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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 the tillage system best suited to a particular farming situation is an important management decision. Formerly, the traditional system was a moldboard plow operation followed by several secondary tillage operations before planting. This system can be appropriate for poorly drained soils having little or no slope and low erosion potential. However, plowing has several disadvantages. The potential for soil erosion is high on sloping lands, and labor and fuel requirements can be substantially higher than with other tillage and planting systems.

Today, conservation tillage systems are used to reduce preplant tillage operations, thus reducing soil erosion and moisture loss while saving labor and fuel. The

Disking

Chisel Plowing

Ridge Planting

No-Till Planting

label "conservation tillage" represents a broad spectrum of farming methods, and is most often defined by the amount of residue cover remaining on the soil surface. The minimum amount recommended is 20 to 30 percent after planting. Research in Nebraska and other midwestern states has shown that leaving at least this much residue will reduce erosion by more than 50 percent of that occurring from a cleanly tilled field. To achieve effective erosion control, this minimum residue cover should be maintained during the critical soil erosion period between spring seedbed preparation and crop canopy establishment.

Conservation tillage does not necessarily require new equipment. Most conventional farm implements can be used. For corn, grain sorghum, or wheat residue, one or two passes with a field cultivator, disk, or chisel plow will usually leave more than the 20 percent minimum cover. Additional operations reduce the amount of residue, and thus reduce erosion control. Other tillage and planting systems such as ridge-plant (till-plant) and no-till leave even more residue, and thus offer greater erosion control. However, no-till planting is the only method that consistently leaves the minimum surface cover in the more fragile and less abundant soybean residue.

No single tillage system is best for all situations at all times. Selecting the best tillage system for a particular soil and cropping situation requires matching the operation to the crop sequence, topography, and soil type. Rotating systems to coincide with crop rotations often provides an excellent combination. For example, a no-till system could follow soybeans while a chisel or disk system might follow corn. This tillage rotation provides the best erosion control following soybeans, and provides an opportunity for some tillage in the less fragile and more abundant corn residue.

Following is a description of five tillage systems which, if used properly, will increase erosion control while cutting labor and fuel costs.

Tillage System Descriptions

Chisel Plow

The chisel plow produces a rough surface and can leave about 50 to 75 percent of the existing corn or sorghum residue on the soil surface. In extremely heavy or wet residue, the chisel plow may become clogged unless a stalk shredding or light tillage operation precedes chiseling. However, this will increase fuel and labor requirements. Several combination tillage implements have coulters or disks mounted in front of the chisel shanks which eliminate the need for a prechiseling operation.

On many Nebraska soils, fall chiseling and overwinter weathering of clods followed by a single spring disking can provide an acceptable seedbed. Limited pesticide and fertilizer incorporation is possible, provided the disking occurs when the soil is relatively dry. A second spring disking or field cultivation may sometimes be appropriate, but erosion control will decrease.

Chisel plowing in the spring will allow winter grazing of stalks. However, the potential loss of soil moisture through evaporation from the tilled zone can result in yield reductions. Spring chiseling may also produce clods which could require additional tillage operations to produce a suitable seedbed. Like spring moldboard plowing, spring chiseling increases labor needs when time is often critical.

Disk

Forty to 70 percent of the residue generally remains on the surface after a single disking of corn, grain sorghum, or wheat residue. The cutting and burial action of the disk destroys residue, reducing potential plugging problems during subsequent tillage and planting operations. When disking, the number of operations must be limited to maintain erosion control. Generally, disking corn or grain sorghum residue more than twice, or even a single disking of soybean residue, will destroy too much residue for effective erosion control. If a field cultivation is used for final seedbed preparation, one disking should be eliminated.

Disking in the fall can save time in the spring; however, the potential for erosion from wind and early spring rains is increased and snow entrapment is decreased. A spring disk system minimizes erosion during the winter, but may not be the most suitable tillage system on soils that tend to dry slowly. Adequately drained and lighter textured soils are well suited to a spring disk operation.

When used correctly, the disk can be an excellent tillage implement. A common problem, however, is that soils are often disked when too wet. Disking wet soils can create clods that require additional tillage operations; will not adequately incorporate herbicides; and can create a compacted soil layer similar to a moldboard plow pan. This layer is generally shallower and less dense than a plow pan, but can restrict root growth and reduce yields, especially in dry years.

A field cultivator, like a disk, can be used for conservation tillage if the total number of operations is limited. However, it may not be the best implement to use if clods are present because clods tend to move around the shanks rather than be pulverized.

Rotary-Till

A powered rotary tiller can be used to prepare the seedbed while incorporating fertilizers and pesticides. Planting units are usually attached to the rotary tiller, making tillage and planting a one-pass operation. Well suited to medium textured soils, the rotary-till system can prepare a finely pulverized seedbed, providing excellent seed-to-soil contact for germination. Because the residue is not disturbed from harvest until planting, erosion is minimized in the early spring. However, depending on use, the surface may be residue-free after planting and subject to erosion and crusting after rainfall.

With the rotary-till system, the depth of tiller operation largely determines the amount of fuel and labor used and the potential for erosion. If the rotary tiller is used for deep tillage, fuel and labor requirements may exceed those of the moldboard plow. However, when the tiller is operated less than three inches deep, this system can be relatively economical. Rotary tilling strips only 10 to 15 inches wide can provide additional erosion control by leaving more residue between the rows. Herbicide incorporation in the row area is then possible.

Furrow irrigated areas tend to be well suited to the rotary tiller. The depth of the rotary tiller can be set so that only the ridge tops are tilled while the residue and soil are moved toward row middles. Tilling only the tops of ridges requires less fuel and labor than many other tillage systems. Crop cultivation and ditching operations can be used to control weeds in the row middle.

Ridge-Plant or Till-Plant

The ridge- or till-plant system is another one-pass, tillage and planting method. Seed is planted in 4- to 6-inch high ridges formed during cultivation of the previous crop. Two cultivations are generally used: one to loosen the soil and the other to create the ridge. For ease of planting, the ridges should be rounded or flat-topped. Sweeps or other row cleaning devices mounted in front of planting units remove the top 1 to 2 inches of the ridges and push clods and residue between the rows. This results in a cleanly tilled seedbed with strips of residue between the rows to reduce erosion. Unfortunately, ridge planting up and down hill may increase soil loss because of channel erosion in the cleanly tilled strips. For the most effective erosion control, till planting should be done on the contour.

Till planting is well suited to furrow irrigated areas and soils that tend to be wet in the spring because the ridges dry out and warm up quicker than non-ridged areas. Herbicide incorporation is usually not possible with till planting. Most often, a band of herbicide is applied during planting and crop cultivation is used for weed control in the row middles.

Till planting requires a change in management practices to maintain weed control, form ridges during cultivation, and maintain those ridges for spring planting. Since planting is done into a ridge that may have mellow and loose soil on top and more compact soil on the sides, achieving a uniform planting depth may be difficult if the planter is not kept on the ridge. Maintaining a uniform depth may be further complicated by excessive crop residue or by peak-shaped ridges. Some producers chop stalks or perform a shallow tillage operation to smooth ridge tops and reduce equipment malfunctions caused by excessive crop residue or ridge shape. However, either of these operations will increase fuel and labor requirements. Care must be taken not to damage or destroy the ridges by wheel traffic, particularly during harvest.

No-Till

Tillage is essentially eliminated with a no-till system. The seed is placed in a 1- to 2-inch wide strip opened with coulters or disk-type seed furrow openers. By tilling only a narrow slot in the residue covered soil, excellent erosion control is achieved. When compared to other tillage and planting systems, no-till planting also minimizes fuel and labor requirements.

Although weed control is essential to all systems, the lack of incorporation with no-till requires surface applied herbicides. One or two properly timed sprayings may be necessary to control weeds and other pests. Crop cultivation for weed control can be practiced with no-till, provided the cultivator can move through the residue without clogging.

No-till planting is well suited to many Nebraska soils having good internal drainage. The residue may appear unsightly, but when uniformly spread, the mulch holds moisture for infiltration and reduces soil moisture losses from evaporation. However, no-till users should be aware that, especially on poorly drained soils, crop residue may delay soil warm up and drying in the spring, which sometimes can delay planting. A fall chisel or ridge-plant system may be better for poorly drained soils.

Tillage System Comparisons

Typical advantages and disadvantages of the tillage and planting systems are shown in *Table 1.* General fuel and labor requirements are listed in *Tables 2* and *3.* This information is useful in selecting the most suitable system or combination of systems for each farming situation. However, the final management decision should be based on specific soil and cropping circumstances as well as management ability. For example, an already weedy field would probably not benefit from no-till. To control weeds, herbicide incorporation and tillage may be desirable, but the fuel and labor requirements and the erosion potential should also be considered.

The moldboard plow tillage system has the highest fuel and labor requirements. Adopting a no-till planting system can reduce fuel use by more than 70 percent when compared to the moldboard plow system, and more than 50 percent when compared to the disk tillage system.

Labor savings of almost 60 percent can be realized by changing from a moldboard plow system to a no-till system. This labor savings allows a larger area to be farmed without added labor. Even if increased acreage is not anticipated, more timely operations may result in higher yields. In addition, tractor and equipment costs and maintenance will be lower with reduced tillage operations.

Several Nebraska studies have compared yields from different tillage systems. In eastern Nebraska, as a general rule, yields from all tillage systems are about the same. However, in rainfall limited areas or in low rainfall years, yields are generally higher with conservation tillage. This is because the surface residue reduces evaporation and runoff, thus contributing to a savings of moisture.

Recent advances in herbicides and their time of application make weed control with no-till easier. Longer-lasting and improved herbicides, and early pre-plant applications are helping assure success.

One way to minimize potential problems associated with no-till is to rotate tillage systems. That is, to use no-till for two or three years and then rotate to another tillage system for one year. With some farming situations, tillage rotation can be combined with crop rotation. As an example, no-till planting of corn into soybean residue is relatively easy. When rotating back into soybeans, limited tillage may be used while still leaving the minimum amount of residue. This provides all of the advantages of no-till while minimizing the potential disadvantages. However, tillage rotation will require more equipment than is normally associated with continuous no-till farming.

Regardless of the tillage system selected, residue should be uniformly spread behind the combine. Uniform distribution will help prevent equipment malfunctions because of clogging, provide for easier weed control, and have better erosion control. In addition, care should be taken in both the spring and fall to avoid soil compaction. Tilling a wet soil is often thought to be the major cause of compaction. However, driving on a wet soil, such as during harvest with a loaded combine or grain cart, can also create considerable compaction. Additional tillage operations may be necessary to spread or reduce the residue, or deeper tillage operations may be required to shatter compacted soils.

Table 1. Advantages, disadvantages, and typical field operations for selected tillage systems.

System	*Typical Field Operations*	*Major Advantages*	*Major Disadvantages*
Moldboard Plow	Fall or spring plow; two spring diskings; plant; cultivate.	Suited to most soil and management conditions. Excellent for poorly drained soils. Excellent incorporation. Well tilled seedbed.	Little erosion control. High soil moisture loss. Timeliness considerations. Highest fuel and labor costs.
Chisel Plow	Fall or spring chisel; spring disk; plant; cultivate.	Less erosion than from cleanly tilled systems. Less winter erosion potential than fall plow or fall disk. Well adapted to poorly drained soils. Good to excellent incorporation.	Additional operations, often performed, result in excessive soil erosion and moisture loss. In heavy residues, stalk shredding may be necessary to avoid clogging.
Disk	Fall or spring disk; spring 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. Few residue clogging problems.	Additional operations, often performed, result in excessive soil erosion and moisture loss. Soil compaction associated with disking wet soils.
Rotary-Till	Rotary-till and plant; cultivate.	Excellent erosion control up to planting time. Excellent incorporation when used full width. Well suited for furrow irrigated areas. Well tilled seedbed.	Depending on use: Low erosion control after planting. Possible soil crusting. Possible increased power requirement.
Ridge-Plant (Till-Plant)	Stalk chopping; planting on ridges; cultivate to maintain ridges.	Excellent erosion control if on contour. Well adapted to poorly drained soils. Excellent for furrow irrigated areas. Ridges warm up and dry out quickly. Low fuel and labor costs.	No incorporation. Creating and maintaining ridges. Keeping planter on top of ridge.
No-Till	Spray, plant into undisturbed surface; postemergent spraying or cultivation as necessary.	Maximum erosion control. Soil moisture conservation. Minimum fuel and labor costs.	No incorporation. Increased dependence on herbicides. Not suited for poorly drained soils or weed infested fields. Management is highly critical.

Table 2. Typical diesel fuel requirements in gallons per acre for various tillage systems.

Operation	*Fuel Use (gal/ac)*					
	Moldboard Plow	Chisel Plow	Disk	Rotary-Till	Ridge-Plant	No-Till
Chop Stalks				0.55	0.55	
Moldboard Plow	2.25					
Chisel Plow		1.05				
Fertilize, Knife	0.60	0.60	0.60	0.60	0.60	0.60
Disk	0.74	0.74	0.74			
Disk	0.74		0.74			
Plant	0.52	0.52	0.52	1.00	0.68	0.60
Cultivate	0.43	0.43	0.43	0.43	0.86(2)	
Spray						0.23(2)
Total	5.28	3.34	3.03	2.58	2.69	1.43

Table 3. Typical labor requirements in hours per acre* for various tillage systems.

Operations	*Labor (hr/ac)*					
	Moldboard Plow	Chisel Plow	Disk	Rotary-Till	Ridge-Plant	No-Till
Chop Stalks				0.17	0.17	
Moldboard Plow	0.38					
Chisel Plow		0.21				
Fertilize, Knife	0.13	0.13	0.13	0.13	0.13	0.13
Disk	0.16	0.16	0.16			
Disk	0.16		0.16			
Plant	0.21	0.21	0.21	0.40	0.25	0.25
Cultivate	0.18	0.18	0.18	0.18	0.36(2)	
Spray						0.11(2)
Total	1.22	0.89	0.84	0.88	0.91	0.49

*Hours per acre assume 100 hp tractor and matching equipment for average soil conditions.

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