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Kimba, South Australia

29th July 2020

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Contents

Influence of header front on stubble micro-climate and winter crop growth	***John Broster,*** *Charles Sturt University*	***9***
Do the challenges of a strip disc system pay off – a grower's perspective	***Richard Konzag,*** *Konzag Grains*	***21***
Chemical residues/MRLs – impact, understanding and potential trade issues	***Gerard McMullen,*** *National Working Party on Grain Protection*	***27***
Perils of ripping on sandy soils- what can be learnt from hindsight?	***Therese McBeath,*** *CSIRO*	***37***
GRDC Southern Regional Panel		*42*
GRDC Southern Region Key Contacts		*43*

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Influence of header front on stubble micro-climate and winter crop growth

John Broster[1], Nathan Hatty[1], Phil Eberbach[1] and Michael Walsh[2].

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GRDC project code: US00084

Keywords

- stripper front, draper front, stubble retention.

Take home messages

- Reductions in wind speed of up to 90% were recorded in the stripper front stubble over summer.
- Significant reductions in air temperature were recorded within the stripper front stubble canopy over summer.
- Minimal differences in daily minimum air and soil temperature on or near the soil surface during winter.

Background

In recent seasons crop production systems have undergone significant changes with a focus on reduced tillage and increased stubble retention (Umbers et al. 2017). Factors that have influenced the adoption of these practices include reduced fuel and labour inputs, reduced erosion and increased soil moisture conservation over the summer fallow period (Chan and Heenan 2006; Thomas et al. 2007; Llewellyn et al. 2012; Kirkegaard et al. 2014).

The introduction of the Shelbourne Reynolds stripper front into Australian farming systems has increased harvester efficiency through less material being processed by the harvester (Tado et al. 1998). The resultant increase in the amount of standing stubble after harvest over summer, in combination with disc seeding systems, provides an opportunity to maximise the benefits of a stubble retention system, however it may also introduce additional challenges for the system that need to be overcome.

Little research has been undertaken to quantify the benefits of using a stripper front compared with a conventional front to harvest cereal crops in Australia, despite repeated adoption of the disc seeding and stripper front harvesting system with only anecdotal evidence to support the benefits of the system. The impacts of the stripper front system on stubble canopy micro-climate, moisture retention and the subsequent crop have not yet been investigated.

Materials and methods

The trial was conducted at Marrar, commencing after the harvest of the wheat crop in December 2018 and ran until the subsequent vetch crop (sown in May) was harvested in October 2019. The site was established across three harvester front widths (each 12 metres) with the outer two harvested using a Shelbourne stripper front leaving the stubble standing at a height of 60cm and the centre row harvested using a D65 Macdon draper ('conventional') front with a cutting height of 15cm. The chaff fraction of the residues for both treatments were placed in a central chaff line 30cm wide while for the draper front treatment the straw fraction was spread across the width of the treatment by the harvester.

Measurements taken - summer period

Over the summer period wind speed was measured at a height of 45cm using a single anemometer for each plot with the average wind speed recorded every 10 minutes. From this data the daily wind run for each plot was calculated.

Air temperature readings were taken every 10 minutes with probes placed at 60cm, 35cm and 10cm above ground level Temperature probes were also placed 2.5cm below the soil surface in each plot, also recording every 10 minutes. These data were then used to determine the daily minimum and maximum temperatures calculated for each height in each plot.

Measurements taken - winter period

All instrumentation was removed from the plots the day before the site was sown and then re-installed the day after. Following sowing, additional temperature probes were installed to record temperature (every 10 minutes) at 10cm below the soil surface and on the soil surface but below the residue layer. Soil moisture probes were also located at 10cm below the soil surface recording moisture content every 10 minutes.

Results and discussion

There was no difference in the amount of total residue present between the two treatments after harvest. After harvest approximately 50% of the stripper front residue was found in the standing stubble, significantly more than the 21% in the draper front treatment. After sowing there was no difference in the proportion of standing stubble and surface residue between the treatments as the sowing operation knocked down the standing stubble. Visually the stubble residue layer in the stripper front treatment was a thicker layer with a rougher texture, due to the longer straw length present in this treatment.

Wind speed

During the summer period the wind speed was reduced in the stripper front system compared with the draper front. For December there was a 90% reduction in wind speed however, this decreased to 50% at sowing due to collapse of standing stubble (Figure 1). The sowing operation knocked down the majority of the standing stubble in the stripper front system but for May through to July there was still a reduction in the wind speed of approximately 20%. It was only in August and September that no wind speed reduction was recorded (Figure 2).

The stubble remaining after sowing in the stripper front system, while below the level of the anenometers, was still likely to impede the movement of air across the area. It was not until September when the vetch crop had grown above the level of the stubble residue that no differences in wind speed were observed between the two systems.

Air temperature

For December and January large differences were observed for the air temperature at 60cm

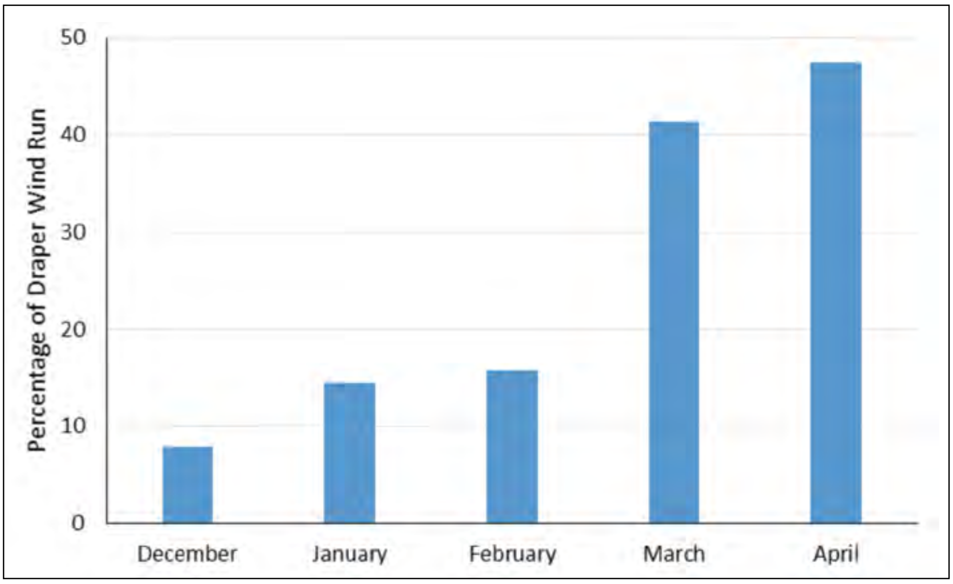

Figure 1. Average daily wind speed over the summer fallow period for the stripper front system as a percentage of the average daily wind speed for the draper front system.

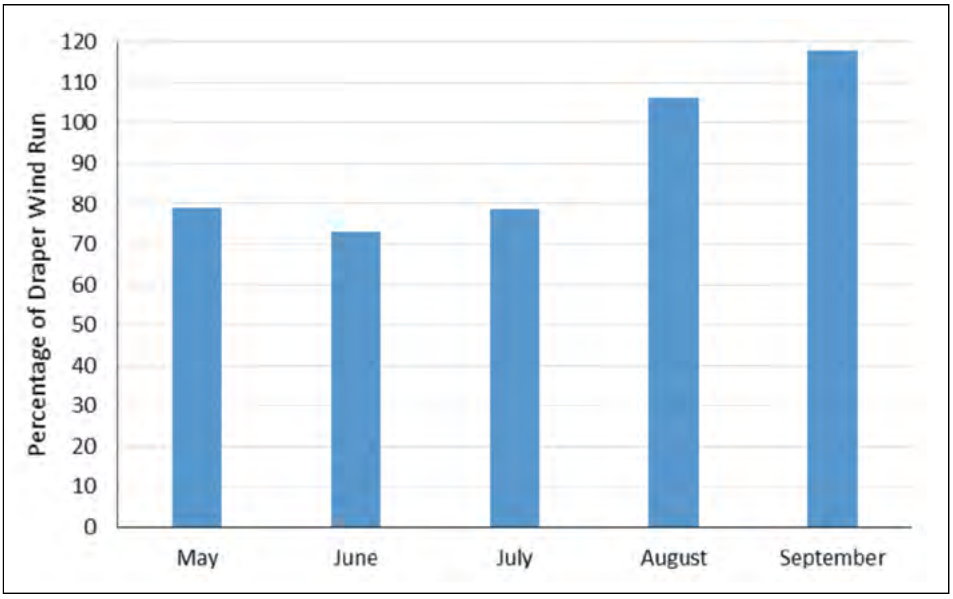

Figure 2. Average daily wind speed over the winter period for the stripper front system as a percentage of the average daily wind speed for the draper front system.

above ground level, or near the top of the stripper front canopy. The average daily maximum temperature at this height for the stripper front system was 43.7°C, over 7°C less than the 51.2°C recorded for the draper front system (P<0.001) (Figure 3). There was also a reduction in the minimum average daily temperature at this height, but not to the same extent, 20.1°C compared with 20.7°C for the stripper and draper front systems respectively (P<0.05).

At 10cm the average daily maximum temperature for the stripper front system was 1.5°C higher than the draper front system (51.5oC compared with 50.0°C; P<0.05) while there was no difference (P>0.05) in the average daily minimum temperatures between the two systems (stripper - 18.6°C; draper - 18.7°C) (Figure 3).

For the remainder of the summer period before sowing the average daily maximum temperatures for the two systems was lower and there was no difference between the stripper (60cm – 32.0°C; 10cm – 35.9°C) and draper (60cm – 32.0°C; 10cm – 35.9°C) front systems (P>0.05) (Figure 3). Unlike the December to January period the daily minimum temperature at 60cm was higher for the stripper front system (stripper - 12.6°C; draper - 12.1°C) than the draper front (P<0.001) rather than lower, and while there had been no difference between the systems in the daily minimum temperature at 10cm for December and January for rest of the summer period, the stripper front system recorded a higher average daily minimum temperature (stripper - 11.9 °C; draper - 10.6°C; P<0.001) (Figure 3).

Over the winter period the stripper front system had higher average temperatures for the 60cm maximum (stripper – 19.5°C; draper – 19.0°C; P<0.001) and 0cm minimum (stripper – 6.6 oC; draper – 6.4°C; P<0.005) while the average temperatures were lower for 60cm minimum (stripper – 2.7°C; draper – 3.0°C; P<0.001), 10cm maximum (stripper – 18.8°C; draper – 21.3°C; P<0.001) and 0cm maximum (stripper – 6.6°C; draper – 6.4°C; P<0.05) while there was no difference between the minimum temperatures at 10cm (stripper – 1.8°C; draper – 2.0°C; P>0.05) (Figure 4).

The difference in air temperature within the stripper front treatment is most likely due to the reduced air movement, which has reduced the exchange of heat that would normally occur through increased wind speeds mixing the air and drawing the hotter air away, resulting in hot air being trapped in the standing stubble. The reduction in these differences over the summer period as the standing stubble falls down and the difference in wind speed reduces are also indications that the reduced wind speeds are influencing the canopy air temperatures.

Soil temperature

Over the summer period there was an approximately 10% decrease in daily maximum soil temperature (2.5cm) in the stripper front system (stripper – 26.0°C; draper – 28.8°C; P<0.001) however there was no difference between the two systems in daily minimum temperatures (stripper – 20.3°C; draper – 20.4°C; P>0.05) (Figure 5).

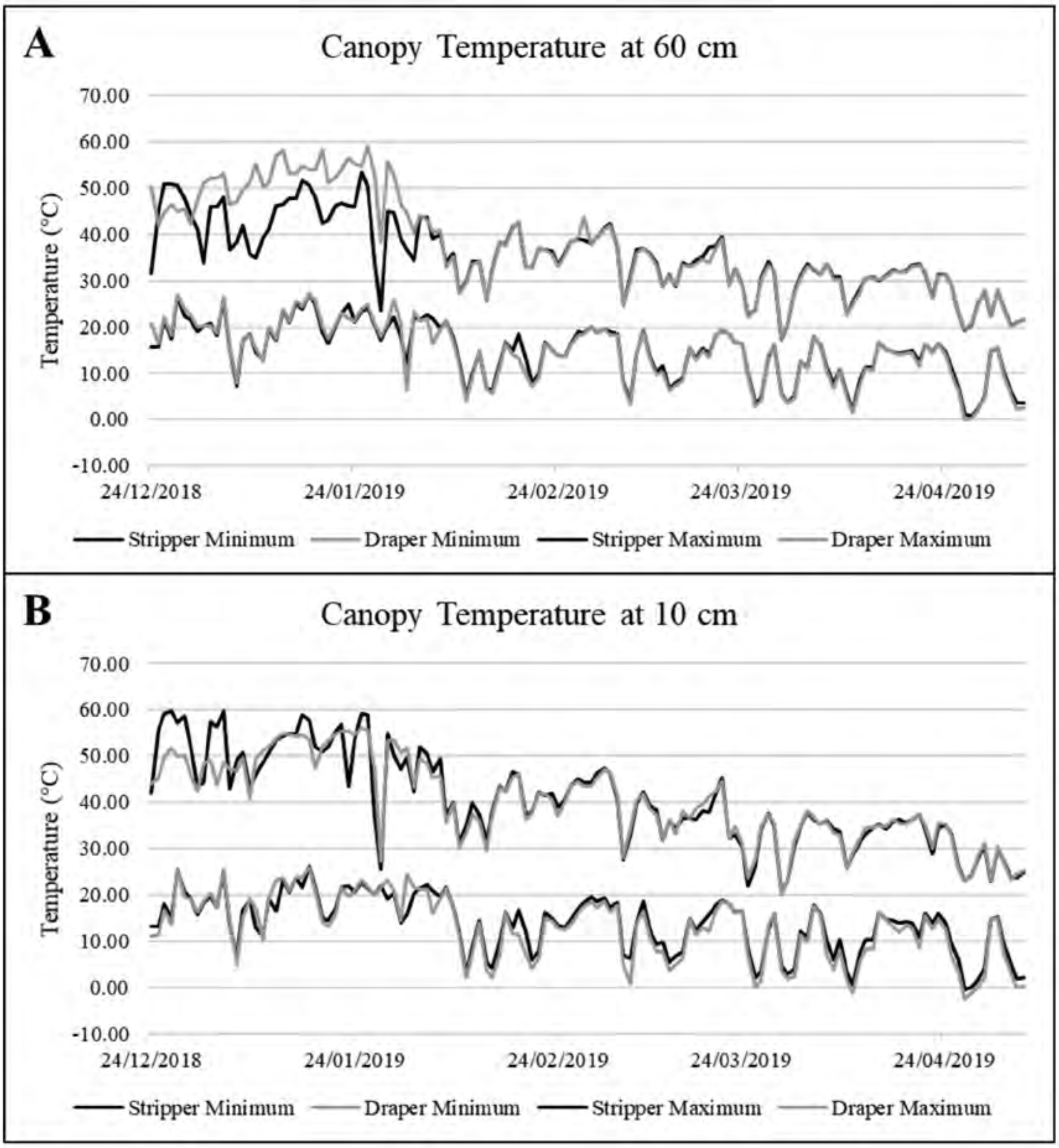

Figure 3. Average daily maximum and minimum canopy temperature at (A) 60cm and (B) 10cm above the soil surface for the stripper and draper stubble treatments over the summer fallow.

Over the winter period there was no difference between the daily maximum temperature for both of the systems while the daily minimum was higher for the stripper front system (stripper – 8.3°C; draper – 8.1°C; $P<0.001$). At the 10cm depth both the daily minimum and maximum soil temperatures were slightly lower in the stripper front system than the draper front system (maximum - stripper – 11.3°C; draper – 11.5°C; $P<0.001$, minimum - stripper – 8.6 °C; draper – 8.7°C; both $P<0.001$) (Figure 6).

Over summer the soil temperature was nearly 3°C higher for the stripper front system than the draper front system, while the amount of residue is the same; much of the stripper front residue is standing while for the draper front residue it has passed through the header and is laying on the ground. The decreased ground cover recorded in the stripper front system could allow the soil to be heated via radiant heat while the soil in the draper front system was more protected. Over the winter period when

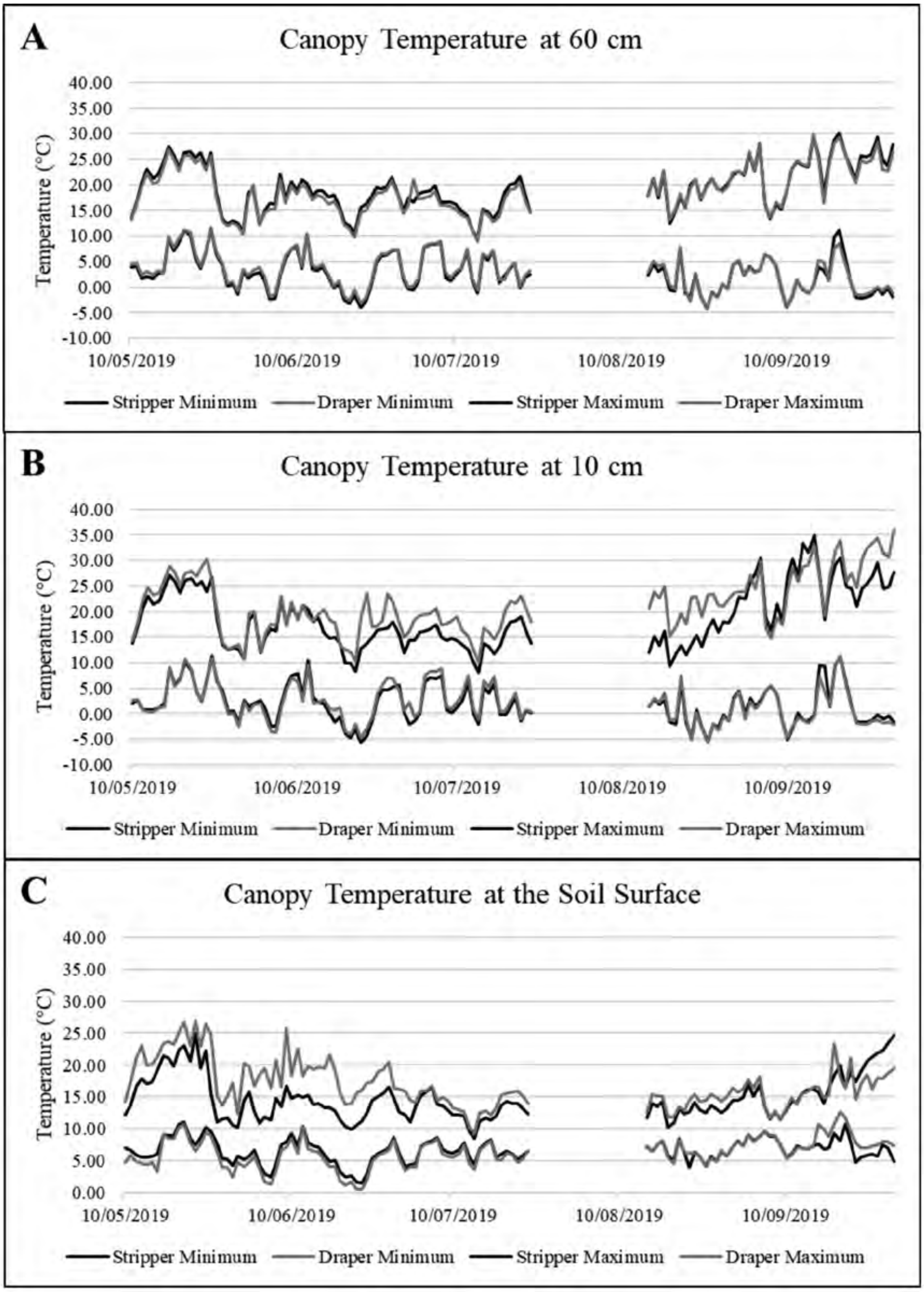

Figure 4. Average daily maximum and minimum canopy temperature at (A) 60cm and (B) 10cm above the soil surface and (C) at the soil surface for the stripper and draper stubble treatments over the winter growing season.

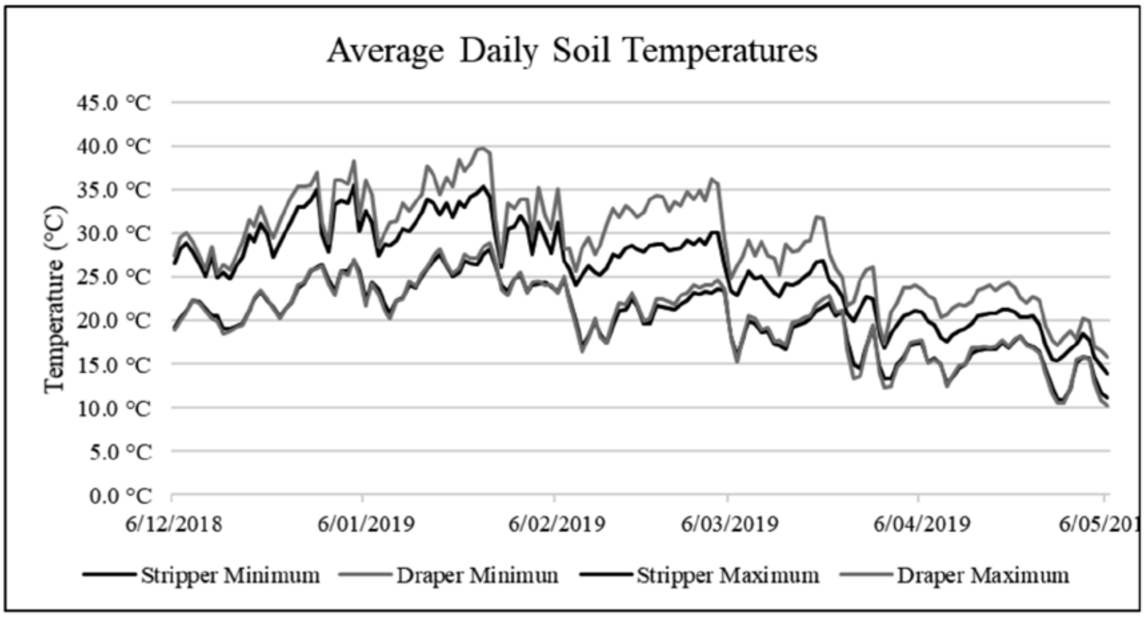

Figure 5. Average daily maximum and minimum soil temperature over the summer fallow period.

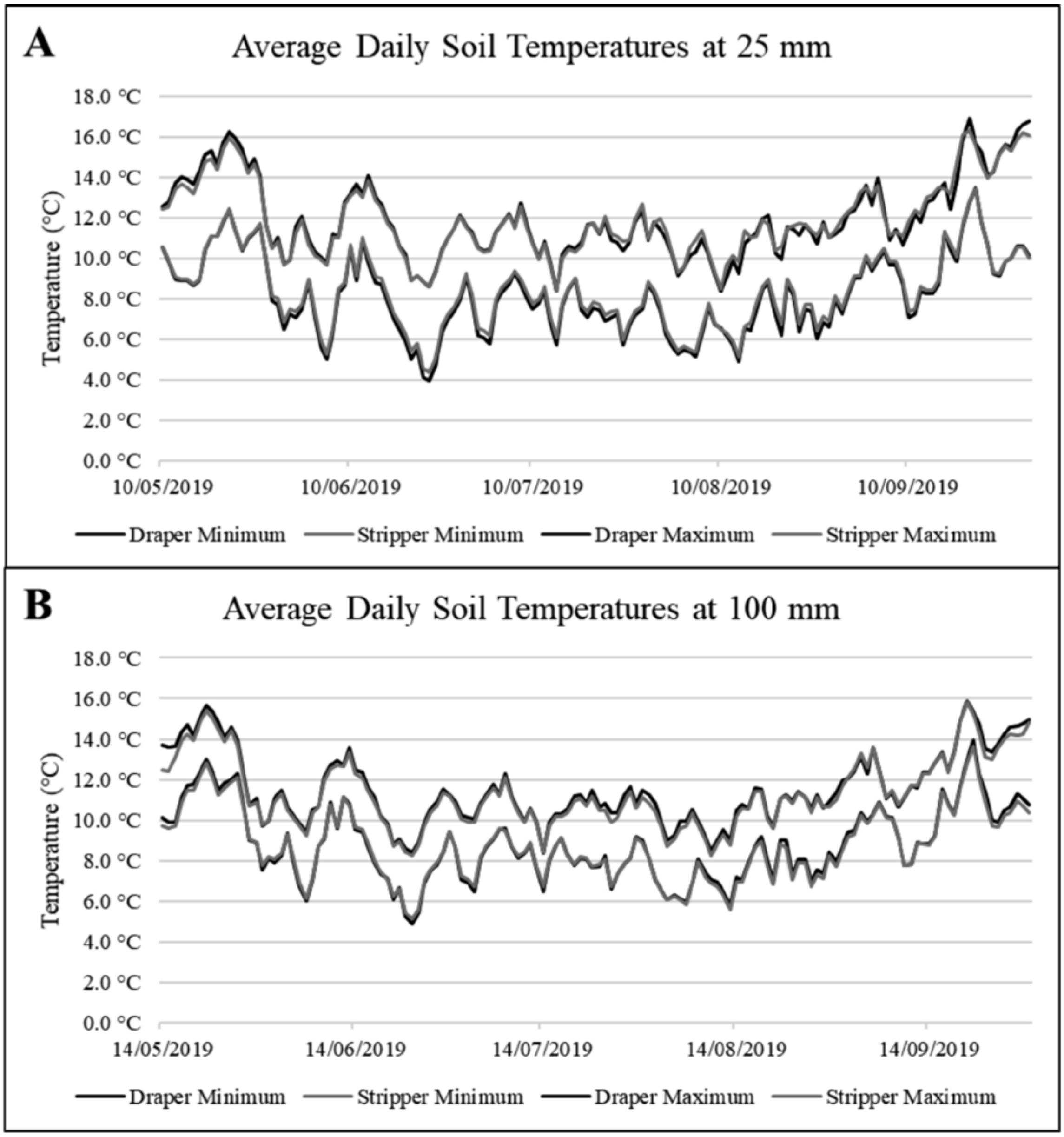

Figure 6. Average daily maximum and minimum soil temperature at a depth of (A) 2.5cm and (B) 10cm over the winter growing period

the stubble in both treatments is flatter the loss of soil temperature overnight is similar for both treatments. Although the differences in minimum daily 0cm air and 2.5cm and 10cm soil temperatures were statistically significant during the winter period, the greatest difference for any of these parameters was 0.2°C.

Soil moisture

While there was a statistical difference in the average daily moisture content at 10cm below the soil surface between the two systems (stripper – 22.3%; draper – 22.4%; P<0.01) it is unlikely that the difference (0.1%) would have any influence on plant growth (data not shown).

Plant emergence and growth

There were no differences observed between the two systems for total emergence, time to emergence, dry matter production (July, August, September and October) and ground cover (September). The only recorded difference was in the amount of ground cover recorded for the crop in July with the stripper front system having significantly less cover (5.1%) than the draper front system (12.1%) (data not shown).

Conclusions

Differences between the two header front systems were recorded for many of the parameters measured over both the summer and winter periods (Table 1). Over the summer fallow period the taller stubble from the stripper front system increased upper canopy temperatures but reduced average wind speed and soil temperatures. The reduction in wind speed and soil temperature should result in increased soil moisture retention due to reduced evaporation but possibly due to the low rainfall experienced over the experimental period this was not recorded.

Over the winter growing period a reduction in wind speed early in the season was still experienced in the stripper front system compared to the draper front system and there also tended to be a slight decrease in air and soil temperature. While both treatments contained similar amounts of stubble, the straw in the stripper front treatment tended to be longer resulting in an increased thickness of residue cover and a resultant greater insulating effect. The reduction in temperatures recorded was not enough to result in any differences in the growth of the vetch crop. While the increased thickness of the stubble cover may prevent radiant heat from the sun from warming the soil it could also slow heat loss in colder periods as shown by the increase in minimum daily air temperatures on the soil surface (under the stubble layer).

Further research

Analysis of the data collected in 2019 is still ongoing (for example; 35cm air temperature) as only limited analysis was undertaken as part of the Honours project. This research is continuing at two different sites to gain further knowledge with soil moisture measurements taken over the summer fallow period. A different crop will be sown at each of the two sites and one the sites contains a stubble residue removed (baled) treatment to further investigate air and soil temperatures near the surface.

Table 1. Summary of differences for stripper front systems compared with draper front systems (summer air temperatures analysed for two periods, bold indicates difference from draper front is greater than 10%, * = not measured).

	Summer	Winter
Wind speed	**Decrease**	**Decrease**
Air temperature 60cm maximum	**Decrease** / None	Increase
Air temperature 60cm minimum	**Decrease** / Increase	**Decrease**
Air temperature 10cm maximum	Increase / None	None
Air temperature 10cm minimum	None / **Increase**	None
Air temperature 0cm maximum	*	Decrease
Air temperature 0cm minimum	*	Increase
Soil temperature -2.5cm maximum	Decrease	None
Soil temperature -2.5cm minimum	None	Decrease
Soil temperature -10cm maximum	*	None
Soil temperature -10cm minimum	*	Decrease
Moisture content -10cm	*	Decrease

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The research undertaken as part of this project is made possible by the significant contributions of growers through both trial cooperation and the support of the GRDC, the authors would like to thank them for their continued support.

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Return to contents

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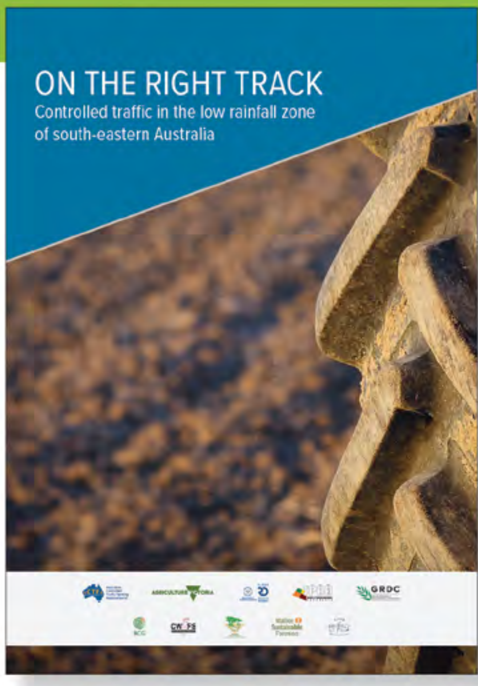

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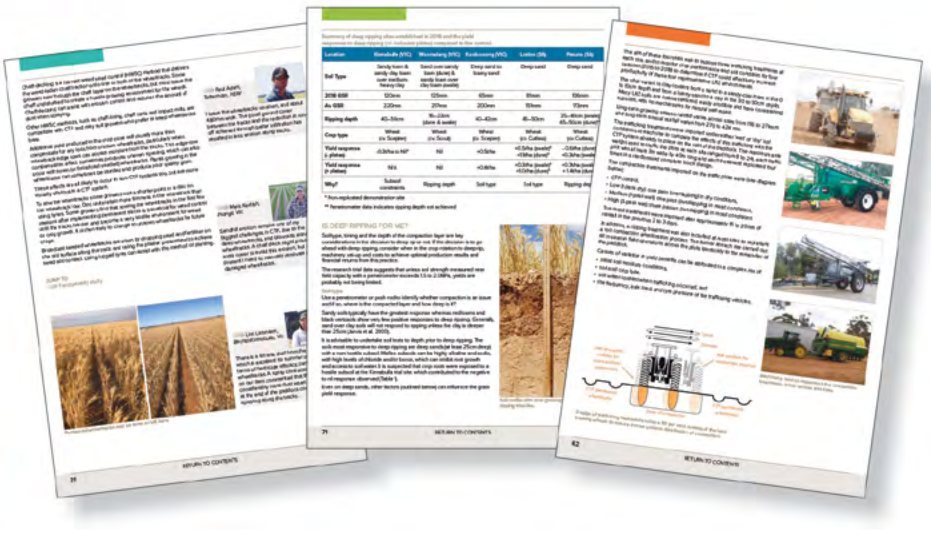

Do the challenges of a strip disc system pay off – a grower's perspective

Richard Konzag.

Konzag Grains.

Keywords

- stripper front, disc seeder, snails, mice, soil cover, moisture retention, strip disc system, row spacing.

Take home messages

- Strip disc systems can retain more plant available water (PAW).
- Mice and insects love the extra soil cover.
- Herbicide options change with a strip disc system.

Background

Konzag Grains farms 2500ha at Mallala in the Lower North of South Australia in a 395mm rainfall zone, growing wheat, durum, barley, lentils, faba beans, chickpeas, canola and oaten hay. Soil types range from clay to grey Mallee loam to sand.

Key question 1- what drove us to switch to this system?

There were several factors that drove us to change systems. We previously ran a ConservaPak seeder on 12" spacings.

- I felt on 12" spacings we were seeing intra-row crop competition which was producing lower biomass levels and when neighbours were cutting droughted crops for hay, we didn't have enough biomass to make a hay crop.
- We had a demo of the JD 1890 (7.5" spacings) in 2013 which we sowed run for run with our ConservaPak. We found 40% more heads in the rows where we planted with the disc seeder (Table 1). Yield difference was much less impressive with the crop sown with the JD single disc, 7.5" row spacing yielding 1-2% higher than the crop sown with the ConservaPak, 12" row spacing.
- I wanted to narrow up our row spacings to increase crop competition with weeds.
- I purchased the stripper front after doing a trial with a neighbour's stripper front in comparison with our draper front and found 48mm more PAW in the stripper straw compared with the draper straw.

Table 1. Seeder and row spacing comparison- 2013.

Seeder	Row spacing	Heads per square metre
ConservaPak	12"	306
JD single disc	7.5"	432

Key question 2- what are the advantages of implementing a strip disc system?

A big advantage of moving to the strip disc system is being able to have total stubble retention which gives complete soil cover while being able to plant crops on narrower row spacings.

Moving from 12" row spacings back to 7.5" row spacings has dramatically increased competition between the crop and the weeds, thereby reducing the pressure placed on herbicides.

Hair-pinning of stubble with a single disc seeder can be an issue, however using a stripper front lessens the amount of smaller straw fractions or ‘cocky chaff’ which is the thing that causes most of the hair-pinning issues.

Depending on the season, using a stripper front can increase harvester capacity and reduce fuel consumption during harvest, as there is less material being processed by the harvester.

There is anecdotal evidence that harvesting with a stripper front can reduce snail numbers because the stripper front rotor either smashes the snails on contact or flicks them against the crop hood, cracking their shells and causing them to dehydrate and die. We do not rely solely on the stripper front as a snail control method but rather, implement a strategic baiting and cabling system to assist with snail management.

Better soil cover in a stripped cereal stubble reduces wind speed over the soil surface which helps to reduce the evaporation of stored soil moisture. Additionally, having full stubble cover reduces wind and water erosion and the impact of raindrops on the soil surface which can cause surface sealing.

Faster sowing speeds with a disc seeder can result in timelier crop establishment when conditions are right.

Flat paddocks with a disc seeder enable easier harvesting of low pulse crops like lentils without having to prickle chain paddocks after seeding.

While we have been retaining stubbles on our farm since the mid-1980s, the stripper front system gave us an opportunity to harvest straw in 2019, following the grain harvest. Income was down due to frost and the dry season, so we took the opportunity to bale the straw and make some money with high straw prices. This was done with reluctance given our focus on stubble retention but nevertheless performed with the knowledge of our history of stubble retention and minimum/zero tillage over a large number of years and and recognising that it will not become a regular practice.

Key question 3 -what were the challenges of switching to this system and are there disadvantages?

Switching to the disc seeder initially felt like I had to learn to farm again.

You cannot just go planting when you want, as the straw needs to be dry for the disc to cut through it effectively and reduce hair-pinning. Moving from 12” spacing to the single disc system caused some concern with the high furrow ridges of the ConservaPak and the possibility of them affecting sowing depth in the first year of the disc. Initially we did have variation of seeding depth and it probably did affect the crop vigour in some rows.

Pre-emergent herbicide options are reduced. Herbicides with high solubility e.g. Boxer Gold® and Sakura®, work better in high stubble systems. We use virtually no Trifluralin® anymore but have not missed its volatility.

Weed spectrums have changed slightly with weeds like fumitory making a comeback in the absence of Trifluralin®. Therefore, you need to be on top of your game with crop monitoring as changes occur.

The disc seeder does not ‘scalp’ herbicides out of the row like a knife point, so herbicide damage can be an issue, particularly in pulses, if you get a big rainfall event post sowing. The disc can also push straw and chaff containing herbicide into the sowing slot and affect germination.

Kondinin Group researcher, Ben White has found that harvesting with stripper fronts resulted in grain losses of at least 1% during trials they have conducted. However, in my experience, we have been unable to detect losses from the stripper front in cereal crops in normal conditions. Modern stripper fronts have variable rotor speeds that can be adjusted to suit varying conditions. In certain conditions, we can harvest the wheat and leave the chaff on the stalk. At this stage we have not had success harvesting lentils with the stripper front although we are aware of people that have done so.

Long stripper straw makes an ideal home for insect and vertebrate pests. Careful management of crops for insect pests is vital for the success of the strip disc system and needs due consideration in pre-season planning. Mice have been a big problem during the implementation of our system and require almost constant attention pre-sowing and during germination. The mice have learned that the long straw offers protection from overhead predators. We have seen on many occasions, near perfect crop establishment on wheel tracks where the straw is rolled down, only to discover mice have cleaned up the seed in the long straw. To address this issue, we have mounted a mouse bait spreader on the back of the seeder cart to apply bait at sowing, with varying degrees of success.

Conclusion

A strip disc system can have both financial and farming system benefits, through timely planting of the crop, improved crop competition with weeds, less wear and tear on machinery and reduced fuel use on the harvester. However, the strip disc system does come with some challenges; with reduced herbicide options, potential for increased herbicide damage of sensitive crops and possible higher pest numbers.

Acknowledgements

I would like to acknowledge the agronomy advice of Bill Long and Stefan Schmidt of Ag Consulting Co, my family, and staff at Konzag Grains.

Useful resources

https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2018/08/stripper-fronts-and-disc-seeding

References

https://www.farmingahead.com.au/harvesting/special-report/1330520/research-strip-show-provides-plenty-of-food-for-thought

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Return to contents

Notes

Notes

LOOK AROUND YOU.

1 in 5 people in rural Australia are currently experiencing mental health issues.

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

The GRDC supports the mental wellbeing of Australian grain growers and their communities. Are you ok? If you or someone you know is experiencing mental health issues call *beyondblue* or Lifeline for 24/7 crisis support.

beyondblue
1300 22 46 36
www.beyondblue.org.au

Lifeline
13 11 14
www.lifeline.org.au

Looking for information on mental wellbeing? Information and support resources are available through:

www.ifarmwell.com.au An online toolkit specifically tailored to help growers cope with challenges, particularly things beyond their control (such as weather), and get the most out of every day.

www.blackdoginstitute.org.au The Black Dog Institute is a medical research institute that focuses on the identification, prevention and treatment of mental illness. Its website aims to lead you through the logical steps in seeking help for mood disorders, such as depression and bipolar disorder, and to provide you with information, resources and assessment tools.

www.crrmh.com.au The Centre for Rural & Remote Mental Health (CRRMH) provides leadership in rural and remote mental-health research, working closely with rural communities and partners to provide evidence-based service design, delivery and education.

Glove Box Guide to Mental Health
The *Glove Box Guide to Mental Health* includes stories, tips, and information about services to help connect rural communities and encourage conversations about mental health. Available online from CRRMH.

www.rrmh.com.au Rural & Remote Mental Health run workshops and training through its Rural Minds program, which is designed to raise mental health awareness and confidence, grow understanding and ensure information is embedded into agricultural and farming communities.

www.cores.org.au CORES™ (Community Response to Eliminating Suicide) is a community-based program that educates members of a local community on how to intervene when they encounter a person they believe may be suicidal.

www.headsup.org.au Heads Up is all about giving individuals and businesses tools to create more mentally healthy workplaces. Heads Up provides a wide range of resources, information and advice for individuals and organisations – designed to offer simple, practical and, importantly, achievable guidance. You can also create an action plan that is tailored for your business.

www.farmerhealth.org.au The National Centre for Farmer Health provides leadership to improve the health, wellbeing and safety of farm workers, their families and communities across Australia and serves to increase knowledge transfer between farmers, medical professionals, academics and students.

www.ruralhealth.org.au The National Rural Health Alliance produces a range of communication materials, including fact sheets and infographics, media releases and its flagship magazine *Partyline*.

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Chemical residues/MRLs – impact, understanding and potential trade issues

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National Working Party on Grain Protection.

GRDC project code: MCM00003 – Strategic oversight and coordination of grain protection chemicals

Keywords

- chemicals, maximum residue limits, MRLs, market access, domestic marketing, export marketing.

Take home messages

- It is a legal requirement to follow all **label directions** when applying any chemical.
- There are different perceptions and legal/contractual requirements of key domestic and export markets for chemical residues.
- There are market access implications when using chemicals – applying a chemical according to label directions does NOT necessarily mean that that grain will meet market requirements.
- There is a need for advisers and growers to understand your market and seek advice on the MRLs that apply. Talk to your marketer if possible before you intend to apply chemicals to a crop.

Introduction - what is a maximum residue limit (MRL)?

A range of different types of chemicals are applied to crops for varying reasons. Chemicals may be used prior to planting, during the crop growth stage or following harvest. Only those chemicals registered in Australia for use on a particular crop may be applied. All chemicals registered in Australia must be used according to label directions, e.g. application rates, withholding periods, etc. This is a legal requirement in Australia.

When using these chemicals, residues may arise on the harvested grain. Residues may also arise via contamination. For example, when moving that grain using equipment such as augers and trucks that have previously held grain containing chemical residues.

The nature of residues arising are considered by the Australian Pesticides and Veterinary Medicines Authority (APVMA) and if necessary, an MRL is set for that chemical and crop commodity combination when a chemical is registered for use.

The APVMA defines an MRL as 'the maximum concentration of a residue resulting from the registered use of an agricultural chemical which is legally permitted or recognised as acceptable to be present in or on a food, agricultural commodity or animal feed'.

Why is chemical advocacy so important these days?

Customers and importing country government regulators have always considered that the chemical residues on the food they are importing and ultimately consuming, needs to be managed. Increasingly there is the perception from some sectors of society that chemicals are a food safety issue when present on food. However, given the large safety margins used when developing MRLs, the MRLs are generally not a food safety issue. However, society's perceptions differ.

The current trends in domestic and export markets are as follows:

- MRLs and chemicals in general are being specified in customer contracts.
- Markets are developing their own chemical regulations and are not relying on international standards such as Codex Alimentarius.
- Markets are requiring lower (or nil) residues on grain that is supplied.
- Markets are also increasing their level of monitoring of imported grain via sampling and testing to check compliance with their needs.
- Markets are demanding to know what chemicals were applied to the crop and the residue status of the supplied product. This includes some form of 'traceability'.

This changing focus places greater scrutiny on Australian grain used domestically or when exported. It places greater pressure on users of chemicals to only use registered products and at the registered label rate. Particular chemicals may be banned from use (and the MRL reduced to a low level or nil) for political rather than food safety issues.

This increased focus can impact on the tools growers have to manage growing a profitable and quality product. It also places greater pressure on marketers to select grain for a market where the Australian MRL may be higher than that applied in the importing country.

If any participant fails in their responsibility, the loss of reputation or worse still, loss of market access, is difficult, if not impossible to overcome.

Do all markets have the same MRLs and where can this information be sourced?

Each market, whether it be in Australia or overseas, is responsible for ensuring the food that is imported and subsequently consumed is safe to eat in terms of chemical residues. Each market has their own chemical legislation based on their own particular chemical usage and food consumption patterns. Hence different MRLs for the same chemical and commodity may apply in each market.

These differences need to be carefully managed when supplying grain. The increase in grain traded internationally may cause a market access issue for Australian grain. For example, there are many instances for a particular chemical and commodity where:

- The market has no MRL.
- The market doesn't apply the international standard (Codex) MRL.
- There is no Codex MRL for those markets that follow or default to Codex.
- The market does not have a default policy and hence a zero limit applies where they do not have an MRL.
- The market applies a low level of detection when they have no MRL.

Importing country regulations and customer requirements may also vary. It is the responsibility of the marketer of the grain to ensure they know the regulations of their customers and that the grain supplied meets those requirements.

Some key Australian markets and their current chemical MRL regulations are listed in Table 1.

Table 1. Example set of markets and their current chemical MRL regulations.

Market	Codex	Australia	China	EU	India	Indonesia	Japan	Saudi Arabia	South Korea	Taiwan	Thailand	Vietnam
Regulation applied	Not adopted by all markets	Own MRL Std	Own MRL Std	Own MRL Std	Own MRL Std	Own MRL Std	Own MRL Std	GCC Std	Own MRL Std	Own MRL Std	Own MRL Std	Own MRL Std
Default MRL	No default	No default	No default	Default system	Default system	No Default	Default system	GCC, Codex, lower of EU/USA, 0.01	Default system	No default	Default system is complex	No default
If no MRL	ZERO	ZERO	ZERO	0.01	0.01	CRA / ZERO	0.01	0.01	0.01	ZERO	0.01	ZERO
MRL Updates	Yearly	Monthly - 6 weeks	Bi-annually	Often	Rarely	Rarely	Often	Often	Often	Rarely	Rarely	Rarely

Note: Above is as at 9 July 2020, variations exist for specific chemicals. MRLs quoted in mg/kg. Std = Standard GCC = Gulf Cooperation Council CRA = Country Recognition Agreement (accepts AUS MRL for some commodities)

Table 2. Example set of markets and the MRLs for chemicals applied to barley.

Chemical, as at 9Jul20	Codex	EU	AUS	China	India	Japan	Saudi Arabia	Vietnam	Thailand	United Arab Emirates	South Korea	Taiwan	Kuwait
2,4-D	0	0.05	0.2	0	0.01	0.5	0.05 (EU)	0	0.01 D	0.05 (EU)	0.4 (expires 31Dec21)	0.02	0
Imazapyr	0.7	0.01 D	0.7	0	0.01 D	0.01 D	0.7 (Codex)	0	0.7 (Codex)	0.7 (Codex)	0.7 (IT)	0	0.7 (Codex)
Diquat	5	0.02*	5	0	0.01 D	5	5 (GCC)	5	5 (Codex)	5 (EU)	0.02 (expires 31Dec21)	0	5 (GCC)
Glyphosate	30	20	20	0	0.01 D	30	30 (Codex)	30	30 (Codex)	30 (Codex)	20 (IT)	0	30 (Codex)
Chlorpyrifos - methyl	3	6	10	T5	0.01 D	6	3 (Codex)	0	3 (Codex)	3 (Codex)	4 (IT)	3	3 (Codex)
Chlorpyrifos	0	0.6	T0.1	0	0.05	0.2	0.6 (USA)	0	0.01 D	0.01 D	0.01 D	0.5	0
Fenitrothion	6	0.05*	10	T5	0.01 D	6	6 (Codex)	6	6 (Codex)	6 (Codex)	0.01 D	0.3	6 (Codex)

*D = Default * = LOD IT = Import Tolerance T = Temporary Yellow = under review Orange = AUS industry agree not to use on malt barley*

Given MRL changes are often slow and are developed under a complex system, it can be difficult to understand current and future MRLs at any given point in time. The key is that often you can't just read an MRL in a table – crop groups and default policies mean the actual MRL may be something different if no MRL is listed.

There is no single source for this information. Information on MRLs must be sourced from various areas, such as:

- Codex - http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/pesticides/en/
- Each country government website – but MRLs are generally hidden and as generally they are in a foreign language, the information needs translation
- Most countries:
  - Subscription based @ https://www.bryantchristie.com
  - https://www.agriculture.gov.au/ag-farm-food/food/nrs/databases
  - https://www.mpi.govt.nz/growing-and-harvesting/plant-products/pesticide-maximum-residue-levels-mrls-for-plant-based-foods/pesticide-maximum-residue-level-legislation-around-the-world/
- AUS APVMA MRLs https://www.legislation.gov.au/Series/F2019L01105

OR

- Contact myself, Chair NWPGP, whose role is to provide industry with this market access information.

Is it the grower's responsibility to ensure MRL requirements are met or the grain buyer?

In short, it is the marketer's responsibility to meet the buyer's MRLs.

As stated previously, even though a grower may apply a chemical correctly and in accordance with label directions, the resulting grain residues may not meet market requirements.

In addition, a grower does not always know the market or the market requirement before they use a chemical?

However, all grain Trading Standards have wording in relation to chemical use that growers must comply with. An example for the Grain Trade Australia Wheat Trading Standards 2020/21 is outlined below:

"Chemicals not approved for Wheat – a nil tolerance applies, and this refers to the following:

- *Chemicals used on the growing crop in the State or Territory where the wheat was grown in contravention of the label*

- *Chemicals used on stored wheat in contravention of the label*
- *Chemicals not registered for use on wheat*
- *Wheat containing any artificial colouring, pickling compound or marker dye commonly used during crop spraying operations that has stained the wheat*
- *Wheat treated with or contaminated by Carbaryl, Organochloride chemicals, or diatomaceous earth*
- *Chemical residues in excess of Australian Commonwealth, State or Territory legal limits"*

Residue testing is done either by the marketer or by the Australian government National Residue Survey on domestic grain and export grain shipments, the latter funded via a levy on growers. If residues arise that exceed the market MRL, price penalties may occur or the shipment may be rejected and returned to Australia. Costs may be passed from the marketer to the supplier of that grain where there is evidence of chemical mis-use or false chemical use declarations. Sampling and testing of future grower loads and shipments, or additional segregations may be created, all creating costs. These increased costs may be passed onto the grower through the purchase price offered for the grain.

Therefore, at a minimum the post-farm gate sector expects that growers apply chemicals following legal requirements.

Given the expense of sampling and testing all deliveries for all possible chemicals used on-farm, this is not conducted. Rather, targeted sampling and testing is conducted based on market risk. Thus growers must provide accurate information on chemicals used on that crop. Growers are encouraged to complete Commodity Vendor Declarations correctly when details of chemicals used are sought by the trade. Failure to do so risks supply of grain that fails to meet market requirements, a loss in reputation of Australian grain and increased costs for all along the supply chain.

Growers should also show compliance with the regulated chemical use requirements by complying with on-farm stewardship guide "Growing Australian Grain" https://www.grainproducers.com.au/australian-grains-guide. That guide shows responsible use of chemicals on-farm.

Grower tools to assist the marketer in meeting market requirements

a) Growers must only use chemicals registered for that crop.

b) It is a legal obligation that growers comply with all label directions, including:
   - Rates of application.
   - Withholding period.
   - Timing for application such as crop development stage.
   - A range of other statements such as "DO NOT ....".

c) Adopt industry practices such as:
   - Compliance with the above listed on-farm stewardship guide.
   - Comply with grain trading standards.
   - Wherever possible comply with the Australian grain industry Code of Practice where grain is stored onfarm and sold to domestic or export customers direct http://www.graintrade.org.au/grain-industry-codes.
   - Correctly complete a Commodity Vendor Declaration form when asked to do so.
   - Document chemicals used at all stages on the crop.
   - Supply representative samples for residue testing as needed.
   - Follow good agricultural practices (for example; integrated pest management (IPM) / resistance management strategies for chemical use).

d) And above all, talk to your buyer (customer) about the MRLs that apply to the product, preferably if possible before applying any chemicals. At a minimum, talk to your adviser about the impact of using particular chemicals and possible impacts on residues arising on that harvested crop. If necessary, seek further advice from technical experts on MRLs that apply in particular markets.

Increased scrutiny on chemical usage

Growers have a good reputation for compliance with Australian chemical regulations and more specifically, label directions. This has enabled successful marketing of grain to existing markets and the ability of the industry to seek alternative markets. However, unfortunately there have been instances where incorrect chemical use (off-label) has been detected discovered via the detection of inappropriate residues on grain to be shipped to a market.

It is recognised that growers have no say in where a marketer may send their grain. However, in the last two years, a greater focus has been placed on providing all sectors of the industry with knowledge of market requirements. This has involved significant communication and liaison with the pre and post farmgate sector. The gap between knowledge of the market requirements and what happens on-farm was recognised and communication to the pre-farmgate sector has increased through development of Fact Sheets and presentations to a range of stakeholders throughout Australia. This has occurred via both the Chair NWPGP, GRDC and various government departments. However further communication with the grower and adviser sector will still be beneficial.

Advocacy has occurred on the following key chemicals that have caused or have had the potential to cause some residue issues on Australian grain in recent years:

- Back-loading of Flutriafol treated urea and inappropriate cleaning of trucks https://grdc.com.au/resources-and-publications/groundcover/gc110/clean-down-priority-when-backloading
- Introduction of herbicide tolerant varieties and use of that chemistry needs careful management http://www.graintrade.org.au/nwpgp/crop-chemicals
- Not following application directions on a label and applying the chemical at the incorrect crop growth stage e.g., haloxyfop on canola https://groundcover.grdc.com.au/weeds-pests-diseases/chemical-regulation/canola-spray-compliance-an-industry-wide-effort

In the opinion of the author, the following will face increased scrutiny in the future and may impact on what chemical tools are available for growers:

- Old chemistry, as it generally is no longer supported for various reasons. Where support from a chemical registrant is not gained, following a regulator review of that chemical, the MRLs may be deleted or reduced.
- Desiccants/harvest aids face increased scrutiny given the potential for residues to arise on the harvested crop. Growers should consider limiting their use where possible.
- Aerial application – contamination of nearby crops and the environment in general highlights these practices and they are increasingly being scrutinised by regulators and the public in general. Compliance with legal requirements is essential.
- Fungicides are generally relatively toxic compared to a range of other chemicals. Only use where required.
- Anything with chemical residue carry-over from crop to crop can impact on the subsequent crop. The potential for residue carry-over is scrutinised by regulators.
- Off-label use is not acceptable and does not follow the principle of 'good agricultural practice'.

Conclusion

Given the changing nature of market regulations, all stakeholders along the supply chain need to be aware of market requirements in relation to MRLs. Given the implications of incorrect chemical use, there is a need for greater transparency and understanding by growers and grower advisers of the impact of chemical use on market access.

Going forward there will be a focus on ensuring all supply chain participants understand the risks of non-compliance with label directions. Reducing gaps in this knowledge, including chemical registrants, re-sellers, agronomists, growers and their advisers, will be a focus of activities.

Growers need to talk to their adviser/agronomist and storage agent/marketer and where needed other experts, to seek advice on current and future market requirements.

Useful resources

On-farm Stewardship Guide 'Growing Australian Grain' http://grainsguide.grainproducers.com.au

National Working Party on Grain Protection www.graintrade.org.au/nwpgp

National Residue Survey https://www.agriculture.gov.au/ag-farm-food/food/nrs

APVMA https://apvma.gov.au

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Return to contents

Notes

Notes

GRDC GROWNOTES

SPRAY APPLICATION GROWNOTES™ MANUAL

SPRAY APPLICATION MANUAL FOR GRAIN GROWERS

The Spray Application GrowNotes™ Manual is a comprehensive digital publication containing all the information a spray operator needs to know when it comes to using spray application technology.

It explains how various spraying systems and components work, along with those factors that the operator should consider to ensure the sprayer is operating to its full potential.

This new manual focuses on issues that will assist in maintaining the accuracy of the sprayer output while improving the efficiency and safety of spraying operations. It contains many useful tips for growers and spray operators and includes practical information – backed by science – on sprayer set-up, including self-propelled sprayers, new tools for determining sprayer outputs, advice for assessing spray coverage in the field, improving droplet capture by the target, drift-reducing equipment and techniques, the effects of adjuvant and nozzle type on drift potential, and surface temperature inversion research.

It comprises 23 modules accompanied by a series of videos which deliver 'how-to' advice to growers and spray operators in a visual easy-to-digest manner. Lead author and editor is Bill Gordon and other contributors include key industry players from Australia and overseas.

Spray Application GrowNotes™ Manual – go to: https://grdc.com.au/Resources/GrowNotes-technical
Also go to https://grdc.com.au/Resources/GrowNotes and check out the latest versions of the Regional Agronomy Crop GrowNotes™ titles.

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Perils of ripping on sandy soils- what can be learnt from hindsight?

Therese McBeath[1] and Michael Moodie[2].

[1]*CSIRO;* [2]*Frontier Farming Systems and Mallee Sustainable Farming.*

GRDC project code: CSP00203

Keywords

- deep ripping, sandy soils, ripping depth, seedbed.

Take home messages

- Know what problem you are trying to solve with ripping.
- Year 1 benefits averaged 0.6t/ha but predicting the longevity of the ripping effect is not easy.
- Managing the seedbed on ripped soils requires special attention.

Background

Poor productivity is commonly reported for the deep sands that make up the cropping soils in the low rainfall Mallee regions of South Australia and Victoria. There is evidence of unused soil water with varying evidence of constraints commonly associated with sandy soils such as compaction, non-wetting, poor fertility or acidity. There is considerable interest in strategic deep tillage with/without agronomic amendments aimed at overcoming physical constraints and increasing water and nutrient supply within the soil profile. Strategic deep tillage includes ripping or deep ploughing (i.e. spading, plozza plowing, inversion) to depths of 30cm and more. Replicated trials including various combinations of these treatments have been established across the South Australian and Victorian Mallee. These trials are part of the research and validation work within the GRDC project; 'Increasing production on sandy soils in the low-medium rainfall areas of the southern region' (CSP00203). Although the benefits of deep ripping in deep sandy soils have been recognised previously, there is a need to understand where ripping can most reliably lead to yield benefits, how benefits can be maximised over multiple seasons, and which sands likely to respond. There are opportunities to improve the seedbed condition following ripping and this is being explored in a SAGIT funded project. Combining knowledge on where gains from ripping will come from and how to best manage the seedbed after ripping will help overcome the 'perils of ripping sandy soils'.

Key question 1 - what is the problem I want to solve with ripping?

The main goal of ripping is to deal with soil compaction or a high penetration resistance. By breaking up the compaction, roots can penetrate deeper and make use of previously unused water. A secondary outcome of ripping is that some unused nutrients (either deep or not mineralised) can become available to the crop. However, with increased crop water use and yield, crop demand for nitrogen will also increase.

If the paddock has repellence that consistently limits crop establishment, then that needs to be the focus of the treatment that is implemented. While deep ripping can improve water infiltration, it will have limited effect on the amount of water repellency. If a disruptive tillage pass is made, and water repellency is not treated, then the vulnerability to erosion is going to increase and will need to be managed.

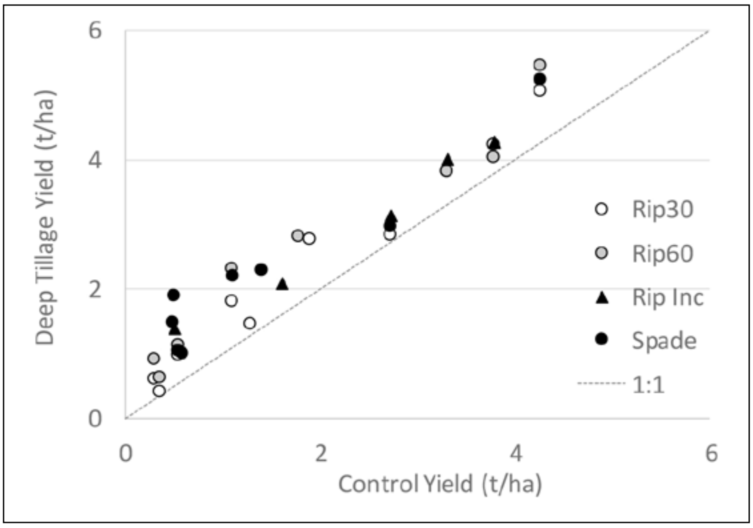

Figure 1. Ripping (where 30= 30 cm deep, 60= 60 cm deep, Inc= inclusion plates at 60 cm deep) and spading yield benefits from Sandy Soils Project Experiments in the year of ripping.

Key question 2 - what benefit will I get and how long will it last?

While a positive response to ripping in the first year appears to be quite reliable, with an average benefit of 0.6t/ha (Figure 1), predicting the yield effects in subsequent years has proven more difficult and has provided varied results from -0.3t/ha to +0.6t/ha.

Key question 3 - how do I manage the seedbed on ripped soils?

Paddock trafficability post ripping is a major constraint to the implementation of deep ripping on a commercial scale. Seeding and spraying operations are particularly affected which can lead to problems such as poor establishment, machinery damage and in some circumstances, soil erosion. A new experiment has been established at Pinnaroo in 2020 to investigate solutions to these problems. The experiment is measuring the effect of ripper type (Hanton and Sharrad ripper fitted with straight shanked Tilco tine and a Williamson Agri ripper fitter with curved Michel tines) and rolling on trafficability, seed depth and crop establishment. The trial was sown commercially by the collaborating farmer using a Horwood Bagshaw PSS system.

To simulate what's likely in a grower situation, the trafficability following ripping was measured by driving a Landcruiser ute across the surface immediately prior to seeding and then measuring the depth of the ruts left by the tyres. Un-ripped treatments had shallow ruts of 40-50 mm but were 120mm in depth following deep ripping with both ripper types. Consolidating the ripped surface with a roller reduced rut depth by 50%. The rut depth data correlated with seeding depth data with wheat seeds from un-ripped and ripped and rolled treatments emerging from 20-30 mm depth while unconsolidated ripped treatments emerged from 50mm for the curved Michel tine and 60mm for the Tilco straight tine. The position of the seeding tine on the bar also affected the seed depth. As the seeder sinks in, soil throw from rear tines can bury seed placed by the front tines and the soil throw may also carry pre-emergent herbicides into the seed row. Seeds were germinating from 75mm depth from the front tine position but only from 45mm when sown with a back tine. This effect resulted in a 16% decrease in wheat establishment and reduced early vigour of the deep sown rows.

There are other pitfalls to watch out for when it comes to trafficability and establishment, including increased risk of damage from pre-emergent herbicides and slumping of furrows which also increased seed depth.

Growers and researchers are trying to improve the seedbed following ripping using a range of options including; press wheel design, ripping at an angle to seeding direction, and implementing a controlled or semi-controlled traffic situation where important wheel tracks are left un-ripped. Different seeding bar setups influence how successful seeding is in deep ripped paddocks.

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Return to contents

Notes

TOP 10 TIPS

FOR REDUCING SPRAY DRIFT

01 **Choose all products in the tank mix carefully**, which includes the choice of active ingredient, the formulation type and the adjuvant used.

02 **Understand** how product uptake and translocation may impact on coverage requirements for the target. Read the label and technical literature for guidance on spray quality, buffer (no-spray) zones and wind speed requirements.

03 **Select the coarsest** spray quality that will provide an acceptable level of control. Be prepared to increase application volumes when coarser spray qualities are used, or when the delta T value approaches 10 to 12. Use water-sensitive paper and the Snapcard app to assess the impact of coarser spray qualities on coverage at the target.

04 **Always expect** that surface temperature inversions will form later in the day, as sunset approaches, and that they are likely to persist overnight and beyond sunrise on many occasions. If the spray operator cannot determine that an inversion is not present, spraying should NOT occur.

05 **Use weather forecasting** information to plan the application. BoM meteograms and forecasting websites can provide information on likely wind speed and direction for 5 to 7 days in advance of the intended day of spraying. Indications of the likely presence of a hazardous surface inversion include: variation between maximum and minimum daily temperatures are greater than 5°C, delta T values are below 2 and low overnight wind speeds (less than 11km/h).

06 **Only start spraying** after the sun has risen more than 20 degrees above the horizon and the wind speed has been above 4 to 5km/h for more than 20 to 30 minutes, with a clear direction that is away from adjacent sensitive areas.

07 **Higher booms increase drift**. Set the boom height to achieve double overlap of the spray pattern, with a 110-degree nozzle using a 50cm nozzle spacing (this is 50cm above the top of the stubble or crop canopy). Boom height and stability are critical. Use height control systems for wider booms or reduce the spraying speed to maintain boom height. An increase in boom height from 50 to 70cm above the target can increase drift fourfold.

08 **Avoid high spraying speeds**, particularly when ground cover is minimal. Spraying speeds more than 16 to 18km/h with trailing rigs and more than 20 to 22km/h with self-propelled sprayers greatly increase losses due to effects at the nozzle and the aerodynamics of the machine.

09 **Be prepared** to leave unsprayed buffers when the label requires, or when the wind direction is towards sensitive areas. Always refer to the spray drift restraints on the product label.

10 **Continually monitor** the conditions at the site of application. Where wind direction is a concern move operations to another paddock. Always stop spraying if the weather conditions become unfavourable. Always record the date, start and finish times, wind direction and speed, temperature and relative humidity, product(s) and rate(s), nozzle details and spray system pressure for every tank load. Plus any additional record keeping requirements according to the label.

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

THE 2017-2020 GRDC SOUTHERN REGIONAL PANEL

JANUARY 2020

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CHAIR - JOHN BENNETT

Based at Lawloit, between Nhill and Kaniva in Victoria's West Wimmera, John, his wife Allison and family run a mixed farming operation across diverse soil types. The farming system is 70 to 80 percent cropping, with cereals, oilseeds, legumes and hay grown. John believes in the science-based research, new technologies and opportunities that the GRDC delivers to graingrowers. He wants to see RD&E investments promote resilient and sustainable farming systems that deliver more profit to growers and ultimately make agriculture an exciting career path for young people.

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DEPUTY CHAIR - MIKE MCLAUGHLIN

Mike is a researcher with the University of Adelaide, based at the Waite campus in South Australia. He specialises in soil fertility and crop nutrition, contaminants in fertilisers, wastes, soils and crops. Mike manages the Fertiliser Technology Research Centre at the University of Adelaide and has a wide network of contacts and collaborators nationally and internationally in the fertiliser industry and in soil fertility research.

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PETER KUHLMANN

Peter is a farmer at Mudamuckla near Ceduna on South Australia's Western Eyre Peninsula. He uses liquid fertiliser, no-till and variable rate technology to assist in the challenge of dealing with low rainfall and subsoil constraints. Peter has been a board member of and chaired the Eyre Peninsula Agricultural Research Foundation and the South Australian Grain Industry Trust.

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JON MIDWOOD

Jon has worked in agriculture for the past three decades, both in the UK and in Australia. In 2004 he moved to Geelong, Victoria, and managed Grainsearch, a grower-funded company evaluating European wheat and barley varieties for the high rainfall zone.
In 2007, his consultancy managed the commercial contract trials for Southern Farming Systems (SFS).
In 2010 he became Chief Executive of SFS, which has five branches covering southern Victoria and Tasmania. In 2012, Jon became a member of the GRDC's HRZ Regional Cropping Solutions Network.

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FIONA MARSHALL

Fiona has been farming with her husband Craig for 21 years at Mulwala in the Southern Riverina. They are broadacre, dryland grain producers and also operate a sheep enterprise. Fiona has a background in applied science and education and is currently serving as a committee member of Riverine Plains Inc, an independent farming systems group. She is passionate about improving the profile and profitability of Australian grain growers.

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LOUISE FLOHR

Lou is a farmer based at Lameroo in the Southern Mallee of South Australia. Along with her parents and partner, she runs a mixed farming enterprise including export oaten hay, wheat, barley a variety of legumes and a self-replacing Merino flock. After graduating Lou spent 3 years as a sales agronomist where she gained valuable on-farm experience about the retail industry and then returned to her home town of Lameroo. She started her own consultancy business three years ago and is passionate about upskilling women working on farms.

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RICHARD MURDOCH

Richard along with wife Lee-Anne, son Will and staff, grow wheat, canola, lentils and faba beans on some challenging soil types at Warooka on South Australia's Yorke Peninsula. They also operate a self-replacing Murray Grey cattle herd and Merino sheep flock. Sharing knowledge and strategies with the next generation is important to Richard whose passion for agriculture has extended beyond the farm to include involvement in the Agricultural Bureau of SA, Advisory Board of Agriculture SA, Agribusiness Council of Australia SA, the YP Alkaline Soils Group and grain marketing groups.

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MICHAEL CHILVERS

Michael runs a collaborative family farming enterprise at Nile in the Northern Midlands of Tasmania (with property also in northern NSW) having transitioned the business from a dryland grazing enterprise to an intensive mixed farming enterprise. He has a broad range of experience from resource management, strategic planning and risk profiling to human resource management and operational logistics, and has served as a member of the the High Rainfall Zone Regional Cropping Solutions Network for the past seven years.

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KATE WILSON

Kate is a partner in a large grain producing operation in Victoria's Southern Mallee region. Kate and husband Grant are fourth generation farmers producing wheat, canola, lentils, lupins and field peas. Kate has been an agronomic consultant for more than 20 years, servicing clients throughout the Mallee and northern Wimmera. Having witnessed and implemented much change in farming practices over the past two decades, Kate is passionate about RD&E to bring about positive practice change to growers.

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ANDREW RUSSELL

Andrew is a forth generation grain grower and is currently the Managing Director and Shareholder of Lilliput AG and a Director and Shareholder of the affiliated Baker Seed Co - a family owned farming and seed cleaning business. He manages the family farm in the Rutherglen area, a 2,500 ha mixed cropping enterprise and also runs 2000 cross bred ewes. Lilliput AG consists of wheat, canola, lupin, faba bean, triticale and oats and clover for seed, along with hay cropping operations. Andrew has been a member of GRDC's Medium Rainfall Zone Regional Cropping Solutions Network and has a passion for rural communities, sustainable and profitable agriculture and small business resilience.

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DR NICOLE JENSEN

Nicole Jensen is GRDC General Manager for the newly created Genetics and Enabling Technologies business group. Nicole brings a wealth of experience in plant breeding and related activities arising from several roles she has held in Australia and internationally in the seed industry including positions as Supply Innovation Lead with the Climate Corporation - Monsanto's digital agricultural flagship, Global Trait Integration Breeding Lead for Monsanto.

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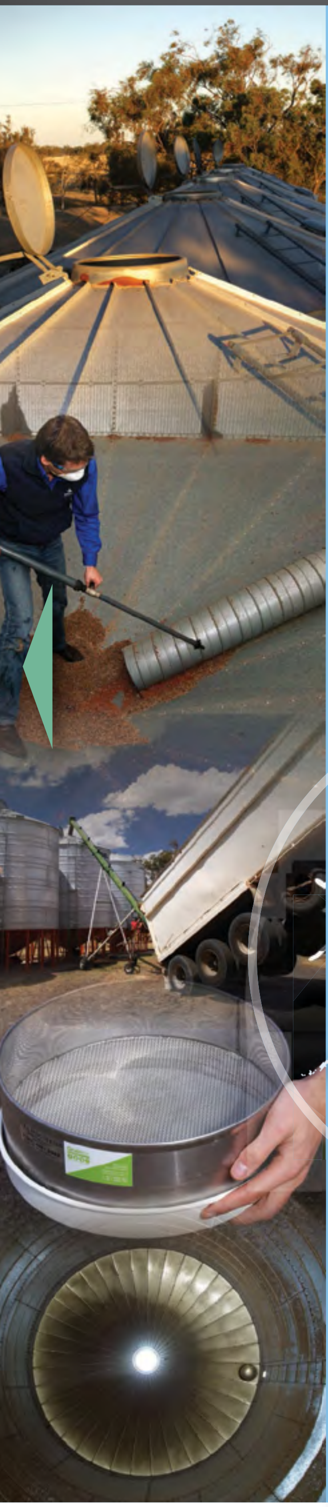

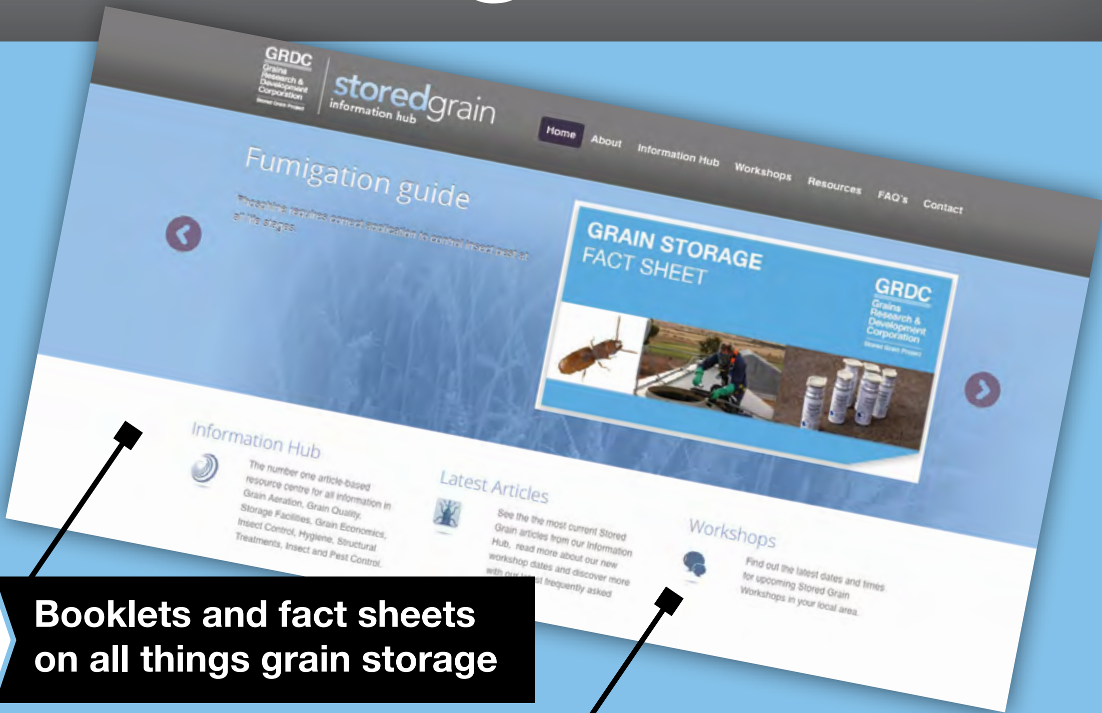

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