DISC SEEDING SYSTEMS FACT SHEET

GRDC
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# Considerations when converting to zero-till

## Converting from no-till to zero-till is not just a case of changing soil openers from tines to discs; consideration of the whole farming system is required.

This fact sheet summarises the key issues to be considered when selecting disc openers. More details on the issue of disc seeders can be found in the publication *Disc seeding in zero-till farming systems: A review of technology and paddock issues* (see Useful resources).

### KEY POINTS

**Consider the following when adopting disc seeders.**

**Paddock conditions at seeding:**

- soil strength and compaction variability across paddocks, influencing penetration or flotation abilities at seeding;
- soil stickiness at seeding that can cause seeding delays;
- proportion of stoney soils as these cause early wear and damage potential;
- typical moisture profile at seeding which also impacts on furrow disturbance; and
- harvest management and residue conditions at seeding.

**The furrow environment to be targeted:**

- seed and fertiliser placement and separation;
- the need for sub-seed soil disturbance to reduce root disease pressure; and
- preferred furrow closing technique.

**The disc seeder technology:**

- penetration and flotation capacity of row unit and suitability of seeder frame weight;
- seeder tracking stability for inter-row sowing;
- module contour-following ability;
- wear rate and maintenance in general operation; and
- implement draft force requirement at the operating depth and minimum tractor power at operating speed.

**The farming system:**

- weed control using an integrated weed management approach;
- labour, fuel use and work rates; and
- crop rotation flexibility and the need for crop establishment in heavy residue and marginal soil moisture conditions.

PHOTO: WANTFA

The use of discs as seeding implements or openers results in very little soil or residue disturbance so that full surface residue cover is maintained during the next crop establishment and growth.

The overall function of the seeding operation can be summarised as 'to uniformly place seeds and fertiliser in the ground and manipulate the physical condition of the soil near the seed zone and surface residue, securing the maximum crop emergence and early vigour in a wide range of soil types and moisture conditions'.

Seeding systems using a disc rather than a tine as the soil opener, have a direct impact on improving seedbed moisture conservation, reducing weed seed stimulation and improving crop water use efficiency. This is due to their ability to maximise crop residue retention and minimise soil disturbance.

A one-pass direct seeding operation using disc openers that achieve minimal soil and residue disturbance is termed **zero-till** seeding. This compares to **no-till** seeding that refers to a similar direct seeding operation using narrow point openers that create more significant furrow loosening and soil disturbance.

It is important to state that both **no-till** and **zero-till** farming are specific versions of a conservation farming approach in which:

- crop residues are retained on the soil surface;
- there is no prior cultivation and soil disturbance while direct seeding is minimised;
- diverse crop rotations are implemented; and
- at best, soil compaction management, such as controlled traffic farming, is used.

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However, experience suggests the adoption of zero-till is sometimes best after a transition period using no-till to first improve particularly degraded soil environments.

During a no-till transition period, vertical tillage within furrows can assist with faster root system development at depth, stimulating soil biology, increasing soil organic matter content and softening hardpan layers. Figure 1 shows a representation of the evolving chain of steps leading to a zero-till conservation farming philosophy in the Australian context.

This need for the transition is due to a rolling disc blade engaging with the soil in a completely different manner to a tine. A disc blade is a fundamentally poor soil-loosening tool, requiring high downward (vertical forces) for penetration in adverse soil conditions. A blade's residue cutting ability is also quickly and dramatically reduced by blade wear and tough residue/soft soil operating conditions.

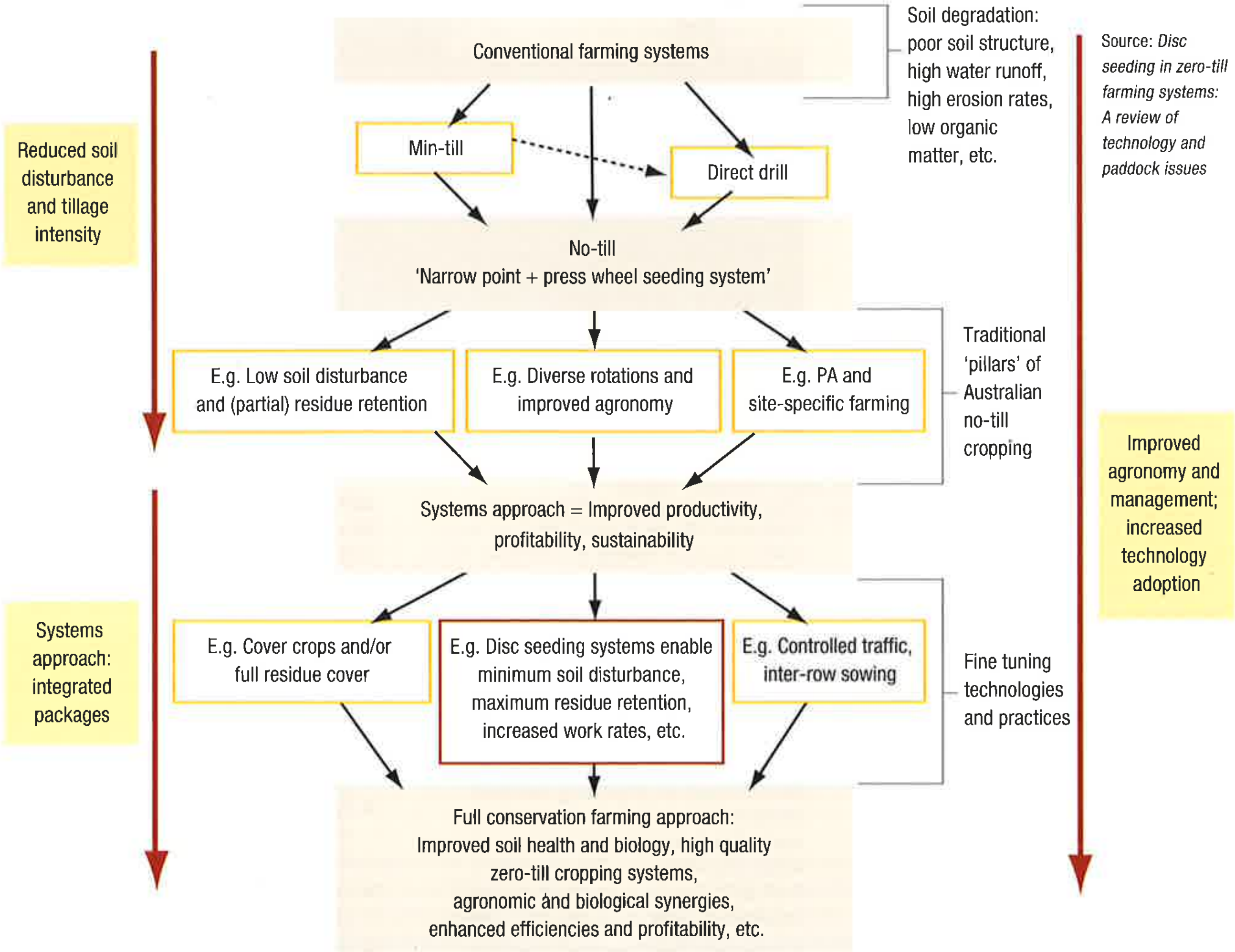
The performance of disc seeding systems improves in farming systems that promote a reduction in soil strength and a faster rate of residue breakdown over time. This can be achieved through:

- active management of compaction risks – such as controlled traffic farming – leading to improvements in soil structure;
- increased organic matter under permanent surface residue cover and improved crop rotations; and
- improved moisture infiltration and retention through reduced disturbance.

When these issues have been addressed, disc seeding can lead to a more efficient zero-till farming system with benefits such as:

- higher operating speeds increasing the seeding capacity within the optimum sowing window and reducing labour costs;
- minimal soil disturbance, which reduces seedbed moisture loss and weed germination and increases the reliability of crop establishment in marginal conditions;
- the use of narrow row spacing to sow pasture and to maximise crop competition;
- more diverse crops can be established reliably in heavy residues including cover crops;
- minimal crop residue management;
- improved performance in stoney soil, without post-sowing operations; and
- minimised draft and power requirements in optimum soil conditions.

**Figure 1 A representation of the evolving chain of steps leading to a zero-till conservation farming philosophy in the Australian context**




Note: The early motivations in tackling soil degradation with residue retention and a reduction in tillage intensity have gradually shifted to developing an integrated cropping system approach, involving various degrees of improved agronomy, management, and technology adoption. The disc seeding system may be seen as an integral part of a fine-tuning phase enabling the multi-facets of high quality conservation agriculture to be more thoroughly and rapidly realised.

Figure 2 **Examples of commercial disc coulter blade styles commonly used in Australia**

Smooth | Notched | Rippled | Bubbled | Fluted (24 offsets) | Fluted (13 offsets) | Fluted (8 offsets) | Turbo™

**Smooth –** Generally has a continuous double bevel cutting edge that is thinner than those used on single seeding discs.

**Notched –** A flat blade with spaced, sharpened notches on the circumference. They are considered more suitable than smooth coulters in hard soils and in heavy residues. Optimum notch size relates to disc diameter and intended working depth. Developed in Brazil, the 'toothed' blade (not shown here) is an evolution of the notched blade and requires less downward force to penetrate soil and cut residues.

**Rippled and fluted –** The rippled or wavy (sinusoidal) disc cutting edge increases furrow disturbance, disc drive and soil throw. Fluted blades are a coarser version of the ripple design and produce greater soil throw.

**Bubbled –** By positioning the convolutions away from the edge of the blade a straight cutting edge is maintained. Bubbled and dimpled blades have a more positive disc drive in softer soil conditions, while maintaining low levels of furrow disturbance and soil throw.

**Wavy –** Reaching outward from the disc face, the larger offsets create a more pronounced sinusoidal cutting edge and more involved furrow loosening. Fewer waves (offsets) are associated with greater but irregular furrow loosening and less soil throw. They have reduced penetration and cutting capabilities than fluted and rippled discs.

**Turbo™ –** This style of fluted coulter blade is directional, and can generate improved cutting and more soil throw, achieved by the waves entering the soil vertically and leaving the soil horizontally. An alternative design is the Directa™ blade (not shown here).

The seeding system in zero-till context needs to fulfil five main functions: residue handling, furrow loosening, seed banding, fertiliser banding, and furrow closing.

Many components have been developed and added to the disc modules to ensure all functions are best achieved. These include residue managers, independent seed pressing and furrow closing systems, double shoot technologies to separate seed and fertiliser, and on-the-go adjustment of the downward pressure on the opener to counter soil strength variability.

When selecting a disc seeding system, the objective is to create a furrow that excludes crop residue (minimal hair-pinning), achieves optimum seed to soil contact and uniform seed depth. The technology used to best achieve this will depend on paddock conditions and farming system context.

# Disc options

Zero-till disc openers can generally be classified into four design categories. The level of soil disturbance and soil throw created by each category is a function of blade design and the depth, speed and angle of operation. Smooth discs, shallow depth, low speed and softer and drier soil conditions, all generally contribute to lowering the level of soil disturbance and soil throw.

## Disc coulters

Disc coulters are designed to cut through surface weeds and residue, loosen narrow furrows and band fertiliser. They can be mounted on a fixed or swivel assembly, often set in association with tine openers or double seeding discs. The disc blades can be flat or fluted with either a continuous or scalloped cutting edge (Figure 2).

Commonly used disc coulter blades in zero-till systems range in diameter from 430 millimetres to 510mm and in thickness between 4mm to 6mm. Thinner and smaller disc blades penetrate harder soils more easily.

In sandy soils residue cutting coulters can be associated in opposing pairs set at a small toe-in angle, which improves disc drive but generates more soil throw, especially in wet compacted soil conditions. The toe-in angle also helps to control soil bridging between paired discs at narrower row spacing. Such paired arrangements are typically best for non-sticky soil conditions. Pairs should be staggered to each other, in order to equally control bridging between outer disc blades of adjacent pairs.

## Double or triple discs

Of all the disc configurations, double disc modules with appropriate depth control are considered the most accurate for seed placement. Double discs can be arranged as pairs of matching discs or in staggered configurations with combinations of large and small discs or smooth and notched disc blades.

Paired discs have a sweep and tilt angle with the discs coming together at the 'pinch point'. Each disc has a single bevel on the outer edge. Excess contact pressure or lack of contact pressure between the discs can cause early bearing failure.

Staggered arrangements with smaller trailing discs place the pinch point in the shadow of the leading disc, potentially reducing the risk of soil build-up between the discs. Different disc diameters result in differential speed at the cutting edge, which is considered to improve residue cutting ability. This effect may be modified by the driving action of depth gauging rings fitted on either disc.

In firm and compacted soil, double discs require a large vertical force to achieve adequate penetration, which leads to furrow smearing and compaction. To minimise the downward force requirement they are best operated behind a leading coulter in a 'triple disc' combination. The depth of seeding penetration is generally regulated by a rear gauge wheel, which typically acts as a furrow press wheel. In precision disc planters, the gauge wheels are fitted on the side of the disc blades, allowing for more effective, independent furrow closing tools.

## Single discs

These modules comprise of a single smooth disc with continuous edge and a single bevel. The blade is in one of two configurations, either set vertically with a sweep angle (five to seven degrees to the direction of travel), or set at both a tilt angle (up to 20 degrees from the vertical) and sweep angle (between three and eight degrees to the direction of travel). This latter configuration gives improved penetration, but this is potentially at the expense of poorer residue cutting.

Single discs in either configuration can be designed to either continuously follow ground contours or remain fixed relative to the implement frame, only occasionally rotating back when encountering obstacles. The latter are less accurate for seed placement across variable terrain, due to lack of depth control. The single disc set-up experiences significant side forces that require careful balancing to minimise implement drift.

## Hybrids

Disc/tine and disc/blade associations offer additional flexibility in fertiliser banding, without compromising seed placement when associated with sub-seed soil disturbance.

Hybrids include any combination of rolling disc blade and a fixed blade/tine opener. Examples include:

- Disc coulters with a banding knife (for example, Yetter Mfg 2995/96 coulters);
- notched coulter with side blades (for example, Cross slot®); and
- seeding tine or disc associations with fertiliser banding discs (for example, Bourgault Mid-Row Bander®).

Coulters with fertiliser banding knives used in triple disc systems enable reliable and independent seed and fertiliser separation but research shows they create significantly increased soil throw relative to the disc blade alone (three to four-fold), especially at higher speed.

# Other issues

In a disc seeder user survey carried out in 2007, 60 per cent of the 195 respondents reported poor handling in sticky soils and 38 per cent reported poor herbicide incorporation as significant limitations experienced with disc openers.

## Sticky soils

The issue of sticky soils is greater as clay content increases and tends to be worse in winter rather than summer cropping where seeding occurs in a wetting rather than drying soil profile.

Many growers reported that waiting until the surface soil forms a dry crust substantially reduced problems of discs becoming clogged with soil. Following rainfall events, disc seeders typically sit idle for one day longer than tine-based seeders. In worst-case scenarios, extended delays of three to four days were reported in the survey by growers who were waiting for a drier surface crust (1 to 2cm). Delays can also occur in some situations on a daily basis due to heavy dew.

Any delays are also mitigated by subsequent higher work rates enabled by disc seeders and their ability to carry on seeding for longer and more reliably establish crops into marginal moisture.

## Weed control

The introduction of a disc seeding machine may require a different approach to weed control than when using a tine. This is partly due to the fact that disc seeding systems aim to have less soil disturbance than tine openers making incorporation of herbicides more difficult.

Due to the need for incorporation and the risk of crop damage, many pre-emergent herbicides commonly used with tined seeding equipment are not registered for use with disc seeding systems.

Field research trial programs are being conducted to assess suitability under disc seeding systems. Growers must consult product labels before selecting herbicides to use with disc openers and seek advice on the latest chemicals and their suitability to disc seeders.

Consequently, pre-sowing knockdown and in-crop selective herbicides, competition from crops in narrower rows and stubble cover, minimising weed germination and seed-set, and weed seed management at harvest are all important approaches in an integrated weed management strategy when using discs.

## Useful resources:

- ***Disc seeding in zero-till farming systems: A review of technology and paddock issues*** **(2010), Mike Ashworth, Jack Desbiolles and ElKamil Tola, WANTFA** **Email: admin@wantfa.com.au, or sales@boffinsbookshop.com.au** **Ground Cover Direct, freephone 1800 11 00 44, www.grdc.com.au/bookshop**
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- **Western Australian No-Till Farmers Association (WANTFA)** — **www.wantfa.com.au**
- **South Australian No-Till Farmers Association (SANTFA)** — **www.santfa.com.au**
- **Conservation Agriculture and No-Till Farmers Association Inc. NSW (CANFA)** — **www.canfa.com.au**
- **Victorian No-Till Farmers Association (VNTFA)** — **www.vicnotill.com.au**
- **Conservation Farmers Inc. (CFI)** — **www.cfi.org.au**



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