



SA Seep Site 1: Kevin and Geoff Bonds, Mannum

“Repairing a recently formed seep scald area back into crop production.”



Background

A seep area that has quickly developed over the few years, becoming initially waterlogged after the 2016 wet year, forming into a rapidly growing bare scalded area, not highly saline yet, but too saline in the surface to support wheat and summer crop growth. This is at the base of a deep sandhill and has the potential to spread into a much larger saline scald (Figures 1-2).

Purpose

This demonstration site aims to test whether land that has recently become scalded can be brought back to crop production through layering of mixtures of hay, manures and sand on top at the discharge zone, while establishing lucerne on the sandy rise above to absorb the recharge and lower the perched water table.

Treatments

A twofold strategy is being employed at this site.

- i. **Recharge Zone:** To intercept the excess recharge water coming from the deep sandhill above the seep, 2 seeder widths of lucerne were sown (35m width) at the base end of the sandhill above the seep (Photos 6-7). This was sown into an establishing cereal crop in early June 2019. The timing and seasonal conditions were not ideal for lucerne establishment, but it was thought that this could be done safely, given that it was a relatively small area. Re-establishment of this lucerne strip will be attempted in 2020.

If there is a substantial reduction in the perched water table at the seep, then this will be a clear indication that targeted narrow strips can be used to intercept the lateral water flow prior to accumulation at the seep site.

- ii. **Discharge zone:** A number of soil amelioration actions have been trialled over this expanding scald area to assess whether land can be brought back into production for both winter and

summer cropping. Through intensive soil testing through the various scald areas and treatments an assessment of what point scalded land becomes too degraded to rehabilitate back to cropping can be made and whether the addition of soil, organic matter and manures can lead to ongoing site benefits.

The seep scald area was divided in to 4 areas (Photos 4-5), 8m wide and 50m long, being:

1. Control,
2. Sand alone (depth 15cm),
3. Sand (ave depth about 10cm) with composted chicken manure (approx. 20t/ha) and
4. Sand (10cm) & straw (approx. 30t/ha) with composted chicken manure (approx. 20t/ha).

Site Assessment

This site will be monitored over the coming seasons to assess whether the rehabilitation has been successful, and to provide recommendations for future potential rehabilitation strategies. Rhiannon Schilling (Adel Uni) has already taken soil samples and will continue to over time. A moisture probe is set up on the sand hill to help monitor rainfall moisture recharge and crop water use, and a piezometer and moisture probe in the seep area is measuring ground water fluctuations and capillary rise (Photos 2-3). Evidence of a long term reduction or disappearance of the perched water table, and the re-establishment of crop cover will be key to success of this site treatments.

Figure 1. Google Earth Image of seep trial site



Figure 2. NDVI image of seep trial site

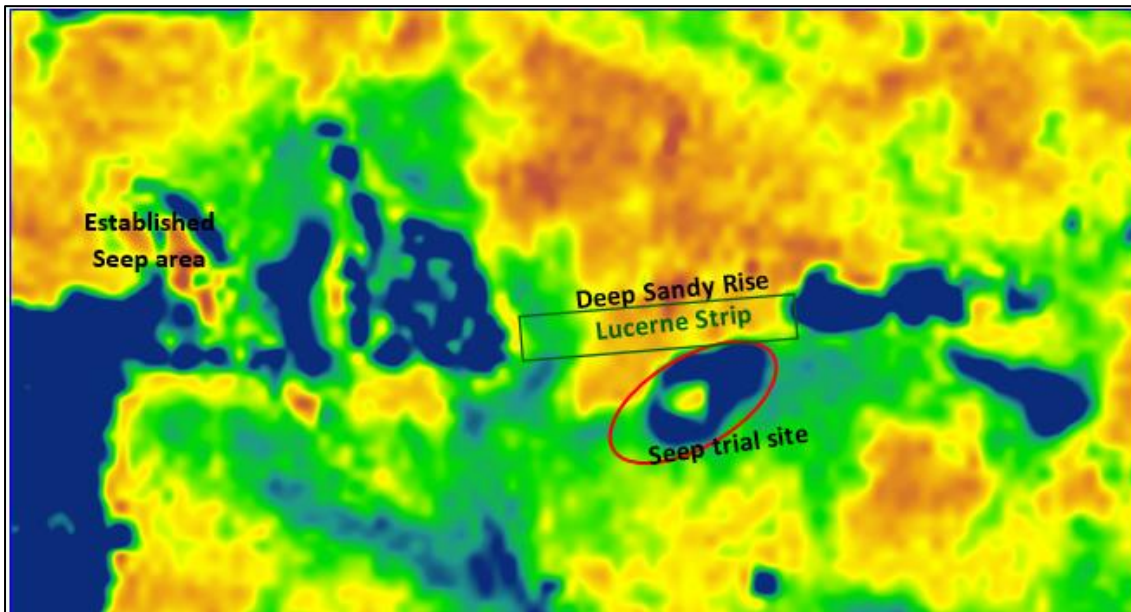


Photo 1. Seep scald in 2018/19 summer with some millet and sorghum surrounding



Photo 2. Shallow water table below the stone at the site



Photo 3. Piezometer placed within the trial measuring water table at 50cm

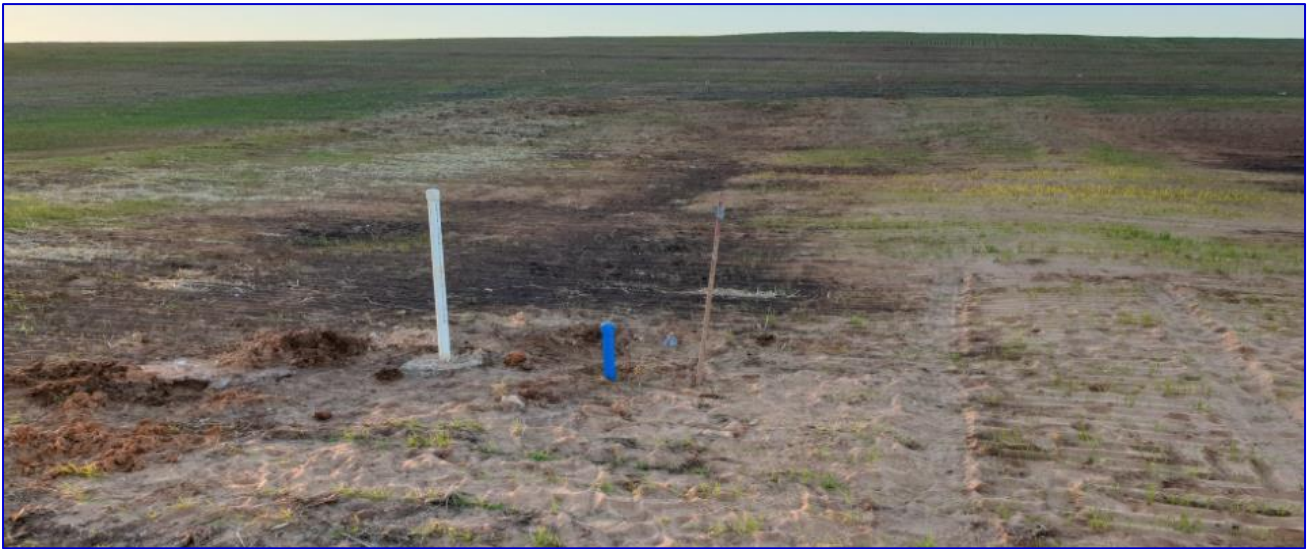


Photo 4. Construction of site treatments by the farmers



Photo 5. Mid-season results with promising crop establishment achieved

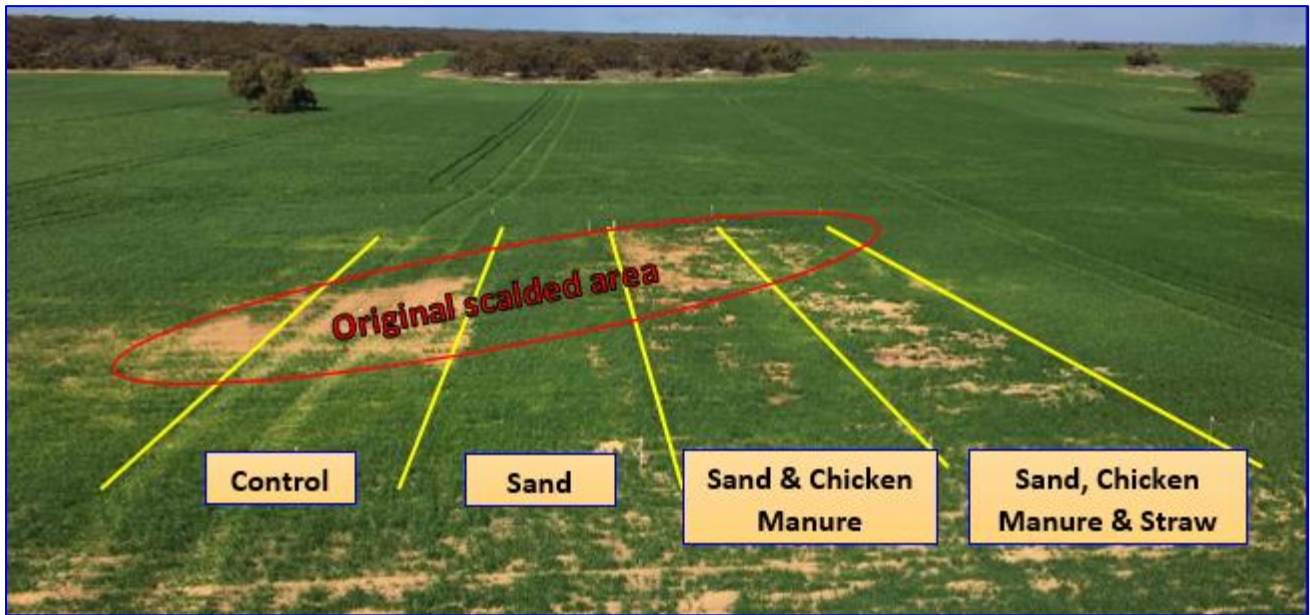
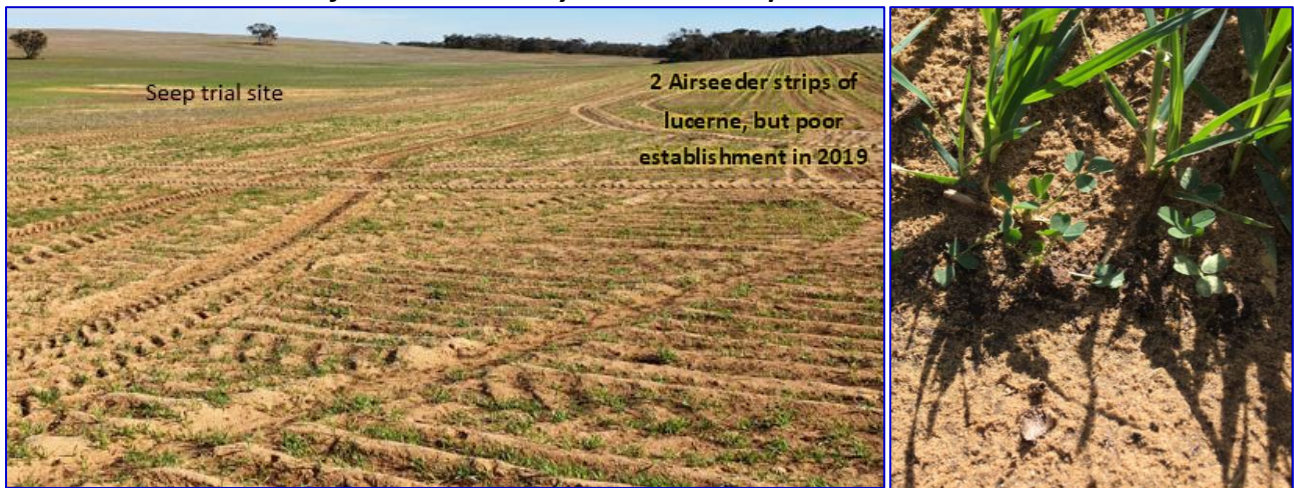


Photo 6. Establishment of lucerne on sandy rise above seep area



2019 Results and Discussion

The Discharge Zone

Each treatment area was tested for soil salinity at different depths and times of the year. This is matched against crop growth so that some threshold levels for crop growth can be established for this remediation. It is also important to assess whether this new soil and organic matter will remain at lower salinity, or revert to the toxic levels of the bare scald over time. Understanding these factors will be critical to the potential success of this rehabilitation process.

Table 1. First soil testing results (August 12, 2019) at different depths (cm)

	Control 1	Control 2	Sand 1	Sand 2	Sand & Manure 1	Sand & Manure 2	Sand Manure & Straw 1	Sand Manure & Straw 2	Ryegrass Dominant Area
Crop Growth	None	None	Good	Good	None	Good	None	Good	Poor
Soil Salinity (dS/m)									
crust	0.86	0.56	0.07	0.17	0.68	0.16	1.2	0.2	0.41
0-10cm	0.77	0.59	0.11	0.08	0.95	0.28	1.0	0.4	0.39
10-20cm	0.72	0.66	0.47	0.46	0.81	0.64	0.94	0.59	0.31
20-30cm	0.71	0.40	0.56	0.46	0.87	0.44	0.66	0.54	0.32
30-40cm		0.43	0.57	0.37	0.54		0.49		0.33
Soil pH									
crust	10.9	10.8	6.8	6.7	8.5	7.0	8.6	7.8	9.8
0-10cm	10.8	10.8	6.9	7	9.4	9.1	8.6	7.5	10
10-20cm	10.6	10.5	10.2	10.1	9.1	10.3	10.4	10.1	9.9
20-30cm	10.2	10.2	10.3	10.4	9.7	10.2	10.2	9.9	10
30-40cm		10.3	10.2	10	9.6		10.0		10.2

When comparing site treatments it should be understood that the site was prepared by the farmers with their equipment, which adds important authenticity to the processes. The sand layer treatment went out fairly evenly at 15cm depth (6 inches). The Manure was spread as evenly as possible with the front end loader and mixed in with about 10cm of sand (using the loader teeth). The Straw was scraped up from the hay shed, spread by tractor and by hand, then spread with manure and sand, and again all mixed using the loader teeth. This did not present a good seed bed for the seeding that happened directly after, which did impact the crop establishment in this area.

The soil test comparisons between treatments in Table 1 and as well as over time in Table 2 reveals critical information. The brown columns represent areas that were bare within the control strip, as well as patches within the Manure and Straw strips, due to uneven site treatment preparation (or some scald crust being brought to the surface). The green columns represent areas where the crop was growing well (above the previous scald areas prior to treatment). The yellow column is a

nearby edge area that is being dominated by ryegrass that is displacing the poor crop growth. Post-harvest samples were taken from exactly the same locations (Table 2).

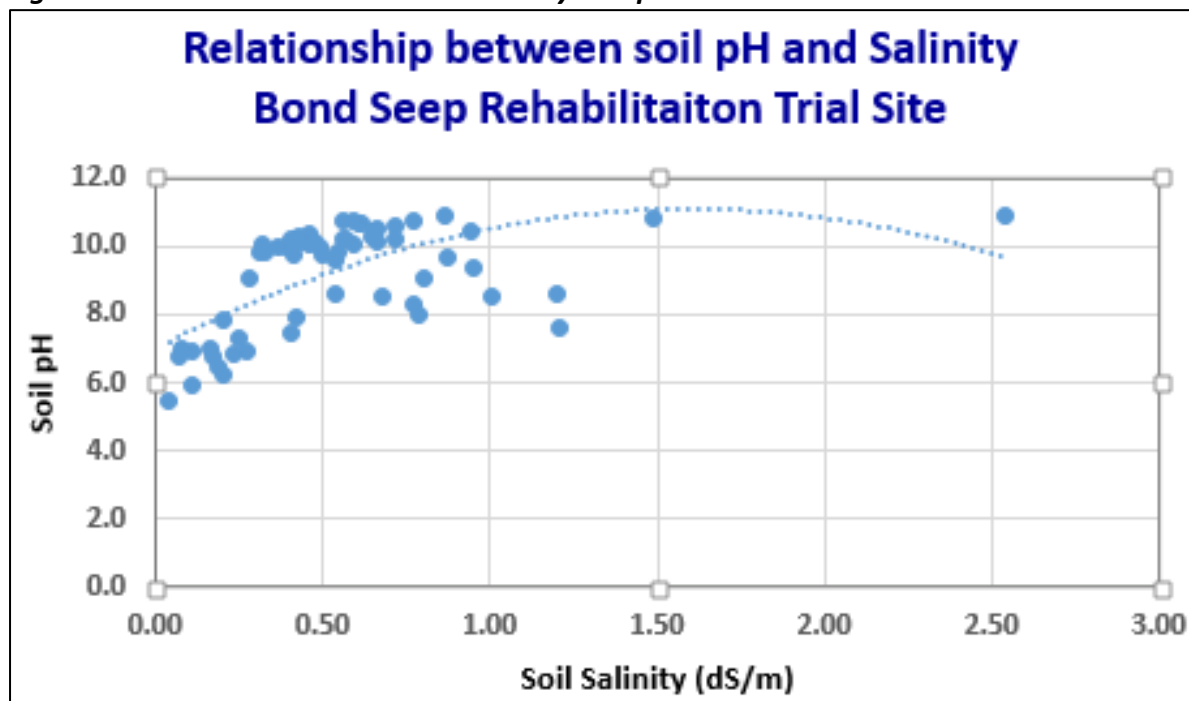
Key findings from these tables are as follows:

1. Surface crust salinity levels (top 2-3cm – but not crusty where crop growing well) ranged from 0.07-0.2 dS/m where the crop established well, but 5.6-1.2 dS/m where no crop grew. The intermediate zone of ryegrass and crop was 0.41 dS/m.
2. Topsoil salinity levels (0-10cm) ranged from 0.08-0.4 dS/m where the crop established well, but 5.9-1.0 dS/m where no crop grew. The intermediate ryegrass zone of was 0.39 dS/m.
3. High pH levels in both the crust and the topsoil control area samples at 10.7-10.9 may well have contributed to poor germination, particularly in the Control 2 area, but did not appear problematic at the other treatment areas.
4. There appears to be some correlation between increasing salinity and pH levels, but this may need further investigation (see Figure 3).
5. High subsoil salinity levels where no crop was growing may be partly due to being central to the worst of the original scald areas, but may have also deteriorated due to remaining bare (see Photo 5). This was not apparent even to 40cm depth where the 15cm of Sand was placed on top and the crop grew well.
6. Crust and Topsoil salinity levels greatly increased in the bare Control 1 treatment area, with only slight variations occurring at all other sample sites. Some crust samples had become quite black and hard.
7. With further investigation into this site and other demonstration sites it is hoped that a clear picture as to what soil conditions are required to be able to rehabilitate early stage seep scalds back to cropping.

Table 2. Second soil testing results (December 11, 2019) at different depths (cm)

	Control 1	Control 2	Sand 1	Sand 2	Sand & Manure 1	Sand & Manure 2	Sand Manure & Straw 1	Sand Manure & Straw 2	Ryegrass Dominant Area
Crop Growth	None	None	Good	Good	None	Good	None	Good	Poor
Soil Salinity (dS/m)									
crust	2.54	0.61	0.23	0.11	0.79	0.2	1.21	0.42	0.50
0-10cm	1.49	0.61	0.25	0.04	0.77	0.19	0.27	0.54	0.66
Soil pH									
crust	10.9	10.7	6.8	5.9	8.0	6.2	7.6	8.0	9.8
0-10cm	10.8	10.7	7.3	5.4	8.3	6.5	6.9	8.6	10.5

Figure 3. Correlations between soil Salinity and pH levels



It was not the intention to try and obtain accurate yield results from each treatment strip, as there were too many variables associated with the size and shape of the scald areas in each plot. However, it was clear that each plot of rehabilitated soil did achieve the desired aim of greatly improving crop establishment and growth on areas that would have otherwise been bare scalds, as evidenced in photos 7 & 8.

Photo 7. After harvest shot showing stubble from strong crop growth on raised Sand strip.



Photo 8. After harvest shot showing poor crop growth from scalded Control area



Photo 9. Blackened crusty areas forming in bare scald areas



This area was sown to summer crop after summer, as is the farmers practice on all developing seep areas, in an effort to maintain soil cover and prevent surface salt accumulation.

Figure 4. Piezometer levels at Rehab Scald site, July to Dec 2019 (not yet set to Aust Datum sea level)

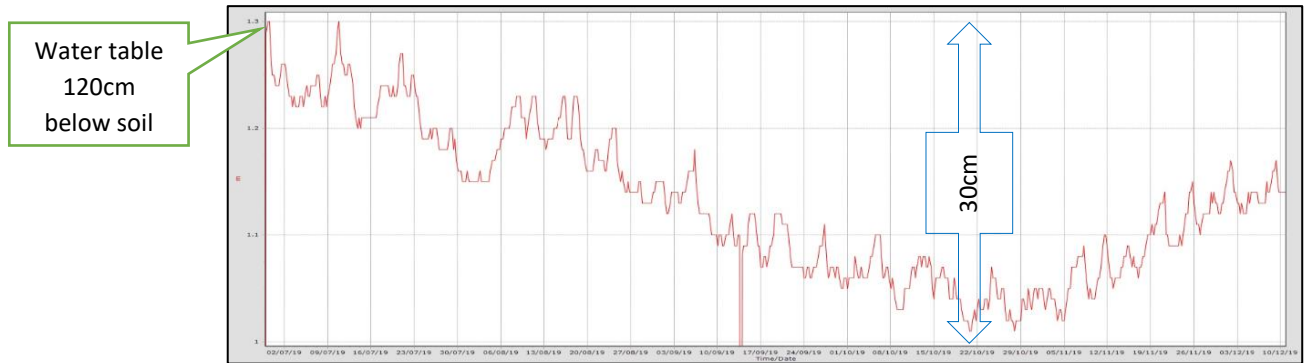


Figure 5. Soil Moisture probe readings at Rehab Flat next to Piezometer (July to Dec 2019)

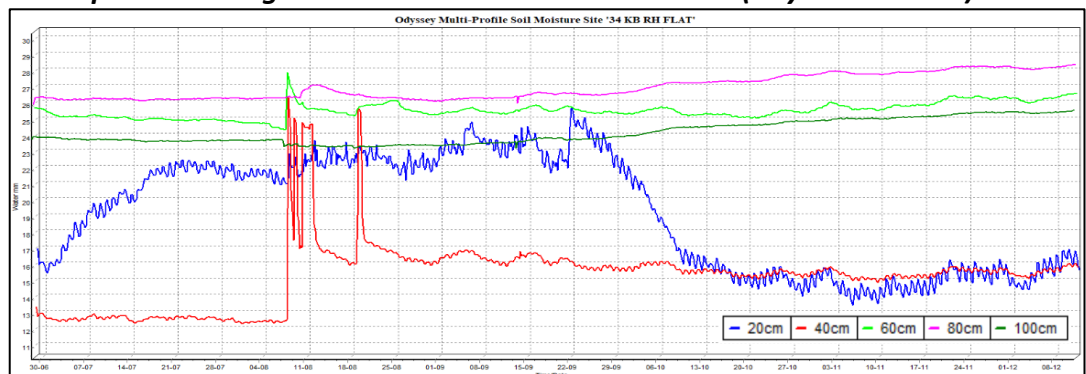


Figure 6. Soil Moisture Probe readings at top of sandhill (June to Dec 2019)

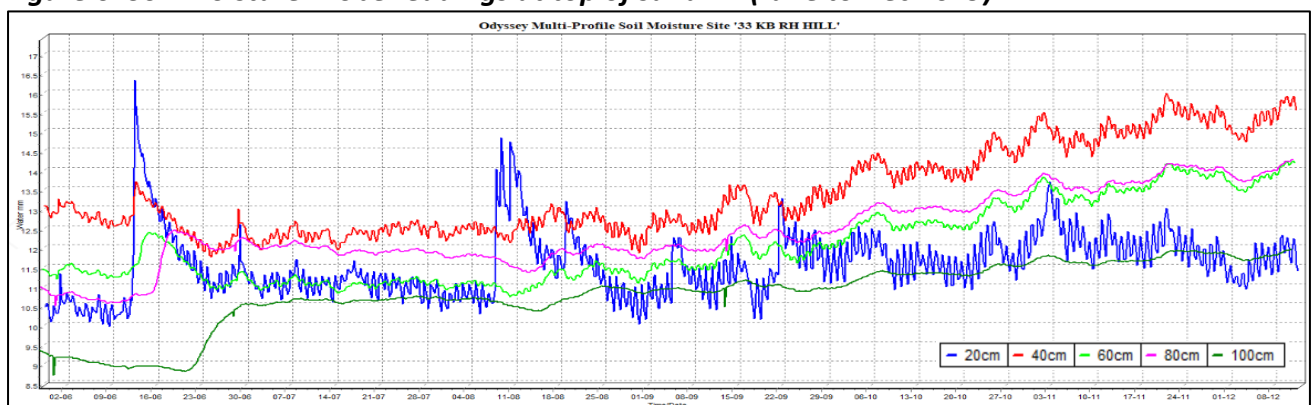


Figure 7. Bond rainfall (June to Dec 2019)

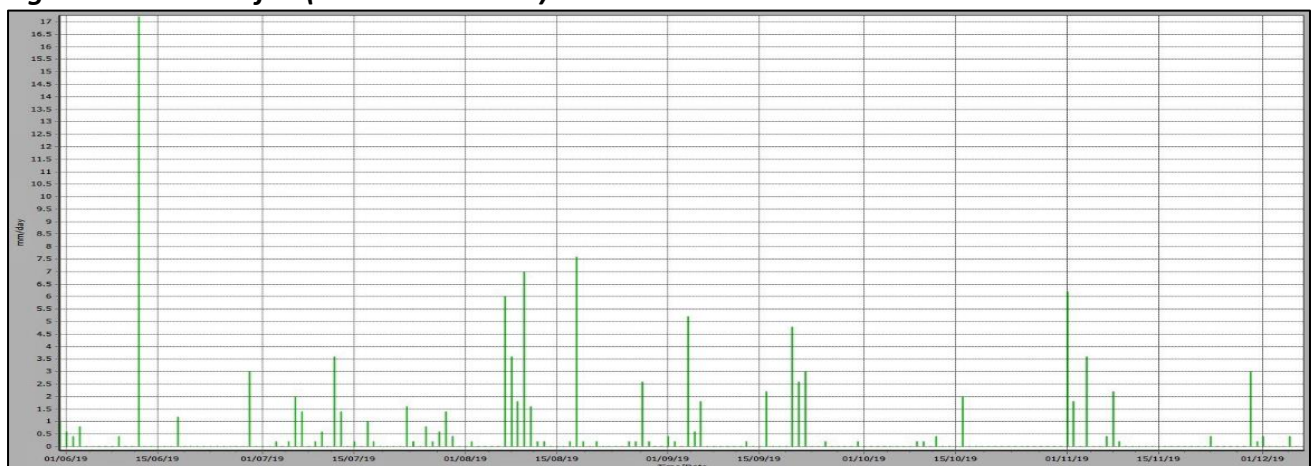


Figure 4 shows that through the latter half of 2019 the water level dropped approximately 30cm from 120cm to 150cm depth, mainly due to the dry season. The level did rise by 15cm at the end of the year, possibly due to the 15mm rainfall in November after the crop had died, or also due to water still moving slowly through the system from earlier rainfalls. The success of this trial site will be seen in the long term reduction of the perched water table, presently sitting just below the limestone layer, over numerous seasons and higher rainfall periods.

Figure 5 shows the soil moisture probe set close to the piezometer. The idea behind this is to measure soil moisture dynamics within the crops rootzone due to rainfall and crop water use. It is also hoped to reveal any capillary rise of moisture from the water table to the surface, particularly over the summer months, and to assess this effect on surface salinity accumulation. Unfortunately, the limestone layer meant that a hole needed to be drilled through the stone to be able to establish this probe, causing far more soil disturbance than when normally inserting soil probes. The effectiveness of this probe is still being assessed because of this. At present the 20cm and 40cm depth sensors are responding to the limited rainfall events, while there has only been a slight rise in each of the deeper sensors down to 1m.

The Recharge Zone

The deep sandhill above the seep scald was sown to barley in 2019 and grew relatively well, despite the late break and poor season. A soil moisture probe was established on top of this hill to measure the soil's ability to retain rainfall for crop use or to contribute to recharge after rain events. The seed passed around this probe meaning there was little crop growing in its immediate vicinity (Photo 10).

Figure 6 shows a slight rise in soil moisture at all levels due to the lack of crop growth at the probe site. There were major rainfall events recorded that would lead to a clear spike in the 100cm moisture sensor that would be indicative of water passing through the rootzone. Next season crop plants will be transplanted next to the probe.

Photo 10. Soil Moisture Probe on top of Sandhill



The Interception Zone

Unfortunately the lucerne strip for the lower section of the sandhill was sown fairly late into an already established barley crop, which was less than ideal given the very poor season.

Consequently, establishment was very poor. It is hoped that this water interception strip will be better established in 2020.

Conclusion

This site has shown that there is great potential for farmers to bring recently scalded land back into crop production with a bit of effort and utilising resources readily available on most farms. It will be important to follow this through over the next few years to make sure that changes made will last. It will also be important to establish higher water use strategies in the Recharge and Intercept zones to reduce the excess water coming into the scald area.

With further investigation into this site and other demonstration sites it is hoped that a clear picture as to what soil conditions are required (through soil testing) to be able to rehabilitate early stage seep scalds back to cropping.