EROSION CONTROL EQUIPMENT

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Summary

The best equipment for erosion control is machinery designed to leave most of the soil surface covered with crop residue. For reducing water erosion on sloping land, a farming system that leaves residue uniformly spread after harvest and lying flat to cover from 30 to 90% of the soil until, and after, planting gives the best control. For reducing wind erosion, a system that leaves crop residue standing in the field is the best way to minimize wind speed at the soil surface and therefore to reduce soil-particle movement.

No-till and ridge-till systems usually give the ultimate protection from erosion. No-till planters and drills with disk seed-furrow openers leave most of the residue on the soil surface. Narrow-spike hoe openers, often used in dry climates for deeper seed placement, cover more residue but still allow for continuous protection from wind erosion.

Ridge-till and fall strip-till leave bare strips after planting, but the residue concentrated between rows protects the soil from water erosion. Mulch-till is a full-width tillage system that gives adequate protection in high-residue crops when properly managed.

Controlled traffic has proved its value in ridge-till. It can provide just as many advantages in no-till. Controlled traffic can reduce input costs by eliminating overlaps and skips in planting and chemical application. Soil compaction is confined to permanent traffic lanes so controlled traffic helps improve timeliness and maximize crop yields. Controlled traffic and conservation farming are a perfect match.
Selection of the tillage system is the most important decision in residue management for erosion control. The right choice for the specific soil type, climate, and crop rotation can help maximize profits while protecting the soil from erosion.

1. Introduction

Erosion control is the primary aim of most conservation tillage systems. The goal is reached mainly by preserving residue from the previous crop. In the past, a residue cover of 30% was considered adequate for erosion control and became the goal. Experience and research have shown, however, that truly effective erosion control depends on the specific situation. Steeper slopes will likely require 40–50% cover for adequate control. Fields that are nearly level or have shorter slopes may be protected with less than 30% residue cover.

While the agricultural community appreciates soil conservation for maintaining the long-term productivity of the land, our urban neighbors are more likely to focus on the benefits of clear streams, pure drinking water, and abundant wildlife habitat. The common goal is to keep the soil on farms where it belongs by reducing erosion.

Many farmers also focus on other benefits including water conservation in drier climates, improved soil tilth, lower input costs, and labor efficiency. By focusing on the benefits, farmers have refined their practices to include some tillage. Different crop rotations, sometimes including forage and livestock production, may require tillage for good yields. Yet good managers can meet the goals of erosion control, even with a system that might include moldboard plowing every 5–10 y.

Several factors influence soil erosion including prior land use, crop canopy, and surface roughness. But the single most important factor is crop residue.

Crop-residue management is the primary tool for managing erosion. Crop-residue management refers to a philosophy of yearround management of residue to maintain the level of cover needed for a given field. (You will note that we use the term “residue” to describe the straw, stalks, and chaff left after harvest, and only when residue plugs a machine do we call it “trash.”) A series of decisions, not a single action, determines the ultimate level of residue cover.

The tillage system of choice is the single largest factor in effective residue management. Generally each additional field operation incorporates more residue into the soil and increases erosion potential. No-till systems reduce erosion by as much as 95% of that which occurs in a cleanly tilled field.

While not the only option, conservation tillage is an easy way to help protect erodible land with the least interruption of profitable cropping practices. On steeper slopes, conservation tillage can be combined with other erosion-management strategies and structural changes such as terraces, contours, strip cropping, grass waterways, vegetative filter strips along streams, cover crops, and crop rotation to provide adequate erosion control. Residue decreases maintenance requirements of established terrace channels and waterways by reducing soil deposits.
Regardless of the conservation tillage system selected, management of crop residue at harvest is a key to best control of erosion from wind and water. If wind erosion is the major concern, cut the crop as high as practical because standing stubble is more effective than residue flat on the ground. Spread residue uniformly behind the combine using a straw chopper or straw spreader. A chaff spreader is usually needed when harvesting small grains 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.

This article is organized primarily by tillage system. No-till systems include drills, row-crop planters, and air seeders. Fall strip tillage is described separately although it is often considered a modification of a no-till system. Ridge tillage is not widely used but has many advantages. High-residue cultivators are described separately because they are not only an inherent part of a ridge-till system, but also suitable for a no-till system. Chisel plows are included as part of a mulch-till system although it is difficult to keep adequate residue cover. The article closes with a section on wind erosion, including how a farmer can use emergency tillage operations to help reduce it.

2. No-Till Systems

Tillage is essentially eliminated with a no-till system. Crop seed is placed in a narrow strip opened with a coulter or disk seed-furrow opener. With little or no modification, most planters can be used in no-till systems. Common attachments include coulters, stronger down-pressure springs, and extra weight for better penetration. By disturbing only a narrow slot in the residue-covered soil, excellent erosion control is achieved. Compared to other tillage systems, no-till also minimizes fuel and labor requirements.

Do not shred standing residue prior to planting. Most planters, drills, air-seeders, and cultivators perform better when residue is standing and attached to the soil, rather than unattached and lying flat.

No-till requires surface application of pre-emergence or post-emergence herbicides for weed control. Full-season weed control may require a second post-emergence treatment or crop cultivation.

No-till planting is well suited to many soils. Uniformly spread residue increases water infiltration and reduces evaporation.

Using a no-till system in poorly drained soils covered with large amounts of residue delays soil warming and drying in the early spring, which delays germination and emergence. When colder, wetter soils are a concern with early planting dates, use no-till planter attachments designed to move residue (but not soil) away from the row. (Fall strip tillage facilitates warming and drying of the row area and may be a better choice.)

2.1. No-Till Drills

Excellent erosion control is achieved when no-till drilling in rows of 250 mm or narrower for small grains, soybeans, and similar crops. The crop forms a full canopy and shades the soil earlier, which reduces weed pressure and absorbs raindrop impact. Residue from the previous crop helps protect the soil until the current crop is established.

No-till drills must be able to cut and handle residue, penetrate the soil, and establish good seed-to-soil contact. Soil may be moist and soft or dry and hard.

2.1.1. Coulters and Seed-Furrow Openers

There are two basic types of no-till drills: a conventional drill to which a gang of coulters has been added (converted drill); and a drill designed specifically for a no-till system. For many situations, either type provides satisfactory performance. In fields with heavy residue a drill designed specifically for a no-till system will probably do better.

Often a drill is “converted” by using a towed carrier cart equipped with coulters (usually called a “coulter cart”). The cart has a three-point linkage to carry the conventional drill. A coulter is positioned in front of each seed-furrow opener to cut the residue and loosen the soil. Weight may need to be added to the cart to give adequate coulter penetration. Because the coulters are usually mounted several feet in front of the drill, the carrier may need wide fluted coulters, pivoting coulters, a pivoting hitch, or a steering mechanism to keep the furrow openers tracking in the coulter slots.

Fluted coulters about 50 mm wide perform the most tillage and open a wide slot through the residue. Wide fluted coulters allow early soil warming and create a wide slot for the seed-furrow openers to follow properly. However, fluted coulters require more weight, disturb most of the soil surface, bury much of the residue, and increase erosion potential. In wet soils, fluted coulters may loosen too much soil and prohibit good seed-to-soil contact. In addition, if loosened soil is wet, it sticks to the seed-furrow openers and press wheels, causing nonuniform depth control and clogging.

Narrow fluted coulters, 25–40 mm wide, do not require as much weight for penetration and do not throw as much soil out of the seed furrow as wide fluted coulters.

Compared to fluted coulters, narrow bubble coulters and ripple coulters perform less tillage, require less weight for penetration, and disturb the residue less. Ripple coulters with a smooth edge or smooth coulters are preferred for residue cutting because they can be sharpened to maintain a good cutting edge. Operate all coulters close to seeding depth to avoid excessive soil throwing at high operating speeds and to avoid forming air pockets below seeding depth.

A no-till drill is a single unit with built-in weight and heavy down-pressure springs to help ensure penetration of the seed-furrow openers into the untilled soil. A typical drill has a large diameter disk opener to improve residue handling ability. When used, the coulters on no-till drills are usually narrow, minimizing soil disturbance and requiring less weight for penetration.

2.1.2. No-till Drills without Coulters

No-till drills that are not equipped with coulters use the seed-furrow openers to cut the residue. Several drills have a staggered double-disk seed-furrow opener. The leading disk, usually about 25 mm in front of the other, cuts the residue, and the second disk aids in opening the seed furrow. Other manufacturers use a single disk set on a slight angle. This drill design provides minimal soil disturbance and requires less weight.

2.1.3. Furrow Spacing, Weight, and Down Pressure

Staggered openers and operational flexibility are other features of a good no-till drill. Adjacent seed-furrow openers are staggered up to 1.2 m on some drills to allow residue to flow through more easily. Wider row spacings, 250–300 mm rather than 175–200 mm provide more clearance for residue flow. Drills with wider spacings require less total weight because there are fewer openers to penetrate the soil across the width of the drill.

Individual openers should have sufficient down pressure and independent depth control with enough movement up and down to keep all rows operating at the same depth. Individual openers on most drills can move 150 mm or more with independent down pressure. Openers operating in wheel tracks can be set with more down pressure to ensure penetration. Some drills have the operational flexibility to no-till in ridged fields, planting on ridge tops as well as in the residue-covered furrows.

Depending on coulter width, opener design and field conditions, up to 1400 kg per row may be necessary for adequate penetration. Down-pressure springs on individual rows must transfer enough weight from the drill frame to the openers and all depth-control devices and seed press wheels must be in firm contact with the soil. Then the seeding depth is actually gauged by the wheels and not determined by soil resistance against the openers. The seed is firmed into the soil to establish good seed-to-soil contact. Drills without coulters have an advantage because they have fewer soil-engaging components and thus require less weight for proper penetration and operation.

Drills have up to about four times the number of rows per unit width compared to a row-crop planter. Therefore, the total weight of a no-till drill needs to be approximately four times the weight of a planter of the same width. When considering the number of openers on a drill, drill weight may not be sufficient for the down-pressure springs to transfer enough weight to ensure penetration. Or, as the springs are tightened, the springs may physically lift the drive mechanism off the ground. In such conditions, add weight as needed for proper penetration and to keep the seed-metering drive in firm contact with the soil.

2.1.4. Depth Control

Drill operation depends on field conditions, drill features, and personal preferences. Seeding depth with a converted drill is controlled either with the operating depth of the coulters or with the press wheels.

To gauge seeding depth with the operating depth of the coulters, till a slot with the coulters and plant to the bottom of the loosened zone. Seed-to-soil contact is obtained with a narrow press wheel (about 25 mm wide) running directly over the seed, pressing the seed firmly into the soil. Using this method, extra weight or heavy down-pressure springs are not needed for the seed-furrow openers, but extra weight may be needed on the coulter carrier. A harrow is often added behind a drill with narrow press wheels to ensure adequate soil coverage over the seed and to redistribute the residue for good erosion control.

Other converted drills and most no-till drills use coulters to cut residue and use seed-furrow openers to perform the tillage necessary for seed-to-soil contact. Depth control comes from a gauge wheel mounted adjacent to the seed-furrow opener or from a wider press wheel behind the seed-furrow opener. The weight and down-pressure springs must be sufficient to force the opener into the soil to the proper depth and keep adequate pressure on the press wheel. The press wheel must be wide enough to ride on the firm soil adjacent to the seed furrow in order to gauge seeding depth, yet narrow enough to cave-in the sides of the seed furrow (or with ribs) for good seed-to-soil contact.

2.1.5. Press Wheels

Press wheels are necessary to firm soil around the seed. Press wheels must be selected based on the seeder design and soil conditions. No one press-wheel design will be ideal for all situations. The main factors affecting seed-to-soil contact with press wheels is the surface area contacting the soil and the force applied. Adequate down pressure is essential for uniform and consistent germination. Surface-area contact depends on press-wheel size and shape.

Narrow V-shaped or small-diameter press wheels can be used to concentrate pressure, and may be beneficial with lightly loaded units.

Wide, flat press wheels are unacceptable for narrow furrow openers because they ride on the firm soil adjacent to the seed furrow and do not firm the seed into the soil. A wide press wheel requires ribs that run on the sides of the seed furrow or a rib that runs directly in the furrow to press on the seed with adequate pressure for good seed-to-soil contact.

Narrow press wheels with significant down pressure in soft soil conditions may sink in causing deep seed furrows. If rain occurs before the crop emerges, the ridged soil between the seed rows will wash down into the seed rows placing the seed too deep resulting in poor seedling emergence. Wider press wheels work better. But wide press wheels may smooth almost the entire soil surface. A smooth soil surface may start eroding in strong winds.

Wheel shape and composition determine how clean a press wheel operates in varying soil conditions. A lightly loaded, flat surface wheel picks up and carries mud and straw in wet conditions. Steel wheels collect wet soil, but scrapers can reduce this problem.

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Bibliography

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Biographical Sketch

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Randall is also a member of the National Speakers Association. He gives speeches as “Will Rogers,” impersonating the popular American humorist of the early twentieth century, for business and agricultural audiences.