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MANAGEMENT OF SOILS
IN **SOUTH-CENTRAL** MINNESOTA

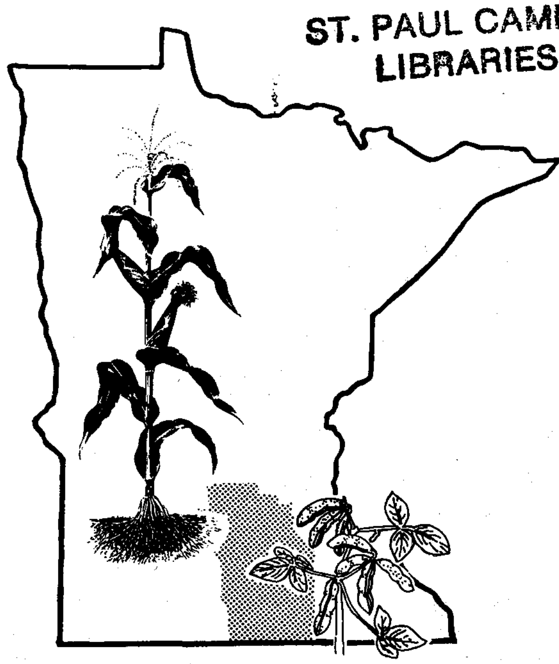
A Correspondence Course

Unit 7: Tillage

John Moncrief, Jim Swan, and Tim Wagar

Objectives

- Understand the reasons for tillage.
- Understand the relationships between tillage and crop sequence, soil type, and climate.
- Relate these factors to crop growth and yield, and develop a strategy that allows reducing tillage while maintaining yields.



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TILLAGE: WHY AND HOW

The main reasons for tillage are: (1) to create favorable seedbed conditions; (2) to incorporate lime, fertilizer, herbicides, and manure; (3) to control weeds; (4) to increase water infiltration and storage and reduce runoff; (5) to manage crop residues; and (6) to loosen compacted soil. Contour tillage, surface roughness, and residue management can reduce soil erosion by water.

Tillage can be either full width or strip. Full-width systems include moldboard and chisel plows, discs, and field cultivators. Strip tillage is usually combined with planting and as the name implies tills only a strip. The strategy is to provide a favorable seedbed in a strip. The untilled row middles are a hostile environment for weed growth but are effective at reducing water erosion. The strip width can vary from 2 to 12 inches. Narrow-strip tillage is sometimes referred to as "no-till," "zero-till," or "slot-plant." Wide-strip tillage includes "ridge-till," "inter-till," "till-plant," and "rotary tillage."

CONSERVATION TILLAGE

Conservation tillage, as the name implies, is any tillage practice that protects soil from wind or water erosion. It can complement other erosion control practices such as surface roughness, tilling on the contour, rotations, and strip cropping. Research suggests that 25 to 30 percent of the soil surface should be covered with crop residues after planting to provide adequate erosion control under most conditions.

THE SEEDBED: WHAT'S IMPORTANT?

The soil environment near the seed (seedbed) affects germination, emergence, and early growth. Germination depends on the rate of absorption of soil moisture by the seed and temperature of the seed zone. Inhibitory chemicals leaching out of crop residues can also affect germination (alleopathy). To minimize alleopathy and maximize soil warming, it is important to restrict the amount of crop residue left in the row area, especially when a crop follows itself (the greatest inhibitory effect of leached chemicals is from residue of the same crop).

Soil temperature is directly related to the amount of soil cover in the row area. The degree to which reduced soil temperatures associated with crop residues affects growth depends on the crop and the temperature range encountered. Corn is the most sensitive common crop, primarily due to growth habit. The growing point of corn remains below the soil surface until about the sixth leaf stage of growth (six leaf collars emerged). Up to this time the soil temperature influences both the above- and below-ground growth. This is one reason why when corn is grown after corn it is usually better to opt for an 8- to 12-inch clean strip for the row area.

Growth delays due to reduced seedbed soil temperature are most noticeable during cold springs, on wet soils, and on north-facing slopes. Research at Lancaster, Wisconsin has shown that during short growing seasons when the growing degree days are marginal and little drought stress occurs, corn with over 30 percent residue cover in the row had increased grain moisture at harvest and decreased yield. Minnesota Experiment Station research has shown that soybeans are much less sensitive to crop residue levels. In a corn-soybean crop sequence less tillage is necessary because the soybeans are less sensitive to soil cover and there is little residue left to affect corn following soybeans.

In-row crop residue also can affect seed placement. Accurate seed placement is important: shallow placement may reduce stand and delay emergence under dry conditions, while deep placement delays emergence under cold and wet conditions. Removal of corn residue from the row area with sweeps or clearing discs on conservation tillage planters reduces the variation in depth of seed placement.

Good seed-soil contact, accomplished by firming the soil around the seed during planting, is necessary to assure rapid water uptake. Where soil is not loosened by tillage, the planter must provide whatever loosening is needed. Thus, planter design is more critical with strip tillage systems, since the planter must penetrate dense, residue-covered soils. Research-based recommendations indicate that for optimal seed-soil contact the average aggregate or clod size in the seed zone should be about one-fifth to one-tenth the diameter of the seed.

CONSERVATION TILLAGE AND STAND ESTABLISHMENT

Reductions in stand due to "no-till" (in-row tillage only by fluted coulter) are frequent in studies on somewhat poorly drained soils in southern Minnesota. However, there also are as many instances where stand reductions are attributable to cloddy conditions from moldboard plowing.

Recent results from Meeker County on a clay loam soil following soybeans illustrate the benefit of crop residue under dry conditions (Table 1). The no-till and ridge-till systems resulted in more even emergence and early growth (5/27) because corn was planted into moist soil (notice effect of tillage on the variability of the leaf number). Moist soil conditions at planting in a dry year more than offset the detrimental temperature effects of 20 to 30 percent in-row cover. Later in the season (6/26) the moldboard plow system appeared to have caught up in growth but still showed a lot of variability.

Three factors are generally responsible for variations in stand under different tillage conditions: (1) with plowing, poor seed-to-soil contact due to cloddy conditions; (2) uneven seed placement; and (3) possible germination inhibition due to alleopathy (toxic effects of chemicals leaching out of relatively fresh crop residue, usually from the same crop).

Lancaster, Wisconsin experiment station measurements for 1984 and 1985 showed a reduction of about 30 plants/A for each 1 percent corn residue cover in the row because residue was pushed into the seed furrow during planting. Thus, 60 percent cover in the row decreased population by about 1800 plants/A. In studies on the somewhat poorly drained soils of southern Minnesota, crop residue in the row area reduced stands more than in the Lancaster, Wisconsin example.

Table 2 illustrates the effect of cloddiness (from moldboard plowing) and crop residue (when eliminating primary tillage) on establishment of corn stands. At the Steele County site in 1985 stands were reduced when planting into a fall moldboard plowed seedbed. In 1986 at the

Table 1. The effect of tillage on corn stand, emergence, early growth, and yields at Meeker County on a clay loam soil in 1987.

Tillage	Stand 5/27 (1000 plants/A)	Percent cover[a] in	Percent cover[a] btw	Growth 5/27 (leaves/plant)	Growth 6/26 (g/plant)	Yield (bu/A)
No-till	37.5±2.3	29	24	3.3±0.5	28.3±6.6	190
Ridge-till	37.8±2.8	20	22	3.8±0.4	24.5±3.2	179
Chisel[b]	36.7±2.9	10	10	3.3±1.0	29.5±2.9	188
Moldboard[b]	34.3±3.4	2.5	2.3	3.0±1.4	31.5±8.5	189
significance[c]	S	S	S	S	NS	NS

[a]Soil cover by crop residue after planting is characterized in and between the row. The in-row area is defined as eight inches centered over the crop row and between-row the remainder.
[b]Primary tillage was done in the fall.
[c]If differences between the averages within a column are due to tillage (the result of a statistical test) it is labeled S (statistically significant) and if not, NS (not statistically significant).

Table 2. The effect of tillage on corn stands on well-drained to somewhat poorly drained soils in south-central Minnesota.

	Stand (1000 plants/A)					
	Steele County[a]			Carver County[b]		
Tillage	1985	1987	Mean	1986	1987	Mean
No-till[c]	27.0	27.1	**27.1**	23.2	24.9	**24.1**
Ridge-till	27.2	26.5	**26.9**	—	23.8	—
Chisel[d]	28.8	26.1	**27.5**	23.3	24.4	**23.9**
Moldboard[d]	24.5	26.2	**25.4**	24.9	23.5	**24.2**
Subsoil[e]	27.0	26.3	**26.7**	—	—	—
Significance[f]	S	NS		S	NS	

[a]Corn followed soybeans in 30-inch rows on a moderately well-drained to somewhat poorly drained soil (Le Sueur, clay loam-Aquic Argiudoll).
[b]Corn followed corn in 38-inch rows on a well-drained soil (Lester, loam-Mollic Hapludalf).
[c]In 1987 a planter equipped with row cleaners was used with this system.
[d]Plowing was done in the fall of 1984 for the 1985 growing season and in the spring for 1987.
[e]At the Steele County site the subsoil treatment was done in 1984 and 1985. In 1987 it was planted no-till with a conventional planter.
[f]NS = no statistically significant difference between tillage systems, S = significant difference.

Carver County site stands were reduced with systems that left residue on the surface. Although in individual years there are significant tillage effects, on average there is little effect of tillage on stands with well-drained to somewhat poorly drained soils.

To minimize the risk of reduced corn stand due to corn residue when using a system that eliminates primary tillage, it's helpful to use planters equipped with clearing discs or sweeps to clean the row area. It is also essential to closely monitor and adjust operation of planting equipment.

IMPORTANCE OF CROP SEQUENCE AND SOIL TYPE

Corn

Minnesota research has shown that the effect of tillage on corn yields depends on soil type, climate, crop sequence, and proper management of crop residue (Tables 3 through 8).

The data in Table 3 show a yield reduction associated with no tillage on an excessively well-drained soil. In this study nitrogen treatments necessitated traffic between all

Table 3. The effect of tillage on corn grain yields in Sherburne County, Minnesota on a loamy sand soil under irrigation.[a]

Tillage	Yield (bu/A) 1982	1983	1984	1985	Mean
No-till	178	137	167	146	**157**
Ridge-till	197	142	185	168	**173**
Chisel	184	150	178	169	**170**
Moldboard	200	147	179	187	**178**
Significance[b]	S	S	S	S	

[a]Corn was grown after corn on a somewhat excessively drained soil (Hubbard, loamy sand-Udorthentic Haploboroll).
[b]NS = no statistically significant difference between tillage systems, S = significant difference.

Table 4. The effect of tillage corn grain yields following a legume in Wabasha County, Minnesota on well-drained soils.[a]

Tillage	Yield (bu/A) 1984	1985	1986	1987	Mean
No-till	154	108	183	181	**157**
Ridge-till	148	102	185	180	**154**
Chisel	146	109	185	184	**156**
Moldboard	—	—	—	—	—
Subsoil disc[b]	154	106	186	180	**157**
Significance[c]	NS	NS	NS	NS	

[a]Corn followed sweet clover in 1984 and soybeans in other years and was grown on a well-drained (Fayette, silt loam-Typic Hapludalf) soil. The ridge till was cultivated twice and chisel was cultivated once. Subsoil and no-till systems were not cultivated. No-till treatments did not have row-clearing equipment on the planter.
[b]Plots received a subsoil treatment in 1985 and only a light spring discing in subsequent years. The row spacing was changed from 38 inches to 30 inches in 1986. Consequently, this is an established year for the ridge-till treatments at this site.
[c]NS = no statistically significant difference between tillage systems, S = significant difference.

rows, which was partially responsible for the yield reduction with the no-till treatment. Course-textured soils are especially susceptible to compaction from traffic when tillage is eliminated. Residue also contributed to yield reduction.

No-till corn grown after corn where all residue is left and no clearing discs or sweeps are used has the highest risk of reduced N availability, stand problems associated with poor seed-soil contact, and inhibition of early growth and development. However, if corn is planted after a low-residue crop such as soybeans or alfalfa, or planters equipped with clearing discs or sweeps are used following corn, many of these problems disappear. Over a wide range in yield levels there is little difference in corn yield due to tillage following soybeans (low residue crop). This is illustrated by data from Wabasha and Steele counties (Tables 4 and 6).

When corn follows a high residue crop such as corn, in some years on moderately well-drained soils there are variations in yield with different tillage systems; however, over a three- to four-year period there was little difference in average yield (Table 5). There is a slight yield reduction with corn grown under a no-till system. The five- and three-year averages for Goodhue and Fillmore counties respectively show a 4 to 5 bu/A reduction in yield with a no-till system.

On well-drained silt loam soils there was no yield reduction with no tillage following soybeans (Wabasha County, Table 4). The wettest soil with the poorest internal drainage (somewhat poorly drained) in these tables is the Le Sueur clay loam at the Steele County site (Table 6). At this site it appears that there was an advantage with the moldboard and ridge-till systems in 1987.

The most severe test for no-till, of course, is corn grown continuously without tillage on a poorly drained soil. Generally, weeds can be controlled in corn with cultivation and currently available herbicides. Annual grass control in continuous corn with a no-till system (total reliance on chemical control of weeds) can be difficult. This is the case in a study run since 1975 (Table 7). A thick mat of corn residue built up after several years of no-till corn in this study. A serious weed control problem (giant foxtail) also accounts for part of the yield reduction associated with the no-till treatment. In some years of this study, no-till showed symptoms of reduced nitrogen availability.

Despite problems, there is still a range of conservation tillage options for continuous corn that allow for reduced production inputs on these soils without a yield reduction. One of the most interesting observations from this study is the comparison of the no-till, till plant-ridged and till plant-flat treatments. The difference between the no-till and till plant-flat systems is a clean row area at planting and a cultivation with the till-plant flat system (10-inch wide strip on 30-inch rows). This resulted in a 17 bu/A average yield increase of the till plant-flat over the no-till treatment. Ridges built during cultivation increased yield an additional 4 bu/A. This illustrates the relative importance of a clean row area and ridges. Most of the advantage of the till plant or ridge-till system occurred with a row area free of residue rather than from a prominent ridge. This is not to say planting in a depression on these soils is desirable, but a slightly elevated situation after planting is generally all that is necessary. In

Table 5. The effect of tillage on corn grain yields following corn in southeastern Minnesota on well-drained soils.

Tillage	Yield (bu/A) Goodhue County[a] 1982	1983	1984	1985	1986	Mean	Fillmore County[b] 1985	1986	1987	Mean
No-till	134	135	154	141	156	**144**	168	201	160	**176**
Ridge-till	131	146	161	144	162	**148**	—	—	—	—
Chisel	131	138	158	155	161	**149**	175	202	164	**180**
Disc	—	—	—	—	—	—	171	207	166	**181**
Moldboard	—	—	—	—	—	—	177	201	165	**181**
Sig.[c]	NS	S	S	S	NS		S	S	S	

[a]Corn grown after corn on a well-drained soil (Mt. Caroll, silt loam-Typic Hapludoll).
[b]Corn grown after corn on a well-drained soil (Tama, silt loam-Typic Argiudoll). All systems were cultivated.
[c]NS = no statistically significant difference between tillage systems, S = significant difference.

Table 6. The effect of tillage on corn grain yields on well-drained soils in south-central Minnesota.

Tillage	Yield (bu/A)					
	Steele County[a]			Carver County[b]		
	1985	1987	Mean	1986	1987	Mean
No-till[c]	162	167	**165**	157	181	**169**
Ridge-till	167	179	**173**	—	184	—
Chisel[d]	167	173	**170**	161	187	**174**
Moldboard[d]	169	185	**177**	160	188	**174**
Subsoil[e]	171	171	**171**	—	—	—
Significance[f]	NS	S		NS	NS	

[a]Corn followed soybeans in 30-inch rows on a moderately well-drained to somewhat poorly drained soil (Le Sueur, clay loam-Aquic Argiudoll).
[b]Corn followed corn in 38-inch rows on a well-drained soil (Lester, loam-Mollic Hapludalf).
[c]In 1987 a planter equipped with row cleaners was used with this system.
[d]Plowing was done in the fall of 1984 for the 1985 growing season and in the spring for 1987.
[e]At the Steele County site the subsoil treatment was done in 1984 and 1985. In 1987 it was planted "no-till" with a conventional planter.
[f]NS = no statistically significant difference between tillage systems, S = significant difference.

Table 7. The effect of tillage on corn grain yields following corn in Waseca County, Minnesota on a somewhat poorly drained clay loam soil (Randall et al.)[a].

Tillage	Yield (bu/A)						
	1977	1978	1979	1980	1981	1982	Mean
No-till	95	147	157	132	135	139	**134**
Till plant[b] ridge	118	165	165	143	172	166	**155**
flat	117	168	156	143	160	159	**151**
Fall chisel	104	157	169	147	168	164	**152**
Fall moldboard	118	164	171	160	178	175	**161**
Significance[c]	S	S	S	S	S	S	

[a]Corn grown after corn on a somewhat poorly drained soil (Webster-Nicollet clay loam-Typic Haplaquoll-Aquic Hapludoll).
[b]Corn was planted into a 10-inch residue-free strip with both till-plant treatments with a planter equipped with row cleaners. The flat treatment was cultivated but not ridged at cultivation.
[c]NS = no statistically significant difference between tillage systems, S = significant difference.

some years root pruning as a result of an over-aggressive ridging attempt can actually decrease yields.

In 1984 this study was changed to a soybean-corn rotation and half of the plots were treated in the soybean year with sethoxydim (Poast, Table 8). Control of giant foxtail increased soybean yield 12 bu/A the first year of no-till (1983). The reduction in soybean yield with the no-till system is not typical of other Minnesota research or farmer situations. In this study there was an accumulation of crop residue from over eight years of continuous corn with the no-till system. The 1986 results are more typical in that there is no effect of tillage on corn or soybean yields when grown in rotation.

In summary, corn growth is not affected by tillage over a wide range of soil types if the row area is cleaned of residue at planting (starter fertilizer should also be used). Corn grown after corn will be less affected by in-row residue on soils that are moderately well-drained or better than on poorly drained sites or sites with north-facing slopes. In some years there may be a small yield decline on moderately drained soils with no-till systems when row area is not cleaned of residue. Corn grown after corn with a no-till system on soils with somewhat poor or worse drainage frequently has shown a substantial yield suppression (10 bu/A or more). The yield decline with continuous corn grown under no-till systems can sometimes be attributed to weed control problems or reduced nitrogen availability. When using systems that eliminate primary tillage, traffic must be controlled to avoid soil compaction problems.

Table 8. The effect of tillage on corn and soybean yields in Waseca County, Minnesota on a somewhat poorly drained clay loam soil (Randall et al., 1984-1987).

Tillage	Yield (bu/A)							
	Corn			Soybeans				
	1984[a]	1986[a]	1986[b]	1983[a]		1985[a]		1986[b]
				Sethoxydim (Poast)				
				yes	no	yes	no	
No-till	137	154	203	37	25	40	41	56
Ridge-till	148	169		41	44	48	49	—
Spring disc	156	171		41	44	49	47	—
Chisel	148	164	195	43	40	48	47	56
Moldboard	155	163	192	43	47	50	52	56
Significance[c]	S	S	NS	S	S	S	S	NS

[a]This is a long-term tillage study that has been in continuous corn since 1975. In 1983 this study was planted to soybeans to begin a corn-soybean rotation. Half of the plots were treated with sethoxydim (Poast) in soybean years.
[b]This is the establishment year of a rotation-tillage study.
[c]NS = no statistically significant difference between tillage systems, S = significant difference.

Soybeans

Statewide research has shown that soybeans are insensitive to tillage over a wide range of soils (with the exception of iron chlorosis on high pH soils, where the soil aeration associated with tillage lessens symptoms). In some years on some soils there are adverse tillage effects but there is little or no difference in yields in the long term (Tables 9 and 10). These data were collected on somewhat poorly drained soils that are well-tiled. These studies had excellent weed control. Soybean yield differences due to tillage are usually associated with weed control. With few

Table 9. The effect of tillage on soybean yields following a high residue crop (corn) in Stevens County, Minnesota on a somewhat poorly drained clay loam soil (Evans, unpublished data)[a].

Tillage	Yield (bu/A)				
	1982	1983	1984	1985	Mean
No-till	40	64	47	55	**49**
Till plant[b] ridge	38	63	47	57	**51**
flat	36	63	45	54	**51**
Spring disc	38	61	45	53	**49**
Chisel	37	64	47	57	**51**
Moldboard	35	64	46	57	**50**
Significance[c]	S	S	S	S	

[a]Soybeans grown after corn on a somewhat poorly drained soil (Hammerly, clay loam-Aeric Calciaquoll) at the West-Central Agricultural Experiment Station, Morris, Minnesota.
[b]Corn was planted into a 10-inch residue-free strip with both till plant treatments with a planter equipped with row cleaners. The flat treatment was cultivated but not ridged at cultivation.
[c]NS = no statistically significant difference between tillage systems, S = significant difference.

Table 10. The effect of tillage on soybean yields following a high residue crop (corn) in Waseca and Redwood counties on somewhat poorly drained clay loam soils (Lueschen and Nelson respectively, unpublished data).

Tillage	Yield (bu/A)								
	Waseca County[a]					Redwood County[b]			
	1982	1983	1984	1985	Mean	1982	1983	1984	Mean
No-till	50	47	46	45	**47**	49	50	39	**46**
Till plant[c] ridge	48	45	46	45	**47**	51	53	39	**47**
flat	47	47	46	43	**46**	50	50	38	**46**
Spring disc	52	46	49	47	**49**	53	49	38	**47**
Chisel	51	48	48	44	**48**	53	47	36	**45**
Moldboard	51	50	49	46	**49**	52	47	41	**47**

[a]Soybeans grown after corn on a somewhat poorly drained soil (Webster, clay loam-Typic Haplaquoll) at the South-Central Minnesota Agricultural Experiment Station, Waseca, Minnesota.
[b]Soybeans grown on a somewhat poorly drained soil (Ves-Normania, clay loam-Udic Haplustoll-Aquic Haplustoll) at the Southwestern Minnesota Agricultural Experiment Station, Lamberton, Minneosota.
[c]Corn was planted into a 10-inch residue-free strip with both till plant treatments with a planter equipped with row cleaners. The flat treatment was cultivated but not ridged at cultivation.

exceptions there is usually a 10 to 15 percent yield advantage to soybeans grown in narrow rows. Data comparing ridge-till tillage and soybeans grown in narrow rows with other tillage systems usually show differences that are due to row spacing and not tillage. Also note that there is no difference in yield between no-till, till plant-flat, and till plant-ridge. It is not as important to keep the row area free of corn residue as it is for corn.

In summary, the effects of tillage system on soybean yields seem to be related to row spacing and weed control rather than to crop sequence or soil type. If weeds are controlled, yields for all tillage systems will be similar.

CULTIVATION

Researchers have shown an advantage to cultivation on crusting silt loam soils due to: (1) weed control; (2) improved infiltration and retarded runoff from roughness; and (3) improved aeration (after crusting conditions).

The effects of cultivation and tillage on corn yields (continuous corn) on a Tama silt loam soil in Fillmore County is shown in Table 11. Tillage and cultivation significantly affected grain yields. In 1985 cultivation resulted in a significant yield increase with moldboard and no-till grown corn. Cultivation did not affect yields with chisel plowing or discing. The dominant weeds at this site are giant foxtail and velvet leaf. The response to cultivation in 1985 was likely due to weed control and improved water infiltration under no-till and moldboard conditions. In 1986 there was abundant and timely rain. Weeds also were effectively controlled with herbicides. Both factors resulted in no yield response to cultivation. In 1987 preemergence herbicides were less effective and rain was more yield-limiting. In this year there was a response to cultivation in all systems.

It is interesting to note that the no-till plots were not cultivated in 1987 because crop residues prevented cultivation with a conventional cultivator. The 15 bu/A response in the no-till plots is from the previous years' cultivation. Weed pressure was much reduced. Three-year averages show no advantage to cultivation with a chisel plow. There is a 3 to 4 bu/A yield advantage to cultivation with the moldboard and spring disc systems. The no-till system by far had the biggest yield advantage to cultivation (10 bu/A).

When evaluating the value of cultivation, tillage from anhydrous ammonia application should also be considered (Table 12). Some studies have shown decreased water infiltration under no-till conditions and imply that there also will be increased phosphorus (P) associated with water runoff since broadcast P accumulates at the surface. This not likely if secondary tillage such as that associated with anhydrous ammonia application or cultivation has been done following broadcast P applications. Planter-applied P is even more effective at reducing runoff losses since it is below the soil surface.

Table 11. The effect of tillage and cultivation on corn grain yields at Fillmore County on a well-drained soil (Tama, silt loam-Typic Argiudoll).[a]

Tillage	Yield (bu/A)							
	1985[b]		1986		1987		**Average**	
	C	NC	C	NC	C	NC	**C**	**NC**
No-till	168	158	204	199	160[c]	145	**177**	**167**
Spring disc	175	171	206	207	164	157	**182**	**178**
Chisel	171	174	199	204	171	161	**180**	**180**
Moldboard	177	170	200	202	167	163	**181**	**178**

[a]Corn was preceded by soybeans in 1985 and corn in 1986 and 1987.
[b]C = cultivated, NC = not cultivated.
[c]No-till corn was not cultivated in 1987. The conventional cultivator at this site was unable to handle the residue that had accumulated. The 15 bu/A response in this year is due to weed (velvet leaf and foxtail) control provided by cultivation from previous years.

EROSION AND YIELDS

There are very little data relating soil erosion and crop yields. The results of one study of the relationship among soil depth, rainfall, and grain yields are shown in Table 13. In 1984 average yields increased 13 bu/A as soil depth increased from 29 to 62 inches. In 1983 under more severe

Table 12. The effect of tillage on water infiltration at Lancaster, Wisconsin in early June.

Tillage	Water Infiltration (in/hr)		
	1981	1982	1983[a]
No-till	1.46	1.10	3.53
Moldboard	0.97	1.52	0.54

[a]Anhydrous ammonia applied preplant.

Table 13. The effect of soil depth (Palsgrove and Rozetta silt loams) to clay residuum and growing season rainfall on corn grain yields at Lancaster, Wisconsin.

	Yield (bu/A)							
	Average depth (inches)				Rainfall (inches)[a]			
Year	29	41	46	62	May	June	July	Aug.
1981	147	147	142	147	0.85	4.28	2.91	11.35
1982	150	143	143	147	5.46	3.45	5.29	4.06
1983	73	85	96	111	5.18	3.28	3.34	3.12
1984	107	110	118	120	3.92	7.77	2.57	1.37

[a]In both 1983 and 1984 long periods of minimal rainfall occurred during the silk and tassel emergence period.

drought conditions soil depth affected yields by 40 bu/A. In 1981 and 1982 when water stress was minimal there was no effect of depth on yields. This study quantifies the relationship between rainfall and soil depth due to erosion and corn yields.

SUMMARY

1. Keep the row area clean when planting no-till corn after corn to ensure uniform and rapid emergence. No-till corn after corn when row area was not free of residue resulted in lower yields (4 and 21 bu/A on well-drained and poorly drained soils, respectively) than ridge-till or chisel and moldboard plowing.

2. Most of the benefit of the ridge-till system is due to a residue-free row area rather than a prominent ridge.

3. Tillage had no effect on yield when corn was grown after soybeans. Starter fertilizer should be used for corn regardless of crop sequence.

4. Soybeans appear to be insensitive to tillage, soil type (with the exception of high pH soils, which cause iron chlorosis), or crop sequence.

5. There is a 10 to 15 percent yield increase for narrow-row soybeans (10 inches or less vs. 30 inches).

6. Weed control and row spacing, rather than tillage system, usually account for yield differences for soybeans.

7. Cultivation or anhydrous ammonia application improved water infiltration and corn yield when the soil crusted.

8. In a drought year decreased soil depth and the associated reduced soil available water holding capacity decreased yields 1.4 bu/A per inch of soil depth.

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