UNIVERSITY OF SOUTH AUSTRALIA

Considerations for successful residue handling at seeding (disc and tine seeders)

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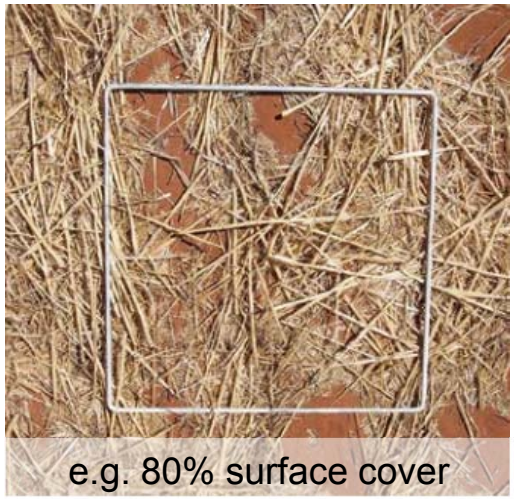
Agricultural **M**achinery **R**esearch and **D**esign **C**entre (AMRDC)

EP Stubbles Extravaganza – Pt Lincoln 9 Nov 2017

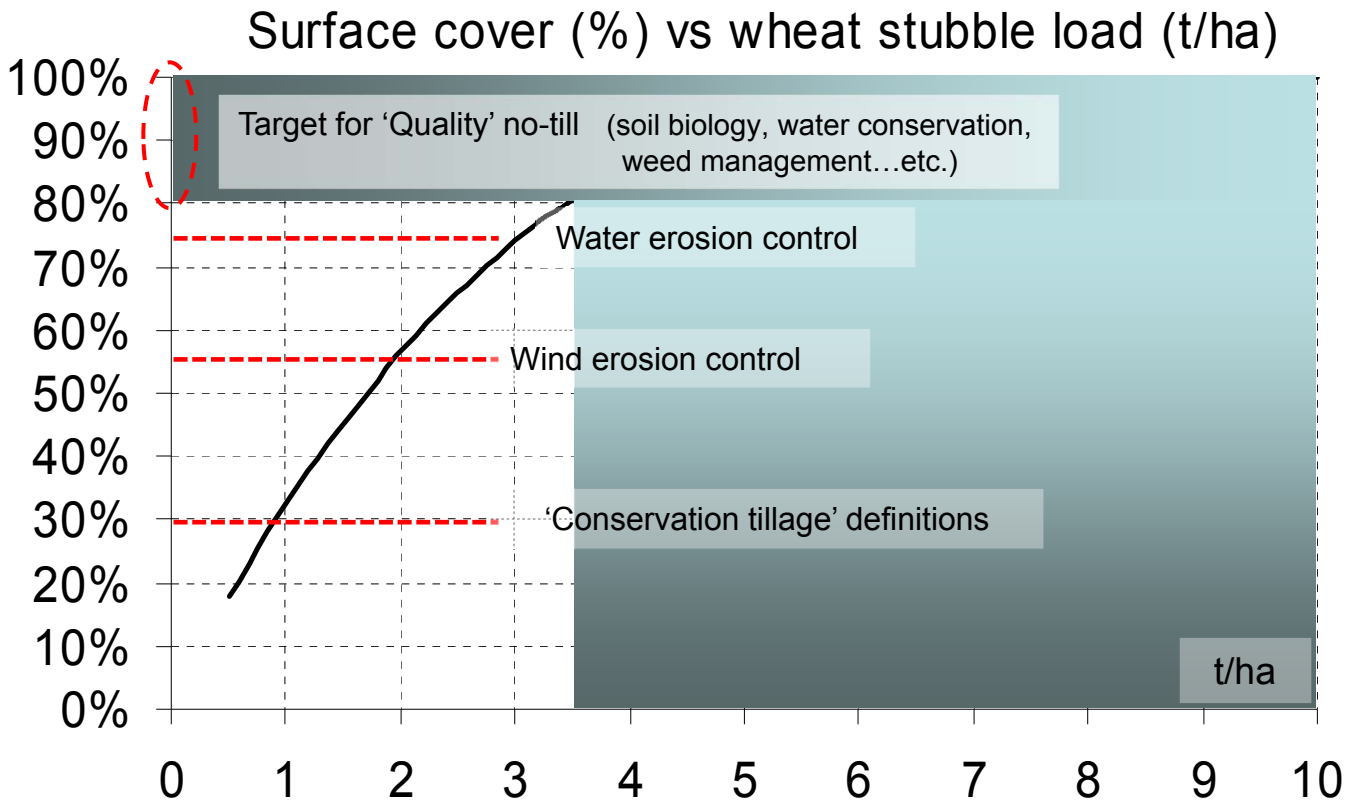
Residue load vs surface cover

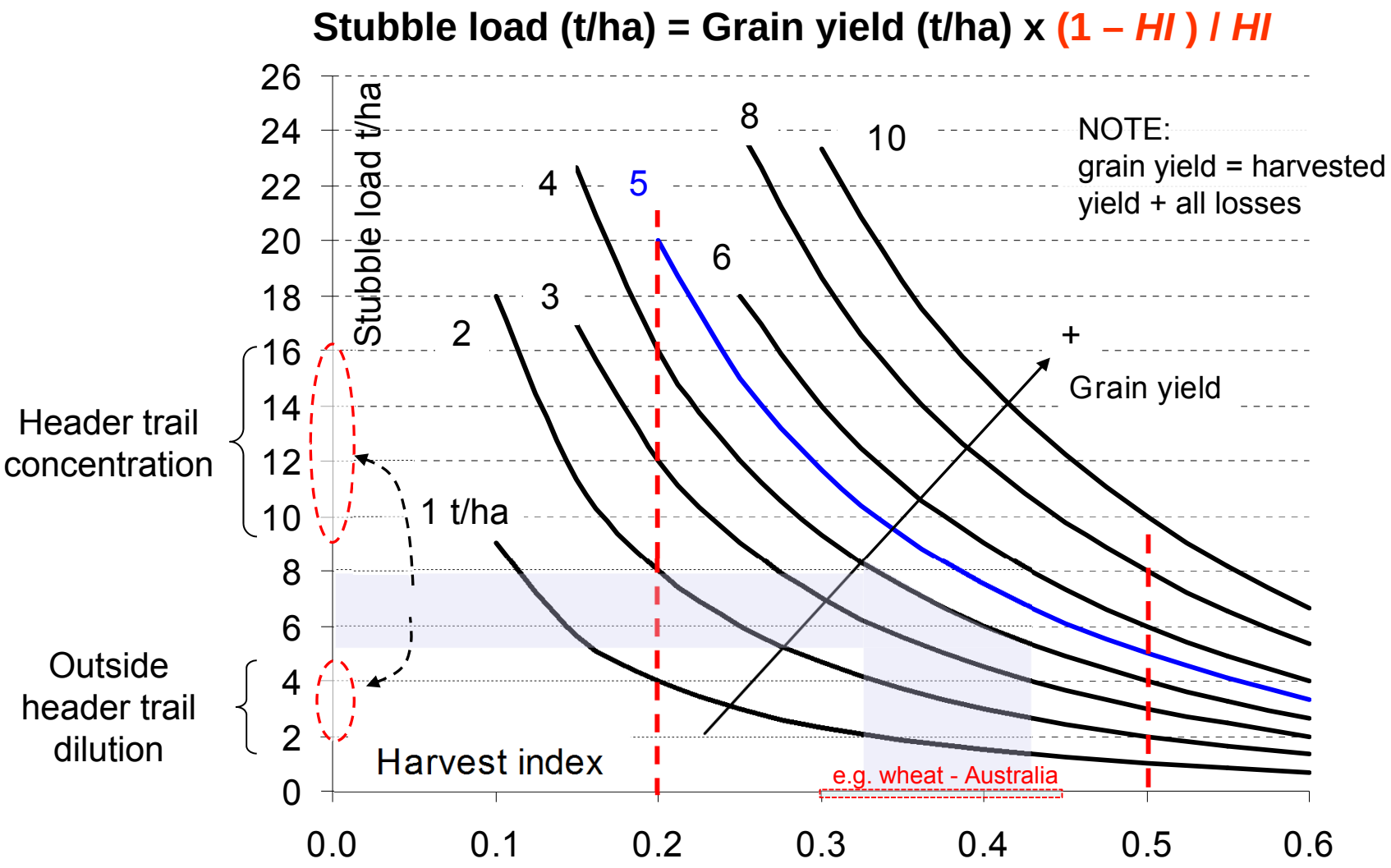
Adapted after
Herrmann (1995)

Targeted cover
for quality
no-till



e.g. 80% surface cover
Source MSF Inc. (2013)




Stubble load (t/ha) = Grain yield (t/ha) x (1 – HI) / HI
Stubble load t/ha
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
2
3
4
5
6
8
10
NOTE:
grain yield = harvested yield + all losses
+
Grain yield
1 t/ha
Header trail concentration
Outside header trail dilution
Harvest index
e.g. wheat - Australia

Residue handling strategies with tine seeders

"Residue management starts at harvest and STUBBLE LENGTH is key…"

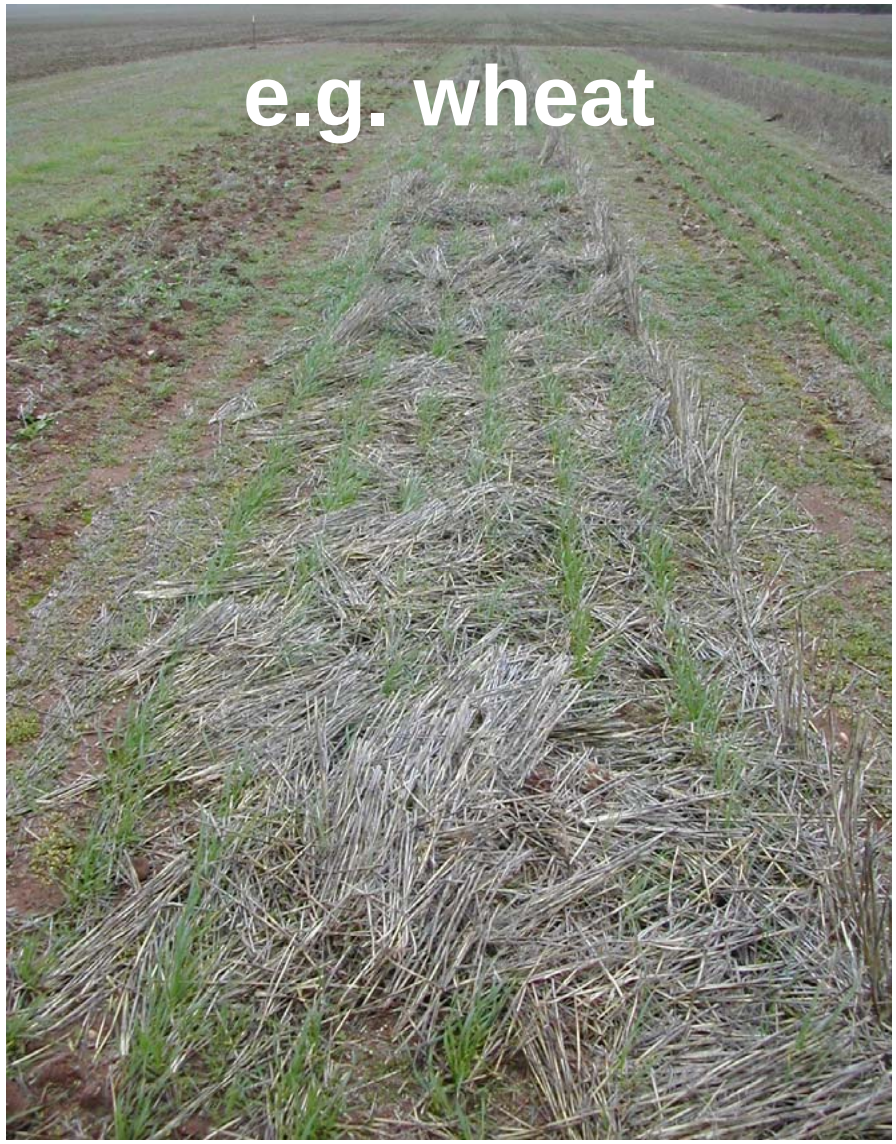
- ➔ Cut stubble short
- ➔ Chop and spread residue evenly
- ➔ Maximise tine seeder capacity
- ➔ Operate in dry stubble & at lower speed
- ➔ Inter-row sow
- ➔ Else, sow at a diagonal to stubble rows and along direction of stubble lean

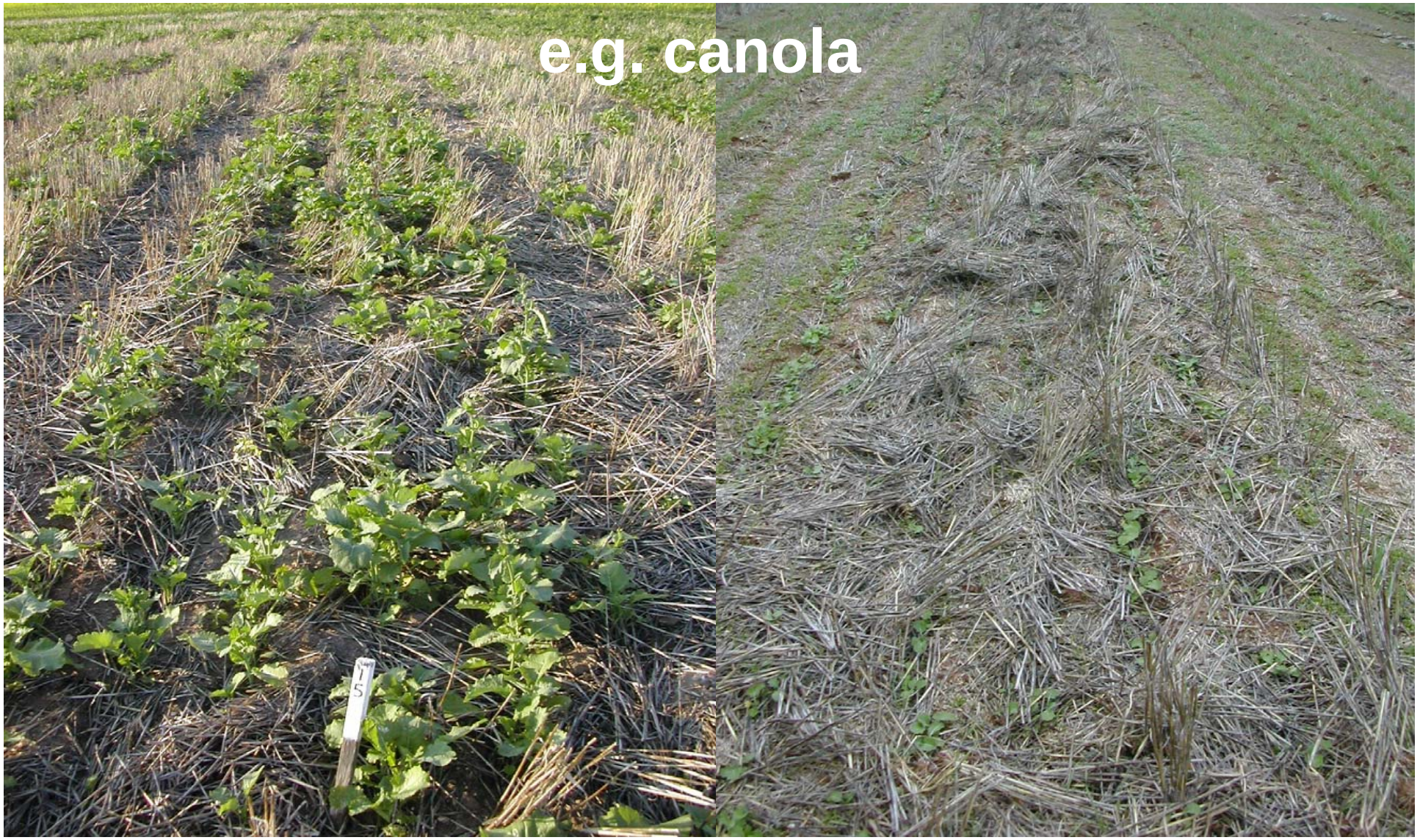
Tine seeder capacity affects blockage risk + extent of residue clumping

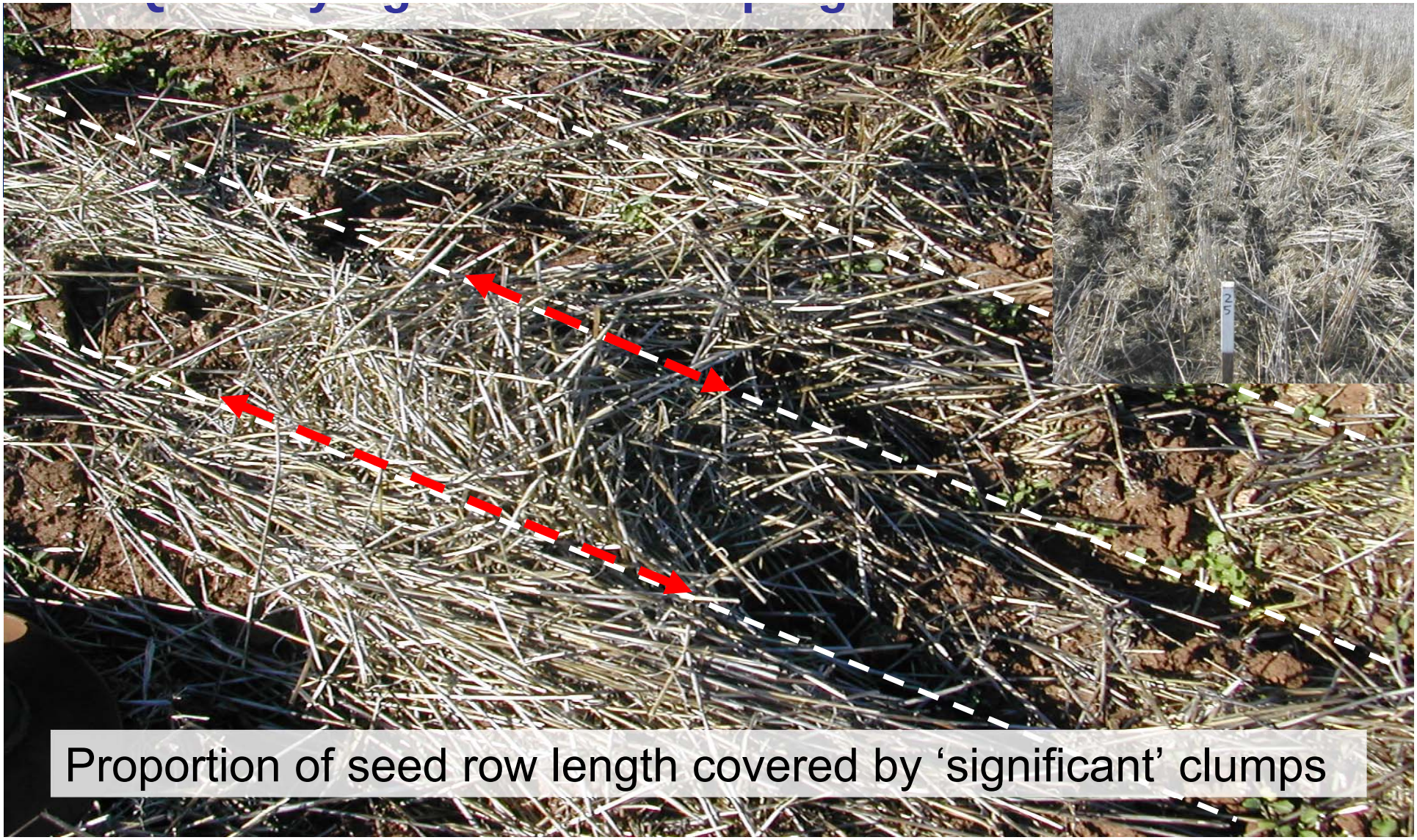
Residue clumping affects no-till crop performance

Residue clumps

- Clumps concentrate residue side-effects (eg. N tie-up, phytotoxicity, harbouring of pest & diseases…)
- Clumps interfere with seedling emergence (esp. canola), crop early vigour and ease of harvestability (e.g. pulses)
- Heavy clumping is the precursor to seeder blockage
- Both seeder & stubble parameters significantly affect residue clumping levels




e.g. canola


Proportion of seed row length covered by ‘significant’ clumps

Example residue clumping data (dry stubble)

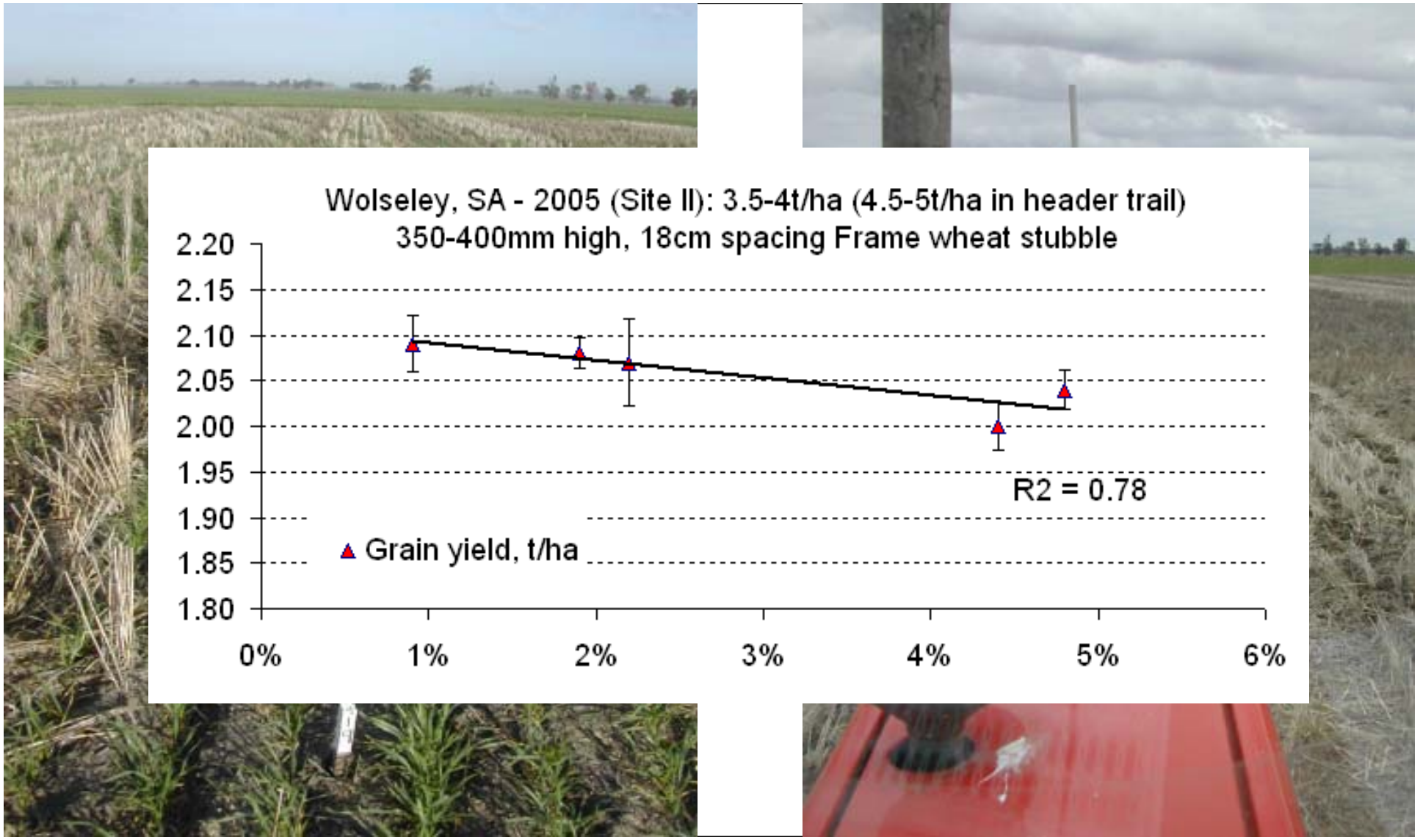
% = seed row proportion covered by 'significant' clumps

Wolseley South East SA Site II - 2005	speed	Clumping %
50mm wide flat on C- shank (c = 800mm)	6 km/h	0.9%
	10 km/h	1.9%
25mm wide edge-on vertical shank (c = 750mm)	6 km/h	2.2%
13mm wide edge-on vertical shank (c = 600mm)	6 km/h	4.4%
	10 km/h	4.8%

Frame wheat DRY standing stubble: 3.5-4t/ha (4.5-5t/ha in header trail), 350-400mm high

Sowing at 15° to stubble rows and at 25cm row spacing - Soft sticky clay soil

c: tool bar to ground surface vertical clearance


Wolseley, SA - 2005 (Site II): 3.5-4t/ha (4.5-5t/ha in header trail)
350-400mm high, 18cm spacing Frame wheat stubble
2.20
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
R2 = 0.78
Grain yield, t/ha
0%
1%
2%
3%
4%
5%
6%

Example residue clumping data (wet stubble)

% = seed row proportion covered by 'significant' clumps

Wolseley South East SA Site I - 2004

Edge-on tine: high speed contrast	10 km/h	16.0%
Edge-on tine + coulter contrast	6.5 km/h	12.4%
Edge-on tine CONTROL (25cm row spacing)		9.8%
Flat-on C shank tine CONTROL	6.5 km/h	4.8%
Flat-on C shank tine speed contrast	10 km/h	7.9%

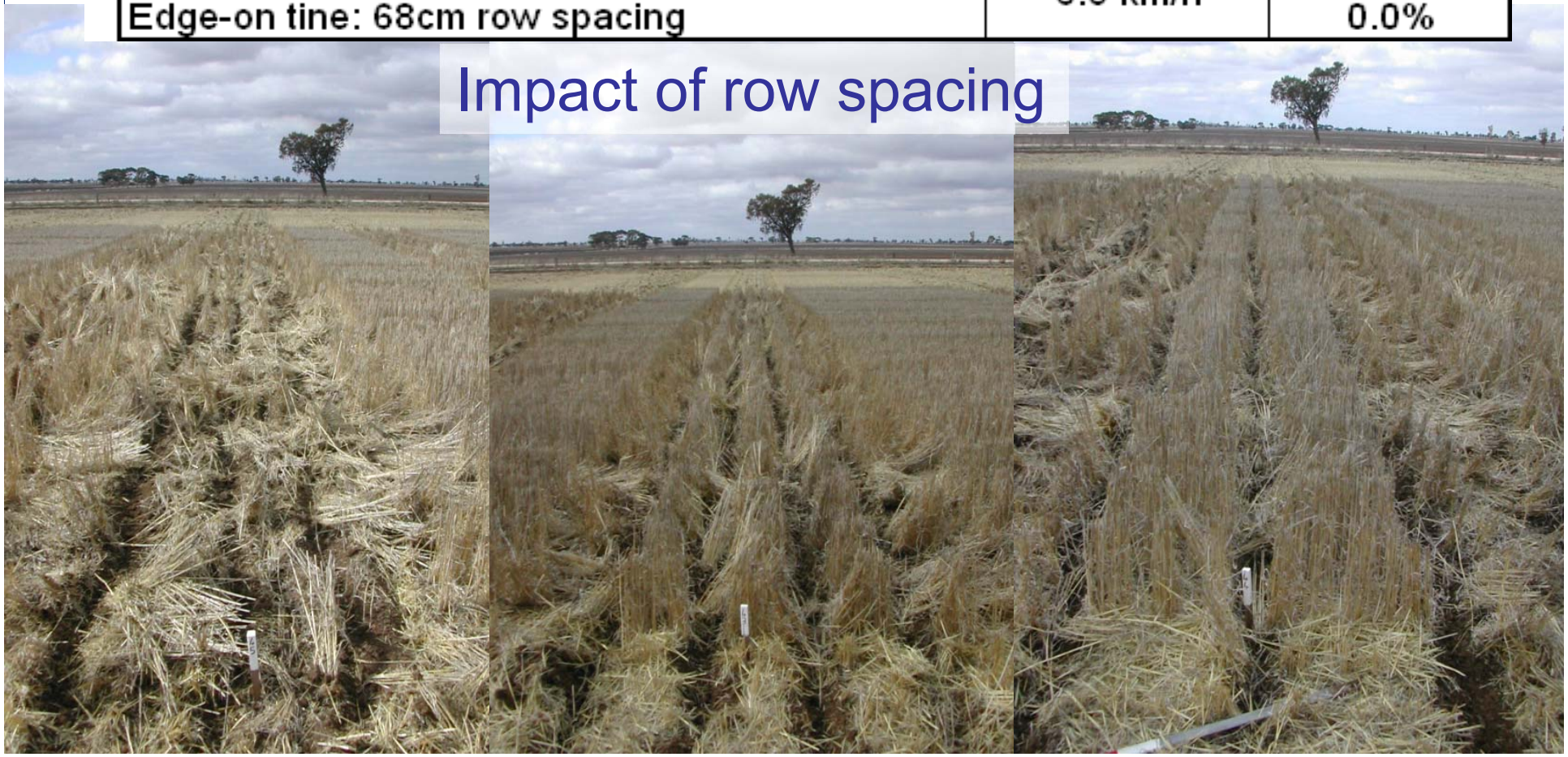
Janz wheat standing (wet) stubble: 5-5.5t/ha (10-11t/ha in header trail), 450-500mm

Sowing at 90° to stubble rows and at 25cm row spacing (unless otherwise specified)

Wolseley South East SA Site I - 2004

Edge-on tine CONTROL (25cm row spacing)	6.5 km/h	9.8%
Edge-on tine: 45cm row spacing	6.5 km/h	3.8%
Edge-on tine: 68cm row spacing		0.0%

Impact of row spacing



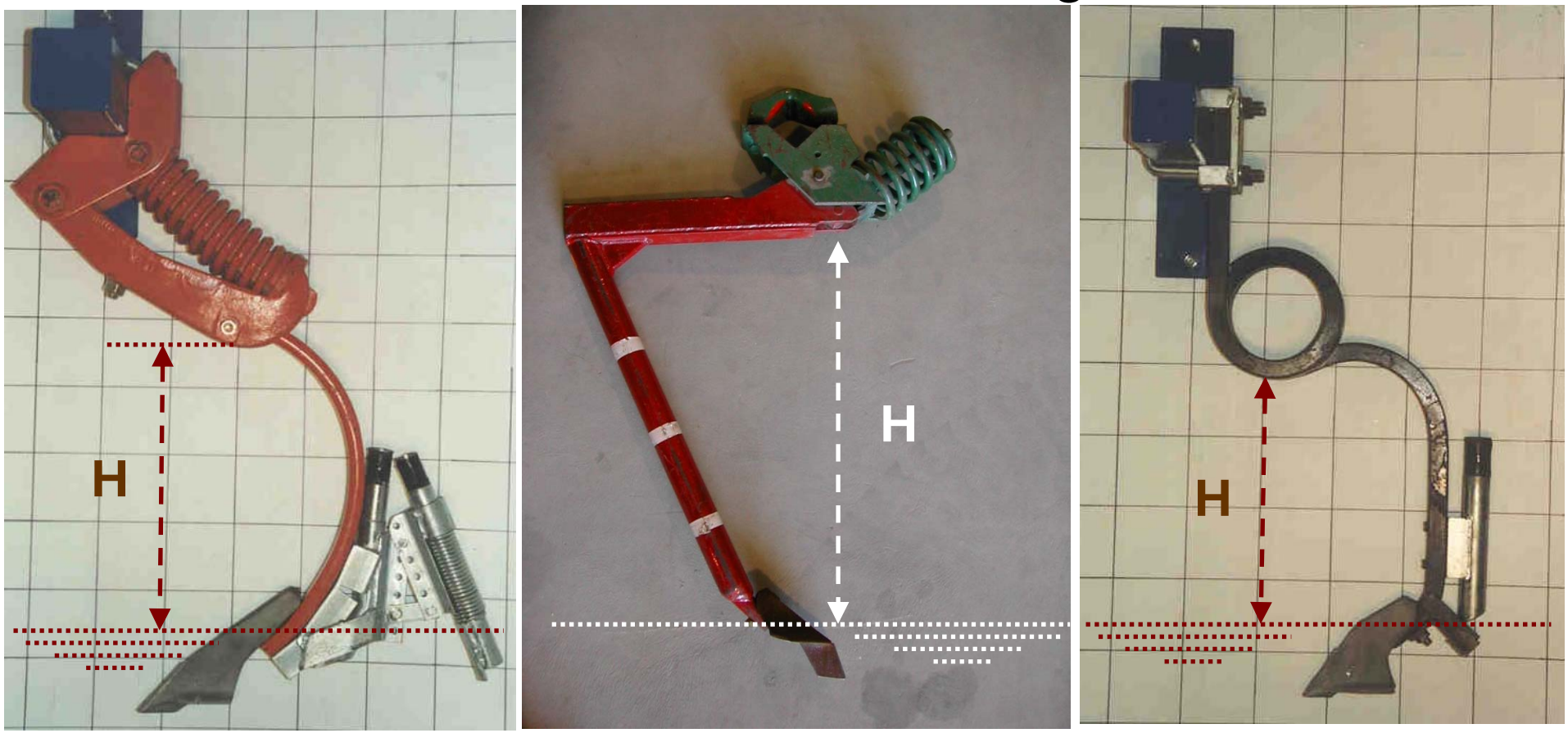
Preferred tine parameters

Optimum tine shank:

1. is straight (not deeply curved)
2. has round edge
3. is vertical or slightly backward leaning
4. has a continuous profile, with only gradual changes in shape
5. provides large vertical clearance

Effective tine vertical clearance (H)

H ≥ 1.5 x stubble height



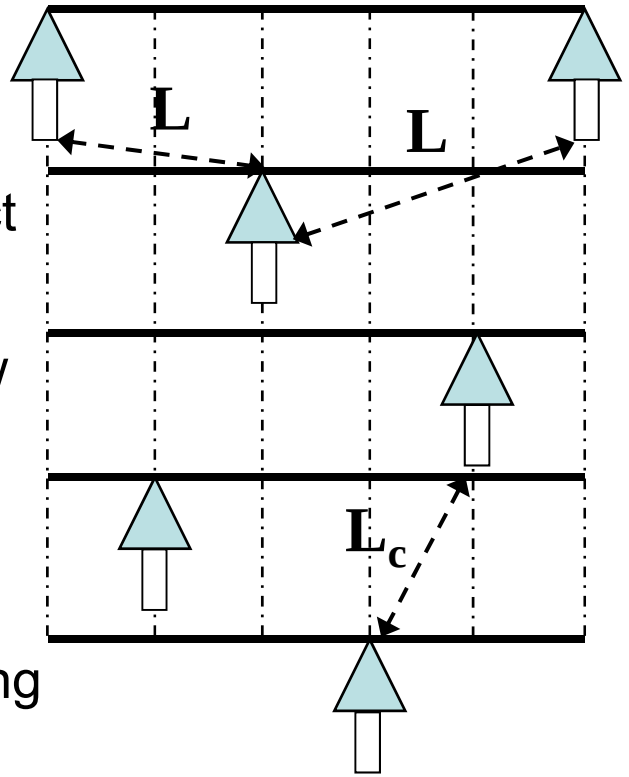
Improving existing seeder tines

- Helpful add-on equipment:
  - residue guard, *Pig's Tail*™ polymer protective wrapping
  - residue cutting coulters (only if they effectively cut residue)
- Wider row spacing (+ paired row seed banding)



Tine layout guidelines

- Minimise number of clump interactions with tines ➔ facilitate free shedding & minimise contact time - clump size is proportional to contact time
- Inter-tine spacing (L) varies with rank spacing, row spacing, number of ranks & tine layout
- Smallest value = bottleneck of the layout = <u>critical inter-tine spacing</u> (L_c)
- Larger clearances expected for wet, heavy standing stubble (>4.5-5t/ha) & at rear of seeder



- <u>Approximate guidelines</u>:
  L_c = 1.8-2 x residue length should be non-restrictive in most instances
  L_c = 1.3-1.5 may be sufficient to avoid blockages up to 4-4.5t/ha

Stubble reduction – harvest and post-harvest options
e.g. stubble mulching and cutting

4-4.5 t/ha stubble (Hart field site)

INTER-ROW SOWING improves residue handling capacity

- ➔ 2cm RTK tractor autosteer + stable implement tracking required
- ➔ additional passive / active implement guidance solutions
- ➔ row spacing > 23-25cm

Inter-row

On-the-row

Take Home Messages: Tine Seeders

- Residue handling capacity is improved by:
  - ➔ maximising tine vertical clearance and inter-tine distances within the layout (in balance with each other)
  - ➔ considering add-on guards and coulters
  - ➔ managing residue length (harvest and pot-harvest)
  - ➔ seeding at lower speed and in dry residue
  - ➔ accurately inter-row sowing
  - ➔ or sow at a diagonal to stubble rows and along direction of stubble lean

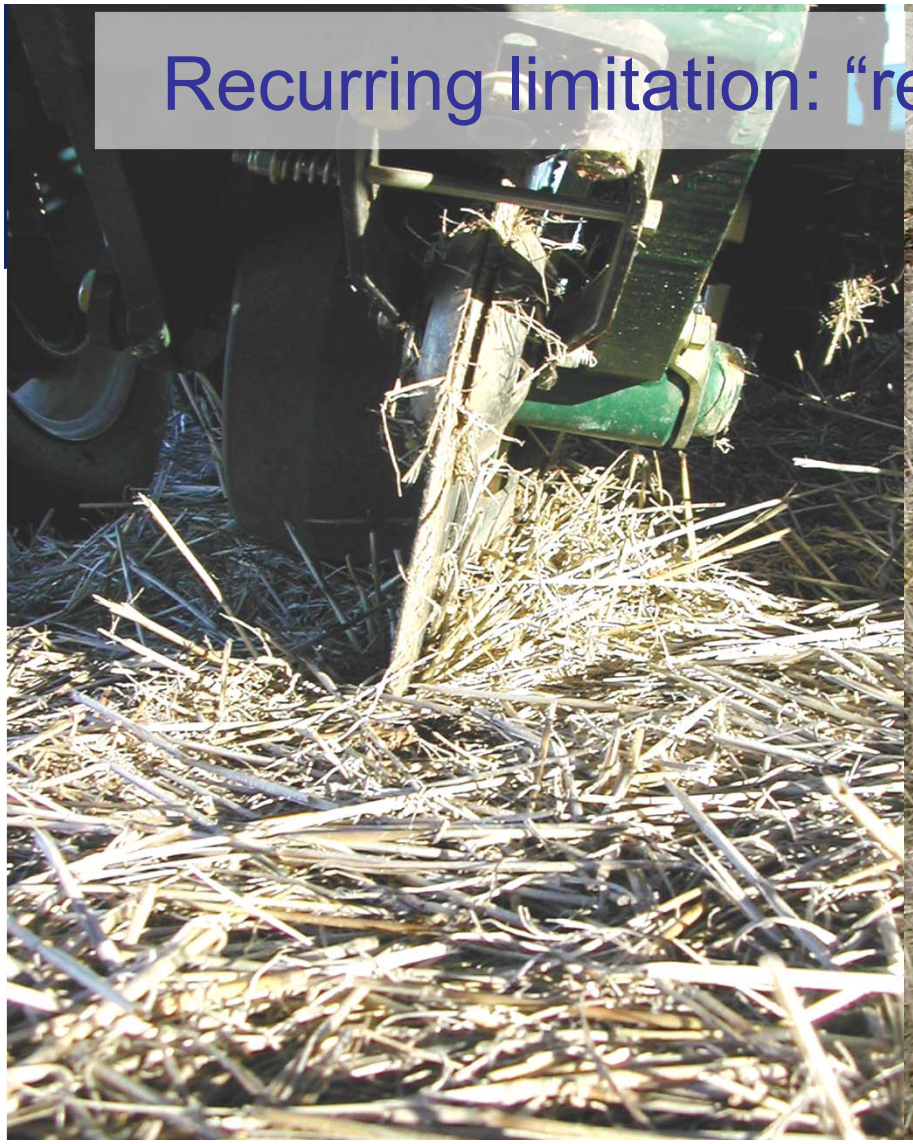
NOTE: The aim is to minimise residue clumping - not just manage blockage risks - in order to maximise crop establishment uniformity

Considerations with disc seeders

Key incentive for disc seeder adoption

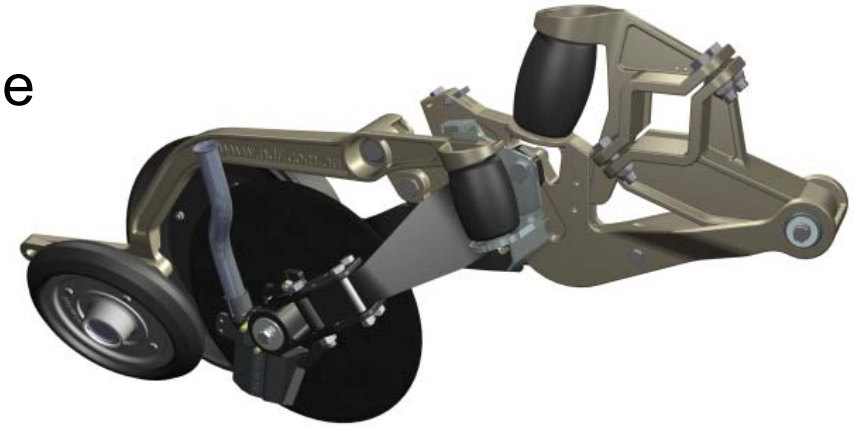
<<< Ability to retain heavy crop residue >>>

Recurring limitation: “residue hairpinning”



Residue hairpinning

- Hairpinning reduces seed germination and seedling establishment due to:
  - poor soil to seed contact
  - phyto-toxicity arising from residue to seed contact
  - highest risks to crop with pre-emergence herbicides (IBS)
  - premature drying of the seed zone (poor furrow closure)
- The ability to control hairpinning is central to the success of disc seeders.



Canola establishment ± residue

Barton single disc seeding system

Strategy for handling crop residue with discs

The aim is to optimise TWO complementary approaches:

i) Minimise the need for residue cutting

ii) Maximise the capacity to cut residue

Approach #1: Minimise the need for residue cutting

a. Minimise the residue load on the ground
   - maximise stubble height
   - uniformly spread all loose residue

b. Inter-row sowing to avoid the bulk of standing residue (issue of seeder tracking stability)

c. Use row-clearing residue managers to remove excess loose/matted residue

Residue managers (row cleaners)

Role: to remove ‘excess’ residue only

- Need contour following ability
- Need good floatation in soft soils
- Be sufficiently aggressive
- Better suited to wide row spacing
- More effective when running along stubble rows
- Can be set to generate some soil throw for herbicide incorporation and improved crop safety

Example benefits of row cleaners in canola

Soil type	Shallow clay-loam		Soft sticky clay	
Stubble condition	SLASHED (long) 2.5-3t/ha barley	SLASHED (long) 6-7t/ha barley	Mulched (short) 4-6t/ha	Standing (400mm) 4-6t/ha
Control	Burnt stubble = 100% crop establishment reference			
Barton disc	73%	56%	35%	45%
Barton disc + residue manager*	82-92%	61-76%	52-55%	--

Approach #2: Maximise residue cutting capacity

➔ Optimise disc and stubble parameters to improve the effectiveness of the residue cutting process

Residue cutting: stubble factors

- ✓ Wet stubble = low bending resistance + high shear strength
- ✓ Stubble decomposition decreases shear strength
- ✓ Cutting along stem direction - rather than across - is easiest
- ✓ Thick residue matting drastically increases cutting force requirements:

  ➔ Poor cutting & hairpinning can equally result from a lack of down-pressure capacity

  ➔ Soil penetration capacity and seeding depth are reduced when hairpinning happens

Residue cutting: disc blade factors

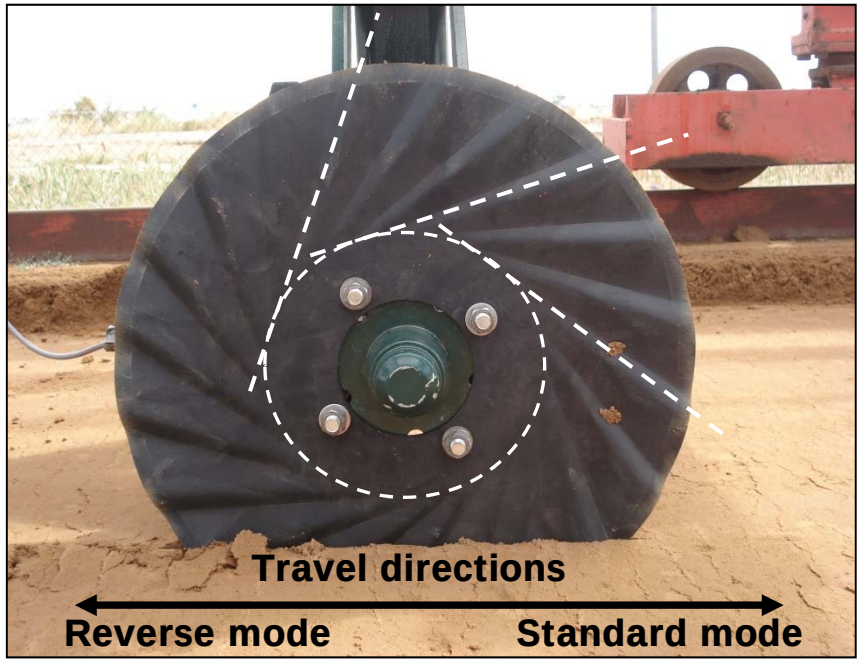
- ✓ Cutting process = wedging + sliding cut actions
- ✓ Effective wedging/parting requires a sharp cutting edge + strong soil backing
- ✓ Sliding cut component is maximised by disc blades with a high speed ratio
- ✓ for a given soil and residue condition, these two actions are best combined at an optimum depth

Optimising coulter operating depth

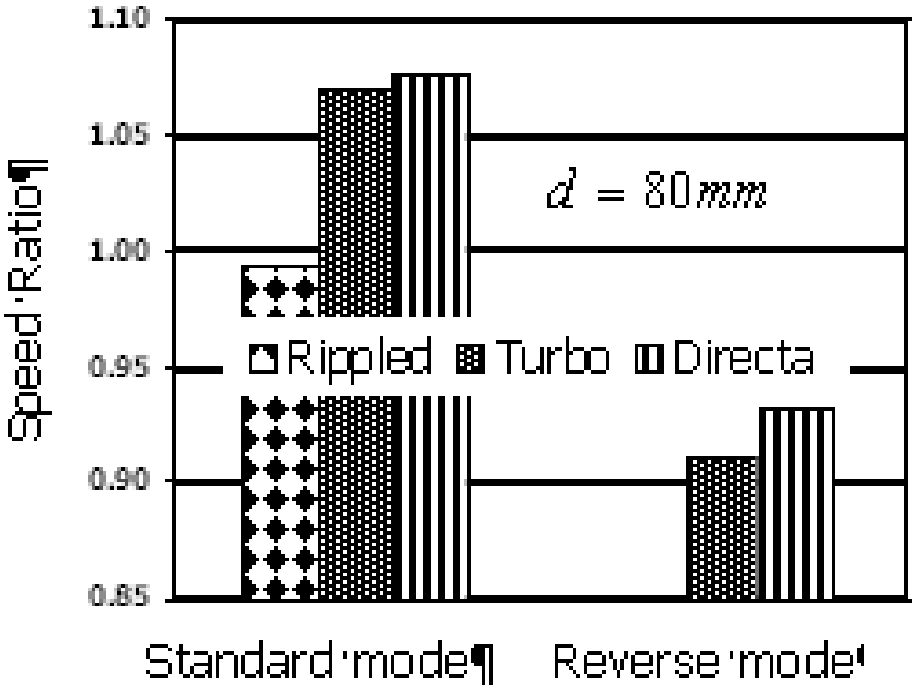
- ✓ Too deep: residue is pushed forward ➔ blockage, high draft & wear
- ✓ Too shallow: low/no residue cutting and tendency to hairpin

Maximising disc blade speed ratio

➔ example: tangential flute style blades

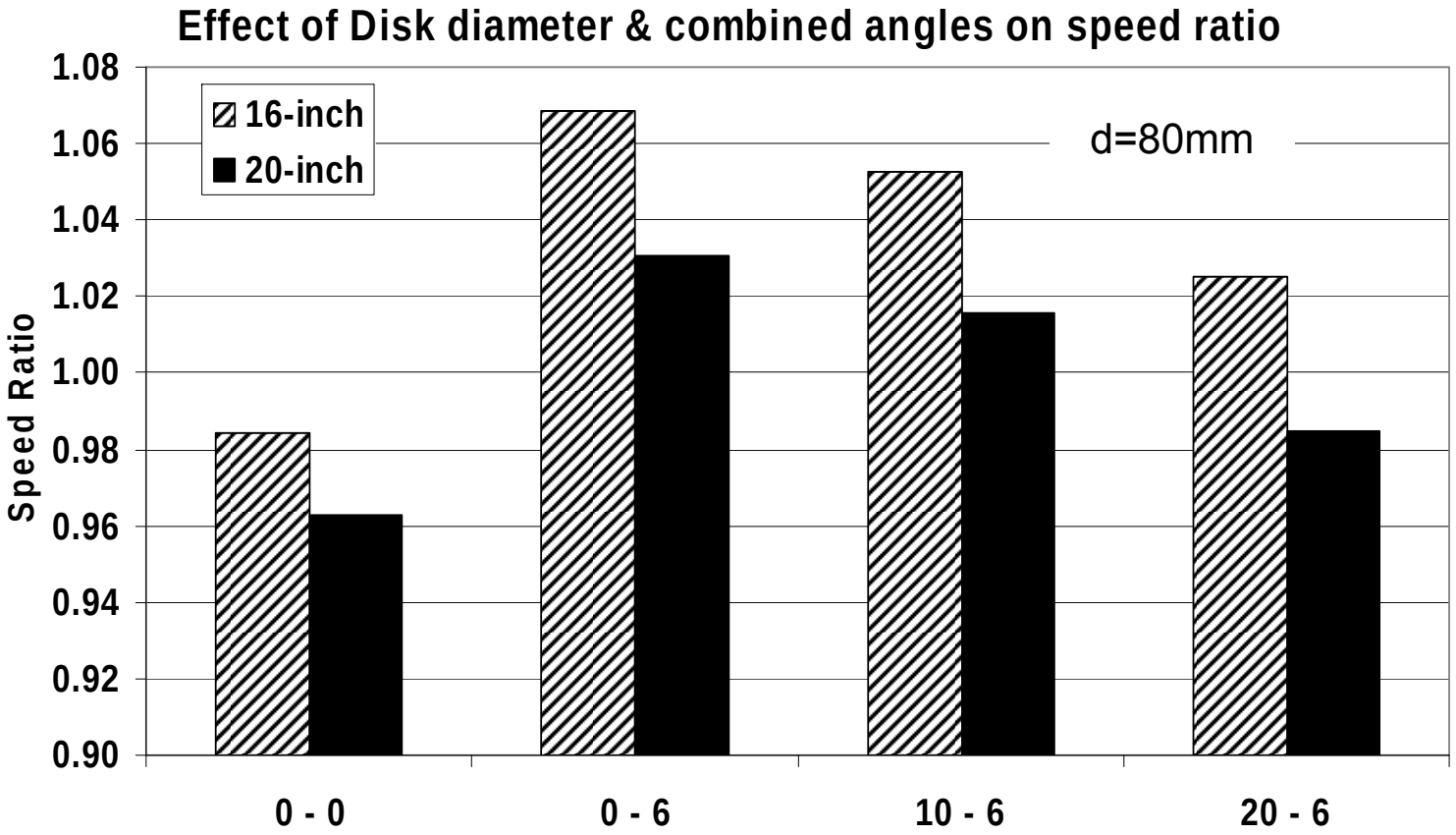


Directa blade
from Ingersoll - Argentina



Maximising disc blade speed ratio

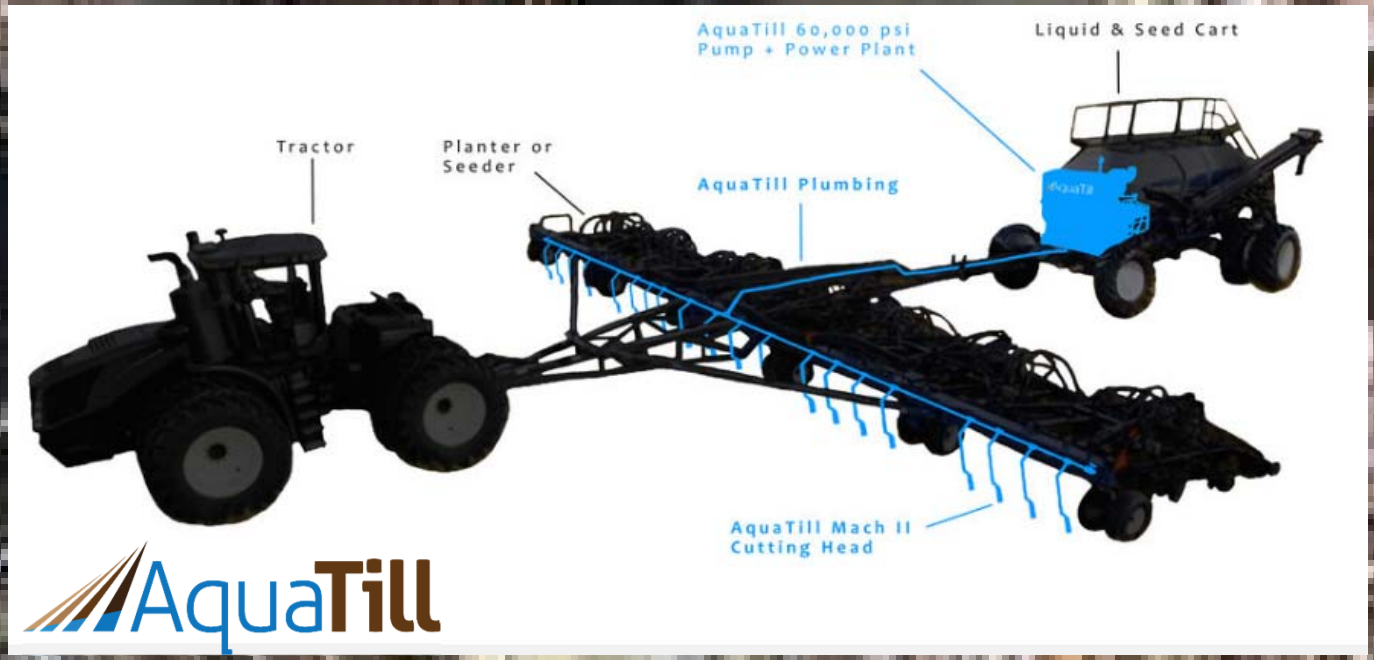
➔ with disc diameter and sweep angle



Take Home Messages: Disc Seeders

- Disc seeder residue handling capacity is improved by applying a two prong approach:
  i) minimising the need for residue cutting and,
  ii) maximising the residue cutting capacity.
- The ability to control hairpinning is central to the success of disc seeders.
- Residue managers and inter-row sowing are an integral part of better performing disc seeders.

Innovation: Aqua-Till liquid coulter



Thank You

Acknowledgments

University of South Australia

- Many GRDC, SAGIT and NLP funded seeding system research projects over the 1994-2017 period
- Seeding system equipment supplied on-loan by countless industry partners
- No-till associations, farmers, farming system groups and interdisciplinary research collaboration

GRDC
Grains Research & Development Corporation

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