CONTROLLED TRAFFIC FARMING

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

WESTERN REGION

CASE STUDIES OF GROWERS IN WESTERN AUSTRALIA

AN INITIATIVE OF THE GRDC WESTERN REGIONAL PANEL

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Controlled Traffic Farming

Case studies of growers in Western Australia
An initiative of the GRDC Western Regional Panel

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Introduction

Subsoil compaction caused by cropping machinery 'traffic' in paddocks is a widespread and increasing problem across the Western Australian grainbelt.

It is estimated to cost the State's growers and the grains industry millions of dollars each year in lost crop and pasture production.

The Grains Research and Development Corporation (GRDC) is making significant investments in managing this issue through its Soil Constraints – West project.

The GRDC's Western Regional Panel initiated the production of this booklet to identify and extend information about the practical controlled traffic farming (CTF) methods being used by a range of Western Australian growers to optimise their production and reduce cropping risks on highly variable soil types and in an environment of fluctuating rainfall.

The tactics they are using that are highlighted in the CTF case studies include:

- Implementation of guidance systems
- Redesigning paddock boundaries
- Matching a range of machinery wheel and operating widths and ratios
- Tramline management
- Inter-row sowing innovations
- CTF with deep ripping/tillage
- Chaff decks and weed control
- Sheep in the system
- Hay production and CTF.

For more than 20 years, WA researchers have found that the use of CTF systems – or 'tramline farming' – to address soil compaction can lift grain yields by an average of 10 per cent in the first year, almost halve the wheeled area of paddocks and improve grain quality.

Department of Agriculture and Food Western Australia (DAFWA) economic modelling indicates CTF can lead to a $47 per hectare improvement in average profit from a cropped area of more than 1000ha on a WA broadacre farm. About half of this gain comes from higher grain yields and half from improved grain quality (with fuel and input savings also being a minor component). This research found estimated profits could be doubled for a mixed enterprise farm of more than 2000ha on a range of soil types.

The principle of CTF is to create permanent wheel tracks that clearly separate the crop zone and traffic lanes. Cropping implements have a particular span, or multiple of it, and all wheel tracks are confined to these traffic lanes (commonly called tramlines by WA growers).

The key aim when setting up the system is to improve soil conditions in the crop root zone to encourage root growth and increase the uptake of soil moisture and nutrients, leading to higher grain yields and quality.

Associated potential productivity and profitability benefits include:

- Reduced input costs by minimising application overlaps
- Better traction and floatation in wet conditions with machinery running on firm tracks
- Less waterlogging
- Improved crop water and nutrient use efficiency
- More agronomic opportunities, such as using chaff decks for weed control and inter-row sowing
- Less fuel use
- Lower greenhouse gas emissions.

Other positive spin-offs for the whole-farm include lower risks of wind and water erosion, less salinity impact and potentially less waterway degradation.

CTF systems being adopted and adapted by WA grain growers are continuing to evolve as new technologies to improve farming practices are entering the market place. There is also stronger motivation to manage compaction that is moving deeper into the subsurface to help manage cropping risks in a variable climate.

Controlled Traffic Farming is being used by many Western Australian growers to reduce cropping risks on highly variable soil types. PHOTO: GRDC

Research and experience is showing clear long-term advantages of adopting CTF when using subsoil constraint amelioration strategies, such as deep ripping, spading, delving and/or soil inversion.

But CTF can be as simple as choosing a wheel track width (typically based on the harvester wheel base, as this is the most difficult machine to modify) and then matching operating machinery, such as seeders, boomsprays and tractors, in multiples of that width.

Implementing a CTF system is not a one-size-fits-all approach and requires consideration of individual soil constraint issues, production priorities and whole-farm business aims.

It is recommended, if considering going down the path of introducing CTF, that a plan is made in-line with machinery replacement schedules.

Each grower featured in these case studies has introduced CTF for different reasons and has set it up in a unique way as just one part of their overall farming system.

Common themes from the case study growers about CTF include the importance of: layout planning; maintaining and renovating tramlines; and managing machinery replacement.

Many say they have faced challenges, but don't view these as insurmountable and are willing to make compromises.

The wet conditions of the 2016-17 summer period, especially in parts of the South Coast, Esperance and Great Southern regions, have tested the growers and their CTF tactics.

But, typically, they have emerged with more resilient systems than those around them who have not employed the same principles and have been keen to share their key learnings in this booklet. One of the case study participants also explores why WA growers may choose not to implement a CTF system.

A guide to useful resources for implementing and managing CTF systems is contained in this publication, along with a glossary of common CTF terminology and advice from Western Australian soils researchers.

It is designed to be a practical resource and is available through the GRDC's Perth office. For more information and to receive a copy, telephone: 08 9230 4600.

We would like to sincerely thank all of the growers, researchers and advisers who have consented to being included as case study participants or provided input and time to this booklet.

Peter Roberts
Chair
Western Regional Panel

Technical Article

Tips and tactics for introducing a controlled traffic system in Western Australia

By Bindi Isbister, Department of Agriculture and Food Western Australia development officer

DAFWA development officer Bindi Isbister. PHOTO: DAFWA

Implementing a controlled traffic farming (CTF) system is the best way to minimise soil compaction on a range of Western Australian soil types and protect investments in long-term amelioration tactics, such as deep ripping, that can be expensive.

The principle is to match all cropping machinery operating and wheel track widths to confine the wheels of heavy equipment (weighing more than one tonne) to permanent traffic lanes, which are commonly known in that State as tramlines.

But CTF is not a one-size-fits-all approach and needs to suit individual farm issues and priorities.

For some growers, matching machinery may be relatively simple and only require small modifications. For others, developing an implementation plan in line with the farm's machinery replacement schedule will help to meet the goal of reducing wheeling percentage over time.

A compromised, or partially-matched, CTF system is better than nothing and, aside from helping to manage subsoil compaction issues, there are a range of other benefits to the whole cropping enterprise. These include:

- Grain yield and quality improvements in some conditions and seasons
- More reliable traction and flotation in wet conditions
- Reduced waterlogging
- Improved water use efficiency
- Less fuel use and potentially less fertiliser use
- Lower greenhouse gas emissions
- Higher productivity and profits from grain growing.

COMPONENTS OF A CTF SYSTEM

Guidance systems

CTF needs accurate and repeatable guidance to be able to return to the permanent wheel tracks every time and set up evenly-spaced wheel tracks.

Guidance can be a simple marker arm, or use Global Navigation Satellite System (GNSS) technology. CTF is most efficient with a GNSS Real-Time Kinematic (RTK) guidance system and autosteer, as this provides repeatable accuracy within two centimetres. But this can be costly, as it requires a base station to provide correctional signals either on-farm or close by.

Service from other base station networks, commonly established by local machinery dealers, are becoming increasingly available. This reduces capital investments for growers considering purchasing their own base station, in what can be an expensive shift to implementing RTK.

An on-farm base station may still be required, though, depending on the landscape and availability of mobile phone coverage.

Machinery fitted with autosteer and high quality guidance provides accurate input placement, less overlap and reduces driver fatigue.

Typically, the bigger the cropping area, the greater the savings from preventing overlap of inputs using electronic guidance. Many WA growers now have electronic guidance systems based on GPS and are well positioned to move to CTF.

Machinery matching

Ideally, it is best to use the same machinery width and match the ratio of operating implement and wheel track spacing.

In WA conditions, the operating width ratio is typically 3:1 for smaller machinery (less than 13.5 metres). For machinery bigger than 13.5m, a compromise ratio of 3 (header): 1 (boomspray): 2 (seeder) can work well.

Convenient matching ratios for Western Australian conditions include (but are not restricted to):

- Harvester widths: 9m, 10.5m, 12m, 13.5m
- Seeder widths: 9m, 12m, 18m, 21m, 24m
- Sprayer widths: 18m, 21m, 24m, 27m, 36m.

Many WA growers use a partial (or compromised) CTF system with an 18m seeder, 36.6m sprayer and 12.2m header. Some overlap is needed on the edge of the paddock by the seeder (or the sprayer and header) to line-up the seeding and spraying wheel tracks. The header lines up on the main wheel-tracks every fourth run.

The compromised system is becoming the preferred option for many growers in that State, where seeding efficiency is paramount, and can reduce wheel track coverage of a paddock to about 18 per cent. This is not the 9-12 per cent target of a 3:1 ratio, but is better than an unmatched system that often has 40 per cent of the paddock wheeled in one cropping season (or more if dual-wheel machines are considered).

Tramline design

It is possible to set up common run lines – or tramlines – for all machines using farm precision agriculture software.

Initially, many WA users of CTF tended to leave tramlines bare – as this was the traditional system. But, due to concerns about poor weed control, evolution of herbicide resistance and potential erosion on non-wetting sands, it is now advised to sow tramlines with a crop (and if practical to use short points or discs to retain a firm running).

Layout planning

Whole-farm planning is important when introducing new technologies, such as CTF, as a change in paddock layout is often needed to improve efficiency by working in straight lines or to minimise erosion risk.

Design of the most efficient system considers the length of the run, access roads, tramline orientation in relation to slope or sun interference and surface water control.

Surface water control is very important. It is advised to give consideration to:

- Stubble cover
- Slope length and degree
- Soil infiltration properties
- Rainfall intensity
- Managing water from areas that shed water or overland water flow from upslope.

Research has shown that wheel tracks up and down slopes cause less erosion than across slopes and are easier to repair.

But water must be controlled to prevent flow concentration either from water-shedding areas, overland flow upslope or length of slope being too long or steep (where the water is not disposed of safely at the bottom of the slope).

Surface water control measures that are compatible with CTF include broad-based grade banks that machinery can drive over, grassed waterways and access tracks designed as catch drains.

Waterlogging can also be managed with raised bed layouts in the high rainfall zone. In practice, there will be low areas in most paddocks that require drainage.

Useful tools for planning layouts for CTF on-farm include:

- Aerial photographs
- Farm maps
- Topographic and soil type maps (including yield maps and elevation data logged with RTK guidance systems)
- Knowledge and experience of paddocks.

CTF COMPATIBILITY WITH OTHER SYSTEMS

CTF is compatible with precision agriculture (PA) technologies, such as variable rate technology (VRT). It is also a great framework for conducting on-farm trials and collecting good quality yield data.

Sandy soils do not naturally repair from compaction after removing traffic, so some mechanical repair (such as deep ripping) may be required.

Research and experience in WA is showing clear benefits from using CTF to preserve the benefits of shallow and deep ripping to depths of about 20-30 centimetres and 40-60cm, respectively, by minimising re-compaction.

For example, assuming a treatment cost of $60 per hectare for deep ripping to a depth of 55cm and a resultant crop yield increase of 0.5 tonnes/ha, the difference between three-year and seven-year duration of effect is a $4.70/ha and $10.80/ha benefit, respectively, for every dollar spent.

Trials in the northern agricultural region and on the South Coast have found deep ripping to 55cm and topsoil slotting, when used in conjunction with CTF, can boost yields by 1-1.7t/ha.

THE ROLE OF CTF IN MANAGING MULTIPLE SOIL CONSTRAINTS

It is common for Western Australian soils to have more than one constraint, such as combinations of compaction, water repellence, subsoil acidity and sodicity.

Some renovation methods – such as mouldboard ploughing, spading or one-way ploughing – do not accommodate CTF easily, as it is difficult to remove a section to avoid digging up the wheel track.

In such cases, it is advised to firstly address problems in the topsoil (to a depth of about 30cm) and implement CTF and then fix the lower root zone by removing the deeper compaction beyond 50cm. Filling of wheel ruts may be needed in the early stages after such renovation if CTF is in place.

Due to the very soft soil conditions after ripping, it is strongly recommended that deeper ripping be conducted under a CTF system. In this case, the ripper tynes 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 typically in smaller widths than the header front due to big horsepower requirements. Removing the tynes on wheel tracks can save about 15 per cent of the total paddock cost of ripping.

BENEFITS AND COSTS OF CTF

Practical on-farm benefits of CTF can be hard to quantify in the early years after conversion, but typically centre on:

- Better trafficability in wet conditions
- Less fuel use
- Less overlap of inputs
- Easier operation
- Potential for agronomic opportunities, such as easier inter-row sowing and use of chaff decks at harvest.

The main costs of starting a CTF system will vary for each farm business. Several case study growers in this booklet have noted that upgrading their GPS to RTK was the most significant expense.

In terms of machinery costs, many growers convert equipment to a CTF system according to their farm's existing budgeted machinery replacement schedule to avoid additional expenses. Others make their own modifications to machinery such as header augers and boomsprays.

On-farm challenges of using a CTF system can include:

- Wearing of bearings on modified axles
- Problems harvesting if the crop lodges in prevailing wind direction
- Uneven spreading of fertiliser or straw
- Re-sale of modified machinery
- Ensuring contract equipment matches the system
- Bogging or falling off tramlines in very wet conditions
- Water erosion.

To address these challenges, it is vital to do some homework and access the many industry resources and trial results available that highlight how CTF systems work for Western Australian soils and environmental conditions.

Careful planning will be needed at a farm and catchment level, especially in medium and high rainfall areas, to manage surface water and potential erosion risks.

CTF is a farming system and requires ongoing maintenance. Tramlines can become deep and rutted over time and there are tramline renovators available to drag soil back into the depressed tracks.

Links to useful information about CTF and soil constraints are outlined in this case study publication.

MORE INFORMATION

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Case study – CTF Andrew Fowler, Condingup

Move to CTF supports deep ripping benefits

SNAPSHOT

OWNERS: Andrew & Marie Fowler, Simon & Robyn Fowler, Tim & Cath Fowler

LOCATION: Condingup, Western Australia

FARM SIZE: 19,000 hectares (cropped), 10,500ha pasture running sheep & cattle

ANNUAL AVERAGE RAINFALL: 500 millimetres (450mm to 600mm)

SOIL TYPES: Sodic subsoils, sandy loam duplex

ENTERPRISES: Cropping, sheep & cattle

CROP PROGRAM (2017): 8700ha canola, 8500ha wheat, 1800ha barley

CTF SYSTEM: Machinery widths 12 metres, 36m, wheel tracks 3m centres

SEEDING: 12.0m wide Morris C2 bars on 30cm rows with a Morris 9360XL air carts with 5000L FlexiN tank. 450hp New Holland T9 wheeled tractors set up on 800 single tyres. Trimble RTK autosteer, all machines 3m centres

SPRAYING: Self-propelled Miller Nitro 6000 series, 36m with Spray Air™, Trimble RTK auto steer

HARVEST: New Holland CR 10.90 harvesters in 3m centre tracks, 12.2m New Holland Vario header front, Trimble RTK auto steer, extended auger to unload into a chaser bin on the tramlines

SPREADING: New Holland T9 450 tractor on 800 singles, Trimble RTK autosteer, Agri-Spread AS 150 tug-a-long spreader – 3m axles 12m spreading width for lime/gypsum and 36m spreading for fertiliser

OTHER FEATURES: Chaff lining on wheel tracks, K-Line Track Attack tramline renovator, Nufab-Tilco 6m deep ripper

Prolonging the benefits of deep ripping and preventing soil re-compaction for as long as possible was the impetus behind the Fowler family's switch to controlled traffic farming (CTF) in 2016.

Across the family's cropping operations at Condingup, east of Esperance, Andrew Fowler says the impacts of deep ripping and matching it with CTF systems have been tangible on many levels in a relatively short space of time, including grain yield gains of more than one tonne per hectare and improved soil health.

Andrew and his wife Marie, along with his brothers and their wives – Simon and Robyn and Tim and Cath – crop 19,000ha and run a sheep and cattle operation comprising 24,000 Merino ewes and 2400 Angus females.

Andrew says they had started deep ripping to address soil compaction on their sandy loam duplex soils, which were prone to waterlogging.

"In 2016, we started deep ripping with a six-metre wide machine that was able to rip down to a depth of 50-60 centimetres," he says.

"It was pretty wet in late August and September – we received 200 millimetres of rainfall in five weeks – and with our soils that have a sandy surface and sodic subsurface, this can create big issues.

"Waterlogging leads to anaerobic conditions which can create big yield reductions in crops sown on some parts of our country.

"In those wet conditions, the effect of the deep ripping is to create more space in the soil for oxygen as much as anything. You get more water infiltration to depth and it leaves more space for oxygenation in the top part of the soil.

"We took a punt but we knew we had some pretty significant compaction in places that needed to be addressed."

Andrew says the cost of deep ripping was, on average, $80/ha and it was vital to ensure the benefits would last as long as possible.

In addition to the advantage of increased grain yields, Andrew Fowler says the benefits of combined deep ripping and CTF on his family's property also include increased grain yields and improvements in the health of the soil and its ability to withstand wet conditions. PHOTO: GRDC

He says in the first year they could see (from 100m away) the difference in crops where the country had been deep ripped and where it had not. This was predominantly evident on sand over gravelly country over clay.

"It's been a long time since I've done a trial where I've been visually seeing a response all year," Andrew says.

"We ended up with just over a 1t/ha yield increase in our wheat.

"Our yields ranged from 3t/ha in non-ripped paddocks to just over 4t/ha in the area that had been ripped."

Andrew's crop yield responses to date are similar to those observed from Department of Agriculture and Food Western Australia (DAFWA) deep ripping trials across the State in recent years. The trials, delivered via the GRDC's Soil Constraints – West Initiative, found this tactic can improve wheat yields by 0.6t/ha in the first year after ripping and that it should ideally be matched with CTF systems.

DAFWA data also indicates that, in sandy soils, yield gains of up to 75, 47 and 92 per cent are possible in wheat, canola and lupin crops, respectively, after ripping to a depth of 50 to 70cm (compared with no deep ripping). More information is available at **https://grdc.com.au/GC126-DeepRipping**

> *"We took a punt but we knew we had some pretty significant compaction in places that we needed to address."*
> *Andrew Fowler, Condingup*

The Fowlers are sowing on deep ripped country for their 2017 winter cropping program and will have close to 4000ha of land deep ripped by the end of their seeding program.

Andrew says seeing the impacts of trial work undertaken by DAFWA researcher Dr Paul Blackwell (now retired) at Munglinup had convinced them to head down the path of deep ripping and CTF systems.

"The trials were on similar soil types to those that we have and used ripping with inclusion plates, which is what we do," he says.

"We could see there were significant plant growth benefits in the middle of a wet winter."

From historical cropping data and experience, the Fowlers have noted their worst years are the wet ones because of their soil type and environment close to the coast where they can experience many drizzly rainfall events. Once the soil is wet, it can take a long time to dry out in winter and early spring.

Andrew says the sodic subsoils hold the water up and create anaerobic conditions, making wet years a challenge.

"We're only two kilometres from the Southern Ocean at our closest point and we don't need a lot of rain to get the crop up and going," he says.

"Our driest years still have a better yield average than our wetter ones."

Switching to CTF

Andrew says making the switch from using guidance systems to full CTF has involved matching sowing and harvesting equipment to widths of 12m, with wheel tracks on 3m centres.

"We have 12m wide bars on our air seeders and 12m fronts on our combines," Andrew says.

The Fowler family's deep ripper in action. PHOTO: GRDC

"We have tracks on four out of the seven combines that we use and they come with extended augers so that we can unload on the tramlines.

"The only machinery that's not lining up yet are three older combines on wheels. They have 3m centres, but the augers are not long enough to unload on the tramlines.

"We had to get auto steering systems put in all of the tractors and headers, which meant we had to get an extra three or four steering units – which isn't cheap.

"We also had to increase the number of seeder bars from two to four because we cut their size right back, and again that's a pretty big investment."

Andrew says, in his experience, 12m bars work well on deep ripped areas because they are a lot lighter than wider equipment and seem to 'float' over the top.

He says bigger bars used in the past were harder to pull straight and to operate to depth in really soft conditions.

Andrew says the family uses articulated 450 horsepower tractors on 800mm tyres on singles for its seeding, spreading and chaser bin machinery.

"We used to not have steering systems in the chaser bin tractors – and we run four or five chaser bins – so we needed steering systems in all these to be able to stay on the run lines," he says.

"To me, the bulk of soil compaction problems come from using big heavy combines and chaser bins that can weigh up to 40t."

Andrew says the transition from guidance systems to full CTF has also involved installing a Real Time Kinematic (RTK) base station.

Prior to that, the family used a Trimble Real Time eXtended (RTX™) system, which he says was nowhere near as repeatable.

"We've certainly increased our risk because we're spending a lot more money doing this and you need to get higher crop yields to justify it," he says.

"We're putting more cash on the table up front growing crops in this way, but I'm reasonably confident that it's probably going to give us a step-up in yield."

Andrew estimates they have spent $200,000 on Trimble systems (automated steering systems that keep machinery online) and says the biggest skill lacking on the farm now is someone with good diagnostic skills for auto electrics.

"Because so much of what we do now is interfacing with these screens that everything relies on, it has become as important as having a good mechanic on-farm," he says.

"We've gone pretty hard at adopting this technology in the past few years.

"We've mapped every paddock and the boundaries – so the operators don't have to do too much.

"The tractors steer themselves around the outside laps and complete the turns at each end of the paddock.

"With the casual labour we have to rely on, we're trying to really take the hands out of it.

"Once you install it properly and you've got automatic switches on clutches, you need the technology to work."

Benefits of shifting to deep ripping and CTF

Beyond the obvious advantage of increased grain yields, Andrew says the other benefits of combined deep ripping and CTF are improvements in soil health and the ability of the soil to withstand wet conditions.

He says in 2017, the farm received 275mm of rainfall between the end of January and end of April – and most of that arrived in some big events in February and early March.

"In the paddocks that were deep ripped before that rain, there was the odd little spot that ran a bit of water – and it is nasty when that happens – but almost without exception, the water infiltrated and didn't run off," he says.

"Even in April, on the paddocks that hadn't been deep ripped when that rainfall event came through, there were lakes in the low spots in paddocks.

"Meanwhile, paddocks next to them that had been deep ripped had no water in the low spots that would usually fill up with water.

"For four or five days after we received 160mm in a period of about a week, all the country was so wet you couldn't drive on it and you couldn't walk on it without sinking past your ankles.

"But even then, the deep ripped paddocks were still oxygenated in the top 3cm to 4cm. The moisture moved through the profile but didn't take the oxygen completely out of where the root zone is.

"On the paddocks that hadn't been deep ripped, soil was going stale from lack of oxygen and a layer of moss was growing on the top of the soil."

Mixing it up

The Fowler family's cropping and livestock operations are incorporated in their business and Andrew says they will continue to graze crops in 2017.

They run 24,000 Merino ewes, with 35 to 40 per cent mated to White Suffolks, and 2400 head of Angus breeding cows.

"My thoughts on compaction are that heavy compaction at depth is from machinery and the shallow surface compaction that livestock create is largely overcome just with seeding techniques," Andrew says.

He says the cropping enterprise is based on a rotation of canola, wheat and then subclover pasture for one year, followed by canola again.

"On some sandier soils, covering about 15 to 20 per cent of the property, a serradella is used instead of subclover, but the benefit of the subclover is that it self-generates," Andrew says.

In areas to be crop grazed, broadleaf weeds and pests are controlled as necessary and paraquat is applied twice late in spring to stop any grass-seed set.

All cereal crops are grazed when at early to mid-tillering (up to Zadoks Growth Scale 30 – Z30) and much of the canola – totaling about 10,000ha.

While Andrew concedes deep ripping and CTF isn't a 'silver bullet' for overcoming soil constraints, he says he knew it was a path the family had to take to address the property's soil issues.

"There will come a time when deep ripping bites us, because it exposes you to more wind erosion, but so far we can see that it's working," he says.

MORE INFORMATION

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Case study – CTF Stott Redman, Hopetoun

Multi-pronged approach to a more robust system

SNAPSHOT

OWNERS: Stott & Charmaine Redman

LOCATION: Hopetoun, Western Australia

FARM SIZE: 8700 hectares

ANNUAL AVERAGE RAINFALL: 475 millimetres

SOIL TYPES: Sandy gravel, deep sand, grey clays

ENTERPRISE MIX: 8700ha cropping, 700ha pasture (cattle)

CROP PROGRAM (2017): 4500ha canola, 4200ha wheat

CTF SYSTEM: 12 metres, 36m, wheel tracks 3m centres

SEEDING: 2 x 12m wide Equalizer bars on 300mm spacings, 2 x John Deere 8370 tractors

SPRAYING: 2 x 36m John Deere sprayers

HARVEST: 3 x New Holland CR 9.90 harvesters with SmartTrax™, 12m wide New Holland Varifeed™ grain front

SPREADING: 2 x 36m wide Amazone spreaders

OTHER FEATURES: Grizzly Wheel Track Renovator, John Deere 1512E Ejector Scraper (for digging drains and roads and levelling wash-outs)

For Stott Redman, controlled traffic farming (CTF) is part of a multi-pronged approach to improving soil health and achieving a more robust farming system on his property, which is prone to waterlogging.

The Hopetoun grower's CTF system is integrated with an extensive drainage system across most of his property which allows excess water to be diverted into natural water courses.

Drains made with a scraper and cut with an excavator intercept and capture water from the tramlines, reducing waterlogging problems.

Stott Redman and son Beau, 10, in three metre wide tramlines in wheat stubble. PHOTO: GRDC

Stott, who farms with wife Charmaine, introduced deep ripping to their farm in 2017 and aims to deep rip as much of the cropping area as possible in coming years.

"CTF is just another tool we have available to use and in isolation won't achieve big improvements in crop performance," he says.

"The drainage and deep ripping are not silver bullets either, but we think we can achieve better results by using a combination of drainage, deep ripping and CTF to help get more oxygen back into our soils.

"We also need to remain focused on things including good timing and agronomy."

Introduction of CTF

Stott and Charmaine started implementing CTF in 2005 across a three-year period with the incremental purchase of matching equipment. The installation of the drainage system occurred later.

To determine the layout of the drainage system, elevation data was collected from Stott's John Deere Real Time Kinematic (RTK) system and TerraCutta software from Precision Agronomics Australia was used.

The Redman's CTF system involves machinery widths of 12 metres and 36m, with wheel tracks on 3m centres.

Stott was encouraged to introduce CTF after observing early trial results from work conducted by the Department of Agriculture and Food Western Australia (DAFWA) with GRDC investment.

"The results were pretty obvious and it made a lot of sense to us – it seemed like common-sense for us to not run over our soil and compact it," he says.

Stott says it is difficult to quantify the benefits of CTF, but there is visible evidence of its value in their paddocks and he believes this is translating into significant crop yield gains.

"Crop plants in areas where machinery turns around at the end of paddocks, as well as in the tramlines, go really yellow from a lack of oxygen, while the CTF areas usually stay greener and healthier for longer," he says.

"It is definitely giving crop plants a little more resilience, particularly during wet spells.

"Having said that, although the CTF helps, in really wet years we can still have thousands of hectares of crop suffer significantly reduced yield potential due to continuous exposure to anaerobic conditions."

Stott believes the CTF system is just as useful in the less frequent dry years, as it is in wet years.

"I think it is just as important in dry years to have good, unrestricted areas for root growth, which is the whole idea of controlled traffic," he says.

Stott says farming technology and machinery has had to 'catch up' to CTF systems and believes this has largely occurred in recent years, with more equipment becoming available to suit a 12m CTF system.

> *"The results were pretty obvious and it made a lot of sense to us – it seemed like common-sense for us to not run over our soil and compact it.*
>
> *Stott Redman, Hopetoun*

However, he thinks machinery systems will need to undergo further evolution to keep up with CTF.

"In particular, most of the machinery will eventually have to be on tracks," he says.

"The more equipment we have working on tracks, the better our tramlines will be."

Wheel damage to tramlines

Currently, Stott devotes two or three weeks at the end of each year to renovating damaged tramlines. Those most in need of repair tend to be on grey clay soils that become rough and slow to dry out.

Tramlines on the farm's gravel soils are not so easily damaged. While tramlines on sandy soils can significantly 'sink in', this does not cause major production issues.

Damage to tramlines on grey clay soils caused by self-propelled sprayers is the biggest adverse issue Stott has experienced with his CTF system.

"Most of our machinery – including our harvesters, seeding tractors and spreaders – are on tracks but the wheels on the sprayers cause significant rutting in the tramlines," he says.

"We have tried going to wider tyres to try to reduce the damage but this only destroys more ground and makes wider and deeper grooves.

"The roughness of our tramlines on grey clays is likely to be affecting the productivity of our spraying operation – due to uneven coverage caused by the sprayer wobbling when it hits the bumps, reduced travel speed and greater 'fatigue' on the sprayer."

Stott Redman views CTF as a tool to help achieve a more robust farming system on his property located in a higher rainfall area. PHOTO: GRDC

Stott has found thin tyres (current sprayer tyre width is 380 millimetres) are the least damaging to tramlines and spray less water from tramline puddles on to crops than wider tyres.

Water spray from tramlines is an issue, as it can wash the chemical off just-sprayed crops.

Stott uses a Grizzly Wheel Track Renovator and then, in some cases, his John Deere 1512E Ejector Scraper to fill in the tramlines with gravel or sand. This helps to repair the tramlines but is 'not the whole answer'.

"We have had a consecutive run of wet years and every time we fix the tramlines we have another wet start and then blow them all out again," he says.

"They never have a chance to compact down hard again.

"In seasons with a drier start, we might have a chance to get some more structure back in our tramlines."

The robustness of Stott's tramlines were put to the test when 170-200mm of rain fell on his property in February, 2017.

"We did have some damage to tramlines but, having said that, the rain did cause some damage to every track on our farm," he says.

"However, we expect the damage might have been greater if we did not have our drainage system in place."

Other CTF considerations

Despite the relatively firm tramlines, Stott says machinery actually gets bogged on his farm more often now compared with when he did not have a CTF system.

“The non-trafficked areas are very soft and hold more moisture, and as soon as you go off the tramlines you sink into the ground,” he says.

“Or in some cases, the tramlines are slippery and it is difficult to get machinery back on them after you slide off.”

Stott believes the answer may be in the use of more tracked machinery and he says shallow ripping of tramlines may help.

He says another issue is the tramlines ‘sinking down’ over time.

“This means it can be difficult to get the seeding bar level and the centre of the bar sinks into the tracks, while the sides are higher,” he says.

With the benefit of hindsight, Stott says he should have originally aligned tramlines to match those in adjoining paddocks.

“Our tramlines are mostly along the longest and most efficient runs,” he says.

“But in cases where we have joined paddocks, we have had to rip out tramlines and put in new ones.

“With more foresight, we should have lined up the tramlines in paddocks a bit better.”

Stott says a CTF system also means more work in conveying messages to seasonal staff.

“It takes more thought about how to get machinery in and out of paddocks and the chaser bin and seeder drivers need to think ahead more,” he says.

“It does require a higher level of management.”

Deep ripping

In 2017, Stott has deep ripped 180ha of land with a new machinery purchase – a Nufab-Tilco 4m deep ripper.

Stott says deep ripping should help deal with any remaining hardpans formed prior to the introduction of his CTF system and alleviate any natural compaction caused by ongoing wet conditions.

The deep ripping is part of his goal to increase the size of the water holding ‘bucket’ of his soils and incorporate more oxygen into them.

“Deep ripping is still a new tool for us,” he says.

“We have implemented it based on anecdotal evidence from people who have seen it achieve big gains in waterlogged situations.”

Going forward, he plans to deep rip as much land as he can, despite limitations posed by some of his soil types, which can contain rocks brought to the surface by deep ripping.

“Dealing with the rocks and implementing deep ripping on different soil types will be a learning curve,” he says.

MORE INFORMATION

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Case study – CTF Kirk Jeitz, Esperance

Tramline erosion prompts re-think of CTF

SNAPSHOT

OWNERS: Kirk & Lisa Jeitz, parents Roger & Gaile Jeitz

LOCATION: Esperance, Western Australia

FARM SIZE: 6500 hectares cropped

ANNUAL AVERAGE RAINFALL: 450 millimetres

SOIL TYPES: Grey clay, gravels, self-cracking red clays, white sand and sandy gravels

ENTERPRISE MIX: 100 per cent cropping

CROP PROGRAM (2017): 2900ha wheat, 3500ha canola

CTF SYSTEM: 36 metres, wheel tracks on 3m centres

SEEDING: Ausplow DBS 18m (60 foot) Multistream with drawbar box

SPRAYING: 36m Beverley Hydraboom on 3m wheel centres, John Deere self-propelled boomspray

HARVEST: Three John Deere S690s on 3m centres with 12m fronts and chaff decks

SPREADING: Fendt tractor on 2.7m centres (last of equipment yet to be replaced with equipment on 3m centres). Bredal spreader

OTHER FEATURES: Cat Challenger tracked tractor, chaff decks on headers, Nufab deep ripper on 6m centres, JNR carry grader

Kirk Jeitz is reconsidering options for his CTF system.
PHOTO: Jeitz family

For the past three years, Esperance grower Kirk Jeitz has used controlled traffic farming (CTF) to successfully curb weeds such as annual ryegrass (*Lolium rigidum*) and wild radish (*Raphanus raphanistrum*), but severe water erosion during a major rainfall event has him re-thinking the system.

In February 2017, a deluge of 200 millimetres in 48 hours from a tropical low compounded the erosion of tramlines from a 'horribly wet' summer, Kirk says, leaving large washouts across a third of the property on the southern side.

"We're 80 kilometres west of Esperance, which is not a perfectly flat environment, and we've got 5 to 10 per cent grade slopes in some paddocks," he says.

"The compacted tramlines were already starting to erode from the steady rain before the main storm, which was a one-in-150-year event.

"The worst damage was on the slopes, where the water washed down the compacted tramlines and left a rill effect on the tracks."

The story was the same across any sloping farming country in the district, necessitating a major investment of time and effort to repair the damage.

"We had one paddock of 200 hectares where every spray line was taken out, and it took us six weeks on the JNR carry grader to fix a heap of washouts and scoured wheel tracks," Kirk says.

He was shocked at the extent of erosion from water running along the tramlines.

"We expected that the hard, compacted tramlines would remain intact and the softer, untrafficked soil would wash out. However, the opposite eventuated, and we saw that everywhere in the flood zone," he says.

His local hydrologist from the Department of Agriculture and Food Western Australia, John Simons, had a good explanation.

"He said the low-trafficked soil contains more air and takes more rainfall to fill up than the compacted wheel tracks," Kirk explains.

"The compacted soil fills up quicker, then the water runs along the top of these flatter and slightly indented wheel tracks. As it picks up speed and increases in volume, the water acts like a chainsaw and cuts a path down the slope."

Kirk is now reconsidering his options for CTF, including potentially changing the direction in which the paddocks are worked, similar to a Canadian system where farmers change the direction of cultivation each year to reduce erosion.

He says a change in the local rainfall pattern is exacerbating the challenge of handling water erosion, as illustrated by almost 40 years of rainfall records from the Jeitz's home property and shown in the photograph on the right.

"In the 20 years from 1979, summer rain was never above 40 per cent of annual rainfall. Over the next 20 years there have been seven years where we've had more than 40 per cent of annual rainfall recorded in summer," Kirk says.

"Our winter rainfall is being topped up by our summer rainfall and we're too good at spraying our country to keep it clean of weeds, which means those big summer rain events fall on already wet country with a full profile of moisture."

Kirk says in the past, the chaff in tramlines slowed the water down during big summer storms, but that was not the case in the February 2017 flood.

"It's hard to know whether to take this as an unusual one-in-150-year event, or to consider CTF as the new kid on the block and re-work the system," he says.

The Jeitz family has worked towards achieving a wholly CTF farm for the past five years. They were initially prompted to implement CTF and chaff decks as they believed this would be a more efficient method of weed control than investing in chaff carts.

Eroded tramlines on the Jeitz family's property following heavy rain in February, 2017. PHOTO: Jeitz family

> ***"While deep ripping improves the soils, we don't think we're getting a soil improvement through the CTF itself. Rather, what CTF provides for us is a weed control benefit."***
> *Kirk Jeitz, Esperance*

"We started about three years ago when we bought new headers – John Deere S690s on three metre wheel tracks – and fitted them with chaff decks that threw the chaff onto the tramlines," Kirk says.

"The initial weed control response was very good, with the annual ryegrass on wheel tracks being choked out by the self-mulching environment.

"From then on we had our GPS lines sorted and we have done seeding, spraying and spreading on the same CTF system."

Prior to implementing CTF, the Jeitz family was burning stubble to get rid of annual ryegrass, but the fire often did not get hot enough on the edge of rows and the weather conditions on the South Coast made it challenging to contain the burns.

In the family's experience, chaff decks have been very efficient but have also had their challenges.

"It's hard to get clean barley seed when you're trying to grow it in a canola/wheat/barley program in a CTF system because there's no perfect header and we always end up with a bit of wheat in the chaff deck lines that grows in the barley crop," Kirk says.

"There are ways and means around it, and to get clean seed you just have to set aside an area on canola stubbles to seed a bit of barley into.

"We considered target-spraying tramlines, but planting barley on canola stubbles is simpler and doesn't require specific equipment."

The impact of CTF has differed on the variable soil types, which range from grey and red clays to white sand and sandy gravels. Kirk started deep ripping the grey clays in 2016, but with the wet summer was only able to do five runs with the Nufab deep ripper on 6m wheel tracks.

"We are also deep ripping the gravel soils to make a deeper profile for root growth so we don't get so waterlogged on these soil types," Kirk says.

"While deep ripping improves the soils, we don't think we're getting a soil improvement through the CTF itself. Rather, what CTF provides for us is a weed control benefit."

The Jeitz family has already put in a significant amount of surface drainage to limit erosion, including flat-bottomed drains about 20cm deep that are shallow enough to allow tractors, air seeders and sprayers to drive through them.

Kirk says the drained paddocks are performing better and yields have improved because they are not getting waterlogged, and they intend to put in more drainage in the future.

Adding more drainage was not an option this autumn as their equipment was being used to repair flood damage.

"We also have drains that are 2-3m deep in some paddocks and water runs down them in a controlled format – and on other areas we have a grassed flat drain, where water is slowed naturally as it spreads out," Kirk says.

"There was erosion in the grass waterways in February, but to a lesser extent. The grasses are left in these areas and broadleaf weeds are controlled so they don't take over.

"The grass waterways suit some situations and allow these areas to be easily managed. I approach each paddock on its own merits."

Kirk says they typically work up and down the slope, so water can follow the furrow and exit at the end of the row at the bottom of the slope.

"Where a paddock is worked across the slope, the water follows the furrow to the lowest point in the gully then cuts its way down the slope, increasing in volume and speed as it goes and it cuts a larger gully," he says.

"That creates more damage than when we work with the slope."

Kirk has not yet had to use a tramline renovator but won't rule out purchasing or building one in the future.

"You really have to treat the tramlines like a public road and put some effort and time into maintaining them," he says.

"We use the JNR carry grader to drive down on the wheel mark and drag nearby dirt into the tramlines, or we can carry dirt to put onto the tracks.

"It's too soon to say if this remediation work has been effective."

For Kirk, it is a case of finding a solution to minimise the risk of erosion, while maintaining CTF for its weed control benefits.

"We will probably continue to do what we're doing for ease of management, but if the water problems continue, we will look at putting in more drainage and maybe changing the direction in which we work the country," Kirk says.

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Case study – CTF Gavin Hill, Holt Rock

CTF chosen for water use efficiency at Holt Rock

SNAPSHOT

OWNERS: Gavin & Hayley Hill and parents Bruce & Kerry

LOCATION: Holt Rock, Western Australia

FARM SIZE: 6300 hectares (arable)

ANNUAL AVERAGE RAINFALL: 330 millimetres

SOIL TYPES: 65 per cent heavy – loam (salmon gum/mallee), 35 per cent light – yellow gravel sand (grevillea)

ENTERPRISE MIX: 100 per cent cropping

CROP PROGRAM (2017): 1625ha barley, 1550ha wheat, 1530ha oaten hay, 920ha canola, 280ha lupins, 140ha field peas, 250ha medic clover

CTF SYSTEM: 9 metre multiples on 3m wheel track centres

SEEDING: 18m Flexi-Coil bar on 12 inch (30cm) spacings for crop and 9 inch (23cm) for hay, 15,000L Simplicity box, 9530 John Deere (JD) tractor on triple wheels

SPRAYING: 36m 7000 litre Sonic boomspray, 8295R JD tractor, 36m 4365 Miller Nitro boomspray – both on 3m wheel track centres

HARVEST: 9m S660 JD harvester, 9m 9660 JD harvester, 9m 9650 CTS JD harvester

SPREADING: 18m/9m 10 tonne Marshall spreader, 8770 JD tractor on 3m wheel track centres

A decade after introducing controlled traffic farming (CTF) to improve water use efficiency (WUE) in his low rainfall environment, Gavin Hill has found this is just one of the many benefits to emerge from the system.

The Hill family – comprised of Gavin and his wife Hayley and Gavin's parents Bruce and Kerry – first started changing machinery over to a CTF system in 2004, as part of the regular replacement schedule on their Holt Rock farm.

Gavin Hill and son Lawson in front of the seeding rig in 2017.
PHOTO: GRDC

Since then, every machine that has been replaced has had 3 metre wheel track centres and operating widths of 9m.

"We chose this width because we could get away with buying cheaper, smaller headers rather than using 12m (or 40 foot) fronts," Gavin says.

"We thought about going wider but it was uneconomical because at the time you couldn't get cheap machines with low working hours on the clock second-hand."

This policy has worked well for the family, with no changes made to the system since the first 'wholly CTF' harvest in 2008, and an average WUE achieved of 12-14 kilograms of grain per one millimeter of rain for cereal crops (when not frosted).

Not all of the farm paddocks are set up on tramlines, though. One consideration in the 9m system was the family's export hay production enterprise, in which Gavin says CTF is uneconomic.

Gavin Hill says improved water use efficiency (WUE) is one of the benefits controlled traffic farming (CTF) has delivered on his family's property at Holt Rock. PHOTO: GRDC

"We have a 2190 Massey Ferguson baler and three point linkage rake pulled by a John Deere 6920 on tramlines," he says.

"But we can't get our mower on the trams and when we're bale mustering, loaders are running everywhere.

"You can get machines such as triple deck mowers, but we have been unable to make this work."

The Hills will sow 1530 hectares of crop for export hay in 2017 and with a run of decent seasons in the past few years, have been averaging production of 3.8 tonnes/ha. The 2016 harvest averaged 5.8t/ha after good summer rain.

Hay production rotates around the farm and paddocks that have been in full CTF for 10 years may get some traffic from mowers and loaders.

Gavin says while it can be difficult to quantify the benefits of CTF in economic terms, he can clearly see the difference on-farm.

"I've grappled with this for a long time but unless you have two paddocks side-by-side that you can generate average production figures from for a 10-year period, it's really hard to put numbers on the benefits because you don't have a control area for comparison," he says.

"When you physically see the headlands pinch off in a dry spell and start going backwards where the traffic is uncontrolled, but the middle of the crop is alright, you know you're doing something right."

Gavin was convinced to try tramlines after seeing the work of CTF proponents, Geoffrey Marshall and Owen Brownley, in his local area.

"It made sense to hold as much water as possible in the soil and to make it more friable, and a penetrometer test has shown that's definitely the case with our soil," he says.

"After a decade, the tramlines are starting to sink slightly but they are not at the stage where they have to be renovated.

"They held up well in the sudden summer storm that caused widespread erosion early in 2017."

This event resulted in 60 millimetres of summer rain falling in 20 minutes, but it did marginal damage and Gavin says they were quite lucky the trams did not wash away.

"Last year we had a really wet summer and wet growing season and got bogged a lot at seeding – but not on the tramlines, just when we were turning around on the ends," he says.

One challenge for the Hills has been management of nutrients following windrowing and burning in the middle of the tramlines, mainly after canola crops.

"We have noticed where we've burnt the canola windrows, there is a lack of nutrients in the crop the following year," Gavin says.

"When you put all the stubble residue in the windrow, it does transfer quite a bit of potash into the row and this can show up in the crop.

"If we spread the residue, we don't notice this. This can limit the effectiveness of windrow burning as a form of integrated weed management when using tramlines."

The Hills tried using chaff decks at harvest to direct weed seeds on to the tramlines, but Gavin says they've given that up because of the configuration of their trams.

"We used to leave bare tramlines on the high traffic trams that are used for seeding and spraying," he says.

> ***"When you physically see the headlands pinch off in a dry spell and start going backwards where the traffic is uncontrolled, but the middle of the crop is alright, you know you're doing something right."***
> *Gavin Hill, Holt Rock*

"This was so that when we sprayed these runs, we were only using every second run line, but we found we were only controlling half of the weeds that had been deposited on the tramlines every 9m by the chaff decks.

"We couldn't control the weeds on the headlands where the headers turned because they were on tramlines where the sprayer ran, and the weeds on the bare trams also crept into the crop.

"We seed crop into all our tramlines now, as the bare tramlines were getting too weedy."

There are other small benefits to CTF that Gavin says make it worthwhile.

"Our fuel use has reduced a bit, it's quite an easy system for new drivers to learn how to operate because they use the physical mark in the paddock to line up runs, and the compacted run lines mean there's not as much dust during summer spraying," he says.

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Case study – CTF Lloyd Burrell, Mt Madden

Lloyd advises vigilance in maintaining tramlines

SNAPSHOT

OWNERS: Lloyd & Cheryl Burrell

LOCATION: Mt Madden, Western Australia

FARM SIZE: 5000 hectares (arable)

ANNUAL AVERAGE RAINFALL: 400 millimetres

SOIL TYPES: Variable from deep white sands to heavy grey clays

ENTERPRISE MIX: 100 per cent cropping

CROP PROGRAM (2017): 1800ha wheat, 1300ha canola, 1300ha barley, 600ha field peas

CTF SYSTEM: 12 metre, 36m, wheel tracks 3m centres

SEEDING: 12m DBS, 12m Great Planes disc seeder on 260mm spacings, Simplicity 17,000 L with liquid, 8335R JD RTK with bar steering (for inter-row seeding)

SPRAYING: 2 x 36m Hydra Boom

HARVEST: Case 8240 with 12m front, RTK, slightly modified auger to upload to the next tramline, use contractor with own harvester, pick up windrows (swath canola and field peas with 40 foot (12.2m) swather – so still on tramlines)

SPREADING: Nufab 22 cubic metre spreader for lime and gypsum and use for claying as well. Capable of spreading lime and gypsum to a width of 12m so can stay on tramlines

OTHER FEATURES: Have own tramline renovator

Long-term controlled traffic farming (CTF) practitioner Lloyd Burrell, who started aligning his machinery widths more than 13 years ago, remains an advocate of the system but advises other growers to be mindful of some pitfalls.

In particular, he says it pays to be vigilant in maintaining tramlines after flooding rain in February 2017 caused severe erosion in 31 of his 36 paddocks.

The erosion included scouring of tramlines (mainly spray lines) which resulted in trenches forming to an average subsoil depth of 30-60 centimetres.

Lloyd and his wife Cheryl received 300 millimetres of rain across a four-day period on their Mt Madden property, near Ravensthorpe, in Western Australia's South Coast region.

To repair the erosion damage in time for seeding, Lloyd invested the equivalent of 1500 working hours – involving three to four men working full-time for more than two months.

He purchased a carry grader and Speedtiller to assist with the remediation works.

Lloyd says damage caused by the floods was worse than that caused when 280mm of rain fell on the property in January 2000.

"We did have erosion then, but not to the extent we saw this year," he says.

"We weren't tramlining back in 2000, so we didn't have the same indentations in the paddock.

"The way I look at what my tramlines have done, it's like contour banks that haven't been really well maintained.

"These will concentrate water and redistribute it into another spot until it can't handle it and it breaks over and erodes.

"You're altering the water flow across the surface of the ground and that's what my tramlines – which are 10-15cm deep – were doing.

"They were in the lowest part of the paddock, so the water was funnelling down them."

Lloyd says a lot of the damage was in gullies (not associated with the CTF system) and there was very little he could do to prevent that type of erosion from occurring again during extreme rainfall.

Lloyd Burrell in early April 2017 on a sandplain canola stubble paddock remediated following severe erosion caused by flooding rain in February. PHOTO: GRDC

> *I don't think research groups have stressed enough the need to try to level-off tramlines.*
> *Lloyd Burrell, Mt Madden*

However, he says the tramlines worsened the erosion and damage was most aligned with canola and field pea stubble paddocks which had less ground cover than cereal stubble paddocks.

"Water moved faster on the canola and pea paddocks, hence there was more damage to them," he says.

"The effects were worst on sandplain country."

Speaking just prior to starting dry seeding in early April 2017, Lloyd said he hoped the remediated paddocks would not be subjected to strong winds.

He compared the appearance of these paddocks to 'new land' country after he cleared it in the 1980s.

"If it blows, we will lose soil even if there is crop on it," he says.

Changes going forward

A key change Lloyd will make to his CTF system as a result of the erosion damage is the regular use of tramline renovators which fill in the ruts and keep tramlines more level with the rest of the paddock.

"We have previously maintained tramlines just once and that was only because they were getting rough," he says.

"I don't think research groups have stressed enough the need to try to level-off tramlines."

In future, Lloyd plans to reform worn or rutted tramlines once or twice in his five-year cropping rotation sequence and will conduct the maintenance when paddocks have a low stubble burden following canola or field pea crops.

A potential challenge with the maintenance operation is that he does not know the required depth of excavation on either side of the tramlines to level them. He is working with manufacturer Nufab to develop a machine that will deposit earth into tramlines.

Lloyd says despite this year's damage and some other adverse issues associated with CTF, he will persist with the system, which he first started implementing as he replaced existing machinery – starting with a harvester and boomspray.

"I don't think we would back out of what we've done in implementing a CTF system – partly because the rutted tramlines make it impractical to change runlines, but also because I believe the system has merits," he says.

"But I encourage other people to be mindful of some of the challenges."

Lloyd's decision to implement CTF was cemented after he attended a CTF conference in Gatton, Queensland, in the early 2000s.

"We always try to push the boundaries of what we're doing and before we adopted CTF we were looking at where we could improve our operation," he says.

Tramline erosion on the Burrell's property in Mt Madden following heavy rainfall in February 2017. PHOTOS: Cheryl Burrell

"CTF made sense to me when I adopted the system and it still makes sense to me now – as far as having the whole system of machinery matching in operational widths.

"If you're in your wife's flower garden and she's planted daisies, you don't go and tread on them."

Pros and cons

Lloyd says it is difficult to quantify the cost: benefit of a CTF system but pointed to local trial work by the South East Premium Wheat Growers Association (SEPWA), funded by the Grains Research and Development Corporation (GRDC).

This showed an increased grain yield of 18-46 per cent in zero trafficked areas (around power lines) compared with trafficked areas. For more information about these results, see: **https://grdc.com.au/r/ctfboostsyields**

Lloyd says the impact of any wheel marks diverging from his tramlines became evident in his crop several months later.

He says another benefit from his CTF system is in simplifying on-farm trial work.

"The system is so defined that it is just a matter of keeping a record of the runline," he says.

"Today I am still able to access a record of the effects of mouldboard ploughing and deep ripping trials that were done almost eight years ago."

Other benefits of CTF on the farm include improved trafficability.

Especially in the first years after adopting CTF, the hard tramlines provided Lloyd with the ability to get machinery on to wet paddocks early.

"As time's gone on, the tramlines have become more depressed, water lies in them and this water gets thrown onto the crop from the machinery wheels," he says.

"Despite this, overall trafficability is good. We get wet harvests and, if you stay on the tramlines, most of the time you will make it straight through the paddock."

Lloyd Burrell standing in the severely eroded edge of a paddock in February 2017. PHOTO: Cheryl Burrell

Lloyd says some of the drawbacks include increased pressure on tyres, causing more frequent blow-outs.

“Especially on today’s tractors – it is difficult to get a 50cm-wide tyre that is going to be able to carry enough weight and speed,” he says.

“A lot of tyres fall short in that they might be rated at 30 kilometres an hour, but most tractors now can travel at 40, 50 or 65km/hour,” he says.

“On our boomspray, which is reasonably new, we have blown five tyres in 18 months.

“Narrow tyres struggle to carry the weight so we are investigating different ideas, such using radial tyres instead of rag tyres and possibly adopting tracks.”

Lloyd says other issues include reduced durability of bearings and hubs, especially on the front axle of tractors, as a result of machinery modifications to accommodate CTF systems.

“We are now servicing front hubs every six months at 750 hours, which is half the time recommended by John Deere,” he says.

“Also, obviously, there is a cost factor with a CTF system because once you set your tramlines you are locked into them.

“For example, if you get a pea or barley crop that leans in one direction, you don’t have the flexibility to adjust your harvesting direction and you have got to look at things like crop lifters to recoup potential losses.

“Depending on the orientation of your tramlines, you also can’t always swath crops in line with prevailing winds.

“If you’re very particular on your tramlines, it can be an issue when contractors come onto your property with machinery that doesn’t match your tramlines.

“Resale of CTF machinery made for three metre centres can also be an issue, as it might not appeal to other people.”

MORE INFORMATION

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Case study – CTF Paul O'Meehan, Borden

Efficiency and flexibility priorities for Borden grower

SNAPSHOT

OWNERS: Paul & Jill O'Meehan

LOCATION: Borden, Western Australia

FARM SIZE: 11,300 hectares (owned and leased)

ANNUAL AVERAGE RAINFALL: 375 millimetres

SOIL TYPES: Gravels, shallow duplex, loams.

ENTERPRISE MIX: 100 per cent cropping with a cattle lotfeeding operation (yearling finishing program)

CROP PROGRAM (2017): 4520ha wheat, 2260ha barley, 2260ha canola, 2260ha legumes (split between lupins and field peas according to soil types)

CTF SYSTEM: 18.2m (60 foot) air seeders and 36.6m (120ft) boomsprays

SEEDING: 2 x 18.2m (60ft) wide Ausplow DBS Auseeder bars, 2 x John Deere 9570 tractors on triple tyres. John Deere RTK autosteer

SPRAYING: 2 x 36.6m (120ft) wide John Deere self-propelled boomsprays. John Deere RTK autosteer

HARVEST: 3 x 12.2m (40ft) wide John Deere harvesters. John Deere RTK autosteer

SPREADING: 20 tonne Bredal spreader, John Deere RTK autosteer

OTHER FEATURES: 13.4m (44ft) offset disc, 18.2m (60ft) Kelly Chain, muck spreader (for cow manure)

Borden grain grower and cattle lotfeeder Paul O'Meehan describes his farming system as 'pseudo CTF', with his partly-matching machinery widths being an incidental – rather than deliberate – choice.

He is not convinced of the merits of implementing and strictly adhering to a full controlled traffic farming system (CTF) in a situation such as his own.

Paul believes CTF benefits – including reduced soil compaction – can in many circumstances be outweighed by reduced flexibility and more inefficiencies.

He says there are some soil types that benefit from CTF (and that his shallow duplex soils are not among them) but recommends close analysis of the cost:benefit ratio of adopting this system.

"CTF can come at a cost and I believe I can avoid that cost in my situation by being more efficient in a more flexible, but simple, farming system," he says.

Efficiencies in his business are achieved by having a streamlined operation and selecting machinery widths to achieve optimal timing of key cropping operations and even application of inputs.

Paul says for him, these benefits more than compensate for the main CTF-generated efficiencies of reduced overlapping of input applications and improved trafficability.

He says his use of wider equipment means fewer wheel tracks anyway.

"There are two things in farming that are critical for us," he says.

"That is seeding and harvest operations, which need to get done right, on time.

"I don't believe in complicating or confounding those two key tasks."

Paul O'Meehan, of Borden, describes his machinery system as 'pseudo CTF'. PHOTO: GRDC

Paul says he and wife Jill are leasing a lot of country, have a rent bill that turns up every year and debt to consider, which means efficiency and profitability drive their system.

"I hear of guys that buy equipment to suit their CTF system rather than to suit their scale or what they are trying to do," he says.

"They make that work, which is fine, but I could not see myself going to a third set of gear just to comply with a certain machinery width match for CTF."

Paul believes the adage – 'When you're on a good thing, don't stick to it', used by well-known herbicide resistance expert and Australian Herbicide Resistance Initiative director Professor Stephen Powles, should apply not just to herbicide resistance but more broadly to agricultural systems, including CTF.

"Doing everything in the same place every year, including harvesting, is like using just a particular herbicide for a certain weed all the time, and I think it is bound to lead to problems," he says.

> *"CTF can come at a cost, and I believe I can avoid that cost in my situation by being more efficient in a more flexible, but simple, farming system.*
> *Paul O'Meehan, Borden*

"CTF has positives – I get that – but I think when you are doing the same thing in the same spot, year after year, problems will develop and they are going to be compounded."

Partly matching system

Paul's cropping machinery widths partly match due to using two Ausplow DBS Auseeder bars that are 18.3 metres (60 foot) wide and two boomsprays that are 36.6m (120ft) wide.

"They just happened to match up," he says.

"But we don't have 3m wheel track centres and we don't worry about strictly keeping to wheel tracks."

In 2017, Paul and Jill are using a new 13.4m (44ft) Summers DK Diamond Disc plough for the first time.

This machine does not match other seeding machinery widths, but they see value in its roles of achieving better weed control and improved stubble handling while providing cultivation to which canola responds well.

The three harvesters used on the O'Meehan property are each 12.2m (40ft) wide and do not match the widths of the seeding or boomspray equipment.

Paul sows his crops and sprays herbicides and/fungicides on the same angle each year because he says they are on the most efficient, long runs. He harvests and uses the spreader on a different angle.

Using a John Deere Real Time Kinematic (RTK) autosteer system, he always runs his boomsprays along the same wheel tracks.

Paul O'Meehan, left, with cropping manager Martin Brooks in front of a new 13.4 metre (44 foot) Summers DK Diamond Disc plough they are using for the first time in 2017. The machine does not match his other machinery widths. PHOTO: GRDC

"But I have got to a point where I know I don't want controlled traffic for my whole operation," Paul says.

"I actually go against that grain of thought of being on the same line all the time."

Paul says two problems he believes are present in full CTF systems are uneven spreading of crop residue at harvest and inefficiencies in spreading granular fertiliser and lime.

"When it comes to fertiliser and lime it is a physics thing," he says.

"If all urea balls were three millimetres in size and weighed three grams, I am sure they would spread quite square – but they are not and do not spread square.

"I do not believe 36m spreading is possible because there is 10m of no-man's land not getting the right amount – and this would happen with every granular product.

"That is without factoring in the influence of wind as well, which never blows from the same place every day."

> *At seeding, everything runs in a pigeon pair – we stick together and march our way through.*
> *Paul O'Meehan, Borden*

Paul also points to the issue of spreading animal manure from his cattle lotfeeding operation.

"I have got access to an animal manure resource that we use on our paddocks, but our muck spreader can only spread to a width of 10m," he says.

"This is problematic for fitting into a CTF system."

Paul believes it is best to keep the widths of spreading equipment flexible to achieve peak efficiency and maximise production, rather than automatically matching widths to fit in with a CTF system.

Simplicity and efficiency

Paul says he is driven by efficiency and strives to maintain a simple operation that is easily understood by his employees.

"I do not confuse the guys who are operating the air seeders, as their job is all about getting a seed in the ground in the right spot at the right time in the right situation," he says.

"If we wanted to get more efficient at seeding, we would get a bigger bar and tank with section control.

"If we did this – enabling our seeding equipment to be slightly wider and allowing us to fill-up every 12 hours – I estimate we would increase our productivity by about 20 per cent, without changing tractors or employing extra staff.

"Running two rigs together that are the same size is super-efficient.

"It is easy to look after with seed and fertiliser and it is easy to spray and fertilise in front of the two rigs.

"I don't want CTF to drive the decision making; I want that flexibility."

Paul says in contrast, if he employed a third rig at seeding, not only would he be managing a third tractor and air seeder, there would need to be two additional operators – with associated costs of extra vehicles and accommodation.

He says he has heard of growers who had sold two seeding machines and traded up to three machines.

"But I can't get my head around that because I know how hard it is to run two machines, let alone three, around the clock," he says.

"We find the best way to run our operation is to have two air seeders in the same paddock and to have the three headers together in the same paddock.

"At seeding, everything runs in a pigeon pair – we stick together and march our way through."

Paul says he does not want to be 'snookered' into a situation where 'every time I make a decision, I've got to make five decisions'.

MORE INFORMATION

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Case study – CTF Gary Lang, Wickepin

CTF provides big benefits for early adopter

SNAPSHOT

OWNERS: Gary & Sue Lang (and Gary's father Colin)

LOCATION: Wickepin, Western Australia

FARM SIZE: 4350 hectares (cropped)

ANNUAL AVERAGE RAINFALL: 400 millimetres

SOIL TYPES: Variable – sands to red and grey clays

ENTERPRISES: 3800ha crop and 550ha for sheep (crossbred ewes)

CROP PROGRAM (2017): 1400ha wheat, 1050ha canola, 400ha lupins, 750ha barley and 200ha oats

CTF SYSTEM: Machinery widths 11.9m and 35.7m. 3m wheel track centres

SEEDING: 11.9m wide, John Deere Conserva Pak™ air seeder on 30 centimetre (12 inch) spacings, with Simplicity TQS 4 bin air (includes liquids), 3m wheel track centres, and Protracker implement steering

765E Cat® Challenger 375hp tractor on 450mm tracks, also on 3m wheel track centres

Trimble XCN 2050 RTK autosteer with second receiver to steer ProTracker

SPRAYING: Self-propelled Miller Nitro 5333 boomspray, 35.7m and 11.9m swathing, with harvester front. RTK autosteer

HARVEST: New Holland CR 9.90 harvester on 3m centre, 900mm single tyres, 11.9m MacDon header front, Trimble RTK from Challenger. Emar chaff decks to put chaff on tramlines

SPREADING: Contractor not on 3m wheel track centres, 12m spreading of lime, and 24m for fertiliser

Gary Lang is a relatively early adopter of controlled traffic farming (CTF) and says it has improved soil moisture retention and boosted crop yields by up to 0.2 tonnes per hectare in drier years on his 4350ha Wickepin property.

He started implementing a CTF system in 2007, about two years after purchasing a harvester that incorporated a Real Time Kinetic (RTK) guidance system. The primary aim was to reduce crop input amounts and costs by improving application accuracy.

"Given we already had the guidance system in place, we thought we may as well give CTF a go," he says.

Gary and his wife Sue, crop 3800ha and run a crossbred ewe operation on the remaining 550ha of their property. Gary's father, Colin, is retired but maintains an interest in the farm.

Their property is in an area traditionally devoted to mixed farming operations, but which has largely swung to majority cropping in the past 15 years.

The Lang's farm has a wide variety of soil types, including heavy grey and red clays, but is predominantly sandy loam over clay duplex.

Frost, followed by dry weather, are Gary's biggest ongoing cropping challenges and he estimates frost cuts his potential crop yields by, on average, 30 to 50 per cent each year.

Switching to CTF

Gary says initial machinery modifications to meet CTF specifications included increasing the width of seeding equipment from 10 metres to 11.9m, which was achieved by welding and bolting on extra frames.

He says the rationale for adopting 11.9m machinery widths, instead of the more commonly used 12m widths, was because 11.9m accommodates 39 tynes at 30 centimetre (12 inch) spacings.

"I believe the system works best if you have an odd number of tynes," Gary says.

Farm worker Ricky Dougall, left, and grower Gary Lang in front of Gary's 35.7m Miller Nitro sprayer, which is the width of three seeder runs. PHOTO: GRDC

The Langs then removed the dual wheels from their four-wheel drive tractor and replaced these with cotton wheel spacers, which are steel and shaped like a cotton reel.

These widened the wheels out to meet 3m wheel track centres, compared with a standard wheeled tractor that has wheel track centres of 2.2m.

Gary says instead of buying all new equipment, they modified machinery to align with an operating width of 11.9m and 3m wheel track centres.

"Then, as we needed to replace machinery, we bought equipment to fit our specifications," he says.

"It didn't feel like a huge risk because we only spent $20,000 to $30,000 setting up the system, which wasn't significant.

"Now we probably only spend between $5000 and $10,000 each year maintaining the CTF system, which is just part of our normal machinery spend."

Gary says it took about three years to make the necessary modifications and purchases to establish a full CTF system and, by keeping expenditure in check, the family minimised financial risks.

He says they always keep an eye out for emerging technologies and will be excited when driverless agricultural machinery becomes available.

"Already, our system can run the cropping machines with minimal involvement from us, so the introduction of driverless machinery won't be a massive step," he says.

"I think we are striking a balance between staying on top of the latest technology and keeping our costs at a sensible level."

Gary notes his spreading contractor's equipment is not set up for 3m wheel track centres, but this does not seem to cause any major problems for the contractor to operate in the Lang's system.

Lupin and weed regrowth on tramlines in a lupin stubble paddock. The lupin crop was harvested with a New Holland 9.90 harvester on 3m wheel tack centres and chaff decks were used to direct chaff onto tramlines. The idea is to control and restrict weed and crop regrowth to one area to minimise weed competition in the following crop. The weed seeds and volunteer regrowth on the tramlines can be selectively targeted with herbicides. PHOTO: GRDC

Benefits of CTF

Gary believes the family's grain business is in front by using CTF due to improved economies of scale and consistent yield benefits.

"We get really good comparative yields for our district, particularly in dry years when our yields tend to be up by about 0.2t/ha compared with the district average," he says.

"Our biggest ongoing agronomic issue is frost, but drought can also be an issue and CTF gives us an ongoing strength for managing this in any dry year.

"We can also see the soil holding up really well due to improved health and structure."

Gary says although he does not deep rip his soils, they remain soft and fluffy year-round (even after significant rainfall) because they are not trafficked.

"Because we are not running over the soils, they retain that quality even during weather extremes," he says.

"During the massive rainfall events we experienced in early 2017, the paddocks ran less water and we only had very minor tramline erosion.

"There was less erosion simply because there was less water movement. We saw that as a real benefit."

Challenges

However, Gary says the ability of the farm's soils to withstand and retain moisture does create some particular difficulties.

"I'm also a sheep farmer, and when you don't get any run-off it is hard to fill your dams," he says.

"However, in February 2017 – when we had 120 millimetres of rain in 24 hours – they did start to fill."

Catching so much water in the soil during the past two summers has resulted in a lot of seepage appearing, which has created some bogging issues, according to Gary.

"But really, the heavy rainfall experienced in the past two summers was one-in-10 year rain events, so you just have to wear them and look forward to the moisture profile benefits you receive in the longer term," he says.

Gary says straw spreading at harvest has caused nutrient deficiencies in subsequent crops when the straw does not spread over 12m.

"Straw spreading has been a big issue for us because it is difficult to spread it over the full 11.9m," he says.

"This has resulted in potash deficiencies at the last metre of each swath.

> *Because we are not running over the soils, they retain that quality even during weather extremes.*
> *Gary Lang, Wickepin*

"I think I may have resolved the issue by putting a different chopper spreader on the header, which runs at 4000 revolutions per minute (RPM) instead of the standard chopper rate of 2100 RPM.

"We also changed many of the blades to wind blades, which increase push and throw and don't chop the straw as much."

Gary points out that CTF effectively removes the family from the second-hand machinery market, as they are now at the point where they need to buy new equipment to meet the specifications of the system.

He says the RTK autosteer guidance system he uses does come with some issues.

"It requires having your own base station and if cropping paddocks are spread out, it can make the system quite difficult and expensive," he says.

Gary says another problem is accessing the necessary technical skills required when setting up new machinery, although he says this is slowly improving.

He is interested to know what the benefits would be from adopting wider machinery widths in a CTF system.

"If you took your swaths from 11.9m to 15m, or wider, I believe this would generate even more efficiencies," Gary says.

"We would like to know how a wider system would work out and it is a key question for future CTF research.

"However, we probably would not adopt a wider system on our own property given our very established tramlines."

Gary Lang with his Cat® tractor on 3m wheel track centres, 11.9m wide John Deere Conserva Pak™ air seeder and Simplicity bin. PHOTO: GRDC

Chaff decks at harvest

In the past two years, Gary has started using chaff decks for placing harvest residue (including weed seeds) onto tramlines.

The idea is to control weed seeds and restrict weed and crop regrowth to one area for minimising crop competition issues in the following year.

The weeds and regrowth on the tramlines can be selectively targeted with herbicides.

"At this stage we are a bit uncertain about whether chaff decks are a sustainable way to ease the weed burden, particularly in the grazed stubble where sheep tend to kick the weeds off the tramlines," Gary says.

"We will eventually make a decision about whether to continue with chaff decks, based on our overall level of weed control in coming seasons."

Gary says the various components of his farming operation are in a state of constant change in order to achieve the best overall results.

"But our CTF system has been with us for over 10 years now and its longevity proves its efficacy for our system," he says.

MORE INFORMATION

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Case study – CTF Ben Ball, Wagin

Don't become obsessed by CTF, says Wagin grower

SNAPSHOT

OWNERS: Ben & Kristy Ball, Greg & Glenys Ball

LOCATION: Wagin & Woodanilling, Western Australia

FARM SIZE: 2300 hectares cropped

ANNUAL AVERAGE RAINFALL: 400 millimetres

SOIL TYPES: Very variable – shallow and deep sandy duplex, loamy duplex, some gravel, some non-cracking clays

ENTERPRISE MIX: 70 per cent crop, 30 per cent sheep

CROP PROGRAM (2017): 500ha canola, 500ha lupins, 200ha oaten hay, 300ha oats, 800ha barley

CTF SYSTEM: 13.5 metre machinery width and 3m wheel tracks

SEEDING: 13.5m John Deere 1820 Air Drill, 25.4 centimetres (10 inch) rows. JD 1900 Air Cart modified to 3m centres with Flexi-N liquid kit on bar. 500 horsepower JD 9400T deep ripping tractor and air seeder, not 3m centres but fits on pseudo tramline

SPRAYING: John Deere 4710 self propelled sprayer on 3m centres (adjustable)

HARVEST: JD 9870 STS 45ft with PowerCast™ Tailboard chopper and spreader fitted with chaff decks

SPREADING: Employs contractor for lime and some fertiliser. Raycol Super Spout or 'whale tail' fitted to JD 1900 Air Cart

OTHER FEATURES: Offset hitch on tractor to allow inter-row or edge row sowing. John Deere 8320 with 4.5m centre pivot mower, 4.5m Bednar TERRALAND deep ripper

While Wagin grower Ben Ball is a firm supporter of controlled traffic farming (CTF), he says it's important not to become obsessed by the system to the extent that it impacts on practical farming decisions.

Ben crops 2300 hectares with his wife Kristy and parents, Greg and Glenys, on a farm that stretches across the shires of Wagin and Woodanilling.

The family has had to remain flexible in decision-making to meet the demands of an export hay business and prime lamb production.

Ben uses a 13.5 metre machinery width on 3m wheel track centres for CTF and a John Deere GreenStar™ guidance system with two centimetre repeatability. However, this has proven a challenge for hay-making.

"We can cut hay in a 13.5m CTF system using a John Deere 8320 on 3m centres with a 4.5m pivot mower, but the contractor's efficiency takes a hit when he has to pick up such a large swath," Ben says.

"The older baling contractors have a real problem with it and the newer operators – who are using the new high density 8x3x4 Krone balers that can bale a larger swath – have not yet replaced their entire fleet of machines.

"I'm aware of people doing CTF systems for hay in the eastern states on smaller systems and I know it is achievable on widths of 13.5m, but the return on income is not there for us to do it yet."

Ben says it's a common assumption that growers using CTF run the system every year, but that is not always the case for his operation, which remains flexible up to a point.

"Two years ago we had a bad-looking oats paddock that returned our highest gross margin after we cut it for hay using random traffic," he says.

"CTF shouldn't hinder good management decisions, although in this case the paddock was a shallow duplex soil that had not had subsoil constraints ameliorated by deep ripping."

At seeding time in April, 2017, are, from left, mechanic Reece Theo, grower Greg Ball, agronomist Wade Longmuir, of Galts Wagin, fitter and turner (CTF modifications) and tractor driver Locko Ballantyne, grower Ben Ball with daughter Violet, and Graham Murray, of AFGRI Equipment Wagin. PHOTO: Ball family

> ***I haven't seen any evidence that sheep can compact the subsoil, so in my mind they are perfectly compatible with CTF, minimum tillage and deep ripping – at low stocking rates.***
> *Ben Ball, Wagin*

This year the family planned to plant a 200ha area to a hay crop in a non-CTF paddock and will consider whether it might be economical to deep rip the paddock beforehand.

"This is an example of how, as farm managers, we must straddle the line between what is ideal for plants, soil and the environment, and what actually pays the bills," Ben says.

"Anyone who farms will understand that."

Another operation that is done outside the CTF system is the unloading of chaser bins at harvest time.

"We run one chaser/tractor wheel on one tramline – for example, the left wheel on the right tramline – while unloading," Ben says.

"To assess the amount of compaction that the opposing wheel has on the paddock, I took into account the bin capacity, the unloading rate and the speed of the John Deere 9870 STS header.

"In a crop that yields 2 tonnes/ha and at an unloading speed of 10 kilometres per hour, this resulted in 0.8 per cent of the paddock being compacted over one year and that is acceptable to me."

Other features of the Ball's CTF system are an offset hitch on the tractor, which allows inter-row or edge row sowing without the need for a guidance system.

"As long as we travel in the same direction with the airseeder on each tramline, our tow-between bar tracks accurately," says Ben.

"There's a method to remembering the tramline direction, which isn't too hard."

Inter-row sown lupins with a 'chaffy' tramline on the left side of the photo at the Ball family property. PHOTO: Ball family

The John Deere 9870 STS harvester was acquired as part of a regular upgrade of farm machinery and is fitted with chaff decks to funnel weed seeds onto the tramlines. A PowerCast™ Tailboard chopper and spreader is mounted at the rear of the chopper.

"We made the decision four years ago not to invest heavily in a chaff cart for harvest weed seed control (HWSC)," Ben says.

"Instead we chose to use some of that capital to implement Real Time Kinematic (RTK) guidance in a CTF system and to buy an EMAR chaff deck.

"The PowerCast™ spreader does a good job of spreading straw full width. This is important because we don't want to end up with 'strippy' crops near the end rows in 10 years' time due to potassium (K) removal."

Fertiliser and lime application also fits into the CTF system for the Balls.

Contractors apply lime prior to deep ripping using a 500 horsepower John Deere 9400T tractor.

Nitrogen (N) is distributed at seeding through a JD 1900 Air Cart with a Flexi-N liquid kit on the bar and as a foliar application during the growing season.

"The relative cost of liquid N compared with granular N in Western Australia makes applying liquid N feasible for us, especially as it has a logistical benefit for us," Ben says.

He says some K and N is distributed through a Raycol Engineering 'whale tail' fitted to the air cart. This results in a two-product variable rate (VR) application on 3m wheel track centres.

The Balls also run sheep, joining Merino ewes to Poll Dorset sires to turn off prime lambs.

"Sheep are really good if you have a weed blowout or want to drop a paddock into stock for a year," Ben says.

"I haven't seen any evidence that sheep can compact the subsoil, so in my mind they are perfectly compatible with CTF, minimum tillage and deep ripping – at low stocking rates.

"Some of our worst erosion patches from the February flood this year were where sheep hadn't even grazed yet."

However, the large paddocks traditionally associated with CTF can be a challenge in a mixed system, especially for mothering of lambs, according to Ben.

"Big paddocks of 100ha-plus minimise headlands because of their size, but I've been advised that in order to maximise weaning percentages, twin-bearing ewes really need to be in mobs of 200 head or less," he says.

"This means quite a low stocking rate is needed on a 250ha paddock.

"Seasonal electric fencing, or potentially livestock geo-fencing, may have a role here in the future to get the best outcomes in terms of large paddocks, improved weaning percentages and higher stocking rates."

In February 2017, the Ball's tramline system was severely tested by a 1-in-50-year rain event for Wagin, which locals say was worse than previous extreme flood events experienced in 1982 and 1955.

After 220 millimetres of steady soaking rain over two days, a sudden fall of 20mm in 10 minutes significantly eroded about 1 per cent of the tramlines on the Ball's property.

The damage was in patches and particularly severe in lupin and canola stubble and in sandy soil where the tramlines ran up and down the slope.

While cereal stubbles were not as badly affected, Ben says the intensity of the storm after previous days of saturating rain caused the water to run down the tramlines like a drain.

"The worst patch of erosion was on headland tramlines running up and down the slope in a particular paddock," he says

"Thanks to some foresight, the tramlines in this paddock were already aligned to the neighbouring one.

"Both paddocks have been joined and deep ripped and this filled some ruts in – and should increase water infiltration rates.

"We have renovated some of the damaged tramlines with a grader and a loader and we're hoping that over time, some minor ones will be filled as the neighbouring tyne throws soil back into the rut.

Tramline erosion after flooding rain in February, 2017. PHOTO: Ball family

"If this doesn't work, plan B will be to hire or build a tramline renovator."

The extent of damage from the flood came as a surprise to Ben.

"This to me appears a bit contrary to what happens over east, where they typically recommend working up and down the slope, rather than across," he says.

"To be honest, we will just pick the longest run and lean towards east-west orientation for annual ryegrass (*Lolium rigidum*) weed management."

Ben has one prerequisite for staff working in the CTF environment – that they must be familiar with the GPS equipment and know how to 'de-bug' the system.

MORE INFORMATION

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Case study – CTF Trevor Syme, Bolgart

Patience the key to implementing CTF

SNAPSHOT

OWNERS: Trevor & Renae Syme

LOCATION: Bolgart, Western Australia

SIZE: 4000 hectares cropping on owned and leased land

ANNUAL RAINFALL: 400 millimetres

SOIL TYPES: Red clays to deep white sand

ENTERPRISE MIX: 100 per cent cropping

2017 CROP PROGRAM: wheat, canola, barley, lupins

CTF SYSTEM: 12.2 metre (40 foot) tramlines, 3m wheel tracks

SEEDING: JD 8345RT track machine pulling 12.2m purpose-built Gessner frame with equaliser sowing modules

SPRAYING: JD 8320 front wheel assist tractor pulling 37m Goldacres boom spray

SELF-PROPELLED: JD 4930 36.3m (120ft) sprayer

HARVEST: JD S680 header, 12.2m (40ft) front, extended auger to feed chaser bin on tramlines

SPREADING: Marshall 910T multi spreader

OTHER FEATURES: Hire an Ausplow Easitill E600-20 deep ripper with 12m cut

It has taken Trevor Syme 12 years to reach his goal of 100 per cent controlled traffic farming (CTF) implementation for his Bolgart operation, but he couldn't be happier with the results.

Whether it is the benefits of less soil compaction, reduced fuel use, more targeted weed control or just making it easier for casual drivers to follow the wheel tracks, CTF has delivered results for Trevor and his wife Renae on their Waddi Park property.

The Symes now have all their machinery tailored to a CTF system on a 3:1 machinery width ratio, using a John Deere S680 header with a 12.2 metre (40 foot) front, a purpose-built 12.2m (40ft) Gessner airseeder and a 36.3m (120ft) Goldacres boomspray.

Trevor traces his interest in CTF back to a field day held by the Western Australian No-Tillage Farmers Association (WANTFA) more than a decade ago, where he says the idea that 'you don't drive where you want to grow a crop' made sense, particularly when combined with deep ripping.

Reduced compaction after deep ripping

Trevor says the majority of the farm's soil types were improved by deep ripping, but the great response in the first year would often be compacted again the following year.

"We thought, why not line things up so we're not compacting the ground as quickly," he says.

He began replacing cropping equipment with machinery to run on 12.2m (40ft) tramlines on 3m wide wheel tracking to match the width of his seeder bar at the time. He also installed a Real Time Kinematic (RTK) two centimetres autosteer system with a base station.

In retrospect, Trevor says it would have been better if he had used a 12m wide system instead of a 12.2m system, as it has since proved easier to buy equipment in multiples of metric – rather than imperial – measurements.

Trevor Syme's advice for growers who are starting to implement CTF is to not rush out and buy the first machine available. PHOTO: GRDC

Don't rush to buy machinery

His advice for growers who are starting to implement CTF is to not rush out and buy the first machine available.

"Do your homework and stick to your typical machinery replacement plan, then it will be cheaper than you realise," he says.

"Instead of buying a 13.7m (45ft) header front, stick with 12.2m (40ft), buy a header with single tyres instead of duals and then you don't need a massive tractor to pull the air seeder in a CTF system."

Trevor sold his 6m deep ripper and now hires a 12m Ausplow Easitill, taking the tynes off where the tramlines are.

"Modifying machinery is common in CTF," he says.

"The autosteer means we have an A-B run line, so we used to have to nudge our whole air seeder across by 150cm (six inches) to sow on the inter-rows of the previous year's stubble rows and ensure there were no double-handling issues.

> *"Do your homework and stick to your typical machinery replacement plan, then it will be cheaper than you realise.*
> *Trevor Syme, Bolgart*

"But because we found the tramlines were sinking, the air seeder cart was dropping back into the tramlines and pulling the air seeder sideways.

"So we asked Gessner to build us a seeder to suit our 12.2m system and it has a bar like a manual side shift, with the wheels in the same spot but the frame moving across to suit."

Trevor has also extended the auger on the harvester so that the chaser bin can stay on the tramlines and has also extended a standard metric width boomspray by half a metre on each side to suit CTF. He says these modifications were cost effective.

Invigorated soil 'like raised bed farming'

Trevor is not sure yet whether the tramlines are sinking, or if the rest of the paddock is lifting because the soil is softer.

"It's nearly raised bed farming in some spots of our farm and the tramlines are 100 millimetres below the surface – which can make seed placement a bit of an issue," he says.

"We've got a parallelogram on the seeder so all seed boots are individual, so that will help, and we're looking at tramline renovators to pull soil from sides of tramlines into the middle to build it up a bit.

"But that would be the only negative aspect of CTF we have experienced – and the positives certainly outweigh this."

Another minor problem was getting bogged – up to 50 times during the 2016 wet winter – whenever his machine ventured off the tramlines.

Trevor Syme and his family have all their machinery tailored to a CTF system on a 3:1 machinery width ratio. PHOTO: GRDC

Trevor says having a 345 horsepower tractor pulling the heavy seeder meant he wasn't 'overly flush' with power and it was a case of using the manual override to keep the machine on the tramlines when moving through any wet spots.

System responds to a wet season

The wet conditions of 2016 also proved to be an interesting test of soil moisture conservation for CTF, which came through with flying colours.

"We did a heap of deep ripping last year and when we had a lot of rain in March I thought we'd wasted our money," Trevor says.

"But several paddocks that hadn't been deep ripped were the worst for waterlogging by far.

"The moisture couldn't get through the hard top pan of the soil quick enough, whereas adjacent paddocks that had been deep ripped didn't have pools of water on top and the whole paddock got harvested.

"I dug a hole in some gravel country with the excavator to look at roots in a wheat crop and in the tramline area these went down to a depth of 30cm and stopped.

"Just off the tramline, the roots went down to a depth of 60cm – and another 60cm away, they went down to 90cm."

Weed control made easier

For the past three years, Trevor has used chaff decks at harvest to drop chaff onto tramlines, which he says makes it unnecessary to burn stubbles and more economical to control weeds.

"If we need to bomb a paddock with a high weed burden, we know that 95 per cent of the weed seeds are on the tramlines," he says.

"We can also test different herbicides on the tram tracks that may be too expensive to use across the whole paddock."

Trevor has also tested some non-herbicide weed control treatments that have worked well.

"We had a paddock in 2016 with high levels of annual ryegrass (*Lolium rigidum*) and we just ran up and down with the tractor, going one way then turning around and going the other way, and the tractor rolled it over and crimped it," he says.

The Syme family had a seeder built to suit their CTF system. PHOTO: GRDC

"Because the tramlines are the most unproductive part of the paddock, the weeds just don't grow as well either – and we get minimal dust when tracking because the weeds are there."

Benefit in savings rather than yield benefits

Trevor is frank when asked if he could quantify the economic benefits of CTF.

"I can't specify a crop yield benefit because the whole farm is under a CTF system," he says.

"I think it's more about cost and input savings than yield benefits – as well as little pluses, such as when you employ casual drivers you can instruct them to 'follow the wheel track' and be confident they will perform the operation well.

"But I can guarantee fuel savings. We lease a 660ha farm to the south of us and, prior to using CTF, I could fill the boomspray and the tractor, drive up to that farm and not be able to get home after a spray application using only one tank of fuel.

"This year I fuelled up, sprayed it all and did an extra 100ha of spraying at the same place and still had fuel. It's a lot more efficient."

The CTF system also enables the Symes to set up trial strips in a paddock to test different applications of fertiliser and compare varieties.

But Trevor isn't having much luck finding any nearby growers to compare systems and results.

"Our only comparison is when we lease more country to farm and the owner has been very surprised at how well the soil responds to controlled traffic," he says.

MORE INFORMATION

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Case study – CTF Lawson Grains, Dandaragan

Company continues WA conversions to CTF

SNAPSHOT

OWNERS: Lawson Grains

LOCATION: 30 kilometres south of Dandaragan, Western Australia

FARM SIZE: 5600 hectares cropped

ANNUAL AVERAGE RAINFALL: 600 millimetres

SOIL TYPES: Light to medium sand plain with gravelly knobs

ENTERPRISE MIX: 100 per cent cropping

CROP PROGRAM: 25 per cent split rotation lupins/wheat/canola/barley

CTF SYSTEM: 12 metre, wheel tracks at 3m centres

SEEDING: 12m Cross Slot® seeder

SPRAYING: 36m John Deere R4045 on single wheels

HARVEST: Two 12m John Deere 690 on single wheels

SPREADING: Lime – 12m AgriSpread spreader 36m three point linkage Kuhn Axis® granular spreader

OTHER FEATURES: Agro Plow AP91 deep ripper with shallow leading tynes, 9510RT used for deep ripping, 8360R on wheels as a utility tractor, 4.5m Farmax trailed spader, John Deere 8370 RT on tracks used as primary tractor for seeding, spreading and chaser bin at harvest

After converting Walyoo at Dandaragan to controlled traffic farming (CTF) in 2014, Jonathan (Jono) Lampp is now implementing CTF on a second Western Australian property – a move that is in line with the national model adopted by his employer, Lawson Grains.

Lawson Grains owns and operates 10 large scale cropping farms covering 88,200 arable hectares across WA and New South Wales and is strongly committed to minimising soil compaction, correcting soil acidity, maintaining full stubble retention and increasing water use efficiency (WUE) through CTF.

Jono Lampp, of Lawson Grains, says there are many quantifiable benefits of CTF. PHOTO: GRDC

The company's machinery fleet includes 16 tracked 370 horsepower tractors on three metre centres used with 12m minimum, or no-tillage, seeders, 32 John Deere S690 harvesters and self-propelled spray rigs with 36m booms.

Jono's first step at Walyoo was to pull out all internal fencing and convert the farm into seven paddocks, ranging in size from 190ha to 1450ha, to minimise input overlap and increase efficiencies.

"CTF requires a lot of forward planning and Walyoo was a very good opportunity for us to start afresh and work out things like what length the run lines should be to work best for harvest," he says.

"Paddocks were mapped and measured for size and electromagnetically surveyed for soil types so that they could be overlaid with yield maps to make variable rate (VR) maps for fertiliser application.

"We then marked according to which tramline orientation would work best for each paddock to get the most efficient runs.

"We use the same tramlines for all operations and, in the second year, we went around all the paddock exterior boundaries and 'mapped-in' A-B curves, so that all headlands can now be used with autosteer as well."

Deep ripping followed by spading has also been implemented across this property.

"They (the experts) say that 60 to 80 per cent of soil compaction is a result of your first pass and, in 2015, we had a very dry spring and could see some old traffic lines from previous years dying-off, so that's what made us rip as deep as possible," Jono says.

"You get a hard compaction layer at a depth of between 20 centimetres and 55cm in the sand and plant roots struggle to get through this, so we've deep ripped all of the Walyoo property to sub-50cm.

"We then used a spader as a tool to mix lime down the profile and reduce the water repellency of the non-wetting sands."

With GRDC investment, the Department of Agriculture and Food Western Australia (DAFWA) is in its third year of trials on one block on Walyoo, designed to assess how quickly the sandplain is self-compacting in a CTF environment.

"We have seen yield uplift of up to 1 tonne per hectare on spaded ground and even a decrease in frost-affected plants," Jono says.

"I think it will be a five to six year deep rip-rotation."

While the economic benefits of CTF can be hard to quantify, Jono is confident the system is working.

"We are seeing an up to 6 per cent reduction in input overlaps compared to non-CTF areas and there are so many other things we are correcting at the same time, such as soil pH, hard compaction layers and water-repellent soils," he says.

"We've now increased the soil water 'bucket size' by eliminating the physical and chemical barrier, which means crop roots can chase the moisture and nutrients down the profile when there is a dry spell."

Jono says plenty of lime – a total of 24,000t – was applied over the entire Dandaragan property in the past three years and applications are now in a maintenance phase.

> ***"CTF requires a lot of forward planning and Walyoo was a very good opportunity for us to start afresh and work out things like what length the run lines should be to work best for harvest."***
>
> *Jono Lampp, Dandaragan*

Lime is spread in front of the canola crop in the rotation at variable rates of between 1.2 and 2t/ha.

Jono says windy days can make it challenging to spread lime and granular fertiliser evenly in the CTF system, as equipment is committed to staying on the 12m or 36m tramlines.

As part of weed management, he says canola windrows were traditionally burned on Walyoo, but a year ago harvesters were fitted with chaff decks. In line with harvest weed seed control (HWSC) strategies, this lays chaff on the 12m tramlines to create an inhospitable environment for the weed seeds on these compacted tramlines.

The property operates on full stubble retention and this year Lawson Grains took delivery of two 12m containers that held a New Zealand-made Cross Slot® seeder on 3m centres as a custom-built bar, which was assembled on farm.

"The Cross Slot® is a hybrid seeder that has a central disc with two blades hugging the disc, one laying the seed and one laying the fertiliser," Jono says.

"The disc penetrates 7.5-10cm below the soil surface and small wings at the ends of the two blades create slots, like an inverted T shape in the soil, so that the seed and fertiliser is placed separately without causing any fertiliser toxicity.

"Because the disc is in the centre of the opener and the two blades hug both sides of the disc firmly, it cuts through the heavy residue and there's far less soil disturbance.

"It's not a busting action like the tyne."

Jono Lampp, of Lawson Grains, says they are seeing an up to 6 per cent reduction in input overlaps compared with non-CTF areas in their operation. PHOTO: GRDC

The ability of the Cross Slot® to seed in heavy stubble means the operators can afford to lift the cutting heights on the headers. Jono says there could even be options to move to a stripper front on the cereals, which would improve harvest efficiency.

He says he expects seeding operations to be around 20 per cent faster due to less furrow-throw from the low disturbance openers allowing higher ground speeds.

Compaction from chaser bins during harvest has been reduced by attaching Grain King Tramline Tops to compensate for the header auger being too short to reach the bins on the tramlines.

“The Tramline Tops push out from the top of the chaser bins to reach the harvester augers and have an endless conveyor belt that brings the grain back into the chaser bin,” Jono says.

“We also run John Deere Machine Sync, so that when the harvester is unloading on the tramline top, the harvester takes over controlling the forward speed of the chaser tractor.

“This means that if the harvester slows down or speeds up during the unloading process, so does the chaser tractor.

“This keeps the auger of the harvester always unloading on to the tramline top.”

Shared data allows two machines to work simultaneously, with each operator having immediate access to coverage maps and guidance lines to ensure complete field coverage.

Lawson Grains uses John Deere GreenStar™ 2630 displays and StarFire™ receivers for the Real Time Kinematic (RTK) autosteer system.

An increase in the soil water ‘bucket size’ has been achieved by eliminating the physical and chemical barrier, which means crop roots can chase the moisture and nutrients down the profile when there is a dry spell. PHOTO: GRDC

A Grizzly Wheel Track Renovator that builds up sinking tramlines will be shared between Walyoo and Lawson Grains’ recently purchased Wongan Hills property, St Leonards, which Jono is now converting to CTF.

“The Grizzly Renovator has two small offset discs that run either side of the tramline and throw soil back on to it,” he says.

“We mainly do the highly trafficked trams, which are 36m, and one pass is enough to build them back up.”

The only other drawback to CTF, Jono says, is the difficulty of swathing timing as small areas of canola that may not be quite ready to swath and are in the same run lines as canola that is typically ready to go.

“When you’re swathing canola, you might have a gravel knob area were the crop has held on a little longer than the sand area and – before we used CTF – we could leave it and come back to it later,” he says.

Fuel savings due to the implementation of CTF on Walyoo were hard to calculate due to the deep ripping that’s also been done, Jono says.

But he says there are many quantifiable benefits of CTF and Lawson Grains is continuing its commitment to minimise soil compaction, increase WUE and eliminate soil constraints by implementing CTF over all its farms.

MORE INFORMATION

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Case study – CTF Avon Rayner, Carnamah

CTF shows promise in first full year of operation

SNAPSHOT

OWNERS: Peter & Carole Rayner, sons Hayden & Avon

LOCATION: Carnamah, Western Australia

SIZE: 3300 hectares cropping on three farms

ANNUAL RAINFALL: 350-400 millimetres

SOIL TYPES: Sand over gravel

ENTERPRISE MIX: 100 per cent cropping

2017 CROP PROGRAM: 800ha wheat, 800ha barley, 750ha canola, 950ha lupins

CTF SYSTEM: 10.6 metre (35 foot) tramlines, 3m wheel track centres

SEEDING: Case IH STX550 tractor, John Deere air cart and Morris Contour Drill modified to 21.2m (70ft) bar

SPRAYING: Case IH STX275 tractor with 31.8m (105ft) Sonic boomspray

HARVEST: John Deere 9650 and 9760 harvesters with 10.6m (35ft) 936D fronts

SPREADING: Bredal spreader behind John Deere 9520 tractor (also tows chaser bins): 10.6m (35ft) and 31.8m (105ft)

OTHER FEATURES: 10.6m (35ft) Gessner deep ripper (extended from 9.1m (30ft) with extra tyne). John Deere GreenStar™ guidance systems on Apex software

Carnamah grain grower Avon Rayner has been using Precision Agriculture's web-based calculator to work out how much cultivation area he is driving over annually, and he is very happy with the results from last year's move to controlled traffic farming (CTF).

"With our previous machinery we were covering 53 per cent of the paddock, but with the new CTF system we've got it down to 24 per cent," he says.

The Rayner family is in its second year of CTF and Avon says he would not hesitate to recommend the system. PHOTO: Avon Rayner

"Our ideal target is 15 per cent, which we hope to achieve once we change to a tracked tractor and get all of our implements based on three metre wheel centres."

It is only the second year of CTF for the Rayner family and while Avon says the system has not really taken off yet in the local area, he would not hesitate to recommend it.

He initially considered the move to CTF after seeing the benefits of deep ripping but experiencing the detrimental effects of higher fuel usage, bogging of machines and soil recompaction, which in turn neutralised those benefits.

"Experience in Western Australia indicates about 75 per cent of soil compaction damage is done in the first pass," Avon says.

"If you calculate that 53 per cent of the paddock is affected when traffic is not controlled, that's 40 per cent of deep ripping that is a waste of time if you can't preserve the benefits."

CTF tramlines in a lupin crop on the Rayner family's Carnamah property. PHOTO: Avon Rayner

To test the extent of compaction caused by uncontrolled machinery traffic following deep ripping, Avon set up his own trials on the farm.

"After one deep ripping episode, before we implemented tramlines, I did a bit of a trial with our main tractor on triple tyres and ran over five hectares of crop when it emerged," he says.

"I wanted to see the differences in crop that had been run over, as opposed to crop that hadn't, and to monitor fuel use at harvest time."

The results surprised the Rayners. The crop that was run over in the trial, replicating the post-emergent wheel tracks of the spreader and sprayer, yielded 370 kilograms/ha less grain than the crop that had been controlled traffic farmed, which equated to a cost of $111/ha.

On the CTF area, the header used 4.5 litres less fuel per hour at an average of 32L/hour.

"I estimated that by reducing the amount of wheel tracks with CTF, we would run over 81ha less crop across our 3300ha program," Avon says.

"Combined with the increase in yield and profit, I calculated we would save $9000 across the program, which made CTF worthwhile.

> ***"With farming you have to make everything as efficient as possible.***
> *Avon Rayner, Carnamah*

"The estimated savings have increased as we match up more of our machinery – the sprayer and the spreader – on the same wheel centres and coverage width."

Avon opted to set up a CTF system based on 10.6 metre (35 foot) machinery widths with wheel tracks on 3m centres. In 2015, he drew up a plan for the type of machinery and system needed for the move towards becoming fully CTF.

In 2017, as part of a machinery replacement schedule, the family invested in a Bredal spreader and 31.8m (105ft) Sonic boomspray.

The Bredal spreader can be set up for variable rate technology (VRT) fertiliser distribution at 31.8m (105ft) but is also used for lime, gypsum and dolomite at 10.6m (35ft).

"I chose the 10.6m (35ft) width because we had header front widths of 10.6m (35ft) and our boomspray and other machines could be modified to suit," Avon says.

"The header fronts are the next on our replacement list though, as our 936D fronts are 53 centimetre offset.

"A 12m (40ft) system is pretty common in CTF and means you can get over the country quicker and cause less compaction. But in our situation, it would have been a lot harder to make the machinery suit."

Avon has modified farm machinery to suit the 10.6m (35ft) spacing and changed machinery over when it was due, rather than buying CTF equipment straight away.

The 10.6m (35ft) Gessner deep ripper was initially 9.1m (30ft) wide, but was extended by removing tynes on the wheel track and placing them on either end.

Late in 2015, Avon invested in a used 21m (71ft) Morris Contour Drill that he re-spaced and cut out to 21.2m (70ft).

"It can be a bit of an issue to get machinery that matches for CTF and it cost us approximately $70,000 by the time we trimmed the second-hand bar and put in new pins, bushes and bearings and prepared it to suit CTF," he says.

"But everything else we've changed over needed doing anyway, so CTF hasn't actually cost us much extra."

Another $70,000 investment was made to upgrade two autosteer guidance systems from John Deere SF1 to Real Time Kinematic (RTK) and buy a third screen and receiver on RTK.

"We started with John Deere's GreenStar™ guidance system and SF1 GPS signal with 25 to 30cm accuracy," he says.

"Now we're using the RTK system with 2cm repeatability and Apex software."

Avon says it is important to plan for the transition to CTF.

"I think it's worth spending a bit of time on the computer to make sure everything is correct in the software from the start and that includes measuring the centre of your first tramline from your fence lines," he says.

"This is a system that will hopefully be there for the long term."

The Rayner's farm has no internal fences and is divided by gravel roads. This year is only their second year of using CTF, but already Avon is noticing other benefits besides reduced soil compaction issues.

"Fuel saving was the main advantage I saw at first, but after doing more research, I can see other benefits that are harder to quantify," he says.

"These include increased grain yield and grain quality and production savings on input costs from reduced overlapping in paddocks."

The Case IH STX275 tractor used for spraying has 480/70 R46 tyres to match the tracks of the 540/65 R28 tyres on the new Sonic boomspray. The spreader is equipped with 800/65 R32 tyres and the tractor that tows it has 800/70 R38 tyres.

Carnamah grower Avon Rayner uses a Case IH STX275 tractor to pull a 31.8m Sonic boomspray in his controlled traffic system.
PHOTO: Peter Rayner

Although it was bought with triple tyres for deep ripping, the Case IH STX550 seeding tractor only needs duals when seeding. Avon says a track machine would have suited them better, had they known they would change to a CTF system.

With the bar measuring 21.2m (70ft), it is necessary to start it on the edge of the paddock between two runs and then move onto a tramline with the second pass, creating a slight overlap. From then on the paddock divides up perfectly.

Avon recommends a 3:1 ratio for spreading and spraying to avoid ending up with this overlap.

He says he also appreciates the simplicity of driving straight to the wheel mark to engage autosteer, without having to continually check the GPS.

Avon expects he may have to renovate tramlines in the future if they get deeper over time from repeated wheeling, but sees that as a small price to pay for the preservation of the soil achieved through the use of CTF.

"With farming you have to make everything as efficient as possible," he says.

MORE INFORMATION

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Case study – CTF Rohan Ford, Binnu

Cropping on the right track east of Binnu

SNAPSHOT

OWNERS: Rohan & Carol Ford

LOCATION: East Binnu

FARM SIZE: 4400 hectares (3700ha cropped)

AVERAGE ANNUAL RAINFALL: 300 millimetres (more recently 285mm)

SOIL TYPES: Yellow sand and red loam soils

ENTERPRISE: 100 per cent cropping (no livestock)

CROPPING PROGRAM (2017): 1300ha wheat, 800ha lupins, 600ha canola, 1000ha fallow

TYPICAL ROTATION: wheat/canola/wheat/lupins/wheat

CTF SYSTEM: Machinery widths 9 metre, 36m, wheel tracks 3m centres

SEEDING: John Deere 8370RT used for pulling 18m seeder bar (wheat) and John Deere 8320t used for 9m seeder bar (lupins and canola)

SPRAYING: John Deere 4930 self-propelled boomspray, 36m

HARVEST: John Deere 9660 with 9.19m header front on 3.4m centre wheel spacing with John Deere RTK 2cm autosteer. Trufab Grain King chaser bin pulled by John Deere 8370RT tractor (same as seeding tractor)

SPREADING: John Deere 8370RT tractor, Roesner Multispreader spreader – 3m axles, 9m spreading width for lime and 18m for fertiliser

OTHER FEATURES: Deep rip using John Deere 8370RT tractor

On the northern fringe of Western Australia's grainbelt at East Binnu, 100 kilometres north of Geraldton, controlled traffic farming (CTF) has helped Rohan and Carol Ford alleviate soil compaction, increase yields and improve fuel use efficiency.

The Fords adopted CTF in 2000 after seeing the benefits of a similar system in England, hoping the change to tramlines would help overcome compaction problems on the farm's non-wetting yellow sand soils.

Rohan says the system is now delivering his business a 10-15 per cent yield increase year-on-year, if the agronomy is right, and a 15 per cent saving on fuel.

"There's a perceived high initial cost of conversion to CTF, but the yield increases and savings made on fuel for our business outweigh the implementation costs," he says.

"With CTF, you'll be 10 per cent in front of your neighbours every year regardless of the season. And the better the year, the better the yield response."

Transitioning to CTF

The negative impact of compaction on crop production has been the primary motivation for the development of the Ford's CTF system.

"Controlled traffic limits the compacted area on our farm to less than 15 per cent, compared with more than 50 per cent from some uncontrolled traffic systems in just one season," Rohan says.

"With our soil types, if we rip yellow sand and drive on it, the first pass does 80 per cent of the damage. I was keen to do something about that."

To combat this challenge, Rohan has taken a gradual, low-cost approach to machinery changeover to implement a nine metre system on their property.

In 2000, Rohan seeded their cropping program to tramlines using two marker arms and a John Deere Differential Global Positioning System (DGPS) guidance system.

He upgraded his seeding tractor in 2003 to a John Deere tracked tractor with autosteer using the John Deere Real Time Kinematic (RTK) system.

This enabled him to sow every second seeder run in one pass across a paddock and fill in the missed runs on the return pass.

Some modifications were required to move the wheels on the original seeder bar, airseeder box, sprayer and spreader – to 3m.

Rohan Ford says his machinery changes have been based on grower innovations, specialist consultant advice, trials with researchers plus on-farm experience to find improved approaches. PHOTO: Nicole Baxter

> ***Controlled traffic limits the compacted area on our farm to less than 15 per cent, compared with more than 50 per cent from some uncontrolled traffic systems in just one season.***
>
> *Rohan Ford, Binnu*

The original seeding tractor – a John Deere 8870 4WD – had the duals removed to run on singles (710/70R-38 radial) for the first season, after which it was traded for the tracked tractor (8320RT) with an adjustable track to 3m for spraying and seeding operations.

"By that stage we'd gone from a 12m system back to a 9m system to match our harvester, for the simple reason that our harvester was the heaviest piece of equipment and would have been expensive to change over at the time," Rohan says.

"Back then we were a 3:1 system but, with some recent upgrades in machinery, we can now be multiple ratios.

"We have just purchased an 18m seeding bar (John Deere 1820) for seeding wheat.

"We now have two tractors in our cropping program: a John Deere 8370RT which we use on the chaser bin, 18m seeder bar and for deep ripping, and a John Deere 8320t for seeding lupins and canola and pulling the 9m seeder bar.

"All machines – including the spreader, chaser bin and harvester – fit on the tramlines. I can buy run-of-the-mill equipment off the floor and plonk it in a paddock and I know it fits," Rohan says.

Benefits of CTF

Even though Rohan has sacrificed engine power and reduced machinery widths from 12m to 9m over time, he says he has not seen a reduction in efficiency.

Firm wheel tracks and soft soil in the untrafficked areas enable better traction and reduced draft requirements. This means lower horsepower tractors, such as front wheel drive tractors, can be used.

"I think you can operate smaller horsepower equipment in a CTF system," Rohan says.

"The machinery isn't under heavy load because driving on the tramlines is like driving on a road. Boomsprays and the chaser bin are easier to operate.

"Also, if you're not compacting the soil, you don't need as much horsepower to pull deep ripping equipment every year.

"We've calculated a fuel saving of 15 per cent for our farm business which certainly adds up over time."

In addition to the fuel saving, Rohan estimates his CTF system delivers an average 10 per cent increase in crop yields.

"I bought some land off my cousin next door which wasn't under a CTF system," he says.

"We ripped it last year, and just unlocking the nutrition that hasn't been used in a long time delivered a 50 per cent yield increase in the first year.

"While you're not going to achieve that same degree of crop yield response in subsequent seasons, I think annual crop yield improvements of 10 per cent can be achieved most years under a CTF system, compared with results from a non-CTF system."

The Ford family has taken a gradual, low-cost approach to machinery changeover to implement a nine metre CTF system on their property. PHOTO: Ford family

On-farm trials conducted with GRDC investment by the Department of Agriculture and Food Western Australia (DAFWA) on the Ford's property have shown the long-term benefits of deep ripping in alleviating soil compaction.

The trials have shown that the benefits of deep ripping in loosening the soil can persist for up to 10 years in yellow sands on the Ford's farm under a CTF system.

Challenges and limitations

For Rohan, there are two major challenges associated with CTF on his property – educating contractors and erosion of tramlines over time.

"Trying to get contractors to understand what they're meant to be doing when they have no understanding of CTF is an ongoing challenge we face each year," he says.

The other problem commonly associated with CTF can be tramlines eroding as a result of constant use.

"We haven't filled our tramlines in 17 years but it's something we'll need to address in the coming years," Rohan says.

"Our challenge here is wind. We get a sea breeze in summer so erosion can be a big problem, making it difficult to fill in the tramlines effectively.

"We also made a decision to get out of our cattle enterprise in recent years because they were walking up and down tramlines in CTF paddocks causing damage."

Advice to growers

Rohan says some of the barriers to CTF adoption include poor understanding of CTF and the perception that machinery changes are expensive.

"You need to put some thought into what you're going to buy. The harvester is the hardest machine to modify and sometimes the heaviest, so this is a good place to start," he says.

"Typically the grain harvester has a 3m wheel spacing. Modifications to tractors, sprayers and other equipment to this track width have been developed and are widely available.

"Machinery changes can be expensive so you need to manage them wisely and weigh up the cost of implementation with future productivity and yield gains."

Rohan's changes have been based on grower innovations, specialist consultant advice, trials with researchers plus on-farm experience to find improved approaches.

"In my experience, eventually you can get away with having less machinery and possibly smaller tractors due to better traction and lower draft requirements," he says.

"My advice to growers is, work out how wide you can go with the least amount of wheels on the ground.

"For example, if your harvester has a 9m platform and tyres that are 80cm wide, you have 1.6m of tramlines for every 9m of harvester. If you can keep the same sized tyres but move to a 12m platform, your percentage of tramlines to non-driven on soil is less.

"This increases your efficiency and makes the system more profitable."

MORE INFORMATION

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Glossary of common CTF terminology

Autosteer – technology that automatically steers vehicles or implements

Axle load – the proportion of the total weight of a vehicle resting on a given axle

Banded spraying – spraying a narrow width to be on, or between, a crop row

Boomspray – another term for a sprayer to apply crop inputs such as herbicides and fungicides

Bulk density – dry weight of soil for a known volume, often expressed in grams per centimetre cubed (g/cm^3)

Cart – airseeder bin that holds seed and fertiliser

Controlled traffic farming (CTF) – a farming system built on permanent wheel tracks where the crop zone and traffic lanes are permanently separated

Crop zone – the soft, uncompacted soil between wheel tracks for optimum plant establishment and root growth

Deep ripping – tillage that digs to depths greater than 20cm to break through a compacted hard pan or distinct constraining layer, allowing root access deeper into the soil profile and increasing plant uptake of water and nutrients

Delving – bringing clay from the subsurface to the soil surface with specially designed tynes

Denitrification – the reduction of nitrate (a compound) to nitrous oxide (gas) by some soil microbes when these cannot acquire enough oxygen in the soil

Dispersive soils – the soil clods collapse when the soil gets wet because the clay particles disperse into solution (in Western Australia, these soils are commonly sodic and have high amounts of exchangeable sodium on the clay)

Duplex soils – soils that have distinct layers with contrasting textures, for example sand over clay or gravel

Electrical conductivity – ability of the soil to conduct an electrical current and commonly used as a measure of salinity (often expressed as milliSiemens per metre)

Fuzzy wheel track – wheel tracks with crop planted in them by dropping seed on to the surface and rolling it in with a wheel, rather than burying the seed by sowing

Grade bank – a form of earthworks for surface water control following a gradient

Header – another term for a harvester

Inter-row – zones between crop rows that are defined accurately (to a few centimetres) and can be easily used for inter-row sowing by using an offset hitch, or minor adjustments to the guidance system

Inversion ploughing/mouldboard ploughing – the subsoil is mechanically inverted to the surface and the topsoil is buried

Normalised Difference Vegetation Index (NDVI) – a measure of plant greenness that indicates crop growth or vegetation cover using remote sensing technology. The index is calculated from the level of red light absorption and near infrared light reflection by plants

No-tillage/minimum tillage – a seeding system based on soil conservation that does not turn the soil over and aims for minimal soil manipulation/ disturbance

Permanent traffic lane (same as wheel track, tramline, wheel way) – permanent tracks that the wheels of all heavy machinery are confined to in a CTF system

Porosity – measure of water or air-filled pores in the soil (this typically decreases with depth)

Seeder – implement used for sowing crops, also called ‘bar’ or airseeder

Spading – implement that has rotating spade attachments to coarsely mix topsoil and subsoil

Sprayer – another term for a boomspray

Subsoil/subsurface – below the soil surface, typically referring to the zone under the topsoil (to a depth of about 10cm)

Tramline (same as wheel track)

Tramline farming – same as controlled traffic farming

Water holding capacity – the amount of water held in the soil after drainage under gravity

Wheel centre – the distance between the centre of the left and right wheel on an axle

Wheel base – the distance from the centre of the front axle to the centre of the rear axle

Wheel track – same as wheel way, tramline, permanent traffic lane – permanent tracks that the wheels of all heavy machinery are confined to in a CTF system.

Guidance terminology

Accuracy – a statistical measurement of 'freedom from error', or how close a measurement is to the true but unknown value

Baseline – the distance between the base station and the rover/tractor

Cross-track error – the distance from the current wayline measured at right angles to the wayline

GNSS – Global Navigational Satellite System (GNSS) – this is a replacement term for GPS and refers to a constellation of satellites providing signals from space to transmit positioning and timing data

Global Positioning System (GPS) – a network of orbiting satellites that send precise radio frequency data that allows positions on earth to be calculated. These signals are obtained by GPS receivers and are used to calculate the position, speed and time at a vehicle's location

Horizontal Dilution of Precision (HDOP) – describes how satellites are positioned around the globe (the lower the HDOP the better the position accuracy)

Implement steering – technology to steer an implement

Marker arms – mechanic guidance that is essentially a length of steel attached to the edge of a seeder to mark the middle of the next seeding run on the ground

Precision – how small a unit the instrument can measure

Racetrack – working around and around

Real Time Kinematic (RTK) – a technique used to improve the precision of position data from a satellite network (GNSS) using a known reference point or base-station to calculate the real-time position to centimetre accuracy

Repeatability/repeatable accuracy – a statistical measurement of the accuracy with which a user can return to a previous position

Wayline/A–B line – the line between two points that sets the initial direction of travel and subsequent path of travel parallel to this line.

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Useful resources

Australian Controlled Traffic Farming Association: http://actfa.net/ and Twitter @CTFFarmingAus

GRDC CTF project in Victoria: Twitter @CTF_Grains

WACTFA Facebook group https://www.facebook.com/groups/1292198200824881/

GRDC Fact Sheet 'Implementing a Controlled Traffic Farming Systems': www.grdc.com.au/GRDC-FS-ControlledTraffic

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DAFWA 'Soil Compaction overview' hub: www.agric.wa.gov.au/soil-compaction/soil-compaction-overview

DAFWA 'The Science of Soil Compaction' hub: https://www.agric.wa.gov.au/soil-compaction/science-soil-compaction

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DAFWA 'Deep Ripping for Soil Compaction': https://www.agric.wa.gov.au/soil-compaction/deep-ripping-soil-compaction

DAFWA and GRDC CTF calculator http://www.ctfcalculator.org/

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