil Tillage	Profile Depth (cm)									
		5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150
		(cm/cm ³ x 10) <u>Center Location</u>									
1989	Chisel (CH)	19.1	10.3	4.2	0.5						
	Deep Lift (DL)	20.8	12.2	5.9	0.6						
	Deep Rip (DR)	24.4	12.9	10.2	0.0						
	Grader Rip (GR)	21.1	11.4	6.3	0.9						
	No Till (NT)	18.6	11.0	9.7	0.0						
	LSD(0.10) ^t	NS	NS	NS	0.3						
1990	CH	24.1	15.5	5.2	1.7	0.3					
	DL	18.5	12.2	5.3	1.3	0.8					
	DR	27.5	12.7	6.2	1.8	0.4					
	GR	23.1	13.5	6.0	1.1	0.7					
	NT	27.6	15.6	6.8	1.2	0.0					
	LSD(0.10)	NS	NS	NS	NS	NS					
1991	CH	42.8	21.6	10.9	3.8	0.0	0.0	0.0	0.0		
	DL	39.0	18.3	15.4	5.3	2.4	1.2	0.8	2.6		
	DR	34.2	24.2	9.8	2.8	1.0	0.7	0.5	0.4		
	GR	54.7	33.8	13.2	4.9	0.8	<0.1	0.0	0.0		
	NT	43.2	30.2	15.7	7.1	0.4	0.0	0.0	0.0		
	LSD(0.10)	NS	NS	NS	NS	NS	0.4	0.5	0.4		
1992	CH	88.3	46.8	27.5	8.5	2.6	0.2	0.8	1.3	0.0	0.0
	DL	58.3	35.0	27.6	5.8	4.0	1.1	2.2	1.4	0.0	0.0
	DR	91.8	53.0	26.2	4.8	5.6	6.4	7.4	3.0	7.2	7.6
	GR	76.8	47.1	32.3	8.6	8.8	1.8	3.3	6.4	7.1	0.0
	NT	123.8	74.7	49.2	14.6	0.0	0.0	0.0	0.0	0.0	0.0
	LSD(0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		<u>Coteau Location</u>									
1989	CH	23.7	19.9	10.0	13.1						
	DL	35.4	22.0	4.5	2.8						
	DR	27.3	21.5	13.9	3.2						
	GR	29.9	20.6	8.0	3.0						
	NT	26.0	15.7	8.6	3.0						
	LSD(0.10)	NS	NS	NS	5.1						

Table A 17 continued.

Year	Subsoil Tillage	Profile Depth (cm)									
		5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150
1990	CH	29.7	18.2	9.4	3.2	0.8					
	DL	29.2	13.8	6.0	0.2	0.0					
	DR	34.2	19.9	7.1	5.7	0.8					
	GR	30.0	15.9	7.9	3.0	1.3					
	NT	22.8	14.2	9.1	4.0	1.9					
	LSD(0.10)	NS	NS	NS	NS	NS					
1991	CH	61.2	30.8	23.4	6.5	6.8	2.7	0.6	1.3		
	DL	51.3	28.8	16.7	3.1	0.5	0.0	0.0	0.0		
	DR	46.4	41.0	17.4	9.8	3.9	0.0	0.0	0.0		
	GR	78.8	29.0	14.4	7.1	4.9	4.9	0.0	0.0		
	NT	43.8	25.6	17.4	7.6	1.5	0.0	0.0	0.0		
	LSD(0.10)	NS	NS	NS	NS	2.0	NS	NS	NS		

[†]Blanks indicate no roots found for these depth increments.[‡]Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values.

Table A18. Mean alfalfa root mass by years as influenced by topsoil tillage treatments at the two topsoil/subsoil tillage locations.[†]

Year	Topsoil Tillage	Profile Depth (cm)										
		5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150	
(g x 10)												
<u>Center Location</u>												
1989	Chisel (CH)	3.2	1.2	0.3	<0.1							
	Deep Rip (DR)	2.7	1.1	0.2	<0.1							
	Grader Rip (GR)	3.5	1.9	0.5	0.0							
	LSD(0.10) [†]	NS	NS	0.2	NS							
1990	CH	7.9	4.2	1.0	0.1	<0.1						
	DR	5.8	2.4	0.9	0.2	<0.1						
	GR	8.7	3.6	0.8	0.1	<0.1						
	LSD(0.10)	NS	NS	NS	NS	NS						
1991	CH	21.5	12.6	2.5	0.3	<0.1	<0.1	<0.1	<0.1			
	DR	18.0	7.0	2.4	0.4	<0.1	0.1	0.1	<0.1			
	GR	17.6	9.1	2.9	0.6	0.1	<0.1	<0.1	<0.1			
	LSD(0.10)	NS	NS	NS	NS	NS	NS	NS	NS			
1992	CH	24.9	13.0	3.0	0.6	0.2	0.5	0.7	0.1	0.4	0.0	
	DR	20.8	12.8	7.4	1.1	0.7	1.3	1.3	0.2	0.1	0.0	
	GR	33.9	16.0	3.4	0.5	0.3	<0.1	<0.1	0.1	0.8	0.3	
	LSD(0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Coteau Location</u>												
1989	CH	4.0	2.2	0.9	0.4							
	DR	4.4	2.6	0.4	0.1							
	GR	3.3	1.2	0.3	<0.1							
	LSD(0.10)	NS	0.8	0.5	0.3							
1990	CH	16.3	7.8	1.6	0.7	0.2						
	DR	19.4	8.4	2.2	0.3	0.1						
	GR	12.2	4.5	0.7	0.2	0.0						
	LSD(0.10)	NS	NS	NS	0.3	NS						
1991	CH	29.1	9.8	3.2	0.7	0.2	<0.1	0.0	0.0			
	DR	32.9	15.8	4.2	1.1	0.3	0.2	<0.1	<0.1			
	GR	34.5	8.0	1.3	0.5	0.1	0.0	0.0	0.0			
	LSD(0.10)	NS	6.0	NS	NS	NS	NS	NS	NS			

[†]Blanks indicate no roots found for those depth increments.[†]Least significant difference at the P = 0.10 level. NS indicates no significant differences among mean values.

Table A19. Mean alfalfa root mass by years as influenced by subsoil tillage treatment at the two topsoil/subsoil tillage locations.^t

Year	Subsoil Tillage	Profile Depth (cm)									
		5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	135-150	
(g x 10)											
<u>Center Location</u>											
1989	Chisel (CH)	2.2	1.1	0.2	<0.1						
	Deep Lift (DL)	3.3	1.5	0.3	<0.1						
	Deep Rip (DR)	3.7	1.8	0.7	0.0						
	Grader Rip (GR)	3.2	1.1	0.3	<0.1						
	No Till (NT)	3.8	1.9	0.4	0.0						
	LSD(0.10) ^t	NS	NS	NS	NS						
1990	CH	10.6	5.4	1.2	0.1	<0.1					
	DL	6.2	3.0	0.7	0.1	<0.1					
	DR	5.6	3.8	1.2	0.2	<0.1					
	GR	6.0	2.3	0.6	0.1	<0.1					
	NT	8.9	2.2	0.8	0.1	0.0					
	LSD(0.10)	NS	NS	NS	NS	NS					
1991	CH	16.6	7.4	2.1	0.5	0.0	0.0	0.0	0.0		
	DL	12.5	4.1	2.4	0.3	0.2	<0.1	<0.1	<0.1		
	DR	21.5	13.1	2.1	0.3	<0.1	0.1	0.1	<0.1		
	GR	15.4	8.2	3.0	0.4	<0.1	<0.1	0.0	0.0		
	NT	29.1	15.1	3.4	0.6	<0.1	0.0	0.0	0.0		
	LSD(0.10)	NS	NS	NS	NS	NS	NS	NS	NS		
1992	CH	22.4	14.8	2.8	0.6	0.1	<0.1	1.6	0.1	0.0	
	DL	12.3	6.4	3.6	1.6	0.3	0.1	0.1	0.1	0.0	
	DR	35.6	17.3	3.6	0.2	1.1	2.8	1.6	0.3	0.5	
	GR	19.2	12.0	7.9	0.5	0.6	0.1	0.1	0.2	0.0	
	NT	44.5	19.3	5.2	0.6	0.0	0.0	0.0	0.0	0.0	
	LSD(0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Coteau Location</u>											
1989	CH	4.1	2.3	0.6	0.4						
	DL	1.9	0.8	0.2	0.1						
	DR	2.9	1.7	0.5	0.1						
	GR	4.5	2.1	0.5	0.1						
	NT	5.5	2.2	1.2	0.3						
	LSD(0.10)	1.7	NS	NS	NS						

Table A19 continued.

Year	Subsoil Tillage	Profile Depth (cm)									
		5-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	120-135	135-150
1990	CH	19.6	8.1	1.5	0.3	0.1					
	DL	14.7	4.9	0.7	<0.1	0.0					
	DR	17.9	8.5	1.9	1.1	0.2					
	GR	15.3	6.5	1.6	0.3	0.1					
	NT	12.6	6.4	1.8	0.4	0.1					
	LSD(0.10)	NS	NS	NS	0.4	NS					
1991	CH	50.2	13.8	2.3	0.6	0.5	0.2	0.1	0.1		
	DL	29.5	9.6	3.4	0.2	<0.1	0.0	0.0	0.0		
	DR	24.2	7.6	2.8	1.2	0.2	0.0	0.0	0.0		
	GR	25.7	11.0	2.7	0.8	0.3	0.2	0.0	0.0		
	NT	29.6	13.9	3.4	1.2	0.1	0.0	0.0	0.0		
	LSD(0.10)	NS	NS	NS	NS	0.2	NS	NS	NS		

[†]Blanks indicate no roots found for those depth increments.

[‡]Least significant difference at the P = 0.10 level. NS indicates no significant difference among mean values.

Table A20. Mean soil bulk densities obtained from access tube installation at the Glenharold tillage location (spring, 1989).

Tillage	Crop	Depth (m)				
		0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
(Mg m ⁻³)						
Chisel	Alfalfa	1.26	1.28	1.42	1.48	1.51
	Native Mix	1.26	1.30	1.42	1.58	1.67
	Precrop Mix	1.16	1.43	1.42	1.67	1.64
	Pubescent Wheatgrass	1.10	1.46	1.40	1.60	1.62
	Small Grain	1.20	1.41	1.40	1.56	1.58
	Tall Wheatgrass	1.34	1.54	1.50	1.55	1.52
Subsoil	Alfalfa	1.16	1.18	1.50	1.58	1.59
	Native Mix	1.18	1.38	1.35	1.40	1.58
	Precrop Mix	1.18	1.35	1.28	1.59	1.54
	Pubescent Wheatgrass	1.12	1.38	1.48	1.52	1.40
	Small Grain	1.11	1.16	1.46	1.64	1.52
	Tall Wheatgrass	1.24	1.28	1.46	1.56	1.62

Table A21. Mean soil bulk densities obtained from access tube installation at the Knife River tillage location (spring, 1989).

Tillage	Crop	Depth (m)				
		0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
(Mg m ⁻³)						
Chisel	Alfalfa	1.49	1.66	1.56	1.75	1.82
	Native Mix	1.59	1.80	1.49	1.64	1.62
	Precrop Mix	1.44	1.72	1.50	1.76	1.69
	Pubescent Wheatgrass	1.42	1.72	1.67	1.80	1.80
	Small Grain	1.58	1.68	1.46	1.43	1.29
	Tall Wheatgrass	1.42	1.81	1.77	1.76	1.62
Subsoil	Alfalfa	1.44	1.28	1.78	1.60	1.78
	Native Mix	1.37	1.68	1.39	1.40	1.71
	Precrop Mix	1.50	1.70	1.60	1.59	1.58
	Pubescent Wheatgrass	1.56	1.44	1.42	1.72	1.62
	Small Grain	1.56	1.61	1.58	1.62	1.70
	Tall Wheatgrass	1.44	1.64	1.62	1.52	1.76

Table A22. Mean soil bulk densities obtained from the Glenharold tillage location.

Year	Tillage	Crop	0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
(Mg m ⁻³)							
1989	Chisel	Alfalfa	1.26	1.28	1.42	1.48	1.51
		Native Mix	1.26	1.30	1.42	1.58	1.67
		Precrop Mix	1.16	1.43	1.42	1.67	1.64
		Pubescent Wheatgrass	1.10	1.46	1.40	1.60	1.62
		Small Grain	1.20	1.41	1.40	1.56	1.58
		Tall Wheatgrass	1.34	1.54	1.50	1.55	1.52
	Subsoil	Alfalfa	1.16	1.18	1.50	1.58	1.59
		Native Mix	1.18	1.38	1.35	1.40	1.58
		Precrop mix	1.18	1.35	1.28	1.59	1.54
		Pubescent Wheatgrass	1.12	1.38	1.48	1.52	1.40
		Small Grain	1.11	1.16	1.46	1.64	1.52
		Tall Wheatgrass	1.24	1.28	1.46	1.56	1.62
1990	Chisel	Alfalfa	1.73	1.74	1.58	1.85	
		Native Mix	1.74	1.72	1.72	1.82	
		Precrop Mix	1.70	1.69	1.67	1.87	
		Pubescent Wheatgrass	1.73	1.69	1.76	1.71	
		Small Grain	1.65	1.80	1.78	1.82	
		Tall Wheatgrass	1.78	1.74	1.77	1.81	
	Subsoil	Alfalfa	1.66	1.70	1.68	1.67	
		Native mix	1.69	1.72	1.76	1.91	
		Precrop Mix	1.63	1.69	1.67	1.78	
		Pubescent Wheatgrass	1.59	1.70	1.75	1.81	
		Small Grain	1.59	1.68	1.82	1.80	
		Tall Wheatgrass	1.60	1.69	1.78	1.80	
1991	Chisel	Alfalfa	1.47	1.65	1.64	1.66	
		Native Mix	1.47	1.66	1.61	1.64	
		Precrop Mix	1.49	1.62	1.65	1.39	
		Pubescent Wheatgrass	1.43	1.62	1.63	1.68	
		Small Grain	1.36	1.68	1.66	1.69	
		Tall Wheatgrass	1.53	1.63	1.60	1.79	
	Subsoil	Alfalfa	1.48	1.67	1.55	1.57	
		Native Mix	1.46	1.55	1.57	1.59	
		Precrop Mix	1.49	1.56	1.67	1.69	
		Pubescent Wheatgrass	1.48	1.64	1.65	1.58	
		Small Grain	1.42	1.55	1.65	1.64	
		Tall Wheatgrass	1.36	1.49	1.59	1.71	

Table A22 (continued).

Year	Tillage	Crop	Profile Depth (m)				
			0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
1992	Chisel	Alfalfa	1.52	1.84	1.53	1.69	
		Native Mix	1.46	1.76	1.58	1.58	
		Precrop mix	1.62	1.80	1.61	1.56	
		Pubescent Wheatgrass	1.47	1.76	1.67	1.84	
		Small Grain	1.51	1.75	1.69	1.87	
	Subsoil	Tall Wheatgrass	1.57	1.60	1.62	1.86	
		Alfalfa	1.44	1.73	1.82	1.96	
		Native Mix	1.39	1.67	1.71	1.87	
		Precrop Mix	1.66	1.85	1.76	1.81	
		Pubescent Wheatgrass	1.51	1.68	1.75	1.90	
		Small Grain	1.50	1.84	1.83	1.76	
		Tall Wheatgrass	1.63	1.73	1.91	1.95	

Table A23. Mean soil bulk densities obtained from the Knife River tillage location.

Year	Tillage	Crop	Depth (m)				
			0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	
1989	Chisel	Alfalfa	1.49	1.67	1.56	1.75	
		Native Mix	1.59	1.80	1.49	1.55	
		Precrop Mix	1.50	1.70	1.55	1.76	
		Pubescent Wheatgrass	1.42	1.72	1.67	1.79	
		Small Grain	1.58	1.68	1.46	1.43	
		Tall Wheatgrass	1.43	1.81	1.77	1.77	
		Subsoil	Alfalfa	1.45	1.27	1.78	1.60
		Native Mix	1.37	1.68	1.39	1.40	
		Precrop mix	1.43	1.73	1.55	1.59	
		Pubescent Wheatgrass	1.56	1.44	1.42	1.72	
1990	Chisel	Small Grain	1.56	1.61	1.57	1.62	
		Tall Wheatgrass	1.44	1.64	1.62	1.52	
		Alfalfa	1.73	1.74	1.58	1.85	
		Native Mix	1.74	1.72	1.72	1.82	
		Precrop Mix	1.70	1.69	1.67	1.87	
		Pubescent Wheatgrass	1.73	1.69	1.76	1.71	
		Small Grain	1.65	1.80	1.78	1.82	
		Tall Wheatgrass	1.78	1.74	1.77	1.81	
		Subsoil	Alfalfa	1.66	1.70	1.68	1.67
		Native mix	1.69	1.72	1.76	1.91	
1991	Chisel	Precrop Mix	1.63	1.69	1.67	1.78	
		Pubescent Wheatgrass	1.59	1.70	1.75	1.81	
		Small Grain	1.59	1.68	1.82	1.80	
		Tall Wheatgrass	1.60	1.69	1.78	1.80	
		Alfalfa	1.47	1.65	1.64	1.66	
		Native Mix	1.47	1.66	1.61	1.64	
		Precrop Mix	1.49	1.62	1.65	1.39	
		Pubescent Wheatgrass	1.43	1.62	1.63	1.68	
		Small Grain	1.36	1.68	1.66	1.69	
		Tall Wheatgrass	1.53	1.63	1.60	1.79	
	Subsoil	Alfalfa	1.48	1.67	1.55	1.57	
		Native Mix	1.46	1.55	1.57	1.59	
		Precrop Mix	1.49	1.56	1.67	1.69	
		Pubescent Wheatgrass	1.48	1.64	1.65	1.58	
		Small Grain	1.42	1.55	1.65	1.64	
		Tall Wheatgrass	1.36	1.49	1.59	1.71	

Table A23 (continued)

Year	Tillage	Crop	Profile Depth (m)			
			0-0.3	0.3-0.6	0.6-0.9	0.9-1.2
1992	Chisel	Alfalfa	1.52	1.84	1.53	1.69
		Native Mix	1.46	1.76	1.58	1.58
		Precrop mix	1.62	1.80	1.61	1.56
		Pubescent Wheatgrass	1.47	1.76	1.67	1.84
		Small Grain	1.51	1.75	1.69	1.87
	Subsoil	Tall Wheatgrass	1.57	1.60	1.62	1.86
		Alfalfa	1.44	1.73	1.82	1.96
		Native Mix	1.39	1.67	1.71	1.87
		Precrop Mix	1.66	1.85	1.76	1.81
		Pubescent Wheatgrass	1.51	1.68	1.75	1.90
		Small Grain	1.50	1.84	1.83	1.76
		Tall Wheatgrass	1.63	1.73	1.91	1.95

Table A24. Selected mean cone indices from the Glenharold tillage location.

Year	Tillage	Crop	Depth (m)				
			0.05	0.25	0.45	0.65	0.85
1990	Chisel	Alfalfa	0.56	4.20	6.40	5.28	5.34
		Native Mix	0.86	3.50	4.51	5.62	6.24
		Precrop Mix	0.50	3.14	4.65	5.92	4.75
		Pubescent Wheatgrass	0.48	3.33	3.43	5.58	6.10
		Small Grain	0.29	2.97	6.01	6.17	5.37
	Subsoil	Tall Wheatgrass	0.69	5.08	4.60	3.20	7.14
		Alfalfa	0.40	4.33	4.36	5.90	4.87
		Native Mix	0.42	1.45	1.64	4.13	4.83
		Precrop Mix	0.59	3.09	4.42	4.07	4.41
		Pubescent Wheatgrass	0.61	2.87	1.95	4.50	5.09
1991	Chisel	Small Grain	0.45	2.41	2.89	4.33	4.66
		Tall Wheatgrass	0.52	2.33	4.02	4.48	5.24
		Alfalfa	2.06	4.22	4.62	5.51	7.05
		Native Mix	0.84	1.77	5.34	5.24	4.81
		Precrop Mix	1.19	2.05	5.29	5.44	4.51
	Subsoil	Pubescent Wheatgrass	1.12	4.08	7.01	6.36	8.59
		Small Grain	0.58	1.98	3.33	4.28	5.28
		Tall Wheatgrass	0.86	3.44	4.34	7.14	5.02
		Alfalfa	0.87	2.86	1.28	9.76	8.11
		Native Mix	1.12	1.39	1.61	4.91	6.20
1992	Chisel	Precrop Mix	1.13	1.88	2.60	6.46	5.85
		Pubescent Wheatgrass	0.84	1.77	1.74	4.44	5.89
		Small Grain	0.52	1.57	3.56	3.29	4.83
		Tall Wheatgrass	0.90	1.93	3.77	6.81	6.90
		Alfalfa	1.76	6.19	5.84	7.01	8.07
	Subsoil	Native Mix	1.89	5.82	7.14	8.30	11.40
		Precrop Mix	1.96	5.91	6.39	6.36	11.32
		Pubescent Wheatgrass	1.74	5.26	6.61	6.55	8.98
		Small Grain	0.50	1.01	2.67	3.78	3.82
		Tall Wheatgrass	1.58	4.50	5.62	6.33	7.12

Table A25. Selected mean cone indices from the Knife River tillage location.

Year	Tillage	Crop	Depth (m)				
			0.05	0.25	0.45	0.65	0.85
1990	Chisel	Alfalfa	0.90	11.30	8.68	5.85	2.90
		Native Mix	1.52	6.92	4.78	2.18	2.93
		Precrop Mix	0.85	10.51	10.71	5.74	6.38
		Pubescent Wheatgrass	0.76	9.81	6.39	2.93	3.64
		Small Grain	0.34	3.65	4.59	3.32	3.59
		Tall Wheatgrass	0.72	9.43	6.37	2.31	3.18
		Alfalfa	0.68	5.90	6.21	9.80	7.93
		Native Mix	0.68	4.31	2.18	2.17	2.12
		Precrop Mix	0.68	4.51	5.68	6.46	7.63
		Pubescent Wheatgrass	0.97	6.05	4.83	3.24	2.98
1991	Subsoil	Small Grain	0.42	3.10	2.76	4.01	3.62
		Tall Wheatgrass	1.41	6.47	4.98	3.81	4.23
		Alfalfa	0.87	11.60	13.36	----	----
		Native Mix	1.69	8.81	7.79	6.93	5.25
		Precrop Mix	1.90	9.93	9.75	9.51	----
		Pubescent Wheatgrass	1.16	8.98	9.86	8.11	10.03
		Small Grain	0.68	4.21	3.61	5.10	4.90
		Tall Wheatgrass	1.36	9.20	6.97	7.07	6.35
		Alfalfa	1.47	7.97	7.48	10.39	5.08
		Native Mix	1.27	5.94	2.52	5.92	3.80
1992	Chisel	Precrop Mix	0.90	7.54	6.32	7.87	6.59
		Pubescent Wheatgrass	2.11	7.34	8.58	8.25	6.76
		Small Grain	0.61	2.32	1.67	4.74	4.67
		Tall Wheatgrass	0.89	5.45	5.44	6.67	6.15
		Alfalfa	1.17	10.27	10.74	13.90	6.74
		Native Mix	1.74	10.62	10.59	6.21	7.97
		Precrop Mix	2.43	15.15	11.48	13.47	14.21
		Pubescent Wheatgrass	1.55	12.43	13.37	6.12	11.33
		Small Grain	0.78	2.77	3.59	2.87	3.97
		Tall Wheatgrass	2.05	11.55	8.89	8.67	5.69
	Subsoil	Alfalfa	1.31	4.58	10.50	7.07	7.62
		Native Mix	2.04	7.46	9.83	6.22	7.31
		Precrop Mix	3.84	7.12	6.92	7.18	11.82
		Pubescent Wheatgrass	2.23	7.59	10.19	7.67	9.04
		Small Grain	0.57	1.42	2.12	3.26	2.95
		Tall Wheatgrass	1.91	9.73	10.69	3.60	2.61

Table A26. Mean wheat yields from the Glenharold and Knife River tillage locations.

Tillage	Year			
	1989	1990	1991	1992
(Mg ha ⁻¹)				
Glenharold				
Chisel	0.11	1.32	1.44	1.33
Subsoil	0.10	1.21	1.41	1.25
Knife River				
Chisel	0.19	0.74	1.05	1.48
Subsoil	0.73	0.86	1.18	1.49

Table A27. Mean 1992 wheat yields obtained from the prior cropping experimental plots at the Glenharold and Knife River tillage location.

Tillage	Prior Crop	Glenharold	Knife River
(Mg ha ⁻¹)			
Chisel	Alfalfa	1.39	0.97
	Native Mix	1.43	1.43
	Precrop Mix	1.32	0.96
	Pubescent Wheatgrass	1.38	1.09
	Small Grain	1.33	1.49
	Tall Wheatgrass	1.37	1.14
Subsoil	Alfalfa	1.41	0.90
	Native Mix	1.82	1.15
	Precrop Mix	1.64	0.88
	Pubescent Wheatgrass	1.50	1.23
	Small Grain	1.25	1.49
	Tall Wheatgrass	1.35	1.31

Table A28 . Mean forage yields from the Glenharold tillage location.

Year	Tillage	Crop	Yield (Mg ha ⁻¹)
1990	Chisel	Alfalfa	1.91
		Native Mix	1.32
		Precrop Mix	1.82
		Pub. Wheatgrass	2.91
		Tall Wheatgrass	1.09
	Subsoil	Alfalfa	2.00
		Native Mix	2.52
		Precrop Mix	2.55
		Pub. Wheatgrass	2.69
		Tall Wheatgrass	0.81
1991	Chisel	Alfalfa	2.35
		Native Mix	2.56
		Precrop Mix	4.22
		Pub. Wheatgrass	4.54
		Tall Wheatgrass	2.38
	Subsoil	Alfalfa	2.49
		Native Mix	3.10
		Precrop Mix	3.76
		Pub. Wheatgrass	5.02
		Tall Wheatgrass	2.52
1992	Chisel	Alfalfa	1.64
		Native Mix	1.53
		Precrop Mix	2.09
		Pub. Wheatgrass	2.38
		Tall Wheatgrass	2.38
	Subsoil	Alfalfa	1.31
		Native Mix	1.52
		Precrop Mix	1.72
		Pub. Wheatgrass	2.12
		Tall Wheatgrass	2.29

Table A29. Mean forage yields from the Knife River tillage location.

Year	Tillage	Crop	Yield (Mg ha ⁻¹)
1990	Chisel	Alfalfa	1.30
		Native Mix	2.39
		Precrop Mix	2.72
		Pubescent Wheatgrass	3.39
		Tall Wheatgrass	3.86
	Subsoil	Alfalfa	2.26
		Native Mix	3.20
		Precrop Mix	3.19
		Pubescent Wheatgrass	4.10
		Tall Wheatgrass	3.60
1991	Chisel	Alfalfa	2.24
		Native Mix	3.02
		Precrop Mix	2.47
		Pubescent Wheatgrass	4.20
		Tall Wheatgrass	3.42
	Subsoil	Alfalfa	2.11
		Native Mix	3.31
		Precrop Mix	3.63
		Pubescent Wheatgrass	4.44
		Tall Wheatgrass	3.33
1992	Chisel	Alfalfa	1.64
		Native Mix	1.70
		Precrop Mix	2.89
		Pubescent Wheatgrass	2.89
	Subsoil	Alfalfa	1.76
		Native Mix	2.32
		Precrop Mix	2.70
		Pubescent Wheatgrass	3.20
		Tall Wheatgrass	2.02

Table A30. Selected mean root length densities obtained from the Glenharold location.

Year	Tillage	Crop	Depth (m)					
			0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.20-1.35	
(km m ⁻³)								
1989	Chisel	Alfalfa	7.9	4.5	0	0	0	
		Native Mix	22.8	5.4	0	0	0	
		Precrop Mix	12.9	2.9	0	0	0	
		Pub. Wheatgrass	23.1	5.6	0	0	0	
		Small Grain	34.0	7.4	0	0	0	
		Tall Wheatgrass	13.7	6.5	0	0	0	
		Alfalfa	12.0	5.5	0	0	0	
		Native Mix	12.7	2.4	0	0	0	
		Precrop Mix	26.1	11.9	0	0	0	
		Pub. Wheatgrass	15.1	2.7	0	0	0	
1990	Chisel	Small Grain	38.8	13.9	0	0	0	
		Tall Wheatgrass	15.6	3.3	0	0	0	
		Alfalfa	38.2	4.1	5.3	3.7	0	
		Native Mix	55.1	11.2	0.6	0	0	
		Precrop Mix	78.9	24.3	6.8	3.1	0	
		Pub. Wheatgrass	67.2	12.6	2.7	0	0	
		Small Grain	28.3	1.3	0	0	0	
		Tall Wheatgrass	56.4	7.3	2.7	0	0	
		Alfalfa	28.5	5.3	3.6	2.5	0	
		Native Mix	72.1	24.6	7.5	0	0	
1991	Chisel	Precrop Mix	62.8	15.6	10.9	0	0	
		Pub. Wheatgrass	76.1	23.7	3.4	1.0	0	
		Small Grain	40.0	2.0	0	0	0	
		Tall Wheatgrass	69.6	18.6	2.3	0	0	
		Alfalfa	57.2	15.0	4.3	2.8	2.2	
		Native Mix	57.9	8.6	0.1	0	0	
		Precrop Mix	48.6	17.6	1.9	0.7	0	
		Pub. Wheatgrass	32.1	6.5	0.3	0	0	
		Small Grain	29.8	8.4	0.3	0	0	
		Tall Wheatgrass	34.4	5.7	0.1	0	0	
1992	Chisel	Subsoil	Alfalfa	28.8	13.7	6.0	12.1	3.3
		Native mix	42.6	12.9	4.9	1.4	0	
		Precrop Mix	29.9	27.5	2.0	0	0	
		Pub. Wheatgrass	36.5	13.6	4.2	0.5	0	
		Small Grain	30.7	10.0	0.7	0	0	
		Tall Wheatgrass	51.1	17.0	2.9	0	0	
		Alfalfa	105.3	25.2	10.6	6.9	0	
		Native Mix	130.8	41.0	9.9	0	0	
		Precrop Mix	152.7	14.5	9.7	0	0	
		Pub. Wheatgrass	95.3	13.2	9.1	0	0	

Table 30 continued.

Year	Tillage	Crop	0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.2-1.35
Subsoil	Alfalfa	85.4	9.4	7.1	0	0	
	Native Mix	88.9	28.8	3.8	0	0	
	Precrop Mix	142.0	51.8	0.7	0	0	
	Pub. Wheatgrass	108.3	72.6	6.6	0	0	
	Small Grain	25.5	4.9	0	0	0	
	Tall Wheatgrass	73.6	8.9	0	0	0	

Table A31. Selected mean root mass densities obtained from the Glenharold location.

Year	Tillage	Crop	Depth (m)					
			0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.20-1.35	
(kg m ⁻³)								
1989	Chisel	Alfalfa	0.72	0.05	0	0	0	
		Native Mix	0.16	0.05	0	0	0	
		Precrop Mix	0.14	0.01	0	0	0	
		Pub. Wheatgrass	0.24	0.03	0	0	0	
		Small Grain	0.33	0.07	0	0	0	
		Tall Wheatgrass	0.16	0.04	0	0	0	
		Subsoil	Alfalfa	1.39	0.23	0	0	
		Native Mix	0.09	0.01	0	0	0	
		Precrop Mix	0.20	0.08	0	0	0	
		Pub. Wheatgrass	0.11	0.02	0	0	0	
1990	Chisel	Small Grain	0.36	0.12	0	0	0	
		Tall Wheatgrass	0.21	0.02	0	0	0	
		Alfalfa	3.66	0.39	0.08	0.03	0	
		Native Mix	0.98	0.11	0.01	0	0	
		Precrop Mix	0.87	0.25	0.07	0.02	0	
		Pub. Wheatgrass	0.88	0.09	0.02	0	0	
		Small Grain	0.23	0.03	0	0	0	
		Tall Wheatgrass	1.16	0.08	0.04	0	0	
		Subsoil	Alfalfa	3.06	0.20	0.06	0.02	0
		Native Mix	1.72	0.22	0.03	0	0	
1991	Chisel	Precrop Mix	0.77	0.10	0.07	0	0	
		Pub. Wheatgrass	1.10	0.23	0.06	0.01	0	
		Small Grain	0.24	0.10	0	0	0	
		Tall Wheatgrass	1.44	0.15	0.02	0	0	
		Alfalfa	10.52	0.51	0.18	0.04	0.04	
		Native Mix	1.77	0.19	<0.01	0	0	
		Precrop Mix	1.44	0.31	0.03	0.01	0	
		Pub. Wheatgrass	0.87	0.11	<0.01	0	0	
		Small Grain	0.23	0.07	<0.01	0	0	
		Tall Wheatgrass	1.07	0.12	<0.01	0	0	
	Subsoil	Alfalfa	4.02	2.18	0.32	0.23	0.03	
		Native mix	1.14	0.24	0.07	0.01	0	
		Precrop Mix	0.91	0.05	0.02	0	0	
		Pub. Wheatgrass	1.63	0.21	0.08	0.01	0	
		Small Grain	0.28	0.10	<0.01	0	0	
		Tall Wheatgrass	1.44	0.28	0.05	0	0	

Table A31 continued.

Year	Tillage	Crop	0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.2-1.35
1992	Chisel	Alfalfa	10.82	0.90	0.11	0.06	0
		Native Mix	4.57	0.53	0.10	0	0
		Precrop Mix	3.78	0.17	0.12	0	0
		Pub. Wheatgrass	3.27	0.11	0.07	0	0
		Small Grain	0.22	0.05	<0.01	0	0
	Subsoil	Tall Wheatgrass	1.65	0.42	0.15	0	0
		Alfalfa	4.36	0.08	0.06	0	0
		Native Mix	1.51	0.25	0.05	0	0
		Precrop Mix	3.80	0.55	0.01	0	0
		Pub. Wheatgrass	1.66	1.01	0.05	0	0
		Small Grain	0.15	0.03	0	0	0
		Tall Wheatgrass	1.55	0.09	0	0	0

Table A32. Selected mean root length densities obtained from the Knife River location.

Year	Tillage	Crop	Depth (m)				
			0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.20-1.35
(km m ⁻³)							
1989	Chisel	Alfalfa	8.6	3.1	0	0	0
		Native Mix	7.5	1.8	0	0	0
		Precrop Mix	12.9	3.0	0	0	0
		Pub. Wheatgrass	13.1	1.7	0	0	0
		Small Grain	37.8	6.0	1.1	0	0
		Tall Wheatgrass	16.0	0.5	0	0	0
		Alfalfa	4.4	1.7	0	0	0
		Native Mix	18.8	2.5	0	0	0
		Precrop Mix	15.6	4.9	0	0	0
		Pub. Wheatgrass	12.9	1.1	0	0	0
1990	Subsoil	Small Grain	43.3	5.6	1.1	0	0
		Tall Wheatgrass	24.7	2.1	0	0	0
		Alfalfa	20.5	9.6	6.4	6.9	0
		Native Mix	64.2	0.7	1.1	0	0
		Precrop Mix	47.6	13.6	7.5	0.7	0
		Pub. Wheatgrass	51.1	3.6	2.1	0	0
		Small Grain	16.3	21.9	0	0	0
		Tall Wheatgrass	35.0	0.4	1.5	0.2	0
		Alfalfa	27.9	9.9	5.4	1.6	0
		Native Mix	32.8	3.8	0.6	1.2	0
1991	Chisel	Precrop Mix	27.7	5.7	6.0	1.2	0
		Pub. Wheatgrass	52.7	6.9	1.2	0.6	0
		Small Grain	19.3	6.9	6.5	0	0
		Tall Wheatgrass	40.7	2.5	0.6	0	0
		Alfalfa	28.3	10.4	1.4	3.5	1.2
		Native Mix	43.4	9.1	1.7	0.5	0.4
		Precrop mix	39.4	3.9	4.4	0.4	0
		Pub. Wheatgrass	49.3	2.9	3.1	0.3	0
		Small Grain	24.1	4.8	0	0	0
		Tall Wheatgrass	48.8	4.5	2.9	0.8	0
	Subsoil	Alfalfa	32.9	10.7	8.8	9.6	1.4
		Native Mix	49.8	18.9	1.9	0.6	0
		Precrop Mix	34.2	5.8	2.1	4.2	0
		Pub. Wheatgrass	41.9	8.0	3.4	0.3	0
		Small Grain	25.0	6.5	0.5	0	0
		Tall Wheatgrass	43.9	14.2	3.6	2.5	0

Table A32 continued.

Year	Tillage	Crop	0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.2-1.35
1992	Chisel	Alfalfa	68.9	41.0	8.9	5.0	5.0
		Native Mix	134.9	4.1	14.8	3.7	43.0
		Precrop mix	105.8	14.0	15.4	14.0	8.0
		Pub. Wheatgrass	80.1	5.2	11.0	0.6	0.5
		Small Grain	25.6	11.5	0	0	0
	Subsoil	Tall Wheatgrass	71.3	6.1	1.7	1.1	0
		Alfalfa	91.3	13.5	15.7	4.5	5.9
		Native Mix	102.3	37.6	6.9	2.7	1.8
		Precrop Mix	76.3	18.0	8.4	2.1	0
		Pub. Wheatgrass	155.3	13.3	6.1	2.9	1.3
		Small Grain	20.4	22.3	0	0	0
		Tall Wheatgrass	90.7	41.7	5.1	0	0

Table A33. Selected mean root mass densities obtained from the Knife River location.

Year	Tillage	Crop	Depth (m)				
			0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.2-1.35
(kg m ⁻³)							
1989	Chisel	Alfalfa	0.56	0.02	0	0	0
		Native Mix	0.09	0.01	0	0	0
		Precrop Mix	0.13	0.18	0	0	0
		Pub. Wheatgrass	0.15	0.02	0	0	0
		Small Grain	0.31	0.05	0.01	0	0
		Tall Wheatgrass	0.20	0.01	0	0	0
	Subsoil	Alfalfa	0.51	0.03	0	0	0
		Native Mix	0.14	0.01	0	0	0
		Precrop mix	0.15	0.05	0	0	0
		Pub. Wheatgrass	0.22	0.01	0	0	0
		Small Grain	0.31	0.04	0.04	0	0
		Tall Wheatgrass	0.29	0.02	0	0	0
1990	Chisel	Alfalfa	8.55	0.37	0.09	0.09	0
		Native Mix	1.01	0.01	<0.01	0	0
		Precrop mix	0.75	0.22	0.09	0.01	0
		Pub. Wheatgrass	1.46	0.06	0.02	0	0
		Small Grain	0.10	0.09	<0.01	0	0
		Tall Wheatgrass	1.23	0.01	0.01	<0.01	
	Subsoil	Alfalfa	5.81	0.58	0.06	0.01	0
		Native Mix	1.30	0.05	0.01	0.01	0
		Precrop Mix	0.85	0.10	0.11	0.01	0
		Pub. Wheatgrass	0.97	0.14	0.02	0.01	0
		Small Grain	0.11	0.04	0.03	0	0
		Tall Wheatgrass	1.64	0.04	0.01	0	0
1991	Chose;	Alfalfa	4.78	0.46	0.02	0.11	0.01
		Native Mix	1.10	0.21	0.03	<0.01	<0.01
		Precrop Mix	0.89	0.05	0.05	<0.01	0
		Pub. Wheatgrass	1.97	0.08	0.05	<0.01	0
		Small Grain	0.23	0.04	0	0	0
		Tall Wheatgrass	1.87	0.48	0.04	0.03	0

Table A33 continued.

Year	Tillage	Crop	Depth (m)					
			0-0.15	0.3-0.45	0.6-0.75	0.9-1.05	1.2-1.35	
1992	Chisel	Subsoil	Alfalfa	4.01	1.02	0.26	0.14	0.01
			Native Mix	1.47	0.41	0.04	0.01	0
			Precrop Mix	1.50	0.15	0.03	0.05	0
			Pub. Wheatgrass	1.51	0.21	0.05	<0.01	0
			Small Grain	0.23	0.04	0.01	0	0
			Tall Wheatgrass	2.22	0.36	0.04	0.04	0
		Subsoil	Alfalfa	11.45	0.91	0.10	0.73	0.05
			Native Mix	1.94	0.04	0.12	0.09	0.07
			Precrop mix	1.67	0.06	0.13	0.17	0.08
			Pub. Wheatgrass	2.14	0.05	0.11	0.01	<0.01
			Small Grain	0.18	0.06	0	0	0
			Tall Wheatgrass	1.38	0.16	0.01	0.01	0

Table A34. Mean soil bulk densities obtained from the Falkirk trench location.

Year	Topsoil Depth (m)	Subsoil [†]	Depth (m)			
			0-0.3	0.3-0.6	0.6-0.9	0.9-1.2
1979	0.23	SL	1.77	1.85	1.42	1.07
		SL+C	1.43	1.43	1.31	1.33
		CL	1.07	1.22	1.13	1.29
		SiCL	1.24	1.45	1.45	1.51
	0.46	SL	1.34	1.56	1.40	1.48
		SL+C	1.41	1.57	1.66	1.57
		CL	1.21	1.58	1.50	1.46
		SiCL	1.31	1.38	1.45	1.50
	0.69	SL	1.63	1.66	1.56	1.18
		SL+C	1.62	1.77	1.58	1.70
		CL	1.16	1.34	1.30	1.36
		SiCL	1.26	1.48	1.48	1.42
1990	0.23	SL	1.66	1.78	2.13	1.82
		SL+C	1.34	1.58	1.81	1.77
		CL	1.35	1.49	1.57	1.66
		SiCL	1.38	1.57	1.59	1.58
	0.46	SL	1.22	2.12	2.12	2.27
		SL+C	1.29	1.56	1.59	1.47
		CL	1.33	1.51	1.70	1.46
		SiCL	1.33	1.51	1.62	1.53
	0.69	SL	1.35	1.51	1.95	2.04
		SL+C	1.29	1.48	1.55	1.58
		CL	1.41	1.51	1.63	1.53
		SiCL	1.29	1.50	1.54	1.57

[†]SL = sandy loam, SL+C = sandy loam plus clay, CL = clay loam, SiCL = silty clay loam.

Table A35. Mean soil bulk densities in 1986 and 1992 from the Center topography location.

Year	Position	Depth (m)					
		0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5	
(Mg m ⁻³)							
Forage Area							
1986	Summit	1.40	1.55	1.49	1.57	1.56	
	Shoulder	1.26	1.60	1.60	1.47	1.42	
	Backslope	1.25	1.54	1.63	1.57	1.59	
	Footslope	1.36	1.56	1.54	1.46	1.57	
1992	Summit	1.39	1.75	1.70	1.80	1.70	
	Shoulder	1.37	1.78	1.84	1.72	1.68	
	Backslope	1.34	1.78	1.85	1.76	1.78	
	Footslope	1.22	1.63	1.70	1.78	1.84	
Small Grain Area							
1986	Summit	1.34	1.68	1.66	1.64	1.62	
	Shoulder	1.16	1.55	1.56	1.56	1.52	
	Backslope	1.26	1.62	1.66	1.54	1.51	
	Footslope	1.12	1.52	1.54	1.52	1.52	
1992	Summit	1.35	1.86	1.76	1.77	1.78	
	Shoulder	1.51	1.86	1.76	1.70	1.63	
	Backslope	1.30	1.82	1.88	1.97	1.74	
	Footslope	1.35	1.63	1.73	1.69	1.75	

Table A36. Mean soil bulk densities in 1986 and 1992 from the Falkirk topography location.

Year	Position	Depth (m)				
		0-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5
		(Mg m ⁻³)				
		<u>Forage Area</u>				
1986	Summit	1.30	1.52	1.56	1.69	1.60
	Shoulder	1.35	1.45	1.48	1.46	1.54
	Backslope	1.36	1.39	1.38	1.48	1.51
	Footslope	1.31	1.48	1.61	1.60	1.36
1992	Summit	1.31	1.70	1.83	1.74	1.72
	Shoulder	1.16	1.61	1.66	1.71	1.73
	Backslope	1.20	1.45	1.47	1.52	1.52
	Footslope	1.35	1.68	1.79	1.74	1.64
		<u>Small Grain Area</u>				
1986	Summit	1.33	1.51	1.62	1.60	1.54
	Shoulder	1.26	1.25	1.39	1.60	1.53
	Backslope-Top	1.20	1.46	1.40	1.56	1.58
	-Middle	1.06	1.44	1.44	1.44	1.55
	-Bottom	1.31	1.39	1.38	1.42	1.54
	Footslope	1.28	1.38	1.46	1.51	1.58
	Toeslope	1.13	1.46	1.56	1.59	1.56
1992	Summit	1.29	1.75	1.72	1.80	1.77
	Shoulder	1.40	1.48	1.61	1.78	1.77
	Backslope-Top	1.29	1.54	1.62	1.73	1.79
	-Middle	1.29	1.55	1.55	1.73	1.84
	-Bottom	1.25	1.38	1.45	1.44	1.71
	Footslope	1.31	1.59	1.54	1.74	1.82
	Toeslope	1.23	1.52	1.76	1.82	1.82

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