The changing options for soil compaction management in the WA wheatbelt

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Key messages
Soil compaction has moved deeper down the profile due to heavier machinery and requires deeper mechanical removal via deep ripping in WA sandy soils.

To maximise deep ripping effectiveness know the soil type, where the hard pan is, any associated constraints and take some time to set up the ripper and seeder to reduce challenges seeding into a soft seed bed.

Develop a controlled traffic farming (CTF) implementation plan in line with the farm machinery replacement schedule to increase the longevity of soil renovation benefits. A compromised CTF system with a 3:1:2 matching ratio is better than no CTF.

Introduction

Options for soil compaction management are changing as soil compaction is being driven deeper down the profile while machinery size and capacity is increasing. A general rule of thumb is that a 10t axle weight causes compaction down to 300mm. Most new large machinery such as headers, tractors, aircarts, chaser bins, spray booms etc exceed 10t axle weight (a header can be 30t fully loaded), causing compaction to move deeper 400-600m.

Soil strengths of 2.5mPA that reduce root growth and more than 3.5mPa which restrict root growth only to bio-pores, are frequently being observed in a range of soil types in WA. In a drying environment where more moisture equals more grain and profit, plant root access to deeper moisture is vital.

New methods of removing compaction in sandy textured soils by deep ripping to 550mm and topsoil slotting are showing great promise with 2015 trials increasing yield by about 1000 to 1700kg/ha at four sites. The return on investment ranged from $6 to $16 per dollar invested (see Blackwell et al 2016). Implementing a controlled traffic farming system will minimise re-compaction and increase the return on investment of expensive soil amelioration techniques.

Options for soil compaction management

Deep ripping

Soils in WA predominantly have <35% clay and have little capacity to naturally swell and crack to remove compaction. Therefore some form of renovation such as deep ripping is required. Shallow compaction down to 200-300mm can be removed effectively by standard deep ripping or other soil renovation methods such as mouldboard ploughing, spading or ploughing. These other methods help alleviate water repellent soils (sometimes with incorporation of suitable clay-rich subsoil) and subsoil acidity (by incorporating lime); constraints commonly found in conjunction with compaction. It is common for soils to have more than one constraint, such as combinations of compaction, non-wetting, subsoil acidity and sodicity. It is important to understand what constraints are present in the soil profile to choose the most appropriate renovation. Some renovation methods do not accommodate CTF easily, such as mouldboard ploughing, spading or one way plough; it is difficult to remove a section to avoid digging up the wheel track. In this case it is recommended to fix up the top soil to about 300mm (ameliorate compaction, acidity, weeds, water repellence), then get lined up (implement CTF) and fix up the lower root zone by removing the deeper compaction beyond 500mm. Wheelrut filling may be needed in the early stages after renovation if the farm already uses CTF.

Due to the very soft soil conditions after ripping it is strongly recommended deeper ripping be conducted under a CTF system, where the ripper tines in line with wheel tracks are removed (or lifted) leaving behind a solid track for seeding, sprayer and harvest machinery to follow. Deeper ripping machines are generally in smaller widths than the header front due to the large horse power requirements. For example, a six metre ripping width to 550mm has a new Quadtrak working at 80% engine utilisation. Removing the tines on wheeltracks can save 15% of the total paddock cost of ripping. To rip deep using shallow leading tine configuration or ripping in two “bites” is recommended to reduce the horse power requirement and achieving more even break out (less large clods). A heavy hydraulic firming crumbler roller is also very useful to firm, level and crush clods.

The ground after ripping can be very soft causing problems with plant establishment. Rather than cross seeding at 5 degrees or across the workings which will re-compact the soil pay some attention to seed bed preparation and bar set up. Towing a roller behind the ripper will help firm the seed bed. There are some commercially available rollers (e.g.

Grizzly as shown in Photo 1) or some farmers have designed their own, for example welded angle iron on to a steel pipe that can be filled with water to add weight. Good stubble cover is important to minimise erosion risk particularly in very sandy soils. In these soils deeper ripping and topsoil slotting provides a significant benefit over the cover burial by mouldboarding and spading.

Photo 1: DAFWA's research ripper with shallow leading parabolic tines set at an aggressive angle. The front tines work at 300mm and the back tines work to 600mm. Topsoil slotting plates are attached to the back tines that run at the base of the topsoil (about 100mm). The Grizzly hydraulic crumbler roller levels, creates a firmer seed bed and crushes some clods.

Controlled traffic farming

Up to 80% compaction damage occurs in the first pass. Therefore adopting controlled traffic farming is the best way to minimise re-compaction and maximise the longevity of soil renovation treatments. Increasing the longevity will improve the economics of treatment. For example, assuming a treatment cost of $60/ha for deep ripping to 550mm and a yield increase of 500kg/ha, the difference between three year and seven year duration of effect is $4.70 and $10.80 benefit respectively for every dollar spent.

The basic principle of CTF is reducing the percentage of the paddock wheeled in any given season so that traffic is confined to "wheel tracks" leaving uncompacted "root beds" for plants to access moisture and nutrients. It is not uncommon for farming operations in the WA wheatbelt to cover 40-60% of the paddock with wheels in one season. The target wheeling for a CTF system at 3:1 ratio is about 12 to 15% depending on the operating width selected.

A compromised system is becoming increasingly common with a match of 12.2m header,36.6m sprayer and 18m seeder this has an estimated wheeling percentage of 18%. A challenge for this system is there is some overlap required on the edge of the paddock of either the sprayer and the header or the seeder to get the majority of the traffic on the main wheeltracks. Most growers using this system overlap the header and sprayer as the cost of double seeding is greater. So while it is not a perfect system if you estimate the benefits of reducing your tracking percentage it is still worthwhile. Some growers who start with this system move to either two 12.2m bars with smaller tractors that are more versatile (can be used for other operations and provide better use of machinery capital depreciation) or one large 24.4m bar. Diagrams of the how to work the compromised fit are available from DAFWA.

There is not a one size fits all approach for controlled traffic due to a huge variation in machinery sizes. When developing a CTF system consider the following steps.

Key questions to ask setting up a CTF system

Decide on imperial or metric

Many early CTF farmers have discovered matching machinery built in imperial or metric can be challenging as twelve metres is not 40ft it is 12.2m. This can make it hard to match Australian vs imported machinery. Choosing to work in one or the other helps keep it simple. However some do choose to run seeders and sprayers in metric and the header in imperial so there is a small overlap of the cutter bar and no crop is missed.

Remember when you measure bars and sprayers to add one row or nozzle spacing, check the header cutting bar width. Often machinery is sold as a certain width but it may cut more or less or have a centre tine. When thinking through the best option consider what system you might like to have in five to ten years time.

Choose an operating width

Machinery matching in multiples of 12m or 40ft is the most common; however other widths can work well. Table 1 summarises the pros and cons of different operating widths from grower experience. The ideal machine to work from when deciding the width is the header as it is the heaviest machine, is the hardest to modify and can have the widest wheel base.

The best way is to decide what width will suit your system is to map out your machinery widths and tracks either using graph paper or the 'Wheeltrak' calculator. This tool was developed by PrecisionAgriculture.com.au with partners including DAFWA's GRDC funded project "Minimising the impacts of soil compaction**"**. The Wheeltrak calculator is available at http://www.precisionagriculture.com.au/Wheeltrak. A new version of this tool is due to be released early in 2016.

The Wheeltrak calculator will give you an indication of your current machinery wheeling percentage. The calculator then allows you to make changes so you can see what happens if you drop off duals, change an operating width or GPS accuracy.

Table 1 Common compatibility challenges to matching machinery for Controlled Traffic Farming for various machinery operating widths. (yes = compatible in much experience).

Challenges to matching	30ft or 9.1m	40ft or 12.2m	45ft or 13.6m	50ft or 15.3m	60ft or 18m	40:120:60ft or 12.2:36:18m#
3 to 1 ratio	yes	yes	yes	yes	possible	No 3:1:2
Spreading Lime evenly	yes	yes*	no*	no*	no*	yes*
Applying liquid inputs	yes	yes	yes	yes	yes	Yes
Spreading straw evenly	yes	yes	Yes new headers	no	no	Yes
Swathing	yes	can be problematic	no	no	no	can be problematic
Chaser bin on wheeltracks	yes	yes	no	no	no	Yes

width of header:sprayer:seeder *spreader curtain or extra spinners maybe an option

Choose wheel track width

Ideally start with the header wheel base as this is the hardest to modify if at all. Most equipment will fit around 3m however this may need to be 3.2m or 3.4m. Often the header is the widest wheel axle and footprint therefore aim to have most machinery wheeltracks within that range. There are now off the shelf modification kits available for many tractors. If you modify equipment check the warranty.

Develop a plan for implementation

For some this will be easy and may involve dropping a tine, adding a few nozzles or modifying axles to a common width such as 3.0m. For other it will be more challenging. It is recommended to develop a CTF machinery investment plan and align it with the farm machinery replacement schedule. There are many examples of successful CTF farmers who have taken up to eight years to fully match machinery wheel spacing.

Conclusion

Controlled traffic farming is the best way to minimise compaction and protect investment in soil amelioration such as deep ripping which can be expensive. For some farmers matching machinery may be relatively simple and only small modifications are needed. For others developing an implementation plan in line with the farm machinery replacement schedule (adopted and owned by the whole farm business) will help achieve their goal to reduce wheeling percentage. A compromised CTF system is better than nothing. There is a range of information available including useful tools such as the Wheeltrak calculator.

Remember CTF is not just about compaction control there a range of benefits including more reliable traction and floatation in wet conditions, easy to do on-farm trials, reduced waterlogging, improved water use efficiency, less fuel use, less greenhouse gas emissions and potentially less fertiliser use, thus better profitability of grain growing.

Available resources

The following are some resources that maybe useful:

Controlled Traffic Farming Technical Manual, Northern Agricultural Catchment Council

Deeper Roots workshop package is available from DAFWA that contains information to assist growers develop a machinery investment plan for CTF. Support to deliver the workshop is available from DAFWA until June 2017 when the Soil Compaction Project concludes. Contact Bindi Isbister for more information.

Join the DAFWA-Soils WA Facebook Group https://www.facebook.com/groups/DAFWAsoilproductivity/

Follow Bindi @BindiIsbister on Twitter and others such as @DAF_WA @Pontagrain @WaddiPark @Crashlah

Wheeltrak calculator PrecisionAgriculture.com.au

www.agric.wa.gov.au information on deep ripping, soil compaction, controlled traffic farming and soil constraints

www.grdc.com.au information on controlled traffic farming, deep ripping and soil constraints the most recent research is in Groundcover issue 118 Soil Constraints

Youtube has some great videos on controlled traffic farming

Key words

subsoil constraints, soil compaction, controlled traffic farming, deep ripping

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Blackwell P, Isbister B, Riethmuller G, Barrett-lennard E, Hall, D, Lemon J, Hagan J and Ward P (2016) Deeper ripping and topsoil slotting to overcome subsoil compaction and other constraints more economically: way to go!, Research Updates 2016

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