Office Use Only	
Project Code	
Project Type	

FINAL REPORT 2022

Applicants must read the *SAGIT Project Funding Guidelines* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be submitted by email to admin@sagit.com.au as a Microsoft Word document in the format shown **within two months** after the completion of the Project Term.

PROJECT CODE	MSF219
PROJECT TITLE (10 words maximum)	
Deep ripping to enhance production on Mallee Sandy Soils	

PROJECT DURATION *These dates **must** be the same as those stated in the Funding Agreement.*			
Project start date	**1/07/2019**		
Project end date	**1/06/2022**		
SAGIT Funding			

PROJECT SUPERVISOR CONTACT DETAILS *(responsible for the overall project)*		
Title:	**First Name:**	**Surname:**
	Tanja	Morgan
Organisation:	**Mallee Sustainable Farming Inc**	
ACN / ABN:	**99 557 839 332**	
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Telephone:		**Email:**
Mobile:		

ADMINISTRATION CONTACT DETAILS *(responsible for all administrative matters relating to project)*		
Title:	**First Name:**	**Surname:**
	Tanja	Morgan
Organisation:	**Mallee Sustainable Farming Inc**	
Mailing address:	**PO Box 11 Jabuk SA 5301**	
Telephone:		**Email:**
Mobile:		

PROJECT REPORT: *Please provide a clear description for each of the following:*

Executive Summary (200 words maximum)

A few paragraphs covering what was discovered, written in a manner that is easily understood and relevant to SA growers. A number of key dot points should be included which can be used in SAGIT communication programs.

This project has highlighted several opportunities for farmers to maximize the benefits from deep ripping sandy soils in the Mallee region. An important consideration is to optimize the setup of deep rippers to achieve adequate soil loosing across the width of the machine. In this project this was achieved by ripping to a depth of at least 45 cm and having tynes spaced 50 – 75 cm apart. Fitting wings to the tyne was also an efficient way to increase the width of soil loosened by each tyne while minimizing additional power requirements.

The greatest benefits from deep ripping are achieved when soil loosening is maximized. If deep ripping tynes are spaced too far apart then soil between the tyne is not loosened and therefore the crop response will not be uniform across the ripped area. This effect can often be seen in paddocks where rip lines are distinctive in the crop or can be seen in a wavey pattern that develops across the crop.

Topsoil burial using inclusion plates enhanced the yield benefit over using only a standard straight leg tyne. The addition of organic amendments such as chicken litter also increased the yield benefit, however the magnitude of the grain yield increase was dependent on the level of incorporation. Therefore, in the low rainfall zone high levels of incorporation are required to maximise the benefit from the addition of organic material and this may require the use of spading or active inclusion techniques.

Trafficability post ripping is a major constraint to implementation on a commercial scale. Seeding and spraying operations are particularly affected which can lead to problems such as poor establishment, machinery damage and in some circumstances soil erosion. Rolling to consolidate the soil can aid in improving post ripping trafficability and can help to maintain seeding depth and prevent excessive soil throw during seeding.

Project objectives

A concise statement of the aims of the project in outcome terms should be provided.

The aims of this project were to increase productivity and groundcover on the Mallee regions deep sandy soils (sand dunes) by increasing adoption of deep ripping.

The project established 5 deep ripping demonstration sites over a three year period with progressive farmers/ early adopters and in collaboration with industry experts to demonstrate regionally relevant research and enhance awareness, knowledge and skills in the wider community.

Virtual tours and field days were developed to support the extension and adoption of demonstration findings and showcase best practice principles of deep ripping.

Overall Performance

A concise statement indicating the extent to which the project objectives were achieved, a list of personnel who participated in the Research Project including co-operators, and any difficulties encountered and the reasons for these difficulties.

The project successfully established all trial demonstrations with leading growers to develop farm ready recommendations for growers. Main difficulties encountered were COVID related issues which required a trial to be established on the Victorian side of the border so that research staff could continue to manage and monitor the site during restrictions.

Michael Moodie was also unable to attend several field days due to border closures.

Key contributors to the project were – Michael Moodie and technical staff from Frontier Farming Systems, Tanja Morgan – Extension and Communication and Chris Saunders and Jack Desbiolles UniSA for technical input.

Farmer contributors – Wade & Chad Nickolls - Pinnaroo, Michael Lange - Woodleigh, James Stephens - Younghusband.

KEY PERFORMANCE INDICATORS (KPI)

*Please indicate whether KPIs were achieved. The KPIs **must** be the same as those stated in the Application for Funding and a brief explanation provided as to how they were achieved or why they were not achieved.*

KPI	Achieved	If not achieved, please state reason.
Establish one farmer deep ripping demo with a leading farmer	Yes ☒ No ☐	
Conduct one field day event at the ripping site	Yes ☒ No ☐	
Develop a virtual reality trial site tour of the deep ripping site	Yes ☒ No ☐	
Establish two deep ripping demos with leading farmers	Yes ☒ No ☐	
Conduct one field day event at one ripping site	Yes ☒ No ☐	
Develop a virtual reality trial site tour of the deep ripping site	Yes ☒ No ☐	
Establish two deep ripping demos with leading farmers	Yes ☒ No ☐	
Conduct one field day event at one ripping site	Yes ☒ No ☐	
Develop a best practice guide for deep ripping	Yes ☒ No ☐	

TECHNICAL INFORMATION (Not to exceed **three** pages)

Provide sufficient data and short clear statements of outcomes.

Technical information has been summarized in the deep ripping guide developed by the project.

This project has made significant contributions to Mallee farmers capacity to maximize the benefits from deep ripping sandy soils in the Mallee.

The first part of this project quantified how deep ripping operations loosen the soil profile. This knowledge is important to assist farmers to optimize deep ripping setups such as tyne spacings and operational depth to achieve the most cost-effective outcome. This work collaborated with the University of South Australia. At the 400 mm working depth, a straight leg tyne loosened a cross sectional area of 0.26 m^2, however the loosened area was doubled (0.44 m^2) by increasing the ripping depth to 600mm. The project investigated how the

addition of wings to the deep ripping tyne improved soil loosening. The addition of the wing increased loosened area by 49% to 53% when the operating depth was 400mm and 600mm, respectively (Figure 1). At the deeper working depth, the addition of the wing improved ripping efficiency with soil loosening increased by ~50%, while the additional draught force increased by only 24%.

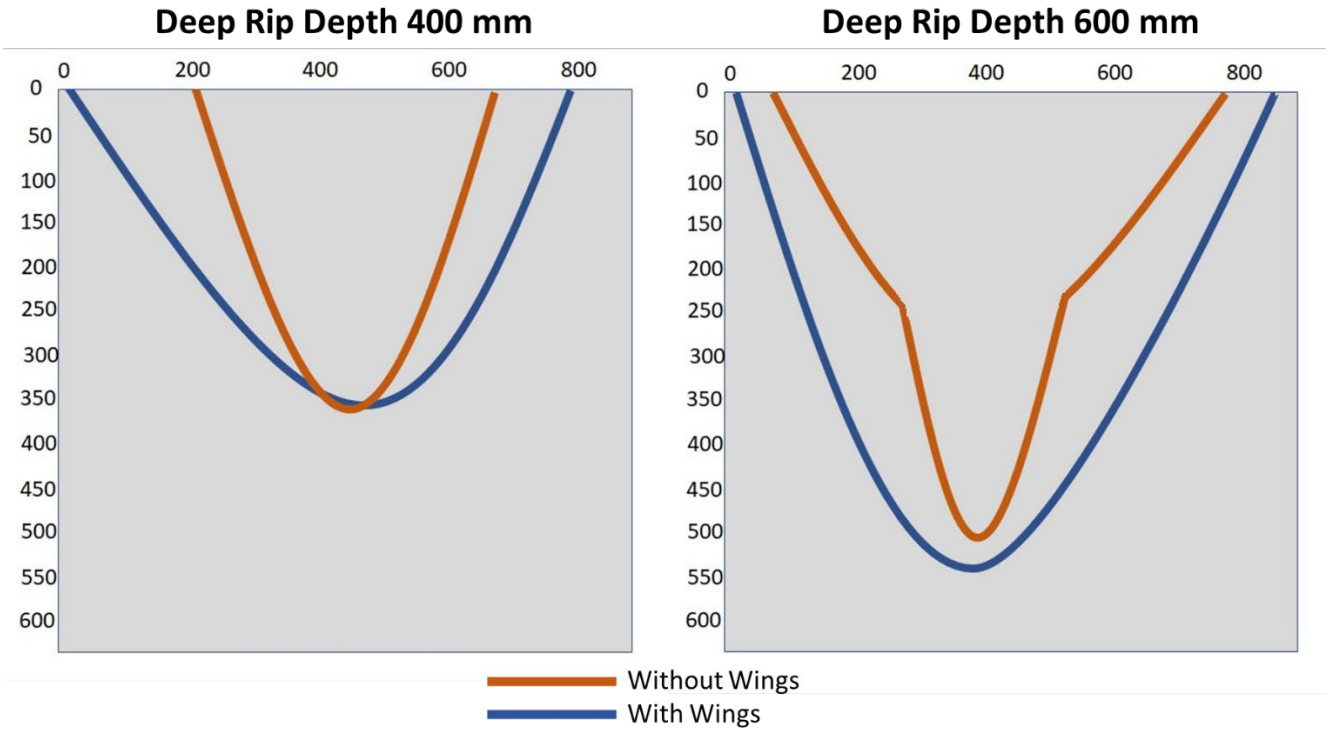

Figure 1. Cross section of loosened soil area for tynes working at 400 mm and 600 mm depth, with and without wings.

The second element of this project was to quantify the impact of soil loosening on crop yield. The first trial site in Caliph (2019) experienced a severe drought with only 100mm of rainfall received at the site for the growing season, and a yield benefit of 0.6 t/ha was observed in the treatments with the highest level of soil loosening. This was achieved by tynes operating at 600 mm depth with a tyne spacing of 0.8 m or less. Where ripping was shallower or tyne spacing was very wide there was no significant benefit from deep ripping.

This research was followed up with a new trial site at Woodleigh in 2020 where a wider range of tyne spacings x ripping depths were investigated. The soil was deep ripped to a depth of 30, 45 or 60 cm with tynes spaced at 0.5 m, 0.75 m or 1 m apart. All ripping treatments were implemented with a Tilco shank tyne however an additional treatment was included where an experimental wing was fitted to the foot of the tyne. Wing treatments were ripped to a depth of 45 cm only.

There were four replicates of each treatment arranged in a randomized block design. The ripping strips were implemented in plots 50 m in length with each treatment plot 4 m apart which provided an un-ripped area between ripped plots which were used for control plots.

A barley yield benefit of 1.2 t/ha was achieved by ripping to a depth of 45 or 60 cm with a tyne spacing of 0.5 m (Figure 2a). This yield benefit could be maintained at a spacing of 0.75 cm only if the soil was ripped to 60 cm or wings were fitted when ripping at 45 cm. All other configurations led to smaller yield benefits, including all treatment which were ripped at 1 m row spacing.

Second year benefits were measured in the subsequent wheat crop in 2021 (Figure 2b). Plots were re-located using RTK receiver and autosteer fitted to the plot harvester. The best treatments which led to yield responses of 50-60 % in 2020 produced a second-year yield benefit of 15-17 %. Furthermore, the ranking of treatments was consistent across seasons so that the highest yielding treatments in 2020 were again the best yielding treatments in 2021.

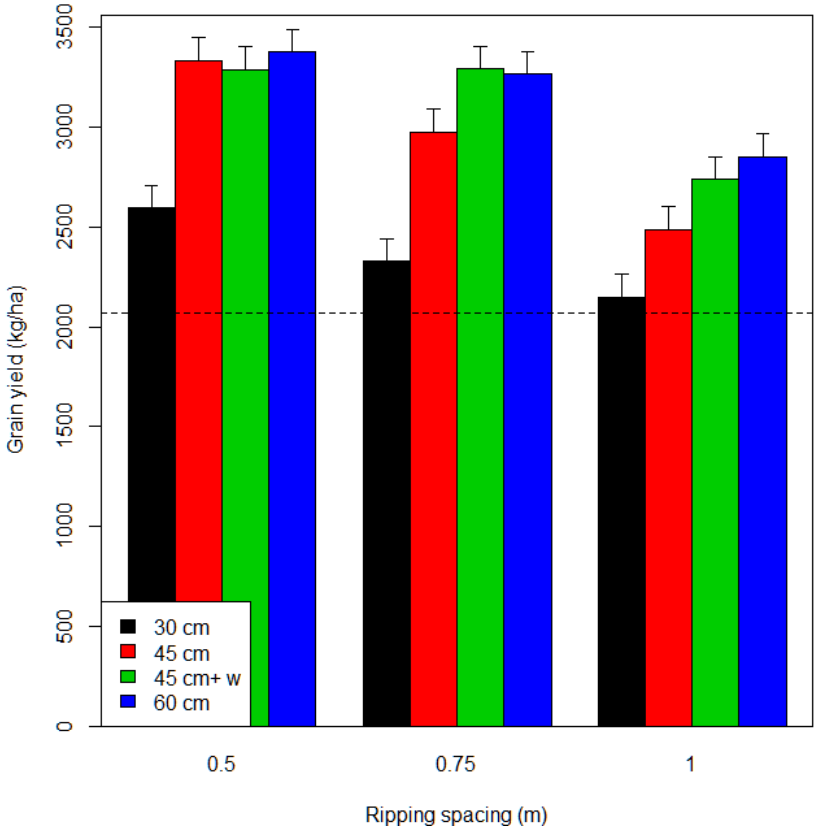

Figure 2a: Grain yield for each depth x tyne spacing combination at Woodleigh in 2021. The control treatment yielded 2072 kg/ha which is shown by the dotted line. Error bars are standard error. The Fischer protected LSD ($p<0.05$) was 228 kg/ha

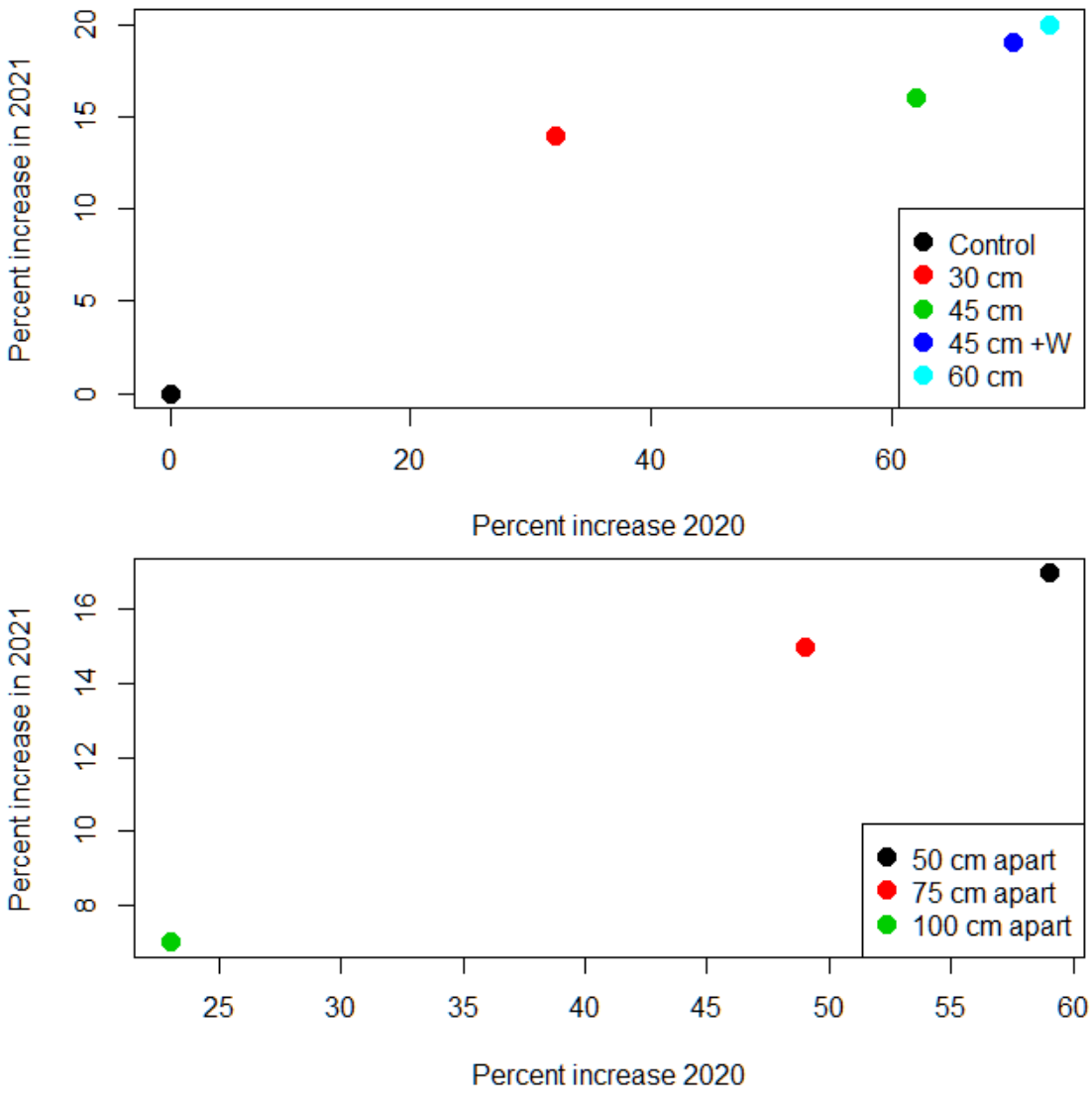

Figure 1b. Graphical comparison of effect of ripping depth and ripping spacing in 2020 compared with 2021.

A site was established at Younghusband in 2021 to evaluate if the addition of organic amendment (chicken litter) can enhance the benefits of deep ripping. We also looked at whether using inclusion plates to increase mixing and incorporation of topsoil and amendments improved the outcome of deep ripping operations. Ten treatments which combined soil amelioration with organic inputs (Table 1) were implemented in a randomized block design with four replicates. Plots were 1.68 m wide and 40 m long.

SOIL AMELIORATION	ORGANIC INPUT (CHICKEN LITTER @ 5 T/HA)
None	❖ Nil ❖ Surface Spread
None + SE14 Soil Wetter	❖ Nil
Spading	❖ Nil ❖ Surface Spread
Deep Ripping	❖ Nil ❖ Surface Spread
Deep Ripping with Inclusion plates	❖ Nil ❖ Surface Spread

- ❖ Direct Injected behind inclusion plate

Without intervention, the grain yield of barley at the site was very low at with less than 1 t/ha of grain production (Figure 3). Deep ripping to 50 cm vastly improved grain yield with a mean grain yield of 3 t/ha across all deep ripping treatments. Deep ripping produced 0.5 t/ha more grain yield than spading (2.5 t/ha). The addition of inclusion plates did not statistically improve yield over deep ripping without plates, however they were beneficial when organic inputs were also applied. Deep ripping with inclusion plates enhanced the yield benefit from surface applied chicken litter where deep ripping alone did not provide a significant improvement (Figure 4). Furthermore using the inclusion plates to direct inject organic matter during the deep ripping operation provided higher grain yield than where chicken litter was surface applied and incorporated with passive inclusion (Figure 5)

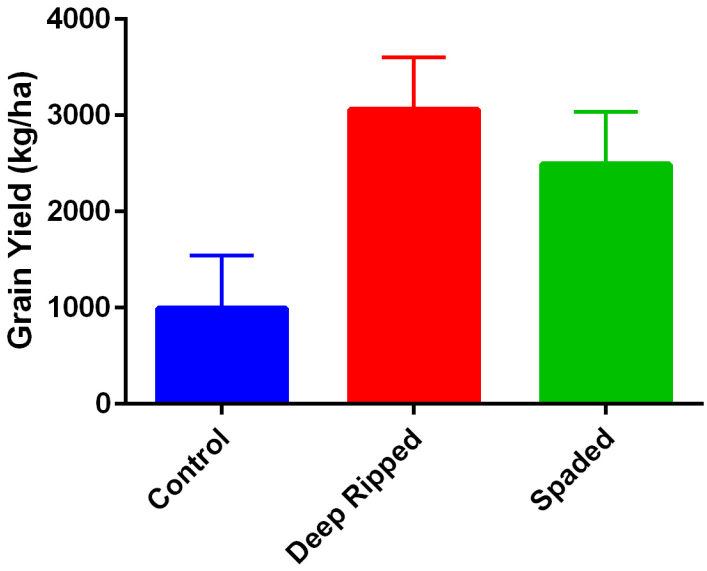

Figure 3. Mean barley yield of control, deep ripped and spaded treatments at Younghusband in 2021. Error bars represent Least Significant Difference.

The application of 5 t/ha of chicken litter to the soil surface increased the yield of all treatments. The control yield increased by 0.25 t/ha, the deep ripped yield by 0.56 t/ha and deep ripped with inclusion plates 0.7 t/ha. The inclusion plate treatment relied on passive inclusion of the chicken litter that was spread on the surface prior to deep ripping, therefore there was most likely incomplete mixing of the chicken litter. However, a second inclusion plate treatment where the chicken litter was directed injected during the ripping operation provided complete burial of the chicken litter and this provided a yield benefit of 1.5 t/ha. Spading was also included in the trial for comparison of a high level of soil mixing. Spading mixed and loosened the top 30 cm of soil, and this provided a yield benefit of 1.4 t/ha. A further one 1 t/ha yield benefit was achieved when chicken litter was mixed into the soil by the spading operation.

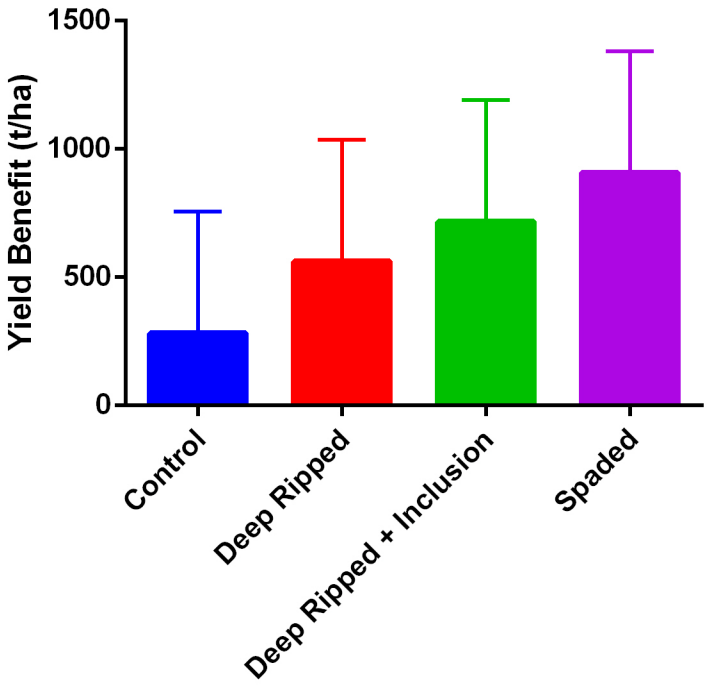

Figure 4: Additional grain yield achieved from the surface application of chicken litter at 5 t/ha prior to soil amelioration treatment. Error bars represent Least Significant Difference.

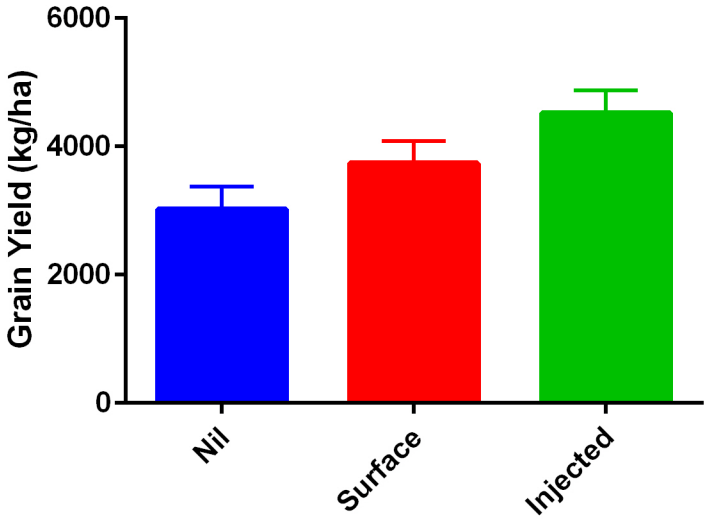

Figure 5. Effect of organic matter on plant grain yield in deep ripped plots with inclusion plates. Error bars represent Least Significant Difference.

The final element of the research investigated solutions to improve paddock trafficability post ripping which is a major constraint to the implementation of deep ripping on a commercial scale. Seeding and spraying operations are particularly affected which can lead to problems such as poor establishment, machinery damage and in some circumstances soil erosion.

A trial conducted near Pinnaroo in 2020 compared two different deep rippers (Hanton and Sharrad ripper fitted with straight shanked Tilco tyne and a Williamson Agri ripper fitter with curved Michel tynes) and rolling on trafficability, seed depth, crop establishment and yield. The trial was sown commercially by the collaborating farmer using a Horwood Bagshaw PSS system.

Trafficability was measured by driving a Landcruiser ute across the surface immediately prior to seeding and then measuring the depth of the ruts left by the tyres (Figure 6). The depth of

rut was measured in 8 locations for each plot. Un-ripped treatments had shallow ruts of 40-50 mm but were 120 mm following deep ripping with both types of deep ripper. Consolidating the ripped surface with a roller reduced rut depth by 50%. Wheat seeds from un-ripped and ripped plus rolled treatments emerged from 20-30 mm depth while ripped treatments without rolling emerged from 50 mm for the curved Michel tine and 60 mm for the Tilco straight leg tyne (Figure 7).

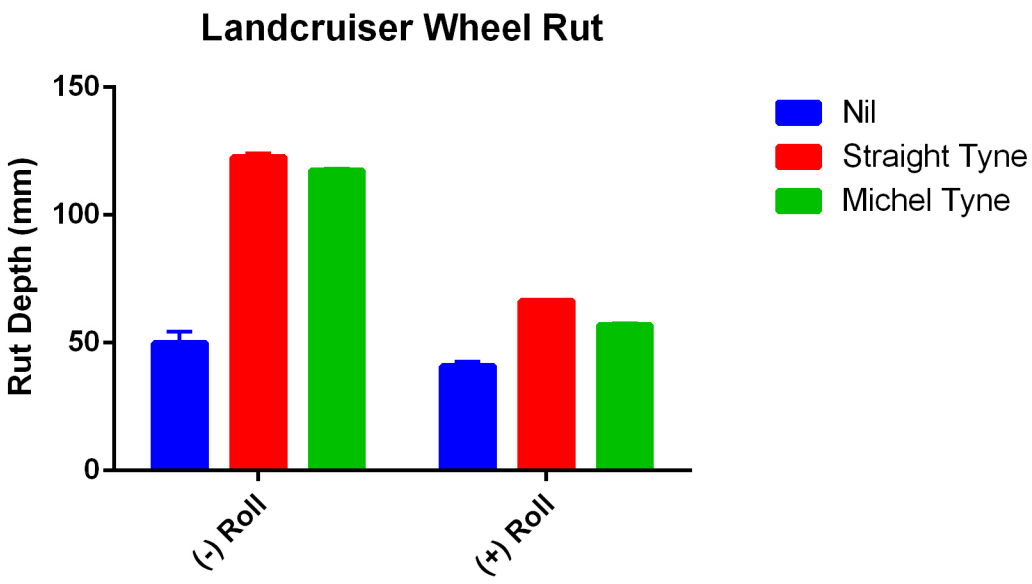

Figure 6. Depth of wheel rut of a Landcruiser ute driven across each treatment immediately prior to seeding. Error bars are the Standard Error of the Mean)

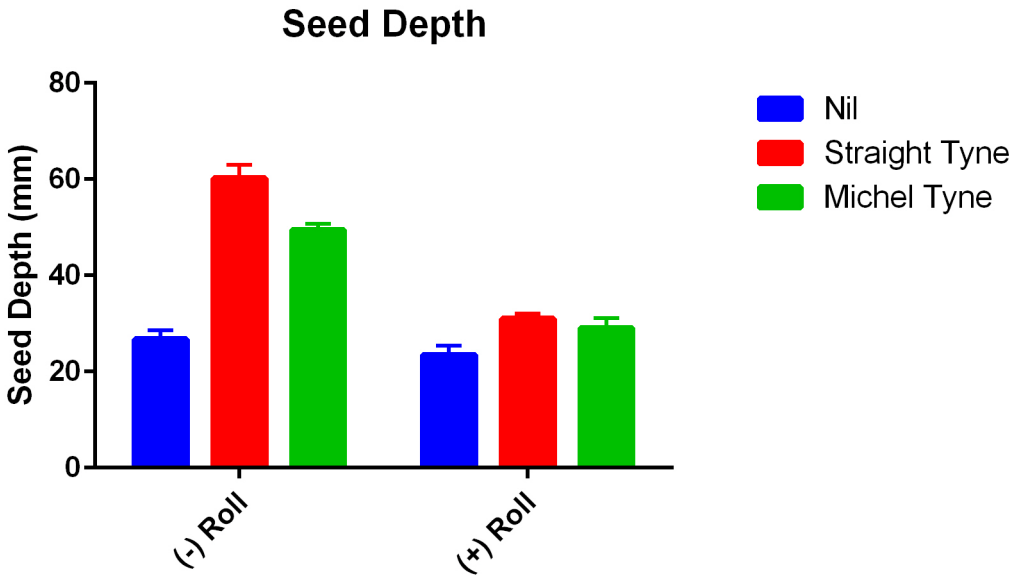

Figure 7. The depth of seedling emergence for each treatment. Error bars are the Standard Error of the Mean

The position of the tyne on the bar also affected the seed depth (Figure 8). Where tynes at the back of the seeding bar work excessively deep, they may throw soil onto adjacent rows sown with tines from the front of the bar. This will increase the depth at which the seeds need to emerge from and may also carry pre-emergent herbicides into the seed row. In this trial seeds were germinating from 75 mm depth from rows sown with the front tyne but only

from 45 mm when sown with a back tyne. This effect resulted in a 16% decrease in wheat establishment and reduced early vigour of the deep sown rows.

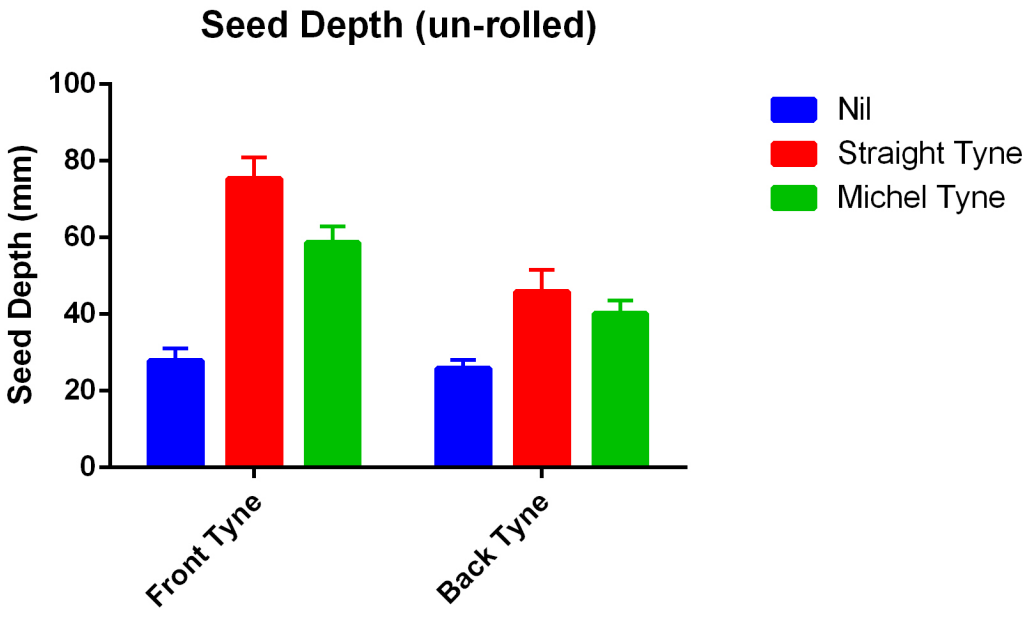

Figure 8. The depth of seedling emergence for plants sown with tynes located on the front or back of the seeder bar in the treatments without rolling. Error bars are the Standard Error of the Mean

CONCLUSIONS REACHED &/OR DISCOVERIES MADE (Not to exceed one page)

Please provide concise statement of any conclusions reached &/or discoveries made.

Several opportunities have been highlighted for farmers to maximise the benefits from deep ripping sandy soils in the Mallee region:

- Ensure complete soil loosening across the ripping zone: Ripping tynes need to be close enough to ensure complete soil loosening across the width of the deep ripper. Leaving soil undisturbed between ripping will diminish the yield benefit achieved by deep ripping.
- Improve ripping efficiency by fitting wings: Wing can increase the zone of soil loosened by the ripper tyne. They could be an efficient method of increasing soil loosening as 50% more soil was loosened while the corresponding increase in draught force was approximately 25%.
- Organic amendments need thorough incorporation: Materials such as chicken litter need to be incorporated to maximise the benefit in the low rainfall zone. The use of spading or active inclusion was more effective than passive inclusion of surface applied chicken litter.
- Rolling improves trafficability: Rolling to consolidate the soil can aid in improving post ripping trafficability. Consolidating the soil surface is important to help maintain seeding depth and prevent excessive soil throw during seeding.

INTELLECTUAL PROPERTY

Please provide concise statement of any intellectual property generated and potential for commercialisation.

NA

APPLICATION / COMMUNICATION OF RESULTS

A concise statement describing activities undertaken to communicate the results of the project to the grains industry. This should include:

- *Main findings of the project in a dot point form suitable for use in communications to farmers;*
- *A statement of potential industry impact*
- *Publications and extension articles delivered as part of the project; and,*
- *Suggested path to market for the results including barriers to adoption.*

Note that SAGIT may directly extend information from Final reports to growers. If applicable, attach a list of published material.

In summary the following extension activities were developed and delivered.

- 6 Videos
- 2 Virtual Tours
- 13 Social media posts
- 7 Mallee Research Updates – 201 attendees
- 5 Field Walks 165 attendees
- Guide to deep ripping

MSF has a Managing Mallee Soils interactive Facebook group that was established with support from the FRRR Future Drought Fund to help promote best practice soil amelioration work. SAGIT project results have been promoted through this group during Autumn. The group has a following of 347 members

https://www.facebook.com/groups/managingmalleesoils

The main extension messages have been summarized in the fact sheet. Once approved by SAGIT for release we will promote this fact sheet through the Managing Mallee Soils group and main social media platforms.

2021 social media posts

https://fb.watch/exF6bnbg_S/

https://fb.watch/exF7cUL7-t/

https://fb.watch/exFai04B8N/

https://www.facebook.com/MSFMallee/posts/pfbid02RrfkZY3SuwQhV3ihvppsz2P9Eoesr47EPe9h1j64ZyZNzVVuo4AsDTVuFiwG3ndRl

https://www.facebook.com/MSFMallee/photos/a.120011081400049/4276188199115629

https://www.facebook.com/MSFMallee/posts/pfbid0XufuoNJMy5nVGLgbJv2TTm6h82Y42bHxdE96kbhcNDpPj1QoVK7TnCv4WU313sigl

POSSIBLE FUTURE WORK

Provide possible future directions for the research arising from the project including potential for further work and partnerships.

The next phase of this work will be delivered through the GRDC investment Optimising Soil Amelioration Costs in Typical Mallee Soils project - Project code: MSF2201-001SAX