

SOIL CRC

Performance through collaboration



ANNUAL REPORT

2021

MAJOR PARTNERS



PARTNERS



ASSOCIATES



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About the Soil CRC

The Cooperative Research Centre for High Performance Soils (the Soil CRC) was established in 2017 to give farmers the knowledge and tools they need to make decisions on extremely complex soil management issues.

It bridges the gap between soil science and farm management. It does so by bringing together scientists, industry and farmers to find practical solutions to improve the performance and productivity of Australia's soil. This enables farmers to optimise their productivity, yield and profitability, while ensuring the long-term sustainability of their farming businesses.

The profitability of Australian farms can be increased by improving soil productivity.

Through its soil research and innovation program, the Soil CRC is developing novel solutions that are unlocking the potential of Australia's agricultural sector.

The Soil CRC is the largest collaborative soil research effort in Australia's history.



Participants

- 4 state government agencies
- 8 universities
- 8 industry partners
- 20 grower groups

Vision

Australian farmers using best practice soil management to underpin a dynamic, sustainable and profitable agricultural sector.

Mission

To contribute new knowledge, tools and practices to help Australia's farmers better manage their soils in order to improve the profitability, sustainability, resilience and wellbeing of the agriculture sector.

Values

Collaborative

The Soil CRC is a collaborative and inclusive research and adoption organisation, passionate about soil, and bold in its approach to delivering outcomes.

End user driven and focussed

The Soil CRC is end user driven in all things it does. Through farmer and other groups, industry are genuine partners in the CRC, helping to set priorities, develop proposals, undertake research, interpret results and communicate new knowledge.

Multidisciplinary

The Soil CRC employs the necessary disciplines and expertise to deliver change during the life of the CRC, while being aspirational in its long-term goals to ensure a continuing legacy.

Research excellence

The Soil CRC is committed to research excellence — in science practice, capacity building, governance, management, integrity and ethics. The CRC is committed to being a national collaborative leader, recognised as an integral part of Australia's agricultural innovation system.

2021 in review



10 Years' funding



\$39.5 million Australian Government investment



\$127 million cash and in-kind industry support



12 new projects approved



10 new PhD students commenced



26 PhD students currently enrolled



25 Milestones achieved to date



4 programs



\$7 million committed to new projects



21 Soil CRC projects in progress



Chair's review

Soil health is a priority for many Australian farmers. It is encouraging to see soil health at the forefront of Australian Government policy, with the release of the National Soil Strategy earlier this year.

The National Soil Strategy is the culmination of many months of consultation with stakeholders across the country, including the Soil CRC and its participant organisations. It has three main goals: to prioritise soil health, empower soil innovation and stewardship, and strengthen soil knowledge and capability. The activities of the Soil CRC align strongly with these goals, and will contribute significantly to the successful implementation of the Strategy.

In December last year, we saw further commitment to soil health from our politicians when the Parliamentary Friends of Soil was created. The group provides a unique opportunity for the broad soil community, and their elected representatives, to acknowledge the importance of healthy soil as a natural resource, and its contribution to Australia's long-term economic, environmental and social wellbeing.

Co-chaired by the Hon Michael McCormack MP, and the Hon Linda Burney MP, the group will provide a forum to bring issues associated with soil health to politicians and policymakers. The group was officially launched at a breakfast at Old Parliament House in Canberra, hosted and organised by the Soil CRC, with the support of Soil Science Australia, Soils For Life and the Office of the National Soils Advocate.

I was saddened by the death of Major General the Hon Michael Jeffery last year. General Jeffery was the inaugural National Soils Advocate, as well as the inaugural Patron of the Soil CRC. He played an important role in ensuring the Soil CRC bid was successful. The Soil CRC is immensely grateful for General Jeffrey's leadership and support both as National Soils Advocate and as Patron of the Soil CRC, and more broadly, as a passionate supporter of soil health throughout his life.

Following in the impressive footsteps of General Jeffery, the Hon Penelope Wensley AC was appointed as the new National Soils Advocate. In March, I was delighted she also accepted the position of Patron of the Soil CRC. She brings knowledge and experience in soil leadership and is passionate about raising awareness of soils as a critical national asset.

As we moved into our second year of living in a pandemic, we were forced to replace our planned Participants Conference with an online meeting. Despite the disappointment of being unable to meet face-to-face, the meeting was a great success. With over 200 attendees from across the country, we were inspired by the vision from new Soil CRC Patron, the Hon Penny Wensley AC.

The four panel sessions on soil carbon, soil stewardship, soil sensors and grower groups proved an excellent opportunity to hear different perspectives from within the Soil CRC, and engage in valuable discussions. As well as individuals dialling in from across Australia, we created hubs at each of our eight university partners for Soil CRC colleagues to gather face-to-face, join the meeting, and enjoy lunch together.

I want to thank all our participant organisations for their continued contributions throughout the pandemic. Each and every one of us has experienced challenges during this time.

The commitment our participants have shown to the Soil CRC and soil research, despite many obstacles, is to be commended.

At the end of 2020, Dr Anna Lavelle stepped down from our board, after three years of service. I thank Anna for her significant contribution to the Soil CRC as an independent director. Her specialist knowledge in commercialisation and



intellectual property, and her role as Chair of the Commercialisation and Intellectual Property Advisory Committee, were especially valued.

I welcome Dr Simon Speirs to the board as an independent director. Simon is an agricultural innovation specialist focused on research, development and engineering strategy, and business model development. He brings technology, innovation and intellectual property knowledge.

I would like to extend my gratitude and thanks to the members of the board and management for their valuable contributions again this year.

Dr Paul Greenfield AO FTSE
Chair, Soil CRC

Chief Executive Officer's report

In this fourth year of the Soil CRC, we continued to increase our research activities, and started delivering project outputs. This has set us up to have a significant beneficial impact in years to come.



As with all sectors of Australian society, we faced the challenges of the COVID-19 pandemic. We worked with our participants to mitigate and manage impacts on our delivery, while simultaneously making new investments in projects to address our mission of helping Australia's farmers better manage their soils for profitability, sustainability, resilience and wellbeing.

My review of 2020–21 is best placed in the context of the 2019–23 Strategic Plan, particularly its five strategies — research; adoption; capability and capacity building; partnerships and leadership; governance and management — and their corresponding objectives, outcomes and actions.

Research — We will undertake high quality research that enhances the productivity, profitability and sustainability of Australian agriculture and meets our agreed commitments.

In September 2020, we reviewed and revised our Australian Government Funding Agreement outputs and milestones and formalised a variation with the Australian Government to ensure our milestones better reflect the needs of our end user participants, and future opportunities. We allocated another \$7 million of Soil CRC funds to 12 new projects that will allow us to deliver on those outputs and milestones, with all projects involving multi-participant partnerships within and across the Soil CRC.

Adoption — We will deliver new and useful knowledge to our industry partners, end users and Australian agriculture, using multiple platforms and formats, through existing channels and the CRC's own communication pathways.

The annual Soil CRC Participants Conference could not be held face-to-face, due to the COVID-19 pandemic. However, the substitute online meeting attracted over 200 attendees from CRC participants across the country and was very well received. After this event, we established a regular fortnightly webinar series, which gave Soil CRC researchers the opportunity to present their progress and findings to a virtual audience, in real time, and through the extensive library of video recordings now on the Soil CRC website.

Capability and capacity building — We will support the development of agriculture industry professionals and industry's capacity to manage soils for sustainable outcomes that support Australian agriculture.

In 2020–21, we put a big effort into building the cohort of Soil CRC PhD students, welcoming 10 new PhD students, and funding another 24 PhD projects. This means we will soon see 50 PhDs in the Soil CRC program. The students are undertaking an 'industry exposure' program, with additional activities designed to build their communication skills, and ability to work with industry and farmers. In addition, 30 soil health staff from grower groups, landcare groups and natural resource management organisations across Australia completed a two-year Soil CRC program. This allowed them to develop their soil health technical skills, and better deliver soil health projects.

Partnerships and leadership — We will actively engage our partners in all stages of planning, design and, development and implementation of research activities, and we will demonstrate national and international leadership in soil research.

Increased national interest in soil health, soil stewardship and soil carbon sequestration saw the Soil CRC take a leadership role in making a science-based contribution to the discussions. As CEO, I was often asked by media for comment and opinion. Each occasion provided an opportunity to promote the activity of the Soil CRC. We had significant input into the development of the National Soil Strategy, released by the Australian Government in May 2021, and look forward to being a leader in its implementation.

Governance and management — We will pursue the highest standards of governance and management, including the development of capacity and capability, embracing diversity and equal opportunity. Our management systems will be fit for purpose, efficient and focussed on supporting the Soil CRC's goals.

The operations of the Soil CRC are supported by a small team of staff — Jodi, Mark, Katherine, Julie, Cassandra, Jessie and Kathy. All made a significant contribution to the effective and efficient operation of the CRC, especially in the face of the pandemic and its impacts. The four Program Leaders — Catherine, Richard, Nanthi and Lukas — all provided effective science leadership to their programs and demonstrated a commitment to working together in a more integrated manner. I would like to recognise and thank the staff and the Program Leaders for their ongoing commitment to the mission and values of the Soil CRC, and the support they provide me. And finally, I would like to thank the Soil CRC Board, led by the Chair, Dr Paul Greenfield, for their strategic oversight of the Soil CRC throughout the year.

I commend this annual report to you as a formal record of our fourth year.



Dr Michael Crawford
Chief Executive Officer, Soil CRC

Executive summary

12 new projects were approved by the board at its April meeting, with a total lifetime investment of \$7 million. This brings the total number of approved Soil CRC projects to 59. The CRC has now allocated \$26 million of its cash resources to projects.

Three projects were completed.

The *Smelling soil* project led by Dr Shane Powell from the University of Tasmania, *Visualising Australasia's soils* led by Associate Professor Peter Dahlhaus from Federation University Australia, and *Why soil management practices are adopted*, led by Associate Professor Vaughan Higgins from the University of Tasmania.

The National Soils Advocate, the Hon Penelope Wensley AC was appointed as the Patron of the Soil CRC. She brings knowledge and experience in soil leadership to both roles and is passionate about raising awareness of soils as a critical national asset.

COVID-19 cancelled our face-to-face Participants Conference, again. Despite our disappointment, the replacement online meeting was a great success.

Two hundred attendees from across the country were inspired by the vision of new Soil CRC Patron, the Hon Penny Wensley AC. The four panel sessions on soil carbon, soil stewardship, soil sensors, and grower groups, gave different perspectives from within the Soil CRC, and resulted in valuable discussions. As well as individuals dialling in from across Australia, hubs at each of our eight university partners allowed Soil CRC colleagues to gather, join the meeting, and enjoy lunch together.

Soil CRC welcomed 10 new PhD students. An additional 24 PhD projects were approved. When these begin, the Soil CRC will have exceeded its PhD student commencement goal, supporting 50 PhD students. This is also a significant step towards reaching the target of 40 PhD completions by the end of the CRC.



> Co-chair Parliamentary Friends of Soil the Hon Michael McCormack MP, Soil CRC Patron and National Soils Advocate the Hon Penelope Wensley AC, and Soil CRC CEO Dr Michael Crawford at the Parliamentary Friends of Soil Launch.

The Parliamentary Friends of Soil group was launched. The group was launched in Canberra on 3 December 2020, prior to World Soil Day on 5 December. The group provides a unique opportunity for the broad soil community, and politicians, to acknowledge the importance of healthy soil as a natural resource, and its contribution to Australia's long-term economic, environmental and social wellbeing.

Co-chaired by the Hon Michael McCormack MP and the Hon Linda Burney MP, it provides a forum to bring issues associated with soil health to politicians and policymakers. The Soil CRC is a key supporter of this group.

The National Soil Strategy was released by the Australian Government in May 2021. The Soil CRC was identified and recognised in the Interim Action Plan as an existing initiative upon which future actions could be built. An area of particular relevance is the work in soil data led by the Visualising Australasia's Soils project (see case study on page 26).

The Soil CRC newsletter moved to monthly distribution. The increased frequency provides more opportunity to regularly share the successes and research findings of the Soil CRC. From project updates to fact sheets, to PhD student profiles, grower group profiles and opinion pieces, the newsletter highlights the research and participants of the Soil CRC.



Media coverage increased steadily, with the following highlights:

- The announcement of 12 new Soil CRC projects
 - Featured in *The Land* and distributed across the regional mastheads.
 - Individual university and industry media releases — University of Southern Queensland, Charles Sturt University, Southern Cross University and Andromeda Metals.
- CEO featured on AU Manufacturing website about the potential for biochar as a soil amendment.
- CEO featured in *The Guardian* Australia, and on ABC Radio's PM program, on the role of soil carbon in reducing carbon emissions.
- CEO featured on ABC news online and radio about the Technology Investment Roadmap and the issue of measuring soil carbon.
- Program Leader Richard Doyle featured on *ABC Tasmania Country Hour* on the National Soil Strategy.
- World Soil Day and Parliamentary Friends of Soil Launch featured by various media outlets, including *The Land* and *The Australian*.
- Numerous research projects received local and regional media coverage.



Fortnightly webinars provided updates on projects. Each webinar includes a research update, followed by a question and answer session. They are a valuable way to share our research and engage in two-way dialogue with our participant groups, and the wider community. Each webinar is recorded and available to watch through our website.

Highlights and achievements

Research

Sustainable, productive, high performance soils are integral to the future success and prosperity of the Australian agricultural sector.

The Soil CRC's research is focussed on providing Australian farmers with knowledge and tools to improve their soil performance, and their farm's productivity and profitability.

In our fourth year, we made further progress towards reaching this goal.

Research activity progressed significantly, with 21 projects underway, and three projects completed, taking the total completed projects to 18.

The fourth major investment round for projects occurred during the reporting period. All proposals were assessed by the Research and Adoption Committee (RAC) and submitted to the board, which approved 12 proposals for funding.

The Soil CRC is currently on track to meet its contracted research output targets. We have now successfully completed 25 milestones and commenced activities against 40 milestones.

In 2020–21, we undertook an internal review of our Australian Government Funding Agreement CRC outputs and milestones. All contracted milestones were reviewed for their ongoing relevance and currency, and input sought from our participants. Several proposed changes were identified. These changes were reviewed by the RAC, endorsed by the board, then approved by the CRC Program Office. A Deed of Variation to the Australian Government Funding Agreement was executed to formalise the changes.

High levels of industry and participant involvement in Soil CRC research continued. The ratio of participant in-kind contributions to Soil CRC cash committed to all projects (including those approved this year) averaged 2.3. The RAC applies a weighted assessment that prioritises the amount of in-kind contribution committed by participants when recommending proposals to the board for funding.

The Soil CRC has continued to effectively monitor and manage all research projects for delivery of outputs and research quality, via the following mechanisms:

- Continued use and improvement of the online project management system, SoilCentral.
- Submission and assessment of quarterly project reports from project leaders.
- Monthly meetings between the CEO, four program leaders and the operations manager.
- Targeted reviews with specific focus topics, such as intellectual property and commercialisation.
- Annual review of Australian Government Funding Agreement milestone progress by the CEO, four program leaders and the operations manager.
- Regular reporting of research investments to the RAC and board, including project agreement execution status, project commencement and completion dates, PhD student progress, project quarterly report summaries, and Australian Government Funding Agreement milestone reports.

The Soil CRC has now made investment commitments of more than \$26 million towards research projects.

Soil CRC research is being delivered through four research programs:



Program 1 Investing in high performance soils

Supporting farmers to maintain the long-term integrity and fertility of soils for future generations.



Program 2 Soil performance metrics

Developing tools linked to soil management products that allow farmers to monitor and assess the performance of their soils, and take corrective action where needed.



Program 3 New products for soil fertility and function

Developing a range of new products to better address challenges in soil management.



Program 4 Integrated soil management solutions

Synthesising our current understanding of soil science, and how it should be applied to the key soil types across Australia.

Program 1

Investing in high performance soils



Program Leader:
Associate Professor Catherine Allan
Charles Sturt University

Program 1 aims to assist farmers achieve their soil stewardship and profitability goals, through research in the disciplines of economics and social science.

The ultimate end user of the majority of Soil CRC research is the farmer or land manager. However, much of the research effort in Program 1 is directed at the 'intermediate users', who influence the management decisions and actions of farmers. Intermediate users involved in Program 1 include other Soil CRC researchers, advisors and staff from grower groups, and a range of agricultural value chain participants such as financial institutions and consumers.

Program 1 researchers work in two primary areas of influence — assisting on-farm and regional adoption of novel and improved farm practice and incentives, and rewarding soil stewardship.

Assisting on-farm and regional adoption of novel and improved farm practice is predominantly focused on improving productivity and profitability. This is at the heart of much Program 1 research. Researchers have been working closely with grower groups and farmers, to learn about and understand their soil management decision-making and practices.

By surveying hundreds of landholders from the Eyre Peninsula in South Australia and the Northern Wheatbelt of Western Australia, researchers have explored the factors influencing farm management decisions. The results added to those from

the survey undertaken in the North Central region of Victoria in 2019–20. Across these three regions, all responding landholders want to pass on a healthier and more sustainable farm for future generations, and farmers' most common source of information is other farmers. Such insights from the surveys help to guide projects led by grower groups and other researchers, in the Soil CRC and beyond.

Other researchers in Program 1 investigated decision-making practice. They worked closely with seven grower groups to develop a framework to assist with implementing innovation in ways that increase adoption by farmers.

Stewardship refers to looking after something for someone else, such as future human societies. It includes, but is greater than, productivity and profitability goals. Rewarding soil stewardship is therefore about valuing the care and improvement of soil.

Most farmers aspire to leave their land in better condition than when they acquired it. Many are willing to consider ecosystem services and other intangible outcomes when considering adopting innovations. However, markets do not currently reward farmers for these aspects of soil management. Researchers in Program 1 are exploring market mechanisms that will more clearly reward soil stewardship,

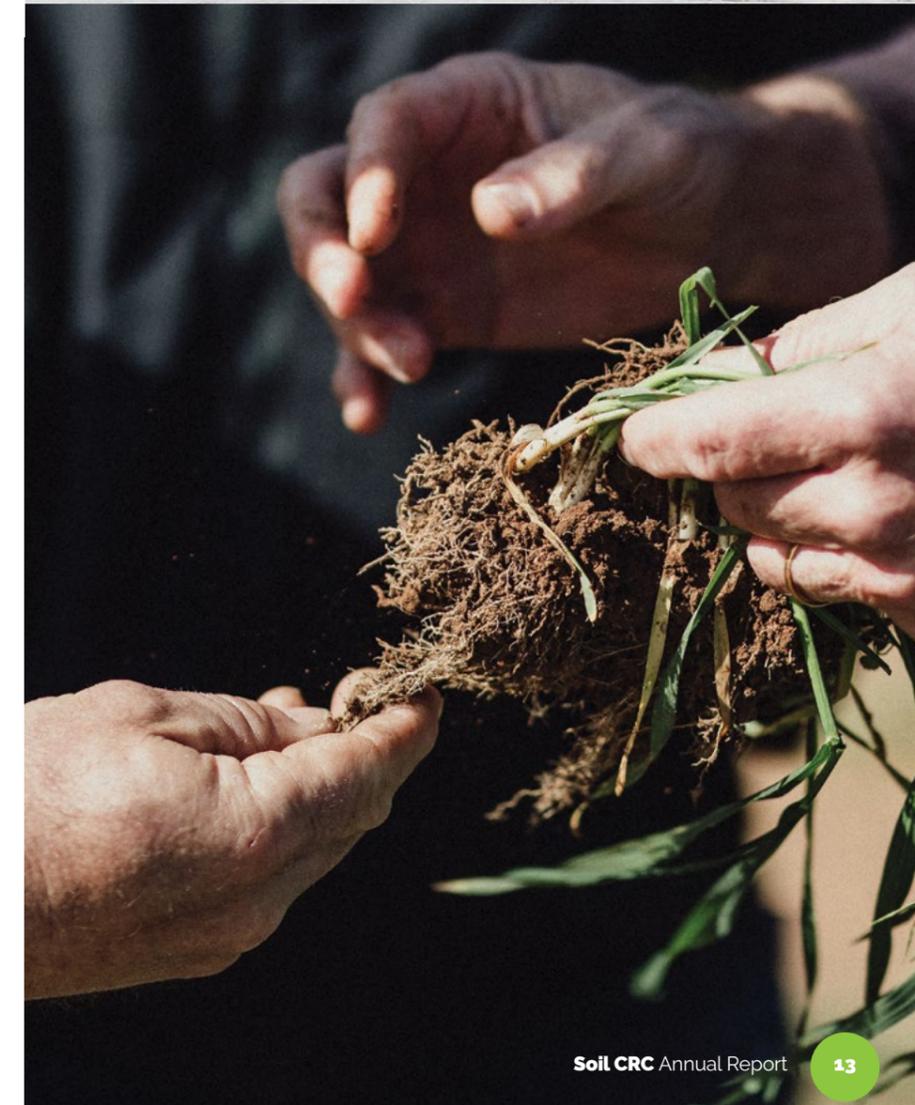


> Mock brand developed for testing consumer sentiment on paying a premium for improved soil stewardship, as part of the project *Understanding and promoting good soil stewardship*.

including focusing on consumer markets and their potential to pay for good soil stewardship. The research includes developing and trialling a range of communication materials aimed at consumers, as well as interviews with food producers, manufacturers, retailers and others. The findings indicate there is interest in highlighting and rewarding soil stewardship, from consumers and others in the market value chain. How to convert that interest into action is the focus of future Program 1 research.

There are also five PhD studies related to this area of influence. The students are researching the social norms of soil management, gendered knowledges in soil management outreach, the role of intuition in decision-making, aspects of regenerative farming, and economic analysis of amending soil.

Projects in Program 1 are highly collaborative in their design and implementation. Because the intended users of the research are active in the projects, the findings and results are immediately accessible to them.



Program 2

Soil performance metrics



Program Leader:
Associate Professor Richard Doyle
University of Tasmania



Program 2 is developing tools that enhance and simplify how farmers measure and monitor their in-field soil performance.

Researchers are developing a range of in-field sensors to aid soil assessment, improve data accessibility and empower decision-making.

This research involves challenging existing chemical, physical and biological assessment methods, as well as developing novel techniques including those made available through 3D printing and smartphone capabilities.

Our vision is to help land managers more readily and efficiently determine and

monitor their soil health and function. This will enable them to make more informed and targeted soil management decisions.

The research teams are working across Australia with grower groups such as Southern Farming Systems in Tasmania, Burdekin Productivity Services, and Herbert Cane Productivity Services in Queensland. The grower groups work within our teams to ensure the purpose, function, design and information output of the technologies serve farmers' needs.

In the area of soil physical properties, we are developing subsurface communication systems to allow easier use of in-ground devices, such as smarter soil moisture sensors. The team are also developing a smart shovel that simultaneously assesses soil strength, moisture and location. This will allow farmers to map and manage issues like soil compaction and moisture status.

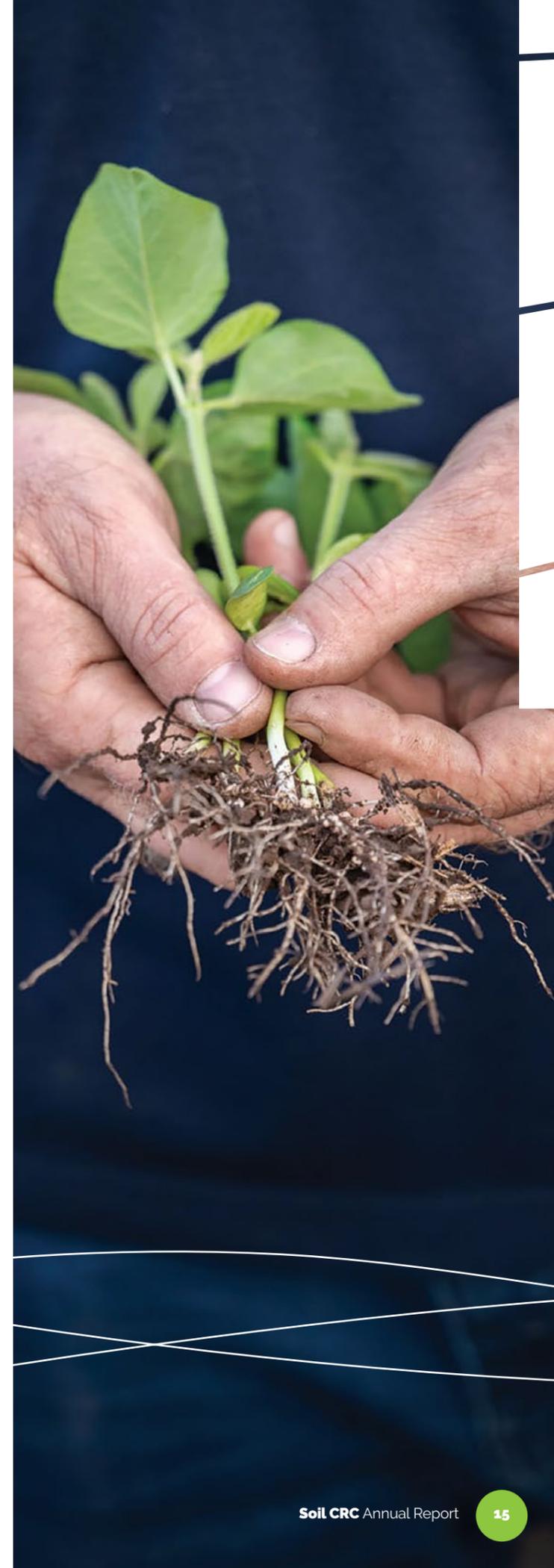
Other researchers are investigating devices that quickly assess the biological and chemical health of soil using on-farm extraction of soil water. This research supports projects working on new chemical and biological sensors, utilising advanced 3D printing of colorimetric microfluidics devices (known as lab-on-a-chip). These devices will link with smartphone camera-based scanning, GPS locating, and data analytics capability, to provide on-farm soil management recommendations. Various 3D lab-on-a-chip designs for nitrogen, phosphorous and pH devices are being developed and tested.

The other approach to improving on-farm soil health monitoring is a multi-sensor electronic nose. The prototype soil eNose has successfully detected microbial activity in the soil and is ready for advanced testing in field trials. These will identify successful commercialisation pathways.

Researchers are linking many of these analytical technologies to smartphone capabilities and data analytical tools, to interpret and provide recommendations for end user soil management actions. These include techniques like cluster analysis, neural network analysis, machine learning and geo-statistical analysis.

Several projects have now matured to a second phase of development. This includes a project aimed at helping farmers to better manage, use and visualise soil data. Researchers are providing enhanced soil data storage, access and visualisation. They have worked with 16 grower groups across Australia to better understand their soil data storage, use and visualisation needs. The data portal is live and continually developing.

PhD students are associated with many of the above projects. Examples includes better mapping water repellence using radiometric signals, and the use of hyper-spectral and satellite image analysis to determine soil moisture and health assessments. The contribution of these PhD students helps advance the more complex aspects of our research projects.



Program 3

New products for soil fertility and function



Program Leader:
Professor Nanthi Bolan
University of Newcastle



Program 3 aims to develop new fertilisers, soil amendments and delivery mechanisms for farmers, to enhance the performance of their soils.

The program delivers this by developing fertiliser products, pesticide delivery systems, soil amendments, and microbial carrier products.

Program 3 research involves developing novel fertiliser products, controlled release pesticide delivery systems, alternative microbial and moisture carriers, and novel amendments to ameliorate subsoil acidity and sodicity and improve sandy soils.

Collaboration is high, including engagement with seven grower groups, eight research providers, three industry partners and 13 PhD students. Researchers have been working with Australian Organic Recycling Association to develop novel microbial inoculation products and nutrient-enriched carbon-based fertiliser products.

Researchers are seeing results in the development of new fertiliser products

derived from waste streams. They have successfully synthesised carbon-based fertiliser products and phosphate compounds, and synthesised micro-lime and micro-gypsum products. These products will improve subsoil constraints which have been difficult to address and will improve crop productivity.

In the area of pesticide delivery systems, researchers have successfully encapsulated pesticides using clay matrix. This is likely to leave little pesticide residue in the soil, and controls pesticide delivery to improve efficiency. Using fewer pesticides is more economical for farmers and can increase soil functions such as microbial activity.

In the area of microbial carrier products, researchers have successfully synthesised and evaluated new products that can substitute for peat and take nitrogen-fixing rhizobia to the soil. This allows them to effectively inoculate plant roots, especially under arid conditions.

Researchers have shown that injecting nutrient-rich organic waste materials such as biosolids into subsoil improves soil quality and health, and can be successfully used as a soil amendment. Trials at Longwarry wastewater treatment plant in Victoria directly injected biosolids into the subsoil, and monitored subsequent impacts on soil properties and groundwater. Safely using biosolids as a soil amendment mitigates the rising cost of fertilisers for farmers, and addresses the need for more efficient and environmentally sound applications of biosolids to soils.

In sandy soils, researchers have found using organic and clay amendments improves soil productivity by increasing nutrient and water availability. They found clay content in sandy soils is important to hold organic carbon, and other properties associated with the clay, such as high iron and calcium content, have a strong influence on increasing carbon storage in soil.

A potential opportunity to use products and technologies developed in Program 3 is developing high-value compost that will add nutrients and carbon to soil. Similarly, applying micro-lime and functionalised clay will help to mitigate subsoil constraints. Drought will continue to be a significant problem for Australian farmers. Microbial carrier products that help improve the inoculation potential of rhizobium will help alleviate some drought stress on soils. Another drought resilience improvement will be using carbon biowaste products to enhance water retention and water use efficiency of sandy soils.



Program 4

Integrated soil management solutions



Program Leader:
Dr Lukas Van Zwieten
NSW Department of Primary Industries



Program 4 aims to achieve cost-effective and sustainable solutions to develop more productive and resilient soil, which will underpin a dynamic, sustainable and profitable Australian agricultural sector.

Projects within Program 4 have involved collaboration between 13 grower groups, eight universities, three government research partners, and one international research provider. Program 4 is delivering data and results from over 15 grower group field trials around Australia. It includes seven PhD student projects.

Projects are identifying plant-based and biological solutions to develop

high-performing, more resilient soils. Researchers are using practices such as cover cropping, mixed-species cropping and intercropping as a biological way to change the root zone. Research found mixed-species cover crops successfully suppressed weeds in sugarcane systems, and including multiple species mitigated the risk of failure of any given species in a particular season.

Innovations in changing microbial populations and functions in the root zone are the focus of PhD research. The intention is to address soil constraints and impaired microbial functions, and better understand chemical signalling between plants and soil microbes.

Results from the assessment of regenerative farming systems are currently being analysed. The data suggests increases in the biologically active fraction of the soil organic carbon pool are associated with regenerative farming practices. Soil organic matter is a key driver of microbial functional resilience.

Collaboration across Programs 4 and 2 is showing how increasing soil carbon stocks improve soil function and resilience. New metrics have been applied to field sites, allowing insights into improved resistance and resilience to stressors, such as drought and compaction.

Highly alkaline soils affect over eight million hectares Australia-wide, and limit crop productivity due to the varied and significant constraints they pose. Early crop vigour can be poor in these soils, and crop production continues to be limited by low water use efficiency. Constraints include low phosphorous status, low water-holding capacity, high burden of rhizoctonia, low nitrogen availability, severe fertiliser toxicity during germination, and at depth, extreme pH, sodicity and salinity.

Eight field trials have been established that utilise a range of chemical, physical and biological amelioration options, and include assessing new carbon-based

phosphorus fertilisers. There will be an increased emphasis in the coming seasons around better understanding the role of soil and subsoil constraints, and their various amelioration options, in accessing soil water, and understanding improved water use efficiency.

A pilot study with 15 farmers has tested a new traffic light system for assessing the risk of crop failure (or impairment) due to residual herbicides in soil. This will be further evaluated in the coming season, prior to a wider rollout to farmers.

Program 4 is bringing new knowledge, together with advanced modelling techniques, to guide soil management decisions at the farm and field level. It is impossible to research and field test solutions for all soils and scenarios. However, by using data from across our projects, grower groups and published research, modelling will fill in the blanks with a degree of reliability.

Researchers have improved the representation of soil phosphorous for the major soil types in Australia, enabled nitrogen volatilisation, and modelled preferential flows and hydrophobicity of sandy soils in Western Australia in the Agricultural Production Systems Simulator (APSIM). Research has modelled water use by weeds in fallows to improve FallowARM, and updated Gypsy for gypsum recommendations to address sodic soils. These improvements and models are putting the most recent knowledge around soil constraints, and the analytical power of models, directly into the hands of farmers.

Highlights and achievements

Collaboration

Collaboration remains an essential element of the Soil CRC's ongoing success. It is one of our core values, as outlined in our Strategic Plan.

Despite the challenges of COVID-19 we have seen researchers and farmers alike continue using technology to ensure collaboration remains at the heart of all our projects.

Some of the collaboration highlights include:

- Establishing a network directory of more than 170 key experts from the finance, agriculture, research, conservation, corporate advisory and government sectors to advise on using programs to reward farmers for good soil stewardship.
- Successfully identifying and interviewing 23 key value chain stakeholders (with further interest pending), including grower groups, food manufacturers, minor and major supermarkets, in potential soil stewardship branding.
- Obtaining access to soil datasets from 19 grower groups, from over 830 soil sites, with approximately 4,400 samples and 77,000 soil observations.
- Completing participatory workshops with seven grower groups, and interviews with local stakeholders involved in implementing soil research and technologies in each region, to identify the attributes of soil technologies that make them easier to adopt.
- Surveying thousands of landholders across three different farming regions to identify why they make particular farm management decisions.
- Establishing five long-term field research sites in Queensland (Herbert Cane Productivity Services Ltd), South Australia (Hart group), Victoria (Riverine Plains), Western Australia (Facey Group) and New South Wales (Central West Farming Systems).
- Establishing eight field trials on calcareous soils in South Australia, with the support of the Grains Research and Development Corporation. Assembling an expert panel consisting of grower group representatives, local farmers and advisers, who meet with the project team to guide the project direction and improve engagement with local agricultural industries.
- Collaborating with media and communications teams across the participant groups to amplify the research of the Soil CRC. This included gaining media coverage, publicising webinars, and sharing content across social media channels.
- Publishing webinars as a valuable way to share research updates and engage in two-way communication with our participants and the wider community, including farmers, advisers and policymakers.
- Collaborating with Soils for Life, Soil Science Australia, and the National Soils Advocate, to launch the Parliamentary Friends of Soils Group in Canberra in December 2020.



Commercialisation and utilisation

Use of Soil CRC research outputs continues to increase, with research findings adopted by participants and the wider community, or helping to inform further Soil CRC research investment and activity.

Other outputs will reach the end user by a commercial pathway, and progress is being made in identifying agents and plans to use commercially valuable products. Some notable examples of use include:

- Discovering several common themes in relation to adoption priorities, drivers and pathways that have implications for understanding the efficacy of soil improvement strategies and programs.
- Bankers, financial market stakeholders and growers accepting the importance of good soil stewardship, and the potentially significant productivity, profitability and/or legitimacy benefits from adopting these practices. This relationship needs to be further demonstrated and conveyed to the finance sector, and connections between researchers, growers and financial markets improved.

- Ensuring participants' data will meet FAIR (Findable, Accessible, Interoperable, Reusable) standards, and will be seamlessly mapped to international community standards and controlled vocabularies. This enhances the value of the custodian's data, as it is immediately suitable for feeding into models, artificial intelligence engines or visualisations used by others in the Soil CRC (i.e. machine-to-machine).
- Trials of tools to assist in spatially visualising soil data, searching and filtering data, downloading data sets and publishing data to the portal by project participants. Feedback will be used to enhance and grow the toolset in the next phase of the project.

- Results from trial sites at Riverine Plains Incorporated and Central West Farming Systems indicate summer cover crops are depleting soil moisture prior to winter crop sowing, but to date this has not significantly impacted winter crop yields. Minimal changes in soil 'function' have been observed due to summer cover crops, owing to in-season crop rainfall. However, for modelling studies, future seasons will also focus on impacts on water infiltration in late autumn. Companion sowing wheat crops with a legume, then terminating legumes after 8–10 weeks, has shown limited impacts on soil function, and no impact on wheat yields. While minor changes in soil properties from the increased plant diversity may not impact on crop growth in the short term, continual evaluation over the medium term is necessary.
- Intercropping trials at the Hart Field Site showed small changes in soil function during the growing season. However, contrary to much of the literature, it has not increased the Land Equivalent Ratio, compared to monoculture treatments. Multi-species cover crops at the Herbert Cane Productivity site were among the top performers in terms of biomass production and weed suppression, and did not cause any yield loss in subsequent cane crops.

- Five main themes of investigation have been identified related to soil carbon functionality, and understanding regenerative agriculture in general. The key metrics chosen as indicators of soil carbon functionality include measures of biodiversity (above and below ground), nutrient cycling, carbon pools, soil physical properties (including insulation from above ground heat) as well as measures of production (biomass) and resilience of production to climate variability.

With respect to commercialisation, proof of concept was achieved for the low-cost eNose to detect volatile organic compounds in soil that may indicate soil biological activity and soil health. Data generated in the pot trials suggests the eNose can detect signals from biological activity, and changes in signals due to variations in soil environment. Further work is needed in a range of soils to fully understand the correlation between soil performance and eNose signal, before commercial partners are sought.

Highlights and achievements

Education and training

The Soil CRC welcomed 10 new PhD students during 2020–21, bringing the total number to 26. An additional 24 PhD projects were approved.

When students begin all of these projects, we will have exceeded our PhD student commencement goal, supporting 50 PhD students. This is also a significant step towards reaching the target of 40 PhD completions by the end of the CRC.

The travel restrictions in place for the COVID-19 pandemic have limited our ability to attract international students. Therefore, our focus turned to potential students already in Australia. In September 2020, we announced an ad hoc PhD expression of interest program to address issues regarding restrictions on international students entering the country. This allowed proposals for Soil CRC PhD projects from our eight university partners to be considered at any time, provided a student had been identified, was ready to commence, and currently within Australia.

After surpassing our goal of 46 positions, the expression of interest program closed in May 2021. However, we will continue to approve PhD studentships embedded within proposals for larger research projects.

The second annual Soil CRC Student Workshop Day was held in March 2021. As with the previous year, this became an online event. It included a communications and social media workshop, followed by a 'career journey' discussion panel with four researchers from within the Soil CRC senior leadership team. Dr Paul Greenfield AO FTSE (Soil CRC Chair), Associate Professor Catherine Allan (Soil CRC Program Leader), Dr Stephen Carr (Soil CRC Board), and Professor Roger Swift FTSE (Soil CRC Board) all joined the panel. The purpose

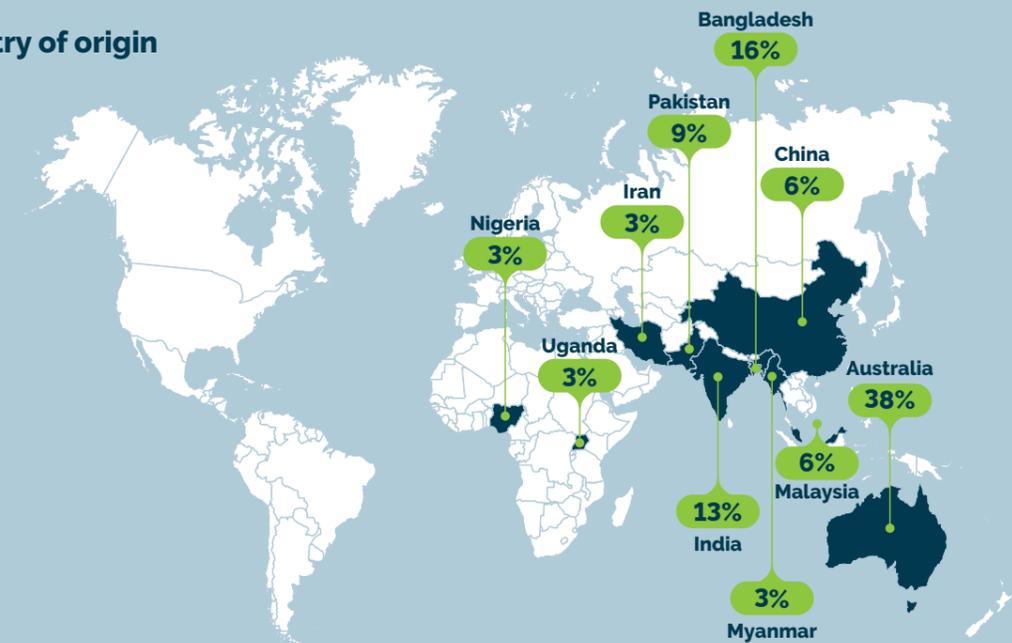
of the panel was to hear directly from some of our leadership team, and provide insight into a range of career pathways and professional experiences.

This helped students think about ways to maximise their PhD experience and professional development through involvement with the Soil CRC. Students also attended the online Participants Meeting in March 2021, as well as two other digital student workshops in October and November 2020, and the fortnightly Soil CRC webinar series.

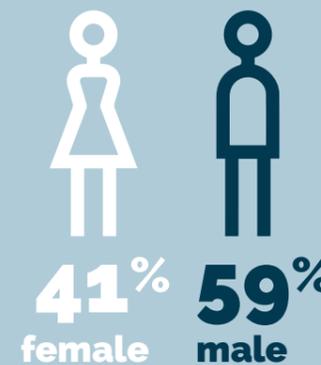
The Student Coordinator developed a Soil CRC PhD Handbook that gives students all the information they need complete their PhD with us. It includes the support and opportunities we offer, student and Project Leader responsibilities, and the organisational structure.

The Soil CRC PhD Hub continues to expand as a 'one-stop-shop' digital community and resource centre. Students can access forms and resources, stay up-to-date on Soil CRC activities, ask questions, and share information and ideas. Most importantly, the hub supports our students to move beyond their local peer groups, and connect with the broader cohort of Soil CRC PhD students. The cohort is situated in eight universities across Australia, with students from a range of disciplines, stages of candidature and cultural backgrounds. It brings together a huge wealth of knowledge, experiences, networks and capabilities for our students to engage with and learn from.

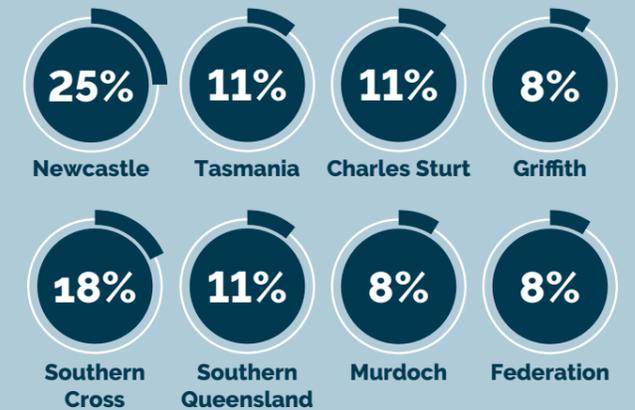
country of origin



female:male



% students at each university



PhD student Sedigheh Abbasi



Case study

Digging up data to unlock production potential



Large amounts of previously hidden soil data in the public and private sector are being unearthed, collated and made available to improve agricultural productivity across Australia and New Zealand, thanks to 'Visualising Australasia's Soils' (VAS) — a foundation project of the Soil CRC.

More than thirty people from 19 Soil CRC participant organisations have joined forces to work on VAS. It will provide Australasian farmers, agronomists, agricultural researchers and agribusinesses with relevant place-based soil information on demand.

Project leader, Associate Professor Peter Dahlhaus, says improving soil data availability will encourage new research ideas, collaborations and investment, both locally and globally. This, in turn, will help farmers with better ways to manage and improve their soil.

Dr Dahlhaus is Principal Research Fellow at the Centre for eResearch and Digital Innovation (CeRDI) at Federation University Australia, in Ballarat, Victoria.

"Soil data has previously been collected by different instruments, machines and humans, and stored in different ways in disparate places, but the projected productivity increase through digital agriculture relies on aggregating this information," explains Dr Dahlhaus.

"By making soils data findable and accessible through clearly established rules of access and ownership, we will gain new insights into short- and long-term trends and enhance research, education and farmer decision-making."

Portal permits sharing of data and access

Already VAS has produced an internet portal to enable users to load data sets, practice sharing and exchanging information, as well as test access rules that aim to protect ownership and confidentiality.

The second phase of the project will focus on providing tangible benefits to project participants.

"Soil CRC grower groups are financially supported to get together a sample dataset to put into the system, then experiment with the portal and provide feedback. What we'd like to do in the second phase is show people what they can do with the data, and how to manage it," says Dr Dahlhaus.

"Most people want to use data for benchmarking. To find out how they compare with everyone else, and to measure trends, for example, soil carbon stocks — what potential is there for me to sequester extra soil carbon, and will it be worth my while?"

Sharing data is a social challenge, not just technical

Federating data is not just a technical challenge, he says, but a social one as well. At the start of the project, participants each had a three-hour discussion with the project team, including a social scientist, to find out what would encourage them to share data.

"A lot of people said 'We don't mind if you see it, but we don't want banks or insurance companies or the government to see it'. For a system to allow this, you need fine-grained access control, a bit like blockchain, where the encryption is carried with the data and you need a key to see it," says Dr Dahlhaus.

"We're also finding that data literacy is quite poor in both the public and private sector. The self-serve system we use resolves that by asking the questions — Is this data yours? Do you have authority to access it? So we're educating users at the same time."

The VAS project participants include 17 grower groups and two catchment management authorities, representing regions from far north Queensland, through central NSW and Victoria, to northern Tasmania and southwest Western Australia, and includes the Riverine Plains group.

Riverine Plains happy not to 'reinvent the wheel'

Set up in 1999 to improve the productivity of broadacre farming systems in north-east Victoria and southern New South Wales, Riverine Plains Incorporated has 350 farmer members.

"All grower groups have a lot of valuable farm data that we collect as part of our projects, but once we finish a project, it generally goes back into the folder or filing cabinet. We want to build on that data rather than reinventing the wheel," says Riverine Plains Project Officer, Jane McInnes.

"Now that the internet portal is ready to trial, we can show farmers how their past research can be re-used to inform issues such as soil carbon and subsoil acidity, and by using GPS reference points, we can add more data to compare and visualise over time."

Formatting and time are the key challenges for farming system groups in processing data, Jane says, as is the sheer quantity of information available, and the thorny question of who should have access to it.

"When we started VAS, it was a real eye-opener for me to see how much data we actually had and how hard it was to find. Searching through files to find soil tests from a past project can be a real challenge when everyone is so time-poor. Hopefully, it will become common practice for us to load data sets into the portal."

"There's certain information that farmers are quite territorial about. However, they're generally supportive of sharing soil data for the right outcome. And we can set different access for levels of information in the portal, which makes it very robust in protecting their information."

"It will also be a case of showing the research community that we have lots of data sets to build on, so rather than research going ahead independently, it will become a case of 'I'll check the portal!'"

Riverine Plains has already provided a soils data set to a Grains Research and Development Corporation and University of Adelaide project aiming to use machine learning for a more detailed analysis of the soil factors that impact grain yield variability.

This will include better linking of soil, agronomic and weather data with spatial information, such as remote sensing, to see whether machine learning algorithms can detect patterns in the data that traditional approaches were unable to identify.

Combining public and private soil data a 'global first'

Dr Dahlhaus says with the advent of drones, sensors and satellites, more data is being collected today than ever before, much of it by private companies.

"If we want to maximise the value of digital agriculture, we need to have data from trusted, authoritative sources all the way from the farmer to the consumer. However, we need the ability to control who has access to the data, and under what conditions," says Dr Dahlhaus.

"Collaboratively designing the portal tools, models and visualisations with 19 Soil CRC partners will ensure the output is a useful, everyday support tool that builds on the most current data sets and can be automatically fed into apps for decision support."

Dr Dahlhaus says the success of the project in combining public and private soil data would be a global first.

"Australia and New Zealand have been involved in international soils and water data exchange for many years, and we've seen the Europeans do particularly well in accessing public data. But the public-private relationship is cutting edge — we're not seeing this anywhere else in the world."



Risks and impediments

Monitoring and managing risks and impediments continues to be a focus for the Soil CRC. There were mixed impacts from major impediments for the CRC in 2020–21.

The breaking of the drought that was impacting much of Australia brought relief for many grower groups. The reprieve meant they could refocus on the CRC programs, and provide their valuable input unencumbered by the hardships the drought caused. On the other hand, the challenges of COVID-19 on CRC operations consolidated as the major impediment of the year.

The Soil CRC quickly implemented COVID-safe workplace practices for staff and researchers, in line with those undertaken at our research provider organisations. Related risks included a resurgence in COVID-19 and associated restrictions, and delays in the roll out to achieve mass vaccination levels such that travel restrictions can be lifted.

COVID-19 continues to pose a significant risk, with the potential to lead to research programs not achieving outcomes, Australian Government Funding Agreement milestones not being met, and projects requiring additional resources to deliver output. Of particular concern were the restrictions on the entry of international PhD students to Australia to commence their candidature, and the continued employment of research staff positions by organisations under financial stress imposed by COVID-19. Our one international participant, Landcare Research New Zealand, indicated it would reduce its involvement with the CRC from 2022 — a direct consequence of COVID-19 travel restrictions and financial impacts.

Changes in participant staffing are also an issue of concern and potential risk. The impacts on programs and projects from changes in key personnel are difficult to anticipate, but can be mitigated by strong research governance. The Soil CRC has a strong four-tier structure of governance. Our projects are overseen by the four program leaders, the CRC management team, the RAC and board.

During this year, the Audit and Risk Management Committee (ARMC) was satisfied with the risk register, and found the 16 risks identified for the Soil CRC were being mitigated and managed acceptably. The pronounced effect of the COVID-19 pandemic on the Soil CRC resulted in a separate risk register for monitoring and managing COVID-19 related risks. The good report card of the CRC's management of the risks has meant no delay in milestone delivery occurred in the year.

The Soil CRC continued to manage our commitments to the Australian Government Funding Agreement, with participant in-kind contributions as an

area of focus. The participants' in-kind contributions have steadily increased in the year, with the last quarter far exceeding committed levels. This in turn begins to offset the shortfall from earlier years. We are well positioned to meet our in-kind commitments through good management of this area.

The Soil CRC was fully compliant in managing and governing with the CRC Constitution, Australian Government Funding Agreement, Participant Agreements and all relevant laws and regulations in relevant jurisdictions.

With all policies and procedures now in place, the ARMC has commenced a review to ensure they provide consistency, transparency, integrity and good governance in all aspects of the Soil CRC's business.

With our established risk management systems and processes, and with governance oversight provided by the ARMC and the board, the Soil CRC has successfully navigated the year in a challenging climate.



Intellectual property management

The Soil CRC continues to recognise that intellectual property (IP) must be managed for the benefit of its participants, while actively facilitating dissemination and use of research outputs in Australia.

To achieve this, we manage IP in a manner that facilitates:

- A collaborative approach to managing, using and commercialising IP.
- Effectively and efficiently disseminating, extending, adopting and commercialising results of research and development activities.

Our IP management and all subsequent commercialisation is aligned with the Australian Code for the Responsible Conduct of Research, and the National Principles of Intellectual Property Management for Publicly Funded Research. This alignment is reflected in our project agreements and governance documentation, and in particular, our IP policies, and management and utilisation plan.

Management of intellectual property in the Soil CRC is overseen by the board through its Commercialisation and Intellectual Property Advisory Committee (CIPAC). This committee provides advice to management and the board on protecting IP, as well as on appointing utilisation agents and approving utilisation plans.

Advice on IP management is provided by an external IP consultancy, IP Active. IP Active specialises in IP management and technology commercialisation services for private and government research and development organisations.

Decisions regarding IP management across the Soil CRC continued to be made on a project basis, with each project assessed for the potential value of the IP it will develop. Those projects identified as having potential to produce high value commercial IP will be managed by exception. This may include requiring a detailed assessment of all IP elements across such projects, including background IP, and third-party IP.

Our ongoing default position is that the legal and beneficial ownership of all IP generated through Soil CRC-funded activities is vested in the Soil CRC on creation. However, in managing IP at a project level, the Soil CRC Project Agreement allows special conditions to be developed regarding rights over use and ownership of IP developed from a project.



Governance

Soil CRC structure

The Soil CRC (the Company) is an incorporated company limited by guarantee. It is registered as a not-for-profit public company which is not listed. It is governed by its constitution, and reports to its members. All Major Partners are eligible to be a member of the Company. As at 30 June 2021, all eleven Major Partners are members.

The Company has a board of nine directors, one of whom acts as the chair. There are five independent and four non-independent directors.

There are five committees that govern research, finance and risk, nominations, remuneration, and intellectual property and commercialisation.

The CEO reports to the board on management of the Soil CRC. The CEO has a team that reports to him to operate the Soil CRC. The Company has an ATO private ruling that confirms the Company is income tax exempt and a FBT rebatable employer.

Directors

Name	Role	Appointed	Number of meetings held while in office	Number of meetings attended
Paul Greenfield	Independent Chair	10 July 2017	6	6
Andrea Bishop	Non-independent Director	27 November 2019	6	6
Malcolm Buckby	Non-independent Director	4 May 2017	6	6
Steve Carr	Non-independent Director	27 November 2019	6	6
Ralph Hardy	Independent Director	28 June 2017	6	6
Anna Lavelle ¹	Independent Director	14 September 2017	3	3
Kate Lorimer-Ward	Non-independent Director	17 January 2018	6	2
Robbie Sefton	Independent Director	26 July 2017	6	6
Simon Speirs	Independent Director	24 February 2021	2	1
Roger Swift	Independent Director	10 July 2017	6	6

¹ Resigned 1 January 2021

The board

The Soil CRC is governed by a skills-based board of directors with an independent chair, and a majority of independent directors. The board provides oversight of the Soil CRC activities, performance and strategic direction, and is responsible for establishing, maintaining and monitoring an appropriate level of governance regarding core tasks of the Company.

Independent directors are appointed by the board from recommendations made by the Nominations and Selection Committee. Three non-independent directors are provided by the Major Partners. One non-independent director is provided by either the Partner or Associate collectives. All appointments are subject to confirmation by the members of the Company.

Dr Anna Lavelle resigned from her role as independent board director and Chair of the Commercialisation and Intellectual Property Advisory Committee on 1 January 2021. Dr Simon Speirs was approved by the board as her replacement. Dr Simon Speirs is a soil scientist and research, development and engineering professional with over 20 years of experience across Australian agriculture. He has extensive experience in Australian agricultural industries and strong capabilities in innovation, strategic planning, and business execution.



Professor Andrea Bishop
Director



Malcolm Buckby
Director



Dr Stephen Carr
Director



Ralph Hardy
Director



Dr Anna Lavelle FTSE
Director



Kate Lorimer-Ward
Director



Robbie Sefton
Director



Dr Simon Speirs
Director



Professor Roger Swift FTSE
Director



Dr Paul Greenfield AO FTSE
Chair

Governance



Committees

Audit and Risk Management Committee (ARMC)

- Assists the board in fulfilling its responsibilities relating to the accounting and reporting practices and provides oversight in respect of the risk management activities.
- The ARMC met on six occasions in 2020–21.

Commercialisation and Intellectual Property Advisory Committee (CIPAC)

- Oversees the intellectual property and commercialisation activities.
- The CIPAC met on three occasions in 2020–21.

Nominations and Selection Committee (NSC)

- Makes recommendations regarding the appointment of the Chair, the CEO and directors.
- The NSC met on one occasion in 2020–21.

Remuneration Committee

- Ensures levels of remuneration are sufficient to attract and retain executives of the quality required.
- The Remuneration Committee did not meet in 2020–21.

Research and Adoption Committee (RAC)

- Oversees the research, adoption and education activities and reviews and advises the board and the CEO on proposals for project funding.
- The RAC met on six occasions in 2020–21.

Staff of the Soil CRC

Name	Organisation	CRC position / role	Time commitment (FTE)
Staff			
Dr Michael Crawford	Soil CRC	Chief Executive Officer	1.0
Mark Flick ¹	Soil CRC	Finance Manager	0.5
Jodi McLean	Soil CRC	Operations Manager	1.0
Julie Moulton	Soil CRC	Research Administration Officer	1.0
Chris Murphy ²	Soil CRC	Business Development Manager	Consultant
Katherine Seddon	Soil CRC	Communications Manager	0.8
Kathy Stokes	Soil CRC	Executive Assistant	1.0
Dr Cassandra Wardle	Soil CRC	Student Coordinator	0.5
Jessie Xu ¹	Soil CRC	Finance Officer	0.4
Program Leaders³			
Assoc Prof Catherine Allan	Charles Sturt University	Program 1 Leader	0.5
Assoc Prof Richard Doyle	University of Tasmania	Program 2 Leader	0.5
Prof Nanthi Bolan	University of Newcastle	Program 3 Leader	0.5
Dr Lukas Van Zwieten	NSW Department of Primary Industries	Program 4 Leader	0.5

¹ Mark Flick and Jessie Xu are employed by CRC CARE Pty Ltd, and provide support to the Soil CRC under a Shared Financial Services Agreement.

² Chris Murphy provides services on an ad hoc basis as required.

³ Program Leaders are provided by their host organisation as an in-kind contribution to the Soil CRC.



Dr Michael Crawford
Chief Executive Officer



Kathy Stokes
Executive Assistant to CEO



Jodi McLean
Operations Manager



Julie Moulton
Research Administration Officer



Mark Flick
Finance Manager



Jessie Xu
Finance Officer



Katherine Seddon
Communications Manager



Dr Cassandra Wardle
Student Coordinator

Financial management

The Soil CRC depends on continued support from its participants and the Australian Government for its ongoing operations.

During the 2020–21 financial year, 66% of the Soil CRC's contributions (cash and in-kind) were provided by participants, and 34% by the Australian Government. It should be noted that realigning the Australian Government Funding Agreement resulted in \$3m being brought forward to the current year from future years (see Figure 1).

The Soil CRC had invoiced all the contracted participants for their cash contributions for the year ended 30 June 2021. Receivables at year end included several participants who still owed their contributions for the most recent quarter. Overall, the Soil CRC is in a strong financial position, with \$13.5m in cash to be applied to our future project commitments.

The Soil CRC's in-kind contributions of \$13.7m exceeded the Australian Government Funding Agreement commitment of \$11m in the financial year. However, this good result should be viewed in the context of the Soil CRC life-cycle.

Specifically, timing of these contributions is linked to major project work, which has ramped up, and will continue to increase in future years.

In 2020–21, cash research expenditure increased from \$4.8m (2019–20) to \$5.4m.

Figure 2 indicates the increase in the Soil CRC's research expenditure.

The overall financial performance of the Soil CRC is on track to allow us to achieve our activity milestones within the committed contribution levels. Financial management strategies during the 2020–21 financial year included maintaining tight cost control, and seeking additional participant and external contributions.

As with all CRCs, the continuing financial sustainability of the Soil CRC, and our ability to support existing and new projects, depend on success in:

- Receiving the continuing support of participants and the Australian Government.
- Securing additional funding where appropriate.
- Achieving sufficient future cash flows to meet obligations.

The directors believe the Soil CRC will be successful in the above matters and, accordingly, the accounts have been prepared on a going concern basis.

The overall financial management of the Soil CRC is provided by way of a shared financial services arrangement with CRC CARE Pty Ltd. The shared financial service is led by the Finance Manager, Mark Flick, a Chartered Accountant, and assisted by the Finance Officer, Jessie Xu, a Certified Practising Accountant. By leveraging the

synergy of CRC CARE, the Soil CRC has continued to reduce administration costs, while freeing up executive time.

No control issues or material recommendations for improvement were identified during the 2020–21 independent audit process. Financial reports are delivered to management monthly, and quarterly financial reports are presented to the board and its Audit and Risk Management Committee.

The independent auditor's report to the members of the Soil CRC for the financial year ending 30 June 2021 expressed the opinion that the financial report of Soil CRC has been prepared in accordance with the *Corporations Act 2001* and is unmodified. Their opinion further states the financial report as at 30 June 2021 gives a true and fair view of the Soil CRC's financial position as at that date, and of its performance for the period ended on that date, and complies with Australian Accounting Standards.

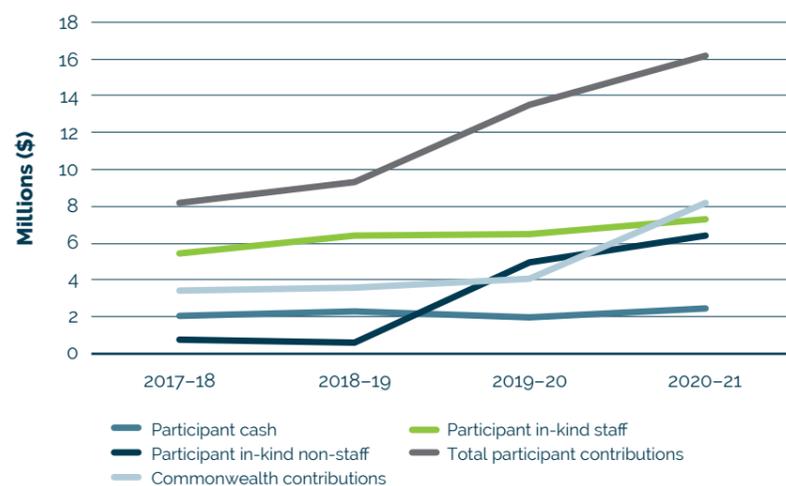


Figure 1. CRC contributions: type and source

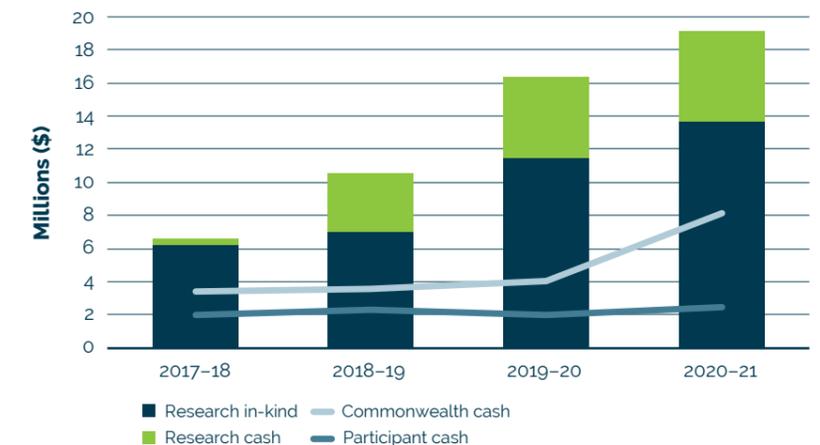


Figure 2. Research expenditure v cash contributed

Financial Statements

For the year ended 30 June 2021

CRC for High Performance Soils Limited

ACN 618 897 224

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Financial Statements

Directors' Report

30 June 2021

The directors present their report on CRC for High Performance Soils Limited for the financial year ended 30 June 2021.

Directors

The names of the directors in office at any time during, or since the end of, the year are:

Names	Position	Appointed/Resigned
Paul Greenfield	Chairman	
Andrea Bishop	Director	
Anna Lavelle	Director	Resigned 1 January 2021
Kate Lorimer-Ward	Director	
Malcolm Buckby	Director	
Ralph Hardy	Director	
Robbie Sefton	Director	
Roger Swift	Director	
Simon Speirs	Director	Appointed 24 February 2021
Stephen Carr	Director	

Directors have been in office since the start of the financial year to the date of this report unless otherwise stated.

Principal activities

The principal activity of CRC for High Performance Soils Limited during the financial year was to fund research programs, to help farmers bridge the gap between soil science and farm management giving them the tools and knowledge to make decisions on complex soil management issues.

No significant changes in the nature of the Company's activity occurred during the financial year.

Members' guarantee

CRC for High Performance Soils Limited is a company limited by guarantee. In the event of, and for the purpose of winding up of the company, the amount capable of being called up from each member and any person or association who ceased to be a member in the year prior to the winding up, is limited to \$100 for members that are corporations and \$100 for all other members, subject to the provisions of the company's constitution.

At 30 June 2021 the collective liability of members was \$1,100 (2020: \$1,100).

Review of operations

The Company specialises in research and development of technologies to provide farmers with knowledge and tools they need to make decisions on extremely complex soil management issues. During the year, the Company received cash contributions of \$9,607,500 (2020: \$6,052,250) and in-kind contributions of \$13,689,801 (2020: \$11,495,214).

Events after the reporting date

No matters or circumstances have arisen since the end of the financial year which significantly affected or could significantly affect the operations of the Company, the results of those operations or the state of affairs of the Company in future financial years.

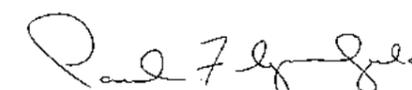
Future developments and results

Likely developments in the operations of the Company and the expected results of those operations in future financial years have not been included in this report as the inclusion of such information is likely to result in unreasonable prejudice to the Company.

Auditor's independence declaration

The lead auditor's independence declaration in accordance with section 307C of the *Corporations Act 2001*, for the year ended 30 June 2021 has been received and can be found on page 42 of the financial report.

Signed in accordance with a resolution of the Board of Directors.



Dr Paul Greenfield
Chair, Soil CRC



Ralph Hardy
Director

Dated: 29 September 2021

Financial Statements

Auditor's Independence Declaration under Section 307C of the Corporations Act 2001

Auditor's Independence Declaration under Section 307C of the Corporations Act 2001

I declare that, to the best of my knowledge and belief, during the year ended 30 June 2021, there have been:

- (i) no contraventions of the auditor independence requirements as set out in the *Corporations Act 2001* in relation to the audit; and
- (ii) no contraventions of any applicable code of professional conduct in relation to the audit.

PKF

PKF

Chartered Accountants

Martin Matthews

Martin Matthews

Partner

Newcastle, NSW

Statement of Profit or Loss and Other Comprehensive Income

For the Year Ended 30 June 2021

	Note	2021 \$	2020 \$
Revenue	4	20,179,132	17,324,989
Other income	4	60,730	133,694
Consultants fees		(62,455)	(77,892)
Employee benefits expense		(532,186)	(490,652)
Finance expenses		(1,015)	(823)
IT expenses		(103,711)	(113,423)
Legal expenses		(5,820)	(8,214)
Other expenses	5	(370,834)	(396,969)
Research expenditure — cash		(5,454,098)	(4,848,702)
Research expenditure — in kind		(13,689,801)	(11,495,214)
Travel expenses		(19,942)	(26,794)
Surplus before income tax		-	-
Income tax expense	2(i)	-	-
Surplus for the year		-	-
Other comprehensive income for the year		-	-
Total comprehensive income for the year		-	-

PKF(NS) Audit & Assurance Limited
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The accompanying notes form part of these financial statements.

Financial Statements

Statement of Financial Position

As At 30 June 2021

	Note	2021 \$	2020 \$
Assets			
Current assets			
Cash and cash equivalents	6	13,505,313	7,876,909
Trade and other receivables	7	222,252	1,211,417
Other assets		37,467	50,039
Total current assets		13,765,032	9,138,365
Total non current assets		-	-
Total assets		13,765,032	9,138,365
Liabilities			
Current liabilities			
Trade and other payables	8	2,904,807	1,628,947
Employee benefits		93,520	53,381
Other financial liabilities	9	10,766,705	7,456,037
Total current liabilities		13,765,032	9,138,365
Total non current liabilities		-	-
Total liabilities		13,765,032	9,138,365
Net assets		-	-
EQUITY			
Retained earnings		-	-
Total equity		-	-

The accompanying notes form part of these financial statements.

Statement of Changes in Equity

For the Year Ended 30 June 2021

	Retained Earnings \$	Total \$
2021		
Balance at 1 July 2020	-	-
Surplus for the year	-	-
Balance at 30 June 2021	-	-
2020		
Balance at 1 July 2019	-	-
Surplus for the year	-	-
Balance at 30 June 2020	-	-

Statement of Cash Flows

For the Year Ended 30 June 2021

	Note	2021 \$	2020 \$
Cash flows from operating activities:			
Cash contributions received from Commonwealth (inclusive of GST)		7,840,800	4,595,800
Cash contributions received from Participants (inclusive of GST)		3,679,783	2,185,700
Payments to suppliers and employees		(5,951,894)	(7,103,918)
Interest received		60,730	133,694
Finance costs		(1,015)	(823)
Net cash provided by/(used in) operating activities	13	5,628,404	(189,547)
Cash flows from investing activities:			
Net cash provided by/(used in) investing activities		-	-
Cash flows from financing activities:			
Net cash provided by/(used in) financing activities		-	-
Net increase/(decrease) in cash and cash equivalents held		5,628,404	(189,547)
Cash and cash equivalents at beginning of year		7,876,909	8,066,456
Cash and cash equivalents at end of financial year	6	13,505,313	7,876,909

The accompanying notes form part of these financial statements.

Notes to the Financial Statements

For the Year Ended 30 June 2021

The financial report covers CRC for High Performance Soils Limited as an individual entity. CRC for High Performance Soils Limited is a not-for-profit Company limited by guarantee, incorporated and domiciled in Australia.

The functional and presentation currency of CRC for High Performance Soils Limited is Australian dollars.

1 Basis of Preparation

In the Directors' opinion, the Company is not a reporting entity since there are unlikely to exist users of the financial statements who are not able to command the preparation of reports tailored so as to satisfy specifically all of their information needs. This special purpose financial report has been prepared to meet the reporting requirements of the *Corporations Act 2001*.

The financial statements have been prepared in accordance with the recognition and measurement principles of all applicable Australian Accounting Standards and Interpretations issued by the Australian Accounting Standards Board and the *Corporations Act 2001*.

2 Summary of Significant Accounting Policies

(a) Revenue and other income

Revenue from contracts with customers

The core principle of AASB 15 is that revenue is recognised on a basis that reflects the transfer of promised goods or services to customers at an amount that reflects the consideration the Company expects to receive in exchange for those goods or services. Revenue is recognised by applying a five-step model as follows:

1. Identify the contract with the customer
2. Identify the performance obligations
3. Determine the transaction price
4. Allocate the transaction price to the performance obligations
5. Recognise revenue as and when control of the performance obligations is transferred

Generally the timing of the payment for sale of goods and rendering of services corresponds closely to the timing of satisfaction of the performance obligations, however where there is a difference, it will result in the recognition of a receivable, contract asset or contract liability.

None of the revenue streams of the Company have any significant financing terms as there is less than 12 months between receipt of funds and satisfaction of performance obligations.

Specific revenue streams

The revenue recognition policies for the principal revenue streams of the Company are:

Grant revenue

Government grants are over time as the research and project outputs are performed.

Government grants relating to costs which have not yet been incurred are included in deferred revenue in current liabilities and are credited to the statement of comprehensive income in the period necessary to match them with the costs that they are intended to compensate.

Participants' contributions

Contributions received in cash (recorded as deferred revenue on receipt — for further information refer note 9) and in-kind from the Participants during the financial year are applied to expenditure incurred in carrying out the affairs of the Company under the terms of the Participants Agreement between the Company and the entities who have undertaken to provide contributions to the Company (other than the Commonwealth of Australia).

Contributions as detailed in note 15 are calculated on a cash basis for reporting purpose to Commonwealth of Australia.

(b) In-kind contributions

In-kind contributions of staff by research providers are valued in accordance with the Commonwealth Agreement, as per Table 1 of the Schedule 4 of the Agreement.

Non-staff in-kind contributions are valued on the following bases:

1. Buildings — a reasonable estimate of the commercial rental value related to the area and time period of occupation related to the activities of the Company.
2. Capital equipment — either an allocation of the replacement cost of the equipment apportioned over the proportion of the useful life utilized by the activities of the Company or an agreed value determined with reference to the cost of an equipment service from a commercial operator.

Office accommodation is provided by the University of Newcastle as part of the Participants Agreement and are treated as in-kind contributions. Where a value cannot be readily obtained by applying the policy rules set out above, a Directors' valuation is used.

(c) Cash and cash equivalents

Cash and cash equivalents comprises cash on hand, deposits held at call with financial institutions, other short term, highly liquid investments with original maturities of three months or less that are readily convertible to known amounts of cash and which are subject to an insignificant risk of changes in value.

(d) Financial instruments

Financial assets

Financial instruments are recognised initially on the date that the Company becomes party to the contractual provisions of the instrument.

On initial recognition, all financial instruments are measured at fair value plus transaction costs (except for instruments measured at fair value through profit or loss where transaction costs are expensed as incurred).

The financial assets of the Company have been reclassified into one of the following categories on adoption of AASB 9 based on primarily the business model in which a financial asset is managed and its contractual cash flow characteristics:

- Measured at amortised cost
- Fair value through profit or loss (FVTPL)

- Fair value through other comprehensive income — debt instruments (FVOCI — debt)
- Fair value through other comprehensive income — equity instruments (FVOCI — equity).

Trade receivables

Trade receivables are recognised initially at fair value and subsequently measured at amortised cost, less provision for expected credit losses. Trade receivables are due for settlement no more than 30 days.

The amount of the impairment is recorded in a separate allowance account with the loss being recognised in finance expense. Once the receivable is determined to be uncollectable then the gross carrying amount is written off against the associated allowance.

Financial liabilities

The Company measures all financial liabilities initially at fair value less transaction costs, subsequently financial liabilities are measured at amortised cost using the effective interest rate method.

(e) Impairment of assets

Assets that are subject to depreciation or amortisation are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognised for the amount by which the asset's carrying amount exceeds its recoverable amount. The recoverable amount is the higher of an asset's fair value less costs to sell and value in use. For the purposes of assessing impairment, assets are grouped at the lowest levels for which there are separately identifiable cash flows (cash generating units).

(f) Trade creditors

All trade creditors unpaid as at the reporting date are recognised at the amount invoiced, net of any applicable taxes. The Company's policy is to pay trade creditors no more than 30 days from the date of invoice.

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

(g) Employee benefits

(i) Wages and salaries, annual leave and sick leave

Liabilities for wages and salaries, including non-monetary benefits, accumulating sick leave and annual leave expected to be settled within 12 months of the reporting date are recognised in respect of employee's services up to the reporting date and are measured at the amounts expected to be paid when the liabilities are settled.

Liabilities for non-accumulating sick leave are recognised when the leave is taken and measured at the rates paid or payable.

(ii) Long service leave

The liabilities for long service leave and annual leave are not expected to be settled wholly within 12 months after the end of the period in which the employees render the related service. They are therefore measured as the present value of expected future payments to be made in respect of services provided by employees up to the end of the reporting period using the projected unit credit method. Consideration is given to expected future wage and salary levels, experience of employee departures and periods of service.

Expected future payments are discounted using market yields at the end of the reporting period of corporate bonds with terms and currencies that match, as closely as possible, the estimated future cash outflows. Remeasurements as a result of experience adjustments and changes in actuarial assumptions are recognised in profit or loss.

(h) Research expenditure

Research expenditure are recognised as incurred and consist of costs incurred as part of day to day research and development activities for research programs. The main items of expenditure are salaries, equipment, consumables and travel costs.

Salaries relate to research and non-research staff working directly on research programs. In some instances salary costs may be allocated between research expenditure and employee benefits when it is identified that time can be specifically attributed to research programs.

(i) Income tax

The Company is exempt from income tax under Division 50 of the *Income Tax Assessment Act 1997*.

3 Critical Accounting Estimates and Judgments

The preparation of financial statements requires the use of certain critical accounting estimates. It also requires management to exercise its judgement in the process of applying the Company's accounting policies.

Estimates and judgements are continually evaluated and are based on historical experience and other factors, including expectation of future events that may have a financial impact on the entity and that are believed to be reasonable under the circumstances.

The areas involving a higher degree of judgement or complexity, or areas where assumptions or estimates are significant to the financial statements are detailed below.

Key estimates — revenue recognition — long term contracts

The Company undertakes long term contracts which span a number of reporting periods. Recognition of revenue in relation to these contracts involves estimation of future costs of completing the contract and the expected outcome of the contract. The assumptions are based on the information available to management at the reporting date, however future changes or additional information may mean the expected revenue recognition pattern has to be amended.

Key estimates — in-kind contributions

Staff contributions are valued in accordance with guidelines and the multiplier set by the Commonwealth of Australia and as detailed in note 2(a). The actual time recorded on project work requires a certain level of estimate and judgement by project leaders. In applying that judgement, consideration is given to project budgets and agreements, as set out and approved by Participants and the Company.

The capital and equipment rates and useful lives used for contributions are based on estimations and agreements as calculated by project Participants and the Company. Valuations are generally based on estimates of the percentage utilisation of capital and equipment depreciation directly related to project output.

The Company believes that the estimates and assumptions in relation to in-kind contributions result in recognition of amounts that represent the fair value of contributions received.

4 Revenue and Other Income

Revenue from continuing operations

	2021 \$	2020 \$
Contributions revenue		
— Allocated contributions from Commonwealth/Participants — cash	6,489,331	5,829,775
— Allocated contributions from Participants — in-kind	13,689,801	11,495,214
Total contributions revenue	20,179,132	17,324,989
Other income		
— Interest	60,730	133,694
Total other income	60,730	133,694
Total revenue and other income	20,239,862	17,458,683

5 Other Expenses

Board expenses	213,022	233,333
Insurance	30,949	29,363
Compliance fees	27,500	26,295
Communications and marketing	37,579	44,513
Other expenses	61,784	63,465
Total	370,834	396,969

6 Cash and Cash Equivalents

Bank balances	4,069,159	719,521
Deposits at call	9,436,154	7,157,388
Total	13,505,313	7,876,909

7 Trade and Other Receivables

	2021 \$	2020 \$
Current		
Trade receivables	131,477	1,107,751
GST receivable	90,775	103,666
Total	222,252	1,211,417

8 Trade and Other Payables

Current		
Trade payables	301,210	433,051
GST payable	312,490	26,934
Accrued expenses	2,291,107	1,168,962
Total	2,904,807	1,628,947

9 Other Financial Liabilities

Current		
Contributions from Commonwealth and Participants	9,592,478	6,981,810
Other deferred revenue	1,174,227	474,227
Total	10,766,705	7,456,037

As per the accounting policy in note 2, contributions from the Commonwealth of Australia and Participants (both cash and in-kind) are treated as deferred revenue until matched against expenditure in the course of the Company's activities.

In the event of a wind up of the Company, any deferred revenue not matched against expenditure is required to be returned to the Commonwealth of Australia and individual Participants in accordance with the terms of the Agreements.

Deferred revenue arising from obligations to make contributions to the Company and not allocated to program expenses at balance date has been included as a current liability as it is anticipated that the relevant sum will be matched against expenditure during subsequent financial years.

Financial Statements

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

10 Members' Guarantee

The Company is incorporated under the *Corporations Act 2001* and is a Company limited by guarantee. If the Company is wound up, the constitution states that each member is required to contribute a maximum of \$100 each towards meeting any outstandings and obligations of the Company. At 30 June 2021 the number of members was 11 (2020: 11).

11 Auditors' Remuneration

	2021 \$	2020 \$
Remuneration of the auditor PKF, for:		
— auditing the financial statements	20,910	20,500

12 Contingencies

In the opinion of the Directors, the Company did not have any contingencies at 30 June 2021 (30 June 2020: None).

13 Cash Flow Information

(a) Reconciliation of result for the year to cashflows from operating activities

	2021 \$	2020 \$
Reconciliation of surplus to net cash provided by operating activities:		
Surplus for the year	-	-
Changes in assets and liabilities:		
— decrease/(increase) in trade and other receivables	1,053,005	(181,967)
— decrease/(increase) in other current assets	12,573	(1,584)
— (decrease)/increase in deferred revenue	3,310,668	373,161
— increase/(decrease) in trade and other payables	1,212,019	(413,405)
— (decrease)/increase in employee benefits	40,139	34,248
Cashflows from operations	5,628,404	(189,547)

14 Events Occurring After the Reporting Date

The financial report was authorised for issue on 29 September 2021 by the board of directors.

No matters or circumstances have arisen since the end of the financial year which significantly affected or may significantly affect the operations of the Company, the results of those operations, or the state of affairs of the Company in future financial years.

15 Participants' Contributions

(Cash basis ex GST as per note 2(a))

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
Agricultural Innovation and Research — Eyre Peninsula				
Cash contributions	20,000	-	-	20,000
In-kind contributions				
— Staff	35,750	42,000	37,500	115,250
— Other	34,102	38,788	2,000	74,890
Total	89,852	80,788	39,500	210,140
Australian Organics Recycling Association Limited				
Cash contributions	-	-	-	-
In-kind contributions				
— Staff	7,500	12,500	95,000	115,000
— Other	-	-	2,000	2,000
Total	7,500	12,500	97,000	117,000
Birchip Cropping Group Incorporated				
Cash contributions	5,000	5,000	10,000	20,000
In-kind contributions				
— Staff	28,250	62,500	205,000	295,750
— Other	36,099	42,676	11,650	90,425
Total	69,349	110,176	226,650	406,175
Burdekin Productivity Services Limited				
Cash contributions	-	-	-	-
In-kind contributions				
— Staff	51,250	50,000	42,500	143,750
— Other	3,750	6,750	1,000	11,500
Total	55,000	56,750	43,500	155,250
Central West Farming Systems Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
— Staff	95,500	62,500	185,000	343,000
— Other	117,783	69,155	33,535	220,473
Total	213,283	131,655	218,535	563,473

Financial Statements

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

15 Participants' Contributions cont.

(Cash basis ex GST as per note 2(a))

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
Charles Sturt University				
Cash contributions	200,000	200,000	400,000	800,000
In-kind contributions				
– Staff	562,500	682,500	825,000	2,070,000
– Other	533,292	359,526	11,600	904,418
Total	1,295,792	1,242,026	1,236,600	3,774,418

Corrigin Farm Improvement Group				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	25,000	-	5,000	30,000
– Other	1,398	-	-	1,398
Total	26,398	-	5,000	31,398

Department of Jobs, Precincts and Regions (VIC)				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	100,000	100,000	822,500	1,022,500
– Other	147,367	88,726	204,000	440,093
Total	247,367	188,726	1,026,500	1,462,593

Department of Regional NSW				
Cash contributions	-	-	525,000	525,000
In-kind contributions				
– Staff	988,750	540,000	1,030,000	2,558,750
– Other	523,842	390,662	22,308	936,812
Total	1,512,592	930,662	1,577,308	4,020,562

Department of Primary Industries and Regions (SA)				
Cash contributions	100,000	100,000	200,000	400,000
In-kind contributions				
– Staff	200,750	137,500	127,500	465,750
– Other	333,847	239,808	8,805	582,460
Total	634,597	477,308	336,305	1,448,210

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
Facey Group Incorporated				
Cash contributions	5,000	5,000	10,000	20,000
In-kind contributions				
– Staff	80,000	147,500	500,000	727,500
– Other	-	5,000	11,500	16,500
Total	85,000	157,500	521,500	764,000

Farmlink Research Limited				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	6,250	2,500	50,000	58,750
– Other	8,700	4,473	9,000	22,173
Total	14,950	6,973	59,000	80,923

Federation University Australia				
Cash contributions	100,000	100,000	200,000	400,000
In-kind contributions				
– Staff	428,750	240,000	1,000,000	1,668,750
– Other	329,959	169,689	160,000	659,648
Total	858,709	509,689	1,360,000	2,728,398

Griffith University				
Cash contributions	75,000	100,000	200,000	375,000
In-kind contributions				
– Staff	393,750	640,000	465,000	1,498,750
– Other	273,722	449,870	123,803	847,395
Total	742,472	1,189,870	788,803	2,721,145

Hart Field Site Group Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	28,750	25,000	27,500	81,250
– Other	69,650	42,000	-	111,650
Total	98,400	67,000	27,500	192,900

Financial Statements

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

15 Participants' Contributions cont.

(Cash basis ex GST as per note 2(a))

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
Herbert Cane Productivity Services Limited				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	41,250	65,000	57,500	163,750
– Other	35,750	54,108	4,000	93,858
Total	77,000	119,108	61,500	257,608
Holbrook Landcare Group				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	19,250	10,000	25,000	54,250
– Other	-	85	2,463	2,548
Total	19,250	10,085	27,463	56,798
Landcare Research (New Zealand)				
Cash contributions	267,000	267,000	534,000	1,068,000
In-kind contributions				
– Staff	26,250	35,000	220,000	281,250
– Other	6,425	1,800	7,777	16,002
Total	299,675	303,800	761,777	1,365,252
MacKillop Farm Management Group Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	10,000	2,500	12,500	25,000
– Other	1,333	1,000	-	2,333
Total	11,333	3,500	12,500	27,333
Mallee Sustainable Farming Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	-	-	22,500	22,500
– Other	-	-	250	250
Total	-	-	22,750	22,750

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
Murdoch University				
Cash contributions	187,500	150,000	263,000	600,500
In-kind contributions				
– Staff	252,500	340,000	205,000	797,500
– Other	234,490	344,918	6,250	585,658
Total	674,490	834,918	474,250	1,983,658
North Central Catchment Management Authority				
Cash contributions	-	15,000	-	15,000
In-kind contributions				
– Staff	22,500	17,500	147,500	187,500
– Other	2,500	7,000	5,000	14,500
Total	25,000	39,500	152,500	217,000
NSW Environment Protection Authority				
Cash contributions	-	-	50,000	50,000
In-kind contributions				
– Staff	5,000	-	-	5,000
– Other	-	-	-	-
Total	5,000	-	50,000	55,000
Nutrien Ag Solutions				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	145,750	90,000	420,000	655,750
– Other	21,900	52,300	8,250	82,450
Total	167,650	142,300	428,250	738,200
Riverine Plains Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	25,500	30,000	21,200	76,700
– Other	42,833	25,000	-	67,833
Total	68,333	55,000	21,200	144,533

Financial Statements

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

15 Participants' Contributions cont.

(Cash basis ex GST as per note 2(a))

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
South Australian Grain Industry Trust Fund				
Cash contributions	150,000	150,000	300,000	600,000
In-kind contributions				
– Staff	16,250	17,500	22,500	56,250
– Other	-	7,500	-	7,500
Total	166,250	175,000	322,500	663,750
South East Water Corporation				
Cash contributions	30,000	30,000	60,000	120,000
In-kind contributions				
– Staff	97,500	125,000	165,000	387,500
– Other	5,500	-	156,000	161,500
Total	133,000	155,000	381,000	669,000
Southern Cross University				
Cash contributions	200,000	200,000	400,000	800,000
In-kind contributions				
– Staff	885,000	840,000	1,337,500	3,062,500
– Other	987,237	601,269	172,563	1,761,069
Total	2,072,237	1,641,269	1,910,063	5,623,569
Southern Farming Systems Limited				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	23,000	7,500	27,500	58,000
– Other	11,337	10,118	16,838	38,293
Total	34,337	17,618	44,338	96,293
Society of Precision Agriculture Australia (SPAA)				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	1,250	5,000	62,500	68,750
– Other	-	500	-	500
Total	1,250	5,500	62,500	69,250

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
The Gillamii Centre				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	-	-	2,500	2,500
– Other	-	-	-	-
Total	-	-	2,500	2,500
The Liebe Group Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	2,750	-	25,000	27,750
– Other	-	-	-	-
Total	2,750	-	25,000	27,750
The Trustee for Soils for Life Trust				
Cash contributions	20,000	20,000	40,000	80,000
In-kind contributions				
– Staff	143,750	85,000	75,000	303,750
– Other	25,700	18,250	6,709	50,659
Total	189,450	123,250	121,709	434,409
The University of Newcastle				
Cash contributions	300,000	300,000	600,000	1,200,000
In-kind contributions				
– Staff	1,000,000	765,000	1,560,643	3,325,643
– Other	1,155,478	935,620	268,000	2,359,098
Total	2,455,478	2,000,620	2,428,643	6,884,741
University of Southern Queensland				
Cash contributions	150,000	150,000	300,000	600,000
In-kind contributions				
– Staff	390,000	390,000	635,000	1,415,000
– Other	381,575	314,211	43,595	739,381
Total	921,575	854,211	978,595	2,754,381

Financial Statements

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

15 Participants' Contributions cont.

(Cash basis ex GST as per note 2(a))

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
University of Tasmania				
Cash contributions	150,000	187,500	263,000	600,500
In-kind contributions				
– Staff	983,750	735,000	755,000	2,473,750
– Other	945,027	609,479	45,000	1,599,506
Total	2,078,777	1,531,979	1,063,000	4,673,756
Western Australian No-Tillage Farmers Association				
Cash contributions	10,000	10,000	20,000	40,000
In-kind contributions				
– Staff	55,000	50,000	210,000	315,000
– Other	36,261	28,337	-	64,598
Total	101,261	88,337	230,000	419,598
West Midlands Group Incorporated				
Cash contributions	10,000	-	-	10,000
In-kind contributions				
– Staff	30,000	12,500	7,500	50,000
– Other	45,000	4,000	-	49,000
Total	85,000	16,500	7,500	109,000
Wheatbelt Natural Resource Management Incorporated				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	36,250	52,500	110,000	198,750
– Other	33,018	42,211	24,000	99,229
Total	69,268	94,711	134,000	297,979
Wimmera Catchment Authority				
Cash contributions	-	-	-	-
In-kind contributions				
– Staff	55,000	92,500	264,800	412,300
– Other	4,678	17,816	38,181	60,675
Total	59,678	110,316	302,981	472,975

	2021 \$	2020 \$	Cumulative to 2019 \$	Total \$
Other Third Party				
Cash Contributions	500,000	-	480,000	980,000
In-kind contributions				
– Staff	-	-	-	-
– Other	-	-	-	-
Total	500,000	-	480,000	980,000
Total Participant Contribution				
Cash contributions	2,479,500	1,989,500	4,805,000	9,274,000
In-kind contributions				
– Staff	7,300,250	6,512,500	11,809,143	25,621,893
– Other	6,389,551	4,982,714	1,406,077	12,778,342
Total	16,169,301	13,484,714	18,020,220	47,674,235
Total Commonwealth Contribution				
Cash contributions	7,128,000	4,062,750	6,998,000	18,188,750
Total	7,128,000	4,062,750	6,998,000	18,188,750
Total Contributions				
Cash contributions	9,607,500	6,052,250	11,803,000	27,462,750
In-kind contributions				
– Staff	7,300,250	6,512,500	11,809,143	25,621,893
– Other	6,389,551	4,982,714	1,404,077	12,776,342
Total	23,297,301	17,547,464	25,016,220	65,860,985

Financial Statements

Notes to the Financial Statements cont.

For the Year Ended 30 June 2021

16 Commitments for Expenditure

	2021 \$	2020 \$
Payable within one year	3,183,769	3,873,793
Payable greater than 1 year but less than 5 years	2,116,823	3,494,667
Total commitments	5,300,592	7,368,460

At balance date the entity had the following commitments for expenditure:

- Funding obligations in relation to research projects that are relevant to the Company's obligations under the terms of the Commonwealth Agreement. The sum of the cash obligations is \$5,219,302 (2020: \$7,298,041).
- Funding obligations for the secondment of employees to provide services to the Company. The total sum of the obligations are \$81,290 (2020: \$70,419).

17 Statutory Information

The registered office and principal place of business of the company is:

CRC for High Performance Soils Ltd

Level 1, IDC Building
University of Newcastle
University Drive
Callaghan NSW 2308

Directors' Declaration

The directors have determined that the Company is not a reporting entity and that these special purpose financial statements should be prepared in accordance with the accounting policies described in Note 2 of the financial statements.

The directors of the Company declare that:

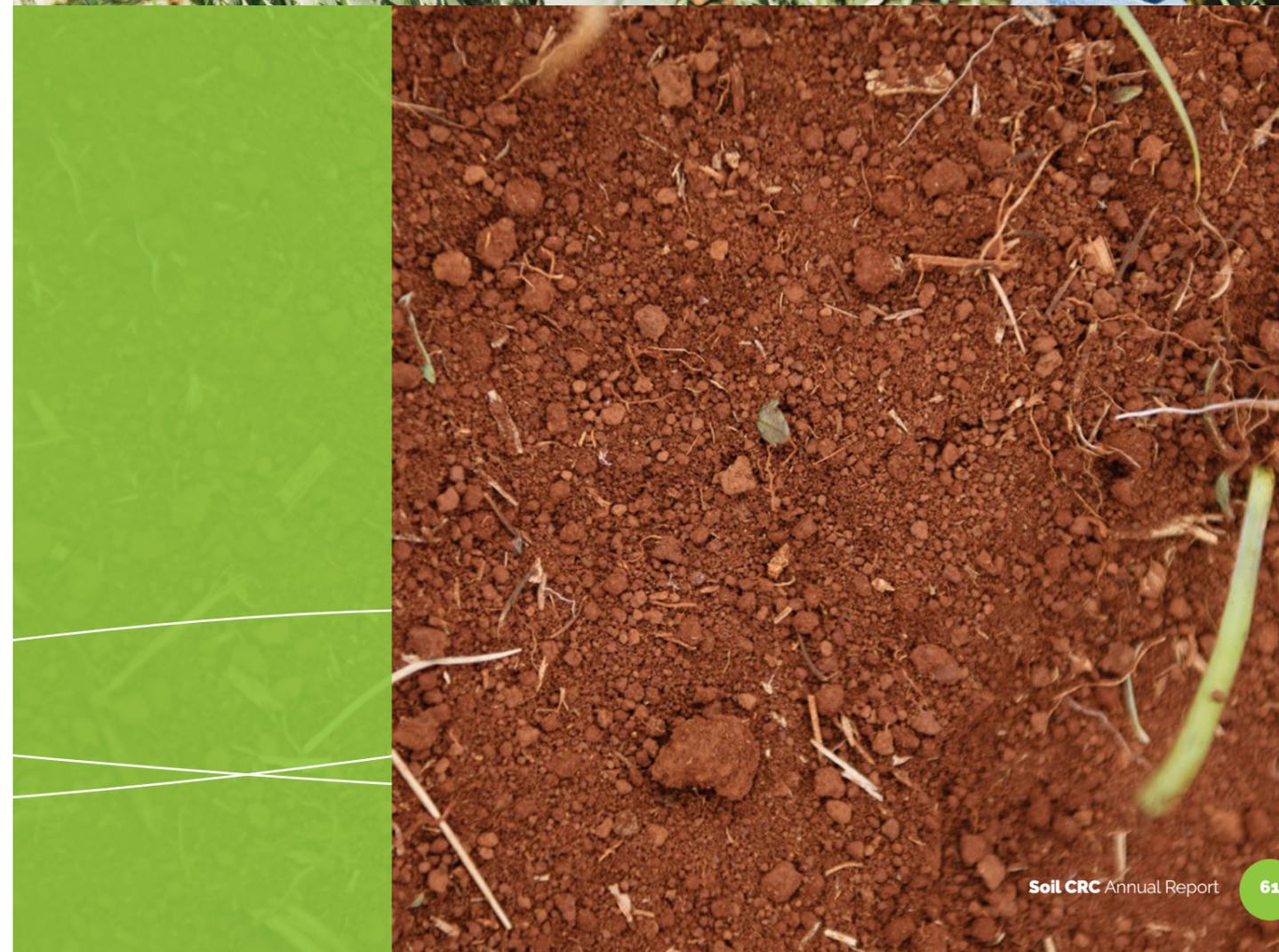
1. The financial statements and notes, as set out on pages 43 to 60, are in accordance with the *Corporations Act 2001* and:
 - (a) comply with Australian Accounting Standards as stated in Note 1; and
 - (b) give a true and fair view of the financial position as at 30 June 2021 and of the performance for the year ended on that date in accordance with the accounting policies described in Note 2 of the financial statements.
2. In the directors' opinion, there are reasonable grounds to believe that the Company will be able to pay its debts as and when they become due and payable.

This declaration is made in accordance with a resolution of the Board of Directors.

Dr Paul Greenfield
Chair, Soil CRC

Ralph Hardy
Director

Dated: 29 September 2021



Financial Statements

Independent Audit Report

To the members of CRC for High Performance Soils Limited

Report on the Financial Report

Opinion

We have audited the financial report of CRC for High Performance Soils Limited (the Company), which comprises the statement of financial position as at 30 June 2021, the statement of profit or loss and other comprehensive income, statement of changes in equity and statement of cash flows for the year then ended, and notes to the financial statements, including a summary of significant accounting policies, and the directors' declaration.

In our opinion, the accompanying financial report of the Company is in accordance with the *Corporations Act 2001*, including:

- (a) giving a true and fair view of the Company's financial position as at 30 June 2021 and of its performance for the year then ended; and
- (b) complying with Australian Accounting Standards to the extent described in Note 1, and the Corporations Regulations 2001.

Basis for Opinion

We conducted our audit in accordance with Australian Auditing Standards. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Report section of our report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Emphasis of Matter — Basis of Accounting

We draw attention to Note 1 to the financial report, which describes the basis of accounting. The financial report has been prepared for the purpose of fulfilling the directors' financial reporting responsibilities under the *Corporations Act 2001*. As a result, the financial report may not be suitable for another purpose. Our opinion is not modified in respect of this matter.

Independence

We are independent of the Company in accordance with the auditor independence requirements of the Corporations Act 2001 and the ethical requirements of the Accounting Professional and Ethical Standards Board's APES 110 Code of Ethics for Professional Accountants (including Independence Standards) (the Code) that are relevant to our audit of the financial report in Australia. We have also fulfilled our other ethical responsibilities in accordance with the Code.

Responsibilities of the Directors for the Financial Report

The directors of the Company are responsible for the preparation of the financial report that gives a true and fair view and have determined that the basis of preparation described in Note 1 to the financial report is appropriate to meet the requirements of the *Corporations Act 2001* and is appropriate to meet the needs of the members. The directors' responsibility also includes such internal control as the directors determine is necessary to enable the preparation of a financial report that gives a true and fair view and is free from material misstatement, whether due to fraud or error.

In preparing the financial report, the directors are responsible for assessing the Company's ability to continue as a going concern, disclosing, as applicable, matters relating to going concern and using the going concern basis of accounting unless the directors either intend to liquidate the Company or to cease operations, or have no realistic alternative but to do so.

Auditor's Responsibilities for the Audit of the Financial Report

Our objectives are to obtain reasonable assurance about whether the financial report as a whole is free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with the Australian Auditing Standards will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of this financial report.

As part of an audit in accordance with the Australian Auditing Standards, we exercise professional judgment and maintain professional scepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial report, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by the directors.
- Conclude on the appropriateness of the directors' use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Company's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial report or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Company to cease to continue as a going concern.
- Evaluate the overall presentation, structure and content of the financial report, including the disclosures, and whether the financial report represents the underlying transactions and events in a manner that achieves fair presentation.

We communicate with the directors regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

We also provide the directors with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence, and where applicable, action taken to eliminate threats or safeguards applied.

PKF
Chartered Accountants

Martin Matthews
Partner

Newcastle, NSW

Dated: 29 September 2021

Appendices

Appendix A: PhD students

Student	University	Project title	Program	Start	Expected finish	Country of origin
Mathew Alexanderson	Southern Cross University	Regenerative agriculture: exploring the boundaries of an alternative agricultural system	1	Nov 2019	May 2023	Australia
Louise Hunt	Southern Cross University	Negotiating the complexities of farming in the 21st century	1	Apr 2020	May 2023	Australia
Salini Khurajam	University of Newcastle	Exploring economic aspects of adopting soil amendments for ameliorating soil constraints in Australia	1	Feb 2021	Aug 2024	India
Melissa Wales	Charles Sturt University	Social norms of soil management	1	Jan 2018	Mar 2022	Australia
Linda Wirf	Charles Sturt University	Beyond adoption: finding more appropriate ways to evaluate the success of soil outreach	1	Nov 2020	Nov 2023	Australia
Ben Buurman	Federation University Australia	Longer-range soil moisture sensing using signal propagation characteristics	2	Jul 2019	Apr 2023	Australia
Jaye Hill	University of Southern Queensland	Proximal soil sensing to measure and map soil nutrients	2	Feb 2019	Sep 2022	Australia
Phillip Kay	University of Tasmania	Microbial changes associated with improved or reduced soil health	2	Nov 2019	Nov 2022	Australia
Reuben Mah	University of Tasmania	3D printed devices for in-field soil measurements	2	Dec 2019	Jun 2023	Malaysia
Arnab Mitra	University of Tasmania	Mobile soil water extraction for biological and chemical analysis	2	Feb 2020	Nov 2023	India
Maria Then	Murdoch University	Evaluation of gamma radiometrics as a tool to manage soil water repellency in cropping soils	2	Feb 2021	Aug 2024	Australia
Peter Weir	Federation University Australia	In-paddock variability of plant available water	2	Mar 2020	Sep 2023	Australia
Sedigheh Abbasi	University of Newcastle	Phosphorus release and labile phosphorus from iron phosphate and biochar in rhizosphere induced by root exudates	3	Oct 2017	Oct 2021	Australia
Maryam Barati	Southern Cross University	Novel approaches for phosphorus acquisition in grain crops	3	Jun 2021	Dec 2024	Iran
Md. Zahangir Hossain	University of Newcastle	Biochar and nutrient interactions	3	May 2017	Nov 2021	Bangladesh
Tania Monir	Murdoch University	Stability of soil carbon under different amendments in sandy soils	3	Jun 2021	Dec 2024	Bangladesh
James O'Connor	University of Newcastle	Food waste valorisation products as a nutrient source and carbon amendment	3	Mar 2021	Sep 2024	Australia
Oluwadunsin Adedeji Oyetunji	University of Newcastle	Compost-blended fertiliser products	3	Nov 2020	May 2024	Nigeria
Md. Aminur Rahman	University of Newcastle	Biochar modification for the generation of high quality phosphorus fertiliser products	3	Nov 2017	Nov 2021	Bangladesh
Rahat Shabir	Griffith University	Developing an effective biochar and biopolymer material for use as an alternative microbial carrier	3	Oct 2019	Oct 2022	Pakistan

Student	University	Project title	Program	Start	Expected finish	Country of origin
Cameron Copeland	Southern Cross University	Influence of root exudates on soil microbial diversity and soil function	4	Sep 2019	Mar 2023	Australia
Daven Gopalan	Southern Cross University	Redox in the rhizosphere and its concept in phosphorus acquisition in plants	4	Jul 2020	Jul 2023	Malaysia
Xiangyu Liu	Griffith University	Developing sensitive soil health indicators of Australian agricultural land	4	Feb 2018	Aug 2021	China
Naveeda Majid	University of Newcastle	Non-wetting soils: the cause and mechanism of non-wetting and remediation	4	Feb 2021	Aug 2024	Pakistan
Win Win Pyone	Murdoch University	Managing phytotoxicity of soil-borne herbicide residues in grain cropping systems	4	Nov 2019	May 2023	Myanmar
Hanlu Zhang	University of Southern Queensland	Soil-moisture profile dynamics affected by cover crops: Effect of changes in soil biology and structure	4	Feb 2020	Aug 2023	China

Appendix B: Participants and third parties

Participant organisations

Organisation	ABN	Type
Agricultural Innovation & Research Eyre Peninsula	30 709 219 010	Individual SME
Australian Organics Recycling Association Limited	17 158 519 736	Individual SME
Birchip Cropping Group Incorporated	92 087 981 510	Individual SME
Burdekin Productivity Services Limited	18 107 846 060	Individual SME
Central West Farming Systems Incorporated	37 814 703 505	Individual SME
Charles Sturt University	83 878 708 551	University
Corrigin Farm Improvement Group	73 411 548 004	Individual SME
Department of Jobs, Precincts and Regions (Vic)	83 295 188 244	State government
Department of Regional NSW	19 948 325 463	State government
Department of Primary Industries and Regions (SA)	53 763 159 658	State government
Environment Protection Authority (NSW)	43 692 285 758	State government
Facey Group Incorporated	59 136 484 550	Individual SME
FarmLink Research Limited	23 109 837 505	Individual SME
Federation University Australia	51 818 692 256	University
Griffith University	78 106 094 461	University
Hart Field Site Group Incorporated	72 015 164 228	Individual SME
Herbert Cane Productivity Services Limited	71 100 551 826	Individual SME
Holbrook Landcare Group	64 092 836 658	Individual SME
Mackillop Farm Management Group Incorporated	60 685 776 966	Individual SME
Mallee Sustainable Farming Incorporated	99 557 839 332	Individual SME

Third party organisations

Organisation	ABN	Type
Department of Agriculture, Water and the Environment	24 113 085 695	Australian Government
Eyre Peninsula NRM	81 927 209 608	Individual SME
Grains Research and Development Corporation	55 611 223 291	Industry

Organisation	ABN	Type
Manaaki Whenua Landcare Research (New Zealand) Limited		Other
Murdoch University	61 616 369 313	University
North Central Catchment Management Authority	73 937 058 422	Individual SME
Nutrien Ag Solutions Limited	73 008 743 217	Large Industry
Riverine Plains Incorporated	95 443 809 873	Individual SME
Society of Precision Agriculture Australia Incorporated	43 553 215 627	Individual SME
Soils For Life Trust	23 744 512 660	Individual SME
South Australian Grain Industry Trust Fund	23 116 814 640	Individual SME
South East Water Corporation	89 066 902 547	Large Industry
Southern Cross University	41 995 651 524	University
Southern Farming Systems Limited	54 093 170 631	Individual SME
The Gillamii Centre	16 887 295 206	Individual SME
The Liebe Group Incorporated	44 748 432 382	Individual SME
The University of Newcastle	15 736 576 735	University
University of Southern Queensland	40 234 732 081	University
University of Tasmania	30 764 374 782	University
West Midlands Group Incorporated	47 325 820 894	Individual SME
Western Australian No-tillage Farmers Association (Incorporated)	33 038 818 613	Individual SME
Wheatbelt Natural Resource Management Incorporated	61 661 518 664	Individual SME
Wimmera Catchment Management Authority	83 900 830 261	Individual SME

Organisation	ABN	Type
National Australia Bank Limited	12 004 044 937	Industry
Rocky Point Production	64 913 938 751	Individual SME
WA Composts Proprietary Limited (C-Wise)	97 962 521 954	Individual SME

Appendix C: Publications

Book chapter

Chowdhury, S., Bolan, N., Farrell, M., Sarkar, B., Sarker, J.R., Kirkham, M.B., Hossain, M.Z. & Kim, G.H. (2020) Role of cultural and nutrient management practices in carbon sequestration in agricultural soil. *Advances in Agronomy* 166 131–196 doi.org/10.1016/bs.agron.2020.10.001.

Refereed journal papers

Hardie, M. (2020) Review of novel and emerging approaches for measuring soil moisture in agriculture. *Sensors* 20 6934 doi.org/10.3390/s20236934.

Hossain, M.Z., Bahar, M. M., Sarkar, B., Donne, S.W., Ok, Y.S., Palansooriya, K.N., Kirkham, M.B., Chowdbury, S. & Bolan, N. (2020). Biochar and its importance on nutrient dynamics in soil and plant. *Biochar* 2 379–420 doi.org/10.1007/s42773-020-00065-z.

Hossain, M.Z., Bahar, M.M., Sarkar, B., Donne, S.W., Wade, P. & Bolan, N. (2021) Assessment of the fertilizer potential of biochars produced from slow pyrolysis of biosolid and animal manures. *Journal of Analytical and Applied Pyrolysis* 155 105043 doi.org/10.1016/j.jaap.2021.105043.

Conference publications

Allan, C. (2020) Collaborating for Improved Soil Stewardship – Insights from Australia's Soil CRC. 2020 International Symposium on Society and Resource Management. www4.iasnr.org/2020-issrm-virtual-conference-program

Allan, C. (2020) Collaboration for soil stewardship. 2020 International Symposium on Society and Resource Management. www4.iasnr.org/2020-issrm-virtual-conference-program

Allan, C. (2021) Soil CRC Program 1 – Investing in high performance Soils. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p8.

Allen, W., Grelet, G., Davenport, D., Dennerly, C., Schapel, A., Gilbert, F., Yeates, K., Masters, N., Haggerty, D., Hagerty, I., Pontifex, G., Sims, G., Seis, C., Hand, G., Royds, M., McAlpine, S., Kelly, N., Ive, J., Marsh, D. & Van Zwieten, L. (2020) Co-designing impact research in regenerative agriculture. 2020 International Symposium on Society and Resource Management. www4.iasnr.org/2020-issrm-virtual-conference-program

Bolan, N. (2021) Soil CRC Program 3 – New products for soil fertility and function. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p27.

Crawford, M. (2021) The Soil CRC – An overview. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p52.

Doyle, R. (2021) Soil CRC Program 2 – Soil performance metrics. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p61.

Hardie, M. (2021) Options for the next generation of soil moisture sensors. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p84.

Hardie, M. & Ridgers, J. (2021) Sending sensor data from and through the soil. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p85.

Luke, H. (2020) Enough about climate change – let's talk about changes in weather patterns. 2020 International Symposium on Society and Resource Management. www4.iasnr.org/2020-issrm-virtual-conference-program

Mitchell, R. & Cann, M. (2021) Managing soil for high performance after a drought: a discussion. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. P147.

Pawsey, N., Allan, C., Ascui, F., Cockfield, G., Cook, S., Frost, M., Wong, A., Lynch, J., Wills, B., & Colliver, R. (2020). The activation of financial markets to reward soil stewardship: Preliminary findings from a systemic co-inquiry. 2020 International Symposium on Society and Resource Management. www4.iasnr.org/2020-issrm-virtual-conference-program

Rose, M., Di Bella, L., Rezaei Rashti, M., Chen, C. & Van Zwieten, L. (2021) Resilience of soil functions to drying – a comparison of virgin, fallowed and cover-cropped soil. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p184.

Surapaneni, A., Hampton, J., Short, G., Uren, P. & Seshadri, B. (2020) Soil injection of liquid biosolids: successful implementation of research development and demonstration (RD&D) pathway project. Oz Water Conference 4–6 May 2021. Adelaide, SA 5000.

Tavakkoli, E., Fang, Y., Koshy, P., Sorrell, C., Aslam, N., Uddin, S., Jia, Y., Ramadass, K., Indirathankam, S., Vinu, A., Sandral, G., Van Zwieten, L. & Singh, B.P. (2021) Amelioration of subsoil constraints using innovative nano-products. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p212.

Van Zwieten, L. (2021) Soil CRC Program 4 – Integrated soil management solutions. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June–2 July 2021. Cairns QLD 4870. p236.

Appendices

Appendix C: Publications cont.

Whatmuff, M., Weiss, M., Armstrong, R., Tavakkoli, E. & Condon, J. (2021) Reactions and interactions between ameliorants used to treat complex soil constraints. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June-2 July 2021. Cairns, QLD 4870. p246.

Zhang, H., Ghahramani, A., McLean Bennett, J. & Erbacher, A. (2021) Effect of cover cropping on soil water dynamic in dryland farming system. The Soil Science Australia and the New Zealand Society of Soil Science Joint Conference, 27 June-2 July 2021. Cairns QLD 4870.

Other publications

Angel, K., Rose, M., Van Zwieten, L. & Rose, T. (2021) Herbicide residues — measuring herbicide carryover. BCG Season Research Results Book, Birchip Cropping Group, Birchip, Vic.

Baker, C. & Luke, H. (2020) Preliminary survey data for South Australian partners. Soil CRC Project Surveying Farm Practices.

Dahlhaus P., MacLeod A., Medyckyj-Scott D., Simons B., Bahlo C., Sexton A., Thompson H., Wong M. & Robinson N. (2021) Soil CRC Project Visualising Australasia's Soils Fact Sheets.

Dahlhaus P., MacLeod A., Medyckyj-Scott D., Simons B., Bahlo C., Sexton A., Thompson H., Wong, M. & Robinson, N. (2021) Soil CRC Project Visualising Australasia's Soils Final Report.

Luke, H., Baker, C., Allan, C. & McDonald, S. (2020). Agriculture on the Eyre Peninsula: Rural Landholder Social Benchmarking Report 2020. Southern Cross University, NSW, 2480. ISBN 978-0-6450707-0-5.

Luke, H., Baker, C., Allan, C., McDonald, S. & Alexanderson, M. (2021). Agriculture in the Northern Wheatbelt: Rural Landholder Social Benchmarking Report 2021. Southern Cross University, NSW, 2480 Australia. ISBN 978-0-6450707-1-2.

Luke, H., Lake, W., Allan, C., Alexanderson, M. & Hunt, L. (2021) Soil CRC Social-Benchmarking Survey Cross-Regional Summary 2021 North Central Victoria, the Eyre Peninsula of South Australia and the Northern Wheatbelt of Western Australia. Soil CRC Project Surveying Farm Practices.

Powell, S.M., Hardy, R., Hardie, M., Mohammed, C., Corkrey, R., Kay, P., Glen, M., Bowman, J.P. & Evans, K. (2021) Soil CRC Project Smelling Soil Final Report.

Rose, M., Van Zwieten, L. & Cook, A. (2021) Persistence of the herbicide clopyralid in Eyre Peninsula soils. Eyre Peninsula Farming System Summary, PIRSA, SA.

Rose, M., Van Zwieten, L., Rose, T., Kearney, L. & Cook, A. (2021) Developing knowledge and tools to better manage herbicide residues in soil. Lower EP Ag Expo 2021 Booklet, Ag Innovation and Research Eyre Peninsula. <https://airep.com.au/wp-content/uploads/2021/04/Lower-EP-Ag-Expo-Booklet.pdf>



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SOIL CRC

Performance through collaboration

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