Considering Strip-tillage

Department of Agronomy MF-2661 Conservation Tillage

The Evolution of Tillage Practices

Producers have choices when it comes to tillage systems. Historically, soil inversion was the only means of soil management practiced when the grasslands of the Great Plains were initially converted to cropland. Many lessons were learned through the Dust Bowls of the 1930s and 1950s. Americans became aware of the need for soil conservation when dust storms descended on Washington, D.C., and pictures of gully erosion — in the heart the breadbasket of the United States — were published in national newspapers.

The first efforts at conservation tillage began with the substitution of a chisel plow for the moldboard plow. This tillage implement, followed by less aggressive disks, pioneered the effort to keep more residue on the soil surface to limit the erosional forces of nature.

In the 1970s a new type of management emerged. The concept of no-tillage became possible with improvements in planting equipment and herbicides. This new approach to farming took many years to master. It required not only a change of equipment, but also a change in management styles and problem solving. Today's successful no-till producer operates quite differently than the farmer of the 1950s.

A new piece of tillage equipment has emerged on the market: strip-till implements designed to till a narrow (≈ 8 inch) strip on crop row (30 inch) centers. This machine marries some of the benefits of no-till with the benefits of tillage. The region between tilled strips is maintained as a no-till area, while the area where the crop is planted is tilled. Will strip-till become the next generation tool for soil management? This publication looks at some of the data and discusses advantages and disadvantages of using strip-till.

Figure 1. *Strip-tillage in a wheat field.*

A Solution for Cold Wet Soils

No-till has been largely successful at reducing soil loss from erosion. It also has proven to be better at retaining moisture by improving infiltration and reducing evaporation. On heavy soils in moist environments, high residue levels have delayed planting and resulted in poor early seedling vigor. This has been a problem for corn production in the Midwest. Strip-till was designed primarily to help improve the seedling environment in early spring. Tillage in the fall or spring helps reduce residue levels, dries excess soil moisture, and causes soil temperature to rise because of increased exposed to the sun. To gain the benefits of tillage in the seed zone, while retaining the needed soil-erosion and moisture-saving benefits of no-till, a hybrid tillage system, strip-till, was created.

This new equipment varies by manufacturer, but in a basic configuration consists of coulters, disks, and a subsurface knife for injecting fertilizer. Strip-tillage can be performed in the fall or spring before planting. Tillage equipment must be designed to match planting equipment because consistent seed placement within the tilled area is critical to gain the benefit of the tilled strip.

Strip-till performance is still being evaluated as the practice is fairly new. In the upper Midwest, some research shows continuous corn production using strip-till has improved over no-till (Table 1). As

Table 1. *Corn yield (3-year average) by tillage and rotation in Minnesota.*

Tillage Type	Following Corn	Following Soybean
	bushels/acre	
No-Till	156	183
Strip-Till	163	183
Conventional Till	167	182
LSD (0.05)	3.2	NS

Source: Vetsch and Randall, 2002.

Table 2. *Corn yield as affected by tillage and fertilizer nitrogen timing, Iowa.*

Tillage Type	Fertilizer N Timing	Ames		Nashua	
		2001	2002	2001	2002
		bushels/acre			
Fall strip-till	Fall	182	226	222	239
Fall strip-till	Spring	179	220	214	214
Spring strip-till	Spring	180	234	212	212
Fall chisel plow,	Fall	193	236	212	238
No-till	Fall	183	225	231	209
LSD (0.05)		NS	NS	NS	21.0

Source: Al-Kaisi and Licht, 2004.

predicted, crop emergence has improved, with more uniform stands and better seedling vigor. In the same study, however, little response to tillage was seen in corn rotated with soybean.

Grain yields in strip-till have shown a limited advantage over no-till, varying with annual weather conditions. In a recent study conducted in Iowa, fall strip-till and fall chisel plow showed the only significant tillage effect on corn production in only 1 of 4 site-years (Table 2). Even with this limited success of corn in strip-till, interest in use of strip-till has expanded into other crops.

Strip-till as a Transitional Tool

Most strip-till implements have a fertilizer shank that allows placement of fertilizer at depth within the tilled zone. Some irrigated corn producers in western Kansas now use strip-till to help manage fertilizer applications in continuous corn systems. In these high-yielding environments, continuous high-residue levels limit adoption of no-till. Most producers apply nitrogen in the fall as anhydrous ammonia. The strip-till implement provides an opportunity to retain a large amount of residue, while still clearing a path for planting and putting down more than half of the annual nitrogen requirement for corn. These Kansas irrigators have adopted this tillage tool as a transitional tool. Without the use of strip-till, the majority of these producers would use some form of complete tillage to reduce residue in order to stay in a continuous corn system. Using strip-till provides a way to manage within high-residue systems. Since two-thirds of the field retains residue in strip-till, the overall effect will be to improve soil and water conservation.

The lesson to learn from the irrigators is that strip-till can be used to help transition traditional tillage systems into less tillage intensive systems. For dryland production, most no-tillers would argue that a strip-till machine isn't necessary. They are comfortable planting through high-residue fields and managing weed and disease pressure through crop rotations. Still, many traditional producers are reluctant to try no-till. Either they lack the proper planting equipment, or feel they don't have enough information to properly manage this new system. This tool may help them move to high-residue crop production systems.

Strip-till in a More Arid Environment

In dryland production in western Kansas, the factor that most limits crop yield is water availability. No-till summer crops capitalize on the moisture saving nature of high-residue levels. Typically the best corn is grown following wheat, Kansas' highest residue producing crop. Strip-till reduces residue levels in the tilled strip, exposing soil to the air. How will this affect the overall water balance for crop production? Research in the panhandle of Texas might provide information on this subject.

In an intensively monitored research plot, where soil water contents were measured to 10 feet, and soil evaporation rates were measured daily using micro-lysimeters, estimates of seasonal evaporation were determined for cotton grown in two tillage systems. Table 3 shows that total evaporation from both systems were similar, but that a greater percentage of water transpired through the plant where residue was retained in the strip-till system. This 37 percent increase in transpiration efficiency resulted in a 35 percent increase in lint yield.

At the end of the season, in an arid or semiarid environment, water added as precipitation or as irrigation will likely end up in the atmosphere from the large and ever-present evaporative demand. Management of

Table 3. *Estimated soil evaporation and plant transpiration from cotton, Lubbock, TX.*

	Soil Evaporation	Plant Transpiration	Total
	inches of water		
Strip-till	3.9	8.8	12.7
Conventional	6.4	6.5	12.9

Source: Lascano et al., 1994.

Table 4. *Changes in soil carbon and nitrogen 16 years after sod in a wheat fallow rotation, Sydney, NE. (Average for 7-inch depth)*

	Organic Matter	Total Nitrogen
	—— % ——	
Sod	4.8	0.27
No-till	3.8	0.20
Stubble mulch	3.6	0.18
Plow	3.0	0.14

the soil will dictate how that water travels to the atmosphere. In this environment, increasing the amount of water that moves through the plant typically leads to higher yields. Maintaining higher residue, whether through strip-till management or through no-till management should increase yield potential in western Kansas.

Soil Organic Carbon in the Balance

Soil productivity is strongly tied to soil organic matter and microbial activity. Many researchers have shown how tillage intensity reduces soil organic matter. The most intense tillage practice involves using a moldboard plow, and as data from Sydney, Nebraska shows (Table 4) all tillage practices result in a reduction of soil organic matter from that of native sod. The greatest loss occurs with the most aggressive tillage system. Total soil nitrogen also follows this trend with tillage. Even though producers provide most of the nitrogen needed for crop production through fertilizer nitrogen applications, the ability of the soil microbiological community to hold that nitrogen and release it to a growing crop is an important factor. In their study, Follet and Schimel showed that increased tillage intensity decreased the soil's capacity to immobilize and conserve mineral nitrogen.

In terms of tillage intensity, strip-till falls in a category between conventional tillage and no-till. Therefore, the effect it has on soil organic matter status is intermediate. Soil organic matter could improve where conventional tillers adopt strip-till, but could be reduced where no-tillers begin to use strip-till. In either case, the effect on soil organic matter should be minimal, and only measurable over long time periods.

Potential Advantages

- Break up surface compaction
- Yield advantage in continuous corn
- Use of older (low residue handling) planting equipment in tilled strip
- Transition from conventional till to reduced or no-till
- Maintain residue in sprinkler irrigation applications
- Reduced wind erosion hazard
- Deep fertilizer placement
  - ✓ Anhydrous ammonia
  - ✓ UAN
- Remove surface compaction following grazing, while maintaining some residue on surface

Possible Risks

- Erosion on strips
- Crusting; poor stands
- Faster loss of fragile residue
- Soil compaction, structural damage from tillage when soils are wet
- Seedling damage from spring anhydrous ammonia applications

Source: Follet and Schimel, 1989.

Conservation Planning

All tillage choices should be weighed against the effects they have on natural resources. Strip-till should not be used on highly sloped ground. In this situation, exposed soil strips are subject to erosion. This is especially risky if the strips run up and down the hill, rather than following a contour. Exposed soil in a tillage strip also might increase the risk of crusting as compared to a no-till system. As a system for wind erosion control, strip-till should be a great improvement over a conventional till system, because the maintenance of standing residue will reduce the wind speed near the soil surface and provide sediment traps for any suspended particles. On sandy soils, place strips east to west, or at least at an angle different from the prevailing winds, to prevent the wind from blowing down the strip. Water erosion potential can be reduced with strip-till as compared to conventionally tilled systems. The alternating strips of residue that remain will slow surface water movement and will maintain high infiltration rates because of surface protection provided by residue. Wildlife also benefit from increased cover and nesting areas.

Summary

Strip-till is fairly new. Research on how to best use this tool is still being compiled. The implement exists in many different designs, which also indicates how uncertain the industry is on how best to use this technology.

There are still many unknowns. For example, for soils with near surface compaction, will strip-till help by shallow ripping directly where the row will be planted? Can strip-till improve planting conditions on fields that have been recently grazed by livestock? Are the positive yield effects seen by some researchers because of soil temperature changes, nutrient availability, more efficient use of precipitation, or some other factor? Time will tell. But what we do know is because of warmer soil temperatures and deep fertilizer placement, continuous corn may benefit from strip-till. Conversely, crops, such as soybean, sunflower, and sorghum, which are typically planted later, when the soil environment has improved, are less likely to respond to strip-till. Strip-till implements provide an excellent means of deep banding fertilizer, which will improve efficiency and reduce the risk of nutrient loss to the environment. Soil erosion potential in a strip-till system will be intermediate to the high risk in conventional tillage systems and the very low risk seen in no-till systems.

Every farmer operates differently. For those who see potential benefits of strip-till in their operations, a strip-till implement may offer an advantage. Many configurations are available, including ways of attaching units to existing tool bars. Strip-till is probably not going to replace all existing soil management systems, but it is a well-designed tool that can help you remain successful.

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