Disc seeders: An overview of benefits & limitations experienced in the paddock

Jack Desbiolles
Agricultural Machinery Research and Design Centre
University of South Australia

1. 2007 Disc seeder user survey

Last year, the Grain Research and Development Corporation (GRDC) and the University of South Australia supported a nation-wide survey of farmers and contractors who currently use - or have used in the past - disc seeders in a no-till cropping context. The survey aimed to identify disc seeder strengths and weaknesses, as experienced by users across a range of soil and rainfall conditions, and highlight how disc seeders may best be successfully integrated into no-till farming systems. Selected early results are highlighted below.

Respondents cited the ability to handle and retain heavy stubble as a primary benefit of disc seeders

The survey compiled 195 responses received from 6 states (WA: 32 ; SA: 31 ; VIC+TAS: 19 ; NSW: 65 ; Qld: 48). 96% of respondents were farmers (15% of which also conducting contract seeding) who manage cropping areas ranging between 100 ha and 18,000 ha, with a 90% average proportion carried out under no-till. Farmer respondents started no-till on their farms an average 10-11 years ago, with 29% of respondents categorised as older no-till adopters (practising for more than 12 years) and 10% as recent adopters (practising for 1-3 years). 39% of responses originated from combined summer/winter cropping regions (Qld and Northern NSW). In the winter cropping regions, 26% of farm responses originated from lower rainfall (<250mm GSR) and 22% from higher rainfall (>350mm GSR) areas.

The main soil limitations at seeding experienced by the respondents included soil stickiness (73% of responses), hardest & compacted soils (51%), stony soils (41%), abrasive soils (31%) and non wetting soils (21%), with additional limitations cited including soft loose soils, waterlogged conditions, recently cleared ground (stumps/sticks), ironstone and high slope.

The vast majority (95%) of respondents commonly operated their disc seeder in standing stubble, with 88% of respondents running a straw spreader/slasher on their harvester. Disc seeding into lightly or heavily grazed stubble was also practised in some areas (56% of responses), while a small proportion occasionally operated into slashed stubble (18%) or burnt stubble (19% on whole paddocks and 11% on burnt windrows only).

Only 44% of respondents practised inter-row sowing, of which a 3/4 proportion used 2cm RTK guidance level. 54% of farmer respondents implemented controlled traffic on their farm, with the highest proportion being observed in Northern NSW (87%) and Qld (76%) and the lowest in SA (13%) and WA (23%).

2. Reasons for initially purchasing a disc seeder

The respondents indicated they had initially purchased a disc seeder for a number of reasons, falling into 3 categories: i) cropping system benefits (e.g., sustainability, agronomy, and economics), ii) machinery motivations (e.g., performance, design) and iii) influence of people (e.g., neighbours, research results, demonstrations).
Overall, the top 5 most cited motivations influencing the purchase of a disc seeder (out of 23 significant motivations and 17

secondary reasons reported) were ranked as follows (% responses):

i) Heavy residue retention and handling ability (49%)
ii) Machine design features (39%)
iii) Low soil disturbance (27%)
iv) Seed placement accuracy (27%)
v) Brand reputation (18%)

The data also revealed that particular issues were more relevant in different states. For example: disc seeders were primarily seen in SA to offer benefits of not pulling up stones and enabling a complete 'zero-till' farming system, while a greater emphasis on achieving faster seeding and providing lower draft benefits were higher ranking in WA.

About 91% of disc seeder users stated that their motivations for purchasing a disc seeder still applied today. However, the remainder 9% had faced problems with their disc seeder that drove them to consider either a better suited disc seeder design or revert back to a tine seeder. Their reasons included the availability of newer and now improved disc seeder technologies, negative experience with specific machine or particular technology limitations in the farm context (eg. poor herbicide incorporation ability, poor depth control in soft soil, lack of penetration in dry years, poor handling of wet sticky clays).

3. *Benefits linked to the use of disc seeders*

Farmers and contractors' experiences over time confirmed a number of agronomic, economic and practical benefits associated with using disc seeders in their cropping systems.

The top benefit identified (53% of all responses) was the ability to handle and retain heavy stubble, ensuring more permanent soil cover, cancelling the need to manage stubble (including burning) and making harvesting and seeding easier. Themes of soil moisture preservation via low soil disturbance at seeding and residue retention throughout the year as well as seed placement quality and row to row depth control were also highlighted. These factors combined into another significant benefit: improved reliability, speed and quality of crop establishment, particularly under marginal moisture conditions, with often an improved yield potential.

Faster seeding (time savings and improved crop seeding timeliness) and a range of cost savings (fuel, power, seeds, labour) were also highlighted as significant economic benefits of disc seeders in the cropping system. The increased abilities in heavy stubble and marginal moisture supported greater cropping system flexibility by enabling rotations over a wider range of soil/stubble conditions and, in particular, facilitating decisions on opportunity cropping and allowing post sowing pre-emergence knockdown applications.

Other noted benefits included improving soil health and quality (biology and structure), soil erosion control, lower weed pressures, and improved cropping results in stony paddocks.

Disc seeders were cited as well suited to narrow row spacing requirements such as for pasture establishment and renovation

4. *Limitations of disc seeders experienced in the paddock*

Contrasting with the above were the detailed reports on limitations of disc seeders also experienced by farmers and contractors. Table 1 summarises the importance and ranking of 14 selected disc seeder limitations reported across all responses.

Table 1: % responses citing experiences with specific disc seeder limitations

	N-NSW	S-NSW	Qld	SA	TAS/VIC	WA	Overall
Poor handling of sticky soils	68%	59%	69%	48%	79%	44%	60%
Inadequate herbicide incorporation	15%	52%	33%	27%	53%	58%	38%
Lack of ground penetration ability	23%	32%	32%	55%	24%	41%	35%
Bearing early failures	26%	31%	40%	26%	37%	41%	34%
Significant residue pinning	37%	21%	24%	26%	72%	45%	34%
Irregular seed placement	33%	19%	33%	23%	47%	27%	29%
Damage & high wear in stony soils	16%	39%	23%	30%	29%	32%	28%
Poor disc drive in soft soils	52%	18%	28%	10%	39%	7%	25%
Furrow smearing & compaction	35%	25%	30%	0%	25%	6%	21%
Uneven furrow closure	20%	16%	25%	10%	35%	19%	20%
High draft / power requirements	19%	16%	4%	35%	24%	6%	16%
Low crop vigour & slow root development	10%	12%	4%	18%	25%	39%	16%
Crop damage due to soil applied herbicides	10%	10%	9%	17%	20%	16%	13%
Crop damage due to fertiliser toxicity	3%	3%	4%	7%	6%	16%	6%

Overall, poor handling of sticky clay soils was a major limitation reported in 60% of responses. The problems encountered included seed boot outlets clogging and soil accumulation against elements in close contact with the rotating disc (eg. seed boot guard, gauge wheel), overloading scrapers and generating high drag forces causing the slowing down or stalling of disc rotation, resulting in furrow bulldozing and poor seed placement.

These problems lead to necessary delays while conditions are wet (eg. later re-start after rain and morning dew) or as conditions become wetter (evening/night setting of dew). Cited delays following major rains were typically one extra day waiting relative to a conventional tine seeder, with reports of extended delays of up to three to four days in the worse cases.

Other issues making up the top five limitations of disc seeders in zero-till systems and reported in 35% to 38% of responses, were: inadequate herbicide incorporation, lack of ground penetration ability, bearing early failures and significant residue pinning.

Inadequate herbicide incorporation led to poor weed control efficacy and herbicide failure. This limitation promoted a shift away from herbicides requiring mechanical incorporation by sowing (such as trifluralin). It also prompted users to develop custom solutions such as adapting harrows behind the disc seeder, applying and incorporating the product pre-sowing (and sowing deep) or applying and incorporating the product after sowing and pre-crop emergence. Triple discs in many instances, and hybrid disc/tine systems were found to achieve adequate herbicide incorporation.

Poor handling of sticky clay soils was a major limitations reported in 60% of responses

Lack of ground penetration was a common limitation in hard soil conditions, such as when dry sowing, moisture seeking at depth, sowing into compacted pastures, or sowing

across wheel tracks and heavy residue patches. Poor penetration resulted in inadequate or irregular soil cover, often leading to partial or staggered seed germination, low crop vigour and/or crop establishment failures. These problems were related to lack of machine weight and/or inability to apply enough down pressure on disc units. Penetration ability was often poorest with twin disc concepts while undercut single disc designs were found superior.

All hybrid disc/blade seeder owners reported satisfactory herbicide incorporation

Early failure of bearings, when reported, occurred mainly on gauge wheels and furrow closing wheels, together with early wear of bushes and pins. Bearing failures especially occurred following periods of sowing into dry and dusty conditions or under very wet conditions. Instances of poor design were also reported such as undersized and/or non greasable bearings, and high exposure to dirt.

Significant residue pinning was reported in situations of heavy, wet residue over loose or soft soil conditions. Poor straw spreading at harvest, lodged and matted stubble, shallow seeding of sensitive crops (eg. canola), and blunted discs were often key factors influencing these problems.

25-29% of responses also reported irregular seed placement, damage and high wear in stony soils and poor disc drive in soft soils as significant limitations in their cropping context.

Irregular seed placement (high scatter, variable depth across soil types, poor soil cover) arose due to a range of situations, such as poor seed boot design, uneven penetration across soil types, seed bounce with excessive airflow, variable depth control in loose ground, and seed entrainment in wet conditions. Problems were increased when shallow seeding into rough and uneven ground.

Low soil disturbance attributes of disc seeders were seen to minimise seedbed moisture loss, reduce weed pressure and improve crop establishment in marginal moisture conditions

Many users who work in stony soils reported damage (eg. cracking, early wear, blunting, bending, and snapping) to gauge wheels, rubbers, discs, and press wheels. They also experienced high wear rates on discs and seed boot guards. Operating under rough conditions (both stones and compacted soils) increased the likelihood of early wear and bearings failures.

Poor disc drive was a significant limitation when operating in loose sandy soils and soft/wet sticky soils, due to the inability to overcome frictional resistance (drag) applied to the disc from a range of sources and leading to gradual slowing down and stalling of disc rotation and subsequent furrow bulldozing. The lack of disc drive was deemed worse with single disc concepts, and exacerbated when seeding shallow and when operating with worn discs.

Table 2: Overview of unit power requirements (Engine HP/row) experienced with selected winter crop seeders

Number of responses	Middle 50% of responses			Maximum cited	Disc seeder brand (type)
	Lower limit	Median	Upper limit		
5	6.9	**7.9**	9.8	10.2	NVI BioBlade "Cross-Slot" (disc/blade hybrid)
4	7.3	**7.7**	7.9	8.6	Morris Industries "Never Pin" (single disc - vertical)
9	4.2	**7.1**	10.8	11.6	Excel Agriculture (twin discs)
17	5.1	**6.3**	8.6	9.3	Milne Industries "Daybreak" (single disc - vertical))
12	5.4	**6.2**	7.1	8.7	NDF Ag Design (single disc - vertical)
9	4.9	**5.6**	7.7	8.2	Austil Equipment (single disc - undercut)
10	4.5	**5.5**	7.0	8.7	CNH Flexi-Coil "Barton" (single disc - undercut)
21	3.5	**5.1**	5.7	10.3	K Hart Industries (triple discs)
12	4.1	**4.9**	5.8	9.6	Tobin Disc Drills (single disc - undercut)
28	3.5	**4.0**	4.5	7.2	John Deere (single disc - vertical)
3	3.6	**3.8**	4.0	4.2	Homan Quality Equipment (twin discs)
7	3.1	**3.7**	5.0	7.5	Great Plains Mfg. (triple discs)

Wet clay conditions created smearing and furrow compaction, as well as uneven furrow closure for approximately 1 in 5 respondents, including dealing with the so called 'Kinze crack' problem when seeding into wet puggy and compact clays, with furrows re-opening upon drying under hot and dry follow-up weather.

16% of respondents complained of a surprisingly high draft from their disc seeders, linked to the heavy weights of some machine (e.g., up to 22 tonnes with air cart) when operating in either soft loose soils (resistance associated with sinkage), in heavy wet clay soils (drag associated with soil stickiness and buildups) and in dry compacted soils (seeking penetration under high down pressure).

A similar proportion of respondents experienced limitations with low crop vigour often linked to poor seed placement, furrow compaction/lack of tilth issues, early sensitivities to herbicides like *Trifluralin* , particularly in cold winters.

Crop damage from soil applied herbicides was also a significant issue in 13% of responses, occurring when operating in very wet or in very compacted soil conditions or due to wash downs after major rains.

A small proportion (6%) also reported issues of fertiliser induced toxicity, mainly linked to single shoot banding restrictions.

5. Tractor power requirements with disc seeding

Overall, larger tractor size correlated well (r = +0.68) with greater disc seeder width. The average tractor size (engine HP) used for disc seeding was higher in SA (312 HP) and WA (318 HP), and smaller in Qld (225 HP) VIC (224 HP) and TAS (203 HP). The % of total available tractor power used at seeding (as perceived by the operator) ranged between 62% and 83% across all states, being highest in SA (eg. 62% of SA responses reported at least 90% usage of available tractor power for disc seeding), and being least in QLD and VIC (eg. 6-8% only of these respondents reporting a greater than 90% usage of available tractor power).

Unit power requirements (ie. Engine HP per seed row – NB: up to 2 disc units per seed row) significantly varied across responses (eg. ranging from a lowest 1-2 HP/row to a highest 10-12 HP/row), depending upon the context of use (eg. operating depth, soil conditions, speed etc…) and the disc seeder type, in particular, the machine weight.

The unit power requirements were estimated from reported seeder features (seed row spacing, disc seeder width) and reported tractor power data (eg. tractor size and % usage of available tractor power). The latter factor in particular depends upon operator perception and in practice, this effect is likely to underestimate the lower values of unit power requirements. The estimated upper

values would however be expected to be relatively accurate in their context, as they often were closely related to the total available tractor power (eg. 27% of all responses cited 90-100% tractor power use). These values represent averages of engine power requirement experienced on-farm which also include the pulling power of the air seeder cart - where applicable.

Disc seeders enabled more timely seeding programmes and allowed savings on fuel, labour and seed costs for most owners

Analyses of winter cropping disc seeder data showed the middle 50% of responses (Interquartile range - IQR) citing unit power requirements of between 2-4½ HP/row and 4-7½ HP/row. Data analyses by main disc seeder model revealed a clearer picture (See Table 2), confirming in particular higher unit power requirements (IQR ranging from 5-7 HP/row to 8-11 HP/row) for heavy duty disc seeders and for those with an ability to target deeper tillage depth settings.

Single undercut disc designs showed intermediate power requirements (IQR from 4-5 HP/row to 6-8 HP/row) slightly greater than lighter duty single vertical discs and triple coulter discs (IQR from 3-3.5 HP/row to 4½-6 HP/row). Simple light duty twin disc systems required the least power requirements, from 2½-3 HP/row to 4-4½ HP/row, in line with their reduced ability to operate in hard soil conditions.

Table 2 also indicates the maximum unit power requirement reported by seeder type in the survey responses. This value would be indicative of a worse case scenario for the particular disc seeder model (eg. faster speed and operation under maximum down force settings, such as in hard soil conditions).

6. The bigger picture

A common theme often expressed by the respondents was that the severity of some of these problems – such as poor ground penetration, significant residue pinning and high draft requirements – declined over time as soils soften under zero-till - often combined with the benefits of controlled traffic - and the improving biological soil life significantly hastens the rate of stubble breakdown.

A number of respondents also indicated acceptance of *de facto* limitations such as poor herbicide incorporation, bearing failures and high wear in stony areas, when assessed in the bigger picture, i.e. in relation to the quality of the overall seeding job achieved (particularly under harsh or challenging soil conditions) and the agronomic and economic benefits generated in the farming systems.

The survey responses indicated that despite a wide range of possible limitations encountered over challenging soil and stubble conditions, a majority of disc seeder users were convinced of the long term benefits offered within the 'cropping system package' facilitated by the use of disc seeders in zero-till context.

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Note: The survey result full report will be finalised in the next few weeks and made available via the state no-till farmers association websites or from the contact below - on request.

Acknowledgements: Key support to the survey was also provided by state no-till associations (WANTFA, SANTFA, VNTFA, CWCFA, CFI), various farming system and industry groups including Southern Farming Systems, as well as a large number of disc seeder manufacturers and importers.

Contact: Jack Desbiolles
Agricultural Machinery Research & Design Centre
University of South Australia
Email: jacky.desbiolles@unisa.edu.au
Tel: 08 8302 3946