‘Area Wide Management for cropping systems weeds, investigating the weed management, social and economic opportunity’:

Final evaluation

SUMMARY REPORT

- May 2023

Acknowledgements

This report was prepared by Colere Group Pty Ltd for GRDC, with thanks to the AWM project team and Steering Committee. The project team and Steering Committee candidly provided valuable insights on their experiences and opinions of the project. The findings of the evaluation have been informed and guided by these insights.

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1 Executive summary

Over four years from 2019 to 2023, the Rural Research and Development for Profit Round 2 project, 'Area Wide Management (AWM) for cropping systems weeds: investigating the weed management, social and economic opportunity' explored the potential for an AWM approach to weed management. The Grains Research and Development Corporation was the project proponent, and contracted CSIRO to implement the project. The project involved a multidisciplinary team of researchers and regional facilitators, as sub-contracted by CSIRO. The project involved three regional trials in Sunraysia, Riverina and Darling Downs with project-wide research in herbicide resistance, genetics, social science and economics.

Colere Group was engaged as an independent evaluator by GRDC. Separate to the evaluation, Colere Group also facilitated two of the project's face-to-face workshops (Mildura in June 2022 and the final project workshop in Sydney, May 2023). This enabled the lead evaluator to establish relationships across the project team and gain a deeper understanding of the project. The evaluation has been informed by desktop review of project documentation (as available prior to 10 May 2023[1]), observations at the workshops and monthly online meetings and semi-structured interviews of the project team and Steering Committee. Insights from the evaluation guided the discussion topics at the final project workshop, however this workshop was not an evaluation workshop and forms part of the project's research activities.

1.1 Summary of achievements

Project achievement highlights included research findings and the experiences of the regional groups. This evaluation considers the regional experiences as pivotal to research endeavour of testing AWM as a concept.

In Sunraysia, AWM was achieved across horticulture and grain cropping industries at a neighbourly scale. The dialogue established across industries identified varying weed management capacity and on-ground improvements in weed control. It is expected that the benefits gained by the participating growers and observed by the agronomist trial manager will continue to influence others in the region. The only example of grower level practice change and collaboration on weed control occurred in Sunraysia.

In Riverina trials were conducted on weed management tactics around irrigation infrastructure and across horticultural industries. The irrigation community were regularly updated through group meetings and research updates. There was strong attendance at field days and evidence of some aspects of participatory research, with ongoing and responsive evolution of research trials.

In the Darling Downs, discussions with local government identified differing perceptions of weed species and management issues, legislative barriers to growers controlling roadside weeds, and layers of institutional decision making, all cumulatively impacting the harbouring and/or spread of agricultural weeds from roadsides and community relations. The key achievement in this region was the increased understanding of weed management from a local government perspective.

In addition to the regional achievements, research was conducted across the regions. There was research on the presence of herbicide resistance, weed genetics, social drivers and motivations for AWM and economic willingness to pay. The herbicide resistance work was considered by the

[1] Final sub-project reports were due to CSIRO on 15 May and this evaluation was due to GRDC on 22 May. There was insufficient time to thoroughly review these reports and update the draft evaluation. It was agreed with GRDC that these reports, including updated and final output counts, would not materially change the findings of the evaluation.

project team as providing a point of interest for grower engagement. In line with this, the results have not been informative on the concept of AWM or future AWM endeavours. In comparison, the genetics research results, social research and economics have all made meaningful contributions to developing an understanding of various aspects of AWM. These results show that AWM of weeds is a concept of potential merit. It is of significant interest to growers, with growers believing there are benefits from improving weed control across boundaries. These research results support the need for ongoing work to develop a working model of AWM as a new way of tackling weeds in the grains industry.

A key finding from the research was that AWM may take many different forms. The project has identified four models of AWM.

- Individual: individual land managers are aware that their actions impact others around them and adjust practices
- Linked: land managers communicate directly or through an intermediary on weed management issues and practices
- Collaboration (together): agreed weed priorities within a geographic area, with a sense of collective action and purpose
- Collaborative coordination (groups): structured coordination with resourcing for shared activities and monitoring

Further work is required to understand the differences between these models including the resourcing and capacity required, and the most appropriate landscape and social contexts for each model.

Finally, a highlight of the project that was commonly identified by team members, was the use of the relationships established within the project to facilitate the release of a biocontrol for fleabane. The formation of regional network of organisations interested in weed management has proven a useful tool for deploying technology.

1.2 Key findings of the evaluation

The project was hampered by a lack of commonly understood definition of AWM across the project team. This has prevented meaningful communication across the project team, with project team members working towards different models of AWM without acknowledging these differences. This has prevented both sharing of like experiences and informed comparison across differences. After four years of research and activity, a set of four models of varying extents of collaboration were defined by the project team at the final project workshop. It is disappointing that these models are comparable to information presented at the initial project workshop.

A fundamental weakness of the project was a lack of research design that explicitly tested the model (or models) of AWM. As result, it remains unknown which landscapes and contexts are most suited to AWM and there is no guidebook for others to follow, should a region or local organisation seek to implement AWM. The regional experiences do however point to various factors that are necessary to consider in any future experimentation on the potential use of AWM to reduce weed impact in the grains industry. These factors are a smaller neighbourhood scale of action, areas of limited land use complexity including a limited number of public land managers, and an actively moving weed.

The lack of research design also meant that the project relied on assumptions on movement corridors, as opposed to landscape dispersal, and that movement of weeds is limited by preventing seed set, as opposed to germination or movement itself. It remains unknown if there are tactics that can limit the spread of weeds across a boundary, for example tactics for land

managers to mitigate or limit reinfestation where a neighbouring land manager is not able to control weeds.

The evaluation found variable evidence and opinions to support the achievement of project outcomes, including outcomes on collaboration across disciplines. For some, participating in a project that involved multiple disciplines was a new experience, while for others with more multidisciplinary experience, there was a lack of joint problem definition, sharing of skills and expertise to directly inform and influence the collective.

Finally, the purpose of the project was to test the concept of AWM, in order to develop more informed future pathways for AWM. While evidence of grower interest and willingness to work together was found, the concept of AWM, as defined by the four models of AWM, remains to be tested. There is future work required to develop a working model of AWM.

1.3 Recommendations

There is interest, willingness and to some extent grower-level demand for improved weed management within regions or across property boundaries. The project has explored the idea of AWM, shown that it could have merit and generated some insights on what various models of AWM may entail.

1. Conduct a pilot trial of the concept of AWM, with an experimental design that applies the now defined different models of AWM as treatments at localised scales.

The challenge and cost of weed management remains an ongoing, and increasingly expensive issue for growers. In the absence of new ways of addressing weeds, it is unlikely that the current situation will change. AWM offers potential for a change in weed management. A trial that is primarily a social science experiment, that is informed by science on weed ecology, on-farm economics, social capacity (individual land managers) and institutional capacity (industry organisations and regional groups) may find an alternative approach for weed management. As a social science experiment, multidisciplinary findings on weed ecology, genetics or other aspects would provide supporting data that demonstrates the benefits and need for an AWM approach. A future pilot trial will need to carefully select project team members and be underpinned by experimental design with social research at its lead and centre.

The project insights have identified some factors that need to be considered in the design of any future attempts to test AWM models if a workable model of AWM is to be developed.

2. Any trial of AWM models needs to be designed to inform future development of a working AWM model, with data collection on the individual and collective costs and resources (skills, time and funding). This means that the research design needs to plan for the standardised collection of resources and capacity used and required by each trialled model of AWM.

3. Treat the project as industry applied research that tests the transferable knowledge and tools from other industries. Treating the project as research means an experimental design that specifies the treatments and comparisons expected, the data that needs to be collected and the research commences with a thorough literature and practice review. A wider scan of weed management practices would show that the project was not seeking to trial or develop a completely novel concept and that there are transferable technologies of potential relevance to grains and cotton industries. AWM of weeds is successfully being used in Australia for weeds of biodiversity concern, with projects spanning multiple land manager types. Remote sensing data, such as drone footage, is successfully being used to map large areas of weeds and monitor treatment effectiveness.

4. Commence multidisciplinary research with a systems thinking approach to problem definition. A critical step in establishing the research is the initial project workshop. This is the opportunity for multidisciplinary problem definition and group forming that can set the tone for

the rest of the project. It is also the most useful timing to identify any disciplines that have been overlooked and any project team members who have not fully embraced the research question. Ongoing facilitation across disciplines and between regions and researchers is then needed to keep the project on track. Collaboration requires more than a reporting back style of meeting, but focused discussion and joint solution development.

5. An individual project manager or leadership team is required that collectively has the skills needed in knowledge brokering, research translation, systems thinking, social research design, facilitation and evaluation. Active leadership is needed to steer multiple sub-projects towards a joint research finding. There remains a role for GRDC and CRDC leadership in providing direction and a voice for research investors (in this case growers) to ensure the project delivers value for growers. Ongoing management requires facilitation and understanding of how the different parts of the project come together into a synergistic whole, ensuring each piece contributes to the project objective or research question.

There are experts in soft skills that can be brought in to complement leadership. For example, there is a well-recognised gap in translation of research to practice change, and it cannot be expected that simply by having researchers in the same project as extension officers that this translation will occur. Specialist support in communication is needed early, if the outputs are to be used and have impact within the project term. Systems thinking skills are also necessary in multi-disciplinary work.

6. Manage risks and adjustments to deliver on project outcomes. Where a project is consistently underspend, the reallocation of budget can change the emphasis and focus of activities. This can impact the achievement of desired outcomes. Changes are inevitable in a longer-term project, so decision-making processes that ensure the project still delivers meaningful results are required. These processes also need a mechanism to address conflicts of interest from within the project team. In this example, a redirection of funding to bring in additional expertise in soft skills in research translation or systems thinking would have assisted all areas of the project and enhanced results.

7. Project manage for turnover of managers and Steering Committee members. A long-term project will inevitably have turnover of key individuals. While at project establishment, strategic thinking, design work and the various project plans need to be completed, a scheduled review point can provide an opportunity for newer project managers or Steering Committee members to have meaningful influence. The onboarding process for new project managers and Steering Committee members could also embrace the opportunity for fresh eyes to review the project. Onboarding needs to ensure new individuals are familiar with the project's objectives, research design and expected final outputs. This requires a clearly documented project plan or experimental design that is supported by sufficiently detailed meeting notes with documented decision-making rationale and action tracking.

A review as part of onboarding, can happen at any point in time. The insights generate points for broader discussion. Review and insights do not automatically translate into sweeping changes, with all suggestions still needing to be considered in terms of resourcing feasibility and appropriateness for the project's objectives.

2 Introduction

The 'Area-wide management for cropping systems weeds, investigating the weed management, social and economic opportunity' (AWM) project, co-funded by the Rural R&D for Profit program[2], has brought together a significant cross section of partners interested in addressing the issue of weed management across boundaries. The project was led by the Grains Research and Development Corporation (GRDC) and the Cotton Research and Development Corporation (CRDC).

The Activity Work Plan (18-04-004) described the project as "This project will identify the benefits, key principles and practices of successful Area Wide Management. AWM involves multiple stakeholders in a coordinated effort to reduce the impact of mobile weeds. This project will develop an improved understanding of the biophysical, geographic, economic and social drivers of AWM success by studying key weed species across diverse landscapes."

The project involves 11 research and development partners: Grains Research and Development Corporation, Cotton Research and Development Corporation, AgriFutures Australia, CSIRO, University of Queensland, University of Adelaide, University of Wollongong, Mallee Sustainable Farming, Millmerran Landcare Group, Irrigation Research & Extension Committee Inc, and the Toowoomba Regional Council.

The overall project approach was described as "involves **forming a network of AWM groups**, comprising of representatives from key growers and industries, in three case study regions: Darling Downs, Sunraysia and Riverina. In these regions, **farm-scale field trials** will be conducted to **determine and test the most appropriate and effective weed control strategies that reduce weed dispersal**. The project will also characterise and identify the social and economic costs and benefits of weed management across a range of land uses." (Activity Work Plan 18-04-004, emphasis added.)

Activities were structured into three regions, with each region having a focal area:

- Sunraysia – across industry control (broadacre – horticulture)
- Riverina - channel bank management
- Darling Downs – roadside management

It was expected that as a result, that "Understanding the key principles which influence successful weed AWM will lead to **development of frameworks that can be tailored and deployed in other locations.**" (Activity Work Plan 18-04-004, emphasis added.)

The purpose of this evaluation is to provide GRDC, CRDC and DAWE with an independent review of the performance of the project in meeting its objectives. As stated in the project M&E plan, "The long-term objectives of the project are to:

- Reduce weed dispersal in target regional areas
- Reduce the negative effects of mobile weeds in target regional areas.

The project aims to achieve its long-term objective impacts by:

- Producing findings relating to weed Area Wide Management best practices, economic costs and benefits, spatial data maps, and social drivers and barriers of adoption that advance knowledge and inform industry decision making
- Delivering targeted extension activities in regional areas to influence land users to adopt best practices."

[2] Rural R&D for Profit records the total investment at $1,867,219 comprising $933,609.42 in cash and $1,143,111.46 of in-kind contribution.

3 Evaluation method

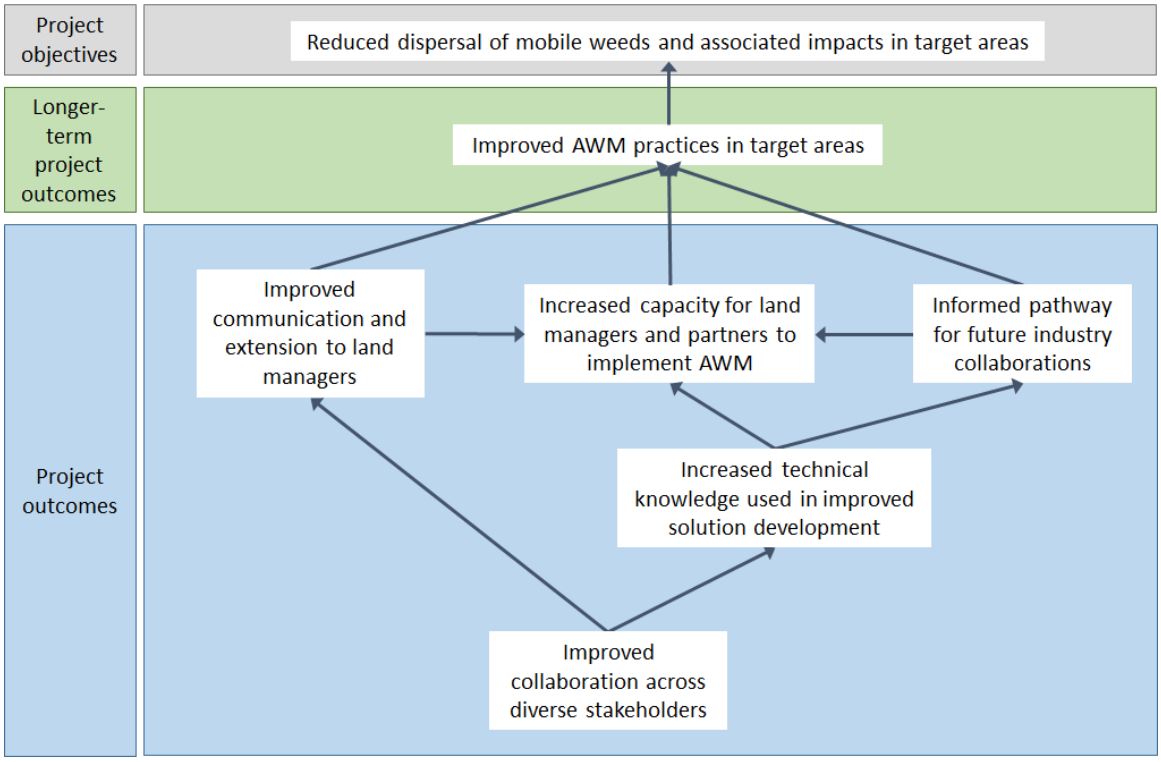
The evaluation commenced with a review of the existing M&E plan. This review highlighted a lack of focus on outcomes, with excessive detail at an activity and output levels. This was reflected in the Mid-term Review that assessed delivery of KPIs, providing accountability against the contractual requirements of the project, as opposed to performance or quality.

3.1 Revised program logic

A workshop was held in Mildura in June 2022. At this workshop there were facilitated discussions on what the project partners viewed as success for the project. A revised and simplified theory of change was then produced (see Figure 1). The project long-term objectives remain the same, with greater clarity on the role of collaboration to increase knowledge and improve communications on AWM alongside informing future industry collaborations for AWM. The project partners viewed the outcome of "Informed pathway for future industry collaborations" as the most relevant and important outcome.

This revised theory of change has been used in this evaluation.

Figure 1 Revised theory of change



3.2 Key evaluation questions

The evaluation is focused on assessing achievement against the outcomes, identifying how the project's management has enabled these achievements and what the findings mean for future investments. This is captured by the following three key evaluation questions.

- To what extent have the outcomes been achieved? (Section 4)
- How has the project governance enabled to these achievements? (Section 5)
- What learnings and insights can inform future projects of this kind? (Section 6)

3.3 Evidence used

Secondary data analysis

Project documentation, as made available through CSIRO's SharePoint, across all components of the project have been reviewed. All documentation extracts are shown in double quotation marks.

Primary data gathering and analysis

16 semi-structured interviews were conducted with key stakeholders. This included members of the project team and steering committee. Detailed handwritten notes were taken, themes analyzed and illustrative quotes re-constructed to evidence findings. All interview quotes are *italicized* and shown in single quotation marks. Shorter quotes are provided within the text and longer quotes are provided in new, indented paragraphs.

The interviews were conducted in January 2023, prior to the project's final extension. Project and research activities were still underway. While some views of the project team may have changed over the last 4 months as the project has completed activities, it is not expected that any changes will be material to the evaluation findings.

Observations

The evaluator, after facilitating the meeting in Mildura June 2022, attended online project team meetings as an observer. Occasional updates on the evaluation were provided to team meetings. Observation of team meetings enabled greater understanding of the project and its activities, built relationships with the team members and influenced the views of the evaluator.

The emerging findings from the evaluation, after the interviews were conducted, also influenced the project. It was a result of the emerging interview findings that a final project workshop was held, with the topics addressed informed by the evaluation. The evaluator used interview quotes to highlight discussion areas and also facilitated the final project workshop in May 2023. This was a workshop that delivered on the project's research findings, as opposed to an evaluation workshop.

4 Project achievements

This section of the report addresses the key evaluation question 'to what extent were the project outcomes achieved?' The response is organised under the six outcomes identified in the theory of change. Multiple lines of evidence are brought together under each of these outcome headings, including relevant output data and interview findings. The broad structure under each outcome heading is:

- Explanation of the outcome;
- Relevant output data; and
- Evidence of outcome achievement, using multiple lines of evidence.

The findings against each outcome were drafted prior to the project's completion, with the final workshop and final project reporting outstanding at the time of writing. Results from the final workshop have been included, but the findings against the outcomes have not been fully reworked using the final project report or sub-project reports. The final report from CSIRO is due to GRDC on the same date as this evaluation, with both needed to inform the final report for DAWE. It is also expected that additional information from the final project report would not materially change the findings and recommendations of the evaluation.

There was an overarching finding from the interviews that is first explained below, as it influences evaluation of outcomes.

Project clarity of purpose

In the opening comments of the interviews, it was common for interviewees to preface responses on project achievements with comments such as '*early research phase, first project of this kind. Pulling together social, economics, biology creating a picture of where, what are the opportunities for AWM'* and '*stepping stone to achieve more*.' There were also comments on a lack of achievement that implied failure with phrases and wording such as '*hasn't worked as expected*' and '*disheartened*'. The impact of Covid-19 was frequently raised as a reason for a lack of outcomes and a few questioned the appropriateness of an area-wide approach to weed management.

> *'The insect approach to AWM wasn't going to be attractive around weeds. Mobile but left to managers themselves what to do, it's not perfect but not end of the world.'*
>
> *'The original intent to test that question, could you use AWM for weeds? The results of the project demonstrate its difficult for a range of reasons.'*

The evaluation has found mixed perspectives of achievement on each of the outcomes, showing significantly different perspectives of AWM and understanding across the project team. The issue of a lack of coherent and consistent definition of AWM and what it looks like in practice, is pervasive and affects achievement of all outcomes. It is difficult to assess progress on an amorphous or contested concept, and this lack of common understanding likely contributed to the variable perspectives of outcome achievement. For some the purpose of the project, as an exploration of the concept of AWM was clear.

> '*It's a new area. Trying to achieve a working definition of AWM.*'
>
> *'To understand if there is potential, remember it's a research project.'*

Definition of AWM and AWM practices

The lack of strategic thinking and clarity on the concept of AWM was highlighted in the interviews with project members and steering committee members, describing the project as

seeking a '*focus on understanding the issue, what does it mean in practice? The spread of weeds, resistance, mechanisms available?*' For some, questions remained on what AWM is:

> '*Pivoted a few times. Initially AWM teams or awareness on issues. How to control and bring people together? Went down rabbit holes like how roadsides led to council. But it's*[3] *not grower engagement and buy-in*.'
>
> *'There's no clarity on contexts. It's still in amorphous terms. Is it a single weed approach vs range of weeds?'*

Others put forward ideas on what AWM is, including that it may be individual action:

> *'Doesn't have to be a group of people working together. It can be ad hoc. People interested in controlling weeds.'*
>
> '*Still need to pin down the scale and design. Is it about getting groups going or 1 to 1 neighbours?*'
>
> *'Just getting it into people's psyche to control their weeds so not to spread. It looks like people talking about and people looking after their patch with good weed management.'*

The question of what AWM at the time of the interviews (January 2023) was unresolved by the project. The lack of clarity on what AWM is, could not be ignored as a significant failing of the project. There was an opportunity posed by the extension of the project from 15 February to 15 May 2023 (date final sub-project reports due to CSIRO) to address this evaluation finding. A final project workshop was held to deliver on the project's fundamental and core research finding, namely a consistent and clear understanding of the concept or concepts of AWM.

Final project workshop

At the project final workshop 4 May 2023, facilitated discussion on what is AWM identified different definitions of AWM which were then grouped, confirming the differences within the project team and lack of consistent structure or language. In the absence of an agreed definition, it is not surprising that the project has not been able to compare treatments (models of AWM) and determine clear recommendations on how AWM can be implemented.

The discussion notes have been used to create the definitions proposed in Table 1. Since the final project workshop ongoing discussions on the four models of AWM have identified a 'Good neighbour' model sitting between 'Linked' and 'Collaboration' (pers comms).

Table 1 Definitions of AWM

Individual	**Linked**	**Collaboration (together)**	**Collaborative coordination (groups)**
Individual land managers are aware that their actions impact others and take their neighbours into consideration when making weed management decisions. As a result, weed management actions may address a different range of weeds or occur more frequently.	In addition to Individual, land managers communicate on weed management actions and priorities with neighbours, either directly or through an intermediary such as an agronomist. As a result, knowledge of weed management issues and practices are shared.	In addition to Linked, there is an agreed decision on weed priorities and a common objective within a defined geographic area, spanning different types of land managers (public, private, industries). There is a sense of collective action and purpose, with explicit awareness of others within the network.	In addition to collaboration, there is structured coordination and resourcing for shared activities such as surveillance or other research to inform control tactics, motivate land manager engagement and monitor progress.

[3] Refers to a lack of grower engagement and buy-in by the project.

This set of four models of AWM spanning different levels or intensities of AWM are comparable to a framework of collective action, as previously published by the project's lead social scientist and presented to the project team in 2019 and previously published (see Figure 2).

Figure 2 Extract from Graham S (2019) Coordinating invasive plant management among conservation and rural stakeholders. *Land Use Policy*, 81, 247-255.

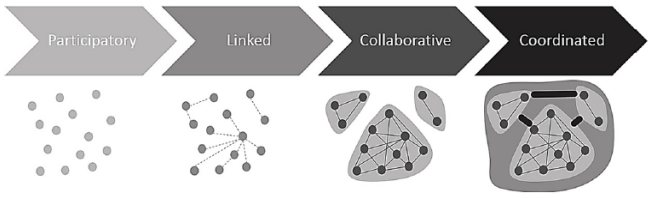


Fig. 3. Continuum of collective action for IPM, as evidenced from the interviews (participatory, linked, collaborative) and other research on polycentric governance (collaborative and coordinated). Dots indicate individual actors involved in IPM, dotted lines indicate weak social bonds, solid lines indicate strong social bonds, and thick solid lines indicate bridging social capital. Grey areas indicate who is involved in collaborative actions.

The similarity between the models of AWM developed at the final project workshop and the framework presented at the project's initiation meeting almost four years earlier is concerning. The evaluation found that absence of a common language and conception of AWM has limited the project's research finding and subsequent achievement of outcomes[4]. At the project's conclusion there appears to be greater recognition and readiness to accept four possible models of AWM within the project team, with the lingering need to trial and compare models to determine the most effective and appropriate model for different contexts.

The future pathway discussed at the final project workshop identified that more work is required to understand the different models and the interviews also spoke to an ongoing need for defining and evidencing AWM.

> *'The AWM idea is a new concept in weeds. Need to build a case for it with evidence across the sciences. Why it is more effective.'*

4.1 Improved AWM practices in target areas

To ascertain improved AWM practices, AWM practices must first be defined. Prior to the end of project workshop, there was no apparent definition or articulation of AWM practices in the documents reviewed, along with the lack of consistent view across the project team on whether the project was seeking practice change.

The goal of practice change was seen as '*a grand aim for change while seeking to understand the problem*' pointing to the parallel research and extension activities, with this compounded by a '*Short timeline. Originally a 2 year project so doing everything in parallel.*' This work in parallel was seen to result in a '*Rush to get understanding before implementation*' and '*Where it's been caught is that it's meant to be doing management solutions and uptake while developing research knowledge.*'

These views that research was required prior to extension, contrasts with the design of the project, as evident through the activity workplan. A few interviewees acknowledged that the project had not been implemented as expected, but that there remains potential for AWM.

> *'Would have expected a bigger shift if project had gone as expected. Grower behaviours haven't changed as quickly, no shift in AWM concept or theory – slow progress. Still a sound concept just needs longer to get there.'*

> *'The social science showed willingness to work together. It is achievable, just ambitious.'*

Not all interviewees considered the project as seeking practice change, instead it was about:

> '*greater awareness of mobile weeds and impacts across land tenure, the possibilities to restrict movement, demonstrating movement and resistance, looking at farmer and*

[4] This is apparent in the following evaluation of the theory of change outcomes.

localized perspectives of the movement' (i.e. individual AWM, as defined at the final project workshop)

Others suggested that AWM is '*an increased critical mass of weed management, not coordination across land managers*' (i.e. individual AWM, as defined at the final project workshop).

Where practice change was seen as a project goal, it was described as immediate neighbours having greater awareness and increased communications on weeds (in line with what was later defined as linked AWM at the final project workshop). The targeted practice change was '*getting industry talking to one another*' with different sectors sharing knowledge on weed control techniques. This was identified as between land managers and at a higher level, '*one practice is that higher strategic level collaboration. Joint weed management efforts.*'

This view of practice change as increased communication was most strongly expressed in Sunraysia where discussions between broadacre and horticultural growers was widely seen as a success,

> '*broadacre and horticulture don't talk. The most significant success was getting AWM in broadacre and citrus. Get some understanding of the concept and then it starts to filter out*.'

The only evidence of on-ground practice change, with land managers working across boundaries and industries is in Sunraysia. While the number of land managers making changes was small, '*for those people involved, its significant*.'

Across the project interviews, it was acknowledged that '*none of the practices are novel. It's about extra effort or strategic effort. It's hard to measure because it's not a specific practice*'. There were two examples of on-ground practice change identified by the interviewees with it viewed that '*herbicide resistance testing is a practice. More people are looking at getting testing done after this project.*' The other example of on-ground change was changes to the use of chemicals with double knock and use of different actives in horticultural industries in Sunraysia.

It was also commonly recognized that there was '*limited impact of practice change*' and '*no or little observation of improvement or change in AWM. Not enough traction*.' The number of growers actually changing practices as a result of the project was considered small. However, where practice change had occurred, it was considered significant to those individuals, '*Citrus completely changed their summer weeds. They have 6 blocks in the region. It's hard to measure now but expect change to be huge over next few years*.'

Enablers of practice change included the individual characteristics of the regional leads and that more time was needed for extension work.

> *'The regions - comes back to the individuals running it. Where it's the right person, with experience, connections, there's traction. What's not clear is the level of uptake.*
>
> *'I'm pessimistic on any extension impact. I'm hopeful for Sunraysia but needs a driver. The other two regions, no hope.'*
>
> *'The change will happen a couple of years after. Extension and adoption not at year 3. Needs more investment in post extension work, after the research.'*

In the absence of a shared definition of AWM in practice, it is difficult to determine if practice change has occurred beyond a small number of land managers improving their own individual weed management.

4.2 Improved communication and extension to land managers

The outcome of improved communication and extension was expected to include coordinated and tailored messaging for different land managers, the availability of supporting resources such as guidelines, and a range of communication and extension formats and media. Extension and communication outputs contribute to this outcome and are summarised below.

Communication and extension delivered

The Rural R&D for Profit activity workplan includes 4 KPIs grouped in Activity 3 Communication and Extension and a further 8 KPIs grouped in Activity 5 Research Activities related to communication and extension.

The communication and extension activities listed in Section 4 of the Performance Reports do not appear to be comprehensive and on occasion reporting statements made against KPIs contradict the information provided. A comparison of the submitted Performance Reports with the communications and extension reported in the regional trial activities report has found that not all reported activities have been included.

The lack of data on communication and extension was raised with the project early in the evaluation and a separate online spreadsheet created to record events. In this spreadsheet, a total of 54 extension activities and communication products have been recorded for the project (to 18 Oct 2022, based on project compilation spreadsheet). The most common activities were conference presentations (8) followed by articles (7), podcast (7) and report (5). Communications also included 2 videos produced and 6 press engagements (print, radio and TV). Grower targeted extension consisted of 5 field walks or days (unknown participation numbers) and 3 workshops with a total of 93 participants[5].

While more communication and extension activities have been undertaken than reported, it appears that relatively little progress has been made with building community awareness and engagement in AWM. The interviews found mixed views on the project's communication and extension focus compared to research, and views that the extension component was a lesser priority may have contributed to a lack of communication and extension activities.

> '*Designed for research to be a hook to get landholders and advisers interested. Got to have something on offer and a reason to get together*.'

The lead responsibility for the production of communications materials remained unclear. It appeared to alternate between a project-wide or technical task and regionally driven activity.

> *'Some of the information and comms products could have used at start, greatest limitation was the technical content, lacking in terms of a real hook.'*

Communication of research and trial findings

Several KPIs in the Activity Workplan are focused on the communication of research and trial findings to regional groups and the broader community.

The perceived role of research in communication and extension varied. For some, the research provided a topic to start a conversation with landholders.

[5] These numbers have not been updated to limit duplication of efforts and potential contradiction. More recent numbers are available in the project final report.

'I felt that one of the ways to engage was talking about herbicide resistance and sorts of land uses. Glyphosate resistance weeds tend to be everybody's problem. Sharing the same problem. Provide conversation starter.'

Other interviewees appeared to struggle to digest the technical information provided by the researchers, limiting their ability to convey findings on a local level and to landholder audiences.

'Grinding my teeth and brain to simplify the message so community can understand. If I can understand and talk about it, then in ways they can understand, terms they relate to everyday language depends on the audience.'

'Some of the stuff I struggle with, and I don't touch that stuff.'

Interview comments highlighted a lack of coordination and support in communications across the project team, with difficulties in getting regional content and input and also difficulties from the regional perspective of not getting timely communications outputs.

'My job is to maintain but need the information to publish. Was going to have a page per region but hard to get information back and ended up cross linking to theirs.'

'Only just now done a video. One pager on the project to hand out. It's come too late.'

'Region was crying out for information early on and not getting anything.'

'Didn't want and then the regions desperately wanted it.'

One interviewee suggested that *'a dedicated comms person or middleman able to pull together might have translated to products quicker. Comms for a diverse project needs writing in upfront.'*

After three years of project implementation, including research and trial work, there was *'Not much disseminating results yet'.*

While drought had a significant influence in the first year, and trials in the Darling Downs were also severely impacted by floods, results coming out of the research and trials for communication appears to be slow and limited.

Improvements to communication and extension on AWM

The AWM project was expected to gain experience with communication and extension on AWM, and this experience alongside the research findings, was thought would lead to improved communication and extension. Improved communication and extension to land managers is more than an increase in activities and resources available. Improved communication and extension requires a shift in the quality of messaging, appropriateness of formats or methods and efficacy of targeting.

When interviewees were questioned on the changes to communication and extension, '*the main change was the pivot to online formats due to Covid restrictions*', with this being a responsive logistical change to an external risk, beyond the control of the project as opposed to proactive improvement of the project's communications.

The communication and extension experience of the regional partners was evident in the description of communications in Sunraysia as meeting grower needs and interests with '*spraying focus for broadacre and horticulture, anyone can listen, trying to use local examples*' and the use of well-established, high performing existing communications channels such as the Riverina's '*monthly newsletter sent out of 560 members and get an open rate of 55%*'.

The communication and extension work conducted by the regions did develop experience with delivering an AWM message. For some this was due to engaging with audiences that were beyond their normal grower and agronomist audience, '*the messaging is different between broadacre and horticulture, completely different ends of the spectrum*.' Insights and findings gained included:

'Care isn't enough to spend money – had to personalise the messages.'

'Don't have a sense of a common problem, it's not a cohesive challenge and set of landholders.'

The social science component of the project was commonly highly regarded by the interviewees, including the production of localised summaries and recommendations. For some interviewees the results were useful, '*social science has informed how you disseminate knowledge gained*.' It appears that the social science findings had some influence. Key messages shared during interviews aligned with findings from the social science and included:

'Starting a conversation across industries and neighbours. Main opportunity is close scale of just coordination with neighbours at a local scale.'

'Looking after weeds is looking after your neighbours'

However, many could not or had not been in a position to see how the results had led to a change in messaging by the regions with one interviewee stating that the project '*hasn't packaged the messages*.'

'*Not a good handle on the comms going out. Not sure if they took the results on in the communications. The Groundcover article was a bit motherhood*.'

'AWM is a nice phrase but on the ground people didn't know what it meant. Better understanding of ryegrass and Fleabane movement, and herbicide resistance.'

A shift in messaging from awareness to dissemination of research results was also identified.

'Message has changed – now have findings. Initially it was awareness, go out and give samples for testing, now it's the results. The next step is working together with neighbours. Drinks, BBQs, try to actively do it.'

There was one positive interviewee who viewed that '*the term AWM is getting more recognised*.'

4.3 Increased capacity for land managers and partners to implement AWM

Capacity includes awareness and motivation to act, along with the resources and skills to take action collaboratively. An increase in capacity for land managers and partners to implement AWM would be characterised by land managers and regional partners having the skills, knowledge and resources to implement AWM. Ideally some capacity is gained during the lifespan of the project that persists after the project concludes.

Evaluation of this outcome is faced with the challenge of a lack of clear definition of AWM, and then subsequently what aspects of capacity are relevant for its implementation. Is AWM weed management in a business-as-usual model of individual action, or is there an element of neighbourly or local communication on weeds or some other change to how weed management is done that makes AWM different? If AWM can take different forms, then what capacity is needed for each?

Facilitation across land managers and industries

If, for the purposes of the evaluation, it is taken that AWM is different from weed management, with that difference being some level of landholder coordination, cooperation or collaboration, then the group activity focus in the project's Activity Workplan remains relevant (see Box 1), and with this, the capacity for partners to facilitate across landholders is a key capacity required.

Box 1 Activity 5.1

"5.1 Mobilise local networks to address landscape-scale cropping system weed management.

Area wide management (AWM) groups will be established in three case study regions (Sunraysia, Riverina, Darling Downs). Each AWM group will comprise a local facilitator, plus representatives from key stakeholder groups representing the different land users. Through the integral community aspect of AWM, learnings and knowledge around best practice integrated weed management will be shared between individual land users.

(a) For each region (Sunraysia, Riverina, Darling Downs) establish one regional AWM group involving participants from a minimum of two different agricultural industries.

(b) Provide input into local research trial plans and implementation in collaboration with project research staff who will oversee six AWM relevant trials, including one in each region, over the project life, that implements a collective weed management approach.

(c) Deliver a region-specific communication program that includes conducting one annual field walk, ongoing annual AWM group meetings and disseminate outcomes of these meetings and project research findings."

The activity workplan points to a locally focused participatory style of research, where a local group is involved in testing collective weed management. This local group approach is also clear in the Communications and Extension Strategy and regional communication plans. However, there is limited evidence that a participatory research method was implemented, beyond initial community meetings. These initial meetings did inform trial work:

> '*The first meeting with farmer groups, it was clear. There was a mix of cotton, grains, graziers, Council. It was clear that when people talk about mobile weeds, the common priority was roadsides*.'
>
> '*Workshopped weeds of significance that weren't notifiable. Came up with a list of 20 weeds and then narrowed it to the top 3. Roundup resistant ryegrass, fleabane and silver leaf nightshade.*'

However, beyond the initial meetings, it was commonly seen that '*There was no group formation*.' There were questions on both the merit and challenges of taking a group approach to weeds.

> *'Was hard to keep the group engaged because of Covid. It wasn't formal. Held events and invited them. Not interactive meetings but research updates with guest speakers from AWM.'*
>
> *'Needs to be locally driven with regional committees. Challenge of Covid plus conflicting pressures on people, so much about coordination and getting people together – resourcing requirement.'*
>
> *'Initially written in a classic view of AWM like a Landcare or catchment group. Findings of research that large commercial farmers are not community focused[6]. There are time constraints for large and corporate farms and cross industry. A group is not a winning path. … There are other approaches. People being more aware of neighbourly implications and public land managers. Still a community approach but less holding hands.'*
>
> *'Not sure if it needs a defined group. A common understanding of reducing weed spread. Just need an opportunity for interaction and a group to get out. As a research project it's*

[6] This was a finding from the social science research based on outside perspectives of commercial farms and literature review. The project has no direct data to support this statement.

better to have a group to track practice change. People form their own groups for all sorts of reasons.'

Despite the lack of group formation, there has been capacity developed for cross-stakeholder collaboration by the regional partners. Some interviewees viewed the dialogue between industries as a major project success. Sunraysia and Darling Downs needed to expand their contacts and networks, with various conversation openings used to establish dialogue that led to shared understanding of weed problems.

'Had to cold call the horticulture industry.'

'Made connections and networks. Getting them thinking about doing. Meeting and knowing the person – seen the person and introductions.'

'No obligation for these weeds on roadsides, not in the biosecurity act, had no idea that their management was significant to neighbours. Those weeds not on radar, council didn't understand.'

One interviewee described how pre-existing capacity for collaboration and established groups influenced the selection of regional leads.

'Started by picking partners with strengths in collaboration and local networks. Spread of local partners in the project, and brought extra people in where there's opportunity or gaps. Contracted extras to come and join. Rather than setting up something that has to be sustained after bringing established groups e.g. weed smart'

In line with this need for pre-existing capacity, there were comments in the interviews on the differing skills, experience, networks and resources available to each of the regional leads and how this related to perceived successes and challenges.

'Skills vs expertise? They had the skills in bringing people together but not experience in trials and weed management.'

'Needs both technical and facilitation skills.'

This suggests that the skills required for AWM were already present in the regional leads, and the gain in capacity is mainly around the additional contacts and networks.

There were also comments on differing farming philosophies and that the differing philosophies limited the capacity of one of the regions. There are significant learnings to be drawn from the Darling Downs case where there was '*a mixed bag in attitudes to chemicals*' but the project '*couldn't find common ground*.' An inclusive approach to weed management that spans different industries must presumably also span differing farming philosophies, bringing individuals together on a common goal of weed control as opposed to a common method of weed control.

Across the interviews, areas of capacity identified as required for AWM included:

- the ability to connect across industries and form relationships quickly, including reaching out to previously unfamiliar organisations and landholders;
- pre-existing networks with established communications distribution channels and resourcing support for tasks such as communications;
- trial management skills, or reliable access to trial management services;
- like-mindedness on farming philosophies for landholders and other stakeholders to come together; and
- regionally located and accessible technical support and expertise to draw on for trial design and extension.

The need for group facilitation skills remains untested. It's not clear if the lack of group formation was solely due to Covid-19, but lock-downs, border closures and limitations on group meetings undoubtedly contributed. Shifts to online media occurred for communication products

but not for maintaining group cohesion and discussions. The reasons for this are not clear. The interviews also suggest that a lack of belief or willingness to proactively drive a group approach to AWM also contributed, with several members of the project team appearing unsupportive of Activity 5.1 or even any role for communication across land holders in their definition of AWM.

4.4 Increased technical knowledge used in improved solution development

There are many dimensions to the technical knowledge needed to improve the design and delivery of AWM. The project has included regional trials and three cross-region research areas:

- Herbicide resistance in the regions
- Genetics of herbicide resistance across landscapes
- Economics to understand the financial costs and benefits of area wide management
- Social research to understand the attitudes and motivations for participation in area wide management

Each of these areas of research can be evidenced by the scientific findings as captured in publications and reports. However, the desired outcome of this increased technical knowledge is its application to improve solution design, namely the implementation of AWM. This means that achievement of this outcome requires not just the technical findings, but for those findings to be used in improving AWM approaches. This section is focused to insights from the interviews on the use of those findings to inform current and future AWM. Details on research findings are available in the project and sub-project reports.

Herbicide resistance research

The herbicide resistance work was a component of 'Activity 5.5 Data integration and spatial analysis to outscale findings of trials and mobility components to demonstrate the value of AWM at regional and/or national scale' in the Activity Workplan (see Box 17). There were two KPIs related to herbicide resistance:

> KPI 2.14 Complete and report on herbicide resistance testing
>
> KPI 2.5 Produce maps of distribution of herbicide resistance in each AWM region

Impact of improved herbicide resistance knowledge on AWM solutions

The main role of the herbicide resistance work was described as a hook or point of interest to engage landholders. While the project had designed the herbicide resistance work as an activity early in the project, herbicide resistance work expanded and continued.

> *'There was an over emphasis on trials. Resistance sampling in the first year as baseline data to start a conversation and then it became a major focus over multiple years.'*
>
> *'Localised data is valuable for saying samples are relevant to you directly'*

Herbicide resistance did act as a hook or point of interest or a *'Good little story to take along when I do my herbicide resistance talk.'*

The findings were described as:

> *'Confirming suspicions, the extent of it, resistance to multiple chemicals while others are just not effectively applying chemicals and need to change. Individual impacts – change droplet size etc.'*
>
> *'Three highly mobile weeds. With fleabane surprising results, other 2 got what expecting. Other two are mobile and resistance is spreading but 50-60% resistance not 100% and its*

up and down across the years. Game is not over with herbicide resistance and actions of growers can make a difference.'

However, the herbicide resistance findings, whilst now sufficient statistically, appears to have had no impact on informing future AWM solutions. There is no evidence of the findings informing the design features needed for successful AWM such as the appropriate scale or other contexts.

Genetics evidence of the movement of herbicide resistance

The genetics research was designed as part of Activity 5.2 Evaluate suitable weed management tactics to mitigate highly mobile cropping system weeds, specifically 'For each region (Sunraysia, Riverina, Darling Downs) …. b) Analyse the movement of weeds from each local research trial.' There were KPIs related to this research, included the collection of weed samples pre- and post-trials.

Impact of improved genetics knowledge on AWM solutions

There were mixed views on the research findings, with one interviewee regarding it as an academic only exercise and others seeing that the findings will have impact on practices and AWM.

'Getting some really good data on relatedness of weeds in landscapes. Exciting academic activity. Won't play out in how we do it differently.'

'The genetics work to prove the spread of weeds is not normally part of a project like this. Results are still coming in. Longer distance between regions. That'll have an impact.'

'The projects most significant achievement is still to come. Last bit of data in to demonstrate weeds and mobility, here to there, and to what extent – extra information and recommendations on how to best tackle.'

To date, there is limited evidence of the genetics work influencing AWM practices and the development of future investments. The final report suggests that annual ryegrass is a good candidate for future AWM efforts on the basis that it has high rates of movement and the ability to rapidly evolve herbicide resistance. This does not consider the controllability of the weed and availability of tactics to slow its movement, but rather takes a blanket-like suppression approach across a broader landscape of unknown scale. The remaining step for the genetics work is to digest the meaning of the results and translate the findings into implications for AWM. This is an example of how the multidisciplinary team could have been better used to assist with the interpretation of findings and improve the project results.

Economics research

The economics component of the Activity Workplan was:

"5.3 Characterise the economic costs of weeds across landscapes and for AWM opportunities

The economic analysis will identify the farm-specific and area-wide benefits from weed management. In collaboration with other research activities, the goal is to identify the conditions an AWM approach and related practices require in order to have the greatest private benefit (incentive) to individual land managers and the location/weed characteristics necessary to offer the greatest area-wide and total benefit."

Impact of improved economics knowledge on AWM solutions

At the time of the interviews the economics work was still underway, with results being refined, as guided by feedback from monthly project team meetings. Communication of results had been

limited to within the project team at monthly project team meetings. At that point in time the impact of economics knowledge concerned understanding land manager motivations, in line with the findings already produced by the social science and to dispel views on the economic cost of glyphosate resistance. The willingness to pay results were not yet available.

> *'Shown areas where there's not a lot of value in AWM. The cost benefit of getting involved is not that high. Need to focus on other benefits. Coming from maintaining a good relationship with neighbours. Rather than make a lot of money out of getting neighbour to do something different. Farmer who is donating the weed problem more a relationship incentive, not financial.'*

> *'The economics is unusual. It shows that glyphosate is not that expensive a loss if there is Integrated Weed Management in place. Modelling shows it's not that expensive to lose glyphosate.'*

Social research

The social research was designed as a component, in:

> "Activity 5.4 Understand social attitudes related to the success of weed AWM
>
> Understanding the social barriers to the adoption of weed management and participation in AWM is a fundamental component in determining its ultimate success. This activity will identify the human drivers and barriers to AWM through exploring attitudes of various land managers and other stakeholders applicable to AWM approach to weed management."

Impact of improved social science knowledge on AWM solutions

The social science findings were highly regarded by the interviewees and are likely to have made the most contribution to improved AWM solution development. Some influence on the communication of AWM has already been noted.

> *'UoW findings have been the project's most significant success. Still waiting on the others. Now have a better understanding of the problem and how it varies across locations, can translate that understanding into proposed management.'*

One member of the project team felt that *'the information collected by Sonya and James (genetics) was incredible and powerful but it went nowhere.'* The need for whole of team digestion and interpretation of the genetics results was previously raised. The same facilitated multidisciplinary solution development discussion was also required for the social science, indicating the lack of findings interpretation was a project-wide issue.

For some the social science findings were seen as validating or motivating for future AWM approaches:

> *'have generated data that there is potential to approach weed management in that way by improving understanding – majority of people believe important to work together.'*

> *'scientific data proves the approach and what the individual does makes a difference - evidence of weed movement.'*

> *'People weren't aware of what AWM means but doing it anyway or open to possibility of more formal arrangements.'*

Regional trial results

The project was designed to have regional work as central to land manager engagement. Each region commenced with a group meeting to identify priority weeds and potential trials. It was

expected that the trials would provide something for the group to coalesce around, as reflected in Activity 5.1 and 5.2 of the Activity Workplan.

Box 2 Extract from the Activity Workplan

> Activity 5.1 Mobilise local networks to address landscape-scale cropping system weed management
>
> Area wide management (AWM) groups will be established in three case study regions (Sunraysia, Riverina, Darling Downs). Each AWM group will comprise a local facilitator, plus representatives from key stakeholder groups representing the different land users. Through the integral community aspect of AWM, learnings and knowledge around best practice integrated weed management will be shared between individual land users.
>
> ….
>
> Activity 5.2 Evaluate suitable weed management tactics to mitigate highly mobile cropping system weeds
>
> Conduct field trials in partnership with the local AWM groups to test the potential impact of appropriate weed control tactics and strategies. Weed control tactics identified as having promise in reducing weed dispersal and their spatial impact will be trialled.

In each region, trial management was subcontracted out to local agronomists. The trials undertaken in each region shifted over time, as expected in participatory action research.

In comparison to the trial work in the Darling Downs, the Riverina trial work was successful in several aspects. It engaged a large number of growers, with both field days and research updates, the trials changed as new questions were identified (as per action research models) and there is documentation of the trial results available. In Sunraysia, the trial work was successfully used to gain a level of collaboration across neighbouring land managers, of different agricultural industries.

Impact of regional trials on AWM solutions

There were insights gained from the experience of trying to work across industries. This includes the difficulty of coordinating meetings across industries that work on different timeframes and the variable resources and investment across industries on weed management. More specifically to the trial work, findings on tactics to limit or prevent movement of weeds, as opposed to control of mobile species of weeds, are either not available, cost prohibitive or still in progress. The most promising results have been early findings from more recent Darling Downs trials suggesting that increased crop competition around the perimeter of sorghum fields may reduce weed establishment.

Spatial analysis

The spatial component of the project was designed as a significant integrative piece. In the context of mobile weeds, knowing where the weeds are moving from and to, and what tactics can slow or prevent the spread of weeds is intuitively critical foundational information to an AWM approach to weeds. Activity 5.5 of the Activity Workplan captured this.

Box 3 Activity 5.5 Data integration and spatial analysis

> Activity 5.5. Data integration and spatial analysis to outscale findings of trials and mobility components to demonstrate the value of AWM at regional and/or national scale.
>
> Collate the trial results, georeferenced genetic data, economic data and other available data to provide summaries and maps of the potential benefit to be derived from application of AWM within the broader study region, and within agriculturally similar regions nationally.

a) Mapping using relevant available spatial data to characterise each of the three defined regions (Sunraysia, Riverina, Darling Downs).
b) Map the distribution of herbicide resistant weeds in each region where trials are conducted.
c) Integrate the research trial data to summarise and visualise results and findings.
d) Combine results and findings into indicative maps that relates the potential for AWM across similar agricultural regions.

While there were KPIs related to Activity 5.5 in each year of the project (KPI 1.18, 2.15, 2.16, 3.14, 3.15, 4.14, 4.15), at the time of the interviews the spatial analysis was still underway.

Impact of spatial analysis on AWM solutions

While final reports remain in preparation, at this point in time (May 2023, post final project workshop), there does not appear to be any findings from the spatial analysis of relevance to the design or implementation of future AWM. The spatial representation of genetic clusters offers some insight into the potential scale of AWM activities, however further investigation is needed to understand the reasons for different scales of genetic clustering. This may require additional research that is designed to test spatial and landscape attributes impacting genetic clustering.

4.5 Improved collaboration across diverse project team stakeholders

Collaboration across stakeholders is more than coordinating and sharing use of resources and knowledge. It involves joint decision-making, actions that connect together to contribute to synergistically achieve common goals in the project. In improved collaboration on a common problem or goal the stakeholders engaged are diverse and include land managers (growers and public land managers), researchers, extension officers and investors. This outcome is focused to actions within the project team, as opposed to improved collaboration between land managers and industries (working across land managers has already been discussed, see section 4.3).

The project was successful in building awareness of different bodies of work across the project team, with interviewees readily seeing an increase in conversations.

> *'Got people talking, thinking in a way that they haven't before.'*

> *'Got 3 regions across 3 states. Different industries. Got them talking and bouncing ideas. More aware of other areas.'*

The connections gained between project team members included networks and working relationships.

> *'Opened up networks. It's a small industry anyway.'*

> *'Head start on future projects working together. Already have a working relationship.'*

However, the interviewees had mixed views on project collaboration. For some there was *'Enough shared interest to get collaboration going but ultimately people made it happen'* and it was the most significant success, '*love to replicate on other projects. Can have working together and not just individual projects.*' In comparison, for others it came across as the most significant disappointment described as '*largely sub-projects working on their own*' and

> '*all supportive and wanted to help out, but had own goals and agendas too. There was limited cross influence. It could have done more innovative things together.*'

> *'It was innovative having the different project parts and I was hoping for more.'*

These differences appear to be due to the individual interviewee's past experiences on collaborative projects, with those with more past experience on multi-disciplinary projects being the most disappointed.

Collaboration between researchers and regions

One area of collaboration that was challenging for the project team was the communication of research results with language and formatting that was comprehensible and useful for the regions to use with landholders.

> *'Business as usual for most. Struggled with the connection points. Want this handout. Tell us what your work does. Should be simple 4-page summary that researchers could do but it is so hard.'*

The disconnect or lack of effective communication of research findings to the extension components of the project is indicative of broader communication issues between the research components and regional extension-oriented components of the project. At an operational level, there were challenges with the regional collection and recording of samples. Researchers commented on protocols not being followed in the regions.

> *'Meant to have unique ID for each sample. Ended up with 6 lots of sample number 7. Takes time to sort through. Need good description of sample area. Not always done to the level of detail needed. … Possible reasons include outsourcing sampling and passing on of instructions, clear verbal instructions. Early on the project went smoothly. Last year and a half. Don't know, change in staff, people have forgotten, lost documentation?'*

> *'It's a national project so forced to work with others. Give a package to someone with an experimental protocol, get no answer or we're fine. Doesn't always work.'*

The regions commented on the protocols not being clear enough, highlighting the two-way nature of the communication, and suggests communication limitations for any meaningful collaboration between researchers and the regions.

> *'The protocols on resistance testing and genetics sampling, I could call on the other regions to get reassurance on the sample collection. I'm not the only one.'*

The disconnect between researchers and regions was not uniformly felt, with one region able to draw on one of the researchers, '*got drafted in to think about trial design and extension activities to talk on ground.*' For other regions, the distance between researchers and the regions was compounded by Covid-19 border closures and this impacted access to support, with consequences to collaboration. While for some, there were '*no problems with ringing to follow up*', others appeared to need face-to-face discussion and onsite connection.

> *'Expertise in the project was very southern farming system focused -support wasn't there for the north. The others could lean on technical expertise from Adelaide. The project lead came up once when looking at trial design and no more. Impacted ability to get trials on the ground.'*

The online monthly meetings were seen as '*giving people an opportunity to present and give updates. Make it inclusive, opportunity to say – might give ideas and contacts to follow up on.*' This was a sufficient level of connection for some relationships, but for others a greater depth of individual discussion was noted as needed in retrospect, *'after first year results, meeting with each region probably a good idea.'*

The role and impact of the monthly project team meetings is further discussed in the following section 5, 'Project Governance'.

Collaboration across industries

The interviews provided some important insights into collaboration across industries, with lessons gained on-ground in the regions (see section 4.3) explained or mirrored at the industry body level. The project was a collaboration between GRDC and CRDC. The motivation for CRDC to match GRDC's financial contribution was high, despite this being a significantly larger portion of CRDC's budget. The two industries are different sizes, with a common grower constituent that makes it '*Hard to look at weeds from a cotton systems perspective*.'

The expected benefit was increased research due to an economy of scale and associated efficiencies, with transferrable research findings to meet the needs of a common set of growers.

> *'Leverage GRDC to look at weeds as a farming system. More economical and findings are transferrable. Our growers aren't just cotton. Usually also grain growers.'*

The motivation to leverage is due to uncertainty on the role in promoting weed management outside of the crop, *'Weeds aren't in the cotton crop. Problem weeds are on roadsides, in channels, thoroughfares. What is our role in weeds if weeds are not in the field?*' High standards of in crop weed control were put down to '*chemistry options between cotton and grains. 3:1 to rotate chemistry to smash weeds.*' It suggests that current best practice management of weeds in cotton is successful, but that the gaps remaining outside the crop maintain weed seed harbours and points of reinfestation. This was confirmed by the project,

> *'Social work reinforced cotton industry has a lot of in crop work. It's not a gap. The main sites still alongside cotton in fallow- concerns for roadside moving in.'*

In this context, an AWM approach is an attractive way to increase overall farm hygiene by motivating action outside the crop to limit dispersal, and reduce the pressure on in-crop control.

The insight on cotton industry finances and motivation to leverage was described as exacerbated for smaller industry groups such as horticultural crops.

> *'Horticulture is a harder organisation to tap into and see where weeds fit. They pay the levy to a particular crop and the amount available for weeds can be little or nothing.*

The end result is that limited research and extension is directed to weeds, and *'small industries like dried fruit and almond hadn't had past exposure to resistance discussions.'*

Collaboration across disciplines

Within the AWM project, the experience of collaboration across research areas varied widely from being described as

> *'The best project ever involved in from that perspective. Learnt a huge amount from others in the project. Strong willingness to share ideas and help out a different piece of the project.'*

with '*people willing to accept advice from other parts of the project*' to a more superficial connection with limited information sharing between social and economics '*kinda got there in the end*', '*the problem got left to the economists. There was no group brainstorm.*'

The benefit of multidisciplinary research is from looking at a problem from different perspectives to build a stronger, cohesive understanding of the problem that identifies new systems-based solution. A systems-based solution overcomes barriers from one part of the system that may limit or prevent a solution implemented on another part of the problem. The definition of a common problem to coalesce around is key, as is understanding how the different disciplines can connect to build a more complete view and solution.

'Bringing together diverse group of researchers, overall nature of collaboration between groups to look at a topic. Value of social science to the project. Close to end the collaboration was with regions.'

'Overall model of different disciplines involved and collaboration set up and run. Good model for future work. Laid groundwork.'

The multidisciplinary design of the project was described as a trial in itself.

'A pilot to see that diversity can work together and how willing people are. The super technical have listened to the social science. If trying to inform practice change, there's value in social science and economics.'

A collaboration highlight mentioned by several of the interviewees was collaboration with another Rural R&D for Profit project. This came about through the GRDC project manager, who also held contract management responsibility for a biocontrol project. The fleabane bio-control project was able to make use of the AWM resources and regions for release. There was coordination and use of the AWM network, but there was limited evidence of shifting or impacting the goals, priorities or actions of each project in collaboration.

While there were multiple disciplines within the same project umbrella, with information sharing via project meetings, there was similarly limited evidence of true collaboration, or integration of the different bodies of research. Instead, there was evidence of coordination and team members supporting each other to complete tasks.

'Original plan was to do field work myself and then pandemic came. Ended up working with groups for them to do the sampling. Every group is different, conditions also differ.'

Integration appeared to remain difficult through the project. The case studies produced in the final months of the project to highlight various aspects of the project. Two of the case studies mentioned the regional trial work and only one of these case studies contained results from more than one body of supporting project-wide research. The genetics or economics were not mentioned in any of the case studies and one of the case studies was focused on the fleabane biocontrol project. As yet, there is limited evidence of integration of the different bodies of research within a region to create a holistic understanding of the potential for AWM, including the supporting or limiting factors specific to each region.

While at the time of interviews '*the integration work is missing*' the final project workshop in early May attempted to bring the project team together. At this workshop, each of the sub-projects provided a presentation and the group was asked, 'What does this mean for these models of AWM?' The definition of AWM through the four models identified, enabled discussion of individual bodies of work using a common framework. The cross-disciplinary connections within each model of AWM were not further explored due to time limitations. Additional in-depth discussion is still needed to connect across disciplines, and identify and challenge points of agreement and conflict within each model and to the regional practitioners.

Fundamental to this level of discussion and collaboration is respect of the different experiences and knowledge held across the project team, with shifts in thinking and activities undertaken. A lack of collaborative mindset was displayed at the workshop when a view was expressed, '*We've been looking at the wrong weed. We should be doing wild radish'* and was seemingly dismissed by a lead researcher. A requirement for collaboration is acknowledgement of different perspectives, flexibility and willingness to learn from others, and as a result, to do something different for a common, greater and shared objective.

4.6 Informed pathway for future industry collaborations

This outcome is seen as the culmination of the previous outcomes. Those interviewees who viewed the project as testing the concept of AWM, saw it as the key outcome for the project. Certainly, if AWM is a potential new approach to weed management and the project was testing various methods of AWM, achieving this outcome is delivering on the project's purpose.

An informed future pathway would be characterised by project partners and other potential collaborators having gained knowledge on the gaps and opportunities for future AWM collaborations. These insights would enable strategic priorities to be set, and collaborators may be seeking opportunities to resource AWM initiatives.

The interviews asked 'how has the project informed future projects?' with most interviewees seeing some future iteration or continuation of the project. In keeping with the previous outcomes, responses varied and conflicted, as summarised in Table 2.

Table 2 Summary of broad future directions

Future directions	Example quotes
Continue doing the same	*'Some things aren't going to be able to investigate. Follow up work e.g. grower behaviour change. Now getting good collection of resistance and genetics – enhanced and better results for future work – continue doing would be useful as things change over time. Easier in future due to links in with regions and industry network'* *'Continue with getting more data, a better story and better picture built up.'*
Expand to new areas and industries	*'Extend or broaden to different areas.'* *'Targeting more of different industries, been grains centric – grain with neighbours like cotton and sugarcane'*
Shift or refine focus	*'Spin off of roadside and good neighbour programs -council and grower relationships.'* *'Much more an issue of how do you get neighbours to work together than regions together'* *'Linear managers need to be in the conversation at the beginning rather than an add on. Road, channel, rail.'* *'AWM is a clearer concept. The scale is much smaller than otherwise thought being about neighbour to neighbour or smaller networks. Not a whole region level.'*
Re-do	*'Foundational information on the social and genetics, brilliant result if we'd just done these things. Can use it now to build something from scratch again. Understanding growers motivations, versus different to pest animal management – 75% of population at one time, not like that with weeds. Don't need to do it at the same time but fundamental common understanding of stopping weed spread.'* *'A project versus informing local groups – what is the basis for developing an approach? Unsure of the adoption level.'* *'I'd like another crack at it with more time. More time with the researchers. Be there from the beginning.'*

A couple of interviewees questioned the details such as the choice of weeds and herbicide resistance:

> *'Already widespread weeds in an area, you're not going to stop further spread. But herbicide resistance, how do you know where it is? Feathertop Rhodes, you can see it, and can do incursion management. Growers can't see herb resistance."*

The lack of visibility of herbicide resistance and need to send samples for testing can be a barrier to both establishing a local AWM network or group as it requires resourcing, and also across industry grower awareness of the problem. While the grains industry may have communications on herbicide resistance, it was found to be a new problem for the small horticultural industries and local government.

It is clear that '*There is demand. There is need to engage across industries because it impacts grains*.' The demand for information on weed management was described as farmer driven with a need to *'Help identify knowledge gaps, what's needed next. Farmers are still looking for this information.'* The social research and economics both also identified grower willingness and interest to work together, with the willingness to pay work stressing there must be confidence in good results to motivate action. There is also willingness to work across organisations in future endeavours.

> *'Making the links across organisations, the collaborations. A success story. Not yet made that step to what's next. Maybe it can be discussed, where to from here.'*

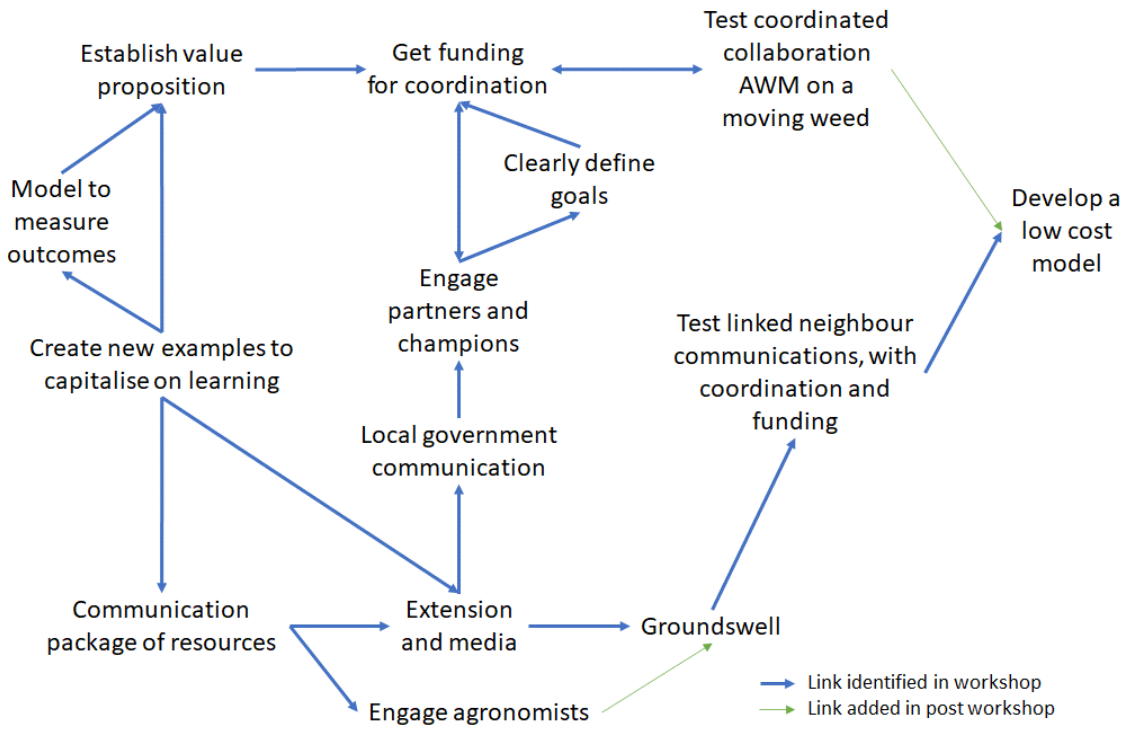
The final project workshop discussed future pathways, with four areas of exploration followed by group discussion and mapping of possible pathways. The four probing areas of exploration with thought provoking sub-questions or points, as identified through the evaluation, were:

- Why should GRDC and CRDC invest in AWM for weeds?
    - What are the benefits for grain and cotton growers?
- What does collaboration across industries look like?
    - Within a region and across RDCs?
- What does a region need to have and do to set up and maintain AWM?
    - Capacity, landscape, social factors, industry mix
- Which weeds (or problem)?
    - Widespread, actively moving, ecology e.g. dispersal mechanisms, management options, engagement perspective, individual weed species or group of weed species

The final result of the discussions produced the future pathways map shown in Figure 3. In this figure, the earlier definition of the four models of AWM are shown to have successfully coalesced thinking and understanding, with two models of interest for further investigation. The comparison of AWM on established and an emerging weed was also of interest. This map of potential pathways is only the start of designing possible future work. For each item on the map, the next step would be analysis of the multi-disciplinary questions and work required to understand the problem, need and solutions from a systems perspective.

Ultimately, achievement of this outcome remained hamstrung by the lack of clear, common understanding and definition of AWM, as foundational to a project conducting research on the appropriateness and legitimacy of AWM. The final project workshop identified four models of AWM, but the timing of this means that only retrospective theorising is possible. There was no explicit testing of these models, or the appropriate landscape and social contexts for each of these models. One interviewee suggested that future work '*could come up with a clear idea of an end goal and how the different parts weave together*' while another suggested '*Do we need to scale back and try different methods within a region?*'

Figure 3 Future pathways identified at the final project workshop, Sydney May 2023



5 Project governance

Project governance is a key factor in influencing success of a project. Governance spans from contract management with delivery of KPIs as defined by the contract between GRDC and the Australian Government, the processes and structures to manage the project and how strategic decisions are informed and made. This project was overseen by a Steering Committee and was led by CSIRO. The main project implementation contract was with CSIRO, with CSIRO responsible for subcontracting researchers and regions and subsequent management of sub-contracts.

Contract delivery

An independent assessment of KPI delivery is detailed in the full report. There are 7 KPIs that were either reported by the project as not achieved in Performance Reports or are considered by the evaluator as not achieved. Achievement of these KPIs is contested by the evaluator on the basis of a lack of evidence to support the Performance Report assessment, or that the intent of the KPI has not been met. Additionally, it is worth noting that several KPIs are on the submission of progress reports, and not the quality of activities delivered, outcomes achieved or comprehensiveness of the progress report.

Steering Committee

A project steering committee was established to provide project oversight and direction on performance, financial governance, risk management, communications and evaluation. The steering committee consisted of the project leader, a representative from all participating RDCs (GRDC, CRDC, AgriFutures) and an independent. Administration of the steering committee was the responsibility of the GRDC representative. Meetings were held approximately every six months (seven meetings to 8 August 2022).

During the course of the project there was high turnover of steering committee members. The CRDC representative changed three times, the AgriFutures representative twice (with a third change forthcoming at the time of initial report drafting) and the independent changed twice.

Interviews were only sought with the Steering Committee members who were currently involved. The turnover of the Steering Committee members limited its effectiveness, with thoughts to the ideal number of participants and the composition of the Steering Committee.

> *'Not really helped. Struggled to get buy-in. There's been turnover in the organisations. Ends up as two people talking. Maybe needed more independents but still needed RDC stakeholders. Needed bolstering. Agronomists or growers can be difficult with time available.'*

> *'Feel haven't been involved in workshops or planning, joined mid-way.'*

Additional balance between the RDC membership and non-RDC membership may have brought new perspectives and encouraged discussion on the strategic aims of the project, and management towards those aims. The overriding view of the Steering Committee was that due to the reputations of the organisations involved, '*it's been in safe hands*.' Challenges with the project were also recognised, with these including grower motivation and the shift in weed strategy represented by the concept of AWM.

> *'The overarching challenge of landholder action on non-declared species and how to get motivations beyond legal.'*

> *'Safe hands. It's not just GRDC and CSIRO, but also cotton. Any change in strategy is a challenge, and that's a challenge across RDCs. I haven't seen cotton projects, just hort, grains and roadside.'*

Despite the view that the project was in 'safe hands', reflection also identified that greater questioning and involvement by the Steering Committee was needed.

> *'The Steering Committee could have been used more, for example attending the meeting in Mildura. The Steering Committee needs to be strategic but also needs to be informed, direct observation, too many cooks, not there from the start. If I had my time again, I'd ask more questions for example, where is the program logic?'*

> *'Asking why questions, what does it mean? Is what you are doing leading to meaningful outcomes? Where is the scientific rigour? Results to draw conclusions from?'*

The balance between strategic oversight, direct participation and operational interference is a common issue for Steering Committees more generally. There were also different levels of Steering Committee participation in the project, with the GRDC and CRDC investors present at all project meetings, both online and face to face. This meant that an external perspective to challenge any group think or hold project management to account was limited to two members, and often only one of either the AgriFutures or independent was able to attend meetings. The number of non-project Steering Committee members was insufficient to manage risk of non-attendance and turnover, or to diversify and balance the CSIRO, GRDC and CRDC participants.

Project management

GRDC held the contract with the Australian Government and CRDC, while CSIRO, the project lead, held the main contract with GRDC, and subcontracted the project team to create a hierarchical contract structure[7]. CSIRO has a reputation for contracting delays associated with working through legals (personal experience) and this project was no different, '*Contracting slowed things down. Dealing with big organisations and departments takes time with contracting.*' Throughout the project, Covid-19 meant sub-contracting was a constant activity, *'Covid meant had to shuffle funding, extensions, renegotiate sub-contracts with regions. Managed to do it and work through the legal teams.'*

[7] The contract between GRDC and CSIRO, and the CSIRO sub-contracts have not been reviewed.

The evaluator observed such contracting delays during monthly project management meetings. Additional social research on local government management of roadsides is first documented in the January 2023 monthly meeting notes. It was contracted about four months later, in the first week of May, significantly condensing the time available to do the work.

The active participation of GRDC in the project was recognised as a change from usual project management.

> *'Complicated. Run by GRDC with a CSIRO lead, but GRDC was strongly involved and continuously putting information into the project.'*
>
> *'This is different from a normal GRDC project. I've had more involvement. Possibly blurred lines in terms of who does what.'*
>
> *'Unclear on roles between GRDC and CSIRO'*
>
> *'Had monthly meetings, effort made, not a lot of interaction in monthly meetings. Lacked guidance, not sure who or where it was meant to be from CSIRO or GRDC.'*

The direct involvement of GRDC in the project was given conscious thought and treated with maturity and care by the GRDC individuals involved.

> *'Am I operational or strategic? I've done strategic things like liaising with the Feds, making sure we're meeting those requirements, looking at synergies and other opportunities like the biocontrol.'*
>
> *'Had to consciously not take over, no management responsibility but GRDC depended on me as the northern link.'*

The result was viewed positively by the project team, and this view was one rare area of agreement across the interviews.

> *'GRDC was good at keeping it on a path and also letting people go down paths if they need but still heading overall in the right direction. Hasn't stopped creativity. Good at stopping too many worm holes.'*
>
> *'GRDC funder and also in the project made it different. Had potential to hinder. Meant we knew firsthand what GRDC was wanting. Don't think it affected how I operated.'*

However, it must be questioned why there was this need for GRDC steering and involvement. This was not explicitly asked in the interviews, but a couple of possible explanations were offered, including that *'The project lead was too busy. Too long between follow ups.'*

The CSIRO project lead retired about a year into the project and this may have contributed to a loss of strategically focused leadership and vision for project. An informal leadership team also emerged, '*Sometimes there was an informal executive type group that did some brainstorming and problem solving.*' The organic development of this informal team suggests there was a leadership gap that needed filling. Possibly due to the organic development of this group, there was no mechanism established to communicate beyond the team and the connection between this leadership team and the project team was unclear.

> *'Not always clear on conversations and decisions at management level to the wider group. Minutes of management meetings could have been a mechanism to communicate better.'*

Monthly project team meetings

Monthly project team meetings were a key mechanism used to manage the project. However. there were mixed views on the effectiveness of these meetings. The reliable regularity of meetings was regarded positively with the online format recognised as needed to work around

Covid-19 travel restrictions. For some, a success indicator of these meetings was that the allocated time was filled, *'Meetings have happened regularly and have filled the agenda.'*

Views varied widely on the level of discussion and subsequent effectiveness of the meetings at driving the research agenda and collaboration. Some felt there was opportunity for discussion and the inclusion of the whole project team meant there was collaboration by default or as a result of individuals asking questions.

> *'Initial face to face meeting for first impressions. It meant everyone was comfortable over zoom to butt in. Monthly meetings good, consistent, kept things going.'*
>
> *'Well-structured communications but also casual. People can jump in and speak, ask questions.*
>
> *'Constant meeting and collaborations. At every project meeting event everyone is in the tent together, not just separate components. There's genuine interaction and collaborations, very collaborative people.'*

In contrast, others felt the monthly online meetings were operational and flat. One interviewee took the commentary on the role of meetings and regular communication in gaining collaboration further, suggesting that instead the project '*needed specific activities for integration*.'

> *'CSIRO set the agenda. They ask for suggestions. There's reporting back and progress updates. Wasn't time or space to deliberate. More operational.'*
>
> *'It was slow at times.'*
>
> *'Lots of meetings, too many meetings. Going around in circles at times. It was Covid impacted.'*
>
> *'Online is flat. Questions and silence.'*

Several interviewees also commented on the difference in depth of discussion achieved face-to-face and online, with broad recognition of the impact of Covid-19 border closures.

> *'Time between the first meeting and next face to face lost focus on the big picture.'*
>
> *'Lack of face to face was a challenge. Mildura was super useful. Could have done with Mildura earlier. Things clicked. It was a different dynamic with more time; realizing how to use the social science to target messaging. Had tried several times and every time scheduled there was another lockdown.'*
>
> *'How important face to face is. One a year or every 6 months getting everyone in the room. Really talk everything through. Actively thinking through things together face to face. Can do day to day running in zoom. Logistics and figuring out what folks doing. But gap in deeper thinking and conversations.'*

5.1 Adaptive management

The project adaptive management centred around managing Covid-19 and associated border closures and lockdowns. The challenge was not unique to this project, with all agricultural research and extension in 2020 and 2021 impacted to some degree.

> *'Covid impacted at the regional level the most. At research and higher level can get around it with online. The inability to get people together. Trials operating early to attract interest and people and communicated through existing forums and networks. Local activities were then limited to videos, podcasts, switched as much as could but doesn't replace face to face.'*

The knock-on effect of Covid-19 to project management was the additional time, without additional staff funding, coupled with unspent operational funds. In the Performance Reports the reasons for underspend included reduced face-to-face work, reduced travel for field research, cancelled regional trial work, reduced project meeting travel and sub-contracting delays. The ready ability of some project members to take on and expend additional funds may have influenced decisions on financial reallocation. Financial data has not been provided so it is not possible to evidence if financial reallocation has effectively shifted the emphasis of work in the project and therefore limited the achievement of some outcomes. However, increases in some project activities have been noted, with under performance of other KPIs documented in in the full report. The underspend was regularly reported to the Australian Government, however there was generally no feedback received from the Australian Government on the Performance Reports.

> *'Unspent operating but labour stretched out and there were conflicting motives for researchers and regions.'*
>
> *'Feds were silent. Too hard. How to update, don't know how to do this. Report on it and then silence. Same with budget. Massive underspend and still silence up until the last couple of months. Each milestone report it was stated and they were approved.'*

Underspend was not 'caught up' with ideas canvassed for a remaining $80,000 of unspent funds at the final project workshop in May 2023. The publicly published budget for the project was $1,867,219 with $933,609.42 of this in cash (https://www.agriculture.gov.au/agriculture-land/farm-food-drought/innovation/rural-research-development-for-profit/approved-projects-round4). However, the approved grant funding detailed in the Performance Reports is $1,867,219. The underspend is either 4% or 9% of the project's cash component.

Covid-19, drought and flood impacted regional trial sites, and this impacted expenditure. Instead of simply shifting the timing of activities, it appeared to change what activities were done.

> *'Biggest impact at start was severe drought no summer weeds. A whole year was delayed. If it was a big summer for weeds then would have been off and running quicker. Easy to forget the drought at the start, with Covid after it. It delayed sampling.'*

The most significant area of adaptive management was in the team working in the Darling Downs. The adaptive management applied to the region was facilitated with heavy GRDC involvement, with little involvement of the project lead. Actions led by GRDC included '*Trying to get northern grower alliance involved, co-location of trials to draw on expertise, comms support in GRDC*.' It was viewed that *'It was a tough call and should have made a change earlier. Someone needed to come up and see what was happening.'* It also appeared that the change in trial manager from a local agronomist to a CSIRO researcher was slow or delayed. Ultimately the Darling Downs trials implemented in the final year of the project, still looked at non-chemical control methods of slashing and crop competition with reportedly high levels of land manager interest supporting ongoing maintenance of the trials beyond the project's lifespan. It suggests the challenge was with the initial trial manager, as opposed to the trial treatments. Regardless, it does appear that in the absence of GRDC intervention, there would have been no regional trial results in the Darling Downs.

> *'Initial areas of work were dead ends. Had to help reverse out and find another path. The Darling Downs Landcare group had a natural tendency towards organic production and it didn't resonate with conventional farmers. It was only going to reach the margins, so had to refocus.'*

There was one adaptive management positive highlight identified in the project of a shift in social researcher brought into the project.

'One of the best things, brought in Sonia at start of project. I didn't like the way the project was heading. Before it was signed off CRDC had someone else in mind, but flexibility was needed to switch providers and researchers.'

Mid-term evaluation findings are a significant opportunity to reflect and identify improvements. It found that:

> "Internal project surveying and inspection of the project reporting documentation found that cataloguing, reporting and evaluation of engagement and extension activities could be improved. Very little dedicated evaluation of extension outputs has occurred." (Mid-term evaluation report)

The mid-term recommendations were:

> "The main recommendations from this report are:
> - Improved engagement between project team members
> - Data collection and evaluation of project extension outputs
> - Development of a project legacy
> - Future research planning"

Stepping through these recommendations, presumably the face-to-face meeting in Mildura was an attempt to improve engagement between project team members, but there was no ongoing change to improve engagement between project team members.

There is little evidence of any meaningful response to the lack of project documentation and the recommendation of improved data collection. The final evaluation interviews found that collection of communication and extension data was an ongoing issue '*I have to bug people to load information. Often didn't know about events until later.*' The communication and extension data available for this final evaluation remained patchy and poorly documented.

The third and fourth recommendations have remained ongoing tasks throughout the project. Legacy is regularly discussed at monthly meetings and both legacy and future research planning were agenda items at the final project workshop. Despite awareness of these needs, there does not appear to be any firm or actionable plan for either of these.

6 Learnings and insights

Project learnings have been questioned and documented several times during the project; in the mid-term evaluation, at the Mildura workshop, in the final evaluation interviews and at the final project workshop in Sydney. Project learnings has been a section in every Performance Report and is a section within the Australian Government reporting template. It is expected that CSIRO's final report to GRDC on 22 May will also document learnings, drawing on the learnings gathered at the Sydney workshop. The four most significant learnings at the final project workshop were:

- Need local activities and demonstration
- Can work across the models of AWM with tailored approaches, in response to the context
- A larger initiative is needed to bring stakeholders together
- The scale of AWM is smaller than you think

Discussion of these four learnings is not duplicated here, nor is there a collation of learnings across Performance Reports, the two workshops and the mid-term evaluation. Instead, the final evaluation has looked across the learnings gathered through the interviews and considered these from a more strategic perspective. Thematic analysis of gathered learnings has not been done, but there has been interpretation of learnings alongside the insights gathered through the

evaluation process. As such this section is aimed at supporting GRDC and CRDC to look deeper at the successes and challenges of the project and use the insights and interpretations to inform the design of future investments.

Research design

The first and foremost learning is on the need for a robust research design that ensures consistent focus on the research question across all levels and parts of the project, from literature review through to experimental design, data collection and analysis. The literature review was described as a '*piecemeal approach to looking elsewhere'.*

There are examples of AWM of weeds in Australia and overseas. These examples may not be in the published scientific literature. A broader scan of weed management would likely have found examples of AWM of biodiversity weeds across mixed agricultural landscapes. There are experiences that can be learnt from and transferrable tools for engaging and coordinating across land managers. For example, in biodiversity focused AWM remote sensing using drones has accurately mapped weed densities and monitored the effectiveness of control across larger areas and weed control works on roadsides have been coordinated with local governments (pers comms). The mapping, analysis and modelling of vegetation connectivity and native fauna dispersal is also more sophisticated than the single data points mapped here (pers comms).

The project was described as '*Lots of disparate projects. How does it come together, what is the synthesis of ideas and management recommendations?'* The mixed findings on collaboration highlights the different past experiences across the project team. Some had more experience working across disciplines, while for others simply being on a project with other disciplines was novel. As stated by one interviewee, the project '*needed specific activities for integration.'*

The research question was to test the concept of AWM and identify where and when AWM is a viable option, i.e. can AWM be used to reduce the impact of weeds, and what are the enabling contexts for successful AWM? The intended experimental design applied a 'treatment' of participatory action research with regional groups designing and implementing trials, with these regional groups supported with herbicide resistance, genetics and social data to understand the science behind weed dispersal, at a regional scale. The regional trials of tactics to reduce weed dispersal across land managers and land uses were intended as an activity to bring land managers together. To answer the research question, the regions were pivotal and primary focal points, with the project-wide research activities ancillary. This means that integration across disciplines needs to occur at a regional scale and within the region.

The trial sites offered potential for bringing the disciplines together to develop a deep and detailed understanding of AWM. Some of the trials purposefully looked at how on-ground tactics impacted the spread of weeds from one site to another. The mapping produced does not show how these sites related to the regional sampling for herbicide resistance and genetic analysis. It is not clear how weed sampling for herbicide resistance and genetics strategically tested pre-identified and articulated assumptions on dispersal, land uses or other criteria to inform decisions on the design of future AWM. A missed opportunity was to sample in relation to the trial sites, perhaps in an expanding radius or along hypothesised dispersal pathways, to build a comprehensive picture of weed movement around the sites. While the first year was challenged with drought conditions and low weed numbers, it appears that sampling was influenced by convenience access along roadways. Instead, the project has developed more generalised findings in each region, and separate findings at trial sites within these regions.

> *'All done in parallel – then evaluation and integration to test models across the regions. Weren't clear enough on what baseline going to be, to do it.'*

When looking at the project from the perspective of doing research on AWM as a potential method for reducing the impact of weeds in a region or across properties, the most important

findings are on the regional experience of facilitating across individuals, industries and organisations at the regional scale. Arguably, the hypothesised function of AWM is to:

- prevent new incursions of emerging weeds, or
- higher standard weed management of a greater density within an area to reduce overall weed management burden, or
- create an area with a collectively higher level of weed control with an internally lower weed seed burden that is not replenished from the surrounding and external landscape, with the potential for this 'weed clean' core area to expand across the landscape.

A multidisciplinary support team for such research would need to have the capacity to understand the weed seed bank including seed bank survival, weed dispersal and the range of farming systems approaches to weed control across land uses. A research design led project would likely have involved additional people or organisations. One interviewee commented:

> '*The relationships were there in advance. With the groups to engage, I don't know how the three groups were identified. It was opportunistic to use existing relationships. It's design versus the people.*'

The project did not have a weed ecologist on the team and there was no research consideration of the weed within the farming system and landscape, beyond the regional trials. As a result, key questions remain. If AWM models was established across properties or a larger networked area, which boundaries are at most risk of weed introduction, what density of land manager participation is required for effective reduction in weed impact, and for a group of neighbouring properties how long would the collective need to be maintained for before the internal area has a sufficiently low weed seed bank, what resources could it save the individual land manager by focusing on collective perimeters, how is weed management burden then shared when the internal beneficiary is essentially a free-loader?

A structured research design around the testing of AWM was not apparent. There has been no articulation of treatments (models of AWM tested) and collection of multidisciplinary evidence to support or refute the potential for any model of AWM.

The interviews also identified lessons in regard to the evaluation.

> *'Learnings around evaluation, wasn't a consistent, we provide report to CSIRO but didn't see what was provided upwards – document having and sharing not there, reliant on meetings.'*

Resistance to innovation (change)

A multidisciplinary view requires discussion and analysis of the problem from multiple perspectives. Discussion of AWM, through to a commonly understood definition of AWM and the range of models, was limited throughout the project with the four models identified at the final project workshop. The distinction of the four models means that the project team can now more effectively communicate with each other on AWM, with awareness of which of the models they are applying, who else is applying that model and who is applying a different model. An experimental design with clear articulation of the research question and treatments, with a common language and understanding of those treatments, may have enabled cross disciplinary communication. However, a common language for communication is not the only precursor for innovation within a team.

Several interviewees commented on the difficulty of getting the project team to understand and embrace the research question, '*getting the research team on board to understand was a challenge.*' There were findings from the social and economic research that shows land manager interest and willingness for greater working together on weed management, but that there are challenges with time availability for group meetings.

However, the most resistance to testing AWM appeared to come from the project team. Possibly greater set up time was needed to gain buy-in '*having time for the group to work things out, pilot before launching in*' or a different group of project team members.

An innovative and different way of looking at weed management requires open thinking and discussion on the underlying assumptions, and listening to the experiences and insights of others. Innovation, as opposed to continuous improvement, requires a change of some form and change can be confronting and difficult for some. The project team and subsequently focus of activities was observed to be dominated by a researcher who did not embrace the research question, and was not able to put aside their area of expertise or position it within a group research question. This remained evident at the final project workshop where probing questions on the underlying assumptions and design of the project were used to generate discussion on future pathways. As guided by an interview, the question on which weed was posed to the group. While others in the room readily questioned and suggested emergent and actively moving weeds, this was met with resistance.

Observations of the varying ability for individuals to openly engage were also observed by members of the project team, '*Interdisciplinary in weeds is a new thing. Big learning is finding people who care and are open to others.*' For an innovative project it is critical to '*consider who you are engaging. Get them on board early and make sure it is someone who is capable*.' The capacity required for innovation is more than technical, but also personality based in terms of openness and willingness to shift outside their area of expertise and comfort.

Coordination and collaboration

Relationships increased and improved during the project; '*Greatest strength is the network and relationships outside of my area*' and '*if there are future projects, if the team continues now, we have a developed base*.'

However, there were mixed views on project collaboration that highlighted differences in past experience working across disciplines, and a generally poor understanding of the differences between knowledge sharing, coordination and collaboration.

Knowledge sharing occurred across the project, and the regular meetings supported this as individuals each presented or briefed the team on progress, '*In meetings might say running this trial, results looking good but that's it.*' Undoubtedly, the project team members '*Learnt a lot by being on the project. What they are looking for, the technical learnings, like the council rules, genetics, State legislation, local govt role on weeds*' and enjoyed the team experience, '*Nice to work on a project with a range of collaborators, from different regions*.'

Coordination is the organisation of different parts to 'fit' or schedule together. It involves clear role definition and hand-over points between different parts of the project. A common research design would have assisted coordination, with team members knowing how their input connected with others. Coordination can occur internally or externally to the project team, with one interviewee providing the following example.

> *'On another project, I make sampling kits, engage with crop consultants, and post them out. After I then send out results to crop consultants in a personalised report.'*

In this example, the crop consultants are participating in the researcher's project. The consultants may support the goal of the research but have not been involved in the design of the research or interpretation of results.

Coordination and collaboration require buy-in to the research problem, and this was not consistent across the project team.

> '*If I had my time again, I'd choose different partners. Some were ok but others struggled to grasp the context.*'

Research collaborations have a shared purpose with each party contributing to problem definition and an integrated, holistic solution. In collaboration there is discussion and shifts in activities as parties come together on a joint goal, as opposed to organisations or individuals separately doing interlocking tasks towards aligned goals.

Coordination and collaboration do not occur without some trigger or driver and '*without the RRnD4P mandate it wouldn't happen. It's deliberately bringing sectors together*.' There was value perceived in the higher-level collaboration across industries and a recognition that weed management differed across industries. Leadership is required across all levels for future AWM endeavours, with regions *'happy to nurture a new project but needs a GRDC or CSIRO. Needs those higher-level connections.'* It undoubtedly '*needs ongoing energy to keep it rolling.'*

Coordination and collaboration also require an investment in time, with greater time and resources required for collaboration, including a greater level of facilitation. The project was designed for collaborative research within the regions, and also across the project. It was difficult for the project to bring together the experiences and learnings across the project and it is suggested that this is largely due to a lack of coherent, commonly understood framework and research design. In this view, cross-learnings may not be about replicated treatments across regions, but research that explores what differences between the regions led to their differing results.

> *'The three regions are so different. The organizations are very different and operate very differently. If the organisations had been more similar there would have been more opportunity for cross learnings.'*

The need for participatory action research at the on-ground level can be debated, with the coordinated and collaborative models of AWM achievable without on-ground participatory action research on weed control tactics across boundaries or areas. Collaboration across the project and its multiple disciplines would have been assisted by facilitated systems thinking, to encourage and support this capability.

> *'May have over- or under-estimated farming systems and how others can understand.'*

Capability and resourcing

Capability and resourcing were variable across the project team. The time needed to manage the project was underestimated,[8] '*need to budget for a dedicated project manager. So much hand holding in the project*.' Comments such as these raise questions on the role of project lead and how this differs from a project manager, and the adequacy of the time and budget allocated to project management by the project lead. The contractual details between GRDC and CSIRO, including the deliverable tasks and time allocated to project management are unknown.

However, feedback gained through the interviews was that *'[The project lead] was too busy. Too long between follow ups*' and that this resulted in a lack of appreciation of the extent of regional challenges and difficult decisions to redirect support to struggling areas of the project were delayed. Interview responses on project learnings and what you would do differently next time addressed the insufficient availability of the project lead with recommendations offered such as:

> *'Underestimated amount of time on the project. Wasn't anyone's core business to lead full time. Always just bits of people.'*
>
> *'Have a dedicated manager to be the liaison between research and on ground coordinators and facilitators.'*

[8] This is difficult to verify. The contract between GRDC and CSIRO has not been independently reviewed, and details on budget allocation between the different parts of the project have not been provided.

There was confusion on project management roles, but as evidenced and discussed previously, it is not clear how this impacted performance of the project. The ongoing input and participation of GRDC into the project appeared to help GRDC have a deeper understanding of the project, as required to write and submit reporting to the Australian Government, and also was observed as a consistent voice reminding the project team of the vision and intent of the project. Suggestions, such as the production of some sort of best practice guide for AWM were repeatedly made[9] but there was no evidence that these suggestions were taken on by the project.

In this context of insufficient resourcing of project leadership, there was limited time available to assist or facilitate connections across different parts of the project. For example, the translation of technical research findings into terms suitable for extension to land managers was challenging across the project. Added to this, there were different organisational capacities across the project team with

> '*Projects partners without experience in larger research project. It was an eye opener for some project groups. To see how others operate, just amazed by others' communications, a real spectrum of capacity*.'

The capability to translate research into farmer ready messaging was not consistently available within the project team. Some regional leads had past experience with trial work, partnering with agronomists and other technical experts, while others didn't.

> *'Localised data is valuable for saying samples relevant to you directly. Local data is valuable, but the person has to have technical know-how or support to coordinate it.'*

There were also differences between the size of the regional organisations and their pre-existing membership base or network of land managers, and the distribution reach of regular established communication channels. The project reacted by sourcing additional support from GRDC's communications team and independent communications expertise to assist with specific outputs such as case studies. The translation of research into extension materials is not evident in any strategic or coordinated manner (individual presentations have been provided to specific audiences).

> *'Maybe if extension focused have clear comms plan and dedicated person to pull things together. Be the knowledge broker.'*

Future projects like this may benefit from '*contracting in expertise*' or have dedicated resources for key communication outputs, '*Need to strengthen website management, might be why didn't get behaviour change. Need dedicated comms to help with promotions*.' While the need for dedicated communications support was identified during the interviews, the evaluation has also found other areas of weakness, such as the research design, systems thinking, evaluation and facilitation. These are all areas that should be considered essential for projects of this nature, and capability and resourcing gaps in these areas can be met through additional, targeted supporting services.

In addition, the social science was a key element in the project and was underutilised. While the contribution from the social science was readily acknowledged and highly appreciated, the project was just as much a social science experiment and should have been given a major role in designing the research.

> *'Advocate for social science and engaging with regions. Bring in from range of people in regions. Getting consultants engaged in the project. Consider cross disciplinary approach to project.'*

[9] The first observation and documentation of this suggestion was at the Mildura workshop in May 2022. Discussion on legacy documents was noted in the February 2022 project team meeting notes.

Regionalisation

Covid-19 necessitated a different way of working across borders. The risk of key project team members not able to travel across the project was not sufficiently planned for or mitigated in the design of the project. Travel restrictions meant that individuals needed to lean on each other to complete some tasks, while limiting the development of some relationships and access to support.

> '*Forced by the pandemic to realise don't have to do everything myself. Got a better result with more than a couple of days of me in the field. The downside is less control over what you get. Always an element of unpredictability. Send out 10 kits, get 5 back. Need to design the project to give to more people. AWM regions are more invested in the results by collecting own samples, when go out and collect, want to know more. It's a model for generating interest and getting work done.*'
>
> '*Needed a consultant in the region to overcome the border issues*.'
>
> '*There's other herbicide resistance work outside of AWM in QLD.'*

It is common practice in trial work to spread sites across agroclimatic zones, to manage for environmental risks such as drought or flood. Covid-19 highlighted that, where possible, technical support should be sourced closer to growers, to promote State and regional relationships with more accessible researchers. While this may be seen to duplicate expertise within the overall project team, this overlap is only from a national perspective. At the regional level, it fills a capacity gap and ensures support is available and accessible, to build longer-term vested relationships.

7 Recommendations

There is interest, willingness and to some extent grower-level demand for improved weed management within regions or across property boundaries. The project has explored the idea of AWM, shown that it could have merit and generated some insights on what various models of AWM may entail. However, the concept of AWM is yet to be tested.

> '*The research question is reflected in the title. Will AWM of weeds work? What's the benefit? Exploring the opportunity. Still haven't answered the research question. The other question is what are the conditions or landscapes and social geography aspects that's important to allow AWM to work.*'
>
> '*Can't say if AWM is more than a concept. Where is the example of it working in practice? What has been the goal in getting this up?*'

While some areas of the project '*have generated data that there is potential to approach weed management in that way by improving understanding, majority of people believe it is important to work together*,' there is no clear guidance on how (and where) to translate AWM in practice, for the benefit of the grains industry.

Recommendation 1. Conduct a pilot trial of the concept of AWM, with an experimental design that applies the now defined different models of AWM as treatments at localised scales.

This is a social science experiment that uses weed ecology, on-farm economics, social capacity (individual land managers) and institutional capacity (industry organisations and regional groups). As a social science experiment, multidisciplinary findings on weed ecology, genetics or other aspects would provide supporting data that demonstrates the benefits and need for an AWM approach. A future pilot trial will need to carefully select project team members and be underpinned by experimental design with social research at its lead and centre. There are

challenges associated with working across industries and even farming philosophies within cropping communities.

The project insights have identified some factors that need to be considered in the design of any future attempts to test and develop a workable model of AWM.

The project findings suggest that the first set of conditions, landscapes or social geography for a future trial is an area with a relatively uniform type of property and farming enterprise, and a limited number of different public land managers. Such a pilot trial would essentially be stripping back some of the complexities identified in this early exploration of AWM.

> *'linking in irrigation makes more complex and compressed – more industries, more neighbours.'*
>
> *'More open mindedness to on ground works – different farming approaches – these differences are in the area.'*

The experiences of the project indicate that future experimentation on AWM also needs to occur at a neighbourhood scale.

> *'The scales went down. Movement over short distances compared to insects.'*
>
> *'More localised discussions on doing better weed management.'*

It may be possible to coordinate smaller groups of directly neighbouring landholders to collectively form a larger weed management unit with a different extent or type of weed control on its collective boundaries, compared to the internal area. This could test a biosecurity style hypothesis that expanding boundaries or areas of weed control can eliminate and then limit reinfestation.

An alternative hypothesis could be that a critical mass of weed control can reduce overall weed burden in an area. This hypothesis may be suitable for testing within a predominantly cotton growing area on the basis that weeds are rarely found in the crop, but are harboured around machinery sheds and roadways. This critical mass hypothesis could test for different densities of weed control across property boundaries within a geographic area.

The question of focal weed or focal weed management problem was raised at the final project workshop. Ultimately, to engage growers to invest their time, energy and funds there must be an identified and agreed problem. The willingness to pay highlighted that land managers need to be confident of a high quality of result. A widespread, established weed is likely to be viewed as an intractable problem with an accepted cost, while a new and emerging weed may represent an achievable target and new cost item. The ability to observe and measure results is also likely to support grower engagement and on-going commitment. While some project team individuals remained firmly of the view that herbicide resistance was the most pressing problem and there was a suggestion in the interviews that spray drift is also a problem of community interest and concern. At the final workshop, the group facilitated discussion on future pathway identified the need to test AWM on a moving weed such as parthenium moving into a new area.

Recommendation 2. Any trial of AWM models needs to be designed to inform future development of a working AWM model, with data collection on the individual and collective costs and resources (skills, time and funding).

The issue of funding to coordinate AWM was raised at the final project workshop and the development of a low-cost model was suggested as needed. Across the four models of AWM defined at the workshop it is reasonable to expect differing levels of project investment. Returning to the project initiation workshop in 2019, social science literature on the types of collective action was presented, see Figure 4. Each of these different types of collective action would have different costs. The concept of AWM, as defined by the four models, needs to be tested first to identify the enablers and barriers to the success of each model.

This means that the research design needs to plan for the standardised collection of resources and capacity used and required by each trialled model of AWM.

Figure 4 Extract from social science presentation 2019

Recommendation 3. Treat the project as industry applied research that tests the transferable knowledge and tools from other industries.

Treating the project as research means an experimental design that specifies the treatments and comparisons expected, the data that needs to be collected and the research commences with a thorough literature and practice review. A wider scan of weed management practices would show that the project was not seeking to trial or develop a completely novel concept and that there are transferable technologies of potential relevance to grains and cotton industries. AWM of weeds is successfully being used in Australia for weeds of biodiversity concern, with projects spanning multiple land manager types. Remote sensing data, such as drone footage, is successfully being used to map large areas of weeds and monitor treatment effectiveness.

Recommendation 4. Commence multidisciplinary research with a systems thinking approach to problem definition.

The project experienced several challenges around collaborative multi-disciplinary research, including research design and the effective translation of research results for grower audiences. These challenges highlighted the critical role of strategic project leadership that can bring disciplines together in a farming systems understanding that fosters ready translation of research results to grower audiences.

A critical step in establishing the research is the initial project workshop. This is the opportunity for multidisciplinary problem definition and group forming that can set the tone for the rest of the project. It is also the most useful timing to identify any disciplines that have been overlooked and any project team members who have not fully embraced the research question. Ongoing facilitation across disciplines and between regions and researchers is then needed to keep the project on track. Collaboration requires more than a reporting back style of meeting, but focused discussion and joint solution development.

Recommendation 5. An individual project manager or leadership team is required that collectively has the skills needed in knowledge brokering, research translation, systems thinking, social research design, facilitation and evaluation.

Active leadership is needed to steer multiple sub-projects towards a joint research finding. There remains a role for GRDC and CRDC leadership in providing direction and a voice for research investors (in this case growers) to ensure the project delivers value for growers.

Investment managers need to feel empowered to take remedial action or at least request deliverables. An example is the ongoing suggestion of a guide to AWM. There was no action on this suggestion, and the suggestion was also not discussed and withdrawn. The underlying need for some finding or output that delivers value to growers remained, and remained unmet.

Ongoing management requires facilitation and understanding of how the different parts of the project come together into a synergistic whole, ensuring each piece contributes to the project objective or research question.

There are experts in soft skills that can be brought in to complement leadership. For example, there is a well-recognised gap in translation of research to practice change, and it cannot be expected that simply by having researchers in the same project as extension officers that this translation will occur. Specialist support in communication is needed early, if the outputs are to be used and have impact within the project term. Systems thinking skills are also necessary in multi-disciplinary work.

Recommendation 6. Manage risks and adjustments to deliver on project outcomes.

The project consistently had underspend. Underspend is often indicative of underperformance. In this case, Covid-19 contributed to savings where team members were temporarily unable to travel to regions. This meant that more distant regions (i.e. Darling Downs) lacked the necessary support. More localised support was eventually sourced, but the delay meant a gap in services and expenses.

Where a project is consistently underspend, the reallocation of budget can change the emphasis and focus of activities. This can impact the achievement of desired outcomes. Changes are inevitable in a longer-term project, so decision-making processes that ensure the project still delivers meaningful results are required. These processes also need a mechanism to address conflicts of interest from within the project team. In this example, a redirection of funding to bring in additional expertise in soft skills in research translation or systems thinking would have assisted all areas of the project and enhanced results.

Recommendation 7. Project manage for turnover of managers and Steering Committee members. A long-term project will inevitably have turnover of key individuals. In this case the CSIRO project manager, CRDC manager, GRDC manager and two other members of the Steering Committee all changed. While at project establishment, strategic thinking, design work and the various project plans need to be completed, a scheduled review point can provide an opportunity for newer project managers or Steering Committee members to have meaningful influence. The onboarding process for new project managers and Steering Committee members could also embrace the opportunity for fresh eyes to review the project. Onboarding needs to ensure new individuals are familiar with the project's objectives, research design and expected final outputs. This requires a clearly documented project plan or experimental design that is supported by sufficiently detailed meeting notes with documented decision-making rationale and action tracking.

A review as part of onboarding, can happen at any point in time. The insights generate points for broader discussion. Review and insights do not automatically translate into sweeping changes, with all suggestions still needing to be considered in terms of resourcing feasibility and appropriateness for the project's objectives.

Appendix 1. Evaluation method

Additional details on the evaluation method include definition of the theory of change outcomes and the interview questions.

Theory of change

Table 3 Definition of the project outcomes

Project outcome	Definition
Improved collaboration across diverse stakeholders	Collaboration across stakeholders includes coordinating and sharing use of resources, knowledge sharing and joint decision-making to achieve common goals in the project. The stakeholders engaged are diverse and include land managers (growers and public land managers), researchers, extension officers and investors. Note this outcome is focused to actions within the project team and direct partners – not improved collaboration across land managers as AWM is adopted outside of the project trials.
Increased technical knowledge used in improved solution development	This includes scientific outputs from the project and evidence of benefits of AWM that can be used to inform the design of solutions, including the communication of AWM to land managers and partners.
Improved communication and extension to land managers	Improved communication and extension includes coordinated and tailored messaging for different land managers, the availability of supporting resources such as guidelines, and a range of communication and extension formats and media. Extension and communication outputs contribute to this outcome.
Increased capacity for land managers and partners to implement AWM	Capacity includes awareness and motivation to act, along with the resources and skills to take action collaboratively. Capacity is increased for land managers and the project partners/facilitators.
Informed pathway for future industry collaborations	Project partners and other potential collaborators have gained knowledge on the gaps and opportunities for future AWM collaborations. Strategic priorities are set, and industry collaborators are seeking opportunities to resource AWM initiatives.

Project interviews

Outcomes and themes that required additional detail from project leaders and team members includes:

- The extent of collaboration gained, how this has been achieved and what have been the benefits?
- What is needed for future industry collaboration?
- How have technical findings informed project activities, and what future directions to these point towards?
- Satisfaction with governance structures and the contribution project governance has made to the project's success?
- What adaptive management has occurred based on findings generated by the project, and how has this improved the project?
- What are the key learnings?

Qualitative data was gathered through 1 on 1 interviews with a sample of up to 15 project team members, including the Steering Committee, researchers and regional leads.

The interviews each took approximately 45 minutes and were conducted at a mutually agreed time with detailed handwritten notes compiled. Full transcripts will not be created and quotes used for illustrative purposes have been anonymised as far as possible.

The interviews were conducted in mid-January 2023. The semi-structured interview questions were:

1. Could you please describe your role in the AWM project?
2. In your opinion, what has been the most significant achievement of the AWM project? Why (what are the benefits or impacts of this achievement)? What has enabled this achievement?
3. How has collaboration contributed to this achievement?
4. What do you think is needed for ongoing future collaboration in this area?
5. How were the project activities informed by technical findings, including the results of the social research conducted?
6. Based on your experience and the findings gathered by the project, what are the priorities for future management of mobile weeds? (including any remaining technical knowledge gaps)
7. How has the management of the project contributed to the project's achievements?
8. Can you describe any adaptive management that the project undertook? How effective was this at ensuring the project outcomes were achieved?
9. Do you have any suggestions for improving management of any future, similar project?
10. Looking back across the project, what do you think are the key learnings gained?