Resources Conservation Practices

Considerations in Selecting No-Till

Conservation Quiz

1. What is the definition of no-till?

2. If planter depth wheels are not firmly contacting the soil, how can seed depth be increased?

3. What nutrient considerations are associated with no-till?

(Answers located on page 4.)

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No-till is a tillage system in which the soil is not disturbed before planting, except for injecting fertilizer nutrients such as liquid manure or anhydrous ammonia and opening narrow strips with a coulter or disk seed-furrow during planting. This means that tillage is entirely eliminated. Furthermore, the entire residue from the previous crop remains on the soil's surface to protect it from erosion. No-till often is used to achieve soil conservation requirements on highly erodible land, but it is also becoming popular due to its advantages and the emerging technologies that address its limitations. Many producers use no-till in conjunction with crop rotations and measures such as contouring and terracing to meet soil conservation requirements on highly erodible soils.

Considerations in Selecting No-Till

Weed Control

No-till requires surface application of premergence or postemergence herbicides for weed control. Using burndown herbicides instead of tillage to eliminate competition from early-season weeds is relatively expensive, which raises production costs. Although no-till means zero-tillage, many producers who practice high residue cropping systems may resort to row cultivation as an alternative for weed control. Controlling weeds in no-till relies on close management and timing of herbicide applications and encouraging crop competition. Timing weed control according to emergence is critical in controlling weeds in a no-till system, and may require multiple spraying passes. Weed species present in no-till may be somewhat different from those present with full-width tillage, thus some change in weed management strategies may be needed. The challenge is that the choice of no-till will be influenced by many factors such as site-specific conditions, equipment availability, soil conditions, economics, etc.

Residue Management

Implementing no-till requires spreading crop residue as evenly as possible during harvest. No-till planters must establish good seed-to-soil contact, without the advantage of tillage, for the seeds to germinate properly. Opening the row for the seedbed requires a row opener on the planter that is capable of slicing through soil and a variety of crop residues. Choosing no-till may mean adjusting current equipment and adding heavier down-pressure springs and row cleaners or a coulter on each planter row unit.

The best location for plant nutrients is below the soil surface, where the plants' root systems can access them. But because incorporating fertilizer and pesticides buries residue and disturbs soil structure, no-till systems require broadcast applications, with occasional exceptions made for the injection of nitrogen or manure. No-till also requires monitoring fertility in the top 2 inches of the soil as well as to a depth of 6 to 8 inches.

Changing from a conventional tillage system to no-till changes the characteristics and behavior of the soil system. No-till promotes the formation and enhancement of more stable soil aggregates (small clumps of soil particles that adhere to each other), which reduces crusting and enhances infiltration of air and water into a more porous soil.

Equipment Requirements

No-till implies that there is no disturbance to stir, loosen, or manipulate the soil other than inserting the seed below the surface and perhaps injecting nutrients into the soil. In the absence of other tillage, virtually all responsibility for optimum seed placement depends on the planter. Adjustment and observation of planter performance should be done with care.

Ensure that depth-gauging wheels on row units are firmly contacting the soil surface. If double-disc seed openers are holding the depth wheels above the surface, more down-force is needed on the row units for penetration. This can be accomplished by tightening down-pressure springs on the parallel links and/or adding more weight or ballast to the row unit.

If the depth-gauging wheels are firmly contacting the soil surface, avoid over-tightening down-pressure springs. Excessive down-force on wet, plastic soil can compact soil in the seed zone. In extreme cases enough weight can be transferred from the planter frame to the row units that seed metering is reduced as the planter frame transport wheels lose traction and slip on the soil surface.

When planting corn in cold soil conditions or into heavy residue, clearing a six-inch-wide residue-free zone with row cleaners ahead of the seed opener will help emergence and early plant growth. Adjusting row cleaner height is important to move residue rather than soil. If a coulter is used with row cleaners, position the coulter behind them if possible to avoid hair-pinning residue into the soil.

Because seed placement and soil-seed contact depends so much on planter operation, pay close attention to the closing system. Closing wheels or discs on most planters have adjustable down-pressure. Use enough down-pressure to ensure good seed-to-soil contact, but don't excessively compact soil.

Check planter operation periodically and when changing fields or soil types to ensure seed is placed at the proper depth and with adequate soil contact. Such checks avoid problems of uneven emergence and plant stand due to shallow planting or poor soil contact and coverage from improper planter operation.

Nutrient Management

Because phosphorus (P) and potassium (K) do not move appreciably within the soil, layering these nutrients (i.e. higher concentrations near the soil surface) is common in a no-till system. Despite layering, nutrient deficiencies usually are not a problem in soil with a medium or higher soil test. Soil moisture near the surface is often greater in no-till, which may promote root uptake of nutrients. If soil tests low in P or K, or if nutrient deficiencies are observed, consider injecting P and K with the planter, injection fertilizer applicator, or manure applicator. Although nitrogen (N) is mobile (downward) in the soil, ammonium-based sources such as urea applied on the surface are subject to volatilization losses and anhydrous ammonia must be injected.

If nutrients are going to be placed below the soil surface, consider the effect of commercial fertilizer or manure injection on residue and soil structure. Avoid injectors that bury excessive residue if erosion is a concern. Injecting fertilizer with the planter avoids an additional field pass, but added weight may be required on the planter frame if fertilizer openers operate too shallowly when tanks or hoppers are nearly empty.

Table 1: Corn yield and economic returns of no-till compared to other tillage systems averaged over years.

Location	Crop rotation	No. of years	Tillage	Yield bu/acre	Yield difference† %	Returns $/acre
Nashua	CS	15	MP	146	1	56
			CP	147	2	68
			RT	142	-1	67
			NT	144		72
	CC	15	MP	137	11	42
			CP	132	7	40
			RT	129	5	44
			NT	123		31
Burlington	CS	13	MP	144	5	76
			RDT	144	5	85
			NT	137		77
Newell	CS	6	MP	146	4	97
			CP	145	3	102
			FC	146	4	110
			TP	141	0	101
			NT	141		102
Central Iowa	CS	4	MP	156	8	133
			CP	148	3	123
			DR	157	9	133
			ST	139	-3	106
			NT	144		119
Crawfordsville	CS	12	CP	144	4	114
		5	RT	134	-4	88
		7	AL	141	1	105
		12	NT	139		108
	CC	12	CP	119	3	45
		5	RT	110	-4	21
		7	AL	124	8	56
		12	NT	115		41
Sutherland	CS	8	CP	155	6	138
			RT	149	2	121
			NT	146		124

† Numbers in this column represent the percentage differences in yield of other tillage systems over NT.

Abbreviations used in Table 1 and Table 2: CS, corn-soybean; CC, continuous corn; AL, alternative tillage; CP, chisel plow; DR, deep rip; FC, field cultivation; MP, moldboard plow; NT, no-till; RDT, reduced tillage; RT, ridge-till; ST, strip-till; TP, till-plant.

Table 2: Soybean yield and economic returns of no-till compared to other tillage systems averaged over years.

Location	Crop rotation	No. of years	Tillage	Yield bu/acre	Yield difference† %	Returns $/acre
Nashua	CS	15	MP	43	5	87
			CP	42	2	92
			RT	40	-2	89
			NT	41		94
Burlington	CS	13	MP	47	9	83
			RDT	45	5	82
			NT	43		75
Newell	CS	6	MP	44	5	68
			CP	43	2	70
			FC	44	5	80
			TP	41	-2	67
			NT	42		75
Central Iowa	CS	4	MP	51	4	121
			CP	48	-2	113
			DR	50	2	114
			ST	48	-2	113
			NT	49		120
Crawfordsville	CS	12	CP	48	0	113
		5	RT	51	6	121
		7	AL	44	-8	99
		12	NT	48		115
Sutherland	CS	8	CP	47	2	108
			RT	46	0	96
			NT	46		105

† Numbers in this column represent the percentage differences in yield of other tillage systems over NT

Quiz Answers:

1. No soil disturbance, except for nutrient injection and planting.
2. Tighten down-pressure springs on parallel links or add more ballast to row units.
3. Stratification of immobile nutrients (P, K, etc.) and NH3 volatilization when applied on the surface.

Yield and Economic Returns of No-Till Compared to Other Tillage Systems

Study Description

Data from several long-term (4 to 15 years) tillage studies at Nashua, Burlington, Newell, central Iowa, Crawfordsville, and Sutherland were used to compare yield and economic returns of no-till to other tillage systems. Experiments at Burlington, Newell, Central Iowa, and Sutherland were conducted in a corn-soybean rotation. Trials at Nashua and Crawfordsville were conducted in both continuous corn and corn-soybean rotations. Alternative tillage consisted of no-till drilled soybean and field cultivation ahead of corn in a corn-soybean rotation; in continuous corn, fall chisel plow was followed with direct planting in the spring.

Corn yield was adjusted to a moisture content of 15.5% and soybean yield to 13%. Economic returns were calculated based on the actual field operations (such as tillage practices, fertilizer and herbicide applications, etc.) and fertilizer rates. However, other costs, including seed, herbicide, lime, and crop insurance, were based on a study by Duffy and Smith in 2002 (see "References"). The time required by each field operation was based on a study by Hanna in 2001 (see "References") using the machine size of intermediate field capacity. The labor cost (hours per crop acre) included the actual fieldwork as well as time for maintenance, travel, and other activities related to crop production. Economic returns were calculated based on corn grain price at $2.20/bushel and soybean seed at $5/bushel. The labor cost rate used was $8/hour.

Corn and Soybean Yields and Economic Returns

Corn yield under moldboard plow slightly exceeded no-till corn at most locations. However, no-till had better economic returns in many cases. Corn yield under chisel plow was generally higher than no-till, but most return differences were less than $10/acre. The yield difference between no-till and ridge-till was never greater than 5% and the return difference was generally fairly small. The corn yield difference between no-till and reduced tillage, field cultivation, till-plant, or strip-till was 5% or less. No-till never had a return difference greater than $9/acre compared to reduced tillage, field cultivation, till-plant, and strip-till. Yield responses and economic returns of different tillage systems were affected by location and crop rotation. See Table 1 for more details.

The soybean yield difference between no-till and moldboard plow was generally 5% or less, with no-till returns generally higher. No-till produced soybean yield similar to that of chisel plow at all locations and a return difference of $7/acre or less. The soybean yield difference between no-till and ridge-till was usually quite small and the return difference was always less than $10/acre. The yield difference between no-till and reduced tillage, field cultivation, till-plant, deep rip or strip-till was never greater than 5%, and the return difference was less than $9/acre. See Table 2 for more details.

Summary

Converting to any conservation tillage plan requires learning and using new techniques and products as well as understanding that yield changes may be caused by factors other than the new tillage system (i.e. weather). How farmers manage their fields plays an important role in the evaluation of corn and soybean performances under no-till. Different farmers may obtain quite different yields and returns in no-till compared to those under other tillage systems.

In general, average yield performances of corn and soybeans in no-till were competitive with moldboard plow, chisel plow, and other tillage systems in most locations. Corn-soybean rotation greatly improved corn performances in no-till. Site-specific production factors including soil type, soil texture, local weather conditions, and management practices were among those that contributed to the variations in no-till performance associated with locations.

Analysis showed the competitiveness of no-till over moldboard plow, chisel plow, and other tillage systems in both corn and soybean yields at the beginning of tillage adoption is as strong as that after 10 to 15 years of continuous tillage implementation. This is encouraging to those corn and soybean producers who are reluctant to use no-till because they are concerned about the poor yield performances in no-till during the beginning years or who are only willing to use no-till systems for a relatively short period (such as 5 years or less).

Most no-till systems produced economic returns with a difference of less than $10/acre from moldboard and chisel plow systems. Corn-soybean rotation increased the economic return of no-till corn compared to continuous corn. This study suggests that the adoption of no-till systems can be accomplished without lowering economic returns in most cases. The specific situations under which no-till can be used depend on the crop rotation, management practices, and hourly labor costs used by the farmer. The adoption of no-till will increase more rapidly as farmers become familiar with the new management practices and hourly labor costs increase.

Because economic returns are affected not only by crop yield but also by the costs of machinery, fertilizer, and labor, etc., high yield does not necessarily mean high economic returns, and a significant yield difference between no-till and other tillage systems does not guarantee a remarkable difference in economic returns. For example, moldboard plow usually has a total production cost of at least $10/acre—and sometimes even more than $20/acre—higher than that for no-till. In the latter case, even though moldboard plow produces yields of about 10 bushels/acre greater than no-till, the economic returns of the two tillage systems are very similar.

To try no-till on a limited trial basis, choose a field that is well drained, has even crop residue cover, is not compacted, and has optimum soil fertility levels. Get good advice, make sure the planter is adjusted properly (seed opener penetrating to depth of the gauge wheels, furrow closing, etc.), and plant at the right time, instead of when you have time. Make it a habit to scout the field for weed pressure and other management considerations.

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