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Tillage Systems For Row Crop Production

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Tillage Systems For Row Crop Production

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Selecting a tillage system that is best suited to a particular farming situation is an important management decision. In the past, a crop producer's primary concerns were field capacity and the costs of owning and operating equipment. However, with rapidly increasing energy costs, alternative tillage systems are being carefully evaluated and selected by more producers.

Previously, the most common tillage system included a moldboard plow to turn residues under either in the fall or spring. Following plowing, spring tillage normally included one or more shallow diskings to kill weeds, incorporate fertilizer and pesticides, and provide loose

Figure 1. Moldboard plowing.

Figure 2. Chisel plowing.

Figure 3. Disking.

Figure 4. No-till planting.

soil for seed. Other light tillage operations, including field cultivation and harrowing, were also conducted to provide a finely pulverized, weed free, seedbed. Today, preplant tillage operations are being reduced on many farms. Labor, fuel and equipment costs, better erosion control, moisture conservation, and more timely planting are all reasons for the trend toward reduced tillage operations.

The wide array of tillage and planting systems available today provides an opportunity to match the tillage system to specific soil and cropping conditions. Six different tillage systems are described here to aid in tillage system selection.

Tillage System Descriptions

Moldboard Plowing. Fall or spring moldboard plowing has been an accepted tillage operation primarily because of soil pulverization and nearly complete residue incorporation (*Figure 1*). When followed by one or two spring diskings, moldboard plowing provides an excellent seedbed and allows fertilizer and pesticide incorporation before planting. Even though the moldboard plow buries weed seeds, postemergent cultivation for weed control is often needed. Fall plowing also speeds up soil drying and warming in the spring, thus avoiding delays in spring tillage and planting on soils that dry slowly.

Fall moldboard plowing has often been used to reduce the number of spring tillage operations. Poor weather conditions in the spring may cause crops to be planted late because of insufficient time to plow and prepare the seedbed. The primary disadvantage of fall plowing, however, is the potential for soil erosion throughout the winter and early spring because no surface residue is available to protect the soil.

Spring plowing not only reduces the potential for wind and water erosion, but also provides winter grazing for livestock. Spring labor and time shortages, however, often offset these advantages. Furthermore, spring plowing may produce clods, which require an extra, unplanned tillage operation to develop a desirable seedbed. Excessive soil moisture loss, especially during dry years, is another disadvantage with spring plowing.

Chisel Plow. The chisel plow produces a rough surface and can leave about 50 to 75 percent of residue on the surface (*Figure 2*). These are important features for fall tillage because the rough, partially covered surface traps moisture and minimizes erosion. Additional residue may be buried by specially shaped chisel points that invert more soil to cover and incorporate residues.

The time and labor restrictions caused by poor weather with spring chisel plowing are similar to spring moldboard plowing. With extremely heavy residues, clogging may occur unless a disking or chopping operation precedes chisel plowing, which further delays final seedbed preparation. However, on light textured soils with low levels of residue, the chisel plow can reduce tillage operations by eliminating or reducing the need for secondary tillage operations.

Disk. The disk generally leaves 40 to 70 percent of residue on the soil surface. Its cutting and burial action minimizes adverse effects of residue on subsequent tillage operations and planting. The disk serves as both the primary and secondary tillage tool, and can be used to incorporate fertilizers and pesticides. If needed because of weeds or cloddy surface conditions, additional tillage operations prior to planting can be accomplished with a disk operated at a shallow depth.

Fall disking is often a desirable tillage operation because valuable time is saved in the spring. Because a larger percentage of residue remains on the surface, the erosion potential for a fall disked field is not as great as from a fall plowed field.

Well drained and lighter textured soils may be best suited to a spring disk operation as the primary tillage. However, winter grazing for livestock or wet fall weather can force the primary disking operation into the spring regardless of soil type. A spring disk system minimizes erosion during the winter, and can be successful if sufficient time is available in the spring to allow two diskings before planting. Although one disking may be sufficient, two diskings reduce both soil aggregate size and the amount of residue to levels well suited for operating most surface planters.

Disking under wet soil conditions can create a compacted layer similar to a "plow pan." Although shallower and less dense than a moldboard plow pan, this compacted layer can restrict root growth which may reduce yields. A proper management technique to minimize the development of a "disk pan" is to avoid disking wet soil.

Rotary-Till. A powered rotary tiller mounted ahead of a planter can be used to prepare the seedbed, incorporate chemicals, and plant the crop in a one-pass operation on lighter textured soils. Occasionally, a preplant disking may be needed to assist in weed control or in leveling the field. Since the residue is not disturbed by tillage from harvest until planting, livestock grazing is possible and erosion is minimized up to planting time. The capability to rotary-till narrow strips 10 to 12 inches (25 to 30 cm) wide for planting can extend erosion control until the new crop is established.

The rotary-till system prepares a finely pulverized seedbed which provides excellent seed-to-soil contact for germination, but the surface may be subject to crusting after intense rains. Depending on the depth of tillage, the rotarytill system may also require a larger tractor or auxiliary engine to power the rotary tiller.

Till-Plant. The till-plant system is another one-pass tillage-planting operation. The seed is planted in 4 to 6 inches (10 to 15 cm) ridges formed during cultivation for the previous crop. The planting unit is mounted behind a sweep or double disk furrower which removes the top

2 to 3 inches (5 to 8 cm) of ridge and pushes the clods and stalks between the rows. This results in a cleanly tilled seedbed with strips of residue between the rows to reduce erosion. With the residue placed between the rows, till-planting up and down hill may result in increased soil loss due to channel erosion in the row area.

The till-plant system provides both winter and spring erosion control and the capability for livestock grazing. Another advantage of this system is early spring planting because the ridges dry and warm up earlier than level fields. These advantages make a till-plant system suitable for many row crop farms.

The primary disadvantage of the till-plant system is that excellent management is required to form ridges in the previous season and to maintain those ridges for spring planting. Currently available till-planters also require precise adjustment and operation to ensure accurate seed placement in the ridges. This problem is further complicated by excessive crop residue. Some producers regularly chop stalks to reduce equipment malfunctions caused by excessive crop residue.

No-Till. Tillage is essentially eliminated with a no-till system *(Figure 4).* The seed is placed in a 1- to 2-inch (2.5 to 5 cm) wide strip opened with fluted coulters, narrow chisel points or angled disks mounted ahead of the planting unit. By tilling only a narrow slot in sod or residue covered soil, the notill system provides excellent erosion control and winter grazing for livestock, and minimizes moisture losses from evaporation.

Excellent chemical management and equipment adjustment and operation are essential to successfully produce row crops with the no-till system. With continuous use, weeds and other pests may become prevalent. This further increases the demand for excellent pesticide management. Although other systems also require weed control, the lack of either a cultivation or pesticide incorporation with no-till requires surface applied pesticides. Two sprayings to replace tillage are generally necessary to control weeds and other pests.

Fuel and Labor Requirements

Fuel and labor requirements for each of the tillage systems discussed are shown in *Tables 1* and *2*, respectively. The moldboard plow tillage system has the highest fuel and labor requirements. Substituting a chisel plow for a moldboard plow reduces the fuel required by 22.7 percent. Eliminating the use of a plow and utilizing only a disk for seedbed preparation can result in a 42.5 percent fuel savings. Adopting a no-till system can result in a fuel savings of nearly 70 percent over the moldboard plow system and more than 45 percent over the conventional disk tillage system.

Since the field capacity for a chisel plow is greater than for a moldboard plow, substituting a chisel for the moldboard plow can result in nearly a 15 percent savings in labor. Reducing the number of operations and increasing field capacity by using a disk tillage system can save about 30 percent of the labor required for a plow system. Labor savings of 50 percent can be realized by changing from a moldboard plow system to a no-till system. Labor savings allow farming a larger area without additional labor inputs. Even if increased acreage (ha) is not anticipated, more timely operations may increase yield.

Summary

Tables 1, 2, and *3* contain comparative data useful in evaluating and selecting the most suitable tillage system or combination of systems for each specific row crop operation. However, the data and subjective comments are typical, and it must be remembered that the management decision to use a given tillage system should be dictated by the specific cropping circumstances.

For example, an already weedy situation would probably not benefit from decreased tillage. To control the weeds, additional tillage operations may be added to the basic system described, but the fuel and labor estimates should also be increased to reflect this addition. And of course, the tillage system should not preclude, but instead complement, good conservation practices including terracing and contour farming.

The six tillage systems outlined represent alternatives at a time when economics require flexibility in crop production. The pressures of inflation are forcing the farmer to maintain or increase yields with less labor and fuel. Continuing concern for preserving the soils and increasing regulatory demands to reduce sediments in surface water also increase the impetus for farmers to carefully evaluate their current tillage system.

Table 1. Typical diesel fuel requirements in gallons per acre (liters/hectare) for various tillage systems.[1]

	Moldboard Plow	*Chisel Plow*	*Disk*	*Rotary-Till*	*Till-Plant*	*No-Till*
Chop Stalks					0.55 (5.16)	
Moldboard Plow	2.25 (21.12)					
Chisel Plow		1.05 (9.86)				
Fertilize, Knife	0.60 (5.63)	0.60 (5.63)	0.60 (5.63)	0.60 (5.63)	0.60 (5.63)	0.60 (5.63)
Disk	0.74 (6.95)	0.74 (6.95)	0.74 (6.95)	0.74 (6.95)		
Disk	0.74 (6.95)	0.74 (6.95)	0.74 (6.95)			
Plant	0.52 (4.88)	0.52 (4.88)	0.52 (4.88)	1.42 (13.33)	0.68 (6.38)	0.60 (5.63)
Cultivate	0.43 (4.04)	0.43 (4.04)	0.43 (4.04)	0.43 (4.04)	0.43 (4.04)	
Spray (2)						0.46 (4.32)
Total	5.28 (49.56)	4.08 (38.29)	3.03 (28.44)	3.19 (29.94)	2.26 (21.21)	1.66 (15.58)

1/ Source: Shelton, et al., 1979, *Nebraska Fuel Use Survey*.

Table 2. Typical labor requirements in hours per acre (hours per hectare) for various tillage systems.[a]

	Moldboard Plow	*Chisel Plow*	*Disk*	*Rotary-Till*	*Till-Plant*	*No-Till*
Chop Stalks					0.17 (0.42)	
Moldboard Plow	0.38 (0.94)					
Chisel Plow		0.21 (0.52)				
Fertilize, Knife	0.13 (0.32)	0.13 (0.32)	0.13 (0.32)	0.13 (0.32)	0.13 (0.32)	0.13 (0.32)
Disk	0.16 (0.40)	0.16 (0.40)	0.16 (0.40)	0.16 (0.40)		
Disk	0.16 (0.40)	0.16 (0.40)	0.16 (0.40			
Plant	0.21 (0.52)	0.21 (0.52)	0.21 (0.52)	0.40 (0.99)	0.25 (0.62)	0.25 (0.62)
Cultivate	0.18 (0.44)	0.18 (0.44)	0.18 (0.44)	0.18 (0.44)	0.18 (0.44)	
Spray (2)						0.22 (0.54)
Total	1.22 (3.01)	1.05 (2.59)	0.84 (2.07)	0.87 (2.15)	0.73 (1.80)	0.60 (1.48)

a Assuming 100 hp (74.6 kW) tractor and matching equipment for average soil conditions.

Table 3. Advantages, disadvantages and normal tillage sequences for several row crop tillage systems.

System	*Normal Tillage Sequence*	*Major Advantages*	*Major Disadvantages*
Moldboard Plow	Fall or spring plow; two diskings; postemergent cultivation.	Excellent seedbed preparation. Uncomplicated. Fertilizer and herbicide incorporation.	High erosion potential. High fuel and labor costs. High soil moisture loss.
Chisel Plow	Fall or spring chisel; two diskings; postemergent cultivation.	Reduced erosion potential. Reduced fuel and labor costs. Fertilizer and herbicide incorporation.	Clogging with excessive residues. Excessive cloddiness with spring chiseling. High moisture loss.
Disk	Fall or spring disk; spring disk; postemergent cultivation.	Well adapted to lighter textured soils. Low fuel and labor costs. Low residue problems at planting.	Erosion control lost with excessive tillage. Possible soil compaction.
Rotary-Till	One spring disking or stalk shreading; tillage and planting; postemergent cultivation.	Excellent erosion control up to planting. Excellent seedbed preparation. Low fuel and labor costs.	Possible increased power requirement. Soil crusting possible. Low erosion control after planting.
Till-Plant	Stalk chopping; till-planting on ridges in spring; postemergent cultivation to maintain ridges.	Excellent erosion control. Good seedbed preparation. Very low fuel and labor costs. High moisture conservation.	Lacks herbicide incorporation. Variable seed placement. High management requirement.
No-Till	Plant into narrow strips in spring; postemergent spraying for weed control.	Maximum erosion control. High moisture conservation. Minimum fuel and labor costs.	Increased dependence on herbicides. Soil slower to dry out and warm up. High management requirement.

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