issues & observations of inter-row sowing

the practice of inter-row sowing refers to crops being sown in-between the previous years' stubble and has been widely adopted by growers due to its compatibility with stubble retained systems.

satellite steering guidance systems (auto-steer) has been the driving force behind its adoption and the system can provide many benefits as opposed to more traditional diagonal or angle seeding across stubble.

benefits:
a study conducted by matthew mccallum (mccallum agribusiness consulting, south australia) found that inter-row sowing had a yield benefit in wheat crops of 6 per cent from 2004 to 2007. the yield benefit was largely due to a reduction in disease pressure, better plant establishment and possibly an improved micro-climate for wheat in standing stubble, for example more sunlight penetrating the stubble canopy promoting faster growth for seedlings and protection from wind.

inter-row sowing can reduce crown rot and root rot inoculum building up in infected paddocks. research by dr steven simpfendorfer (nsw dpi) has shown that sowing cereals between the previous cereal rows reduced the incidence of plants infected with crown rot by 45 per cent and the severity

key messages

- reduces the impact of diseases such as crown rot in wheat on wheat rotations.
- can reduce hair-pinning of stubble in disc seeders.
- improves trash flow through the seeding machine, especially with tined implements and heavy stubble loads.
- may reduce early uptake of residual nutrients from previous crop for the first year.
- may have less available moisture for seedlings than on-row on sandy soils.
- requires tractor guidance and stable instrument tracking.
- offers other potential benefits including improved water infiltration, increased timeliness of sowing and conservation (less erosion and an increase in soil organic matter) and fuel savings.
of disease by 51 per cent across sites from southern QL.D to Walgett (NSW), although he concedes the higher the amount of crown rot in previous cereal residue the higher the likelihood of the pathogen moving into the inter-row through stubble fragmentation. Inter-row sowing should be seen as part of an integrated disease management program and not as a form of control on its own.

In-crop spraying is more efficient in inter-row sown paddocks than those with slashed or mown stubble. Slashing stubble can reduce herbicide efficacy if more than 50% of the ground is covered by stubble residue.

However, in sandy soils with low levels of disease inoculum, on-row sowing may produce higher yields due to better moisture retention and wider availability of remaining nutrients from the previous year’s crop, particularly for seedlings.

Seeder setup:
Blockages are perceived to be one of the major issues with inter-row sowing, although modifications to the profile and tine layout can reduce stubble clumping and blockages. Straight shanks instead of curved shanks will ease the trash flow through the machine, while shanks that are slightly backwards leaning are effective for facilitating movement of trash through the machine. Inter-tyne spacing of approximately 60cm is suitable for 3-4t/ha of wheat stubble cut at a height of 35cm.

What GPS accuracy is needed?
The way to implement inter-row sowing is using a 2cm RTK system with a base station. This allows for repeatable accuracy.

The sub-metre auto steer (10-20cm) doesn’t allow for the same level of repeatable accuracy. It is important that the base station remains in the same location for a particular paddock year in year out. The auto steer program should have the ability to store and recall an A/B line for a particular paddock, as well as a nudge feature to move the required distance to inter-row sow.

Issues and observations of row spacing
Since the uptake of minimum till strategies, the ability to vary row spacing and sow within the inter-row has increased. However there are advantages and disadvantages to differing row spacing (Brendan Scott et al).

In Central West NSW, row spacings of 20cm on average are commonplace, with some farmers in drier areas opting for wider spacing (out to 30 cm). Further east in higher rainfall areas a reduction in row spacing is common, depending on what crops are grown.

Cereals:
Ultimately the impact of row spacing on cereal crops is largely dependent on the season’s rainfall, the time of sowing and the potential yield of the crop. If a crop has a high yield potential then there is a greater negative impact on the crop’s potential yield as the row spacing increases, with specific reference to wheat and barley crops.

In wheat on wheat rotations, diseases such as crown rot are less likely to move from the previous stubble zone to the new crop in wider rows. However, in many areas a reduction in the size of row spacing can result in an increase in crop yield.

It should be noted that by reducing row spacing other issues may arise at sowing (such as blockages in machinery).

Crops that are grown on wider row spacing often tend to grow taller, which may leave them vulnerable to lodging later in the season.

Pulses:
Pulses often exhibit a positive response to row spacing out to a width of 25 cm in low rainfall areas and 35 cm in high rainfall areas (GRDC 2011).

However, different pulses can exhibit different behaviour. A paper by South Australian No-Till Farmers Association (Santa) in 2013 titled “Many Variables in Row Width Equation” explores row width trial results on both grain and pulse crops across Australia including Central West NSW.

The benefits of wide row spacing in lupins include:
- The ability to sow into large amounts of stubble.
- Obtaining more stable yields in low rainfall environments.
- The potential use for inter row spraying for better weed control.

Rows that are wider than 50 cm have a higher yield potential when compared to the narrower rows in warm, dry environments of low to medium rainfall. This is a direct result of the crop using less water during the winter period, which leaves more soil moisture for the pod filling period.

Narrower rows (less than 50 cm) are much more likely to yield better in cooler, longer season climates. Pulses such as peas and lentils that are grown on a wide row spacing of 30-60 cm generally have a greater podding height. It should be noted that harvesting height can also be improved by using stubbles to form a trellis by inter row sowing.

Soil moisture:
By reducing the width of row spacing it is possible to conserve more moisture and minimise the degree of evaporation by increasing the rate of canopy closure. In conditions where wider row spacing is preferred, stubble mulching within the inter row can be used to alleviate the negative effects of evaporation.

Research has shown that water use by wheat and barley was unaffected by the row spacing. However, faba beans in wider row spacing have been observed to use less moisture during their early growth stages which left more moisture for grain filling.

Weed control:
Farmers that have adopted wider row spacing have been experiencing higher weed burdens within the inter-row, with ryegrass being the main weed issue. By increasing the size of row spacing the crop’s ability to close the canopy and to begin to shade out the weeds is limited.

Glen Riethmuller (DAFWA) demonstrated in 2005 that reducing crop row spacing from 27 cm to 18 cm resulted in a 38 per cent reduction in ryegrass seed set. A strategy to alleviate the issue may be the use of IFS herbicides that are concentrated within the inter rows.

Establishment:
There is a relationship between the responses of cereals and broadleaf’s to row spacing and the interaction with plant populations. As row spacing and seeding rate increases, the distance between seeds declines. This can impact on the final establishment for the crop.
Case study 1:
Grower: Graham Mason  
Location: ‘Westcourt’, Ungarie, NSW  
Enterprises: Continuous cropping, wheat, vetch, canola, barley, lupins  
Soil and pH: Red soil with a pH of around 5  
Property size: 2500 ha.

Overview:  
Graham follows a continuous cropping, no-till farming program. Some of his country is trending to acidic so he is currently liming those areas. He last limed ten years ago and has only just seen country slipping back.

Most of Graham’s cropping is done on a controlled traffic system and has been for nearly ten years, except for some paddocks that have issues with contour banks and rocky areas.

Issues and observations of controlled traffic farming:  
One issue with controlled traffic farming Graham has noticed is the occasional need for renovating his tram tracks which are currently becoming quite depressed. However, he sees this as an opportunity to use a green manure crop on these paddocks before cultivating, as well as the chance to use different chemical groups with pre-emergent prior to sowing the following crop.

Levelling of tracks is only done about every ten years. One of Graham’s primary motivations for moving into controlled traffic farming was after converting to a disc seeder and finding it gave him a less than optimal performance behind a heavy tractor even in header tracks. By using tram tracks, his sowing efficiency with the disc seeder was greatly improved.

The ability to inter-row sow was also a key factor in his decision, allowing him to accurately sow with 2 cm accuracy. Graham sees a huge advantage in being able to accurately sow between stubble rows; sowing into clean ground and avoiding stubble contact, yet still retaining the stubble.

Smaller seeds (such as canola) germinate more evenly without stubble contact in the soil, as well as not being covered by stubble. His system is still evolving and Graham feels it will keep evolving as things change. He has encountered herbicide resistance developing with ryegrass and black oats and used a tyned implement as a control strategy. However, it then created problems switching back to a disc implement – so he is certainly finding challenges and limitations within the system he needs to overcome.

Another control strategy he uses for resistance is brown manuring vetch (varying his chemicals) which gives 100% control of weeds as well as supplying nitrogen and organic matter to his soils. He then follows the brown manure with canola which gives two years of good weed control. As stubble from previous crops builds up in the rows Graham has found a disc seeder to be superior over a tined implement in slicing through any old remaining crowns that may be present.

If a tined implement must be used Graham may slash a paddock to aid in faster stubble breakdown. Although he has not physically recorded fuel usage differences between tram track and conventional, Graham has noticed the engine of the boom spray working much harder if it deviates off the tram tracks.

Off-row seeding and moisture availability:  
With the adoption of auto steer technologies, growers are now able to accurately place the seed wherever they see fit.

In drier areas of Central West NSW, minor improvements in soil wetting around the seed can lead to major improvements in crop establishment. Wetting around the seed can be achieved naturally by more available stored moisture under the previous year’s standing stubble.

Studies indicate that under no-till systems, old and current crop rows provide pathways for water movement within the soil profile. Stubbles leave behind crowns, root channels and bio pores that are all capable of trapping moisture within the stubble zone. These factors are capable of improving the soils wettability.

However, it must also be considered that disease transference could be an issue with cereal on cereal crops and hair-pinning may occur with small seeds such as canola.

Benefits of wider row spacing:  
A great deal of no-till operations are sowing cereals and canola on 20 to 30 cm rows and pulses on 30 to 65 cm rows between the standing stubbles. Before adjusting row spacing it is important to do an economic analysis by the use of a benefits and costs analysis by the use of a benefits and costs savings on fuel, a controlled traffic system may be beneficial depending on soil type, farming enterprises and machinery set-up.

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- **Benefits of wider row spacing:** A great deal of no-till operations are sowing cereals and canola on 20 to 30 cm rows and pulses on 30 to 60 cm rows between the standing stubbles. Before adjusting row spacing it is important to do an economic analysis by the use of a benefits and costs comparison. Not every system suits every farm and individual considerations should be taken into account. To obtain the full benefit of inter-row sowing, including savings on fuel, a controlled traffic system may be beneficial depending on soil type, farming enterprises and machinery set-up.

   - **The ability to inter-row sow was also a key factor in his decision:** Allowing him to accurately sow with 2 cm accuracy. Graham sees a huge advantage in being able to accurately sow between stubble rows; sowing into clean ground and avoiding stubble contact, yet still retaining the stubble.

   - **Smaller seeds (such as canola) germinate more evenly without stubble contact in the soil:** As well as not being covered by stubble. His system is still evolving and Graham feels it will keep evolving as things change. He has encountered herbicide resistance developing with ryegrass and black oats and used a tyned implement as a control strategy. However, it then created problems switching back to a disc implement – so he is certainly finding challenges and limitations within the system he needs to overcome.

   - **Another control strategy he uses for resistance:** Is brown manuring vetch (varying his chemicals) which gives 100% control of weeds as well as supplying nitrogen and organic matter to his soils. He then follows the brown manure with canola which gives two years of good weed control. As stubble from previous crops builds up in the rows Graham has found a disc seeder to be superior over a tined implement in slicing through any old remaining crowns that may be present. If a tined implement must be used Graham may slash a paddock to aid in faster stubble breakdown. Although he has not physically recorded fuel usage differences between tram track and conventional, Graham has noticed the engine of the boom spray working much harder if it deviates off the tram tracks.

   - **His advice for anyone moving into a controlled traffic system is to make sure the tracks are suitable to header use as it is this component which is an integral part of avoiding soil compaction.**

   - **Soil health:** The benefits to soil health of controlled traffic farming that Graham has observed is a far better retention of moisture in his soils, with soils being softer and much more friable.

   - **Listen to a podcast of Graham’s case study or follow the link below:**

Case study 2:
Grower: Nick Eckermann
Location: ‘Hillview’, Rankins Springs, NSW
Enterprises: Continuous cropping
Soil and pH: Loams with a pH of 5 to 5.5
Property size: 10,000 ha

Overview:
The Eckermann’s are broad-acre croppers and have not run livestock for ten years. They felt they were compromising their farming country by running livestock in a mixed farming operation due to soil moisture decisions and compromises with weed management; deciding to concentrate purely on a stubble retained cropping system.

Issues and observations of controlled traffic farming:
Nick explains they are not 100% controlled traffic farming at this stage. They work on a twelve metre system but still use duals on their main tractor and header, though everything is confined to a designated wheel track area.
Nick considers their operation currently in a conversion phase and can see their future cropping enterprise being 100% controlled traffic.
They currently renovate their tram tracks (sow over them) as it better suits their soil type rather than leaving them bare.
The Eckermann’s primary motivation for moving toward controlled traffic farming was the desire to improve their soil’s water retention capability and keep soil compaction to a minimum, after gaining information from various sources.
The practice has evolved over a five or six year period with the existing machinery spacing suitting the transition.
Areas where they using controlled traffic are already showing a marked improvement in water infiltration and retention, resulting in increased crop yields over the traditionally farmed areas.

Reduced fuel use has not been noticeable to this point, though Nick is aware that single wheel permanent tracks would undoubtedly give more efficiency.
Taking on new country a few years previously that had been conventionally farmed in a mixed farming operation, Nick observed the soil was not as friable or as easy to work as the country they had farmed using no-till methods for some years.

Issues and observations of inter-row sowing:
The Eckermann’s began inter-row sowing in 2006 and had good success using one bar on a 30cm spacing.
Then in 2010, they switched to a disc sowing system on 50 per cent of their planting operation but found they had more difficulty keeping within the rows with this system.
They returned to a single bar system but this year are incorporating a satellite steering guidance system into their farming plant which will simplify the operation considerably.
Nick is not considering changing their row spacing, being happy with where they are at now. He feels that with a guidance system the rows filling should not be an issue. It should also make sowing of small seeds such as canola easier and improve germination as they have tried most stubble management techniques in the past, but inter-row sowing is by far the most effective.

Break crops play an important role in their cropping program, largely for disease control. Depending on seasons and markets between 25% and 40% of their country is sown to alternate crops of wheat, canola if soil moisture is sufficient and various legume crops which he prefers. Flexibility remains the key.

Weed resistance is starting to become an issue and Nick has been using windrow burning the past couple of years as a new tool to combat this. He is also growing vetch for brown manure or hay as another management option in paddocks where there is suspected annual ryegrass resistance.

Soil Health:
Nick is focused very much on stubble retention in his cropping program and does not consider full burning of stubble a viable tool. Even if the stubble load is over three tonne a hectare (an amount possibly detrimental to the following crop) he would rather take a short term yield loss for the longer term benefits to the soil.

Some of their lighter country can blow if ground cover is insufficient. This, combined with increased soil retention and organic material is the reason Nick and his family are determined to tackle the many challenges of inter-row sowing and full stubble retention.

Listen to a podcast of Nick’s case study or follow the link below:

Case study 3:
Grower: Geoff Chase
Location: ‘Waitara’, Tottenham, NSW
Enterprises: Angus cattle stud and commercial herd, wheat, chickpeas, faba beans, lucerne hay, fodder (which is brown manured for fallow as well as grazing).
Soil and pH: Self cracking grey clay soils with a pH of 7.8 – 8.
Property size: 7,500 ha.

Overview:
Geoff manages the cropping enterprises on ‘Waitara’ while his son and daughter-in-law manage the Angus stud and cattle operation.
Geoff runs a controlled traffic farming system with everything on three metres, apart from chaser bins.
The cattle are allowed to briefly graze stubbles providing the top 100 cm of soil is dry. He finds it helps to control surviving weed seed and in years of heavy stubble load can break up and spread the straw for the following crop, although he prefers standing stubble in most years. Paddocks are rarely cultivated, on average once every eight years or so to regenerate paddocks and allow for incorporation of pre-emergent spray.

In the past couple of years Geoff has moved away from canola in favour of faba beans as a break crop; for better nitrogen fixation and soil friability, though his core crop is wheat. He has sown more chickpeas than usual this year due to the strong prices.

Issues and observations of inter-row sowing:
Geoff began inter-row sowing about eight years ago. In the early days he was able to accurately sow about 85 per cent of crop between the rows of the previous crop and immediately saw the advantages of doing so.
One advantage he quickly realised was that sowing between the rows of stubble proved easier on the machinery and used less fuel. Another was the more accurate placement of seed, with no stubble to interfere with depth and seed soil contact.

Additional benefits were avoiding contact with stubble from the previous year when sowing wheat on wheat, particularly when yellow leaf spot was present.

Then four years ago, he purchased a disc planter on 50cm spacings to make the practice easier again. The wider spacing allows for crops to be inter-row sown in successive years with no stubble contact. Although this method perhaps reduces yield slightly in wetter years he feels this is compensated by increased yields in drier seasons.

Reduced canopy cover in later sown crops has not been an issue as they are able to sow on time with the efficiencies of controlled traffic farming.

Fuel usage has been reduced even further with the disc seeder combined with controlled traffic farming and he now uses up to a third less fuel than when farming conventionally.

With signs of weed resistance (ryegrass) starting to appear, Geoff is now mixing his chemical groups and also spraying fence lines to control all volunteer weed seed set.
He has also set up the header for narrow windrow burning and this is a tool he’ll use into the future.

Soil Health:
Geoff classifies himself as a conservation farmer and since switching to no-till and controlled traffic farming he has noticed a distinct improvement in his soil structure, being more friable with better moisture retention.
Geoff puts sustainability and profitability together and thinks they go hand in hand. He has been cautious about pushing for maximum profits at the expense of soil health and in ten or fifteen years hopes to

Still be improving his farming methods, increasing diversity and remaining flexible in his approach to utilizing all tools available. His advice to other farmers contemplating change in their farming practice is to set goals and try to achieve them, but not to become too rigid in implementing new ideas if markets or seasons are adverse to a certain decision.

Listen to a podcast of this case study or follow the link below:
Case study 4:

Grower: Roger Todd
Location: ‘Wirrinun Pastoral Company’, Condobolin, NSW
Enterprises: Controlled traffic farming on 2500 ha plus mixed farming with agistment stock.
Property size: 5000 ha.

Overview:
Roger runs a controlled traffic farming system with a six year rotation of long fallow, canola, wheat, chickpeas and barley. He tends to stick with this rotation regardless of what markets are doing, only replacing (chickpeas and canola) with long fallow in extremely dry years.

He sows at 30cm spacing on a three metre wheelbase, with a twelve metre disc seeder and a thirty six metre boom spray. Moisture retention is the driving force behind most of Roger’s cropping decisions.

Issues and observations of controlled traffic farming:
Roger was motivated to move into controlled traffic farming in 2003.

His red soils compact quite easily and the combination of no-till and tram tracks have allowed for improved water infiltration into his farming country, particularly during summer storm events.

He renovates his tram tracks about every six years and uses that as a chance to incorporate lime (after chickpeas and before wheat) and gypsum (before canola).

The tram tracks have given Roger noticeable fuel savings. On established tram lines he is using 2.5 l/ha of diesel, compared to 5 to 5.5 l/ha on the mixed farming country. Another benefit of CTF is that in wet seasons he can get on country quicker than conventional farming, with only some areas of headlands becoming boggy.

Issues and observations of inter-row sowing:
Inter-row sowing was not a driving force to Roger adopting controlled traffic farming, although he finds it a convenient tool. He finds his stubble loads are usually not excessive in the majority of years and his disc seeder can handle it well. Hair-pinning has not been an issue when stubble is knocked down.

One thing Roger has noticed is that where stubble has been knocked down as opposed to standing, he is seeing more vigour in germinating crops, except for chickpeas. He puts this down to less shading and is contemplating knocking more stubble down in coming years to open the canopy. He would prefer that to burning and although a late, cool burn is an option, he is aware of the nutrients that are being lost in doing so.

He is also exploring his sowing direction, currently sowing half his crop in a north/south direction and half east/west.

Disease is not an issue Roger has had to deal with as his rotations keep carry over to a minimum. But he is finding the rows are starting to fill with remaining stubble of previous crops, again prompting him to knock stubble down for more rapid decomposition.

Soil Health:
The main driver for Roger is retaining moisture and he has no doubt that his profitability due to increased yields has increased through the adoption of controlled traffic farming.

(Phone interview conducted April 2016)

Latest research & updates

Implement guidance:
New use of auto-steer technology has now included the ability to have a seeder steer partly independently of the tractor pulling it. This extra accuracy is particularly useful in narrow rows and in avoiding two or more years of remaining stubble.

Implement guidance falls into two categories - passive guidance and active implement guidance.

Passive guidance combine GPS data from mounted receivers on both the tractor and implement to auto-steer the tractor such that the implement always remains on the intended guidance path. This is the cheapest option but requires the tractor to move on and off track to keep the implement on the targeted path. It is best used combined with a stable seeder bar to minimize transient and random drift.

Active implement guidance systems guide the implement independently of the tractor. Active implement guidance is more expensive but the extra accuracy may be warranted to improve cropping returns. This auto-steer is achieved by either a hitch correction where the tractor draw-bar or the implement hitch tongue is hydraulically adjusted side-to-side to guide the implement, or by an implement steering kit which actively directs the implement frame over the guidance path using steerable wheels or disc blades to generate a corrective force.


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- “Crop Placement and row spacing fact sheet” (GRDC)
- Glen Riethmuller (DAFWA)

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