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Project Code	
Project Type	

FINAL REPORT 2019

PROJECT CODE : EP216

PROJECT TITLE
Using soil water information to make better decisions on Eyre Peninsula

PROJECT DURATION

Project Start date	1 July 2016				
Project End date	30 June 2019				
SAGIT Funding Request	2019/20		2020/21		2021/22

PROJECT SUPERVISOR CONTACT DETAILS

Title:	First Name: Andrew	Surname: Ware	
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ADMINISTRATION CONTACT DETAILS

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PROJECT REPORT

Executive Summary

In 2016 32 new and existing soil moisture probes located across Eyre Peninsula were integrated into an online network that was made available to all growers, advisors and industry personal via EPARF's website.

Currently the network is able to provide live indications of soil moisture at 36 locations as well as display weather readings (at 15 sites). The information is used to provide an increased awareness of how crops utilise soil moisture across a wide range of soils and farming systems representative of much of Eyre Peninsula's agricultural area.

The project assisted in discussions around how management decisions across Eyre Peninsula could be improved with more real time knowledge of plant available water.

During the three years of the project, soils adjacent to the moisture probes were cored twice yearly, tested for soil moisture, and grain yields taken. The soil moisture probes were each calibrated to provide an estimate of plant available water content.

The probes were able to:

- demonstrate the benefits of summer weed control
- demonstrate how effective crop types were in extracting moisture (in general pastures and pulse crops used less soil water, than cereal crops).
- Assist growers better understand plant water use and availability, on their soils.

Project Objectives

To use an existing network of soil moisture probes across Eyre Peninsula to provide growers across the region with information on how data the soil moisture probes collect can be converted into easily utilized decision support tools that will assist them in targeting yield potential and tailoring inputs to match.

Overall Performance

Personnel:

Leigh Davis, Agricultural Officer, SARDI, Minnipa Agricultural Centre, who was working on this project 20%FTE concluded his work with SARDI in early January 2017. He was replaced by Brenton Spriggs who had been working alongside Leigh for seven years.

Andrew Ware, Snr Research Scientist, Port Lincoln. 5%. Andrew left SARDI in Jan 2019 but has been contracted to write the final report.

Co-operators:

This project relied heavily on the support of the 33 growers who hosted each of the soil moisture probes. Their names and locations are provided in the report attached.

Shane Oster, Alpha Group, provided much of the maintenance of both the probes and the website where data could be viewed.

Achievements

A network of 36 soil moisture probes has been created, providing live data on soil moisture and rainfall (and further weather data at 15 sites), as well as estimates of plant available water holding content and soil limitations. This has the potential to become a valuable resource, forming a platform for future research and extension on Eyre Peninsula.

The project was able to improve growers' knowledge of plants' water use patterns, the value of controlling summer weeds to conserve moisture and created discussion on how plant water use efficiency could be improved. Good grower recognition and interest in the project was created.

Difficulties:

1. Being able to accurately characterise soils using the method described by Burke and Dalgliesh*

Despite soil coring at the start and end of each growing season and measurements to capture Drained Upper Limit, Crop Lower Limit and Bulk Density there was a low correlation between the soil moisture probe outputs (in most cases thought to make logical sense) and the soil core data.

Communication with CSIRO has found that this is a common finding in many low rainfall environments, particularly soils with high stone levels. Their findings were that it sometimes takes more than three years of concentrated effort to get accurate plant available water data.

An estimate of plant available water capacity and estimates for plant available water at any time of the year, for each probe site, were able to be made using the CSIRO developed Soil Water Express web tool and live soil moisture probe data.

Estimates of plant available water using soil coring data and how they relate to soil moisture probe outputs can be found in Appendices 2 of the attached report.

*Burke, L and Dalgliesh (2008) Estimating plant available water capacity – a methodology. 40pp. Canberra: CSIRO Sustainable Ecosystems.

2. Time taken to develop an understanding of how soil water was behaving at each probe site.

It took two growing seasons to gather enough information to start to provide some assessment of how soil moisture was behaving at each site (where the fullest point of the soil was, how dry the soil could get, how much moisture could be extracted by different crops).

This limited the amount of information that could be provided to growers and advisors during the project.

3. Ease of access for growers and advisors

While the EPARF website provided an easy and low-cost platform for the information to be accessed, many growers suggested that a phone app would have improved accessibility and increased usage.

Key Performance Indicators (KPI)

<i>KPI</i>	<i>Achieved (Y/N)</i>	<i>If not achieved, please state reason.</i>
Fully characterise three sites for plant available water	Yes	Three soils were characterised for plant available water.
Meet with three to six farmer groups on two occasions and publish regular e-newsletters throughout the season	Yes	Awareness of the project was raised in EPARF newsletters to its members and presentations were made at seven post-harvest meetings to over 150 growers and advisors explaining the project and how they could access the data. A workshop was held in February 2017, explaining how to use soil moisture probes and their data. 20 attendees.
Analyse data collected from 2016	Yes	Information being captured on 32 Eyre Peninsula soil moisture probes was brought together onto a single platform and made available via EPARF website.
Conduct pre-season soil testing on 20 sites and fully characterise seven sites for plant available water.	Yes	Soil testing (coring to 1m) was conducted at 29 soil moisture probe sites in March 2017. Soil was analysed for soil chemistry and soil moisture levels. Soil coring for pre-harvest moisture levels was conducted at 26 sites in early November 2017. Eight sites were characterised for plant available water.
Meet with three – six farmer groups on two occasions and publish regular e-newsletters throughout the season.	Yes	Soil moisture probe sites were visited by seven grower groups in Spring 2017 and a summary of findings from 2017 was presented to seven post-harvest meetings with over 150 growers and advisors attending. EPARF continued to raise awareness of the probe network through its newsletters. Further information on the project was delivered to growers through three meetings convened by this project, held on 8-9 February 2018. Shane Oster, Tim McClelland and Andrew Ware presented. 60 growers and advisors attended.

Analyse data collected from 2017	Yes	A summary of all data collected from 29 soil moisture probe sites was collated in Feb 2018 and sent to all growers hosting a probe (summary provided to SAGIT)
Conduct pre-season soil testing on 20 sites and fully characterise seven sites for plant available water	Yes	Soil testing (coring to 1m) was conducted at 30 soil moisture probe sites in April 2018. Soil was analysed for soil chemistry and soil moisture levels. Soil cores were collected in early November for assessment of end of season moisture levels on 26 sites. Ten sites were characterised for plant available water.
Meet with three - six farmer groups on two occasions and publish regular e-newsletters throughout the season	Yes	Soil moisture probe sites were visited by seven grower groups in Spring 2018 and a summary of findings from 2018 was presented to seven post-harvest meetings with over 150 growers and advisors attending. EPARF continued to raise awareness of the probe network through its newsletters.
Analyse data collected from 2018	Yes	A report with analysis, commentary on 29 of the soil moisture probe sites has been compiled and distributed to each of the growers hosting a probe. Collated summary provided to SAGIT with this report.
Conduct exit survey of growers and advisors involved in the project	Yes	Surveys were conducted at post-harvest meetings in both 2018 (83 participants) and 2019 (106). A summary of findings appears below in "Application / Communication of Results" and attached to this report with farmers views on what practices they could change and how the probe network could be improved.
Technical Information		
<ul style="list-style-type: none"> • A report on each probe site, including commentary of soil moisture activity, and plant available water capacity is attached to this report. • In 2016 a network of 32 soil moisture probes across Eyre Peninsula was created. • The network consists of previously installed and newly installed soil moisture probes located on strategic soil types and with key farmers across Eyre Peninsula. • The purchase of each of the newly installed moisture probes was funded by the growers whose property they are located with an automated rain gauge accompanying the probe funded by EPARF. In addition, ten weather stations capable of logging temperature, humidity and wind speed have also been installed funded through contributions by EPARF and AgFarm. • Shane Oster, Alpha Group, installed all new soil moisture probes in September 2016 and updated existing moisture probes so that the data they were generating is now available through the EPARF website. 		

- In 2016 three sites with existing soil moisture probes were characterised for their soil moisture holding characteristics (i.e. soil moisture present at sowing, soil moisture present at maturity collected from under rainout shelters).
- In 2017 soil testing for soil chemistry and soil moisture was conducted at 29 of the sites in late March.
- In 2017 15 of the sites were planted to wheat, seven to pasture, four to pulse crops, three to barley and two to canola.
- Eight sites were characterized for drained upper limit, crop lower limit and bulk density in 2017.
- Yield Prophet was run at eight sites (Lock, Cleve, Elliston, Kimba, Ungarra, Warrambo, Pinkawillinie and Karkoo). End of season reviews at each site are currently being conducted and will be circulated to growers once complete. Tim McClelland, from BCG/ Yield Prophet, attended a series of three meetings held in early February to help explain 2017 Yield Prophet outputs.
- Soil moisture testing and hand harvest samples were conducted at 26 sites in early November, at crop maturity. The sites that weren't tested at this time were not mature and rainfall shortly after meant that soil testing for moisture at these sites was futile.
- +/- additional nitrogen was applied in replicated plots adjacent to soil moisture probes at five sites (Pinkawillinie, Warrambo, Ungarra, Karkoo and Rudall)
- Further to this SARDI/ SAGIT/ GRDC intern, Danielle Allen, as part of her project used five soil moisture probe sites and monitored them for plant growth and spectral reflectance.
- Danielle was also able to use APSIM to model soil moisture on five sites and got it to highly correlate with soil moisture probe outputs.
- A short report providing a summary of the data gathered from each probe in 2017 was provided to each land holder with a probe in January 2018.
- In summary soil moisture probes were able to demonstrate the benefit of summer weed control in terms of storing moisture and using it for crop production.
- The soil moisture probe sites demonstrated that applying nitrogen showed a benefit at two of the five sites it was demonstrated.
- The crops that had the highest water use efficiency were sown early and had sufficient moisture to germinate shortly after sowing (as opposed to sitting in dry soil for up over a month).
- The majority of the pasture paddocks monitored in 2017 demonstrated a net increase in the amount of soil moisture at the end of the growing season compared to the start.
- How growers and advisors are best able to use this information was discussed at meetings held 8-9 February 2018.
- In 2018 soil testing for soil chemistry and soil moisture was conducted at 30 of the sites in late March.
- In 2018 11 of the sites were planted to wheat, three to pasture, six to pulse crops, five barley.
- Ten sites were characterized for drained upper limit, crop lower limit and bulk density in 2018.
- Yield Prophet was run at seven sites (Lock, Cleve, Kimba, Warrambo, Koongawa, Pygery and Yeelanna).
- Soil moisture testing and hand harvest samples were conducted at 26 sites in early November, at crop maturity. The sites that weren't tested at this time were not mature and rainfall shortly after meant that soil testing for moisture at these sites was futile.
- In general, the outputs from the soil moisture probes gathered in 2018 showed the value of being able to store and utilise summer rainfall and convert that into grain.
- Increased information about how available stored soil moisture is can now be used by growers to better target yields.
- Information of plant water holding capacity for each probe site was developed using Soil Water Express (<http://www.apsim.info/swe/Default.aspx>). A web tool developed by CSIRO.
- Information such as crop type and sowing date, drained upper limit, and the maximum extraction limit for each probe were added (where known) to the website and can be viewed by the general public.

- All of the soil coring data (both as the start and finish of each growing season, as well as drained upper limit, crop lower limit and bulk density) was collated (summarised and presented in attached report in appendices 2).
- A summary of the findings for each probe has been distributed to each grower.

Conclusions Reached &/or Discoveries Made

This project was able to develop plant available water capacity at 29 sites across Eyre Peninsula and created a live platform to view soil moisture and meteorological data at 36 sites.

Much of the information generated relates specially to the part of the paddock where the soil moisture probe is located and will have most relevance to the grower whose property it is on and anyone who can specifically relate to that data.

There were many commonalities across sites and this project showed that soil moisture probes were able to demonstrate:

- **The benefits of summer weed control**

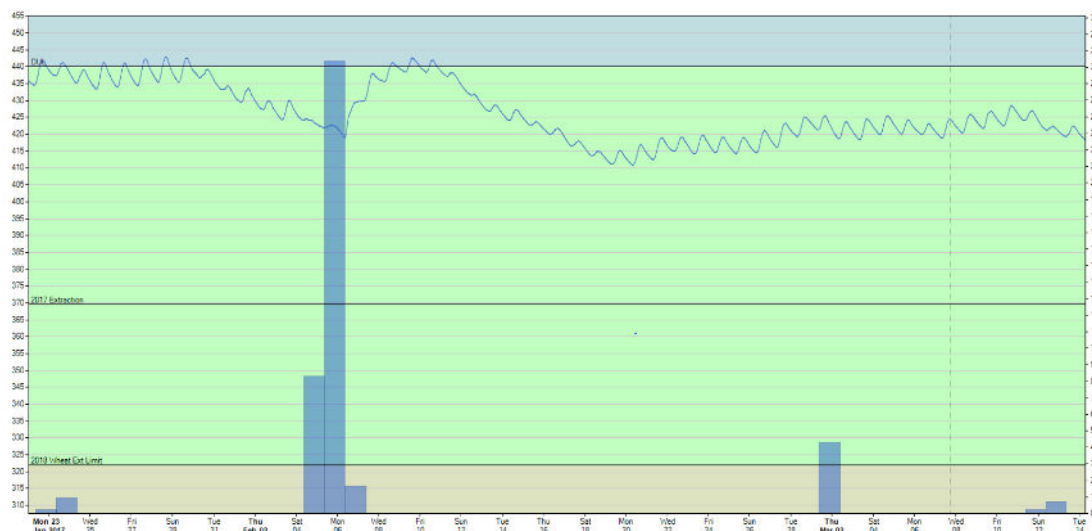


Figure 1.

Figure 1 shows the total moisture present at a probe site (blue serrated line near top) during February 2017. The blue bars show rainfall.

- The soil moisture probe indicated that the 36mm of rain that fell between 5-7 Feb 2017 was all removed (by summer weeds) by 20 Feb. 2017.
- Effectiveness of different crop types in extracting moisture (in general pastures and pulse crops used less soil water, than cereal crops).



Figure 2.

Figure two shows the plot of soil water at a site in 2018 the (blue line gradually declining from left to right), This paddock grew wheat in 2018 and can be seen that this crop had used the maximum amount of water ever seen at this site, by late October. The heavy line going straight through the plot a bit below halfway was the maximum amount of soil moisture that a field pea crop was able to use in 2017. This was quite common at most of the probe sites where pulse crops and pastures did not use as much soil moisture as cereals and canola crops.

A survey of 106 growers and advisors conducted in March 2019 indicated how they would use the information the soil moisture probes generate for decision making:

- N application x 7
- Grain marketing confidence increased x 2
- Time of sowing decisions
- Weather Stations (including FDI) x 3
- Summer weed spraying x 3
- Increased confidence of sowing
- Risk management – dry sowing knowing moisture at depth, confirm gut feel
- Target yield, knowing bucket size
- Soil moisture vs satellite information??
- When we have enough confidence, it will help us make EVERY decision
- Measuring WUE and stored soil moisture to know what's going on
- Know where frost has occurred (quicker decision can be made)
- Crop choice at start of season
- Towards end of season – how much is left for pasture/crop

Intellectual Property

N/A

Application / Communication of Results

Main findings of the project

The soil moisture probes were able to:

- demonstrate the benefits of summer weed control
- demonstrate how effective crop types were in extracting moisture (in general pastures and pulse crops used less soil water, than cereal crops).
- Assist growers better understand plant water use, on their soils.

Industry Impact

A survey of growers and advisors was conducted in both March 2018 and 2019 at the post-harvest meetings. The information collected displayed below, with further information attached.

2018: n=83

2019: n= 106

Have you looked at the EP soil moisture probe network on the EPARF website?

	2018	2019
Yes	34%	50%
No	51%	47%
Not sure	0%	3%

If yes, what has been the most useful or interesting information? (can select multiple answers)

	2018	2019
Weather station information (temp, humidity, wind speed, wind gust, barometric pressure)	13%	15%
FDI	1%	11%
Delta T	5%	8%
Rainfall	26%	15%
Soil temperature	2%	4%
Soil moisture	31%	13%
All of it	21%	31%
None of it	0%	4%

Extension activities

The project hosted a workshop in Port Lincoln on 17 February 2018 for advisors/researchers/agronomists where Shane Oster, Alpha Group, presented information on soil moisture probes -how to access and read the soil moisture probe data and make sense of it. 20 attended, mostly consisting of advisors.

At the EPARF/ SARDI post-harvest meetings conducted in March 2018 at eight locations, a 20-minute session explaining the soil moisture probe project, and how soil moisture probes can be used was conducted. 157 growers and advisors attended.

Visits to soil moisture probe sites and discussions about information the probes were generating and how that was being used occurred at six 'Sticky Beak' days in Spring 2017 and again in 2018. Approximately 220 growers and advisors attended these events each year.

Further information on the project was delivered to growers through three meetings convened by this project, held on 8-9 February 2018. Shane Oster, Tim McClelland and Andrew Ware presented. 60 growers and advisors attended.

Andrew Ware presented findings from this project to the GRDC grower update held in Lock, 1 August 2018. Approximately 80 growers and advisors attended.

Extension articles

Ware, A., Scholz, N., Spriggs, B. and Budarick, S (2018) Soil moisture probe network - using soil water information to make better decisions on Eyre Peninsula. In 2017 Eyre Peninsula Farming Systems Summary.

Ware, A., Scholz, N., Spriggs, B. and Budarick, S (2018) Soil moisture probe network - using soil water information to make better decisions on Eyre Peninsula. In GRDC Update Lock Proceedings, August 2018.

Path to market for the results:

- Presentations at field days and seminars have been given during the project.
- The compendium of results for each probe site (attached to this final report) will be distributed to each of the property holders that host a soil moisture probe and then more widely if deemed necessary.
- To fully capitalise on this project some of the items detailed in the Future Work section should be investigated.

Barriers to adoption:

- In general, it took two years of data collection to be able to describe how soil water was being used by plants specifically at each site. This meant that the project was not able to extend the information until quite late in the project.

POSSIBLE FUTURE WORK

Future directions:

- To be able to extrapolate the data being generated from the soil moisture probes across a wider area. Using soil moisture probes as a pinpoint reference so that management decisions based on soil moisture can be developed to account for variation in soil type.
- To better be able to describe each of the soil types so that growers can more readily identify which soils in the network relate to their property.

- To develop a phone and tablet app that is able to display the probe outputs in a more user-friendly manner.
- To continue to regularly inform growers and advisors of soil moisture readings, with some interpretation.
- To better characterise the soils plant available water holding content.
- To utilise the soil moisture probes for future research, as each site provides good historical and current information.

Appendix 1: *Using soil water information to make better decisions on Eyre Peninsula Final Report 2020*

Full document: 18MB

Split document available x 12 parts @ 2MB each

Via sharepoint:

https://epagresearch-my.sharepoint.com/:w:/g/personal/andrew_epagresearch_com_au/ERKHENrcPIZEo9YPW-j0M7cBUCK3Vmb88I1i2DgQtXNWWg?e=7lcc7D