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SOUTH AUSTRALIAN DROUGHT RESILIENCE ADOPTION AND INNOVATION HUB

Exploring the use of strip and disc systems on Eyre Peninsula to improve drought resilience

A needs analysis for the barriers to adoption of strip and disc systems on Eyre Peninsula

FINAL REPORT

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Contents

Executive Summary

Improving farming systems drought resilience is a key priority for growers on the Eyre Peninsula (EP). With many growers located in low to medium-rainfall zones (LRZ / MRZ), maximising water use is essential. Growers, advisers, researchers and farming systems groups continue to innovate in this region and are always exploring new farming practices and tactics to help retain stored soil moisture and improve productivity and profitability.

The use of the 'Strip and Disc' system has been around for about 20 years, with many growers in higher rainfall zones reporting benefits. Several early adopter EP farmers are experimenting with strip and disc in medium and low rainfall environments. This adoption was driven by the aspiration of better retaining soil moisture at sowing (achieved through less soil disturbance and retained stubble) which can enable earlier sowing. Adoption was also driven by the ability to have narrower row spacing which assists in weed control; direct seeding; improved stubble residue retention; and the potential ability of the stripper front to use less fuel and go slightly faster at harvest compared to a draper front, due to it not needing to process the volume of straw.

A workshop was held at Rudall in February 2024 to explore the use of strip and disc systems on the EP to improve drought resilience. It considered how the system could be used to minimise soil disturbance, conserve more soil moisture, and potentially improve yield in water limited seasons. Areas of future investment in research, development and extension activities for strip and disc systems were also identified. Information from the workshop and follow up activities was used to develop a Needs Analysis for the barriers to adopting strip and disc systems on Eyre Peninsula.

Guest speakers at the workshop, Kelvin Tiller (a grower from Pinery), Michael Brougham (an agronomist with Elders), and Paul Bammann (a farmer from the Eyre Peninsula) were keynote presenters at the workshop. Speakers openly discussed the pros and cons of their adoption journey, noting that they had to make significant changes to their farming system and approach to ensure it suited their soils, rotations, weed and disease management and overall growing region. They also noted that they went on the journey with their agronomist and invested in their own trials to test chemical control on small areas prior to wider implementation. They have been committed to learning, maintaining and refining the systems and continually seek new research to hone their program.

While there were a range of benefits reported with the system, there were also some risks and challenges. For example, the system is reported to have higher maintenance; there can be hair pinning of stubble; challenges with seed-soil contact; challenges with pests as the higher stubbles provide an ideal habitat to thrive/hide; and fewer pre-emergent herbicide options. Some also raised issues with hard panning through compaction; poor seed placement in damp conditions; the potential for reduced herbicide efficacy due to spraying into standing stubbles; and the potential for establishment issues with herbicide toxicity (as there is less soil throw/disturbance with discs). Challenges were also reported with the stripper front not performing as well (grain loss) in low rainfall / low yielding (less than 2.5 tonne per hectare or low biomass) years where plants are shorter, indicating some potential engineering modification needs for the LRZ. The cost of adopting the new system was also considered a barrier, especially in today's market where machinery costs are high, and there is limited stock in the second-hand market. Concerns were also raised around frost management.

Feedback from grower stakeholders at the workshop, and in follow up calls, suggests that there are significant knowledge and research gaps which are impacting their adoption of the system. They acknowledged that AIR EP and SARDI / MAC have some trials looking at stubble heights, plant establishment, weeds, moisture and spray efficacy which are of great interest and value to

the region. Participants shared their own learnings, knowledge gaps and concerns with barriers to adoption. They also stated they are keen to be engaged in the ongoing extension of the findings. However, more research and knowledge are sought to guide adoption and investments.

Growers and advisers reported that more research on moisture, weeds, herbicide packages and engineering is needed. For example, growers are seeking research to establish the actual stored moisture saving from strip and disc systems on the EP, considering groundcover, stubble height, row spacing, soil type and rotations, noting this would build on the trials conducted at Cleve, Buckleboo and Minnipa conducted by AIR EP, BFIG and SARDI MAC (AIR EP, 2023). They would also like to better understand crop establishment timing (whether they establish earlier) and evaporation rates due to higher stubble loads. Growers want to see a comparison between soil moisture measurements at harvest and pre-sowing as well as the germination / establishment and vigour of a disc versus a tyne system.

Another priority identified by workshop and survey participants was the need for an economic analysis of the strip and disc system to help guide grower's decisions before they invest. They expressed a need for an economic analysis to review and compare costs (including machinery, repairs, maintenance, time, human resources, pest / weed / disease management) against return on investment through moisture, time saving, yield increases and efficiencies over a five-year period in the local EP setting.

Coincidentally, as part of this project one of the project partners (Pinion Advisory) conducted an economic analysis of strip and disc systems. The analysis indicated:

- Upfront costs will be situational depending on farm size and value of purchased machinery.
- Benefits are hard to conclude from existing research and are unlikely to be across every hectare due to variations in existing stubble cover. It is also difficult to put an accurate assessment on how much moisture is saved by using a disc seeder and the reduced soil disturbance at sowing.
- The main benefits will likely be on a smaller portion of the farm that requires additional effort to maintain stubble cover.
- Variations in machinery performance will be situational depending on yield and the performance of previously owned machinery relative to new machinery (e.g. 18 m bar vs new 12 m disc).
- The main differences between the two seeding systems are in the capital invested, width, operating speed, repairs and maintenance costs. The repairs and maintenance costs are higher due to the additional moving parts in a disc seeder compared to a tyne seeder.

Overall, this Needs Analysis identifies the risks and opportunities faced by growers using strip and disc systems on the upper Eyre Peninsula to improve their drought resilience. The analysis considers feedback from a range of farmers and agronomists, and presents the pros and cons, plus the knowledge and research gaps which should be considered to guide adoption decisions on the Eyre Peninsula. The initial findings of the economic analysis and insights into the considerations needed to guide further adoption are also presented.

Background

A workshop held in August 2021 at Wudinna by the South Australian Drought Resilience Adoption and Innovation Hub (SA Drought Hub) identified strip and disc strategies as a priority topic for the Minnipa Node, which covers the upper Eyre Peninsula. The workshop was attended by growers, industry organisations, farmer groups, researchers and community members who stated that more information on the system was needed.

Three SA Drought Hub strip and disc demonstration sites were implemented during the 2022 and 2023 seasons. There was a high level of interest in the system at grower sticky beak days in 2022, which visited several farmers using these systems.

A workshop was held at Rudall in February 2024 to explore the use of strip and disc systems on the EP to improve drought resilience. It worked to identify areas of future investment in research, development and extension activities for strip and disc farming and considered how the system could be used to minimise soil disturbance, conserve more soil moisture, and potentially improve yield in water limited seasons.

Guest speakers at the workshop Kelvin Tiller (a grower from Pinery), Michael Brougham (an agronomist with Elders) and Paul Bammann (a growers from Eyre Peninsula) shared their experiences implementing the system and some of the pros and cons they had found. The speakers also shared their learnings regarding disc seeding set up (depth and force), row spacing, herbicide control options, pest management and stripper front set up (height, weed seed control and speed). These findings have been captured in this report and represent a range of important factors for growers and advisers to consider. It was evident from this workshop that while there is a lot of interest in the new system, there are many questions regarding the costs (machinery purchasing and maintenance), pros and cons, and implementation of the strip and disc systems in low-rainfall zones. Knowledge and research gaps have been captured, as this represents future areas for RD&E investment to help guide growers' decision making.

We sincerely thank and acknowledge Kelvin, Michael and Paul for sharing their learnings as it provides the foundations for this report. It is important to note that this report is based on the concept of shared learnings. Some of the learnings are anecdotal and are based on individual experiences and systems. Anyone wanting to adopt the system will need to weigh up the pros and cons relevant to their region, rainfall, machinery type and farming system. Individual advice should be sought.

Objectives and scope

The findings from this workshop have been combined with grower consultation and an informal desk top analysis to develop this needs analysis for adoption of strip and disc farming systems in the low-rainfall environment of the upper EP. The aims of the needs analysis are to:

- Identify the benefits, risks and knowledge gaps of adopting the strip and disc system.
- Identify opportunities for activities across research, development and extension to assist in informing the adoption of strip and disc farming systems on the upper EP.
- Inform the development of strategic communication outputs which detail the potential risks and benefits of adopting strip and disc farming systems to improve drought resilience, ultimately increasing grower awareness.

Note that the project also includes an objective of increasing awareness of the GRDC National Risk Management Initiative (NRMI).

Adopting the strip and disc system on the EP

The 'strip and disc' system, refers to the use of a disc seeding system for better seed placement in a stubble retention system, combined with a stripper header, which generally works to take the grains out of the head of the plant, leaving the plant residues standing. This system is gaining interest from growers on EP. While some growers have adopted, many are hesitant as there are range of knowledge gaps.

Growers have indicated they are interested and motivated to learn more about the system as they are interested in the potential of the system to help:

- Retain stubble, which can improve conservation of water, and decrease soil temperature. It can also reduce soil disturbance, which in turn reduce the impacts of water and wind erosion.
- Establish crops on less rainfall, which is particularly relevant to growers in the LRZ.
- Edge row sow in non-wetting or saline country.
- Sow into stubbles on narrower row spacings.
- Sow earlier, which offers greater flexibility in the seeding system.
- Improve weed management through narrower row spacings, which can improve crop competition with weeds.
- Improve harvest efficiency through less plant material passing through the harvester.
- Cut the straw after harvest and sell.
- Improve their overall drought resilience and water use efficiency.

Improving the drought resilience of their farming system was a key priority for participants at a strip and disc workshop held at Rudall in February 2024. With many participants located in low to medium-rainfall systems, maximising water use is essential. Guest speakers Kelvin Tiller, Mick Brougham and Paul Bamman explained that one of their primary reasons for adopting the system was due to the benefits of retaining stubble, which can improve rainfall infiltration into the soil and boost the plant available water supply. This means the seed has access to more water to germinate, while the increased moisture holding capacity of the soil means it can carry plants through to spring if the season dries out. They reported that the use of a disc seeder has helped them to improve their seeding program, allowing them to sow into moisture on-time.

Speakers and participants shared their experiences with the strip and disc system, and provided insights into equipment, maintenance and operation tips, benefits, challenges and economic considerations. They also shared their knowledge and research gaps.

Facilitated discussions and individual phone surveys were also conducted to further gauge feedback from growers on the strip and disc system. The findings of this consultation are presented in this report and form the basis for the next steps in implementing strip and disc systems on the Eyre Peninsula.

Disc seeding

The following insights were provided by workshop presenters and participants who have adopted disc seeding systems, and through individual grower consultation. Insights were provided on equipment, maintenance, operating tips and benefits and challenges of using a disc seeder. The information provided is gathered from farming systems on the Adelaide Plains and Eyre Peninsula and as such may not be relevant to all farming systems.

DISC SEEDERS

Those growers who have adopted disc seeders noted they were selected due to their ability to place seeds directly into a tilled furrow with minimal soil or residue disturbance. The system can ensure more precise seed placement (direct seeding) and consistent seeding depth, depending on soil type, speed and equipment set up. The disc system also allows higher operating speeds and narrow row spacings for growers who are keen to sow into systems with high stubble / residue loads.

EQUIPMENT AND MACHINERY

Disc seeders come with various configurations, including single, double or triple discs, which cut through residue to create a slot for the seed and fertiliser. Firming wheels that press seeds down within the slot and furrow closing/crumbler wheels that collapse the sidewalls of the furrow are used to improve soil to seed contact. Strip-till equipment usually consists of coulters, row cleaners, and shanks to create a tilled strip that provides a good seedbed.

MAINTENANCE CONSIDERATIONS

Growers recognised that ongoing maintenance is a must and reported that maintenance costs can be higher in disc seeding systems. The following issues must be closely managed:

- Discs must be maintained so they remain sharp and cut through stubbles and soil.
- New discs will need to be purchased each season (or season and a half), noting greater wear and tear on stony/rocky soils.
- Ongoing maintenance and testing are needed for gauge wheels, firming wheels, residue managers (note that we refer to Aricks wheels in this document as this is brand which was utilised by the speaker, it is not an endorsement) and crumbler wheels to ensure they are not throwing soil.

SHARED LEARNINGS – OPERATIONS

The following tips were shared to get the most out of the system.

- FORCE: There is a need to carefully manage downward force on-the-go, to ensure even and adequate soil penetration by disc seeders.
- SOWING SPEED: Growers who use the system suggest that they can operate at 10-11 kilometres an hour, which is faster than a tyne system. This can result in time and labour efficiencies over the seeding window. It was noted that driver comfort and maintenance work well at this speed, but trial and monitoring is needed regarding soil types.
- SEEDING DEPTH: Optimal seeding depth differs for varieties, however some aim for cereals at 30-40mm as part of their crop safety approach for residue risks. Lentils might be sown at 60-70mm but can emerge from 120-130mm. Seeding depth is an important tool for crop safety if not using residue managers (e.g. Aricks wheels). Soil type and penetration issues need to be assessed when making this decision.
- ASSESS SOIL VARIABILITY: Soil type can influence seeder stability for inter-row sowing.

- CONSIDER SEEDER FRAME WEIGHT: One grower reported the need to have about four tonnes of weight on the seeder frame, saying that if there was no weight there were issues penetrating areas with high soil strength or compaction. There was also some floatation of the unit. This variation needs to be managed across a paddock.
- RESIDUES: The disc seeder does not move herbicides out of the way like tyne seeders (less soil throw), meaning it remains close to the seed. The disc can also push straw and chaff into the slot, causing what is known as hair pinning which negatively impacts germination/establishment.
- USE OF CLOSING WHEELS: Lots of different furrow closing wheels can be used for different situations / conditions to cover the slot (seed) following the disc. These should be selected considering soil type and conditions. i.e. the Martin-Till wheel was selected by Kelvin as it is generally robust and suitable for a wide spectrum of conditions. In clay soils there can be surface sealing if using a smooth closing wheel, the Martin-Till wheel can prevent this.
- RESIDUE MANAGERS: The use of residue managers (such as Aricks wheels) can also increase herbicide safety and reduce hair pinning by pushing residue aside (to the inter-row away from the disc). The use of such wheels needs careful evaluation as their effectiveness is based on stubble height, soil type and speed. Straw can ball up if there is too much stubble (i.e. the Aricks wheels can get in the way and cause a blockage) so it is important to monitor residue levels carefully.
- TIME OF SOWING: Carefully consider the time of sowing to ensure sowing into dry stubbles. Sowing into damp or wet stubbles can result in hair pinning.
- ASSESS SOWING SPEED CAREFULLY: It was noted that the faster they sow the more wear and tear there is on disc machines. For Kelvin sowing speed of 10-10.5km/hour was set based on maintenance rather than stubble flow. Note that different discs and equipment have different speeds ranging from 8 to 15km/hour and these should be evaluated in each system and in each machine.
- DOUBLE SHOOT TECHNOLOGIES: Growers questioned if any discs are running double shoots. It was commented that most single disc minimal disturbance systems are not generally running double shoot system (whereas many tynes are running this).
- FERTILISER RATES: Fertiliser toxicity is a risk with disc seeders (minimal disturbance or single disc systems). Common practice is to use lower fertiliser rates to avoid toxicity for example, Kelvin is running 50-80 kg/ha of DAP.

SHARED LEARNINGS - PERCEIVED BENEFITS

- Helps maintain soil cover, which can reduce erosion.
- Helps retain soil moisture at sowing, which is beneficial in low-rainfall systems.
- Extra moisture can reduce production risk i.e. earlier sowing opportunities.
- Increased seeding speed (as the ground is not being fractured), can reduce risks and costs, and allows more seeding to be done within the optimum sowing window.
- Does not generate clods at the surface like tynes can.
- Can have narrower row spacing, which helps weed management through a more competitive canopy.
- Retaining stubble seems to improve crop germination rates on saline soils.

- Can help with milk thistle management due to the increased coverage on the ground which stops them germinating.

SHARED LEARNINGS - PERCEIVED CHALLENGES

- Can require more maintenance than tyne systems, with replacement of parts cited as one of the key issues.
- Lack of access to herbicide packages and fewer pre-emergent herbicide options due to the lack of soil disturbance. Ability to separate the seed from the herbicide is an issue.
    - Many herbicides are not registered for use in disc sowing systems.
    - There are minimal pre-emergent choices i.e. the choice of IBS (incorporated by sowing) herbicides is limited so can become reliant on PSPE (post-sowing pre-emergent) options. This means growers may be more reliant on weather events (rainfall to incorporate) and miss opportunities.
    - Seek advice from your agronomist or adviser and always follow the label rates.
- Hair pinning of stubble, especially when sowing into damp stubbles. Time of sowing is an important consideration.
- Blockages if clumps of residue are left after harvest.
- Insect pressure can be higher, and they can be more difficult to manage.
- Can cause soil movement depending on the disc or the residue manager. This needs to be tested in individual systems as it can depend on the soil type and speed.
- Can cause some hard panning due to compaction. Need to consider how to manage this over time. If the soil is sticky at sowing, there can be delays.
- Rocky and stony soils cause extra wear and tear, so keep an eye on the discs. Some reported having to get new discs each season.
- Time of sowing needs to be considered because in damp or wet conditions there can be placement and penetration issues with discs and residues.
- There is the potential for fertiliser toxicity, especially in dry years, so seed and fertiliser separation need to be considered.
- There can be some risks of Rhizoctonia, which may require some periodic tillage or rotation consideration. Research is needed to review this in the EP strip and disc system.

COST CONSIDERATIONS

- Growers questioned the costs associated with the increased maintenance costs vs efficiency gains from earlier sowing (and retained moisture) and increased harvest efficiency. However, no formal economic analysis has been done on these assumptions. Growers are seeking an economic assessment to better inform purchasing decisions.
- Growers would like to better understand the maintenance costs.
- Some farmers noted that they might need to have both a disc and a tyne seeder to ensure they can cover their farm variability as well as seasons or situations when a disc will not work.

- Growers also commented that they still need a draper front for pulse/break crops. For example, one grower only uses the stripper front only for cereals. He tested the stripper front on canola and lasted around 100 m before reverting back to the draper front. He commented that the stripper front is good in most scenarios but constantly requires adjustment. He also noted it can be challenging in short barley, as it can pull dirt into the sample which is problematic at delivery point at times.
- There was also discussion about sowing lentils with a tyne seeder and needing to harvest with a draper front and not stripper front.
- One grower commented that he finds the stripper front challenging in yields of less than 2.5t/ha (low biomass crops), with the main factor impacting harvesting success being the height of the plant. Lower plant heights tend to be challenging.

Stripper fronts

Stripper fronts are specific headers (or header fronts) that have been adopted due to their ability to strip the grain from the heads while leaving most of the plant residue/stubble standing. They are also utilised by growers keen to achieve harvest efficiencies (increased ground speed and low fuel use).

The following insights on the use of stripper fronts were gathered from workshop participants and grower consultation.

STRIPPER FRONT EQUIPMENT

The stripper header / stripper front has a rotating stripping rotor, with rows of stripping fingers that strip the grain or seed from the crop.

MAINTENANCE CONSIDERATIONS

Growers reported that the maintenance of the stripper front was minimal but noted that the rig is rigid and does not float like a flex front. This can cause some issues in undulating country, where the front does not pick up as well on the ends. It was noted that the new models have springs which offer more float and guidance.

SHARED LEARNINGS – OPERATIONS

Once yields drop below 2-2.5t/ha, some growers have reported that the stripper front can start losing grain and effectiveness. This could be a significant issue in the LRZ where lighter crops are more common.

SHARED LEARNINGS - PERCEIVED BENEFITS

- SPEED: Some growers report that they can increase their harvest speeds, as the stripper only processes the grain not the straw. This allows more ground to be covered in a given timeframe, improving overall harvest efficiency and reducing risk by harvesting in the optimal window. However, in a low yielding environment, this may not hold true (see grain loss section, in a LRZ a draper front may be more efficient).
- OVERALL EFFICIENCY: Less hours on headers, less fuel consumption and getting the crop off quicker.
- LESS CHAFF: In comparison to the draper front, which can cause large amounts of chaff to be left on the soil surface, the stripper front leaves less chaff. Too much chaff can present a challenge as discs can struggle to cut through, and chaff can be pushed into the slot which can reduce crop establishment.

- SNAIL MANAGEMENT: Anecdotal evidence suggests that stripper fronts can help manage snails in cereal crops as they tend to get belted off by the front, which reduces snail numbers and contamination in the grain sample. Kelvin thought it may also crack the shells, killing the snails and helping reduce numbers, but does not have concrete evidence on this, suggesting it is an area of future research.

SHARED LEARNINGS – PERCEIVED CHALLENGES

- GRAIN LOSS: Some growers reported grain loss at harvest through the stripper front, especially in low yielding years (below 2.5t/ha) where tillers/plants are short. A few growers commented on the need to have a draper and stripper front to suit different years.
- SET UP: It can take a while to hone the set-up, and it requires a lot of trial and error. Drop trays are required to test harvester set-up and ongoing review is necessary.
- INCREASED FIRE RISK: Fire risk is heightened due to the increased standing stubble load. Being prepared for a fire, including having the right equipment on hand, is essential.
- HOOD HEIGHT: Some growers reported that they need to carefully manage the height of the hood on the stripper front, so it does not snap plant heads off. They would like to see the length of the hood reviewed (and potentially doubled).
- TWO FRONTS: Some report that their end goal is stubble management, so they have two fronts, the stripper front for harvest and then the additional draper front for managing the stubble load (which runs closer to the ground). This is an additional capital expense, and it requires two passes.
- HARVEST WEED SEED CONTROL: Growers were concerned that HWSC is not economical and the efficacy of this in a strip and disc system is largely unknown. It may also slow the system down and require more horsepower. They are seeking trials and extension to inform and guide decisions on this.
- WHEEL TRACKS IN THE SYSTEM: Wheel tracks can become an issue at seeding time, so where you strip and lay the wheel tracks if you come back against the direction of travel it can create an issue blocking up the seeder.
- CAPITAL OUTLAY: There seems to be more costs associated with machinery, but growers feel they are getting this money back through efficiency (fuel, speed, getting out to harvest quicker). However, this is only anecdotal and needs to be properly validated.
- SOWING EQUIPMENT NEEDED TO HANDLE STUBBLE: An appropriate disc system is required which can handle high stubble loads on an ongoing basis.

Overall system pros and cons

As well as risks and benefits observed with the individual components of the system, speakers and participants reported a range of risks and benefits of the whole strip and disc system. It should be noted that these risks and benefits are not a 'one size fits all'. Feedback suggests that each strip and disc system is different and how it fits into a farming system is dependent on soil types, climate zone, rotation, topography etc. Growers need to consider these factors when making their decision.

PERCEIVED BENEFITS

- IMPROVED SOIL: Overall improvement in soil health and structure through better soil organic matter retention and reduced erosion. No hard calculations were provided. A yield benefit through cover on the hills was common feedback. This requires validation.
- YIELD INCREASE: One of the workshop presenters reported they had achieved yield increases since 2011, and partially attributes this to the strip and disc system. He noted that they also changed other variables in the farming system and had made some variety changes, so there were many variables which may have impacted this.
- IMPROVED EFFICIENCIES: Efficiency gains in labour and time, some fuel reduction through efficiency gains were also discussed through going faster at seeding and harvest (however these were not validated). Noting that discs don't go to the width of tyne seeders, so there may not be much saving – it is not a straightforward calculation.
- ABILITY TO HARVEST EARLIER: Growers reported that in general, they were able to commence harvest earlier in the day after a rain event, as the straw thatch minimised the sticky dirt.
- OVERALL IMPROVEMENT IN SOIL MOSITURE: While growers were unable to provide 'hard' numbers, they reported better soil moisture in the strip and disc system, which enabled them to get crops established earlier. They noted that there also seemed to be reduced evaporation due to higher stubble loads.
- LESS DUST: Sprayer speed and efficiency can be maintained and there is generally less dust.

PERCEIVED CHALLENGES

- INITIAL CAPITAL INVESTMENT: The capital outlay for equipment, coupled with the trial and error of honing the system, was reported as a barrier for some.
- AVAILABILITY OF EQUIPMENT: Some were concerned about manufacturers being able to meet the demand for equipment and then providing the technical support (repairs, maintenance, servicing).
- SPECIALIST KNOWLEDGE: The system requires a lot of specialised knowledge and trial and error. There needs to be a commitment to on-farm trials, constant testing and monitoring to get the gear working efficiently.
- FROST: Systems with stubble retention can increase the risk of frost. The thatch of straw means the sun (solar radiation) cannot heat the soil up during the day and cannot give heat back to the canopy. This means it is colder and results in higher frost impact. Participants are seeking trials which compare different systems.
- DISEASE: There is a concern that the system will increase the risk of some diseases, such as Rhizoctonia. It was noted that growers need to consider a range of management tactics to

control disease in the system and are seeking updates on this. Queries included the levels of stubble borne disease in the system and the best tactics to manage these, plus more insights into what happens with wheat rust in straw. More information was also needed on the management of Septoria tritici blotch and powdery mildew.

- LONG-TERM STRAW MANAGEMENT: Some reported that disc seeders can block up with straw in the third year of adopting the system and wanted to understand the long-term straw management approach to minimise stubble issues and reduce the stubble load. They are keen to minimise stubble issues at seeding. It was noted that some GRDC research says 5 t/ha stubbles are when the issues start to occur, but problems have occurred for some even after two years of stripper front straw. Observations suggest the stripper straw gets brittle and can rot at the crown, this is what blocks the discs. It can also impact the use of residue managers such as Aricks wheels.
- HERBICIDE PACKAGES:
    - A limitation to the system is the availability of herbicide packages. Growers are concerned that there are no registered chemicals specifically for disc systems and note that this is due to every disc system being different.
    - Some discussed that they feel Boxer Gold® (applied ahead of the seeder) has been quite safe in the disc system even without Aricks wheels. However, it was stressed that growers must do their own trials to assess safety at a small scale before spraying whole paddocks. Some do hand boom trials and compare different approaches.
    - Some noted that applying Boxer Gold® or Sakura® PSPE can work well.
    - The use of Overwatch® and Callisto® needs to be reviewed.
- CROP SAFETY: The issue of residues such as Lontrel® was a concern. Some noted that chemical can be retained in wheat stubble. If a large load is retained it does not break down and can last for approximately five years.
- PESTS: Growers report that they see more slaters, earwigs and millipedes in their strip and disc system and feel it is harder to both monitor and manage. This is considered a significant knowledge gap, as growers do not know what to do to manage these pests effectively and there are no chemicals registered for control. Research is needed, especially if chlorpyrifos is going to be deregistered.
- MICE: Paul presented on his challenges with mice in the strip and disc system, providing an example of his canola on wheat stubble, where a large amount of wheat was left on the ground. He found differences in the paddock when reapt using a draper front (less affected by mice) and chaser bin tracks. A learning reported was that to manage this better he would have used 50 mg of bait behind the header / air seeder. Kelvin uses a “baiter” on the seeder so while sowing they are baiting so it is all done in one pass. Their evidence suggests that the best time to bait is at the same time as seeding, so when you disturb the rodent’s habitat they will go and forage that evening which improves rodent control. Other growers shared their experience as follows:
    - One stated they need to bait at least three times with the 25 mg baits to manage populations.
    - Some are buying in sheep to control / reduce mouse populations – bury food, move the soil, stress the populations.

Integration of livestock into the system

SHEEP / LIVESTOCK MANAGEMENT – Kelvin emphasised the need for producers with livestock to monitor the paddock conditions prior to deciding when to sow using disc vs tynes (e.g. compaction, weed management, moisture).

CONTROL/REDUCE MOUSE POPULATIONS – Some growers are buying in sheep to control / reduce mouse populations to help bury food sources, move the soil, stress the populations.

STOCK GRAZING – growers observed sheep avoided sections of paddocks harvested with the stripper front. Unsure as to whether they had an issue with the texture of the stubble but could be an opportunity to keep stock away from sand hills, bare ground to reduce erosion/drift etc.

Tips

Given the range of benefits and challenges of the system, the speakers and growers provided some key learnings which should be considered when making the decision to adopt:

- Growers should be prepared to relearn their farming system. Carefully assess the move, considering how to manage sowing time, residues, weeds, pests and diseases.
- Conduct small trials on-farm prior to purchasing equipment. Borrow or lease equipment and work with an agronomist, researcher or farming systems group to trial the system along with different herbicide packages and pest and disease management options.

Economic analysis

With growers indicating that understanding costs and economics is a barrier to adopting the strip and disc system, the team from Pinion Advisory conducted an economic analysis of the system.

The basis for the economic analysis considered that the aims of implementing a strip and disc system are usually based on improving stubble cover on lighter soil types and consequently improving moisture retention. The system can also improve operational logistics by increasing operating speed at seeding and harvest, providing the seeder/harvester is the limitation on work rate. Therefore, the economic modelling and analysis worked to assess the investment in additional plant and equipment relative to the proposed agronomic/economic gains. The economic modelling includes the following additional costs to implement a strip and disc system:

- Upfront investment in a disc seeder and a stripper front.
- Upfront nitrogen requirements due to increased amounts of retained stubble.
- Ongoing herbicide costs due to limitations of pre-emergent applications.
- Mice control due to increased stubble cover.
- Changes in machinery running costs such as fuel, labour, repairs and maintenance.

This was then compared to various yield benefits due to variations in the additional stored soil moisture.

Several elements that were raised by growers have been excluded from the modelling due to difficulty in defining values, or because they are very situational. This includes variations in results during practical implementation, frost and operational timeliness.

The initial implementation of the strip and disc system will likely have some teething issues. The resulting financial performance will likely be less than the budgeted uplift in the initial few years, before increasing once the system is established. Anecdotal responses indicate the transition to a strip and disc system is “like learning to farm again”. Therefore, it is reasonable to expect a delay in the expected benefit, but to what extent is unclear.

The impact of frost has been left out of the modelling. Whilst previous research has indicated that a higher stubble load increases the severity and duration of a frost, it also indicated that landscape plays a greater role. Therefore, it has been left out of the modelling due to being highly situational.

The impact of seeding and harvest timeliness benefits have also been left out, again due to being very situational in impact. Whilst disc seeders can operate at faster speeds resulting in a higher work rate (hectares/hour), this benefit may be reduced by either the previous tyne machine being wider, or the disc seeder not operating at all hours of the day due to moisture limitations on trafficability. If there was potential for yield improvement through improved time of sowing, then it could be due to other limitations on work rate that won’t necessarily be fixed by purchasing a disc seeder. The opportunity for improvements in harvest timeliness is more realistic in higher yielding crops where a draper front would be travelling <12km/hour. However, it is likely that the supporting equipment/logistics would become the limitation on the increased number of tonnes reapt per hour.

The benefits of a strip and disc system largely depend on how much additional moisture can be stored. This is often going to be focused on particular areas, such as lighter soil types that currently struggle to produce and retain enough ground cover over summer. The use of a disc seeder with less soil disturbance than a tyne should also help increase the amount of soil

moisture retained. The overall benefit needs to be assessed relative to the cost across all hectares.

The following table shows the impact of additional soil moisture stored on the zones with potential for improvement, which is then averaged across the entire farm to create an average plant available water (PAW) improvement.

Average soil moisture (mm) increase		Percentage of total farm area improved									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Additional soil moisture (mm) on the improved area	2.5	0.3	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5
	5	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	7.5	0.8	1.5	2.3	3.0	3.8	4.5	5.3	6.0	6.8	7.5
	10	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
	12.5	1.3	2.5	3.8	5.0	6.3	7.5	8.8	10.0	11.3	12.5
	15	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
	17.5	1.8	3.5	5.3	7.0	8.8	10.5	12.3	14.0	15.8	17.5
	20	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
	22.5	2.3	4.5	6.8	9.0	11.3	13.5	15.8	18.0	20.3	22.5
	25	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0

Assuming the additional moisture stored results in additional yield, an increase in income can be expected. The following table outlines the average uplift in income across the rotation with the additional moisture. It assumes a set yield increase for each additional millimetre of moisture stored.

	Percentage of total rotation	Price $/t	Yield increase with increased moisture kg/ha/mm	Income increase with increased moisture $/ha/mm
Wheat	40%	$325	14	$4.55
Barley	30%	$280	14	$3.92
Lentils	30%	$700	5	$3.50
Average over the rotation				$4.05

Income ($/ha) increase		Percentage of total farm area improved									
		10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Additional soil moisture (mm) on the improved area	2.5	$1	$2	$3	$4	$5	$6	$7	$8	$9	$10
	5	$2	$4	$6	$8	$10	$12	$14	$16	$18	$20
	7.5	$3	$6	$9	$12	$15	$18	$21	$24	$27	$30
	10	$4	$8	$12	$16	$20	$24	$28	$32	$36	$40
	12.5	$5	$10	$15	$20	$25	$30	$35	$40	$46	$51
	15	$6	$12	$18	$24	$30	$36	$42	$49	$55	$61
	17.5	$7	$14	$21	$28	$35	$42	$50	$57	$64	$71
	20	$8	$16	$24	$32	$40	$49	$57	$65	$73	$81
	22.5	$9	$18	$27	$36	$46	$55	$64	$73	$82	$91
	25	$10	$20	$30	$40	$51	$61	$71	$81	$91	$101

Conventional systems that maintain stubbles and minimise soil disturbance are unlikely to see a significant increase in moisture retention by switching to a strip and disc system. If there is an increase, then it is also unlikely that it will be across all areas uniformly.

The upfront costs in shifting to the system include the purchase of a stripper front, disc seeder and additional nitrogen to account for the increased immobilisation in the first year. Potentially there may be an opportunity to sell the tyne seeder and the conventional draper front. However, most growers utilising this system have kept either their tyne seeder and/or draper front for the following reasons:

- Tyne seeder wasn't worth much anyway (was already due for changeover) so it provided a good back up without tying up too much capital.
- The tyne seeder can provide additional pre-emergent herbicide options once in the rotation. This is normally following a pulse where sowing into high stubble loads is less of an issue.
- Still required the draper front for other crop types such as lentils and canola.

The upfront costs will vary a lot between different businesses due to differences in scale and whether they're buying a new or second-hand machine. There are also plenty of options for different style disc machines which add to cost variability. The requirement for additional nitrogen will also vary considerably and potentially could be required over multiple years depending on how much stubble is retained.

The following modelling assumes a 2,500ha farm in a low to medium rainfall cropping district (approx. 2.5t/ha average wheat yield).

Item	Assumptions	Total
Stripper front	Second-hand	$100,000
Disc seeder	Second-hand	$270,000
Additional Nitrogen	2.5t/ha additional stubble, 5kg of N/t stubble, 2500 ha and $700/t for urea.	$47,554
Sale of tyne seeder		-$150,000
Total upfront costs		**$267,554**
Total upfront costs per hectare		$107.02

When comparing the cost of seeding operations, the following points have been kept constant between a conventional system and a strip and disc system:

- 76% of tractors annual hours used for seeding.
- Tractor and air cart depreciation of $12,829 p.a.
- Tractor and air cart interest costs of $14,342 p.a. at an interest rate of 7%.
- 2,500 hectares sown
- Fuel usage of 50 litres/hour at a cost of $1.80/litre
- Labour at $40/hour

The main differences between the two seeding systems are in capital invested, width, operating speed, repairs and maintenance costs. The repairs and maintenance costs are higher due to the additional moving parts in a disc seeder in comparison to a tyne.

	Conventional system	Strip and disc system
Seeder depreciation	$11,000 p.a.	$15,000 p.a.
Seeder interest cost (7%)	$11,550 p.a.	$13,650 p.a.
Seeder repairs and maintenance	$4,000 p.a.	$15,000 p.a.
Operational speed	8 km/hour	12 km/hour
Seeder bar width	18m	12m
Work rate	10.08 ha/hour	10.08 ha/hour
Total cost of ownership	**$39.18/ha**	**$46.10/ha**

When comparing the cost of harvester operations, the following points have been kept constant between a conventional system and a strip and disc system:

- 2,500 hectares harvested.
- Front width of 12m.
- Fuel usage of 50 litres/hour at $1.80/litre.
- Labour at $40/hour.

The main differences between the two harvesting systems are the difference in capital invested, additional maintenance costs with two fronts rather than one and operating speed.

	Conventional system	Strip and disc system
Items included in cost of ownership	Header and draper front	Header, draper front and stripper front
Total depreciation	$71,667 p.a.	$61,750 p.a.
Total interest cost	$47,250 p.a.	$49,700 p.a.
Total repairs and maintenance	$26,000 p.a.	$29,000 p.a.
Average operating speed	8.7 km/hour	11 km/hour
Number of hours per year	319	253
Header lifetime (0 – 2000 engine hours)	6 years	8 years
Total cost of ownership	**$77.01/ha**	**$71.95/ha**

Other than the change in machinery running costs the main changes are an increase in herbicide expenditure and an additional application of mice bait. The additional herbicide costs are due to losing the options of cheaper pre-emergent herbicides such as Reflex® or trifluralin.

Annual costs	Total $/ha
Additional pre-emergent herbicide costs	$10.00
Additional mice bait including cost of application	$11.00
Finance cost on additional N at 7% p.a.	$1.33
Additional cost for seeding (as above)	$6.92
Additional cost for harvest (as above)	-$5.06
Total annual costs	**$22.86**

These costs could vary further so the following sensitivity analysis has been provided to show the influence of 10-20% variations in cost against variations in additional stored soil moisture.

Sensitivity analysis		Additional costs ($/ha)					
		$19	**$22**	**$24**	**$27**	**$29**	**$31**
Additional PAW across whole farm (mm)	**2.5**	-$9	-$12	-$14	-$16	-$19	-$21
	5	$1	-$2	-$4	-$6	-$9	-$11
	7.5	$11	$9	$6	$4	$1	-$1
	10	$21	$19	$16	$14	$11	$9
	12.5	$31	$29	$26	$24	$22	$19
	15	$41	$39	$36	$34	$32	$29

This indicates that a strip and disc system would be worth considering if it could achieve >7.5mm of additional stored soil moisture as an average across the whole farm once accounting for some variation in cost. Ideally the additional moisture would be greater than 10mm to account for the additional margin rather than just cost recovery. This is a significant increase when the area available for increase is considered. If the additional moisture was only going to be captured on 40% of the farm (assuming the other 60% is already storing moisture to its potential under the conventional system) then an additional 25mm would be required on those areas to average an additional 10mm over the property.

Key messages

- Upfront costs will be situational depending on farm size and value of purchased machinery.
- Benefits are hard to conclude from existing research and they're unlikely to be across every hectare due to variations in existing stubble cover. It is also difficult to put an accurate assessment on how much moisture is saved by using a disc seeder and the reduced soil disturbance at sowing.
- The main benefits will likely be on a smaller portion of the farm that requires additional effort to maintain stubble cover.
- Variations in machinery performance will be situational depending on yield and the performance of previously owned machinery relative to new machinery (e.g. 18m bar vs new 12m disc).

Next steps

- Look at how much area would significantly benefit from additional stubble cover and if it was achieved, how much additional moisture would it save.
- What would be the upfront cost for a disc seeder/stripper front and could this be discounted by the sale of the existing seeder/front.

Grower case studies: Exploring barriers to adoption

Two growers who attended the workshops were contacted and asked about their experiences. They provided the following feedback:

GROWER 1

For our farming business, the decision to not adopt a strip and disc system is based on money and time. If it was up to the agronomic factors, I would have adopted it! We are attracted to the agronomic benefits of the system such as the prevention of erosion, the ability to achieve maximum preservation of soil moisture, and the ability to get a good environment for the emerging seedlings (i.e. moisture conserved close to the surface). However, in the current environment we just cannot afford the outlay for new machines, and we haven't been able to find good options in the second-hand market. We looked for a long time, and ended up going with a parallelogram seeder, which we could afford and manage. The cost of changing our systems would be huge. For example, a new stripper front is about $150,000 and a disc seeder is about $300,000.

We were also concerned about the maintenance. We looked into things and for an operation of our size we would need to replace all the discs every year, plus replace a full set of bushes and bearings each year. We don't currently have the time and money to do that maintenance. One grower we know with the system allocates about six weeks a year to maintain their disc seeder. We only need a week's labour to maintain the parallelogram.

The management of pests like millipedes, slugs, slaters, snails and mice is also a limiting factor, and we are concerned with the huge amount of straw that we wouldn't be able to control these effectively. We also need to see more herbicide management options. We are aware that there are limited options for chemical control in disc seeder systems.

We are interested in the strip and disc system and will continue to read and watch the research, as we might consider it down the track.

GROWER 2

We adopted the stripper front system two years ago, and while we are impressed with its performance in good years, we are keen to see some improvements made so the system is better suited to the low-rainfall zone in poor years.

When we purchased the stripper front we were aware of its limitations, specifically that it does not perform optimally in years where yields are below 2-2.5t/ha and plants / tillers are short. In these years we use the draper front.

For the stripper front to be better adopted in low-rainfall zones (so we don't need two fronts), there needs to be some engineering and design reviews to enable it to harvest low yielding, short cereals. We think there is an opportunity to rethink the design of the rotor and fingers so the grain is flicked upwards. The current design causes some grain loss in low yielding years as grains can hit the hood and shatter out of the head.

We just need the system to capture the grain and leave the stubble. More flexibility in the front is required. There is currently no flex and the front is rigid across the whole 12.8 metres. The angle of the fingers, rotor and grain gathering system also needs a rethink.

A benefit of the system is the additional grazing value of the stripper straw. More soil cover is retained after grazing as well. This is a benefit for our mixed farming system as we have more stock feed, and it better protects the soil.

Risk assessment: Social, environmental and economic risks and barriers to adoption

In addition to the agronomic and farming system challenges, there are a number of social, environmental, and economic barriers impacting adoption of strip and disc systems. The industry must address these concerns through further research, extension and support, as these issues are impacting decision-making. The key risks and concerns are presented below.

SOCIAL

- Access to technical training and support is required to help guide set-up and management of the system. It was noted that implementation needs to be done with support from agronomists, researchers and farming system groups, as specific insights are needed to guide set-up, weed, disease and pest management, chemical rates and use, and the overall system. Growers want to see ongoing professional development and training to support the farming community.
- Concern was raised that there is not enough research specific to the EP region to make informed decisions about the system, given the financial outlay. It was noted that both AIR EP and SARDI are investing in a range of research projects, and growers are pleased these projects are underway and are keen to see these results actively extended.
- Growers are concerned that the availability of local suppliers and experts for equipment, parts and repairs or troubleshooting may impact their implementation. They are also concerned over costs from purchasing, maintenance (external support required) and time they will need to spend on maintenance.

ENVIRONMENTAL

- Growers need a clear understanding of the actual plant available water savings or otherwise under a strip and disc system. Systems which help retain moisture are key for the LRZ and MRZ.
- Growers need a clear understanding of how different soil types and rainfall systems influence outcomes, and what tactical agronomy levers they need to pull.

ECONOMIC

- The cost of purchasing (or leasing / contracting) strip and disc equipment is an ongoing issue. Growers reported that cost is a major barrier to adopting new machinery and technology. Therefore, clear insights are needed on the return on investment as well as an understanding of the full capital outlay across different farming systems. Insights are sought on the investment over a 5 to 10 year timeframe, and must consider the variables such as labour, fuel, efficiencies, maintenance, pest, weed and disease management, soil moisture and overall yields. This comprehensive piece is missing for EP growers.
- Whether soil amendments and additional inputs are initially required is an unknown, particularly in regard to what, when and how much.
- The cost of labour / fuel / maintenance in a disc vs tyne system. Note this needs to be guided by a more formal analysis.

INFRASTRUCTURE

- Modifications may be required to existing farm infrastructure to accommodate new equipment.
- Improved storage and handling facilities for different crop inputs.
- Understanding the need for additional farm storage or transport support at the right time.

Stakeholders

The implementation of the strip and disc system in EP farming systems is relevant to a wide array of stakeholders, detailed below.

- **Eyre Peninsula Growers**
    - Growers are the primary decision maker when it comes to the adoption and implementation of the strip and disc system. They are also the primary investors in the equipment (its purchasing and maintenance), resourcing and training. They are seeking research, including trials which are specific to their rainfall zone, soil and environmental conditions as well as independent information on machinery set up and performance, return on investment (for example considering the outlay costs versus efficiency, fuel and water savings versus risks such as limited herbicide packages, pest and disease management), and agronomic management to guide the adoption decision.
- **Farming systems groups such as AIR EP and Buckleboo Farm Improvement Group / SARDI / Local researchers like EPAG Research / Ag Excellence Alliance / research agronomists / adoption/extension advisers**
    - These groups have been fundamental in testing and trialling research on the EP to help guide growers in the adoption of new farm practices. These groups have a range of different trials currently underway in the EP.
    - These services play a key role in helping trial the technology, identifying how it fits into the EP farming system, then if appropriate, can help support farmers in their adoption of the technology via the provision of research reports, crop walks, presentations, workshops or demonstration days.
    - Contribute to the development and refinement of the strip and disc system, providing evidence-based recommendations and innovations.
- **Machinery dealerships / manufacturers / engineers**
    - There are a range of companies which sell stripper fronts and disc seeding equipment on the Eyre Peninsula, these dealerships are stakeholders due to the demand for their products. They need to be aware of the limitations of the system in the LRZ, have the knowledge to guide implementation and also provide technical support and timely servicing on both the stripper header front and disc seeding systems.
- **Government and SA Drought Hub**
    - **Funding providers**: These providers need to understand the limitations and benefits of the systems, as well as the barriers to adoption so they can support research, development and extension initiatives.
- **Agronomy dealers / suppliers**

    - **Economic stakeholders:** Businesses that supply agricultural inputs, such as seeds, fertilisers and pesticides, may see changes in demand and need to adapt their offerings.

- **Financial institutions**
    - **Investors and lenders:** Banks and other financial entities that provide loans and investment capital to farmers for purchasing new equipment or technologies.

Beneficiaries

The beneficiaries of any research, development and extension in the strip and disc system space are the stakeholders. The benefits of further research are detailed below.

1. **Growers**
    - Growers on the Eyre Peninsula will directly benefit from the knowledge obtained in this project, coupled with the complimentary trials / research projects currently held by AIR EP and SARDI (noting both organisations have current trials and projects in this space). The work will help inform growers of the benefits and risks of adoption and help them evaluate how the system would help with their drought preparedness. The research needs to help support growers to confidently make the decision to adopt or not adopt based on evidence regarding a return on investment rather than just gut feel.
2. **Agronomists**
    - Agronomists will benefit from the project as they will gain knowledge which will help them better support their clients make a financial / investment decision. Agronomists need to be aware of the pros and cons as well as the clear agronomic risks / benefits.
3. **Researchers / farming systems groups / consultants**
    - Researchers benefit from this project as the knowledge gained from the farmers and agronomists surveyed has identified gaps in knowledge, research and investment. Service providers on EP can then ensure their work reflects the on-the-ground needs. The project may result in more research investment, which is important for creating jobs and opportunities.
4. **Machinery dealerships / manufacturers / engineers**
    - Machinery dealerships are secondary beneficiaries to this project. They may see increased enquiries about stripper fronts and disc seeders. It may also impact the second-hand market, with growers looking to adopt the system using second-hand machinery to minimise their initial outlay. There may be increased sales and support from this work as growers will be seeking insights on machinery performance and set up to guide their purchase decision. Note there may also be additional opportunities for engineers to review the disc seeder design and the stripper front system to better suit the low rainfall zones, noting that UniSA are currently looking at some design modifications of discs.
5. **Employees / farm hands > training providers**
    - This project indicated that there is a gap in training for farm hands and machinery operators. There is an opportunity to develop and deliver training programs to upskill farm workers.
6. **Wider agricultural community – including Drought Hub, Landscape Boards**
    - This project helps identify the gaps in research knowledge and barriers to adoption of the strip and disc system. While the strip and disc system has a range of benefits, there are cost and farming systems considerations which need to be carefully evaluated. This project is extremely important in helping guide the decision with an informed understanding of the risks and rewards, especially around stored soil moisture. The benefits of the project could flow through to the community as confident and informed decision makers. If adoption occurs,

there may be increased sales, increased research and extension, and increased utilisation of local agronomists.

Knowledge gaps & areas for further research

A number of farmers – who are considered early adopters – have begun using the strip and disc system on the EP, with the aim of retaining soil water through less soil and stubble disturbance, more stubble residue retention at harvest, and greater rainfall infiltration to increase their resilience in dry conditions. However, feedback from stakeholders suggests there are significant knowledge and research gaps which are impacting effective utilisation of the system and further adoption.

The priority area of research is for an economic analysis of the strip and disc system to help growers make an informed decision before they invest. The economic analysis must review and compare costs (including machinery, repairs, maintenance, time, human resources, pest / weed / disease management) against return on investment through increased moisture retention, time saving, yield increases and efficiencies interrogated over a five-year basis in the local EP setting.

Another priority is moisture investment trials. Research to establish the actual stored moisture saving from strip and disc systems in the LRZ, considering ground cover, stubble height and row spacing in different rotations is required. This research should also investigate crop establishment timing (whether crops establish earlier) and actual evaporation rates due to higher stubble loads. Growers want to see a comparison between soil moisture measurements at harvest and pre-sowing as well as the germination / establishment and vigour of a disc versus a tyne system as there is not much data available in this space. Carrying out the research over multiple years at the same sites will be critical in determining longer term benefits and risks.

Other priority areas for RD&E identified are outlined below.

Trials / research

- **TIME OF SOWING:** Review the time of sowing in strip and disc systems, comparing the approach to a tyne system over a five-year period with yields considered.
- **SPRAY EFFICACY TRIALS - EXTENSION:** Work has been done on spraying into high standing stubble, and events have been run on increasing spray efficacy. However, there are still knowledge gaps on the best practice approach for spraying into stripper straw.
    - Extension activities are needed to guide herbicide options, boom spray set up (for example spray spacing, nozzle direction and height, water rates and rates), speed and maximising efficacy and chemical penetration into stripper stubble. Note that risks of this system also need to be covered.
- **WEED BURDEN OF TYNE VS DISC:** Review herbicide rates and packages in tyne vs disc seeders. Investigate options and where possible, areas for label review.
- **REVIEW ROW SPACING IN EP SOILS:**
    - Review the optimal row spacing for EP systems and assess impact on yields, weed control and pest management. Note that narrow row spacing in a disc has been reported to increase cereal and canola yields by 1% (Condon, 2019), growers questioned if this was relevant or similar to EP systems.
    - Growers have found that 240mm row spacings seems to work well in EP systems, with 250mm for cereals and legumes. Can cereals be narrower? 15 inch too wide for legumes on Plains, anything over 10 inch we get grass coming in so 10 inch seems to

be the way to go. Others questioned 7.5 inch. Investigate spacing considering competition. With lentils consider thatching.

- **FROST:**
    - Review the impact of frost in a strip and disc stubble system versus a tyne system.
    - Review solar radiation penetration, soil and canopy temperatures, and overall damage.
- **HARVEST SYSTEM:**
    - Review the economics of a stripper front at harvest, considering time efficiencies and the ability to start earlier in the day due to the straw thatch minimising sticky dirt. Some 'rules of thumb' are required for growers.
    - Review the efficiency of the stripper front under different yield scenarios, and determine best practice set up.
- **STUBBLE MANAGEMENT**:
    - Review stubble management over a five-year period.
    - Review the use of stock (sheep and cattle), the use of Aricks wheels, the best stubble height for soil protection, spraying strategies and residues.
    - Trial the impact of strip and disc systems on saline country and whether germination is improved.
- **MANAGING CHAFF:** Research the use of a stripper front in combination with a chaff cart and whether there is a value-add opportunity in baling and selling chaff. Some growers noted that even selling bales for $50 each covers fuel and baler maintenance. One grower reported that this harvest weed seed management approach was cost neutral.
- **SOIL HEALTH**: Measurements of soil microbiome in different systems. Some growers have observed a difference in soil health through ground cover sitting for a year and are keen to see this validated.
- **DELVING / STUBBLE INCORPORATION**: Investigate the best practice approach to delving sand in a strip and disc system and whether there are any benefits. Some commented that they have not done any delving since moving to a strip and disc system.
- **STRATEGIC TILLAGE:** Research is required to review whether strategic tillage has a place in a strip and disc system to improve penetration, with a particular focus on how much tillage is required and how often and in which soil types.
- **WEED MANAGEMENT:** Review the safe herbicide packages for use in strip and disc systems and investigate options for label change.
- **DISEASE – RHIZOCTONIA:** Research and trials are sought to provide insight into the impact of this system on pressure from diseases such as Rhizoctonia. Need clear guidance on management tactics to control diseases in the system considering disease levels, testing strategy, control / management options.
    - Growers also reported that they need more insights into managing wheat rust in straw.
    - More knowledge is needed on the management of Septoria tritici blotch and powdery mildew.

- **PESTS:** Review best practice management of millipedes, earwigs, slugs and slaters in a strip and disc system and whether a granular option or seed coating could be developed.
    - SNAIL MANAGEMENT: Investigate the impact of stripper fronts on snail management. Anecdotal evidence from farmers suggests that the stripper fronts can help manage snails in cereal crops by flicking the snail off and cracking its shell, meaning no snails get left in the sample.
    - MICE: Investigate the best practice approach to mice management, considering the approach to baiting, rates and set up at seeding.

ENGINEERING

- **HOOD MODIFICATIONS:**
    - A review of the stripper hood, fingers and rotor is needed to investigate potential modifications to reduce harvest losses in low-rainfall / low-yielding years. Growers want to be able to harvest the lower heads on shorter plants without getting dirt in the sample.
    - In these years, growers also report that there can be grain losses out of the front as high as 50kg/ha.
    - Growers also want to see if there can be any flex incorporated into the system.
    - Knowledge is required on the best set-up to minimise grain loss.
- **RESIDUE MANAGERS IN DIFFERENT SYSTEMS:** Investigate the use and performance of residue managers such as Aricks wheels for crop safety and performance. Confirm set-up approach along with residue managers.
- **WEIGHTS ON DISC SYSTEMS**: Investigate the use of weights on the disc seeder and the impact on drift. Where to hang or modify and results.
- **VARIABLE WEIGHT / DOWNWARD FORCE**: Investigate the possibility of including precision ag into the system so the seeder adjusts downforce to areas of high compaction or soil strength.
- **HARVEST WEED SEED COLLECTION WITH STRIPPER FRONTS**: A review of harvest weed seed collection effectiveness with stripper front systems, including the following.
    - Impact on horsepower, speed of system and fuel use – overall economics.
    - Weed seed kill rate for a range of different weed seeds (barley and brome grass).
    - Compare weed control in stripper and draper fronts.
    - Overall maintenance (some stripper fronts keep blowing belts).
    - Approach to chaff lining (some have had issues with barley coming up in lentils, others report that weed seeds are coming up in concentrated rows).
    - Independent review of the different systems, including chaff carts.

TRAINING / RE-SKILLING

Growers and their advisers who have adopted this system report that significant reskilling is required to help them adjust to the new approach. As an industry there is a need to ensure we have skilled growers – as well as consultants / researchers / agronomics / technicians and service specialists who are able to support adoption as an industry. Training content and industry learning events are needed which include the tips as well as their mistakes, as many

suggested the want to learn via other's errors! They find what not to do's powerful learning. Investments in train-the-trainers could be considered.

OPERATING SPEEDS

The disc system allows higher operating speeds and narrow row spaces for growers who are keen to sow into systems with high stubbles / residues. This can result in sowing timeliness benefits; however these benefits can be offset somewhat by their decreased inability to sow in moist conditions following rainfall and dew. There was some discussion that disc seeders can be smaller in widths than their tyne counterparts, so the increased speed doesn't always result in increased work rate (ha/hour). Kelvin noted that he started with a 36 ft disc seeder, but his current disc seeder is 18 m (almost 60 ft) which is wider than his original tyne seeder.

Stripper fronts also allow for a faster operating speed in higher yielding cereal crops; however, the speed is almost constant at approximately 12km/hour. This is slower than a conventional front in a lighter yielding environment. Therefore, the impact on harvest work rate is dependent on the yield environment. It is also worth noting that if harvesting capacity is increased due to adoption of a stripper front, then other supporting harvest equipment may become the limitation on work rate. For example, access to on farm storage or freight capacity may become the new limitation. This is something that just needs to be managed i.e. there is no point taking off 150 ha/hr if you know your truck can only get rid of 80 ha/hr.

Conclusion & recommendations

This Needs Analysis indicates that further research, knowledge, insights and information is required on EP to help inform decisions on whether to adopt a strip and disc system, and to validate the extent to which this system can improve drought resilience.

Transitioning to a strip and disc system requires a comprehensive evaluation of the entire farming system. Growers are motivated to learn more about the system as they chase increased soil moisture and yields. They are also intrigued by the narrow row spacing options a disc system can provide to increase crop competition against weeds.

However, there is concern about the financial outlay for new machinery and the limitations of it in a low-rainfall system. Such limitations include herbicide residues, pest management, utilising the stripper front effectively in low-rainfall years, and the limited herbicide options and uncertainty around pre-emergent safety.

RD&E is required to help in the adoption decision. This needs analysis presents a range of pros, cons and areas for future research, but given the priority of the SA Drought Hub in extending research knowledge related to preparing drought resilience, the following actions are recommended as priority. These priorities consider the feedback from primary stakeholders.

Short-term

- Establish demonstration strips which review plant available water in a stripper system against a draper system. Include different row spacings and compare weed establishment, and pressure on herbicides. Monitor and document changes in soil health and crop performance, over multiple years.
- Conduct an economic analysis of the strip and disc system to help growers make an informed decision before they invest. The economic analysis must review costs (including machinery, repairs, maintenance, time, human resources, pest / weed / disease management) against return on investment through increased soil moisture, time saving, yields and efficiencies interrogated over a five-year basis.
- Establish a harvest trial of the stripper front and review performance in different crop yields. Assess harvester capacity, fuel consumption and snail management.
- Review herbicide management packages for growers in the LRZ and MRZ, trialling different products, rates (on label) and timings to help support decision making.
- Continue extension of the two trial programs on the EP, which are valued by growers for example:
    - Cook, A., Zeppel, K., Standley, C., and Richter, I (2023) Impact of stripper front and straw length on harvest efficiency, summer weed control, soil moisture retention and pest populations in upper Eyre Peninsula systems: Viewed online at: Eyre Peninsula Farming Systems Summary 2023 (pir.sa.gov.au)
    - AIR EP (2023) Project Report – Strip and Disc Trial Report. Viewed online at: Microsoft Word - DN1_23_02-Technical-Report-Strip and Disc-Dec-2023 (airep.com.au)

Medium-term

- Establish moisture retention trials assessing the actual stored moisture from strip and disc systems in the LRZ, considering ground over, stubble height and row spacing in different rotations. This research should also investigate crop establishment timing and

evaporation rates due to higher stubble loads. A comparison of soil moisture measurements at harvest and pre sowing is also required.

- Develop and deliver strip and disc set-up workshops or on-farm demonstrations which look at different header front set-ups to minimise harvest losses and different seeder set-ups considering row spacing, soil disturbance and the use of Aricks wheels.
- Development of case studies and online resources so growers can assess the economic return of adopting the strip and disc system considering their farming enterprise.
- Deliver training to upskill agronomists, researchers and crop advisers specialising in strip and disc farming.
- Seek funding for engineer trials to support the integration of the systems into the LRZ.
- Review frost impact in strip and disc systems.

Long-term (18+ months):

- Extend findings of the soil water use efficiency trials.

REFERENCES

AIR EP (2023) Project Report – Strip and Disc Trial Report. Viewed online at: Microsoft Word - DN1_23_02-Technical-Report-Strip and Disc-Dec-2023 (airep.com.au)

Cook, A., Zeppel, K., Standley, C., and Richter, I (2023) Impact of stripper front and straw length on harvest efficiency, summer weed control, soil moisture retention and pest populations in upper Eyre Peninsula systems: Viewed online at: Eyre Peninsula Farming Systems Summary 2023 (pir.sa.gov.au)

Condon, G. (2019) 3-Step implementation of the 'strip and disc' system. Written by Cindy Benjamin. Viewed online at: 3-step implementation of the 'strip and disc' system - WeedSmart

RESOURCE STOCK TAKE

The following case studies are on Strip and Disc seeding:

- Robinson (2018) GRDC Case Study. Stripper fronts and disc seeding. Viewed online at: Stripper fronts and disc seeding
- Baxter, N (2024) GRDC Ground Cover Case Study: Bean plantings expand with family's switch to 'strip and disc'. Viewed online at: Bean plantings expand with family's switch to 'strip and disc' | Groundcover (grdc.com.au)
- Strip show provides plenty of food for thought: RESEARCH: Strip show provides plenty of food for thought (farmingahead.com.au)
- 3-step implementation of the 'strip and disc' system - WeedSmart
- Disc Seeding Systems - Handy Fact Sheet - GRDC (ryannt.com.au)

APPENDIX 1

Strip and disc systems - Potential risks and benefits

The following is a list of potential risks and benefits that has been collated from consultation with SA growers who have adopted, considered adopting or chose not to adopt strip and disc systems. Much of the information is anecdotal and this list should be read as a working draft of issues growers should consider when looking at adopting strip and disc. The list is not comprehensive or in order of priority, and the project team welcomes feedback. Growers are always encouraged to seek their own professional advice prior to making decisions.

POTENTIAL RISKS

Fire

- Fire risk may be heightened due to the increased standing stubble load. Being prepared for a fire, including having the right equipment on hand as well as a fire management strategy, is essential.

Frost

- Anecdotal reports that systems with higher stubble retention may increase the risk of frost. The thatch of straw may mean the sun (solar radiation) is less effective at heating the soil up during the day and less heat is available to release back to the canopy at night.
- Thermography and temperature loggers monitoring surface and air temperature in plots with and without stubble showed that stubble reduced the minimum temperature, particularly in light-coloured stubbles with the effect diminishing as the season progressed. [1]
- Stubble is a major host of ice nucleating bacteria (INB) and by crop canopy closure stage, the stubble would be expected to be primed with INB, increasing the crop sensitivity to a frost event, at equal temperature. [2]

Pre-emergent herbicide options

- Growers concerned that there are no registered chemicals specifically for disc systems due to every disc system being different.
- All herbicide labels recommend knife point-press wheel systems for IBS practice, while some labels specifically rule against use under disc seeders. Crop safety concerns are linked to uncertainty around separation of seed from herbicide-contaminated soil and crop residue.
- Need herbicide safety trials on different soil types/rotations and by disc seeder type.

[1] https://sagit.com.au/project/frost-learning-centre-for-farmers-advisers-and-researchers-mhr121/
[2] https://sagit.com.au/project/frost-learning-centre-for-farmers-advisers-and-researchers-mhr121/

Herbicide residues

- Some growers report that their disc seeder does not move herbicide residue out of the way like a tyne seeder meaning it can remain close to the seed, such as when hair pinning occurs.

Hair pinning of stubbles

- Sowing with disc seeder into heavy, damp stubbles can result in hair pinning, especially in softer soil conditions - where the disc blade pushes crop residue into the furrow near the seed zone, rather than effectively cutting through residue and kept away from the seed zone.

Bigger stubbles

- Some growers report that disc seeders can block up with straw in the third year of adopting the system, due to accumulation of stubble biomass from low breakdown rate of standing stubble. Risks can be minimised by operating in the same direction of the harvester.
- Some growers have utilised residue managers to push residues aside (to the inter-row away from the disc) to reduce hair pinning. Use of residue managers needs careful individual evaluation as their effectiveness is based on stubble height, soil type and speed. Straw can ball up if there is too much stubble and cause blockages so residue levels need to be carefully monitored.
- Observations suggest the stripper straw gets brittle and can rot at the crown and this is what blocks the discs. It can also impact the effectiveness of row cleaners or residue managers such as the Aricks wheels.
- Research has shown herbicide spray coverage can be reduced in stripper stubble compared to medium or low-cut draper stubble[3]. Growers may need to look at increasing water rates or spraying in lower delta T conditions to improve coverage in stripper stubble.

Pest and mice pressure

- Stripper stubble can provide a more favourable environment for pests and protection from predators.
- Greater front losses at harvest may additionally make things worse for managing mice.
- Some growers report that they see more slaters, earwigs, millipedes and mice in their strip and disc system and feel it is harder to both monitor and manage.

Having to learn a new system

- Many growers fear they would be on their own with a disc system. If adopting a different system and things go wrong, it can have big impact on business.
- Changing systems means throwing away what you know works and it's a big risk
- Need a step-by-step manual on what the changes are

[3] Unlocking the value of strip and disc systems - GRDC

- Need to carefully manage downward force on-the-go with a disc seeder to ensure even and adequate soil penetration. High tech solutions (e.g. Active down force) can assist managing variable soil condition across paddocks.
- Growers report that some stripper fronts are rigid and do not float like some draper fronts which can cause issues in undulating areas where the stripper front does not pick up as well on the ends. Larger models have spring-loaded gauge wheels complementing the underside skids to offer greater floating stability and ground following capabilities.
- Firming wheels have been used by some growers to improve soil to seed contact. Different types are available and should be selected considering soil type and conditions.

Maintenance requirements

- Disc blades must be kept sharp so they can cut through stubbles and soil
- Growers report having to get new discs each season or season and a half
- Rocky and stony soils cause extra wear and tear – need to keep an eye on the discs and replace when worn
- Gauge wheels, firming wheels, residue managers and crumbler wheels require ongoing checks and maintenance

Investment costs

- New or even second-hand machinery is a large upfront investment when changing to the new system and growers are changing from what they know
- Uncertainty around if need a higher-capacity harvester to best manage the stripper front. Growers wondering if there is an optimal capacity.
- Need breakdown on profit margins for each area to justify investment. Moisture retention benefits are likely to only be on a small portion of the area (i.e. areas currently with inadequate soil cover).
- Need to know ownership costs over time that also considers maintenance costs
- If growers have to run a stripper and a draper front then it costs more
- Some growers may choose to retain their knife point seeder which makes the upfront investment larger due to no sale proceeds from the existing seeder. Also, running 2 seeders adds to the total cost.
- Parts may not be readily available everywhere, waiting for parts can have a major impact on the business

Cereal diseases

- Concern that the strip and disc system will increase risk of some diseases such as Rhizoctonia or crown rot

Harvest weed seed management

- Economics and efficacy of harvest weed seed collection with stripper fronts not well known
- Impact on horsepower, speed and fuel use not clear

Low yielding crops

- Growers report that using a stripper front is challenging in shorter, low yielding crops as grains can hit the hood and shatter out of the head leading to greater front losses
- Need engineering and design reviews to improve harvest in low yielding, short cereals

POTENTIAL BENEFITS

Improved stubble retention

- Observations suggest greater stubble retention is particularly valuable on lighter soil types to stabilise soils and potentially retain soil moisture

Improved soil moisture retention

- Some evidence that low draper front stubble retains less soil moisture than stripper front stubble but needs more research[4]
- Growers want data on soil moisture differences – if not saving moisture then the benefits have to add up somewhere else

Less soil disturbance

- Disc seeders create less soil throw and less or no residue burial and therefore can help reduce wind and water erosion
- Some growers say they are able to take advantage of smaller rain events at sowing as less soil is moved using a disc seeder, so less soil moisture is lost to evaporation
- Disc seeders leave the soil surface flatter with more stubble cover retained and no clods or straw clumps that can impact on germination and establishment

Improved efficiencies

- Seeding – disc seeders may allow growers to sow faster than they can with a tyne seeder. Driver comfort and maintenance generally ok at increased speed but need to ensure its ok in all soil types. Trials and monitoring are needed to ensure appropriate results are obtained on different soils of different structures, strengths, types and moisture levels.
- Harvest – stripper fronts only need to process the grain not the straw so harvest speeds can be increased and there is less wear and tear on header. May be able to cover more ground in a given timeframe which can reduce risk as more of the harvest can be completed in optimal time windows.
- Potential to start seeding earlier in the day after a rain event due to stubble cover making soils less sticky, providing disc seeder can cut wet/dewy stubble.
- Anecdotal reports that strip and disc system can mean less operator hours seeders and harvesting, less fuel consumption per ha and getting the crop in quicker as well as off quicker. However, the size of the new front and seeder needs to be considered compared to existing equipment.

[4] Unlocking the value of strip and disc systems - GRDC

Improved harvestability in lentils

- Soil surface is left flatter with a disc seeder and a thatch is left with a stripper front header which can mean less wear and tear on machinery and cleaner samples especially when running a header front close to the ground reaping lentils. Rolling post-seeding can be avoided at best.

Less issues with rocks and stones

- Disc seeders are able to cope better with rocky and stony ground – don't pull up big rocks like tyne seeders do

Grazing value of stripper straw

- More straw left behind after harvest means more stock feed and also more soil cover retained after (controlled) grazing

Snail management

- Anecdotal evidence that stripper fronts can help manage snails in cereals as they get belted off by the front which reduces contamination in the harvested grain
- Possible that stripper fronts also crack snail shells which helps reduce whole snail numbers

Improved crop/weed competition

- Disc seeders allow for narrower row spacing to maximise crop-weed competition and increase yield potential while maximizing residue retention.
- Narrow row spacing disc seeding is part of an integrated weed management system, including low soil disturbance disc seeding.
- Narrow row spacing also improves the effectiveness of stripper front harvesting and potential weed seed collection at harvest.