Resources Conservation Practices

Consider the Strip-Tillage Alternative

Conservation Quiz

1. How much of the field is tilled with strip-tillage?

2. What is the minimum level of soybean residue cover recommended prior to strip-tilling?

3. What types of equipment can be used for strip-tillage?

(Answers located on page 3.)

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Strip-tillage, which creates a soil environment that enhances seed germination, is a new alternative to no-till in areas where poorly drained soils are dominant. Where soil moisture conditions are suitable, strip-tillage creates narrow-width tilled strips, traditionally in the fall, to increase early spring soil evaporation and soil temperature in the top 2 inches. This is particularly effective in poorly drained wet soils, where slightly raised soil strips are created by normally available farm equipment such as anhydrous knives, disks, coulters, tool bars or manure injection equipment. Both fertilizer application and strip-tillage can be performed in one operation. The basic requirements for strip-tillage to be effective are accuracy in matching tillage equipment on the tool bar with the planter and placement of seeds in the tilled zones.

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Concept of Strip-tillage

Traditionally, in the fall, anhydrous ammonia injection knives, fluted coulters, or other tool attachments are used to create residue-free strips and tilled zones that are approximately 6 inches wide and 4 to 8 inches deep. In the spring, seeds are planted directly in the same strips. Fertilizers may be incorporated while tilling these strips.

This concept is similar to another system, zone-till, with one exception. In zone-till, multiple fluted coulters create a zone that is approximately 1 to 2 inches deep and 8 inches wide and free of residue. These coulters operate at shallow depths to avoid creating void pockets below the seed. Another variation involves making a deep vertical slit with a thin profile knife centered in the middle of an 8-inch tilled zone. Zone-till can be achieved by using a planter equipped with fluted coulters. Coulters may be operated 2 or 3 inches to 6 inches deep if the soil is dry. Farmers in southeastern states with particularly compacted soils have used in-row sub-soiling with planter-mounted shanks in each row to create a tilled zone 12 inches deep. Seeds are then planted in the disturbed zone directly behind the shanks. This system is different from the above two systems in that it is often used with the full width conventional tillage system.

Studies have shown corn is more susceptible to delayed germination or disease in cool soil temperatures when soil is poorly drained and there is high no-till residue cover. Other studies show that by removing residue over the row or disturbing a narrow zone (6 to 8 inches wide) the seedbed warms up more rapidly. This can help corn in the early part of the growing season; in some cases corn grain yield improved over no-till simply due to improved soil temperature. Recently it was found that removing residue or strip-tilling to create a residue-free zone improves corn germination due to increased soil temperature at the top 2 inches. Many producers are currently using planter attachments that move no-till residue away from the row during planting. This assists in more rapid warming of the soil and combats slow germination caused by cold and residue-covered soils.

Topography is important to consider before using strip-tillage. In areas where the soil slope is steep or on highly erodible land (HEL), strip-tillage may not be the best choice. The disturbance of soil and removal of crop residue can create a significant water erosion problem in the row on steep slopes. It is recommended that after soybeans, at least 70 percent residue should be on the surface before strip-tilling. Strip-tillage is recommended on relatively flat land with poorly drained soils, where soil temperatures tend to be cold.

Equipment

Every tillage practice requires specific equipment to achieve the intended results. For most farmers, strip-tillage equipment is readily available with slight modifications. The main components can include but are not limited to anhydrous ammonia applicator knives or other subsurface fertilizer injection systems, rototillers, in-row chisels, row cleaners, double-discs, and planters equipped with fluted coulters.

A few adjustments may be needed. For example, an adjustment may be needed to ensure a good match between the strip-tillage devices and the planter. Another consideration is to ensure consistent tilled-zone depth and width (for example, 8 to 9 inches deep and 6 to 8 inches wide). The most common implement for strip-tillage systems consists of a heavy tool bar to which row markers, coulters, knives, and covering disks are attached (Fig. 1). With anhydrous applicators or other fertilizer injection knives, consider moving the knife positions out of the wheel tracks to avoid planting in compacted soil. This is especially advisable if strip-tillage is conducted in the early spring. The knives, coulters, and covering disks must be located on the tool bar to exactly match the planter size (e.g., 8-row, 30-inches, or 12-row, 30-inches). The front coulters must be large enough to help cut into corn residue without getting plugged. The knives, which can be used for anhydrous application, must be located exactly behind the coulters, where they can open an area 6 to 8 inches wide and 8 to 9 inches deep.

Strip-tillage also can include fertilizer application attachments. The integration of tillage and nutrient or fertilizer application equipment makes strip-tillage more appealing and challenging at the same time. A typical strip-tillage set consists of a dry fertilizer cart and an anhydrous ammonia tank hitched to the tillage toolbar (Fig. 2). Adequate horsepower for the

Fig. 1: Coulter, fertilizer injection knives, and covering disks on strip-tiller.

Fig. 2: Complete fall strip-tillage equipment system.

Fig. 3: Fall-tilled strips before planting.

Fig. 4: Strip-tilled field after planting corn.

*Adapted and modified from "Conservation Tillage Systems and Management," MWPS-45, Page 195, 2nd Ed., 2000.

depth of tillage and the load resistance created by fertilizer equipment is critical. Depending on tillage depth and speed, 20 to 30 horsepower per knife may be required to ensure satisfactory performance. Inadequate horsepower will compromise the efficiency and performance of the system.

Timing

The timing of strip-tillage is critical to achieve the system's objectives. Traditionally, strip-tillage is conducted in the fall to maximize the benefits of creating the tilled zone before spring planting. Soils are generally drier after harvest than in the spring. Soil conditions are more suitable for strip-tillage when soil moisture is at or below field capacity, minimizing soil compaction. Fall strip-tillage dries and warms the soil ahead of spring planting, preparing a more uniform seedbed and improving seed-to-soil contact.

Strip-tillage in the fall has its limitations, as well. This is particularly true now since fall application of nitrogen is being discouraged in many areas. If soils are wet under the heavy residue, tillage tools used to prepare a strip for seed placement can compact soil and forms clods. Wet soils in the spring can cling to the depth gauge wheels on the planter, inhibiting uniform seed depth. Labor needed to complete fall tillage may directly compete with labor required for harvest, so consider the number of hours available for fall tillage after harvest. Another challenge is the precision of planting in the tilled strips (Figs. 3 and 4).

Strip-Tillage and Soil Environment

In general, tillage significantly affects soil environment by altering the soil's physical properties such as soil structure, compaction, aggregate stability, hydraulic properties, and thermal properties. The degree to which the tillage affects or improves these properties depends on the intensity of the tillage system. The changes in soil properties will cause changes in the soil environment where crop production can be used as an indicator. Allowing soil to dry in the tilled zone before planting helps the planter's soil-engaging components (seed opener, depth wheels, closing wheels) establish proper seed depth without excessively compacting soil.

Strip-tillage can have a significant impact on soil temperature, particularly in poorly drained soils and when soil moisture conditions remain relatively near field capacity. The improvement in soil temperature can be limited by excessive wet weather conditions. Studies show that strip-tillage improved soil temperature in the top 2 inches by more than 2° F over no-till in central Iowa.

Cool temperatures, soil-borne diseases such as Pythium damping-off, Fusarium root rot, Phomopsis seed decay, brown stem rot, and sudden death syndrome can cause problems for Iowa soybeans. Fungal pathogens of these diseases infect soybean seeds or seedlings when soil temperatures are low and moisture is high. These dis-

Quiz Answers: 1. 20-25% of soil surface is tilled. 2. At least 70% residue cover should be on the soil surface. 3. Anhydrous ammonia injection knives, rototillers, in-row chisels, row cleaners, double-discs, fluted coulters.

Table. 1: Typical field operations advantages and disadvantages for selected tillage systems.*

System	Typical Field Operations	Major Advantages	Major Disadvantages
Moldboard plow	Fall or spring plow; one or two spring diskings or field cultivations; plant; cultivate.	Suited for poorly drained soils. Excellent incorporation. Well-tilled seedbed.	Major soil erosion. High soil moisture loss. Medium to high labor and fuel requirements.
Chisel plow	Fall chisel; one or two spring diskings or field cultivations; plant; cultivate.	Less erosion than from cleanly tilled systems and less wind erosion than fall plow or fall disk because of rough surface. Well adapted to poorly drained soils. Good to excellent incorporation.	Little erosion control. High soil moisture loss. Medium to high labor and fuel requirements.
Disk	Fall or spring disk; spring disk and/or field cultivate; plant; cultivate.	Less erosion than from cleanly tilled systems. Well adapted for lighter to medium textured, well-drained soils. Good to excellent incorporation.	Light eroision control. High soil moisture loss.
Ridge-till	Chop stalks; plant on ridges; cultivate for weed control and to rebuild ridges.	Excellent erosion control if on contour. Well adapted to wide range of soils. Ridges warm up and dry out quickly. Low fuel and labor costs.	No incorporation. Narrow row soybeans and small grains not well suited. No forage crops. Machinery modifications required.
Strip-till	Fall strip-till; spray: plant row crops on cleared strips; post-emergent spray as needed.	Clears residue from row area to allow preplant soil warming and drying. Injection of nutrients directly into row areas. Well suited for poorly drained soils.	Cost of preplant operation. Strips may dry too much, crust, or erode without residue. Potential for nitrogen fertilizer losses.
No-till	Spray; plant into undisturbed surface; post-emergent spray as needed.	Maximum erosion control. Soil moisture conservation. Minimum fuel and labor costs.	No incorporation. Increased dependence on herbicides. Some limitations with poorly drained soils, especially with heavy residue. Slow soil warming.

*Adapted and modified from "Conservation Tillage Systems and Management," MWPS-45, Page 190, 2nd Ed., 2000.

eases are especially problematic in early-planted soybean fields. Recent increases in soybean disease problems in Iowa are in part associated with the increased use of early planting. Strip-tillage warms soils in the seed zone or bed quickly and promotes fast germination and growth of seedlings, reducing disease risk.

Comparison of Strip-Tillage to Other Tillage Systems

Strip-tillage creates soil conditions similar to ridge tillage because it clears soils in the tilled row prior to planting. However, the strip-tillage row zone is flat to slightly elevated, eliminating the problems that can occur with ridge-till when machinery crosses ridges as well as the need to rebuild ridges with row-crop cultivation.

The performance of strip-tillage as compared to conventional and conservation tillage systems still needs evaluation, because it is relatively new. However, some research shows that strip-tillage on sandy loam soils provided yields similar to fall moldboard plowing and higher than no-till. On silt loam and clay loam soils, strip-tillage yield was intermediate to fall moldboard plowing and no-till systems.

The research also showed that the yield of corn following crops with high residue such as corn, small grains, or hay increased by as much as 10 percent when a 6-inch band of corn residue was cleared from the row's area using planter-mounted furrowers. The choice of fall strip-tillage is better suited to corn after small grains, alfalfa, red clover, or corn planted into cold, wet soils. The advantage of strip-tillage over other tillage systems is summarized in Table 1.

Table. 2: Typical field operations for various tillage systems. *

Tillage System	Field Operation	No. of Field Trips
Strip-tillage	Strip preparation with application of fertilizer; plant	2
No tillage	Apply N; plant; apply P and K with the planter; (maybe fall broadcast P and K)	2 - 3
Ridge tillage	Apply N; plant; cultivate (apply liquid N); cultivate to prepare ridge; (maybe fall broadcast P and K)	3 - 5
One-pass tillage	Knife-in N; broadcast P and K; field cultivate; plant	4
Conventional tillage	Broadcast P and K; chisel plow; knife in N; field cultivate; plant	5

*Adapted and modified from "Conservation Tillage Systems and Management," MWPS-45, Page 198, 2nd Ed., 2000.

Fig. 5: Strip-tilling with an anhydrous ammonia knife and covering discs.

Strip-tillage after row crops is more adaptable if the row spacing is similar to the previous row crop spacing. In addition, using similar row spacing will help to control wheel traffic within the inter-rows. (See Iowa State University Extension Publication PM-1901b, "Understanding and Managing Soil Compaction.")

Economic Considerations

The economic value of strip-tillage is very much limited to the input associated with tillage operations. Strip-tillage has few field operations (till/fertilizer application, planting, weed control, harvest) similar to no-till (Table 2). There may be a significant difference in power and fuel required per acre, however, depending on the depth of tillage and fertilizer incorporation. Tractor power and energy requirements to pull subsurface injection knives are greater than for shallow stirring of soil with a no-till planter following broadcast fertilizer application.

The yield under strip-tillage has a very limited advantage over no-till, depending on the weather conditions and soil moisture status. The improvement in yield under strip-tillage is due to the combined effect of both nutrient placement and soil conditions of the tilled zone. Many studies showed a small increase in corn yield over no-till. If strip-tillage is conducted in the fall, conflicting labor requirements between harvest and fall tillage can make labor scarce and thus more costly and valuable. In addition, the precision of locating rows in the same fall-tilled strips during the following spring planting is very important to achieve the benefit of strip-tillage.

Potential Benefits/Concerns

Strip-tillage is best suited to poorly drained, wet, cold soils where seed germination is delayed. This tillage system helps dry and warm soils in the spring, easing planter operation and promoting germination.

Enhanced efficiency is another potential benefit when manure injection is incorporated into the tillage operation, reducing passes over the field. Because most farmers already have the strip tillage equipment accessible (such as in-row chisels and ammonia applicator knives), specialized equipment may not need to be purchased.

These benefits must be weighed against a variety of potential concerns. For instance, strip-tillage can induce erosion, particularly in highly erodible soils. Strip-tillage also can contribute to soil compaction between tilled zones.

Nitrogen fertilizer application in the spring can be problematic due to the potential effect on seed germination.

In the fall, farmers must consider whether there is enough labor to manage both the harvest and strip tillage. Tractor horsepower also must be considered when the tillage depth and load resistance are increased.

Strip-tillage, when carefully considered and evaluated, can be a viable alternative to farmers in particular circumstances.

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