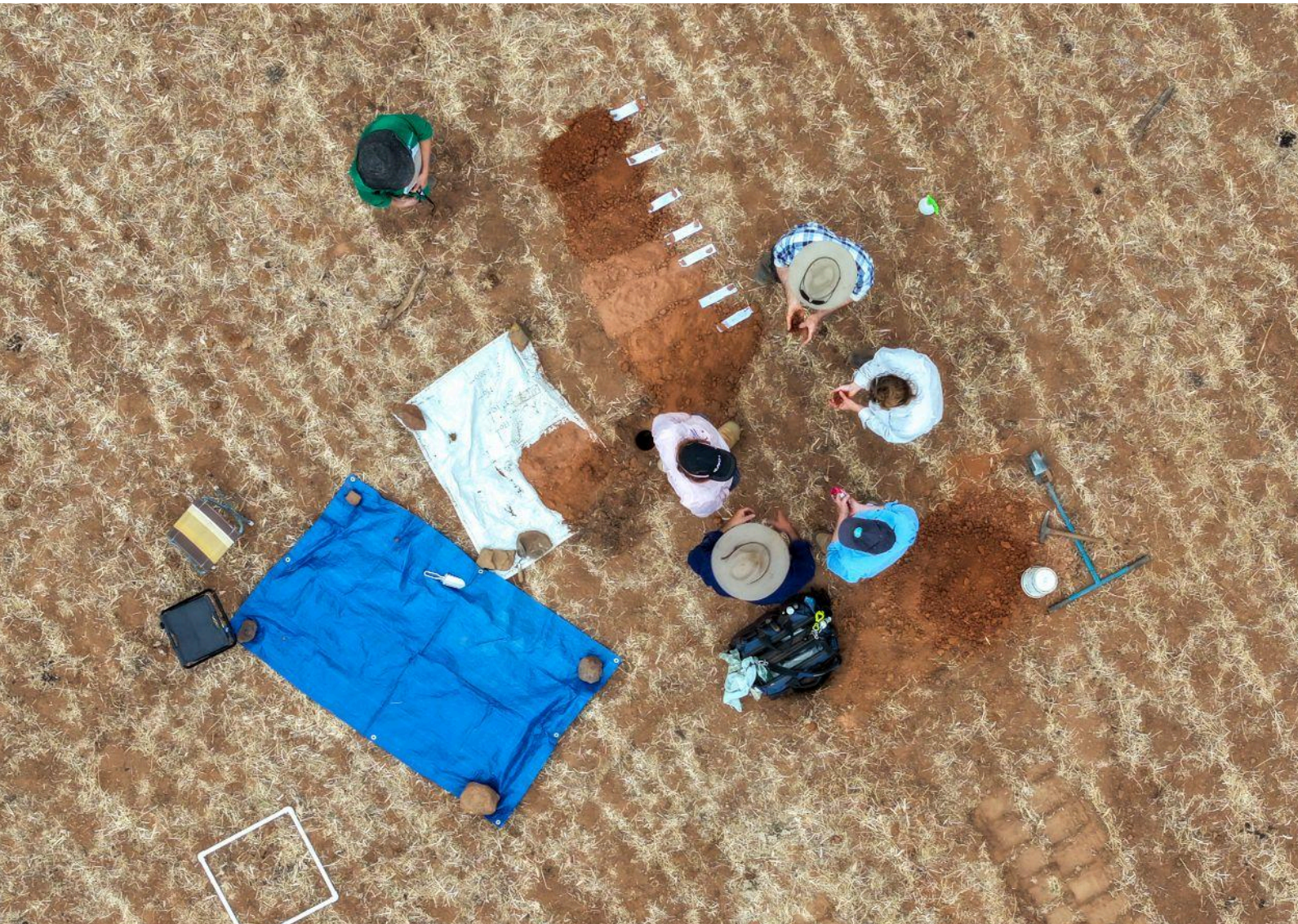
SoilsforLife

Riverina Group Case Study

Coming together to build soil monitoring capabilities and infrastructure for profitable farming and soil health

Part of the Riverina LLS Drought Resilience and Soil Monitoring Series

July 2024



Acknowledgements

This case study is part of the Riverina Drought Resilient Soils and Landscapes project, which aims to support producers in adopting drought resilient practices and enhance their landscape and soil monitoring capabilities.

The project is supporting 15 producers to adopt one of three well-established management practices that enhance agricultural productivity and profitability during or after droughts while safeguarding natural resources. The project also involves the farmers participating in soil monitoring activities, field days, an online farmer discussion group and a WhatsApp group.

As part of the project, Soils for Life produced a series of case studies following farmers as they implement a practice and set up soil monitoring. This group case study presents the range of project activities, explores the benefits of farmer discussion groups and the experiences of seven of the producers.

This project is led by Riverina Local Land Services, in conjunction with ANU Sustainable Farms and Soils for Life. This project has received funding from the Australian Government's Future Drought Fund.

We acknowledge that the contents of this document do not necessarily reflect the views of these contributors.

About Soils for Life
Soils for Life is an independent, not-for-profit organisation that works across Australia to support Australian farmers to regenerate soils, for resilient people, communities, businesses and landscapes.

Front image: Sampling soils at the Wilkes-Bowes' property.

Image source: Grow Love Project.

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Published by Soils for Life
Canberra, ACT, July 2024

Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

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Soils for Life

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About the **Project**

The Riverina Drought Resilient Soils and Landscapes project supported 15 farmers across four regions of the Riverina - Murrumbidgee, Upper and Lower Slopes, and Lachlan - to implement one of three drought-resilience practices (enhanced farm dams, native shelterbelts or stock management areas) and to set up and conduct soil and landscape monitoring, including in-field assessments and soil lab testing (see Image 1 for soil sampling at one farm). Led by the Riverina Local Land Services (LLS), in partnership with Soils for Life and ANU Sustainable Farms, the project was developed to improve drought resilience and build soil literacy for the group of Riverina farmers.

To help enhance learning and build supportive farmer networks, the core practice and soil monitoring activities were supported by a number of farmer-to-farmer learning opportunities, including:

- Field days
- Online farmer discussion group
- Quarterly webinars
- WhatsApp group

Watch the video about the project.

Image 1. Soil sampling at Highfield Farm and Woodland. Source: Soils for Life.

Meet the **Riverina Farmers**

Seven of the 15 farmers shared their experiences for this group case study. Each farmer implemented drought resilient activities relevant to their farming context, each of which is geographically dispersed around the Riverina (see Figure 1 for the location of each farm).

Farmers	Riverina Region	Enterprise	Drought resilience practice
 Bert and Liz Matthews at Bedarbidgal	Murrumbidgee	Dryland grazing Merino sheep and Angus cattle	Paddock tree regeneration with tree guards
 Cindy and Steven Scott at Glen Elgin	Lower Slopes	Seedstock, cattle breeding, commercial Angus beef production and wheat and canola cropping	Shelterbelts
 Jack and Annabell Hanna	Murrumbidgee	Dryland Merino sheep grazing, with seasonal cattle production and agistment, typically during and after a flood from the Lachlan River	Stock management area

 Craig and Dee Wilkes-Bowes at Anderloose	Lachlan	Grazing sheep and cattle, fodder crops and occasional commercial cropping	Stock management area
 Di Kelly-Chirgwin at Farm 643	Murrumbidgee	Mixed grazing	Farm dam enhancement
 Louise Freckleton at Highfield Farm and Woodland	Upper Slopes	Small-scale direct to customer Dorper lamb, Dexter beef, pasture-raised eggs and chicken	Farm dam enhancement
 Peter O'Connell at Stormy Lodge	Lower Slopes	Mixed cropping and sheep production	Stock management area

Riverina Landscapes and **Soils**

The Riverina region sits mostly on Wiradjuri Country in south-western New South Wales. It is one of Australia's most productive and diverse agricultural regions. Covering approximately 115,000 sq km, the climate and landscapes vary greatly; from the steep alpine slopes of the Snowy Mountains to the dry, inland plains of the rangelands around Hay and Carrathool.

The region occupies a large section of the Murray–Darling Basin, and is defined by the Murray and Murrumbidgee Rivers. Water management is crucial for the landscape, with irrigated farmland constituting 5% of the region's area. The Riverina region supports predominantly dryland grazing and cereal-based cropping – which together account for 80% of land use – and also supports other diverse enterprise types such as fruit and nut orchards, vineyards and cotton. In addition to being an agriculturally productive area, the region also supports many national parks and reserves, as well as the Ramsar-listed site Fivebough and Tuckerbil Wetlands.[1]

There are six unique landscapes in the Riverina LLS region: Rangelands, Irrigation Areas, Riverina Plains, Murrumbidgee, South West Slopes and South West Highlands. The participating farmers are spread across these different landscapes (see Figure 1).

[1] NSW Government

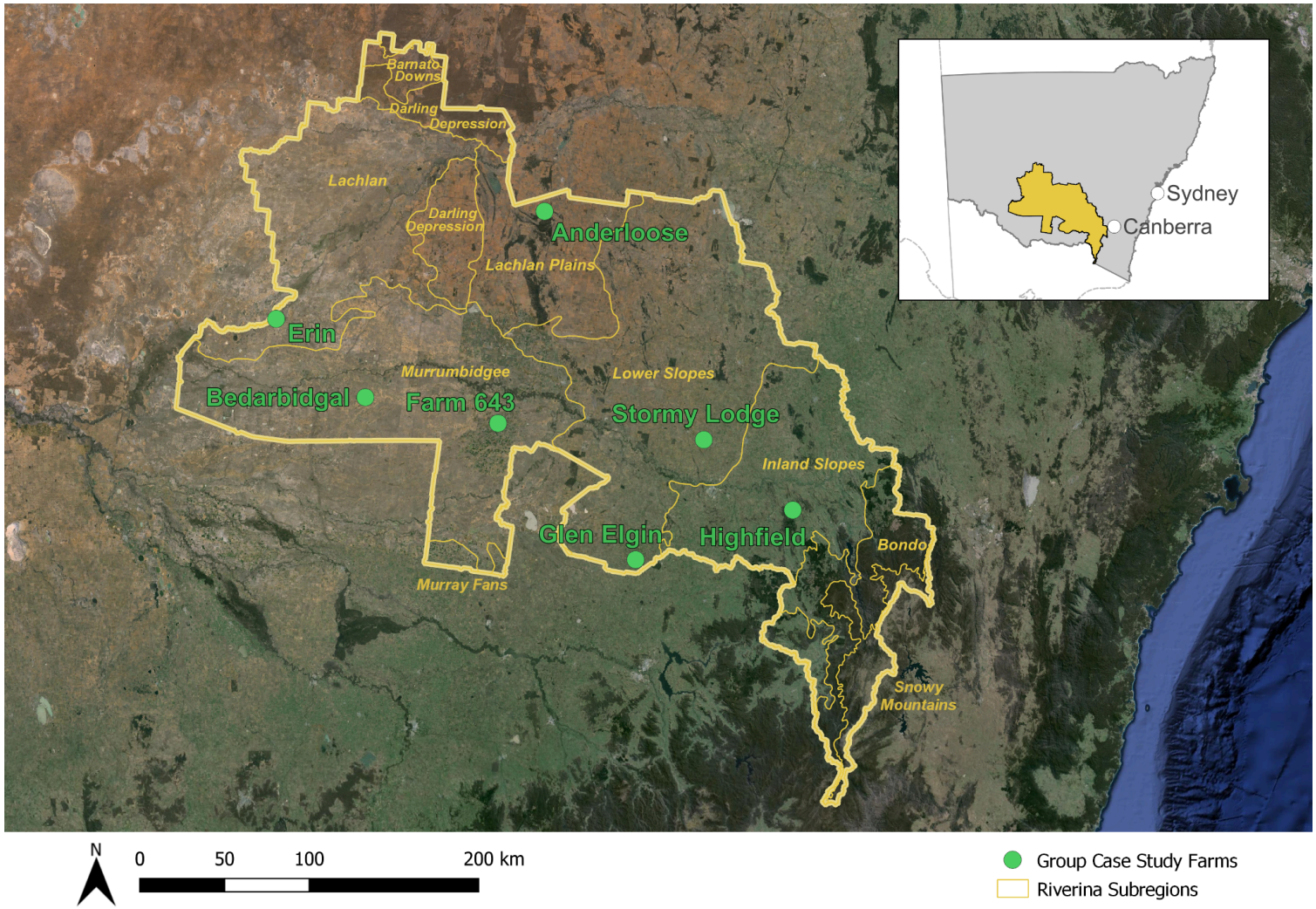

Figure 1. A map of the Riverina region showing the seven participants' properties. Source: Soils for Life.

Building Drought **Resilience on Farm**

Three practices

Each farmer chose one of three drought resilience practices: stock management area (SMA), enhanced farm dams or shelterbelt, and received practical guidance and financial support from the Riverina LLS.[2]

Stock management areas

As purpose built pieces of infrastructure, SMAs can make feeding, watering and monitoring stock health more efficient, ease the process of destocking and offer a fast way to get stock off pasture. This practice allows retention of groundcover, which prevents soil erosion from wind and rain, and supports the preservation and faster recovery of pastures and landscapes across the farm.

Watch Anthony Nicholls explain why and how he built an SMA at Tumulla.
Read about why and how the Wilkes-Bowes and the Hannas implemented their SMA.

Farm dam enhancements

Revegetation in and around a dam is the key to good management. Healthy, well-vegetated dams provide habitats for a host of animals, which in turn help improve the function of the dam by cycling nutrients from the dam into the wider landscape, and by modulating sediment, nutrient salt and algal levels within the dam. Farm dam enhancements generally involve excluding stock with fencing infrastructure to enable vegetation to regrow. Stock exclusion has the added benefit of preventing pugging, bank erosion and water pollution, all of which can degrade the dam's water quality.

Watch Dee and Craig Wilkes-Bowes and Anthony Nicholls explain why and how they built their dam enhancements.

Shelterbelts

Whether as part of shelterbelts or standing individually in a paddock, trees serve as vital tools for livestock protection, erosion mitigation and wind-speed reduction across pastures. Their significance extends beyond these functional aspects, as native trees play a crucial role in supporting diverse wildlife populations and aiding natural pest control on the farm.

Watch the Matthews and the Scotts explain why and how they are growing and protecting trees on their property, through the implementation of shelterbelts and tree guards. **Read** their case studies.

[2] To read more about these practices, explore our project partner resources Riverina LLS free training. For information on SMAs see a recent publication produced by MLA. For more information on dam enhancements and shelterbelts see ANU Sustainable Farms.

Developing soil monitoring routines

With support from Riverina LLS and Soils for Life, the farmers have been monitoring the health of their soils through their own observations and in-field assessments, complemented by soil sampling and lab testing. Each farmer participating in the project received a report offering a general interpretation of their soil test results and had the opportunity to discuss their results with a Soils for Life soil scientist. They were also encouraged to share their photos and insights of their in-field observations and assessments with each other via the online farmer discussion group, Whatsapp group and field days.

In-field assessments

Farmers were encouraged to do four rounds of monitoring in August 2023, November 2023, February 2024 and May 2024. Each time, they applied the following monitoring techniques: photopoints, groundcover, soil infiltration, aggregate stability, soil organisms and soil pH assessment using guides provided by Soils for Life.

The in-field assessments have been developed into a 'Soil Health Challenge', see the Soil Health Assessment Guide Appendix 1 (with the exception of the pH assessment[3]).

Image 2. Steven Scott doing one of his regular in-field assessments. Source: Grow Love Projects.

[3] Farmers used a Manutec Soil pH Test Kit, which comes with easy to follow instructions. The kit is based on Raupach and Tucker's field method for assessing soil pH. See Raupach, M and Tucker, B (1959) The field determination of soil reaction. Journal of the Australian Institute of Agriculture Science 25:129−133. To see a soil pH demonstration, visit: https://www.youtube.com/watch?v=HZz3-cv_GGc&t=123s

To supplement the in-field assessments, each farmer collected soil samples from one location for laboratory analysis. The samples were collected from four different depths in the soil (see Image 4) and submitted to the laboratory for a range of soil physical, chemical and biological tests. The purpose of sampling at a single location was to provide the farmers with a more in-depth account of the soil at their monitoring site so they can track changes in these soil over time. With additional investment, soil monitoring and sampling at multiple locations across a property would provide the farmers with a broader understanding of their soils.

The monitoring information generated by the landholders also fed into the field days and became a feature of the 'farmer-to-farmer' learning experiences described below.

Image 3. Collecting soils at the 'Kyeema' soil monitoring site at Bedarbidgal. Source: Riverina LLS.

Image 4. Soil at different depths at the 'Kyeema' site at Bedarbidgal. Source: Riverina LLS.

Read about five of the farmers' journeys into soil and landscape monitoring through their case studies and **watch** the soil monitoring video.

Farmer-to-farmer learning

Farmers had the opportunity to participate in several activities (field days, webinars, an online discussion group and a WhatsApp group) with the goal of building a community of farmers supporting each other in implementing their projects and soil and landscape monitoring.

The online farmer discussion group ran for 90 minutes each month over the course of a year and provided a mix of presentations and free discussion. These sessions created a shared learning environment where participants could introduce ideas, ask questions of the project partners and the group and receive feedback on what they were noticing

about their drought resilience practices and soil and landscape monitoring. The online sessions included quarterly webinar presentations by LLS, Soils for Life and ANU staff. The WhatsApp group allowed the farmers and project team to 'keep the conversation going' in between meetings and to ask questions or share experiences as they arose. Field days offered an opportunity for some of the 15 farmers to open their gates to others in the group as well as to neighbours and curious farmers in the region (see Table 1).

Table 1. A snapshot of program elements over two years.

Month	Activities	Description	Project partner
2023			
April	Field Day 1	Kolonga, Harefield	LLS/SFL/ANU
June	Discussion Group	Welcome and onboarding	SFL
June	Field Day 2	Bedarbidgal, Hay (Case Study Farm)	LLS/SFL
July	Webinar	Soil monitoring methods	SFL
August	Webinar	Dams	ANU
September	Discussion Group	Open Discussion - Share monitoring results	SFL
October	Webinar	Soil monitoring methods	SFL
November	Webinar	Shelterbelts	ANU
November	Field Day 3	Tumulla, Coolac (Case Study Farm)	LLS/SFL
December	Discussion Group	Open Discussion - Australian Feedbase Monitor Tool and Share monitoring results	Cibo Labs / SFL
2024			
February	Webinar	SMA	LLS
March	Discussion Group	Share monitoring results	SFL
March	Field Day 4	Wooroola, Maxwell	LLS/SFL/ANU
March	Field Day 5	Anderloose, Naradhan (Case Study Farm)	LLS/SFL
April	Webinar	How to read a soil lab test report	SFL
May	Discussion Group	Questions about your soil lab tests	SFL
June	Discussion Group	Wrap up, reflections and close	SFL/LLS

Insights and **Reflections**

Being proactive for dry times

Making changes to infrastructure and farm management when the season is good rather than waiting for a crisis to act was a positive outcome for many of the farmers and helped build their confidence to face future dry times. For example, Bert Matthews put in tree guards after a wet season when a lot of young trees came up and needed protection. And the Hannas built their SMA when pasture was abundant, so it meant they had no pressure to use the SMA immediately.

'We shouldn't waste that opportunity and if we had not gone around and started to guard them, well, then the stock would have taken them back and like the next dry time we wouldn't know they were even there.'

Bert Matthews

For many of the farmers, the funding for implementing a drought resilient practice was very welcome. The funding helped their long-term goals of building drought resilience, supported the implementation of new drought resilience infrastructure in the near-term, provided accountability in reaching goals and provided support through hands-on guidance from experts. The infrastructure was supported by a $10k grant from Riverina LLS, funded by the Australian Government's Future Drought Fund, and while in most cases additional co-investment from the farmers was required, most farmers said that having the funding put the project to the top of the list of priorities and meant that there was accountability to follow through.

Building and refining knowledge for farm resilience

Overall, the farmers reported increased levels of new knowledge. All eight farmers in an end of project survey felt that their learnings from the project have led to their farm being more resilient to manage dry times. Many farmers commented on their increased or refined knowledge of their own soils and of soil monitoring methods. Six out of eight farmers felt better equipped and two felt somewhat better equipped to undertake soil monitoring as a result of the online learning and WhatsApp group. Participating in the Riverina project has led Steven Scott to reflect on 'how little value he had been getting out of lab results in the past', and 'how little he really understood about what the soil test results mean'. He found it 'incredibly valuable to have expert consultation' in interpreting the soil test results and relating the results to practical implications in the context of his farming enterprises.

Combining practice implementation with monitoring soil health was viewed as having great value within the program for many participants. Bert Matthews believes his own

knowledge of soil health has increased and his monitoring habits have improved. The farmer-led soil assessments gave him greater confidence and helped prepare him to recognise changes in soil health. He believes he can use this information in a more preemptive way to make management decisions. Some farmers commented on the benefit of ongoing, informal communication of the soil monitoring experience within the group, which allowed stories, insights and challenges to be shared along the way.

As a result of the learning, many farmers plan to expand their soil monitoring programs. For example, the process helped the Hannas see the value of monitoring more than one site to capture the variability across the landscape. They now plan to extend their monitoring to other sites across their property to better understand how their range of soils respond to changes in land use and management.

Types of information

Expert knowledge was appreciated by many but some farmers wanted more time with specialists than was available within the scope of the project. For the Hannas, the expert advice from LLS representatives was invaluable in getting started. Bert Matthews also found LLS very supportive in advising on optimal locations for installing tree guards based on site conditions and goals. The Scotts found the discussion groups most useful when there were expert presentations. At least one farmer was seeking more technical, information-rich content across the activities and would consider participating in future groups if they had a technical focus on detailed management practices that could improve soil health and productivity specifically in cropping enterprises. Another farmer felt there was an overemphasis on soil at the expense of a more holistic ecological approach.

Value of having a mix of activities

Many of the farmers enjoyed the mix of different formats for learning and skills development and having expertise close on hand, including soil scientists, agronomists and agricultural specialists, to ask detailed questions and dive into specifics off the cuff.

For the Wilkes-Bowes, the combination of webinars, online discussion group sessions, WhatsApp, farm visits and field days worked well, with the field days providing practical feedback and the smaller online sessions becoming more focused towards the end of the series when fewer people could attend.

Steven Scott observed the quality of engagement in the online sessions was genuine and those who committed really gave each other support. And for the Hannas, the field days were the most useful because they were able to see solutions in the actual environment with their own eyes.

The Hannas really enjoyed the WhatsApp group because they could see images and comments that were happening in real-time (see Images 5 and 6). The WhatsApp also offered an opportunity for both targeted discussions to take place and for organic connections to form within the group. And the platform was also a useful place for

sharing resources and for reminding the group about upcoming events. Steven had a lot of positive feedback on the WhatsApp coordination and supplementary content provided to support those who missed in-person events.

Image 5. Steven Scott's infiltration assessment images showing infiltration rates and comments in the WhatsApp group. Source: The Scotts.

Image 6. Jack Hanna discusses groundcover observations within the WhatsApp group. Source: the Hannas.

Working across different farming contexts

Many of the farmers valued learning about drought resilience with other farmers in the group who shared similar contexts (e.g. region), but given the diverse landscapes within the Riverina, sometimes found it hard to relate to the other contexts. Yet, many also saw value in the diversity of experiences and contexts and connecting with others across different stages of career or practice change.

Reflecting on their participation in the project, the Wilkes-Bowes found that learning from people in similar rainfall areas was most valuable, though hearing different approaches from different regions provided additional perspectives. They also found relief and greater confidence approaching drought knowing that there are others in similar situations.

> It's good to hear what people are doing in other places. I probably learned most from people who are in a similar area ... on one hand if everyone had been within a 200 km radius of us that might have been more relevant. But it's also good to hear what people are doing in slightly different systems and landscapes. You just have to remember to put outcomes in context of rainfall!
>
> **Dee Wilkes-Bowes**

The Hannas had a similar experience. Overall the experience has revealed to them a lot of new information and, while certain topics weren't especially relevant to their farming context, they can see the advantages of participating in broad-focused groups.

Cindy and Steven Scott valued the online sessions as an opportunity to ask questions and hear different perspectives. Steven highlighted the diversity of ideas presented and noted that he always tried to keep his Tuesday morning free.

> 'Everyone came from their different background with their different thoughts and tossed those ideas in.'
>
> **Steven Scott**

A 'safe space' to share knowledge, 'failures' and stage of practice change

Many of the farmers appreciated having a safe space within the group discussions to share 'failures' as well as successes. Overall many farmers appreciated being met where they were at in terms of their existing soil knowledge and being supported to build on and refine existing knowledge.

It was helpful for farmers to know that they weren't alone, especially when trying out new practices and monitoring techniques. For example, quite a few of the farmers experienced compaction issues at their monitoring sites. As Bert recalls:

> 'A number of us couldn't get our shovels into the soil for a start. So that's interesting and tells a story of what's happening … and the compaction that's in the soil … and how quickly or how little infiltration there is in the soil.'
>
> **Bert Matthews**

The Matthews believe their knowledge of soil health has increased and their monitoring habits have improved as a result of the variety of farmer-to-farmer engagements and facilitated learning sessions. Undertaking the soil monitoring within a shared learning environment has given the Matthews greater confidence and helped them to recognise changes in soil health. Bert Matthews found value in farmer-to-farmer peer learning through the exchanges of ideas and insights on revegetation practices.

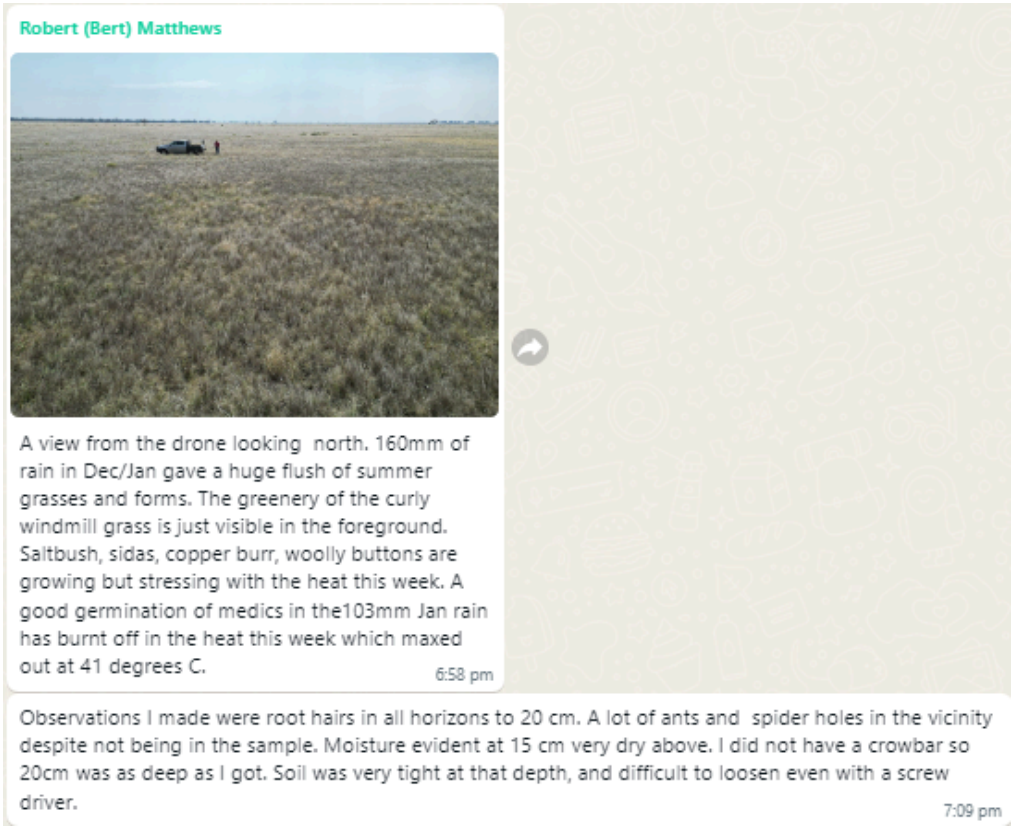

Image 7. Bert Matthews sharing his observations from soil monitoring in the Riverina WhatsApp group. Source: Bert Matthews.

For the Wilkes-Bowes, the program helped focus and refine their approaches to drought resilience rather than fundamentally changing their understanding. The financial assistance through the program also enabled them to complete their important drought resilience goals and focus on the infrastructure they know they need.

Attendance and putting aside time

For many, putting time aside for multiple activities, including joining the online sessions or doing the in-field assessments, was a challenge. Many farmers couldn't make it to the field days, and for some the ongoing expectation of monitoring and contributing was too much given their other commitments.

Most of the 15 farmers joined the online discussion group, except in the case where the timing clashed with other farm commitments. Finding a time that worked for everyone was a challenge for project staff, which was disappointing for at least one farmer. And while attendance at the start was pretty strong at just under 100%, it petered out towards the end of the project. Some found the smaller numbers useful to focus the sessions but for some of the regulars, the lack of overall attendance was a disappointment. And while there was acknowledgement that those not attending had good reason, some felt it affected the overall cohesion of the group. One suggestion was to have an in-person event at the beginning of the program to help people to establish relationships and build trust within the group.

Future steps

There was strong overall enthusiasm from four of the seven farmers in this case study to maintain an ongoing version of the group following the end of the project. One farmer would first like to know what would be the focus and expected benefits of a future group, suggesting that now the group has introductory knowledge, there could be an opportunity to break up into more specialised areas. While one farming family found some topics weren't very relevant to their environment, they were still open to a variety of information and they could see the benefits of a broad group. Rather than continuing in a group, another farming family would like ongoing access to expertise from program facilitators as this would be beneficial, even if just ad hoc or through annual check-ins. And another farmer would like to see a version of the group continue, with a particular focus on supporting and facilitating those who are committed to doing the work.

References

Raupach, M and Tucker, B (1959) The field determination of soil reaction. Journal of the Australian Institute of Agriculture Science 25:129−133.

SoilsforLife

Soil Health
Assessment Guide

About this guide

Is your soil health getting better or worse? What can you do on the farm to track progress? To find out, take on the Soil Health Challenge. This guide will walk you through the Soil Health Challenge, involving five quick and easy field methods to assess the health of your soil. These methods are an effective starting point for understanding soil health and monitoring changes over time. Observing and recording the outcomes of these methods can help with decision making in the paddock and understanding the effects different management practices have on your soils.

The Soil Health Challenge involves five soil health assessment methods

- **Photopoints**
- **Groundcover**
- **Water Infiltration**
- **Aggregate Stability**
- **Soil Organisms**

The Soil Health Assessment Guide builds on guides developed through the Riverina Drought Resilient Soils and Landscapes Project, led by Riverina Local Land Services in partnership with Soils for Lifeand ANU Sustainable Farms. The guide was refined for Soils for Life's Soil Health Challenge and continues to be developed. For the most updated version visit www.soilsforlife.org.au.

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Tips

Observe

Observation is the most powerful tool in a farmer's toolkit. The Soil Health Challenge encourages you to get out in the paddock and observe what's happening by taking photos, recording what you observe, and grabbing a shovel to see what's happening in the soil.

Be consistent

Consistency in where, when and how you assess the health of your soils is important for comparing your results and tracking your progress. We encourage you to apply the five soil health methods at a similar time each year, for example in October (Spring) and March (Autumn). Try to use the same equipment and follow the same process every time you assess your soil health.

Keep good records

We will provide you with a record sheet to print as a hardcopy, and a spreadsheet to record your results digitally. Taking a photo of the record sheet as soon as you have filled it out can keep the data in one place, you can also easily share information this way. If you prefer to work on paper, we encourage you to use a filing system with appropriate labelling so you can store and easily locate your records. If using the digital spreadsheet, be sure to store it securely and file your photos in an accessible way. Feel free to adapt the spreadsheet to suit your needs and objectives.

Understand your goals

Knowing what you want to achieve or improve on your farm will guide your decision-making and motivate you throughout the Soil Health Challenge. It can also be helpful to have your team or family join you throughout this process.

Site selection

The site that you choose to observe and assess your soil may depend on your objectives and your enterprise. There is no limit to how many locations you can monitor your soil health. Your site selection may be based on soil types, land use or management history, or paddock productivity. Consider your goals and ask yourself, what am I hoping to learn by choosing this site?

Once you have chosen, don't forget to name the site/s (ie. South Paddock), record the GPS coordinates of the site location and use a site marker if appropriate.

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Soil Health
Assessment Guide

Photopoints

What are they?

Photopoints are permanent locations where photos are taken at different times, and following a consistent technique, to capture change over time. It is a quick and inexpensive way to record visual change at ground level, at a site, or across a landscape, without having to rely on memory or measurements.

Why are they important?

Photopoints are an effective way of demonstrating the short, medium, or long term impacts of nature (e.g., weather) and/or management practices (e.g., grazing). When taken correctly, photopoint photos are an unbiased visual account of the site conditions at a point in time, and are a useful assessment and communication tool.

To make the most of this assessment, you should consider your objective (what it is that you want to monitor over time) and at what scale. For example, your photo could focus on the ground, across a site, or across the larger landscape.

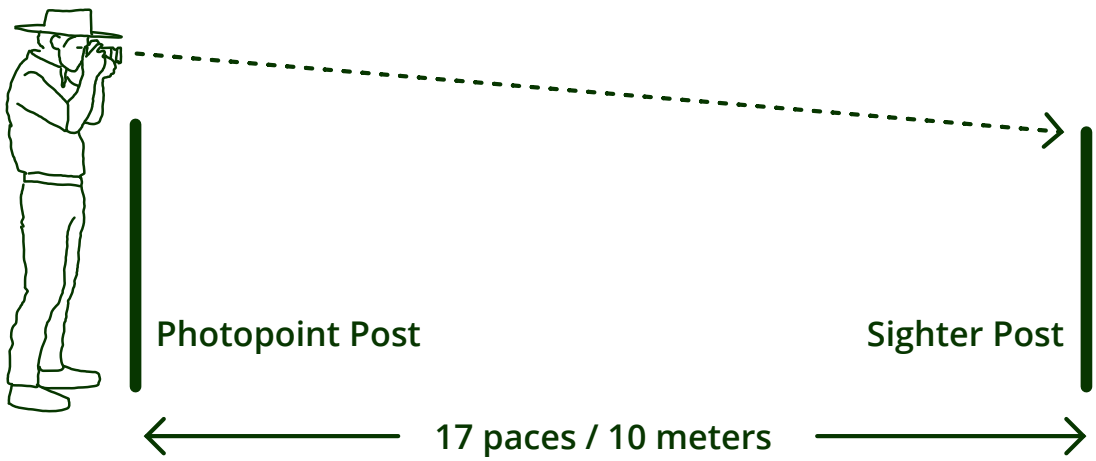
What you will need

- [ ] Location marker (e.g., star picket* or permanent feature),
- [ ] Optional sighter marker (e.g., star picket* or permanent feature)
- [ ] Gloves and hammer
- [ ] Camera or phone
- [ ] GPS or phone

**If star pickets are not ideal, and a permanent feature is not an option, record the GPS coordinates."*

How to measure it

1. Decide the location of your photopoint based on your objective and preferred scale (ground, site or landscape)
2. Insert a location marker or use an existing structure (star picket, fence post, trough, or mature healthy tree)
3. Record the GPS coordinates of your monitoring site location marker and mark the location on your farm plan, map, or satellite image
4. Insert a sighter marker for consistent framing and angles (optional)
5. With the sun behind you, or at least not facing directly into the sun, take the photo. Tip - choose another time of day if this is not possible.
6. Record additional relevant information (e.g., weather, recent management activities)
7. Download and rename the files for future reference (e.g., year/month/day/site)
8. Import photo files to attach to record sheet, or link/list file name



Source: Soils for Life adapted from Grodecki A and van Willing G (2010) Land Manager's Monitoring Guide – Photopoint Monitoring. State of Queensland (Department of Environment and Resource Management).

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Soil Health
Assessment Guide

Groundcover

What is it?

Groundcover is the amount of living (pastures, crops, weeds, etc.) or dead (litter, mulches, stones, manures) plant or mineral material that covers the soil surface. These materials protect the soil surface, and in the case of plant and animal material, increase the soil organic matter, and provide a food source and habitat for soil organisms.

Why is it important?

Groundcover has several important functions, including protecting the soil surface from the elements (sun, wind, water) and animal and vehicle traffic. In agriculture, groundcover is typically used as an indicator of the soil's susceptibility to wind and water erosion, plant vigour and grazing pressure. Bare soils are more likely to degrade, either from natural causes such as erosion, or from a lack of protection under certain land management practices. Both will result in the loss of soil, or the loss of soil structure, leading to reduced soil water infiltration rates. Adequate groundcover is an effective way to increase soil water infiltration.

What you will need

- [ ] Quadrat (or similar frame such as a hula hoop)
- [ ] Camera or phone
- [ ] Pen and record sheet, or device to record results digitally

To make a quadrat about 1 m x 1 m use stock wire and bend to the required size or use four equal lengths of narrow PVC pipe joined with elbow joints. You can also use a hula hoop.

How to measure it

One of the simplest methods of measuring groundcover is by visually estimating the percent (%) of the soil surface within a confined area (framed by a quadrat, or similar) that is covered and not bare.

1. Source (or construct) a quadrat or hula hoop.
2. Standing at the monitoring point, throw the quadrat 4 to 5 metres away.
3. Walk to the quadrat to assess and record the groundcover (%).
4. Take a photo as a record.

Source: GroundEd Land Management and Education (left), NQ Dry Tropics 2019, NQ Dry Tropics RASH Manual 2019, NQ Dry Tropics, Townsville (right).

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Assessment Guide

Soil Infiltration

What is it?

Soil infiltration is the downward entry of water into and through the soil. The rate at which the water enters the soil over time is the soil infiltration rate. Soil infiltration is governed by several factors, including the intensity and duration of rainfall events; position in the landscape; type and area of groundcover; soil properties such as soil texture and structure; and management practices.

Why is it important?

The capacity for the soil to accept and store water directly influences water use efficiency and plant growth, including the potential for the loss of water through evaporation and runoff.

Soil infiltration rate (mm/hr) can be estimated in the field by timing how long a volume of water takes to infiltrate the soil.

What you will need

- [ ] DIY Infiltrometer - *See guide*
- [ ] Mallet & block of wood
- [ ] Scissors or secateurs
- [ ] Timer - Stopwatch or phone
- [ ] Cling-film - Optional
- [ ] Ruler
- [ ] 10-20 litres of water
- [ ] Pen & record sheet

Source: Soils for Life.

How to measure it

Soil Infiltration rate (SIR) is estimated using an infiltrometer inserted into the soil surface. It is best assessed in Spring or Autumn when the soils are not dry, hard or cracked. In regions where such ideal conditions are rare, consistency in the timing and location of testing will be most important.

1. Avoiding cracks and holes, and without disturbing the soil surface, clear the area of sticks and stones and trim any vegetation using scissors or secateurs.
2. Place the infiltrometer on the soil surface and push it (or hammer it using the block of wood to protect the top edge of the pipe) about 5cm into the soil.
3. With the infiltrometer level in the soil, position the ruler on the inside wall and ease it a few millimetres into the soil so it stays in place and can be easily read.
4. (Optional). Line the inside of the infiltrometer with cling-film to prevent water from infiltrating until you are ready to begin the test.
5. Gently fill the infiltrometer to the top with water (minimising disturbance to the soil surface) and, with a timer at the ready, carefully remove the cling-film (if used).
6. Reading the ruler against the inside of the infiltrometer, measure and record the water level drop (depth in mm) in 6 minutes (initial infiltration rate).
7. Multiply the depth (mm) recorded by 10 to estimate infiltration rate in mm/hr.
8. Repeat steps 1 to 7 once or twice at the same location for a more reliable estimate of the soil water infiltration rate.

Make your own *infiltrometer*

What is it?

An infiltrometer is a tool for measuring soil infiltration, the downward entry of water into, and through, the soil. The infiltrometer can be as simple as a piece of PVC pipe, although steel (e.g. a large coffee can) is recommended. The infiltrometer should be large enough to hold at least 1 litre of water.

What you will need

- ☐ Steel or PVC pipe (About 15 cm diameter x 20 cm length)
- ☐ File for sharpening the bottom edge of the infiltrometer
- ☐ Mitre saw or hacksaw
- ☐ Permanent marker
- ☐ Super glue
- ☐ Wooden or plastic ruler

How to make it

1. Wearing gloves and safety glasses, cut the steel or PVC pipe with a mitre saw or hacksaw to a length of about 20 cm.
2. Bevel or file one end of the pipe (now an infiltrometer!) to sharpen the edge for easier insertion to minimise disturbance to the soil.
3. Draw a line with permanent marker around the outside of the pipe about 5 cm from the bottom edge (this is the depth the pipe will be pushed into the soil)
4. Optional if using a wooden ruler: Cut a 30 cm wooden ruler at 10 cm with the saw*. Glue the top 10 cm of the ruler to the inside of the infiltrometer (the 0 cm end should be flush with the top)
5. If skipping Step 4, or using a metal ruler, simply hold the ruler in place when measuring the water level drop as it infiltrates into the soil.



Source: Katharine Brown.

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Aggregate Stability

Note: the aggregate stability test is not applicable to non-aggregated sand or gravel soils.

What is it?

Soil aggregate stability is a measure of the potential for soil aggregates to "collapse" during wetting or following disturbance (such as cultivation). Soils with stable aggregates are more likely to withstand the forces imposed by wetting and drying, raindrop impact, stock trampling, cultivation, or other disturbance.

Why is it important?

Soil aggregation regulates the movement of air, water and organisms (and therefore nutrients) into and through the soil. Soil aggregate stability is also an indicator of soil resistance to wind or water erosion. Ultimately, stable soils are more productive, more resilient to disturbance and functional.

What you will need

- [ ] Shallow, clear or white plastic tray(s) (or ice cube tray)
- [ ] Aggregates of soil
- [ ] Rainwater (distilled or deionised water)
- [ ] Stopwatch or phone
- [ ] Camera or phone
- [ ] Pen and record sheet, or device to record results digitally

How to measure it

There are several methods for assessing soil aggregate stability in the field. Most are modified versions of the Emerson Aggregate Test. The following method is just one such adaptation.

1. Collect 3 aggregates of soil (small dry clods about 5 to 15 mm in diameter) from 3 different depths in the soil (eg, the top 0-5 cm, 5-15 cm and 15-30 cm).
2. Fill a flat-bottomed container (a clear or white ice cube tray works well) with rainwater or distilled or deionised water.
3. Gently drop the individual soil aggregates in the water-filled container(s), keeping the aggregates separate from each other. Make sure not to disturb the container whilst the test is in process.
4. Observe the aggregates carefully at 0 minutes, 5 minutes, and, if you can, at 60 minutes (slaking or slumping typically occurs within the first hour).
5. Record your results (see table below), including the date, location, and depth at which you collected the samples.

Source: NQ Dry Tropics 2019, NQ Dry Tropics RASH Manual 2019, NQ Dry Tropics, Townsville.

What it means

1. Stable
There is no change to the aggregate over time. Stable aggregates reflect suitable moisture content, a balance of nutrients (no excess sodium), and the presence of organic materials, fungal hyphae, and roots. Stable soils are less susceptible to structural problems.

2. Slaking
Breaks down into smaller aggregates to resemble a collapsed form of the original aggregate. Slaking occurs when water replaces air in the soil pores and the increase in pressure breaks the bonds that are binding the aggregates. Dry soils and soils lacking organic matter, fungal hyphae, and roots, are most prone to slaking.

3. Slaking and partial dispersion
Breaks down into smaller aggregates, followed by the partial dispersion of clays. The aggregate initially slakes, followed by the partial dispersion of clays (some separation of fine clays from the smaller aggregates resulting in cloudiness or milkiness only around the base of the aggregate).

4. Slaking and complete dispersion
Breaks down into smaller aggregates, followed by the complete dispersion of clays. The aggregate may or may not slake but there is complete dispersion (the separation of fine clays from the smaller aggregates resulting in a distinct cloudiness or milkiness of the water) and no evidence of the original aggregate or smaller aggregates.

Source: NQ Dry Tropics 2019, NQ Dry Tropics RASH Manual 2019, NQ Dry Tropics, Townsville.

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Soil Organisms

What are they?

In addition to microorganisms such as fungi, bacteria and protozoa, healthy soil is home to a range of larger organisms that are more easily seen (meso and macroorganisms). These include, but are not limited to, nematodes, mites, springtails, potworms, termites, centipedes, millipedes, snails, spiders, beetles, earthworms, and a range of insects. The soil micro, meso and macroorganisms are known collectively as the soil biota.

Why are they important?

Soil organism diversity is important for effective nutrient cycling and disease suppression.

Soil organisms help to decompose organic matter and to cycle nutrients. This process involves the organisms breaking down organic matter and releasing nutrients in mineral forms that are available to plants. Other organisms such as earthworms, termites, ants, and dung beetles, also contribute to soil formation and structure by channelling and burrowing. These activities create pathways for the movement of soil particles, nutrients, and water through the soil. Earthworms in particular are a good indicator that soil conditions are suitable for plant growth because their populations tend to increase as soil organic matter levels increase.

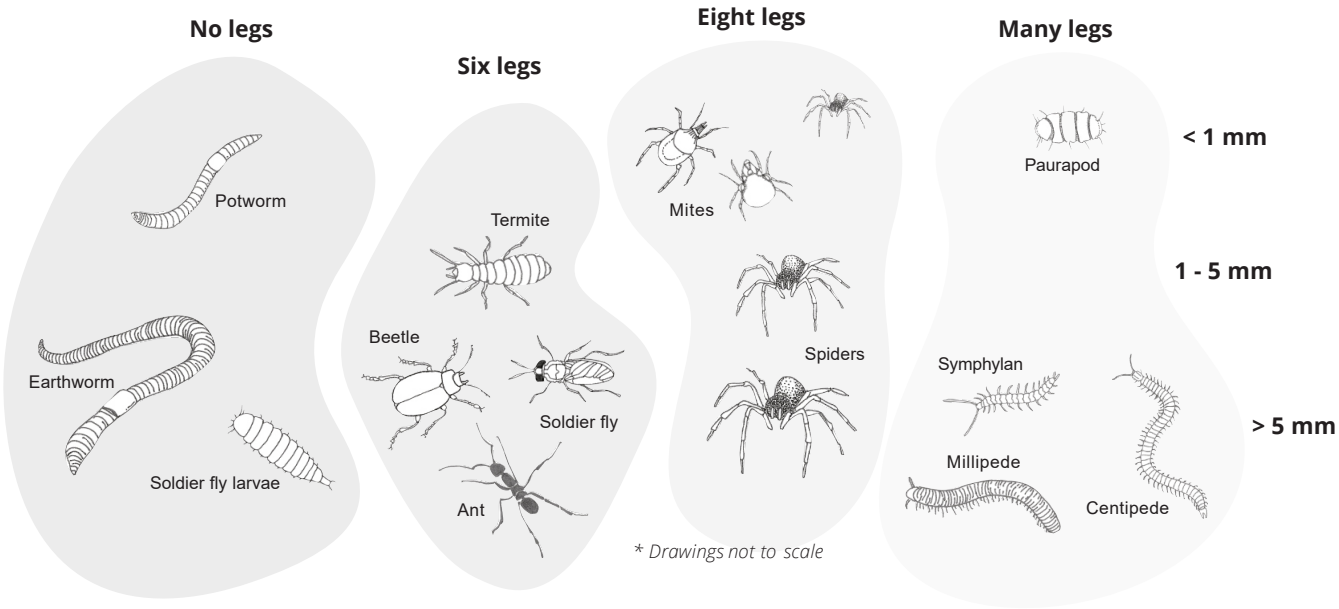
What you will need

- [ ] Spade or shovel
- [ ] White tarp or tray
- [ ] Magnifying glass or hand lens
- [ ] Tweezers
- [ ] Phone or watch
- [ ] Soil organisms ID guide
- [ ] Pen and record sheet

How to measure it

One of the simplest methods to estimate soil macroorganism diversity is to count the number of different organisms in a sample of soil within a measured period of time. It is best to count soil organisms at the same time each year, e.g. in early Autumn or late Spring, avoiding extreme weather conditions and fertiliser/manure applications. The visual estimation method is best undertaken on an intact block or 'cube' of soil (about 20 cm x 20 cm x 20 cm) that has been dug from the ground with a spade.

1. Carefully slice the top 5 cm off the soil 'cube' and place it on a tarp or tray.
2. Spread the soil evenly and observe it for 10 minutes, noting any organisms.
3. Identify and record the number and type of organisms based on their size and the number of legs.
4. Note any evidence or soil organism activity, such as the presence of burrows, channels, and casts (e.g. the end product of worm digestion).



Source: NQ Dry Tropics 2019, NQ Dry Tropics RASH Manual 2019, NQ Dry Tropics, Townsville.