

No-Till Equipment

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Once the decision has been made to start no-till, planting the crop seems to be a major concern. Obtaining good stands in no-till conditions requires planters and drills that can penetrate firm soil and cut or move heavy surface residues without plugging. Planting seed at a uniform depth and in firm contact with moist soil assures a good stand (Figure 1). There are many planters and drills on the market that can accomplish this task. There are also some older seeders available that perform quite well with the proper adjustments and/or attachments.



Figure 1. No-till corn in wheat residue.

No-Till Drills

No-till seeding of corn and other drilled crops differs from conventional till in many ways. More residue must be cut or moved out of the path of the opener. This is a challenge for the narrow 6- to 12-inch row spacing used for grain drills, and some of the solutions used for row crop planters are simply too expensive or the attachments are too large to be used on drills. On the positive side, soil moisture is

Seeding Equipment

No-till seeding of crops differs from conventional tillage with respect to the equipment needed. Considerations include:

- Row spacing
- Types of openers
- Press wheels
- Depth control
- Residue management
- Topography of fields

usually closer to the surface in no-till than in conventional till. This means that seeding depths can often be shallower with no-till, provided the seeding depth is still sufficient for adequate early season plant growth. Also, heavy residue slows the rate of soil drying and reduces the tendency of the soil to crust before the plant emerges.



Figure 2. A no-till drill ready to seed into wheat stubble.



Figure 3. No-till drilling soybeans into milo stubble.

Component/Design Features

When looking at no-till drills there are some items that are worth comparing. Row spacing, types of openers, linkage, press wheels, and depth control are just a few of these. Consider all crops that will be seeded with the drill and choose the best options for your environment (Figure 3).

Row Spacing

The standard row spacing for most drills is 7.5 inches. For wheat, this row spacing tends to be much wider than the theoretically ideal square plant zone (equal distance in all directions to nearest plant). A bushel of wheat typically contains between 800,000 and 1,000,000 seeds, so achieving the square plant zone would require approximately 2-inch row spacing at a 1.5 bushels per acre rate. The concept of ultra-narrow row openers has been investigated in Oklahoma. A research study compared 3-, 6-, and 9-inch row spacings for two years at several locations. The study predicted a yield increase of about eight percent and nine percent for 6-inch and 3-inch rows compared with 9-inch rows. The yield response to the narrower rows occurred in both cheat-free and cheat-infested fields. The study concluded that the optimum row spacing for seeding rates commonly used in Oklahoma was about 6.6 inches. Thus, 6-inch and 7.5-inch row widths appear to be appropriate for wheat in Oklahoma.

For producers whose primary use of a no-till drill is soybeans and grain sorghum, a 10-inch spacing may be the most economical compromise, if wheat acreage is low. Grain sorghum growers who use seeding rates in the range of 30,000 to 60,000 seeds per acre can block half of the openers in the raised position to achieve satisfactory (12- to 20-inch) row spacing while eliminating unnecessary opener wear. The same technique can also be used for soybeans.

Naturally there is added cost of narrow row spacing on drills. A drill with 7.5-inch spacing has a third more openers than a drill with 10-inch spacing. However, the narrower row spacing may provide better weed control by allowing the crop to canopy sooner.

Types of Drills

The type of seed slot openers typically categorizes drills. There are three primary types of openers used in Oklahoma. They are the single-disk, double-disk, and hoe.

Single Disk Openers

For conventional tillage, single-disk openers were the standard grain drill in Oklahoma for more than 50 years. These openers usually consisted of a single concave 13-inch disk suspended by a simple swing arm. Depth control was acceptable in conventional tillage seedbeds without using an attached press wheel for depth control. Although these single disk drills are still available, the market for conventional till to reduced till drills has been largely captured by double disk openers during the last two decades.

No-till single-disk openers are available from several manufacturers (Figure 4). Designed for no-till, these openers are equipped with large (16- to 22-inch), heavy, flat disks with a heavy duty disk hub and bearing. These openers use a swing arm suspension, with depth controlled by a gauge wheel

Figure 4. A single disk opener on a Flexi-Coil air seeder. Note the tilted opener disk.





Figure 5. A single-disk opener operating in wheat stubble.

beside the opener. A narrow press wheel is typically operated directly in the seed furrow to create seed-to-soil contact and a furrow closing wheel typically follows (Figure 5). Although the single disk is subject to hairpinning when planting in tough residue, these openers can place seed at the desired depth with minimal disturbance of crop residues. They may be equipped with hydraulic down force adjustment (sometimes called “active” down force). The hydraulic down force system keeps a nearly constant force on the opener to maintain more consistent depth control over rolling terrain.

Double Disk Openers

Double disk openers usually have a press wheel attached directly behind the opener for depth control, seed-to-soil contact, and furrow closing. Double disk openers move less soil laterally than the concave single disk drill, allowing them to operate at higher speeds than the concave single disk. However, they have more lateral soil movement than the newer single disk no-till drills.

Double disk openers may be suspended by a swing arm, parallel arms, or a strut and swing arm combination (Figures 6, 7, and 8). Down force may be applied by springs, hydraulics, or a combination of the two. Most double disk openers that are intended for no-till have the disks offset slightly (0.5 to 1.5 inches), so only the leading disk edge cuts residue. In some cases, the trailing disk is a smaller diameter than the leading disk. The leading disk may also be notched, which should help cut residue better (Figure 9).

Coulter/double-disk combinations are a popular style of no-till drill, sometimes known as the “fluff-and-plant” system (Figure 10). These machines use coulters (usually rippled or wavy) aligned to run directly in the path of the double-disk openers. The coulters cut the residue and till the soil in front of the opener. Depth of the coulters

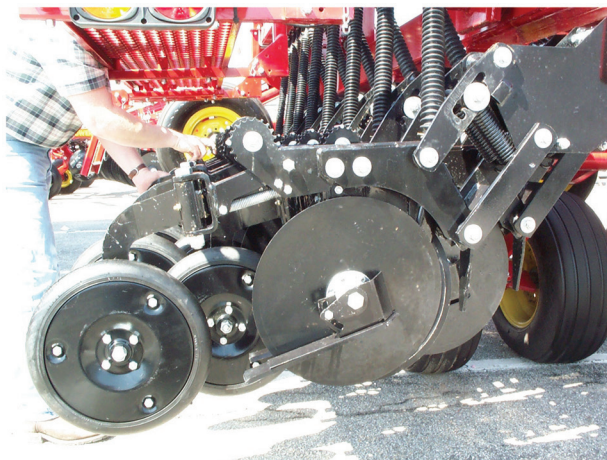


Figure 6. A Sunflower no-till drill with parallel linkage system.



Figure 7. A Great Plains no-till drill with parallel linkage system.

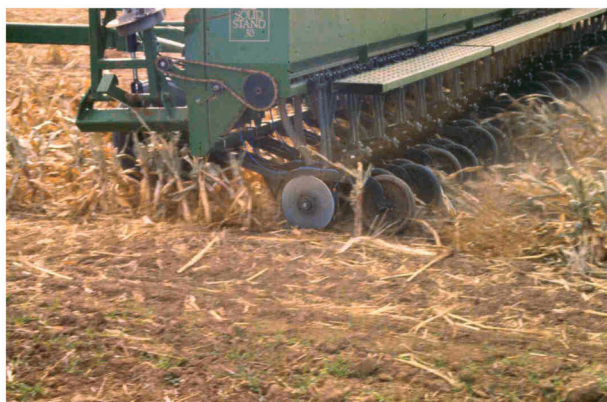


Figure 8. A Great Plains no-till drill with a swing arm linkage system.

and speed of operation have a major impact on the function of this concept. The addition of the coulters will cause more soil and residue disturbance than single disk and double disk no-till drills operating without coulters.



Figure 9. A double disk opener on a no-till drill with staggered disks and a notched leading blade.



Figure 10. Tillage action of coulters on a no-till drill.



Figure 11. A Great Plains no-till drill operating in milo stubble.

Hoe Openers

Hoe openers generally require much less down force to penetrate firm soil, and they usually move more soil laterally than disk openers. A hoe tends to lift the residue and allow it to fall to the side, whereas disk openers tend to push residue into the soil as they cut it. These features have made hoe drills more popular in western Oklahoma than in the east (Figure 12). The challenge of planting in dry conditions is to place the seed into moist soil without covering it too deeply. The hoe opener, operated on



Figure 12. A Haybuster no-till hoe drill. Note the under frame clearance for residue flow.

relatively wide spacing (10 to 14 inches), can move a layer of dry soil into a ridge between the rows. This can allow the seed to be placed 4 inches below the original soil surface, while covering the seed with about 2.5 inches of soil.

Hoe openers are usually used with gangs of “full press” wheels, which can carry much of the drill or air seeder frame weight. Full press wheels can apply heavy down force, forming well-defined furrows and ridges on the soil surface.

Though the hoe opener may require less down force for soil penetration, it will pull harder than most disk type no-till drills. Also the greater lateral soil movement created by hoe openers tends to limit the maximum speed of operation. At high speeds, the second (and third) ranks of openers tend to cover the front rank with additional soil. This may produce a noticeable stand reduction produced by the front rank. Attachments have been marketed to limit lateral soil movement from the rear rank.

On hoe drills, the openers are usually attached to the frame via a swing arm. There are a few examples of hoe openers having depth control/press wheels. With hoe-type air seeders, the opener is often rigidly attached to the seeder frame (the opener may be equipped with a spring linkage for shank protection). Such seeders rely on good frame flexibility to allow the machine to comply with lateral terrain features. Floating hitches, used with support wheels in front of the main frame, allow the frame to follow the ground independently from the tractor. Hoe openers may be selected to apply seed in narrow or wider bands and dual place fertilizer.

Older-model hoe drills do not function well in heavy residue. There are typically three dimensions that dictate how well a hoe drill will operate in residue: clearance, rank spacing, and spacing between openers on a rank. Increasing any of these dimensions improves the operation characteristics of hoe drills in no-till systems. Current hoe drills have much greater clearance than previous generation hoe drills. Three-rank hoe drills are available with

26-inch vertical clearance and 20-inch longitudinal spacing between ranks. Coulters are available on some models for operation in very heavy residue.

Depth Control

Depth control is a concern with any seeding system. A survey of conventional grain drills conducted in 1994 by Oklahoma State University researchers indicated a strong tendency for farmers to plant wheat much deeper than they intended. Only about 20 percent of producers were at or near the intended depth, and 68 percent of the fields were planted too deep. Excessive depth delayed emergence and reduced stands. In more than half of the fields examined, emergence was less than 60 percent. Kansas State University research in no-till wheat indicated that each half-inch of excess depth reduced the stand by six to 22 percent, depending on location.

“Start with the right equipment, talk to experienced no-tillers, check your planter settings, and constantly adapt, adapt, adapt!”

**Larry Davis
Miami, OK**

It is critical that depth be checked, especially when changing fields or planting conditions. This can be time consuming, especially in grain sorghum, where the seeds are small and more widely spaced than wheat. The objective is to place the seed in contact with moist soil, with an acceptably shallow covering depth. Because soil moisture varies with both location in a field and the time of planting, depth is usually a compromise between the need to place the seed into moisture and the need to plant shallow for quick and uniform emergence.

With most disk-type openers, the two primary adjustments affecting depth are a) the down-force applied to the opener, and b) the relative position of the disk and the depth-control wheel. Understanding how these two adjustments affect depth control is important. The down-force applied to the opener is balanced by the up-force of the soil on the disk itself and on the depth control wheel. In some cases, a seed firming wheel or runner also applies force to the soil.

As the opener moves through the field, the force on the disk changes in response to soil hardness and residue conditions. Any down-force not used to make the disk penetrate to the desired depth is fed

into the depth control wheel. No-till seedbeds usually require more down-force for disk penetration. If an opener is planting too shallow, check to see if the depth control wheel (in some cases the press wheel) is carrying a load. If the depth control wheel is not supporting down-force, depth will not be increased by raising the wheel. The solution is more down-force. Conversely, when moving a drill from firm soil to looser conditions, down-force should be reduced to prolong the life of the opener suspension, the depth control tire, and the bearing. In general, use just enough down-force to consistently force the disk to the desired depth, with enough left over to let the press wheel do its job. Depending on the drill, down-force may be adjusted by changing spring preload, hydraulic pressure, or even the operating height of the drill frame. Check the operator’s manual for specific instructions on depth and down-force adjustment. Also, many disk openers have more than one style of down-force springs available. Heavier springs are used for reduced or no-till seedbeds.

Residue Management

There are two basic options with residue management. One option is to cut through the standing residue and leave as much as possible still standing. Another option is to use coulters to mulch the residue ahead of the openers. If the residue is left standing, the risk of hair-pinning into the seed trench is possible.

Naturally, residue disturbance is a function of opener spacing, but the following generalities can be made regarding opener design. Residue disturbance is least with single disk openers. Double disk openers disturb more residue than single disk openers, but still leave a substantial amount of residue attached and standing (Figure 13). Drills with coul-



Figure 13. The area on the left was seeded with a single disk opener drill and the area on the right was planted with a double disk drill equipped with coulters.



Figure 14A. A single disk Flexi-Coil air seeder.



Figure 14B. A single disk Flexi-Coil air seeder.

ters will leave very little residue attached and standing, but the surface generally has ample residue to protect the soil from erosion.

Air Seeders

Air Seeders are now available with both disk and hoe openers, plus sweep and paired-row openers (Figures 14A and 14B). Using air to convey the seed (and fertilizer) from a central tank offers at least three basic advantages over conventional grain drills. First, the central hopper of an air seeder eases filling. Secondly, wings can be folded vertically for road transport like a tillage tool. These two advantages become more important as the width of the seeder increases. The third major advantage is the ability of the air seeder to transport seed horizontally under the soil. This allows one opener, such as a small sweep, to seed multiple rows of seed. It also facilitates the concept of the paired row.

A wide variety of openers are available for air seeders. Knife-type openers cut a narrow slot for seed placement with minimal soil disturbance, while sweep-type openers accomplish some mechanical



Figure 15. No-till planting of corn in milo stubble.



Figure 16. No-till planting of soybeans in milo stubble.

weed control at seeding time. Double-shoot openers use separate tubes for seed and fertilizer, allowing a heavy rate of nitrogen to be placed a safe distance from the seed. Openers are available to dual place dry, liquid, and even anhydrous ammonia fertilizer with the seed. Some air seeder openers split the seed stream into two rows, 3 to 7 inches apart, and place the fertilizer between the seed rows. The paired row concept is intended to give the crop preferential access to the fertilizer.

Topographical Conditions

Tillage tends to even out or “level” a field. Conversely, for reduced and no-till farming, unevenness is often more extreme and may increase with time. Erosion may be a major cause, especially for steep slopes, but terraces and contour farming are also causes of topography variations. With larger machinery and farming more marginal land, there is a greater requirement for machine flexibility. Most new planters have flex linkages that allows each row to move up and down independently of each other. This feature allows the planters to accommo-

date the soil unevenness. Flexing of the frame will be required for wide planters or uneven topography.

Planting on the contour often requires sharp turns. The distance from front to back (coulters to opener and press wheels) determines how well the planter will follow the row. The shorter front-to-back distance, the better the planter will stay on the row. Pull-type planters will follow curves better than mounted planters, but keeping spacing on steep side slopes may be a greater challenge.

No-Till Row Crop Planters

Row crop planters can be used to obtain good stands in no-till conditions even if the planter was not originally equipped for no-till. Most late model planters are heavy enough to be set up for no-till. They may require additional, or heavier, down-force springs to help penetrate firmer seedbeds. Coulters to slice through heavy residues or row cleaners that move residue from the seed slot may also be needed. Selecting the correct optional equipment and a good knowledge of planter adjustment are important for best planting in heavy residue and firm soil. If the planter is adjusted properly, it can operate in most no-till conditions without coulters or row cleaners.

Adjustments

For optimum planter performance, the frame should be leveled. Leveling the planter allows the row unit to stay parallel to the soil surface throughout its full range of motion. When a planter is level, the row unit will operate parallel to the ground. If the planter is not level, it will be more difficult to 'fine tune' the adjustment for operating in crop stubble. Making adjustments at the drawbar typically levels pull-type planters. Leveling of mounted planters is accomplished by adjusting the third link, while adjusting the carrying wheels levels semi-mounted planters.

Seed Metering

A well-controlled and evenly distributed plant population is essential for high yields. The metering mechanism should drop the same number of seeds per unit length regardless of variation in seed size and shape, travel speed, and slopes. Planter plates with individual openings for each seed are much more precise in spacing than feed cups used on drills. The spacing should be the same in all rows. Changing seeding rate (number of seeds per acre) should be simple. Plateless seed mechanisms are helpful in achieving uniform spacing with unsized seeds, especially for corn. A survey of planters in Nebraska showed a decrease in spacing uniformity when coulters-driven planters were used in tilled

fields and when press wheel-driven units were used with less tillage.

Seed Depth Uniformity

A planter should place seed at a uniform depth regardless of soil or residue conditions. Tillage tends to mask soil variations, which help improve uniform seed placement on old style planters. In no-till and reduced-till planting systems, the variations in soil conditions will usually be greater than with conventional tillage. Variations in soil texture are common, especially in alluvial soils, where they may range from clay to sandy soil in the same field. Surface residue retards soil drying so uniform residue conditions are especially important for no-till planting. Obtaining uniform residue spreading with wide combine platforms is especially challenging, but large spreaders and some straw choppers generally improve residue uniformity.

"You must be willing to commit to no-till and buy a drill made for no-tilling. You can add attachments and make a normal planter work in normal conditions."

Greg Leonard
Afton, OK

Variations in soil conditions make design of a planter that will perform equally well under all conditions difficult. New planters with depth gauge wheels at the side of each opener can drop seed at a uniform depth under a wide range of soil texture and moisture conditions. This feature, plus heavier weight and heavy-duty coulters enable accurate seed placement in difficult soil and residue conditions.

Press wheel or coulter controlled depths are generally more variable than gauge wheels beside the opener. Press wheels are adjacent to the opener rather than leading or following the opener as with press wheels or coulters.

Openers

The primary items of interest on row crop planters are the slot openers and presswheels. The opener forms a slot or groove in the soil for seed placement and one or more press wheels compact soil around the seed. Openers on row crop planters are typically double disks or runners. Because runner openers re-

quire looser soil for adequate penetration, the fluted coulter may be required. Double disk openers will usually penetrate following a coulter that has cut residue and penetrated firm soil.

Openers shape a groove for the seed and provide a bed for seed-to-soil contact. The runner opener shapes a sharp 'V' groove, which centers the seed. The double disk alone provides a less accurate flat or slightly raised center seed slot. Some double disks also have a small chisel or runner in the center to shape a rounded or 'V' groove. The shape of the seed opening is probably not as important as depth control, which provides seed placement in firm contact with moist soil.

Double disks and runners may press residues and dry soil into the seed opening which can delay germination and emergence. In a reduced tillage condition, buried residue and large soil clods can be serious detriments to obtaining good seed-to-soil contact for all planters.

Attachments

Though adjustments are probably the most critical item affecting row crop planter performance, there are several attachments that can help improve performance. These attachments help planters operate in heavy crop residue and improve seed-to-soil contact.

Coulters

Coulters are used to cut residue and penetrate firm soil planting conditions (Figure 17). The amount, condition, and distribution of previous crop residue as well as soil conditions affect proper operation of the coulter. Fresh, damp, wheat straw is tough and difficult to cut. Dry, decayed straw can be cut easily with sharp coulters.

Sod crops, such as grass or alfalfa, or stubble grazed by livestock on wet soil may result in very firm soil, especially when dry. Coulters in front of the planting units are essential to cut through sod and firm soil. In other conditions, such as moist soil



Figure 17. A bubble coulter on an older John Deere planter.

and little residue or following soybeans, the same soil may be quite soft and easily penetrated. Some coulter units are adjustable for down pressure and some have provisions for adding weight to increase penetration and cutting capability. When the soil is firm and dry, these features may be essential to ensure penetration.

Many types of coulters are available to cut residue and penetrate the soil. Each have advantages and disadvantages, so choosing one can be confusing. Large diameter coulters will mount residue but require more weight (or down pressure) to cut residue and penetrate soil.

Smooth or rippled coulters are preferred for cutting residues. Coulters with a smooth surface can be rolled to ensure a sharp edge for cutting heavy, tough residue. The rippled coulter with a smooth edge cuts well, loosens a narrow band of soil, and helps the coulter rotate.

Fluted and wavy coulters are available in a variety of widths and designs. They are ideal for tilling a narrow strip of soil ahead of the row opener. In some soil conditions this tillage may be required, but most often for spring planting the soil is soft and crumbly and requires little or no tillage. The need for tillage is partly dependent on the opener type and weight of the row units. The amount of tillage that fluted or wavy coulters provide is dependent on coulter width and number of waves. Wider coulters and less waves typically means the coulter will till the soil more. Wider coulters usually require more weight for cutting and penetration.

Row Cleaners

Row cleaners can be used on disk-opener type planters to move residue from in front of the opening disks and gauge wheels. Moving the residue means that the opener no longer needs to cut through it. This should increase the life of the opener disks by reducing wear.

Moving residue also provides gauge wheels a smoother operating surface, which allows more uniform depth control. Row cleaners can provide earlier emergence when planting crops in early spring. By moving residue off the seed slot, the soil in the row warms more quickly since it is a darker color than the residue covered soil between the rows. For later planted crops this is probably not an issue.

Row cleaners also have some disadvantages. If preplant herbicides are broadcast on the field, row cleaners can move them out of the row with crop residue. This can be disastrous. Row cleaners can have some problems operating in wet wheat straw and fields with heavy weeds. When these conditions exist, row cleaners tend to clog and stop turning.

Types of row cleaners vary widely (Figures 18, 19, and 20). They typically consist of concave disks

or spoke wheels, and may also have some type of a coulter mounted with them. In general, the disk type row cleaners move more soil than the spoke type. The disk type row cleaners are adequate for some no-till applications, but the spoke type units work better in more conditions.



Figure 18. A spoke-type row cleaner on a Kinze planter.



Figure 19. A combination coulter/row cleaner.



Figure 20. A 'saw' or 'shark tooth' type row cleaner.

Press Wheels

There are many current options for press wheels when ordering a planter or retrofitting an older planter (Figure 21). These range from cast iron to plastic in construction. Though many options exist, proper adjustment is still a necessity. Remember the primary function of press wheels is to provide good seed-to-soil contact for uniform emergence. When properly adjusted, factory press wheels generally provide adequate seed-to-soil contact. However in some no-till conditions where the soil may be wet, obtaining good seed-to-soil contact is challenging. The side walls of the seed trench may be smeared or compacted. Some of the spoke type press wheels, used with a seed firmer, can break up the tight soil around the seed to create a better environment for early season root development (Figure 22). The seed firmer becomes a key component in this arrangement because it provides most of the seed-to-soil contact.



Figure 21. A spike closing wheel used with a standard John Deere closing wheel.



Figure 22. Spoked closing wheels on a John Deere planter.

Seed Firming Devices

Several companies are offering devices to firm the seed in the slot (Figure 23). These may be plastic rods or small wheels that operate in the furrow or small closing disks that force the sidewall closed. The devices are intended to improve seed-to-soil



Figure 23. A Keaton seed firmer on a John Deere planter.

contact, reduce seed bounce, and ensure the seed is placed in the bottom of the furrow. While all these items typically work well, experience in Oklahoma has found the conditions most needed are where some of these do not perform well. Wetter soils with higher clay content tend to stick to small wheels operating in the seed furrow, reducing their ability to operate as designed. Plastic seed firming devices that slide in the seed furrow seem to be more effective. Research in Kansas has indicated the plastic devices help stand establishment to a certain degree.

References

This material was adapted from the Chapter 11 – Seeding Equipment for No-till, *Kansas No-till Handbook*, Kansas State University. November, 1999.

Photos courtesy of Randy Taylor, Oklahoma State University