Agronomic Spotlight

Evaluation of Tillage Systems

- Tillage helps prepare the seedbed for planting and is also used to incorporate nutrients, manage crop residues, and disrupt weed and pest lifecycles.
- Each tillage system has advantages and disadvantages that need to be assessed for each field situation.
- The best tillage system will depend upon the characteristics of each individual field and production practices.

Tillage System Classifications

The goal of a tillage system is to provide a proper environment for seed germination and root growth. Tillage can also kill weeds and disrupt pest lifecycles, incorporate nutrients, and manage crop residues. The intensity of soil disturbance and the number of operations can be used to define a tillage system (Table 1). **Primary tillage** is deep tillage (> 6 inches) that loosens and fractures the soil for weed control and incorporation of residue, fertilizer, lime, and manure. **Shallow tillage** (< 6 inches) kills weeds, cuts and covers crop residue, incorporates herbicides, and prepares a seedbed. In-season tillage for weed control or incorporating fertilizer or manure is considered **tertiary tillage**.[2]

Table 1. Typical field operations for several tillage systems

System	Typical field operations
Plow	Fall or spring plow, two spring diskings or field cultivations, plant, cultivate
Chisel	Fall chisel, one to two spring diskings or field cultivations, plant, cultivate
Disk	Fall or spring disk, spring disk and/or field cultivate, plant, cultivate or post-emergence spray
Stubble mulch	Blade plow in summer, one or more shallower operations with wide sweeps or a field cultivator, one or more rod weedings, drill, post-emergence spray
Ridge-till	Shred corn stalks, plant on ridges, cultivate for weed control, rebuild ridges
Strip-till	Strip-till, spray, plant, post-emergence spray as needed
No-till	Spray, plant, post-emergence spray as needed

Source: University of Nebraska CropWatch Tillage website - http://cropwatch.unl.edu.

- **Conventional tillage.** A primary tillage system that involves multiple tillage passes that disturbs 100% of the soil surface (full width), including moldboard plowing, that leaves less than 15% residue on the soil surface after planting.
- **Reduced tillage.** A full-width tillage system that leaves 15 to 30% residue cover after one to three tillage passes.
- **Mulch tillage.** A one to three pass, full-width tillage system using a chisel, disk, field cultivator, or a combination of tillage tools that leave more than 30% residue cover after planting.
- **Ridge tillage.** A minimum tillage system where the soil is left undisturbed from harvest to planting except for 4- to 6-inch high ridges built during row cultivation. One to two inches of the ridges is scraped off during planting.
- **Strip tillage.** A minimum tillage system where the soil is left undisturbed except for strips where the soil is tilled and residue removed to facilitate planting. A mole knife is used to till a zone about 10 inches wide and 4 to 5 inches high and fertilizer is applied in the zone.
- **Vertical tillage.** A full width, shallow (2-3 inches) tillage system leaving 30% or more surface residue; used to cut, mix, and anchor residue in the upper few inches of soil and break up surface compaction and crusting.
- **No-till.** A system with a minimal amount of soil disturbance (> 70% residue cover) which uses a row cleaner, coulter, seed opener, or another planter attachment to facilitate planting.

Tillage Comparisons

For decades, agronomists have studied corn and soybean yields in no-till versus other tillage systems and continue to find that overall, no-till systems provided grain yields nearly equivalent to tillage systems.[1] The outcome of each different tillage system will depend upon the individual field and production practices. No-till corn and soybeans tend to perform better in southern and western regions over other tillage systems. Overall, yield decreases were noted in north-central states and Canada (Table 2). No-till systems do not perform as well when soil drainage problems exist. Many of the tillage studies that are cited in reviews did not have a stable no-till system in place prior to initiating an experiment, which may bias the results.

Evaluation of Tillage Systems

Table 2. Yield comparisons for no-till and other tillage systems expressed as percent yield advantage (+) or disadvantage (-) for no-till[1]			
		Corn	**Soybean**
Region	Northern	-5.5%	-3.9%
	Central	-1.8%	-0.6%
	Southern / Western	+12.2%	+5.0%
Soil drainage	Moderate / well drained	+2.0%	+2.0%
	Poorly drained	-4.5%	-1.4%
Crop rotation	Corn / soybean	+1.9%	+0.7%
	Continuous corn	-1.5%	+1.1%

Choosing a Tillage System

Each tillage system has advantages and disadvantages that need to be assessed for each field situation (Table 3). Selecting the best tillage system for a specific situation requires consideration of several factors.[4]

- **Crop rotation.** The amount and durability of the residue left in the field is crop specific. Corn generates a large amount of residue that degrades slower than soybean residue. It may be difficult to maintain adequate residue cover in crops following soybean.
- **Erosion potential.** The erosion potential of a field is determined by the length and steepness of the slope, topsoil depth, and soil texture. Soils with a high erosion potential may require a large reduction in tillage operations to maintain residue and crop productivity.
- **Internal drainage.** Poorly drained soils usually require more tillage to aid in warm-up and drying. High levels of residue common with no-till may keep soils cool and wet too long for sensitive crops.
- **Surface compaction.** Primary tillage may be needed to alleviate compaction caused by field activities on wet soils.
- **Nutrient management.** Tillage may be needed to incorporate fertilizers. Surface applied nitrogen needs incorporation to minimize volatilization and runoff losses. Tillage should be used to incorporate broadcast applications of phosphorus and potassium.
- **Pest management.** Reduced tillage systems may have more weed, insect, and disease problems than conventional systems. Residue cover can serve as an overwintering site for some insects and diseases, or delay crop development due to cool, wet soils, increasing the risk of early season disease and insect problems. Tillage can bury weed seed, disrupt weed, disease, and insect lifecycles, and bury residue that harbors pests.
- **Planting equipment.** Planter modifications (coulters, row cleaners, starter fertilizer attachments) may be required to handle higher crop residue levels in conservation tillage systems. Planting equipment specific to a strip-till, ridge-till, or no-till system may be required to match tillage and planting operations in each system.

Table 3. Advantages and disadvantages for several tillage systems		
System	**Advantages**	**Disadvantages**
Plow	Suited for poorly drained soils; excellent incorporation; provides a well-tilled seedbed	Major soil erosion; high soil moisture loss; highest fuel and labor costs
Chisel	Less winter wind erosion from roughened soil surface; well adapted to poorly drained soils; good incorporation	Little erosion control; high soil moisture loss; shredding may be needed for residue flow; medium fuel and labor requirements
Disk	Less erosion with more residue; well adapted for well-drained soils; good incorporation	Little erosion control with more operations; high soil moisture loss; destroys soil structure; compacts wet soil
Ridge-till	Excellent for furrow irrigation or poorly drained soils; ridges warm up and dry out quickly	No incorporation; wheel spacing and other machinery modifications may be needed; creating and maintaining ridges
Strip-till	Tilled, residue-free strips warm up quickly; injection of nutrients into row area; well suited for poorly drained soils	Cost of preplant operation; strips may dry too much, crust, or erode without residue; not suited for drilled crops; possible RTK guidance costs
No-till	Excellent erosion control and soil moisture conservation; minimum fuel and labor costs; builds soil structure and health	No incorporation; increased dependence on herbicides; slow soil warming on poorly drained soils
Source: University of Nebraska CropWatch Tillage website - http://cropwatch.unl.edu.		

Sources

[1] DeFelice, M., Carter, P.R., and Mitchell, S.B. 2006. Influence of tillage on corn and soybean yield in the United States and Canada. Plant management Network. [2]Tillage management. Agronomy Guide. Pennsylvania State University. [3] CropWatch Tillage/no-till systems http://cropwatch.unl.edu. University of Nebraska-Lincoln. [4]Randall, G. and Vetsch, J. 2005. Factors to consider when making tillage decisions WW-08315. University of Minnesota Extension. [5] Harper, J. Economics of conservation tillage. Agronomy Guide. Pennsylvania State University. Web source verified 3/3/16. 130826133418