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G91-1046 Conservation Tillage and Planting Systems

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Conservation Tillage and Planting Systems

Tillage system descriptions and comparisons are included here.

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Moldboard plowing, followed by such secondary tillage operations as disking and harrowing, was once the most common, or traditional, tillage system before planting. Soil erosion potential from rainfall on sloping lands was great and requirements for labor and fuel were high compared to other tillage and planting systems.

One of the most commonly used tillage systems in Nebraska today is two diskings followed by field cultivation. Unfortunately, the potential for soil erosion may be great because the number of tillage operations involved may not leave adequate residue cover for erosion control.

Today conservation tillage systems reduce soil erosion and moisture losses while saving labor and fuel. "Conservation tillage" can represent a broad spectrum of farming methods, provided at least 30 percent of the soil surface remains covered with crop residue following planting. Research in Nebraska and other midwestern states has shown that leaving at least 30 percent residue cover reduces erosion from water by more than 50 percent, as compared to a cleanly tilled field.

Following corn, grain sorghum or wheat, one or perhaps even two passes with a field cultivator, disk or chisel plow usually leaves about a 30 percent residue cover. Additional operations incorporate more residue, reducing erosion control. Other tillage and planting systems such as ridge plant and no-till leave even more residue, offering greater erosion control. No-till planting is the only system that consistently leaves at least 30 percent residue cover following soybeans.

No single tillage and planting system is best for all situations. Selecting the most appropriate system for a particular soil and cropping situation requires matching the operations to the crop sequence, topography, soil type and weather conditions. Rotating tillage and planting systems to coincide with crop rotations often provides an excellent combination.

For example, a no-till system following soybeans and a chisel or disk system following corn provides the most erosion control after soybeans, and allows for some tillage in the less fragile and more abundant corn residue. However, rotating tillage and planting systems slows the development of improved soil structure and weed control benefits that often are obtained with the continuous use of either ridge or no-till systems.

Following is a description of four tillage systems which, if properly used, increase erosion control.

Tillage System Descriptions

Chisel Plow

The chisel plow produces a rough surface and leaves about 50 to 70 percent of the existing corn or sorghum residue on the soil surface, depending on chisel point selection, shank spacing, operating speed and depth. Straight, narrow points, about 2 inches wide, leave the most residue. However, following soybeans, even narrow points bury too much residue to be considered conservation tillage.

Where erosion is not of primary concern, 3 or 4 inch wide, twisted points may be used to invert more of the soil, burying more residue. In western Nebraska wider sweeps on the chisel plow are sometimes used in wheat residue to undercut weeds and still leave substantial amounts of residue.

The type of chisel point influences the amount of residue remaining on the soil surface. Typically the chiseling operation is performed in the fall and followed by one or more secondary tillage operations in the spring. The fall operation cuts and incorporates some of the residue, making it more susceptible to decomposition and over-winter weathering than undisturbed residue. This partially decomposed residue is easily broken up and covered by secondary tillage operations, negating much of the effect of selecting chisel points which leave more residue.

On many Nebraska soils a single spring pass with a disk, field cultivator or combination tillage implement provides limited pesticide and fertilizer incorporation on fall chiseled fields. A second pass may be appropriate for more complete incorporation, but residue cover and erosion control will decrease.

Chisel plowing in the spring provides erosion control over the winter and allows extended grazing of stalks. The loss of soil moisture through evaporation following spring tillage can result in yield reductions, particularly in lower rainfall areas. Spring chiseling also may produce clods that could require additional tillage operations to produce a suitable seedbed.

In extremely heavy or wet residue, the chisel plow may clog unless stalk shredding or light tillage precedes chiseling. Several combination tillage implements have coulters or disks mounted in front of the chisel shanks that eliminate the need for a pre-chiseling operation.

Disk and Field Cultivate

The tandem disk harrow is the most commonly used tillage implement in Nebraska. Typically, a field cultivator is used for final seedbed preparation with a disk system.

Forty to 70 percent of the residue generally remains on the surface after a single disking of corn, grain sorghum or wheat residue. Generally, disking corn or grain sorghum residue more than twice destroys too much residue for effective erosion control. If a field cultivator is used for final seedbed preparation, only one disking should be used. In soybean residue even a single pass with any tillage implement will not leave enough residue cover for effective erosion control.

Disking in the fall saves time in the spring, but the potential for erosion from wind and rain is increased, and snow entrapment is decreased. A spring disk system minimizes erosion during the winter, and is well suited to adequately drained and lighter textured soils.

The disk is commonly used for incorporating herbicides and other surface applied materials. A common problem is that soils are often disked when too wet. Disking wet soils may not uniformly incorporate surface applied materials and can create clods that require additional tillage. It also can create a compacted soil layer below the depth of disking that may restrict root growth and reduce yields.

The field cultivator is used as a secondary tillage implement immediately preceding planting. The amount of residue covered by a field cultivator depends on the amount of time and weathering since the primary tillage operation. If the field cultivation occurs two or three days after the primary tillage operation, the field cultivator may not reduce the residue much further.

In some circumstances, particularly with corn residue, field cultivation immediately following the primary tillage operation may in fact increase the residue cover by a few percentage points. On the other hand, if time between the primary tillage operation and the field cultivation allows for some precipitation and weathering of the residue, the field cultivator will significantly reduce the residue cover.

Some producers no longer use the disk, but use instead one pass of a field cultivator or combination tillage implement. Unfortunately, the most common use of this one-pass tillage system is in soybean residue. While successful in fields where erosion is a minor concern, these implements generally do not leave enough soybean residue to effectively reduce soil losses on fields prone to erosion.

Ridge Plant and Ridge Till

In ridge systems, crops are planted into ridges formed during cultivation of the previous row crop. A band application of herbicide behind the planter typically is used in the row for weed control. Crop cultivation controls weeds between the rows and rebuilds the ridges for the following year. (See NebGuide *G88-876, Ridge Plant Systems: Equipment, for more information*.)

Ridge systems help control erosion by leaving the soil covered with residue until planting. After planting a 30 to 50 percent residue cover may be left, but the residue is not uniformly distributed. Residue-covered areas between the rows alternate with residue-free strips in the row area. For erosion control the Soil Conservation Service specifies the ridge must be 3 to 5 inches higher than the furrow after planting, and the ridge must be shaped to shed water to the furrow. For the most effective erosion control, ridge systems should be used around the hill.

Two cultivations are generally required in ridge systems, the first to loosen soil and control weeds, the second for additional weed control and to rebuild the ridges. For ease of planting next season, the ridges should be rounded or flat topped, and 6 to 8 inches tall after cultivation. Proper ridge shape and annual maintenance are keys to a successful ridge system. Care must be taken not to damage or destroy the ridges by wheel traffic, particularly during harvest.

Level or gently sloping fields, especially those with poorly drained soils, are well suited to ridge systems. The elevated ridges tend to shed some residue to the row middles, allowing earlier soil warming in the spring. This warming, combined with drainage from the ridge, allows soil in the ridge to be drier at planting time than unridged soil.

Ridge systems can be an excellent choice for furrow irrigated fields. Ditching, furrowing or hilling for irrigation provides suitable ridges for planting on the following year. To aid in furrow irrigation, especially on flat soils with higher infiltration rates, some producers chop stalks or perform a high speed tillage operation to remove residue from the ridges.

In a ridge plant system, row cleaning devices on the planter push a small amount of soil as well as residue and weed seeds lying on the soil surface off the top of the ridge. Ridge cleaning components include sweeps, disk furrowers and horizontal disks. Except for possible nutrient injection, no soil disturbance occurs prior to ridge planting.

In contrast, ridge till systems have some tillage prior to planting. The tillage is generally shallow, disturbing only the ridge tops but not completely destroying them. This tillage can be used to flatten or smooth peak-shaped ridges to aid in keeping the planter on the old row. Depending on the tillage implement used, some control of emerged weeds and/or incorporation of herbicide in the row area is possible. However, the tillage also incorporates some of the weed seed, rather than removing it from the row.

The most common ridge till system uses a rotary tiller with planting units mounted behind it. To maintain the old row and avoid excessive power requirements, the rotary tiller should be operated only in the top 2 or 3 inches of the ridge. Rotor tines should be limited to, or at least concentrated in, the row area to provide a strip till configuration. Some additional tines can be included between the rows if it is necessary to break up residue or to kill growing weeds.

Other types of ridge till systems include use of mulch treaders, rolling stalk choppers or flexible harrows. Regardless of the tillage implement used, the operating depth should be shallow and chemical incorporation should not be a tillage goal. With shallow tillage, the old row should remain visible.

No-till

Tillage is essentially eliminated with a no-till system. The crop seed is placed in a narrow strip opened with a coulter or disk seed furrow opener. Most currently available planters can be used in no-till systems with little or no modification. Common options or attachments include coulters, stronger down-pressure springs and weight for penetration. (See NebGuide *G83-684, Row Crop Planters: Equipment, Adjustments and Performance in Conservation Tillage*, for more information.) Tilling only a narrow slot in the residue-covered soil achieves excellent erosion control.

Shredding standing crop residue prior to planting is not recommended in no-till systems. Performance of planters, drills and cultivators is improved when the residue is standing and attached to the soil, rather than when unattached and lying flat.

Although weed control is essential to all systems, the lack of tillage for incorporation with no-till requires preemergence, surface applied or postemergence herbicides. One or two properly timed applications may be necessary.

For later planted crops, such as grain sorghum and soybeans, an early preplant herbicide application at a one-half or two-thirds rate, near the first week of April when the probability of rainfall for herbicide incorporation and activation is high, has proven successful. This eliminates the need for a burndown herbicide.

For full season weed control a second, lighter preemergence herbicide application at planting time, a postemergence treatment, or crop cultivation may be needed.

No-till planting is well suited to many Nebraska soils. Residue, when uniformly spread, increases water infiltration and reduces soil moisture evaporation.

In some poorly drained soils covered with large amounts of residue, the use of no-till may delay soil warming and drying in the early spring, which delays germination and emergence. This condition is rare in Nebraska for normal planting dates. When colder and wetter soils are of concern with early planting dates, the use of no-till planter attachments designed to move only residue and not soil away from the row have proven successful. Another option would be the adoption of a ridge system to aid in warming and drying of the row area.

Tillage System Comparisons

Typical advantages and disadvantages of the tillage and planting systems are shown in *Table I*. General fuel and labor requirements are listed in *Tables II* and *III*. This information is useful in evaluating a tillage system or combination of systems for various farming situations.

The most important advantage of conservation tillage systems is significantly less soil erosion due to wind and water. Other advantages include reduced fuel and labor requirements. However, increased reliance may be placed on herbicides with some conservation tillage systems.

Of the systems compared in *Table II*, the moldboard plow system has the greatest fuel and labor requirements for tillage and planting. Compared to the commonly used disk system, no-till requires less than one-half the fuel and two-thirds the labor.

The labor savings allow a larger area to be farmed without additional help. Even if increased acreage is not anticipated, more timely planting may result in greater yields. In addition, costs for tractors and tillage equipment is less with fewer tillage operations.

Several studies have compared yields from different tillage systems. In eastern Nebraska, as a general rule, yields from all tillage systems are about the same during the first few years. Continued use of a no-till or ridge system has resulted in greater yields because of improved soil structure, organic matter accumulation and decreased weed pressures.

With limited soil moisture, all conservation tillage systems out-yield systems which have intensive tillage. This occurs because tillage results in moisture losses, and conservation tillage both reduces the amount of tillage and leaves residue on the soil surface, further reducing evaporation and runoff.

Recent advancements in herbicides make weed control with no-till easier than with many conventional tillage systems. Longer-lasting as well as early pre-plant herbicide applications are helping assure success with no-till.

Regardless of the tillage system selected, residue should be uniformly spread behind the combine using either a straw chopper or straw spreader. With larger combines the addition of a chaff spreader may be desirable, especially when harvesting wheat or soybeans. Uniform distribution of residue and chaff reduces equipment clogging, and provides more uniform soil conditions for planting, easier weed control and better erosion control.

Summary

Conservation tillage systems represent alternatives at a time when economics require flexibility in crop production. The growing concern about agricultural sustainability and environmental concerns requires that soil erosion be reduced. Conservation tillage systems, which leave protective residue covers on the soil surface, have proven to be one of the most effective and least costly methods of reducing soil erosion and the resulting sedimentation, a major water pollutant.

It is necessary to reconsider and carefully evaluate the need for each and every tillage operation, pesticide application and the suitability of alternatives. Systems with more than two tillage operations prior to planting need careful examination. Often additional operations are unnecessary and only increase potential soil losses.

Table I. Advantages, disadvantages, and typical field operations for selected tillage and planting 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 to most soil and management conditions. Suitable 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 chisel; one or two spring diskings or field cultivations; 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.	Larger number of operations cause excessive soil erosion and moisture loss. In heavy residues, stalk shredding may be necessary to avoid clogging of chisel.
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.	Larger number of operations cause excessive soil erosion and moisture loss. Soil compaction associated with disking wet soils.
Ridge Plant	Chop stalks (on furrow irrigation); plant on ridges; cultivate to rebuild ridges.	Excellent erosion control if on contour. Well adapted to poorly drained soils. Excellent for furrow irrigation. Ridges warm up and dry out quickly. Low fuel and labor costs.	No incorporation. Creating and maintaining ridges. Narrow row soybeans and small grains not well suited.
No-Till	Spray; plant into undisturbed surface; postemergence spraying or cultivation as necessary.	Maximum erosion control. Soil moisture conservation. Minimum fuel and labor costs.	No incorporation. Increased dependence on herbicides. Not well suited for poorly drained soils.

Table II. Typical diesel fuel requirements from a Nebraska on-farm survey for various tillage and planting systems.					
Operation	**Fuel Use (gallons/acre)**				
	Moldboard Plow	**Chisel Plow**	**Disk**	**Ridge Plant**	**No-Till**
Chop Stalks				0.55	
Moldboard Plow	2.25				
Chisel Plow		1.05			
Fertilize, Knife	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	0.68	0.60
Cultivate	0.43	0.43	0.43	0.86(2)	
Spray					0.23(2)
TOTAL	5.28	3.34	3.03	2.69	1.43

Table III. Typical labor requirements for various tillage and planting systems.					
Operation	**Labor (hours/acre)***				
	Moldboard Plow	**Chisel Plow**	**Disk**	**Ridge Plant**	**No-Till**
Chop Stalks				0.17	
Moldboard Plow	0.38				
Chisel Plow		0.21			
Fertilize, Knife	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	0.25	0.25
Cultivate	0.18	0.18	0.18	0.36(2)	
Spray					0.11(2)
TOTAL	1.22	0.89	0.84	0.91	0.49
*Hours per acre assume 100 hp tractor and matching equipment for average soil conditions.					

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