Matching Machinery for Controlled traffic farming

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The basic principle of controlled traffic farming (CTF) is to match as many wheels as possible so that machines run on firm compact tracks and crop is able to grow happily in un-compact zones. About 70% of the paddock maybe wheeled in one season of an unmatched minimum till system compared to only 11% in a fully matched CTF system.

Machinery design in the past has not focused on matching widths for all operations therefore the thought of matching machinery is often very daunting and puts many people off developing a controlled traffic system. However "Rome was not built in day" so neither does your controlled traffic system need to be.

Following the steps outlined below will help you develop a machinery investment plan to suit your farm business.

Steps to develop a machinery investment plan
1. Decide on imperial or metric measurement
2. Select an operating width & match in multiples
3. Match the tracks
4. Choose the type of wheel track you want to leave?

1. Decide on imperial or metric measurement

Many of the early controlled traffic farming adopters have discovered 9 metres is not 30ft. A 30ft front is 9.14m, a 40ft front is 12.2m, and therefore it is easiest to choose one or the other measurement to use to avoid miscalculating. Sprayers are often in metric with 50cm nozzle spacing so matching to an imperial seeder can be a challenge. Converting the sprayer to imperial 20" (50.8cm) may be cheaper than converting headers or seeders. For soil applied herbicides the best nozzle position is either on top, or central between, previous stubble rows to reduce losses on the standing stubble.

2. Select an operating width & match in multiples

The ideal machine work to from, as a base, is the header. The header is one of the heaviest machines used in farming operations with a full capacity of approx 10 tonnes of grain. It also has the widest wheel base usually about 3m and some new models cannot be modified less than this. Some may argue that compaction does not occur at harvest when the soil is usually dry but it only takes one wet harvest for the residual compaction to have a lasting effect for many years and loose sands do compact at depth when dry. Research in Eastern Australia has found harvest compaction may cause 15-24% yield penalty (Neale).

The easiest machinery width ratio to operate is a 3:1 ratio. See Figure 1. This works very well for smaller operating widths for example:

a) 30ft header front, 30ft airseeder bar, 30ft spreading and 90ft boomspray
b) 12m header front, 12m airseeder bar, 12m spreading and 36m boomspray
c) 40ft header front, 40ft bar, 120ft boomspray

Setting the bar width to match the cutter bar of the header is important to prevent the header front not being full, as often the point guards on the front are wider. Header fronts may be custom made up to 60ft. Spreading widths may not also match particularly for lime where 8-9m is the recommended spreading width for all but the latest spreaders.

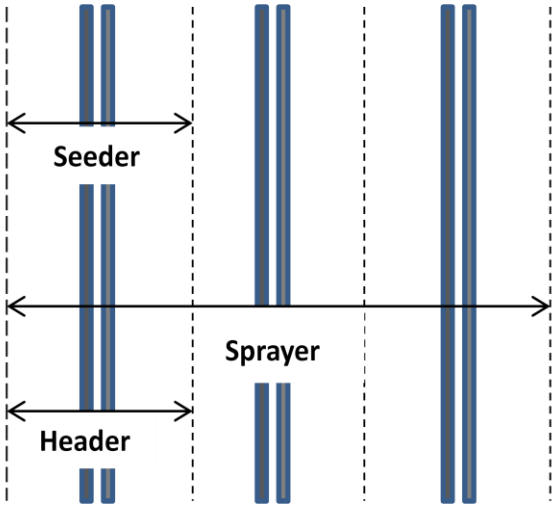

Figure 1. 3:1 seeder bar/header to boomsprayer ratio.

Larger airseeder widths of greater than 50ft are harder to match at a 3:1 ratio to include the header. For larger machinery a 2:1 matching ratio is an option.

The 2:1 boomspray: air seeder bar ratio can be tricky on the edge of the paddock but can be done by shutting off sections of the boomspray (Figure 2). Consider how many sections would be ideal when upgrading your boomspray.

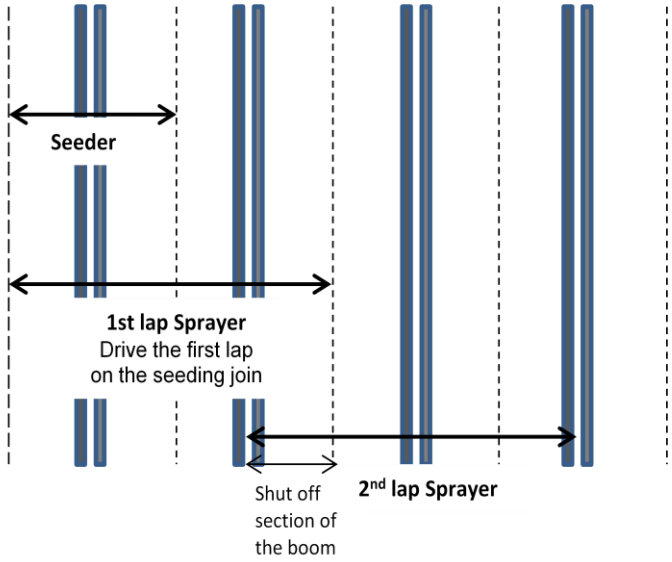

Figure 2. 2:1 seeder to boomspray matching ratio

An alternative to shutting off sections of the boom is to make spraying tramlines in the wings of the air seeder bar and drive down the seeding joins. This can be effective if you have a 17.6 m bar, 35 m boomspray and a 9.1 m harvester. Alternatively Figure 3 shows a compromise at the edge of the paddock to allow normal use of tramlines after the first pass with the boomspray.

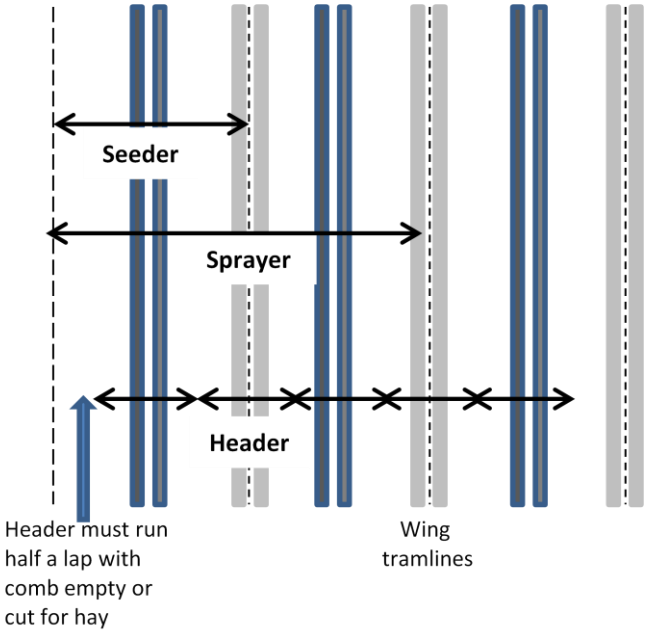

Figure 3. 2:1 seeder to boomspray matching ratio including the header eg 60ft seeder, 120ft boomspray, 30ft header.

Another option proposed for larger seeders is to match the header in multiples of the boomspray 3:1 and the seeder to the boomspray 2:1. For example 40ft header, 120ft boomspray and 60ft seeder. In this way the seeder will run on tramlines every second run See figure 4. This does mean there will be a compromise of the edge either of the paddock with either the seeder double seeding half a width on the second run or the header and boomspray do part passes. Some airseeders may have section control to avoid double seeding. Alternatively you could skip over to the 4th header wheeltrack after the first seeding run and then fill in the second run with only a slight overlap.

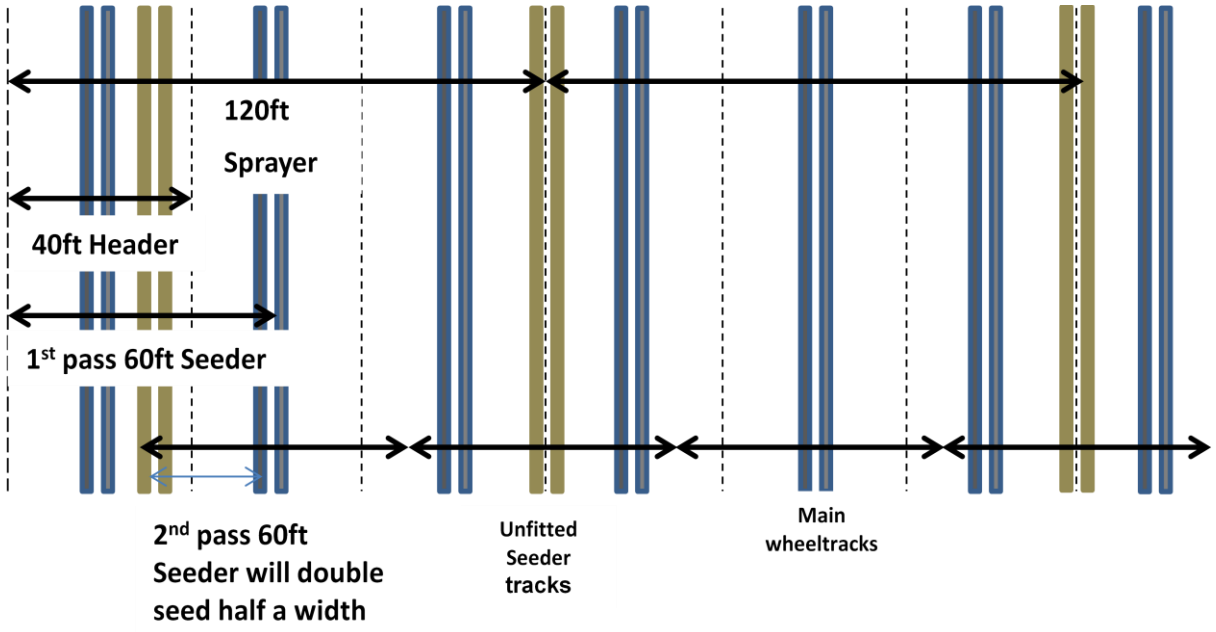

Figure 4. Matching of a header and boomspray 3:1 and boomspray to seeder 2:1

Seeders are getting wider (>60ft) as the wish to get as much seed in as quickly as possible is increasing in lower rainfall areas where the seeding window with good moisture conditions is narrow. It is possible to increase the seeding capacity of a 12m seeder to equal an 18m system

by increasing speed and capacity (Blackwell et al 2013). Capacity at seeding can be increase by increasing forward speed, aircart capacity or loading rate when filling. See figure 5.

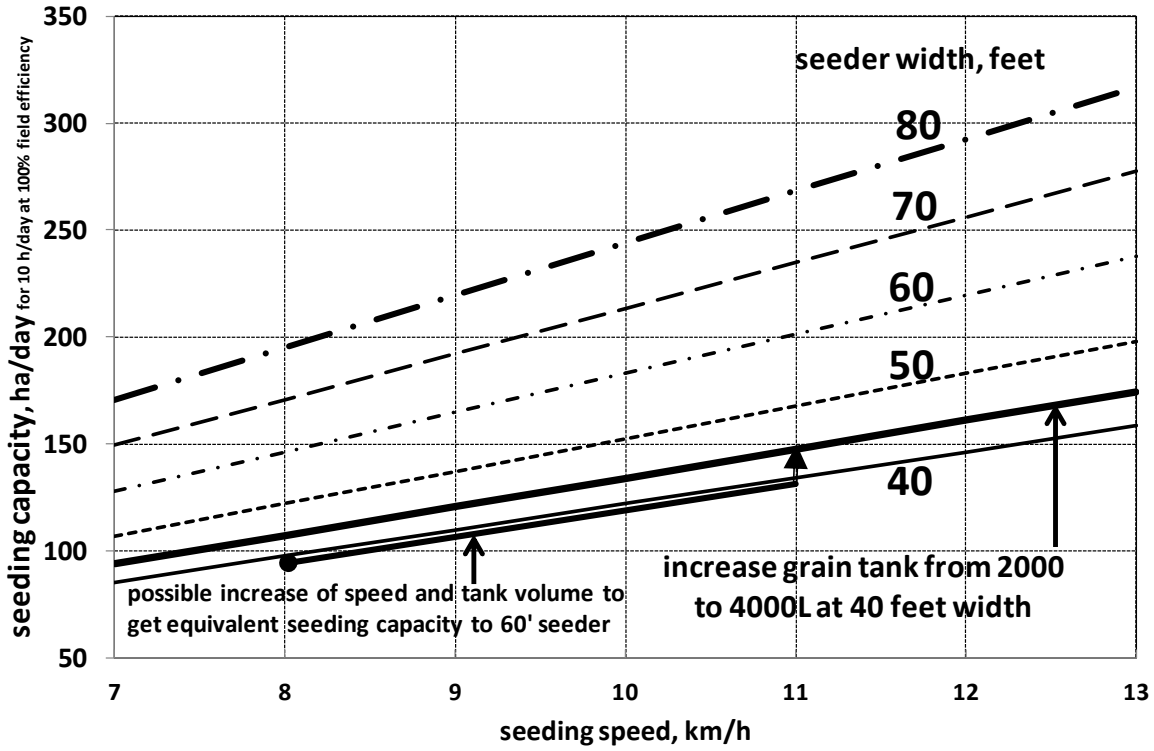

Figure 5. Calculated effect of seeding speed and seeder width on seeding capacity 10 hr/day and 100 per cent seeding efficiency. The anticipated benefits of speed increase and loading frequency are shown as a path with arrows. Doubled air bin size assumes a current downtime of 20 minutes to prepare for refill and restart seeding. The number of refills is halved, giving 50 per cent less time when not seeding or loading (from *Blackwell et al. 2013*).

Other strategies used by growers include:

- widening row spacing and using a twin or fuzzy row rows of crop to allow the seeding speed to increase (eg 15 inch row spacing could increase speed by 20%),
- plan to eventually double the bar width eg 30ft to 60ft or 40ft to 80ft,
- increase seeder width to 1.5 times so every second run fits permanent wheeltracks eg 40ft to 60ft
- run 2 seeders with smaller tractors although this is an extra cost that needs to be considered.

Options for modifying machinery width include (exert from Webb et al 2004):
Boomspray — Changing the width of a boomspray may be as simple as adding a tap or clamp to reduce the spraying width or small extensions to increase it.

Air seeder bar — It may be possible to remove tines or discs to reduce the width or extend the frame to add more tines or discs.

Spreader — Adjust the throwing distance of the spinners, which is often difficult beyond 18 m. Otherwise change to an air spreader system with suitable ease of loading.

Harvester front — Wider harvester fronts are normally offset to assist unloading. Centred fronts are required for the best tramline layouts. Some engineering companies are offering modification of offset fronts.

Otherwise change the front or the harvester. There are now centred belt front harvester fronts available up to 14 m. However, to unload into a chaser bin on the run the auger may need to be lengthened or extensions added to the chaser bin. Prices vary depending on width, platform type and options required. For example, a 12.5 m centred draper front with a bat reel begins at approximately $110,000 plus GST (2013 price www.midwest.net.au/platforms.htm).

Deep ripper — Some increase of deep ripping width, for the same tractor power, may be possible when tines are lifted or removed from where the wheeltracks are needed. Matching the ripper to a wider air seeder may also be possible by using guidance to rip with two lifted tines where the tramlines go (in the central part of the air seeder width), then modifying the width of the ripper and dropping the two lifted tines to rip the miss between. For example, for a 12 m seeder and a 9 m ripper, the ripper first runs on guidance at 12 m spacing with the two tines lifted for the unripped tramlines, then the two tines are lowered, the ripper folded to rip 3 m and the gaps between the first runs are ripped out. Some are using ripping tines at 50cm spacing to fit between 25cm rows, which allows a wider ripper to be pulled.

3. Match the tracks

Wheel track spacings are commonly 3m or 2.2-4 metres. 3m is around the ideal spacing as this will incorporate the header. There is an increasing range of machinery that can come from the factory set at 3m. It is important to check that the machinery can be modified to have a wheel track of 3m. Be aware that not all manufacturers will warrant machinery modified to 3m so check the warranties for each machine and follow the appropriate occupational health and safety standards. 2.2m wheel tracks are usually used in systems that only match the seeder and the sprayer. While this is a great start, with experience CTF farmers have found they will eventually move out to 3m to include the header and wish they had started from there. Remember that wheel tracks can be changed if need be although depending on soil type compaction may need to be removed mechanically.

On-farm costs of modifications on WA farms have ranged from $2,000-10,000 (Webb et al 2004). Some options for modifying wheel tracks out to 3m include *(exert from* Webb et al 2003) :

Boomspray — It may be possible to move and strengthen the axles. Hydraulically adjustable axles (2–3 m) are commercially available that will extend or retract the axle for more convenient road travel. Alternatively, change the sprayer, especially to a self-propelled model if moving to 3m tramlines.

Tractor (spraying, seeding and spreading) — use manufacturer's adjustments; extend and strengthen axles; use 'cotton reels' to extend front wheel assist axles; change to a tracked tractor with row-crop settings for a 3m wheeltrack. It is better to extend the axles because farmers who have used cotton reels to extend their front axles have reported increased wear on the wheel bearings. However, if the tractor is needed for other purposes such as mowing, the ease of removing the cotton reels to narrow the track is an advantage.

Photo 1 Cotton reels have been used to extend the axels to 3m on this JD4250MFWD Source: DAFWA Bulletin 4607 Webb et al 2004)

Seeding tractor — Duals can be removed within manufacturer's specifications to allow singles on 3 m centres. In some cases duals or triple tyres may still be required in the early stages of establishing permanent wheeltracks to help provide enough traction for deep ripping through the existing compaction. The additional wheels may also be needed for flotation in other parts of the seeding program. To confine most of the compaction to the main wheeltracks if the spacing is 2m increase the pressure in the inner dual tyres and reduce it in the outer tyres. The outer tyres then cause less compaction outside the wheeltrack and can improve flotation when off the track, such as on end workings, like trainer wheels on a child's bicycle. Be careful not to reduce the pressure in the outer tyres too much and cause tyre damage. Minimum tyre pressure specifications must be observed and the combined pressures must be sufficient to carry the total load. In 3m wheeltrack systems often the outer dual is on the tramline and inner off but tractor warranty might be affected by low inner and high outer tyre pressures.

It may be possible to offset the rims to change the wheeltrack spacing. Tracked tractors and self-propelled sprayers can sometimes be run on row-crop settings (3 m) and can thus match the track width of the harvester.

Spreader — the axles of the spreader could be modified using cotton reels or old truck rims or by extending the axles for 3 m tracks.

Harvester— It is difficult to change the axle of a harvester so most other machines must be modified to match it. The front wheels could be rotated on some older model harvesters. Access to grease points behind the wheels may be reduced on some models. The general rule to modifying harvester tracks is that the front wheels are set at their minimum track and the rear wheels follow within the wheel marks of the front wheels.

Chaser bins — Axles can be widened to fit wider wheeltracks, but the main difficulty is unloading the harvester while both are on adjoining wheeltracks. Rob Taylor of Dalby, Queensland has a catching hopper on the side of his chaser bin and a cross auger to distribute the load evenly (Photo 2). Old PTO harvesters can be converted into chaser bins which fit a 3 m track. The harvester auger must then be long enough to reach. For example, a 9.1 m harvester front can unload into a chaser bin on adjacent tramlines with a 6.7 m auger. It is possible to extend the augers of some harvesters to unload into a chaser bin (See Photo 3).

Photo 2-catching hopper and cross auger on the chaser bin to allow unloading from the wheeltracks
Source:www.precisionagriculture.com.au

Photo 3-Auger extended to allow unloading on the wheeltracks

Source: DAFWA Webb et al 2004

4. Choose the type of wheel track you want to leave?

The traditional wheel-track is left bare by removing the tines behind the wheels. Research has shown that the overall yield increase of the crop growing in un-compact soil and the higher yielding edge rows from better access to nutrients more than compensate for missing one or two rows of crop. However in cropping areas like Western Australia, where weeds and the risk of developing herbicide resistance are an issue, shallow seeding the wheel tracks is most common. Herbicides like trifluralin used to control ryegrass require some cultivation to activate. It may be that over time as the wheel tracks harden and become a hostile environment for growing crop the tines can be lifted and bare tracks left.

Setting up the bar row spacings for the wheel tracks(exert from Webb et al 2004)

When setting up the bar the guess row is very important to consider. The guess row is the gap between two neighbouring seeding runs, for example one row spacing. If the guess row is not considered when setting up the bar the gap between two neighbouring seeding runs can be too small or rows may overlap. The overall width of one seeding pass is obtained by measuring outside tine to outside tine plus half a row spacing.

Tine spacing does not have to be evenly spaced across the bar. A variation in tine spacing, such as rows between the wheel tracks closer together, can provide some extra in-crop guidance. This is particularly helpful if you do not have an accurate guidance system on all machines or if the guidance system is not working. Some farmers start by:
1. setting up the tines for a centre row or central gap in the middle of the seeder bar;
2. setting the tines in place around the wheeltrack and;
3. on the edges on the bar;
4. then fill in the gaps.

If you are going to change the row spacing between cereal and pulse crop or summer crops you may wish to keep tines more evenly spaced. If you are planning to include an inter-row shielded sprayer in the system, ideally the tine spacing needs to be the same on both sides of the bar.

The following row spacings work well if alternating between wide and narrow row spacings using 3 m centre wheel tracks:
- 38 cm/76 cm
- 25 cm/ 76 cm
- 25 cm/50 cm
- 19 cm/76 cm

If using 2 m wheel track centres try:
- 34 cm/101 cm
- 45 cm/101 cm

Inter-row sowing

Sowing between the rows for better stubble handling maybe one option to consider, rather than nudging the guidance system across. An offset hitch on the air seeder bar can be attached to move the bar left or right half a row spacing so the wheel tracks remain in place year after year.

Photo 4 a) The late Owen Brownley's offset hitch b) Mark Wandel's offset hitch

Conclusion

Before getting out the gas axe or welder a wise man once said "Measure twice cut once". This will avoid frustration when you find out you forgot to add the guess row or didn't measure the header front cutter bar, 2 very common errors.

Guidance is another key component of a controlled traffic farming system to keep machinery running on the same tracks. Mechanical guidance such as marker arms on the seeder are a low cost option. The ultimate guidance system for controlled traffic is RTK 2cm autosteer. The cost of these systems is very affordable now for broad-scale cropping with most new machinery is autosteer ready. Lower accuracy systems are able to be used however you need to keep in mind drift over a 24hr period. Where possible keep to the one brand of guidance as systems use different geo-referencing that can cause drift in the AB lines.

Consideration must also be given to layout planning. Up and back is the most efficient direction for operating a controlled traffic system. There are some farmers who have done it round and round successfully with one marker arm. There is a risk of erosion with up and back working so you must consider the degree of slope, length of run, areas that can shed water and ground cover. Roll over banks or other surface water control measures may need to be put in place to reduce the risk of erosion. If in doubt consults a lay out planning expert.

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Websites and other sources of information

http://www.agric.wa.gov.au/objtwr/imported_assets/content/lwe/land/cult/bulletin4607_complete.pdf Tramline Farming systems technical Manual Bulletin 4607

www.precisionagriculture.com.au

www. controlledtrafficfarming.com

www.actfa.com.au

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