GRAINS RESEARCH UPDATE

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Loxton

Wednesday 18 August

9.00am to 1.00pm

Loxton Hotel

45 East Terrace, Loxton

#GRDCUpdates

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Loxton GRDC Grains Research Update convened by ORM Pty Ltd.

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GRDC Grains Research Update
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9.00 am	**Announcements**	***Tim Bateman,*** *ORM*
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9:55 am	**Using satellite data and imagery to assess frost damage and enable timely decision making**	***Moira Smith,*** *D-CAT* ***Brian Lynch,*** *Elders Loxton*
10:35 am	**Morning tea**	
11.05 am	**Ameliorating sandy soils – strategies to improve productivity**	***Therese McBeath,*** *CSIRO*
11:45 am	**Vetch – getting more from this versatile legume**	***Stuart Nagel,*** *SARDI*
12.25 pm	**Wind erosion recovery – what actions can we take?**	***Chris McDonough,*** *Insight Extension for Agriculture* ***Brenton Schober,*** *farmer from Borrika*
1.05 pm	***Close and evaluation***	***Tim Bateman,*** *ORM*
1.10 pm	***Lunch***	

On Twitter? Follow **@GRDCSouth** and use the hashtag **#GRDCUpdates** to share key messages

Mallee Sustainable Farming

Mallee Sustainable Farming Inc. (MSF) is a farmer driven, not for profit, organisation delivering research and extension services to the less than 350mm rainfall Mallee cropping regions of New South Wales, Victoria, and South Australia. MSF operates within a region of over four million hectares, extending beyond Balranald (NSW) in the east to Murray Bridge (SA) in the west.

Our Vision

Dynamic, profitable, and sustainable farming.

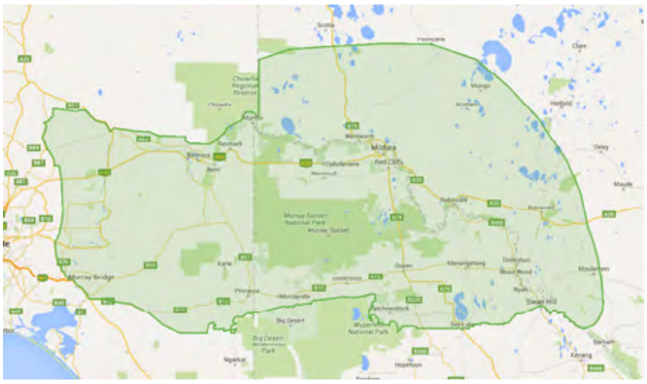
Our Mission

Provide excellence in research, development and extension initiatives for the dryland Mallee of South eastern Australia.

Principal Purpose

To protect and enhance the natural environment by the encouragement of sustainable dryland farming practices.

MSF Tri-State Region Map



The MSF Advantage

MSF operates to ensure that the vital research development and extension that will underpin the future productivity and sustainability of farming in the low rainfall Mallee continues.

Our partnership approach facilitates the application of key research and development activities within the region. This brings together national, regional and local research and development capabilities to create an impact far greater than if we operated independently. The scientific rigour of this program is something that MSF is very proud of and is critical for providing a sound basis for the MSF extension program.

Annually MSF directs between $1.5 and $2 million into farming systems research and extension aimed at meeting the specific needs of farming in the Mallee, working with leading research providers and consultants to deliver quality outcomes.

MSF has identified key areas for work as a guide for investment in research, development and extension in this region;

- Supporting the adoption of break crops

- Sandy soil improvement
- Preventing and managing Mallee seeps
- Frost research
- Innovative pasture systems
- Integrating stock and grazing systems
- Supporting improved farm management
- Supporting adoption of integrated weed management
- Innovative extension platforms

MSF has a strong emphasis on farmer extension, and with a 24-year history is well networked to engage farmers and stakeholders in the region.

MSF uses multiple approaches to facilitate the easy flow of information to farmers, advisors and researchers including:

- **Field days** and **field walks** to view and discuss research in the field
- **Farmer discussion groups** to facilitate peer to peer learning
- **Mallee Research Updates** to deliver the latest research results and connect researchers with farmers and advisers
- **E-news updates** to promote project activity and important dates, currently 950 subscribers
- **Compendium of research** – research papers available on-line summarising the relevant work in the region
- **Immersive Ag** – 360° virtual tours and videos of trial sites, soil pits, machinery demonstrations, farm infrastructure, livestock
- **Social media** – Twitter, Facebook, Instagram, YouTube platforms with daily posts and project promotion
- **Video snapshots** – Providing project overview or delivering key messages or results
- **Podcasts** – MSF Farm Talk podcast series capturing topical and timely content

All of this is backed up by the **MSF website** www.msfp.org.au which houses all of the information produced by MSF making it available whenever industry requires it.

MSF has a significant membership of around 950 people. This gives MSF significant reach when it comes to promotion and engagement through extension activities.

Feedback is also regularly sought from MSF members to provide input and direction on future research requirements, and this helps to guide our project focus.

The MSF Board strives to maintain a no cost membership policy which allows MSF to engage freely with all members of the farming communities in the region.

The "David *Roget Award for Excellence*" has been created by Mallee Sustainable Farming in memory of the late David Roget who worked with the CSIRO for over 30 years as a Sustainable Ecosystems Researcher. The award recognises an individual, business or group who has made a significant contribution to dryland farming production systems in the Mallee Sustainable Farming region. The most recent winner was Agriculture Victoria Senior Research Agronomist, Jason Brand for his dedication to sustainable pulse production in the Mallee and extension services to growers across the region".

Partner with MSF

Mallee Sustainable Farming's current project portfolio has over 20 projects with many different partners. MSF is lead organisation on several large southern region wide projects and is a delivery partner on many others.

For organisations looking to establish trials in the region, MSF can help identify sites and cooperators offering linkages to growers, or researchers and consultants in NSW, VIC and SA.

MSF has an established project delievery partnership with CSIRO, universities, government agencies, agribusiness and natural resources management organisations and other farming systems groups.

In 2021 MSF is involved with at least 15 trial and demonstrations sites on farms across SA, Vic and NSW covering a wide range of research topics and engaging a wide group of growers.

A key strength of MSF is the established grower and stakeholder audience that is seeking cutting edge research information, therefore organisations choosing to partner with MSF will have a defined audience and ready made delivery pathway for communications and extension.

Multiple communications pathways and extension programs can be tailored to suit different projects and the needs of collaborators to maximise extension outputs and encourage rapid adoption.

MSF is governed by a farmer Board and invited specialist Directors providing strategic oversight of the organisation and ensuring a culture of good governance.

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MSF Farm Talk Podcast

The WeedSmart

Big 6

Weeding out herbicide resistance in winter & summer cropping systems.

The WeedSmart Big 6 provides practical ways for farmers to fight herbicide resistance.

How many of the Big 6 are you doing on your farm?

We've weeded out the science into 6 simple messages which will help arm you in the war against weeds. By farming with diverse tactics, you can keep your herbicides working.

Rotate Crops & Pastures

Crop and pasture rotation is the recipe for diversity

- Use break crops and double break crops, fallow & pasture phases to drive the weed seed bank down,
- In summer cropping systems use diverse rotations of crops including cereals, pulses, cotton, oilseed crops, millets & fallows.

Mix & Rotate Herbicides

Rotating buys you time, mixing buys you shots.

- Rotate between herbicide groups,
- Mix different modes of action within the same herbicide mix or in consecutive applications,
- Always use full rates,
- In cotton systems, aim to target both grasses & broadleaf weeds using 2 non-glyphosate tactics in crop & 2 non-glyphosate tactics during the summer fallow & always remove any survivors (2 + 2 & 0).

Increase Crop Competition

Stay ahead of the pack

Adopt at least one competitive strategy (but two is better), including reduced row spacing, higher seeding rates, east-west sowing, early sowing, improving soil fertility & structure, precision seed placement, and competitive varieties.

Double Knock

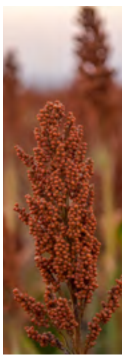
Preserve glyphosate and paraquat

- Incorporate multiple modes of action in the double knock, e.g. paraquat or glyphosate followed by paraquat + Group 14 (G) + pre-emergent herbicide
- Use two different weed control tactics (herbicide or non-herbicide) to control survivors.

Stop Weed Seed Set

Take no prisoners

- Aim for 100% control of weeds and diligently monitor for survivors in all post weed control inspections,
- Crop top or pre-harvest spray in crops to manage weedy paddocks,
- Consider hay or silage production, brown manure or long fallow in high-pressure situations,
- Spray top/spray fallow pasture prior to cropping phases to ensure a clean start to any seeding operation,
- Consider shielded spraying, optical spot spraying technology (OSST), targeted tillage, inter-row cultivation, chipping or spot spraying,
- Windrow (swath) to collect early shedding weed seed.



Implement Harvest Weed Seed Control

Capture weed seed survivors

Capture weed seed survivors at harvest using chaff lining, chaff tramlining/decking, chaff carts, narrow windrow burning, bale direct or weed seed impact mills.

WeedSmart Wisdom

Never cut the herbicide rate – always follow label directions
Spray well – choose correct nozzles, adjuvants, water rates and use reputable products,
Clean seed – don't seed resistant weeds,
Clean borders – avoid evolving resistance on fence lines,
Test – know your resistance levels,
'Come clean. Go clean' – don't let weeds hitch a ride with visitors & ensure good biosecurity.

Download our latest Harvest Weed Seed Control Cost Calculator on the HWSC page of the Big 6!

weedsmart.org.au/big-6

WEED smart
every weed every seed every farm every year

COST OF HARVEST WEED SEED CONTROL CALCULATOR

On-farm assessment of new long-coleoptile wheat genetics for improving grain yield with deep sowing

Greg Rebetzke[1], Andrew Fletcher[1], Shayne Micin[1], and Callum Wesley[2].

[1]*CSIRO Agriculture and Food,* [2]*Charlesville Ag, Southern Cross WA.*

Keywords

- breeding; coleoptile; dwarfing gene; establishment; sowing depth.

Take home messages

- The trend has been for increasing summer rain and later autumn sowing breaks throughout the WA wheatbelt. Long coleoptiles will permit deep sowing into subsoil moisture stored from summer rains allowing for earlier germination, and crop growth to occur under conditions optimal for crop development and maximising water productivity.
- On-farm, deep-sowing studies at Southern Cross (WA) showed benefits of new dwarfing genes in increasing coleoptile length and seedling emergence at sowing depths of up to 140mm. Studies are underway in WA, SA, NSW and QLD to understand systems and performance benefits across a wider range of environments.
- Australian breeders are using new dwarfing and coleoptile growth genetics to fast-track the delivery of new higher-yielding, long coleoptile wheat varieties suited for deep sowing.

Aims

1. To validate coleoptile lengths measured under controlled conditions in the field, and examine the potential for seedling emergence of selected long coleoptile wheats at sowing depths exceeding 120mm; and
2. Assess the yield potential and water productivity with deep-sowing in a grower-led, on-farm field experiment

Introduction

Optimal and timely plant establishment is critical in rainfed cropping systems. Well established crops provide ground cover to protect ameliorated soils, reduce water loss through soil evaporation, and increase crop competitiveness with weeds. Early emergence also increases yield potential of crops through increased duration for root growth, tillering and building of crop biomass while ensuring crop development coincides with conditions optimal for growth and flowering while avoiding hot, dry conditions late into grain-filling.

The coleoptile is a tube-like shoot that grows from the seed protecting the elongating sub-crown internode and crown. It is typically 60 to 85mm in length in modern semi-dwarf wheats, and this length limits the depth from which can successfully emerge. Changing weather patterns are associated with proportionally greater summer rainfall (see Fig. 1) and increasingly later sowing breaks (Flohr et al. 2021; Scanlon and Doncon 2020). There has been increasing interest in deep sowing systems (typically at 50-200mm) to utilise summer rainfall and ensure earlier establishment (Rich et al. 2021). However, the shorter coleoptile of modern wheat varieties limits our ability to utilise these. In turn, many crops are sown dry to accommodate large sowing programs. An ability to germinate and establish wheat crops from seed placed 100mm or deeper in the soil would be beneficial in situations where the subsoil is moist but the surface soil dry (Rebetzke et al. 2007; Rich et al. 2021).

A separate but concerning issue is the influence of increasingly warmer soil temperatures on reductions in coleoptile length. Earlier sowing into warmer soils will reduce coleoptile length by up to 50% so that a conventional variety with a 75mm coleoptile at 15°C will likely produce a 40mm coleoptile at 25°C soil temperature (Rebetzke et al. 2016).

New dwarfing genes

The green revolution Rht-B1b and Rht-D1b dwarfing genes are present in most wheat varieties globally. They reduce plant heights to reduce lodging, increase grain number and increase crop yields. These dwarfing genes reduce cell size in plant stems to shorten plant height, but a major drawback is that they also reduce coleoptile length and seedling leaf size by as much as 40% (Botwright et al. 2005). A range of alternative dwarfing genes have been identified with potential to reduce plant height and increase yields while maintaining longer coleoptiles and greater early vigour. Some of these genes (e.g. *Rht8* and *Rht18*) have been used commercially overseas but have not been assessed for use in Australia. Further these genes have not been assessed for their potential with deep sowing in germination and establishment.

Methods

The Rht18 dwarfing gene was bred from an Italian durum wheat variety, Icaro, into the tall, long coleoptile Halberd background. A fertile progeny was identified, 'HI10S', which was then used for crossing into the Mace⦶, Magenta⦶, Scout⦶ and Yitpi⦶ commercial backgrounds using both conventional and DNA-based selection methods. Four cycles of crossing and three rounds of selection were undertaken to develop BC_3-derived lines where the existing, conventional *Rht-D1b* dwarfing gene was replaced with *Rht18* to reduce plant height but maintain coleoptile length. Resulting BC_3 progeny were then assessed for coleoptile length under controlled environment conditions in Canberra ACT to identify semi-dwarf, long coleoptile lines. These selected lines were seed-increased at Condobolin in NSW in 2018 before releasing to Australian breeding companies with residual seed used in subsequent experiments.

An experiment was sown on 7 May 2020 at Southern Cross in the eastern WA wheatbelt using grower planting equipment - the seed-bin was modified on a Gessner Landmaster® planter with curved points permitting sowing of small experimental seed-lots (up to 10kg) to depths of up to 200mm. Plots of size 60 × 4.5m were sown in a two-replicate experimental design at two sowing depths: 40mm (dry-sown) and 120-130mm (sown into summer sub-soil moisture). Genotypes included long coleoptile Mace ('Mace18'), Magenta ('Magenta18'), Scout ('Scout18') and Yitpi ('Yitpi18') breeding lines, commercial varieties Mace⦶ and Scepter⦶, and tall check variety Halberd. Mace⦶, Mace18 and Scepter⦶ were sown at shallow (40mm) and deep (120-130mm) depths for comparison. There was limited seed of Magenta18, Scout18, Yitpi18 which restricted sowing to the deep treatments only.

Results

Coleoptile lengths in controlled environments

Coleoptile lengths of the control varieties Halberd and Scepter⦶ were 132 and 65mm, respectively, and Mace⦶ and Mace18 were 102 and 151mm, respectively, at 15°C controlled environment conditions in Canberra. The long coleoptile Mace18 containing a new *Rht18* dwarfing gene established well with deep sowing (up to 80% of 40mm shallow depth) and was consistent with the greater

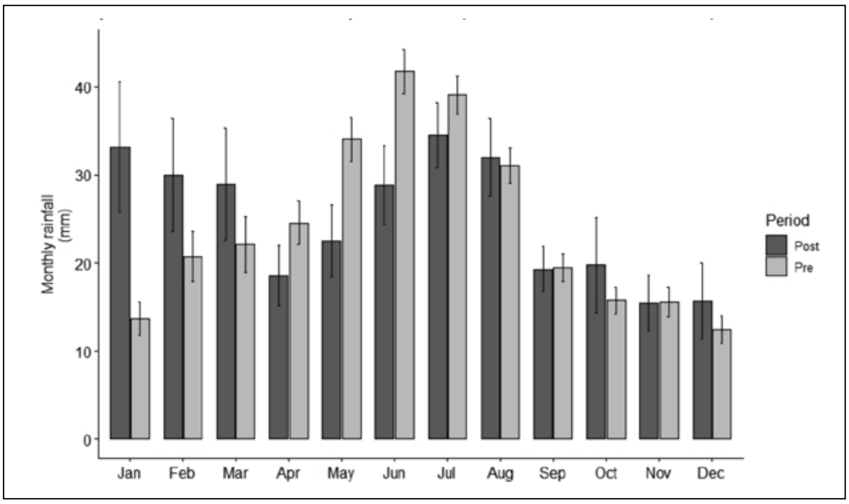


Figure 1. Monthly average rainfall (mm) for Southern Cross (WA) in all years pre- and post-2000.

coleoptile length of the tall control variety Halberd (data not shown). By contrast, the shorter coleoptile of Mace(D) and Scepter(D) were associated with reduced establishment with deep sowing (30-40%) (data not shown).

Field experiment

Available crop water at Southern Cross represented three large summer rainfall events (totalling 115mm in January-February) and an additional 76mm rainfall in-crop. Seedling emergence in the deep-sowing treatment commenced 18 May with the shallow-sowing emerging approximately two weeks later (following a 7 and then 5mm rainfall event May 24 and 29, respectively). Despite the dry decile 1 GSR, conditions through flowering and grain-filling were cool with modest rainfall (23mm) in mid-August.

Grain yields were high for shallow sowings despite the 2-week delay in emergence. Cooler conditions through grain-filling may have contributed to the increase in yields. The performance of the shallow sowing was unexpected given the reduced grain yield previously reported with delayed time of sowing (e.g. Anderson and Garlinge 2000; French and Zaicou-Kunesch 2019) and with APSIM modelling (Zhao and Wang unpublished. data). Yet despite this, comparisons between Mace(D) and Mace18 indicated grain yields, head number and water productivities were significantly (P<0.01) larger for deep-sown Mace18 compared with deep-sown Mace(D) (Table 1). Harvest index and grain size was commonly greater with deep sowing suggesting a favourable water balance for deep-sown crops after flowering. High yields and water productivities with deep sowing were also observed for long coleoptile selections in Magenta(D) and to a lesser extent Scout(D) and Yitpi(D) genetic backgrounds. Grain protein concentrations were consistently larger with deep sowing and was particularly high in the deep Mace(D) and Scepter(D) sowings (Table 1).

This grower-led study highlighted the opportunity for deep-sowing in reducing risk a marginal environment characterised by a low rainfall year. Other genetic opportunities are being explored that should complement long coleoptile length in wheat variables adapted to future climates. These include high biomass '100-day' wheats for late sowing, weed competitive wheats to assist in managing herbicide use and resistance, and high grain-filling rates to avoid hot and dry conditions at season end. There is also opportunity to translate learnings in breeding of long coleoptile wheats to other crops including canola and barley.

Conclusions

The long coleoptile trait has been demonstrated to provide good establishment and higher yields with deep subsoil moisture retained from summer rains. Further studies are underway including use of earlier sowing dates and multiple sites in WA, SA, NSW and QLD to assess the potential for long coleoptiles as part of a broader set of environments and farming systems. Coinciding closely with this assessment is the pursuit by breeders in selection of the long coleoptile trait in delivering new wheat varieties to Australian growers.

Table 1. Grain yields and yield components for different wheat varieties and breeding lines sown deep at 120-130mm and shallow-sown at 40mm (in parenthesis). A subset of lines (Magenta18, Scout18, Yitpi18) were only sown in the deep sowing treatment.

Entry	Grain yield (t/ha)	Number of heads (m-2)	Harvest Index	Seed weight (mg)	Protein conc. (%)	Water productivity (kg/ha/mm)
Scepter(D)	1.41	80	0.49	44	10.2	15.4
	(1.86**)	(121*)	(0.45**)	(39**)	(9.2**)	(19.3**)
Mace(D)	1.25	76	0.49	42	10.4	13.7
	(1.95**)	(149**)	(0.44**)	(38**)	(8.4**)	(21.0**)
Mace18†	1.80	137	0.45	39	10.6	19.8
	(1.87ns)	(174*)	(0.41**)	(34**)	(10.2*)	(20.6ns)
Magenta18†	2.01	172	0.44	37	10.8	22.1
Scout18†	1.60	147	0.48	42	10.3	17.6
Yitpi18†	1.68	132	0.42	38	11.4	18.4
Halberd (tall)	1.59	138	0.43	38	10.3	17.5
LSD¥	0.32	24	0.04	3	0.6	3.7

† long coleoptile Rht18 selections; ¥ LSD for comparisons between entries with deep-sowing

Acknowledgements

We would like to thank DPIRD Merredin for their assistance in harvest of the experiment, and Dr Sarah Rich for helpful discussions on the value of deep sowing into subsoil moisture.

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Notes

Notes

TOP 10 TIPS

FOR REDUCING SPRAY DRIFT

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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.

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Using satellite data to assess frost damage

***Moira Smith*[1] *and Brian Lynch*[2].**

[1]Digital Content Analysis Technology Ltd (D-CAT); [2]Elders Ltd.

Keywords

- frost damage detection, satellite imagery, services, cutting decisions, precision ag.

Take home messages

- A proven and reliable on-demand frost damage detection service is now available.
- You can order frost damage maps for a given frost event and receive results as soon as the next satellite image for your paddock/farm is available (revisit rate typically 3 days).
- The technology is rooted in trusted ground truth data gathered across Australia and has been subject to validation by Elders across the southern wheatbelt over several years.
- A 'so what?' decision aid is also planned that enables comparison of estimated financial returns if all, some or none of the paddock is cut for hay.

Background

In 2017 D-CAT was chosen by Elders to be their remote sensing partner. This led to the launch of AgIntel in 2018, which provides regular field monitoring services for Elders' agronomists and their clients using satellite imagery. Functionality includes a wide range of insights into crop status, enabling multi-layering of maps, paddock benchmarking, and actioning of data via automated or manually generated variable rate maps.

Figure 1. AgIntel screenshot.

D-CAT has listened to the needs expressed by so many for tools to assist with the ever-increasing number of frost events that have to be managed.

Yield loss is a significant issue for Australian grain growers operating in frost prone areas across Australia. Significant financial losses can arise if frost damage occurs and appropriate action isn't taken. If frost damage is detected early enough, crops can be cut for hay to deliver some financial return to the grower instead of risking crops dying or yielding very little.

Knowing the magnitude of the problem, and the technical challenges posed when harnessing sensor data from space, an R&D project of substance was proposed by D-CAT that would build upon our expertise and capabilities, and focus on an accurate, reliable and commercial outcome. Hence matched funding was sought to enable two seasons of live testing and validation in parallel with R&D activities and historic data analysis, and this was supported by the owners of our satellite of choice, the European Space Agency (ESA). Elders partnered to provide agronomic advice, broadacre sector appreciation, ground truthing and validation effort.

Specifically, the development of this software service addressed the following requirements captured during engagement with advisors and growers across the country, as well as Grain Producers SA:

1. Finding damaged crops within days of a frost event is essential if a grower is to be able to assess the impact on the crop and decide whether to cut for hay or leave for yield. Being able to 'call up' a map on demand showing areas of damage and quantifying them is desired, and automated variable rate maps would enable detailed cutting for those operating precision agriculture (PA) equipment.
2. Having found areas of damaged plants via a map of relative damage, deciding to cut is a cost/benefit decision: cut all for hay, just some for hay, or leave for yield. A financial decision tool would help greatly.
3. Any service has to be cost-effective as well as trusted (accurate, reliable, sound basis).

Method

The project built upon initial work undertaken on frost damage detection by D-CAT, and developed an automated, on-demand service that uses Sentinel-2 [1] as the main data source. Sentinel-2 is one of ESA's Copernicus mission constellations which comprises two satellites, each of which is equipped with a highly advanced multispectral sensor that was specifically designed to meet the needs of agriculture clients worldwide. With an update over most of the planet every three to five days, an image resolution of 10m, and one of the richest sets of spectral measurements available, Sentinel-2 was the obvious satellite of choice. For broadacre farming, where interventions are often at the resolution of 15m using typical equipment, 10m provides sufficient detail to enable PA to be applied (although it is noted that often straight lines are preferred for hay cutting even when detailed shapes are available as VR maps).

Our approach was one of iterative development utilising the latest machine learning (ML) techniques, which relies on large volumes of appropriate, timely and accurate ground truth data as well as satellite imagery. Such data is essential for training of the algorithm, but also for its testing against known outcomes so that accuracy can be quantified. The method extended to include data fusion (the intelligent combination of different data sources, such as weather) in order to achieve high levels of reliability and accuracy. A number of fusion approaches were explored, as well as a range of preferred ML techniques, and understood in detail before successive development iterations resulted in a final design. Included in the study were a wide range of possible data for fusing, yield maps from damaged paddocks for informing training, hand-drawn maps of damaged areas, and constant engagement with advisors and growers regarding our latest results and their needs.

Avoiding model bias is essential when developing quality ML algorithms, and so much effort was spent ensuring an unbiased model was achieved. Collection of extensive ground truth data from across a variety of broadacre farms in the Australian wheat belt assisted greatly with this process. Ground truth data included the location, date and extent of damage and was provided by growers and agronomists. In some cases, yield maps were also shared to illustrate impact on yield.

Data cleansing and analysis is another essential ingredient in the process of developing trusted ML models, and this was performed before a range of machine learning techniques were applied to explore the potential for accurate detection of frost damage across the crops affected in areas as small as one pixel. An optimised algorithm was the result of much development effort over the project's duration, delivering very good detection probabilities across all paddocks tested.

The final step in the development, once the frost damage detection algorithm had amassed a substantial validation case that saw it deemed as ready for market, was the extension to include a financial decision model using P2PAgri. This enables a grower or agronomist to trade-off the cost and return that is likely to occur given three different scenarios:

- cutting all crop in the paddock for hay;
- leaving it all to mature to grain;
- or cutting only the damaged areas.

Scenarios were designed, tested and independently verified by Elders.

Results and discussion

Frost damage detection

The algorithm was tested across more than one hundred sites across Australia, covering hundreds of millions of data points, and validated for the following broadacre crops: wheat, barley, canola, oats, field peas. Seasons 2019 and 2020 provided in-situ measurements and assessment of damage as well as yield maps (not available from all farms). Previous seasons were also used for wider testing and evaluation but ground truth data for such cases was less reliable as hand-drawn maps from memory were sometimes the only data available for certain locations. Others provided historic yield maps. In all cases, only trusted, properly calibrated yield data was used for testing and validation.

An example of hand-drawn 'ground truth' data provided is shown below for two paddocks, with the algorithm-generated frost damage risk maps next to them. Each 10m x 10m pixel is assigned a likelihood of damage score for that paddock, ranging from 0 (no likelihood) to 1 (highest likelihood). The values are coloured, typically, using a traffic light colouring system of green (no likelihood of damage) to red (highest likelihood of damage). However, in the greyscale print used for this document colour variation will not be evident.

Often satellite image processing is only known for, or associated with, a parameter called NDVI (Normalised Difference Vegetation Index). An important result to note from our research is its inability to be used as any reliable indicator of frost damage in crops. Figure 3 below shows the inseparability of frosted and non-frosted cereal crop NDVI values gathered into histograms from our substantial data sets.

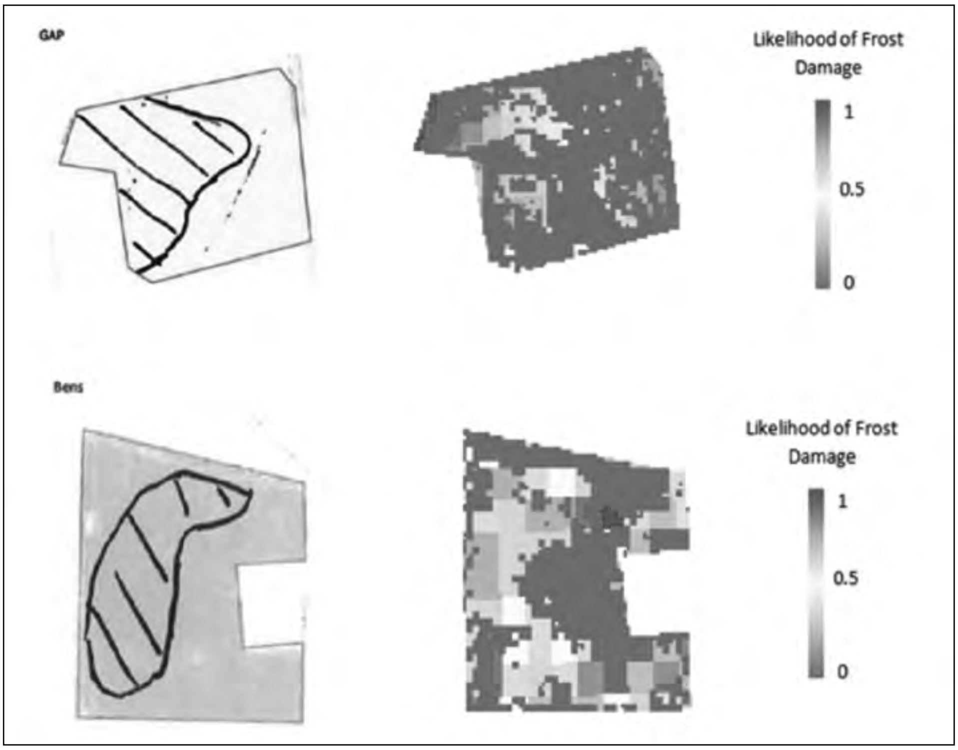

Figure 2. Frost damage likelihood maps (right) with grower-supplied 'ground truth' (left).

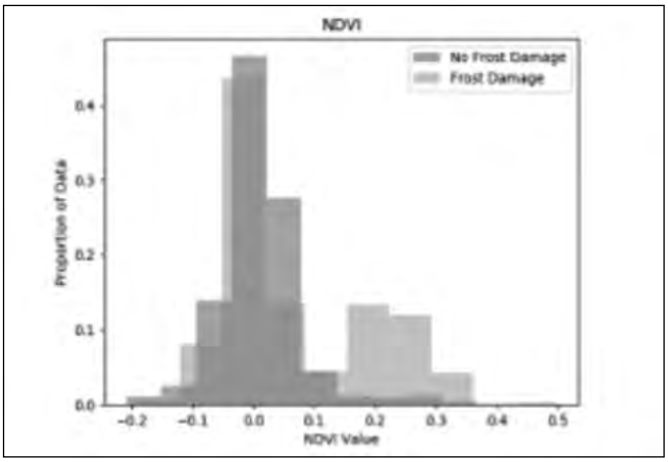

Figure 3. Histograms of NDVI values for frost damaged and undamaged crops.

Quantifying accuracy against some ground truth data was challenging due to the error bounds associated with the hand-sketched maps. Yield maps and other data provided by in-situ measurements allowed more reliable quantification, and classical ML metrics such as precision and recall were also used to determine algorithm performance and any limitations. Overall, high levels of performance were noted, and across all crops, with no frosted paddocks not detected and false positives extremely rare. One common way to summarise performance of a classifier is a Confusion Matrix, which is used here to compare the algorithm output ('Predicted') to the actual case across the greater than 200 000 sample locations tested (Figure 4).

Financial decision aid

When a paddock has been damaged by frost, the algorithm can then be used as input to a financial model from P2PAgri which calculates the predicted profit for the paddock given one of three outcomes: all crop is cut for hay; only those areas identified as damaged are cut for hay; or the whole crop is left to mature to grain.

Figure 5 below shows a screenshot of the financial calculator tool, which takes the percentage of the paddock that has been damaged as one input, crop type, hay price, grain price and other key factors as input. The output of the tool for the paddock shown in Figure 5 was:

a)	**Cut all for hay**	**Loss of $47**
b)	**Leave all for grain**	**Profit of $669**
c)	**Cut only damaged crop for hay, leave rest for grain**	**Profit of ~$15k**

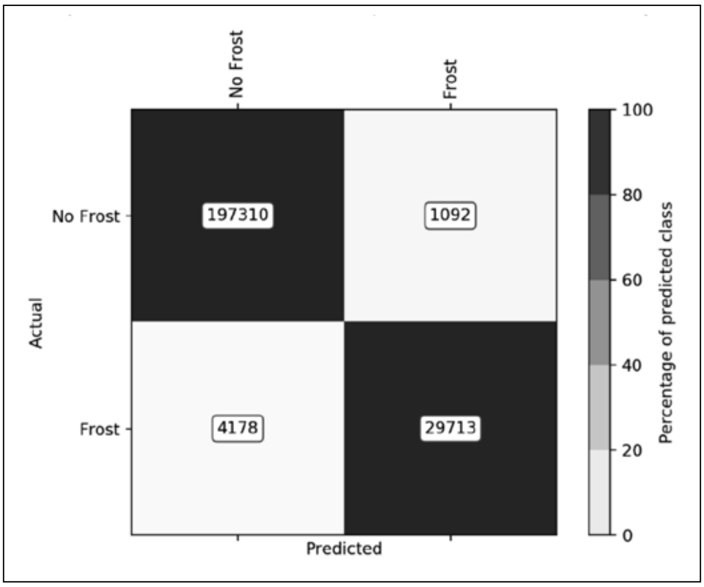

Figure 4. Confusion matrix from a sample validation test.

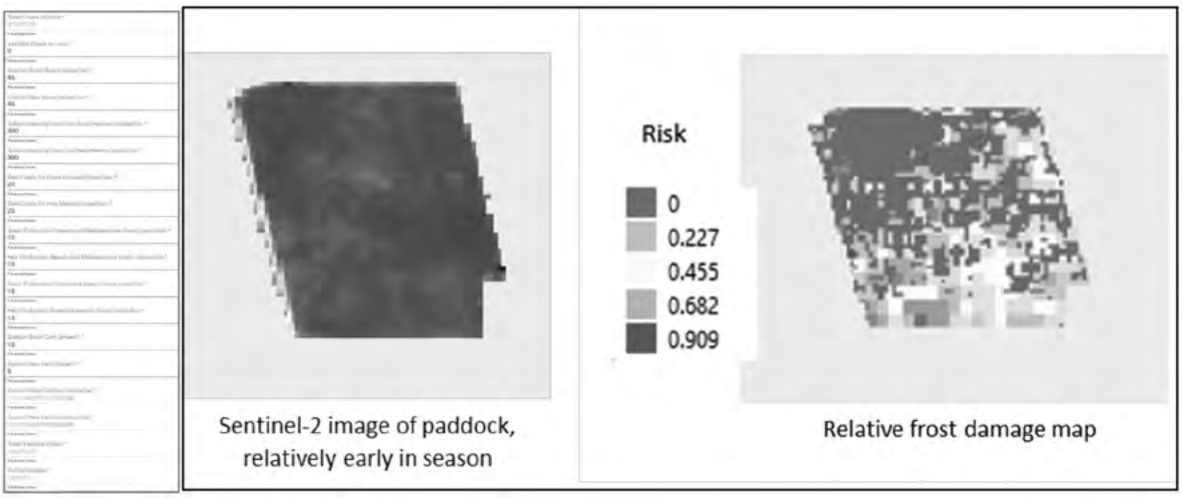

Figure 5. Example showing paddock, frost damage risk map and financial tool.

Conclusion

Satellite imagery has been shown to be capable of reliably detecting the signs of damage that is typical of when a crop (wheat, barley, canola, oats, field peas proven) has been frosted. This is only possible through careful pre-processing and data cleansing to ensure that it is radiometrically accurate and reliable before it is subjected to an advanced classifier that fuses multiple data sets, including spectral bands from the Sentinel-2 satellite, and produces a frost damage likelihood map for the paddock as well as area and percentage statistics. If operating a PA farm, then a VR map can be exported and used in equipment.

A valuable addition is the financial tool that will assist in decision making around whether to cut for hay or leave for grain. Results are available almost as soon as a satellite has passed over the crop, but cloud patches will automatically be removed from any imagery to avoid any false reporting.

Acknowledgements

D-CAT wishes to thank the European Space Agency for its co-funding of this project, and the partnership of Elders throughout the project where they provided invaluable agronomic and application advice, ground truth data and validation effort. Growers who kindly agreed to engage with D-CAT as well as their Elders' advisors are also thanked for their contributions and data provided.

Useful resources

www.d-cat.com.au

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1. https://sentinel.esa.int/web/sentinel/missions/sentinel-2

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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

beyondblue
Depression. Anxiety.

Lifeline
13 11 14
www.lifeline.org.au

Lifeline
13 11 14

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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Amelioration strategies to improve crop productivity on sandy soils

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GRDC project codes: CSP00203, GRDC00432

Keywords

- soil constraints, compaction, hardsetting, water repellence, ripping, spading, inclusion.

Take home messages

- All sites without significant repellence or subsoil toxicities in the Southern Region have demonstrated positive first-year responses to deep ripping ranging from 0.2 t/ha to 1.2 t/ha, with an average gain of 0.6 t/ha.
- While most experiments demonstrate multiple years benefit from ripping, yield penalties have been evident following consecutive drought years (2018, 2019), with poor season penalty risks higher in deeper ripped soils (60 cm vs 30-40 cm).
- Some sands have demonstrated extreme hardsetting behaviour which means they have very high soil strength, especially upon drying, and this may limit the longevity of ripping treatments.
- Across project experiments with water repellence and where subsoil toxicities are not present, spading treatments showed a mean annual yield response of +0.77 t/ha.
- Although spading remains the more effective amelioration approach in repellent sands, inclusion-ripping has shown smaller benefits that persist over multiple years.
- Reliable and effective inclusion of topsoil is strongly influenced by operating conditions (e.g. moisture, operating depth and speed), but design modification alongside optimising operation set-up may provide opportunities to improve inclusion-ripping outcomes.

Background

Uptake of amelioration practices to improve productivity in Southern Region sandy soils has gained strong momentum in recent years. These practices include deep ripping which aims to shatter hard/compacted layers; inclusion ripping which both shatters and ‘includes’ some of the topsoil layer at depth; and deep ploughing and spading which aims to mix and dilute repellent or hostile layers, and/or incorporate topsoil into bleached layers. Additionally, inclusion-ripping, deep ploughing and spading practices offer opportunity to incorporate amendments or fertilisers into the profile to improve soil condition or nutrient supply. First year yield responses are often positive but return on investment can require benefits over multiple seasons. Multi-year benefits can be challenging in a water limited environment with high seasonal variability, or where amelioration effects are short-lived. The impact of the quality of soil/amendment mixing and/or inclusion is often not considered. Building on previous amelioration experiments (PIRSA New Horizons est. 2014, Trengove est. 2015), CSP00203 research aims to improve the diagnosis and management of primary soil constraints across deep sandy soils in the Southern low-medium rainfall environment. Including 10 research experiments (5 years) and 18 validation experiments (3 years) the research project is working to define which sandy environments and amelioration treatments are more likely to provide strong return on investment, and where environmental risks or short-lived effects are likely to limit potential benefits.

Method - CSP00203 research and validation trial overview

A range of research experiments have been established across the Southern Region low to medium rainfall environment which have been grouped according to the primary soil constraints identified (Table 1).

All sandy sites have inherently low biological and chemical fertility with topsoil (0-10 cm) organic carbon contents of between 0.3 and 0.7%, and ECEC of 2.1-5.0 cmol+/kg, while the pH (5.9-8.8) and Colwell P (11-48) both varied across sites. The starting depth of severe soil strength ranged from 10-30 cm and total depth of the profile affected by severe soil strength ranged from 10-50 cm (Table 1).

Research experiments were established between 2014 and 2020 and include a range of deep ripping and/or ploughing approaches, with/without additional amendments (fertiliser, N-rich hay, chicken manure, clay). All experiments monitored the impact of amelioration on crop growth and yield. Experiments have different levels of measurement whereby some include more intensive measurements to understand the impact of amelioration on crop water use and soil constraints over time and others just focus on crop growth responses. This paper reports responses to deep tillage practices (ripping, spading) alone, without including responses to incorporation of amendments. Findings report the range of yield responses to deep tillage for: a) sands without water repellence issues where physical constraints have been targeted through ripping-based practices; b) water-repellent sands where approaches have focused on spading and/or inclusion ripping to disrupt repellent layers and physical constraints.

Results & Discussion

Ripping deep sands with physical constraints - shattering to maximise root exploration

Yield responses to ripping across experiments with physical constraints are summarised in Figure 1. Except for one non-responsive site, all sites demonstrated a positive response to ripping in the

Table 1. Summary of sites targeting a range of different constraints including the long-term average annual and growing season rainfall (mm) grouped according to the target soil constraints and associated treatments. Soil properties including repellence as Molar Ethanol Droplet (MED), Depth to severe soil strength (> 2.5 MPa penetration resistance measured near field capacity), surface organic carbon (% OC), surface Colwell phosphorus (P mg/kg), surface pH (1:5 H_2O) and surface exchangeable cations (ECEC cmol+/kg) are shown. *Surface is 0-10cm depth #Not analysed.

Research Site_State_ Yr Established	Avg. Ann Rain	GS Rain	Topsoil Repellence	Severe (>2.5MPa) soil strength	Surface* OC	Surface Colwell P	Surface pH	Surface ECEC
	mm	mm	MED	cm	%	mg/kg	H_2O	cmol+/kg
Physical constraints and low inherent nutrition (deep ripping at 30-60cm)								
Lowaldie_SA_19 (2)	339	235	0	30-70	0.4	17	7.5	2.4
Ouyen_Vic_17 (2)	333	213	0	15-65	0.4	12	6.6	2.4
Carwarp_Vic_18	286	174	0	15-45	0.3	13	6.3	2.1
Waikerie_SA_18	245	157	0	15-55	0.5	11	8.1	5.0
Bute_B_SA_18	394	298	0	25-35	0.5	26	8.8	2.9
Yenda_NSW_17	295	252	0	15-48	0.2	39	5.8	2.6
#Karook_Vic_19, Walpeup_Vic_20, Kimba_SA_19, Telopea Downs_Vic_20								
Water repellency, physical constraints and low inherent nutrition (spading, ripping and inclusion ripping)								
Karoonda_SA_2014	339	235	2.2	10-40	0.4	21	6.8	2.4
Murlong_SA_2018	335	251	2.3	#	0.7	17	7.1	4.3
Bute_SA_15	394	298	1.9	20-70	0.5	48	5.9	2.8
Brimpton Lake_SA_2014	398	377	2.3	#	0.6	24	6.0	2.1
#Tempy_Vic_19, Wynarka_SA_19, Younghusband_SA_20, Mt Damper_SA_19, Kybunga_SA_19, Warnertown_SA_19								

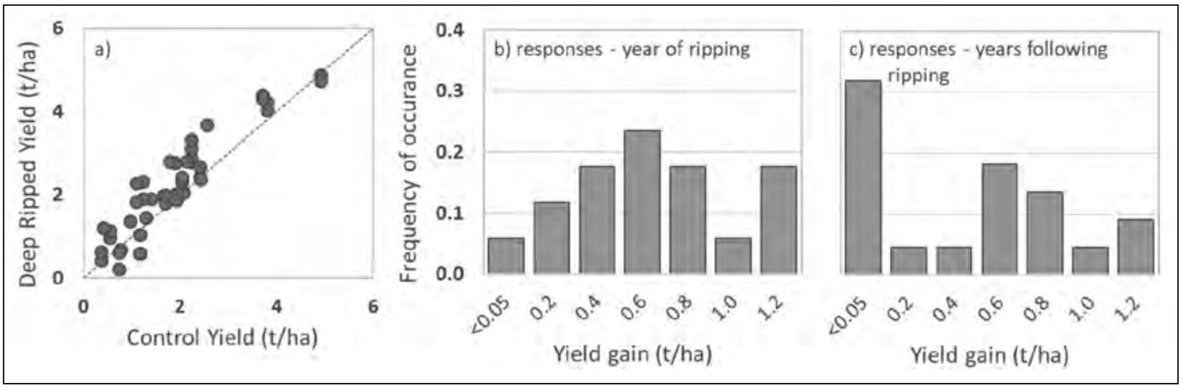

Figure 1. Annual crop yield (t/ha) responses to deep ripping in sands where physical issues are considered dominant including (a) biplot demonstrating unmodified control yields against deep ripped yields; and (b) frequency distributions of yield gains (ripped yield – control yield) in the year of ripping and (c) subsequent years following ripping across CSP00203 trial sites. Data represent treatment averages from seven research experiments (multiple years, *n=4*) and two validation experiments (single year, *n=3*) with a total of 40 response years. The linear regression has a fit with R^2 of 0.81 at P<0.001.

first year (Figure 1b). Yield gains ranged from 0.2 t/ha to 1.2 t/ha, with an average gain of 0.6 t/ha. These responses are similar to those reported by Dzoma et al. (2020) across 5 sandy soil experiments (Loxton, Peebinga, Buckleboo). The non-responsive example is the only project site with severe subsoil acidity (Yenda, NSW) which has shown larger responses to nutrition compared to physical interventions (ripping 30 cm, deep sweep tine) over 4 years of monitoring. Subsequent year responses to ripping across the remaining experimental sites demonstrate an average yield gain of 0.3 t/ha but also include a higher incidence of yield penalties of up to -0.6 t/ha. All observed yield penalties relate to the 2019 season and represent a consecutive year of dry seasonal conditions, likely due to extreme water deficit after crop establishment. Ripping responses in a more favourable 2020 season show benefits ranging between 0.3 t/ha and 0.9 t/ha at responsive sites, including those that suffered penalties in 2019.

We are examining the soil processes that limit the longevity ripping effects, causing sands to return to their physical constraint over a short timeframe. The four sites that we were able to access in 2020 did not classify as having a cementing layer, but they did have a hardsetting layer that is prone to becoming extremely hard (restricting all root penetration) over very small reductions in soil water content (just 4% w w-1) (da Silva et al. 2021). This is likely to be a critical issue in low rainfall environments. We will continue to explore this hardsetting response across a broader range of sites (when accessible) and contrast the process under different amelioration strategies.

Analysis of the role of physical disturbance for closing the yield gap (where ripping comparisons were available) reveals that at half of the sites examined the yield gap was closed (Figure 2). At 5 sites, the yield potential (denoted by stars within the stacked column at Bute_B, Kimba, Tempy, Kybunga and Warnertown) determined according to Sadras and Angus (2006) was exceeded. Many of the examples, where a substantive yield gap remained occurred in the very dry season of 2019 (Figure 2). Further analysis of experimental data has revealed that crop rooting depth and water extraction has played a key role in the yield benefits gained by amelioration treatments (data not shown).

Water repellent sands – mixing to maximise water capture and root exploration

Early research experiments led by PIRSA (New Horizons 2014-2018) demonstrated that spading can have long-term yield impact on water repellent sands with physical constraints, providing subsoil chemical toxicities are not present. Five years of monitoring two research sites (Karoonda, Brimpton Lake) have shown ongoing establishment, biomass, and/or yield gains. A research site at Murlong and seven validation experiments continue to improve our understanding of amelioration responses in repellent sands, including comparing spading and alternative deep tillage practices (Figure 3a). Where subsoil toxicities are not present, there was an average annual yield response of +0.8 t/ha, including examples of substantial gains (+2.1 t/ha) as well as no response in some seasons (Figure 3b).

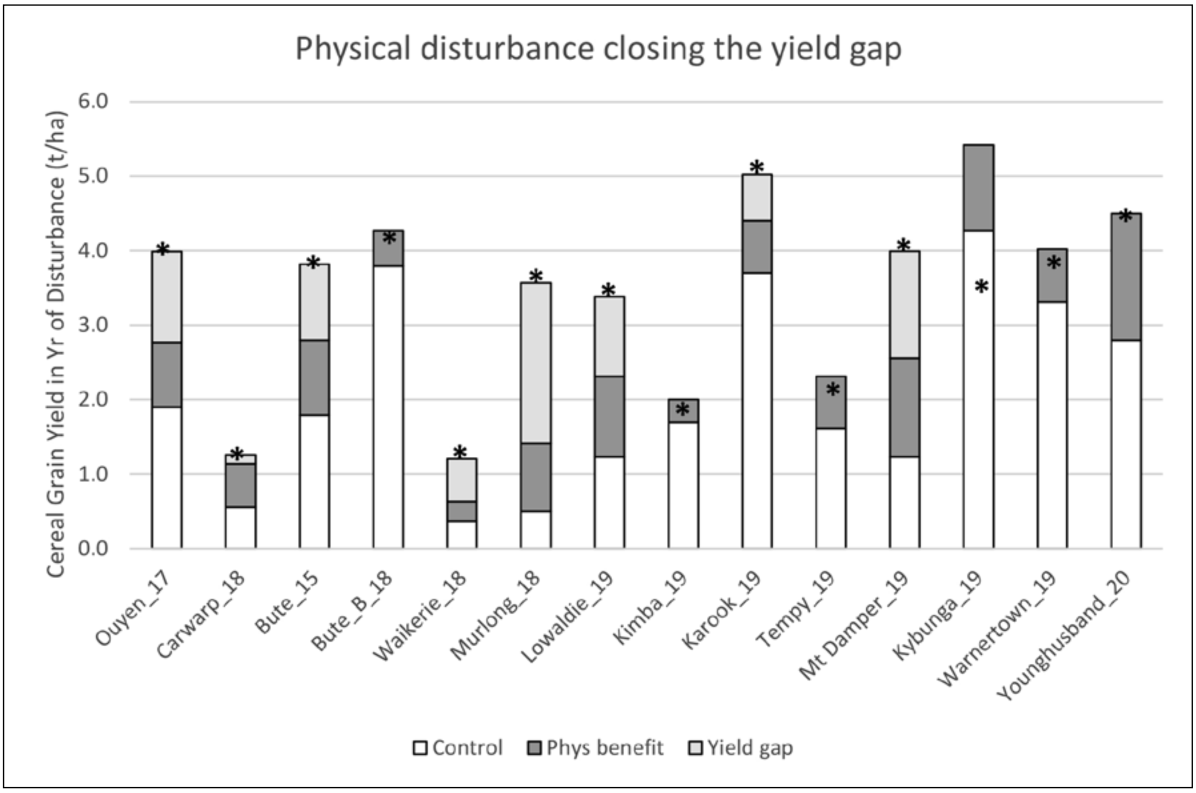

Figure 2. Demonstration of the role of ripping (using the best performing treatment including ripping with inclusion) for closing the yield gap at sites where high soil strength is the primary constraint. The cumulative stack shows the control yield (white), the yield benefit due to ripping (dark grey) and the remaining yield gap (light grey). The yield potential calculated according to Sadras and Angus (2006) is represented as a star.

Although proven to have long-term effect in repellent sands, spading offers practical challenges including trafficking and managing seed depth to successfully establish the following crop. One-pass operations to simultaneously spade and seed, when conducted into a moist profile, can have advantages including minimising erosion risks, securing uniform crop establishment and increasing flexibility of when in the crop rotation spading might be implemented. While spading is the most effective approach to mix and dilute repellent layers, alternative deep tillage practices can offer some benefit by disrupting water repellent layers, or by overcoming co-occuring physical constraints to root growth. Comparison of spading to inclusion ripping at a severely repellent sand (Murlong), had intermediate benefits from

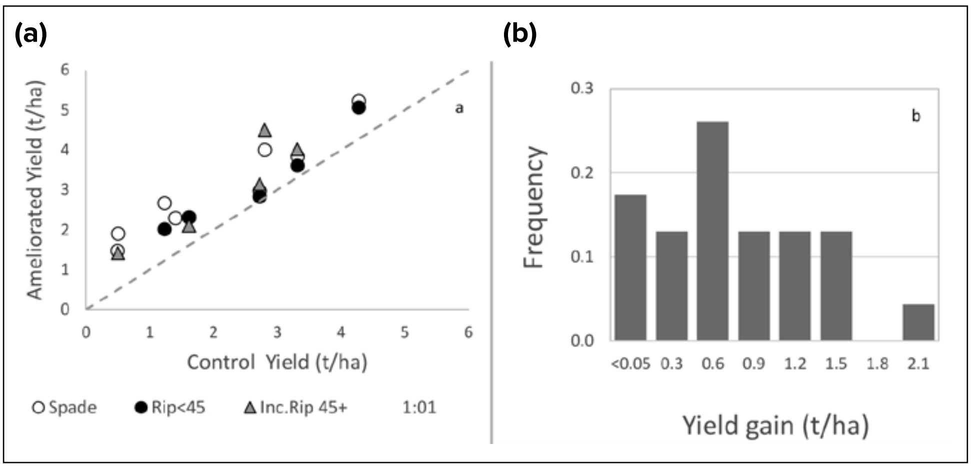

Figure 3. Annual crop yield (t/ha) responses to spading, ripping (<45 cm) and inclusion ripping (>45 cm) in sands where repellency and physical issues combine presented as (a) biplot of unmodified control yields against deep ripped yields (t/ha) with the dotted line representing 1:1, and (b) frequency distributions of yield gains (ameliorated yield – control yield). The linear regression has a fit with R^2 of 0.85 at $P<0.001$.

inclusion ripping. A cumulative three-year benefit of 2.9 t/ha was been achieved from spading under a wheat (+1.4 t/ha), barley (+0.9 t/ha), and vetch (+0.6 t/ha) rotation while inclusion ripping showed cumulative gains of +1.4 t/ha and 2.2 t/ha for 30 cm and 40 cm depths respectively.

Although inclusion ripping may appear an attractive option, topsoil inclusion and crop response variability alongside elevated running costs pose challenges for reliable return on investment. Experiments in WA and SA Mallee sands have shown higher draft requirements (+24% to +40%), reduced workrate (-24%), and extra fuel use (+3.7 L/ha) with baseline inclusion ripping compared to ripping alone (Parker at al. 2019). Simulation modelling with field validation has been used to optimise the design of inclusion plates and has shown that effective depth and included volume of soil could be increased by lengthening the inclusion plate (Ucgul et al. 2019). A validation trial (2020) conducted on a repellent SA Mallee sand has demonstrated yield benefits of 0.8 t/ha from inclusion-ripping (modified long plates, 60 cm) over and above deep ripping alone (3.9 t/ha) where the control yield was 2.8 t/ha. While effective inclusion of topsoil is strongly influenced by operating conditions (e.g. moisture, operating depth and speed), opportunities exist to improve this amelioration approach through design modification alongside optimising machinery set-up and operation.

Conclusion

Grouping our sites according to primary constraints and reviewing the ability of amelioration strategies to close the yield gap has revealed that physical disturbance techniques closed the yield gap at half of the sites analysed. All sites which targeted physical constraints (without significant repellence or subsoil toxicities) have demonstrated positive first-year responses to deep ripping ranging from 0.2 t/ha to 1.2 t/ha. While most experiments demonstrate multiple years benefit from ripping, yield penalties have been evident following consecutive drought years (2018, 2019), with poor season penalty risks more likely in deeper ripped soils (60 cm vs 30 cm). Experiments with spading treatments on water repellent sands showed an average annual yield response of +0.8 t/ha. Although spading remains the more effective amelioration approach in highly repellent sands, optimisation of inclusion-ripping is currently being examined considering significant responses on moderately repellent sands.

Acknowledgements

This research has been enriched by preceding research experiments, the significant contributions of growers and consultants across the Southern Region, and the support of the GRDC. CSP00203 research and validation activities are a collaboration between the CSIRO, the University of South Australia, the SA Government Department of Primary Industries and Regions, Mallee Sustainable Farming Inc., Frontier Farming Systems, Trengove Consulting, AgGrow Agronomy and Research, AIREP, and MacKillop Farm Management Group.

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Notes

Herbicide MoA alignment: Stage 1

Herbicide Mode of Action (MoA) classifications have been updated internationally to capture new active constituents and ensure the MoA classification system is globally relevant.

The global MoA classification system is based on numerical codes which provides infinite capacity to accommodate new herbicide MoA coming to market, unlike the alphabetical codes currently used in Australia.

Farming is becoming increasingly global. Farmers, agronomists and academics around the world are now, more than ever, sharing and accessing information to assist them to grow crops, while managing sustainability issues such as herbicide resistant weeds.

It's important then that the herbicide MoA classification system utilised in Australia be aligned with the global classification system. This will ensure more efficient farming systems into the future and allow Australian farmers and advisors to access the most up-to-date information relating to managing herbicide resistance.

CropLife Australia is working with key herbicide resistance management experts, advisors and the APVMA to ensure farmers and agronomists are aware of the planned changes.

Growers can expect to start seeing herbicide labels with the new mode of action classification system from early 2022. There will be a transition period during which herbicide labels will exist in the supply chain, some bearing the legacy alphabetical MoA classifications, and others transitioned to the global numerical system.

The numerical classification system should be fully implemented by the end of 2024.

A mobile app compatible with Android and Apple systems is available via the **HRAC website** (hracglobal.com) at no cost to users. It will cross reference the herbicide active ingredient with its former MoA letter and new MoA number. Printed materials will also be made available to enable cross referencing of the changes.

CropLife Australia

Frequently asked questions

Q. Why change from letters to numbers?

A. A numerical code system is more globally relevant and sustainable, compared to the current alphabetic code used in Australia. Today there are 25 recognised MoAs. Over the next 10 years we anticipate up to four new modes of action to be commercialised, which will exceed the 26-letter maximum in the English alphabet.

Q. What is going to change?

A. The current alphabetical codes for herbicide active ingredients will change to numerical codes, in alignment with the global MoA classification system. For example, Group A herbicides will be labelled as Group 1 herbicides and Group M (glyphosate) will become Group 9.

Some new MoA will be introduced to accommodate some of the new chemistry being introduced world-wide. Some active ingredients will also be reclassified into different groups to better reflect their actual mode of action, not chemical structure.

A complete summary of the changes is available via the mobile app. More detailed information regarding the changes will be available in mid-2021.

Q. What are the main changes?

A. The main changes are outlined in the free mobile app, which you can download from the **HRAC website**. We are still working with industry experts to identify the consequences of these changes regarding how products fit into an integrated weed management program and will provide more specific guidance on the changes in mid-2021.

Q. How will the changes affect what we do?

A. The way growers use herbicides in the field will not change. The science hasn't changed and the mix and rotate messages remain correct. It is just the classification codes used on product labels and literature that will change from a letter to a number. Continue to follow your current IWM strategy and rotation plans.

Q. When will the changes take place?

A. There will be a transition period starting from July 2021, with growers likely to begin to see labels bearing the new MoA numbering system in the marketplace in early 2022.

Q. Does this mean the current MoA are wrong?

A. The science has not changed. Stick with your current IWM strategy and plans to rotate herbicides. In this era of multiple cross resistance, there is no magic bullet amongst the new modes of action.

Q. How will I know which products to rotate?

A. The science hasn't changed – stick with your current IWM strategy and plans to rotate herbicides. If in doubt, particularly with newer herbicides recently introduced, consult the manufacturer or your local agronomic advisor.

A summary of the changes is available via the mobile app. More detailed information regarding the changes will be available in mid-2021.

Q. Can I still use product on hand which has the old MoA printed on the label?

A. Yes. Legacy labels will be phased out over the next few years and will continue to be legally valid, although growers are encouraged to familiarise themselves with the new MoA classification system and corresponding resistance management strategies from 1 July 2021.

Q. Where can I find out more information?

A. You can find more information at the **CropLife website** and the free mobile app is available on the **HRAC website**.

Download the Global HRAC Herbicide MOA Classification app via Google Play or the App Store.

To find out more visit:

croplife.org.au/MoA

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Vetch Agronomy and Management

Stuart Nagel, Gregg Kirby and Angus Kennedy.

SARDI.

GRDC project codes: DAS1711-015RTX, UOA2104-011RTX 9178755

Keywords

- vetch, vicia, break crops, agronomy.

Take home messages

- Choose the species and variety of vetch depending on your end goals, or desired end-use.
- Get initial management and agronomy decisions right to enable flexibility of end-use.
- There is no “one size fits all “approach with vetch, the diversity of end-uses and environments vetch is grown in require different agronomic approaches and tools.

Background

Vetch has long held a place in the low rainfall mallee cropping areas of southern Australia, particularly with farmers looking for a reliable legume. Recently there has been an increased use of vetch in a variety of farming systems, leading to growing interest in agronomic practices to get the most out of the crop. Being a crop with a diversity of end-uses means there is no one right way to manage it, however there are some basic agronomic practices to get right before getting too creative. Your planned end-use does not have to be locked in, flexibility can come with getting the basics right and watching how the season develops.

The most important point to remember is to treat vetch as a crop, not a break. The more you put into the crop the better your potential return, be it yield, in any form, or the ancillary benefits that come from legumes.

Paddock selection and planning are vital. Knowing the weed burden/profile along with the desired/preferred end use dictate many subsequent decisions. Vetch can be used to fill in, provide extra feed or just replace fallow as well as for hay and grain production, but if you are looking to maximise benefits and outputs put the planning in.

Once you have selected the paddock choose the vetch species and variety that best suits your conditions and major objectives. For specific details on vetch variety characteristics please refer to the 2021 Crop Sowing Guide relevant to your state or area, these can be found online at:

https://grdc.com.au/resources-and-publications/all-publications/crop-variety-guides

Choose disease resistant varieties wherever possible, all varieties released from the National Vetch Breeding Program are resistant to rust.

If you have hostile soils or a poor legume history, inoculate seed with appropriate rhizobia. New acid tolerant strains of rhizobia are being released which will assist areas with acidic soils get the best out of legumes.

All legumes benefit from phosphorus but do not require significant amounts of nitrogen, so choose appropriate fertiliser. Vetch can usually “make do” with residual fertiliser from previous cereals but will benefit from well placed P, helping development and vigour.

When looking at different end-uses, time of sowing (TOS) plays an important role in strategic planning. If the crop is to be grazed, early sowing is vital to get the crop up while the soil is warm, early growth is vital for this end use. This also applies to using the crop for green or brown manure, the bigger the biomass the better and early canopy closure to out compete weeds is preferred.

For hay production TOS helps dictate when the cutting and drying window will occur. There is a balance to be struck between getting the best growing conditions and timing drying for when the weather warms in late September. In Victoria in 2020 several areas had excellent rains in March enabling very early sowing (mid-March-early April), this resulted in large dense crop canopies developing early. Canopy closure occurred in some cases in early-mid June, this resulted in perfect conditions for disease development. As canopy closure occurred so early, fungicide applications could not penetrate the canopy after this point allowing disease to proliferate and causing significant damage particularly to hay crops. This shows the importance of planning TOS around your preferred end-use, as grazing early may have helped to keep canopies open longer and helped with disease suppression.

Chemical selection, particularly for broadleaf weed control is still limited in vetches. Pre sowing, IBS, chemicals and Post sowing pre- emergence (PSPE) chemicals offer the best options and results. There are now in crop options for broadleaf control, but they can set the crop back for a period of time. It is recommended to talk to local agronomists for chemical advise specific to your soil type and region.

Rolling is recommended post sowing. This does several things, it prepares the paddock for hay or grain harvest and also can improve seed to soil contact, but care should be taken as some tillage systems can push soil back into the seed row, concentrating chemicals over the seed and potentially causing issues if there is good rainfall following.

Growth regulators are becoming more commonly used to control and influence plant development. In Vetch, gibberellic acid (GA) is the most common used. GA elongates the plant cells and stretches the plant out by artificially increasing the natural occurring hormone (gibberellins) in the plant, promoting elongation of plant cells=. The aim of used GA is to increase plant height to facilitate cutting for hay, to promote growth and development after grazing and to delay onset of flowering, which helps to delay the cutting window for hay production. It should not be seen as essential, but as a tool to use in specific situations.

As part of the GRDC investment Southern Pulse Agronomy, SARDI conducted trials in 2020 looking at the interaction between GA and vetch. They found it had a significant impact on plant height for up to 6 weeks after application but did not significantly increase fodder yields and was found to have a negative impact on grain yield (personal comms. Sarah Day), this data has been published in the 2021 Eyre Peninsula Farming Systems Summary and will be loaded to Online Farm Trials (https://www.farmtrials.com.au/).

For GA to work it requires moisture and nutrients to be available and timing of application is vital, particularly when attempting to delay flowering. Application for this must be just prior to the commencement of flowering, there is only anecdotal evidence on the length of the delay to flowering caused by GA, this needs further investigation.

Vetch is not Vetch

There are three different species of vetch grown in Australia, common vetch (Vicia sativa) and woolly pod vetch (*Vicia villosa*) being the two most popular species, and purple vetch (*Vicia benghalensis*) which has a much smaller part of the market. These different species all have different characteristics, need different management and suite different conditions, but all produce good fodder and can return significant amounts of nitrogen to the soil. The hard seed levels of woolly pod vetch and purple vetch should be a major consideration when choosing the species of vetch to sow.

Common vetch (CV)

Varieties include Studenica⍉, Morava⍉, Timok⍉, Volga⍉, Rasina⍉, Blanchefleur and Languedoc. Common vetch is the most widely grown species, predominately grown in low rainfall areas in SA, Vic, WA and NSW, where it is seen as a good, reliable legume option in farming systems. It offers flexibility to the grower and is an excellent tool in a grower's fight against issues like soil borne diseases and herbicide resistant grass weeds, while still offering good returns in the form of fodder/grazing, hay, improved soil nitrogen and organic matter levels.

Common vetches are generally shorter season than the other species (varieties flower between 85 and 115 days) and are more tolerant to grazing. They are palatable at any growth stage, either green or dry, and the grain is a high protein feed (on average 29% crude protein and 12.5MJ/kg DM metabolisable energy) that can be used for all ruminants.

The Australian bred and released varieties Studenica⍉, Morava⍉, Timok⍉, Volga⍉ and Rasina⍉ are all resistant to rust, whereas older varieties like Blanchefleur and Languedoc are highly susceptible to this disease. This is important because rust can drastically reduce yields and may induce abortions in pregnant livestock if they are fed heavily infested plant material.

Management issues to consider

Grow rust resistant varieties whenever possible. In higher rainfall areas monitor for Botrytis symptoms, this disease can greatly reduce yields. In all vetches regrowth after grazing is very dependent on seasonal conditions, good moisture and favourable environmental conditions.

Woolly pod vetch (WPV)

Varieties include Capello⦶, Haymaker⦶, RM 4⦶ and Namoi. These varieties are better suited to medium-high rainfall areas, doing best in regions receiving a minimum of 450mm annual rainfall. All the varieties of WPV flower later than the common vetch varieties, flowering around 125 days after sowing. Regions looking for later hay varieties should consider WPV. They have superior hay yields to CV, on average yielding approximately 1.5t/ha more dry matter in the same environment (yields between 5-12t/ha can be achieved), however grain yields are much lower (0.8t/ha average) and it can be difficult to thresh at harvest.

WPV grows well in mixed crops situations and can tolerate some shading from competition, which makes it a good companion plant in forage mixes. The grain of WPV varieties should not be fed to any livestock, as it contains high levels of toxin and can cause death in ruminants if consumed at high levels. WPV varieties should not be grazed before 15 nodes of growth or after pods have formed seed, due to the toxicity of the grain. There is no data available on what is considered to be safe levels of this grain in a dietary mix. Care should be taken when grazing, as this species is susceptible to over grazing early due to its slower growth through winter.

Management issues to consider

Make sure paddocks are relatively free of broadleaf weeds as there are limited options for control in this crop and WPV is a poor competitor for weeds in early growth stages. Herbicide options are limited for broadleaf weed control, especially in crop. The best option is to use registered herbicides post sowing pre-emergent. Don't graze early (before 15 nodes), ensure you cut hay or graze before pod start to set seed. Be aware this species has hard seeds (RM 4⦶, 5-7%, to Namoi > 30%) and can appear as volunteers in subsequent crops. This species is cross pollinated, and if you are producing or/multiplying seeds from RM 4 which has a low hard seed level, isolate from higher hard seed varieties like Namoi by over 1 km.

Purple vetch (PV)

Varieties include Popany, Benatas and Barloo. This species is similar to WPV or later in flowering time (>125 days) and is suited to medium to high rainfall (>480 mm annual average rainfall) areas with a good finish. PV is a high fodder producer in these higher rainfall areas but is not suited to areas of lower rainfall. PV can tolerate some waterlogging compared to other vetch species, grain cannot be used to feed ruminants but there is a small market as birdseed.

Management issues to consider

Like WPV this species has very slow winter growth and does not compete well with weeds early. One advantage is that Broadstrike® is registered for use in the variety Popany, allowing for control of a range of broadleaf weeds in crop. It should not be grazed before 10 nodes or grazed/cut for hay after pods start to set seed.

For specific details on vetch variety characteristics please refer to the 2021 Crop Sowing Guide relevant to your state or area, these can be found online at:

https://grdc.com.au/resources-and-publications/all-publications/crop-variety-guides

Method

In 2020, four trials were conducted by the NVBP across lower rainfall areas at Werrimull, Koolooonong, Curyo and Speed in Victoria. These trials were designed to include four varieties and eight advanced lines to demonstrate varietal performance and assess the potential of the advanced lines in specific regions. The four trials were individually designed as randomized complete block designs. All trials were assessed for emergence, vigour, time to flowering, dry matter production and grain yield. The trials at Werrimull, Koolooonong and Speed were sampled for dry matter production twice, first in early autumn and again at early flat pods. This was done to assess early grazing potential in mixed farming/livestock systems. The Curyo trial was sampled for dry matter at late flowering/early flat pod. All trials were harvested for grain yield at full maturity.

Table 1. 2020 growing season rainfall (mm) at Speed, Kooloonong, Werrimull and Curyo.

2020	April	May	June	July	August	September	October	Total
Speed	73	32	15	21	39	40	56	276
Kooloonong	50	4	20	2	43	42	71	232
Werrimull	52	14	14	7	43	32	60	222
Curyo								205

Table 2. Biomass yields (tDM/ha) of common vetch varieties and an advanced line at four sites in the Victorian Mallee in 2020.

Variety	Speed		Kooloonong		Werrimull		Curyo
	10-Aug	10-Sep	13-Aug	31-Aug	15-Jul	20-Aug	14-Sep
Morava	3.6	8.3	1.6	3.1	2.6	5.1	3.8
Studenica	3.9	7.3	2.6	3.3	3.7	7.1	4.2
Timok	3.7	8.5	2.3	3.5	3.1	5.5	4.9
Volga	3.4	7.0	2.3	4.0	3.3	6.2	4.5
SA 37107	3.8	9.7	1.9	2.8	3.6	5.3	4.1
Lsd P=0.05	1.83	2.95	1.05	0.79	0.97	1.53	0.69

Table 3. Grain yields (t/ha) of common vetch varieties at four sites in the Victorian Mallee in 2020.

Variety	Speed	Kooloonong	Werrimull	Curyo
Morava	2.2	1.6	2.1	1.8
Studenica	1.7	1.3	2.4	1.7
Timok	2.6	1.9	2.7	1.8
Volga	2.6	1.9	2.4	1.9
SA 37107	2.9	2.0	2.9	2.0
Lsd P=0.05	0.45	0.39	0.51	0.15

Results and discussion

The results above give an excellent example of the regional potential of the released varieties.

Studenica demonstrated its early growth and vigour, showing potential for use as an early fodder production or winter grazing option in mixed farming systems. Studenica has very early flowering and maturity, so does not always suit spring hay production unless sown later.

Biomass cuts conducted at the more traditional hay timing showed the mid maturity varieties, Volga, Timok and SA 37107, have the ability to continue growth through September and increase fodder production. Morava can produce excellent hay yields but requires adequate soil moisture late in the season, in October, to fulfill its potential for fodder production.

Breeding line, SA 37107, is a likely candidate for release in the future. It flowers at a similar time to Timok, as a mid-maturing line and has shown improved adaption to low pH soils, consistently topping trials of both hay and grain at sites with <5.5 pH. SA 37107 achieved hay yields consistent with other varieties across these sites, as well as topping the grain yields across all sites.

With the increase in vetch use across the Mallee areas it is important to choose varieties aligned with your initial end use goals. Time to flowering and maturity are important considerations when targeting specific end uses and will dictate the optimum seeding window. With the increased diversity of maturity in vetch varieties, it is now possible to swap varieties if you can't sow vetch until later in the seeding program or if it is to be the first in the ground. Like other crops, choose varieties with end goals in mind, not as a one size fits all approach. For specific varietal details see the 2021 Victorian Field Crop Sowing Guide.

Conclusion

Vetches have the ability and potential to fit into modern farming rotations in most areas, particularly in mixed farming systems where growers are looking for a versatile break option that still allows for strategic action against specific cropping problems. Unlike pulses and other break crops, the focus is not solely on grain production. Vetch can be used as a tool to combat herbicide resistant grass weeds and still produce a return with hay, grazing or grain and have an impact on subsequent cereals with increased levels of soil nitrogen.

A successful vetch crop can:

- Allow an extended phase of cropping.
- Decrease many cereal diseases – grass-free vetch crops can break the life cycle of root diseases, preventing multiplication and build-up of disease levels
- Provide an opportunity to control grass weeds: Especially in forage use – hay is cut before many grasses set seed providing a chemical free option to combat herbicide resistance, green/brown manuring can be used with vetches to control competitive weeds which are difficult to control in other crops, e.g. brome grass and barley grass.
- Available soil nitrogen is maintained and can be improved by an average of 56, 92 and 145kg/ha after grain, hay and green manuring, respectively (data from three years x five sites) helping to increase grain yield and protein of subsequent cereal and oilseed crops.
- Grain and hay/silage from Common vetch varieties can be used to feed ruminants without limit.

The key to a successful vetch crop and achieving the maximum benefits from vetch is to treat it as a crop, not as a set and forget break option. Inoculate with appropriate rhizobia, control weeds where possible and monitor for insects and disease.

Successfully grown vetch can be an effective risk management tool on farm, allowing for a reduction in fertiliser and chemical use in following crops, reducing costs and the risks involved with in crop nitrogen applications. This can have a significant impact on profitability and the stress levels associated with these decisions.

ⅅ Varieties displaying this symbol beside them are protected under the Plant Breeders Rights Act 1994.

Acknowledgments

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

Useful resources

2021 Crop Sowing Guide (https://grdc.com.au/resources-and-publications/all-publications/crop-variety-guides).

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Notes

Dealing with the Dry

As grain growers across Queensland and New South Wales and parts of Victoria and South Australia continue to be challenged by drought conditions, the GRDC is committed to providing access to practical agronomic advice and support to assist with on-farm decision making during tough times.

Visit our 'Dealing with the Dry' resource page for useful information on agronomy in dry times and tips for planning and being prepared when it does rain.

www.grdc.com.au/dealingwiththedry

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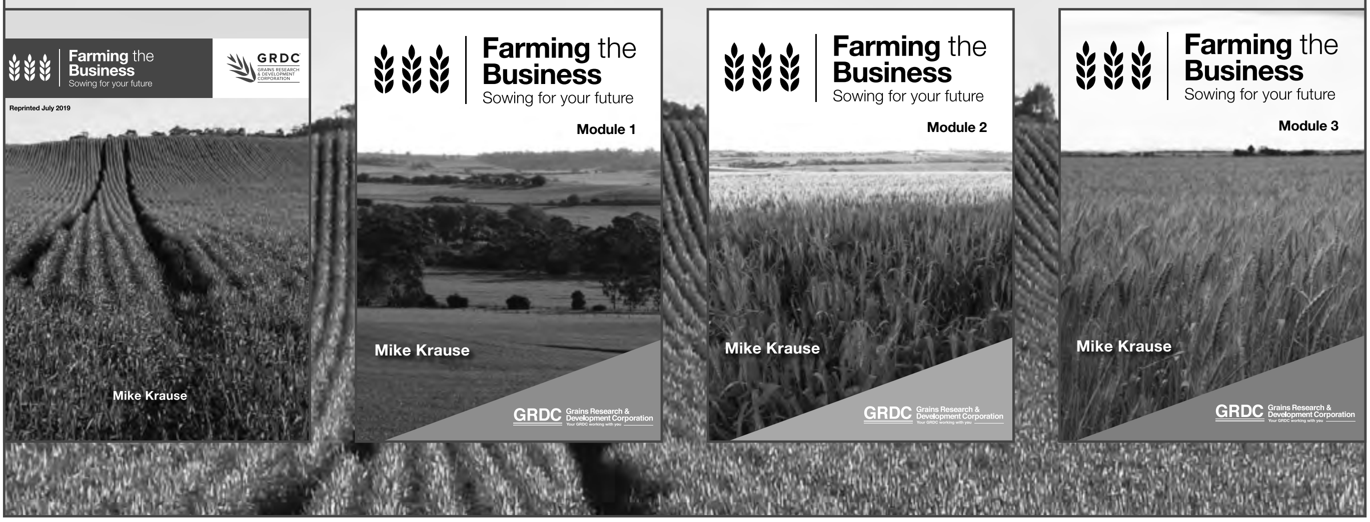

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Overcoming wind erosion during and following drought

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GRDC project code: MSF2010-002SAX

Keywords

- wind erosion, drought, recovery.

Take home messages

- Wind erosion during extended drought periods presents challenges for all growers in maintaining soil cover and stability, with high risk for applying rehabilitation ground works.
- Sands can quickly stabilise with conservation farming practises and reduced grazing, but changes are needed to current benchmarks and strategic management planning to minimise major degradation.
- The practical use of satellite-based monitoring tools are being explored to give growers/advisers more predictive, interactive localised information to make more informed management decisions.

Background

Wind erosion has been a feature of mallee farming landscapes since settlement. The good news is wind erosion has dramatically reduced over the last 20 years with most growers adopting conservation farming techniques. However, extended drought periods reduce a growers' ability to grow and maintain adequate soil cover due to lack of rain and increased pressures from livestock and pest animals. This means that farms are highly vulnerable to wind erosion, often with no easy solutions available due to seasonal unpredictability.

The two key factors that influence wind erosion in the Mallee are:

1. The natural erodibility or susceptibility of the soil.

   Heavy soils contain relatively high levels of fine clays (>20%) which help hold soil particles together to form stable aggregates which reduce the erodibility. They are naturally more fertile and readily grow and retain organic matter in surface layers, which increases biological activity. Bacteria acts like glue within the soil, while fungi also wrap around particles holding them together (Figure 1).

   Most mallee sands have less than 5% clay content and are naturally infertile, with very low water holding capacity, organic matter, and biological activity. This makes them extremely erodible in periods of strong winds. As coarse sand particles bounce along the surface they expose and displace the most fertile portion of the soil – the clay fines and organic matter – which are quickly lost in raised dust. Wind tunnel research has shown that the portion of soil lost can be 5 to 10 times as fertile as the soil from which it has come (Leys, Butler et al. 1993).

2. The protection of soil from erosion hazard influences through farm management.

   Soil protection from wind erosion is achieved by maintaining adequate soil cover and by enhancing soil aggregation. Fifty percent soil cover is used as a general benchmark, but this may vary due to several considerations such as:

   - Anchored cover, particularly with some pulse residues over summer.
   - A higher standing stubble can greatly reduce wind speed at ground level.

- A sandy soil on a rise will require higher cover level than less exposed heavier soils.

When soil aggregation is broken up through cultivation or heavy trafficking by grazing, feral animals or machinery, all soils (including loams and clays) become vulnerable to wind erosion. Conversely, conservation farming practices that encourage high levels of organic matter turnover will greatly increase microbial activity (even within very sandy Mallee soils), binding particles together and provide substantial protection from wind erosion.

Recent extended drought creates significant issues.

Unfortunately, since the wet season of 2016, most mallee districts across the Southern Region experienced 3-4 years of late season breaks, well below average rainfall and low spring rainfall. This made it extremely difficult to achieve adequate soil protection. Initially, on more erodible soil types, such as sandy rises, but also on more loamy flats as the grazing and pest pressures increased. Strong winds sand-blasted crops when seedlings, and the dry springs produced little water for vegetative growth to both protect the soil surface and to feed vital soil microbes.

Repeated years of drought made it difficult to re-establish soil cover, and mechanical rehabilitation strategies such as levelling or even re-sowing areas often lead to further degradation when follow up rainfall didn't eventuate. Small vulnerable areas soon became catalysts for far greater blowouts, often with very few options for remediation and leaving long-term damage.

The severe impacts of wind erosion place our soil resources, the environment, farming businesses and our rural communities under extreme pressure with some irreversible consequences. To address this, the GRDC has invested in a project to identify key knowledge gaps of growers in the SA, NSW and Victorian Mallee and the Upper Eyre Peninsula, developing a series of grower case studies on best practice for soil preservation.

New approaches and management practices need to be adopted to prevent and minimise these impacts from occurring. This project aims to provide practical strategies and solutions for growers within a range of farming systems and low rainfall environments to best protect their farms from soil degradation and rehabilitate land safely back into production.

Method

The project began by conducting a survey across each of the four project districts of Eyre Peninsula, SA, Vic & NSW Mallee, to assess key issues and knowledge gaps regarding wind erosion management through drought periods for growers in the Low Rainfall Zone (LRZ) of the Southern Region. Initial findings based on the 44 grower survey responses and case study grower interviews has helped steer the direction of ongoing project activities.

The project has selected eight growers (two from each district), representing a range of farming systems and situations for in-depth site monitoring of wind erosion rehabilitation and measurement of ground cover satellite data. These are being developed into a series of case studies that will capture:

- The management system and identify the factors that have caused a reduction in ground cover
- The strategies used to re-establish ground cover and the relative success of the strategies
- A measure of the change in ground cover levels over the season and where the trigger points lie for decision making to prevent erosion, including seasonal impacts
- Grower comments and recommendations on the success of each strategy

These case studies will provide growers with easily accessible insights, improved benchmarks, and strategies for overcoming these significant issues in very uncertain times.

Results and discussion

Wind Erosion Survey Report results

Key findings from the initial Wind Erosion Survey Report for GRDC revealed the following:

- The estimated average cost of erosion per grower surveyed was $80,000. The average farm size was 5000ha with an average annual rainfall of 300mm.
- Sandy soil types are the most susceptible to wind erosion through drought periods, accounting for 75% of eroded land according to all growers surveyed, but only 50% of area in NSW.

- Lack of winter and spring rainfall is considered the greatest cause of wind erosion by respondents, alongside strong summer, and autumn winds.
- Erosion was most likely to occur in the second and third year of dry conditions, not so much the first.
- For all the regions surveyed, crop establishment is the main driver for cereal wind erosion issues through dry conditions, followed by management of poor residue areas.
- 75% had livestock in their farming system. Residue/feed management over the summer and autumn months presented the greatest erosion challenges but continued throughout whole drought period.
- Respondents indicate that the four greatest factors contributing to wind erosion are previous blowout areas, cropping vulnerable paddocks then experiencing poor follow up rains, overgrazing and livestock camping on hills/vulnerable areas.
- The most frequently used successful management strategies are no-till/narrow points, confinement feeding, early sowing, establishing specific crop varieties, major soil grading/levelling, reducing stock numbers and reseeding damaged areas. Leaving eroding paddocks out of production generally did not work.
- 64% of respondents indicated that the most challenging factor when trying to manage wind erosion, is a fear of making things worse if the right follow up conditions are not received. The lack of time/labour (43%), appropriate machinery (30%) and financial resources (23%) also feature highly in the challenges faced. Growers also expressed difficulties in knowing what to do (30%), as well as a lack of options that suit their situation (20%).
- Overwhelmingly, respondents use their own visual assessment observations to monitor ground cover levels. Nine percent are using remote sensing and no respondents use paddock measurements (step pointing/ photo standards).

Recommendations to overcome identified knowledge gaps and assist growers in managing wind erosion through drought are:

- New strategies to adequately protect eroding land through drought periods, and to safely restore and rehabilitate eroded land during seasonal, as most current options cannot be achieved without high exposure to risk. These need to be targeted based on the soil and crop types in each region.
- The redefinition of benchmarks for both livestock, crop choices and management decisions that take a longer-term view of the potential for poor outcomes given extended drought periods.
- Practical, accessible, objective assessment tools that support sound and accurate grower decision making for soil cover levels. There may be an opportunity to develop remote sensing tools into interactive applications to monitor and warn growers of impending risks.
- More accurate predictive medium-range seasonal climate forecasts in the low rainfall zone to aid appropriate decision making.
- An improved understanding of how changes to climatic patterns will impact future management strategies and enterprise mixes.
- Adoption of affordable virtual fencing, or other applicable technologies, to mitigate risks of erosion caused by livestock camping on vulnerable areas.
- The impact of kangaroos on soil erosion in NSW has been devastating. Collaborating growers are exploring the implementation of strategic fencing lines to overcome this issue but need support.

Early monitoring findings – Dry Aggregation (%DA) differences – even in sand

Site monitoring has clearly shown the benefits conservation farming can bring to protect these soils against wind erosion. Table 1 shows direct comparisons between the erosion risk of nearby soils with different management practices. While all low erosion risk sites benefited from growing and maintaining ground cover (>49%), retaining stubble and excluding grazing increased %DA of topsoils from 0 to 28-35%. This is a result of increased microbial activity binding particles together.

Table 1. Selected comparable monitoring sites that were all bare and blowing in 2019.					
Adjacent Sandy Sites	Description	Clay %	Dry Aggreg. %	Soil Cover %	Erosion Risk
Nildottie 1	Bare sand blowout	<1.0	0	5	High
Nildottie 2	Medium grazed sandy rise on 2020 Stubble	1.1	10-20	47	Medium
Nildottie 3	No-graze sand, 2020 chicken manure, cross sown, resulting in strong standing stubble	<1.0	28	70	Low
Borrika 2	Bare Sand Blowout after levelling & crop in 2020	2.6	13	22	High
Borrika 1	Strong Stubble after levelling and crop in 2020	1.9	25	62	Low
Cleve 1	Rolling bare sand deposit area	<1.0	4	3	High
Cleve 2	Sand covered with good 2020 cereal rye stubble	<1.0	35	49	Low
Mildura 2	Clayey sand, high grazing burden on 2020 stubble	9.4	19	13	High
Mildura 1	Clayey sand, low grazing pressure on 2020 stubble	8.8	25	63	Low

Livestock producers within this project have said they need to change their benchmarks for how long stock should remain in paddocks, as paddocks need to be managed according to their most vulnerable soil types, taking into account the possibility of extended drought into following seasons. They also expressed the importance of being better prepared with on-farm feed reserves, confinement feeding facilities and being more responsive to managing trigger point areas before wind damage takes hold. These and other important strategies will be further explored, analysed, and reported on through the remainder of the project.

Satellite monitoring tools

One clear finding from the wind erosion survey is that growers aren't using soil cover estimation tools to benchmark estimates but rely on general visual estimations and experience to base their decisions on. More accurate, accessible and locally relevant and warning systems are needed, with links to suitable management strategies.

CSIRO has supported the development of the GEOGLAM RAPP tool that provides regional soil cover maps. The data is currently based on a large 500m pixel size and used to indicate changes between years and present trends and warnings (Figure 2). This can indicate areas that are vulnerable to wind erosion at a given point in time. Figures 3 and 4 show comparative trend lines between different seasons that may be used to gain an early indication of potentially adverse outcomes.

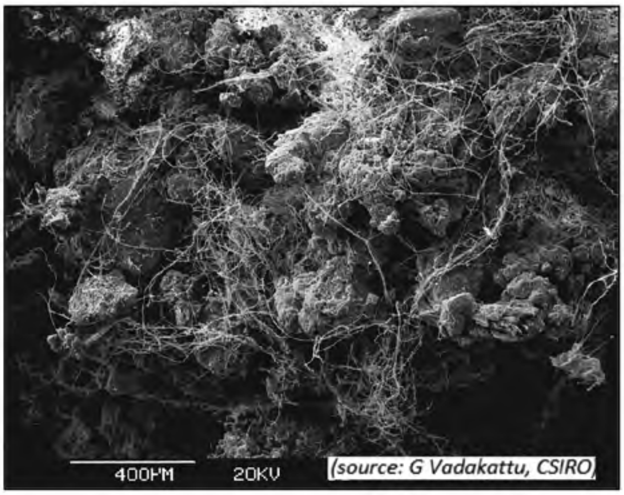

Figure 1. Rapid DA increase in Cleve site sand, with image of fungi binding sandy soil particles together.

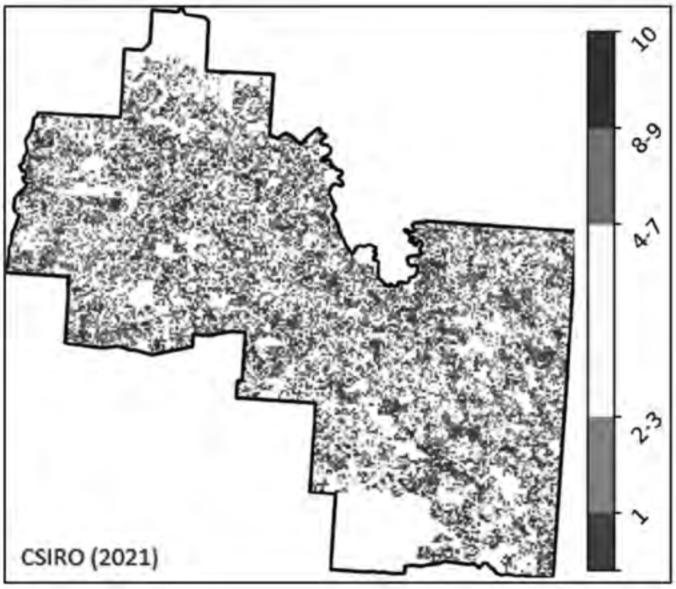

Figure 2. Total Vegetation Cover Decile () map of LGA Loxton Waikerie, June 2021.

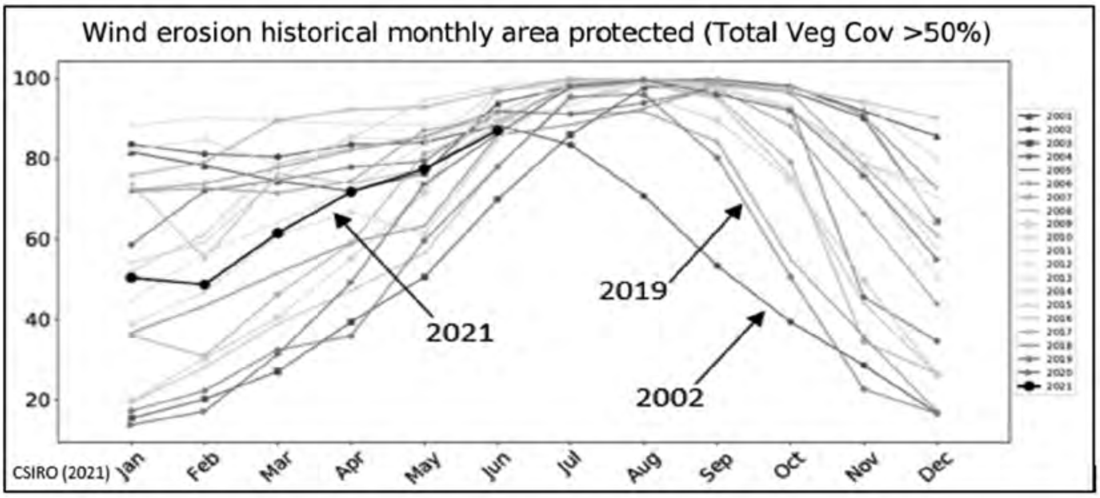

Figure 3. Seasonal comparisons of district average Soil Cover Protection for LGA Loxton Waikerie.

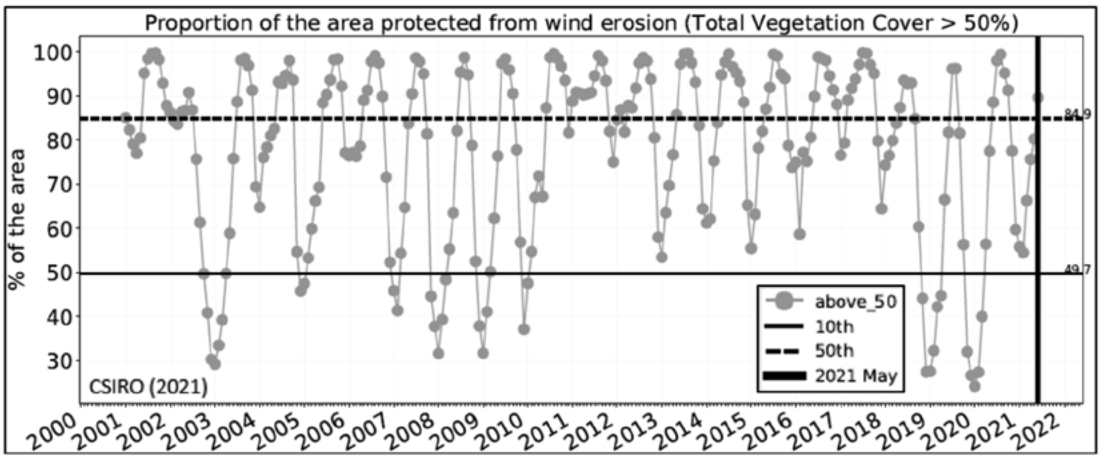

Figure 4. Proportion of areas protected from wind erosion through time. LGA Loxton Waikerie June 2021.

Conclusion

Soil degradation in Mallee environments are a key challenge for growers during extended drought periods. These conditions prevent the conservation of critical soil cover levels and increase the physically damaging impacts of livestock and pest animals. The most challenging factor when trying to manage wind erosion, is a fear of making things worse if the right follow up conditions are not received.

The GRDC project “Practical tactics to improve ground cover and ensure soil preservation following successive low rainfall seasons” with Mallee Sustainable Farming is currently exploring the issues and practical solutions across low rainfall areas in four sub-regions. Over the next year, eight grower case studies will be produced compiling monitoring results and strategies for improving ground cover along with other extension activities.

Acknowledgements

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 and MSF project team, and the author would like to thank them for their continued support.

Useful resources

Schober Case Study Sand Rehabilitation at Borrika Video https://youtu.be/XgFRa1r5r4Q

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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.

GRDC™ GRAINS RESEARCH & DEVELOPMENT CORPORATION

THE 2020-2022 GRDC SOUTHERN REGIONAL PANEL

May 2021

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

CHAIR - JOHN BENNETT

Lawloit, VIC

Based at Lawloit, between Nhill and Kaniva in Victoria's West Wimmera, John and his family run a mixed farming operation across diverse soil types. The farming system is 70 to 80 per cent cropping, with cereals, oilseeds, legumes and hay grown. 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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Andrew is Managing Director and a 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 a 2500ha mixed cropping enterprise south of Rutherglen. Lilliput AG produces wheat, canola, lupin, faba bean, triticale, oats and sub clover for seed and hay. Andrew served on the GRDC's medium rainfall zone RCSN (now National Grower Network) and has held many leadership roles. He holds a Diploma of Rural Business Management and an Advanced Diploma of Agriculture.

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Jon has worked in agriculture for the past three decades, both in the UK and in Australia. He has managed Grainsearch, a grower-funded company evaluating European wheat and barley varieties for the high rainfall zone, and his consultancy managed the commercial contract trials for Southern Farming Systems (SFS). Jon was a member of the GRDC's HRZ (RCSN (now National Grower Network) and became a GRDC Southern Panel member in 2015. In 2020 Jon set up an independent consultancy, TechnCrop Services.

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Lou is a farmer based at Lameroo in the Southern Mallee of South Australia. With her parents and partner, she runs a mixed farming enterprise which includes export oaten hay, wheat, barley, a variety of legumes and a self-replacing Merino flock. Prior to returning to the family farm, Lou had a 10-year agronomy career, servicing the Upper South East and Mallee. She is passionate about her industry, particularly in recognising the role that women play in the industry and on the land.

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Andrew is a research agronomist, based at Port Lincoln on SA's Eyre Peninsula. He started his career with the South Australian Research and Development Institute (SARDI) at the Minnipa Agriculture Centre, and then spent time at CSIRO in Adelaide. Andrew managed the family farm on Lower Eyre Peninsula for 10 years before returning to SARDI in late 2009. In 2019, Andrew started his own research company EPAG Research, delivering applied research across Eyre Peninsula. Andrew received the GRDC Southern Panel's Emerging Leader award in 2018, and prior to joining the Panel he served on the GRDC's low rainfall zone RCSN (now National Grower Network).

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Michael is a third-generation grain grower based at Cummins on South Australia's Eyre Peninsula, where he grows wheat, barley, canola, beans, lupins and lentils on a range of soil types. He has been involved in the South Australian Grains Industry Trust, the Lower Eyre Agricultural Development Association and the South Australian No Till Farmers Association. He believes research and development underpins profitability in Australian farming systems and the GRDC is pivotal in delivering research outcomes that support growers.

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In February 2020 Professor Michelle Watt was appointed the Adrienne Clarke Chair of Botany at the University of Melbourne. From 2015 to 2019, she was Director of the Plant Sciences Institute at the Helmholtz Centre and Professor of Crop Root Physiology at the University of Bonn in Germany. Prior to 2015 Michelle was at CSIRO. She has been in multi-partner projects with Australia, the USA, India, the Philippines, UK and Germany in the under-studied but critical area of plant roots. She is President of the International Society of Root Research and Co-Chair of the Root Phenotyping.

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- Stem nematode
- Blackspot (field peas)
- Yellow leaf spot
- Common root rot
- Pythium clade f
- Charcoal rot
- Ascochyta blight of chickpea
- White grain disorder
- Sclerotinia stem rot

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Acknowledgements

We would like to thank those who have contributed to the successful staging of the Loxton GRDC Grains Research Update:

- The local GRDC Grains Research Update planning committee that includes growers, advisers and GRDC representatives.
- Partnering organisation: Mallee Sustainable Farming (farming systems group)

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Prefer to provide your feedback electronically or 'as you go'? The electronic evaluation form can be accessed by typing the URL address below into your internet browsers:

www.surveymonkey.com/r/LoxtonGRU

To make the process as easy as possible, please follow these points:

- Complete the survey on one device
- One person per device
- You can start and stop the survey whenever you choose, **just click 'Next' to save responses before exiting the survey**. For example, after a session you can complete the relevant questions and then re-access the survey following other sessions.

2021 Loxton GRDC Grains Research Update Evaluation

1. Name [ ]

ORM and/or GRDC has permission to follow me up in regards to post event outcomes

2. How would you describe your main role? *(choose one only)*

- ❑ Grower
- ❑ Agronomic adviser
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- ❑ Communications/extension
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- ❑ Farm input/service provider
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- ❑ Accountant
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- ❑ Student
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Your feedback on the presentations

For each presentation you attended, please rate the content relevance and presentation quality on a scale of 0 to 10 by placing a number in the box (**10 = totally satisfactory, 0 = totally unsatisfactory**).

3. Adapting to dry sowing – long coleoptile wheat: *Greg Rebetzke*

Content relevance [ ] /10 Presentation quality [ ] /10

Have you got any comments on the content or quality of the presentation?

4. Using satellite data and imagery to assess frost damage and enable timely decision making: *Moira Smith and Brian Lynch*

Content relevance [ ] /10 Presentation quality [ ] /10

Have you got any comments on the content or quality of the presentation?

5. Ameliorating sandy soils – strategies to improve productivity: *Therese McBeath*

Content relevance [ ] /10 Presentation quality [ ] /10

Have you got any comments on the content or quality of the presentation?

6. Vetch – getting more from this versatile legume: *Stuart Nagel*

Content relevance [ ] /10 Presentation quality [ ] /10

Have you got any comments on the content or quality of the presentation?

7. Wind erosion recovery – what actions can we take? *Chris McDonough and Brenton Schober*

Content relevance ☐ /10 Presentation quality ☐ /10

Have you got any comments on the content or quality of the presentation?

☐

Your next steps

8. Please describe at least one new strategy you will undertake as a result of attending this Update event

☐

9. What are the first steps you will take?

e.g. seek further information from a presenter, consider a new resource, talk to my network, start a trial in my business

☐

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10. This Update has increased my awareness and knowledge of the latest in grains research

Strongly agree	Agree	Neither agree nor Disagree	Disagree	Strongly disagree
❑	❑	❑	❑	❑

12. Do you have any comments or suggestions to improve the GRDC Update events?

☐

13. Are there any subjects you would like covered in the next Update?

☐

Thank you for your feedback.