Increasing Awareness and Knowledge of Management of Soil Organic Carbon on Eyre Peninsula

PROJECT SUMMARY 2019-2023

1. INTRODUCTION

The Australian Government, through the Regional Land Partnerships of the National Landcare Program, funded the Eyre Peninsula Landscapes Board Regenerative Agriculture Program (RAP).

The RAP involved rolling out a range of management activities to prevent and abate soil acidity, soil erosion, and improve soil carbon and on-farm biodiversity.

The Eyre Peninsula has large areas of agricultural land that is subject to acidification; as well as having a significant proportion of soils at moderate to severe risk of wind erosion and soils with low organic carbon - the RAP focused on giving farmers an opportunity to trial methods that can help address these issues.

The 'soil carbon' stream encouraged farmers to use interventions to overcome subsoil constraints with long-term benefits for increased soil organic carbon and productivity across a range of soil types. Interventions used included deep ripping, rock crushing, and the addition of soil amendments.

Under the RAP, by 30 June 2023, 80 farmers would have an increased awareness and knowledge of reducing sub soil constraints through management of soil carbon. Guidelines would be produced, and 12 demonstration sites identified and managed to improve soil carbon levels.

2. BACKGROUND

Clearance of land for agricultural production has likely resulted in the reduction in soil organic carbon stocks because the natural balance of inputs and outputs to the soil carbon cycle have been disrupted. Harvest represents a reduction in the return of dead plant biomass to the soil system, while tillage, seeding, and nutrient amendment alter the physical, chemical, and biological controls over the main output pathway, decomposition.

Further loss of soil organic carbon can occur where management leaves surfaces exposed to wind and water erosion.

Red-brown earth soils are particularly important to production in the Eastern and Lower Eyre Peninsula. Historically red-brown earths have suffered from erosion due to management techniques in the early years following clearance, but modern practices better consider managing surface cover to reduce erosion risk. Due to the inherent soil fertility and high productive potential across a wide range of crops, these soils are considered to have good potential to accumulate soil carbon.

Previous projects, particularly on lower Eyre Peninsula (LEADA Soil Modification on LEP Improving Access to Soil Moisture) demonstrated that:

- The addition of clay to sandy soils does increase soil inherent fertility, pH and generally soil organic carbon levels. These factors do deliver substantial increases in production over the long term.
- The addition of clay appears to be a "one off" treatment with differences in clay levels on treated sites observed up to twenty years post application.
- The incorporation of organic matter enhances soil organic carbon for at least 3 years following application. Increases are greater than the amount of carbon applied in the treatment suggesting that carbon input from another source is occurring (probably carbon from increased root mass at depth).

How to build soil organic carbon

1. Minimise carbon losses through reduced cultivation practices, grazing management and retention of residues.
2. Keep cover on soil as long as possible through the use of species mixes and diversity of species.
3. Maximise organic matter inputs through growing as much biomass above and below ground (grow roots deeper).
4. Address soil constraints to production – pH, compaction.
5. Ensure crop nutrition is targeted to production.
6. Utilize grazing management to encourage root exudates.
7. Learn and adapt as new information comes along.

3. OUTPUTS

Farmers were invited to apply for small grants over the life of the project, to assist in demonstrating options for improvement in soil carbon.

The grants aimed to provide farmers with the opportunity to implement farmer scale large plot demonstrations with interventions intended to overcome subsoil constraints and have long term benefits for increased soil organic carbon and productivity across a range of soil types.

Workshops and field walks were held to demonstrate the project outputs to the broader community. COVID created some disruptions, particularly service delivery for several consultants and service providers. In addition, in 2020, there were no field days run by the EP Landscape Board. This was combined with the general stress of farmers and participants as the number of logistical issues were significant, including obtaining seeds, fertilisers, contractors, and other inputs. This was most prevalent during 2020/21, and into the 2021/22 season.

To assist with communications during these times, social media was utilised extensively to ensure ongoing delivery of information and updates.

1. Small Grants Program

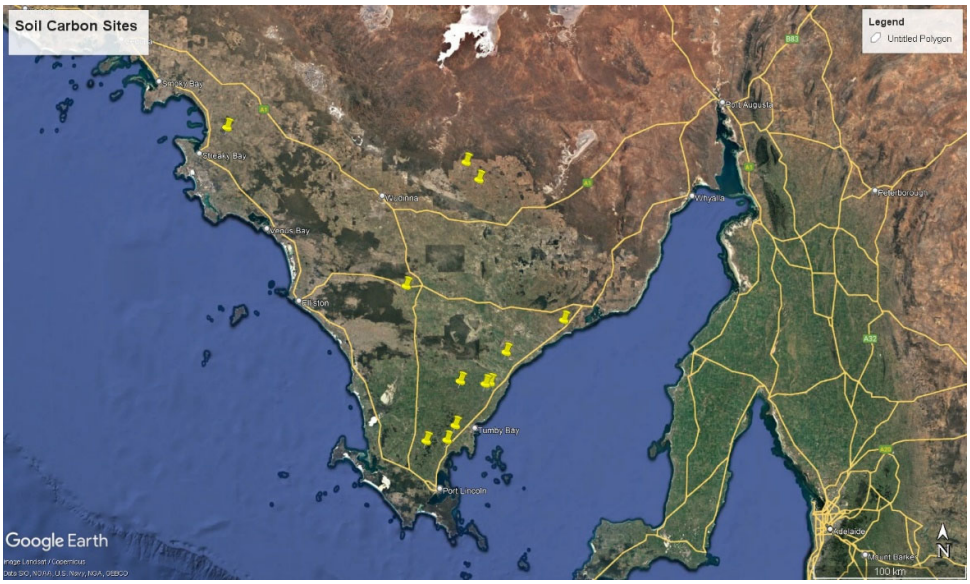
Over the life of the project, 12 farmers established and monitored demonstration sites and provided opportunities for farmers to visit and discuss their findings.

Examples of key soils constraints and possible outcomes from management interventions included:

Key Soil Types and Constraints.	**Desired Outcomes from Intervention**
Sodic soils and soils with high soil strength (hard setting soil layers)	• Reduced soil strength • Improved soil structure • Improved water infiltration and drainage • Improved crop/pasture establishment • Improved crop and pasture root growth and production • Improved water use efficiency (WUE)
Sandy soils/non-wetting sand	• Improved crop and pasture establishment by overcoming water repellence • Improved fertility and moisture holding capacity of bleached A2 horizons

	• Reduced wind erosion risk
Soils with acidic subsurface layers	• Improved soil pH in subsurface layers • Reduced aluminium toxicity • Improved fertiliser use efficiency • Improved crop and pasture production and crop competition

The demonstration sites were spread across the region, with a focus on eastern and lower Eyre where the issues are greatest (see map below).



Map of Eyre Peninsula soil carbon demonstration sites.

What were the farmer aims?

- Ripping with inclusion plates and additional nutrients to increase crop yield.
- Demonstrate the capacity for modified tillage equipment to improve crop growth and soil organic carbon levels on sandy soils.
- Overcoming the lack of soil carbon, water repellence, wind erosion and general infertility with deep ripping.
- Increasing Phosphorous availability in highly calcareous soils and production of dry matter
- Improving duplex sandy soils with surface water repellence, infertile bleached A2 layers, and subsurface layers with high soil strength (penetrometer resistance >2000kpa) limiting the development of crop roots.
- Managing the acidic topsoil with hard setting alkaline sub soils, by ripping the sub layer and applying lime/and or gypsum, then sown to vetch and tillage radish, to promote deeper root growth, into the subsoil, to increase organic carbon levels in the soil.

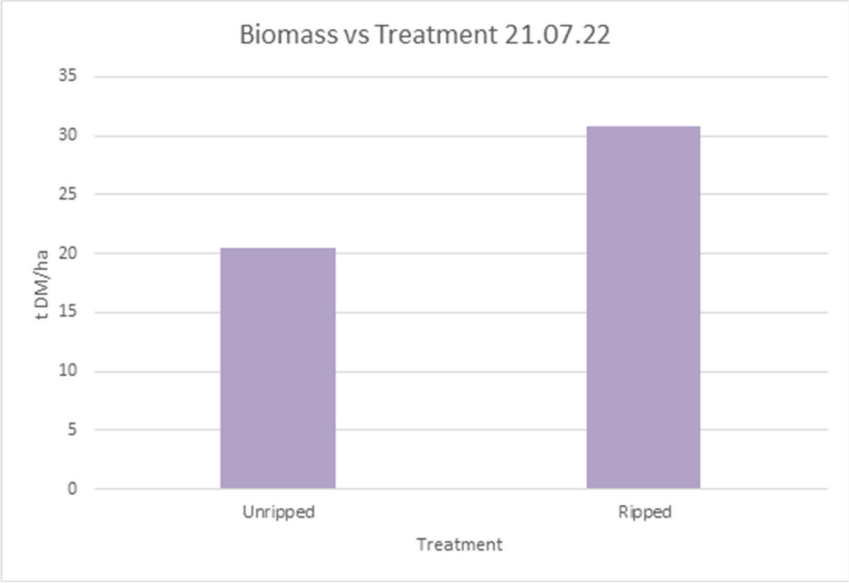
- Deep-ripping and gypsum application to break the thin band of white ("bleached") sand (a result of water-impenetrable clay making water move sideways along the profile) and stripping nutrients.
- Managing grey 'magnesia' ground to return productive potential and improving soil health.
- Clay spread and spaded to effectively overcoming water repellence.

What were the challenges?

- Due to COVID19 restriction, no community engagement could be undertaken for a small period, although some engagement was provided through video footage and updates on social media.
- Heavy frost in 2021 affected plant growth and demonstration effectiveness.
- The start of the 2022 season looked promising with early rains ensuring a good start for the paddock, in July when conditions were excellent, but with limited rainfall (7 mm) for August and then nothing for September plants started to run out of puff.
- High biomass treatments were (visually) more affected by dry and warm conditions in late August to early September than the low biomass treatments.
- *"Two years of below-expectation results got me digging holes deep into the sub-soil to try and understand what was affecting my crops late in the season as this is ultimately where the roots were when the crops seemed to take a backwards step."*

What was measured?

- Plant densities evaluated 4 to 6 weeks post sowing showing little difference in crop establishment. Spring biomass assessments were undertaken at flowering.
- Plant establishment counts and dry matter cuts.

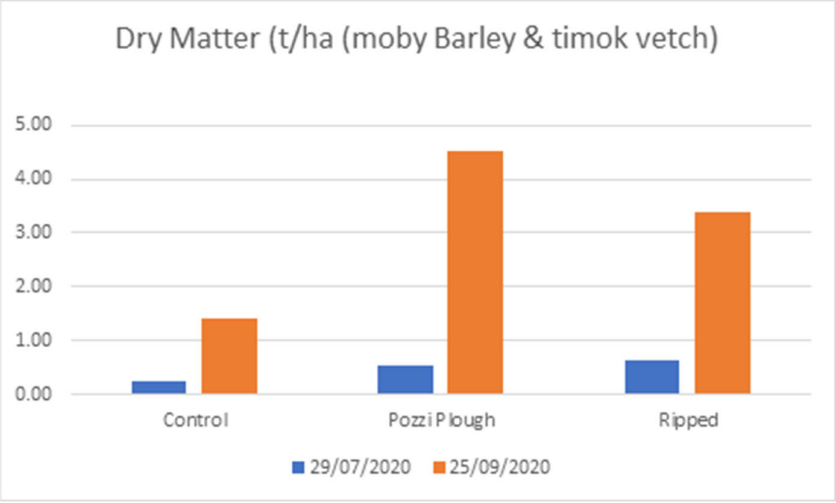


An example comparison of dry matter biomass (t/ha) in unripped (control) vs ripped treatments.

- Visual and photographic assessment of differences between treatments and control.

Example photo of root mass in ripped vs unripped site (ripped on the right).

- Penetrometer resistance readings.
- Crop emergence counts at the 2-4 leaf stage.
- For crop and pasture, a 50 cm ruler between crop row, count plants either side of ruler and record. Repeat 4 locations per plot.
- For volunteer pasture, a 0.1m^2 quadrat placed on the ground, with plant count in quadrat.



An example of dry matter (t/ha) comparison of treatments compared to the control treatment.

What was learnt from individual small grant demonstrations, according to the farmers?

- Knowledge of soil characteristics throughout the profile is vital for identifying key production constraints and determining an appropriate and effective management strategy.
- Both biomass and grain yield data show better performance from the plough and rip treatments compared with the control.

- Surface sealing can occur as a result of bringing sodic clay to the surface. This causes an impenetrable layer that plants cannot grow through. Need to assess clay prior to making decision to bring to the surface.
- In 2019 ripping with inclusion plates resulted in flowering biomass increases of at least 33 % compared to the control. In 2020 the deeper ripping (45 cm) treatments with deep placement of nutrients improved biomass production.

Paxton plough ripping to 450 mm

- White poorly performing sand, incorporation of clay killed skeleton weed and stopped water repellence.
- Greater access to moisture also increased the tolerance to numerous frost events that decimated the surrounding crop on the un-ripped paddock.
- Deep ripping negatively affected emergence as a result of ripping and inaccurate seeding depth due to rip lines coinciding with tines and a cloddy soil profile being left causing a reduction seed-soil contact.
- Clay spreading and spading appeared to overcome water repellence and high soil strength constraints to 30 cm.
- Surface sealing occurred as a result of bringing sodic clay to the surface creating an impenetrable layer that plants can't grow through.

- Breakdown of clay takes time and results will be seen in future years.

2. Field walks and workshops

Local field walks were held as part of the annual farmer "Sticky Beak Days", plus a range of site visits from various interested groups.

Some examples of group interactions as demonstration sites included:

- GRDC Panel visit 2019
- Women's group – Understanding Crop production visit

- Demonstration site visit by 34 attendees during the Mixed Species Masterclass at Lock on 12 September 2019.
- 2019 - Buckleboo Annual Field Walk
- 2020 - site visited by attendees of the Lock/Murdinga/Tooligie sticky beak day with soil consultant Brett Masters explaining the treatments and results prior to harvest.
- 2021 - Ag Day with 80 participants learning about different ways to improve soils that will provide resilience to ensure agriculture is sustainable for the future.

A final survey of farmers indicated that over the last five years, 94% of respondents had an improved, to greatly improved knowledge and understanding of increasing soil health and production through management of soil carbon.

3. Case studies

Two farmer based case studies addressing ameliorating soils to increase soil carbon were generated throughout the RAP, which are housed on both the EP Landscape Board and AIR EP websites.

- Pugsley, Ungarra: Deep ripping to address compaction and improve plant growth.
- Hodge, Lock (Lock, Murdinga Tooligie Farmer Group): Soil modification in duplex sandy soils.

4. WHAT FUTURE?

Whilst modification of soils with severe production constraints can increase biomass and grain yield, results are highly variable and it can take some time following modification to see benefits, particularly with deep ripping.

The ability to visually demonstrate the effectiveness of treatments at a paddock scale provides a very effective learning environment.

There are currently several projects being delivered on Eyre Peninsula to address physical soil constraints, utilising a demonstration model similar to this program.