Office Use Only

Project Code	
Project Type	

FINAL REPORT 2021

Applicants must read the *SAGIT Project Funding Guidelines 2021* prior to completing this form. These guidelines can be downloaded from www.sagit.com.au

Final reports must be emailed to admin@sagit.com.au as a Microsoft Word document in the format shown ***within 2 months*** after the completion of the Project Term.

PROJECT CODE :	MFM218

PROJECT TITLE (10 words maximum)
Improved soil water data decisions across the South East cropping region

PROJECT DURATION

Project Start date	1/5/2018					
Project End date	31/12/2020					
SAGIT Funding Request	**2018/19**		**2019/20**		**2020/21**	

PROJECT SUPERVISOR CONTACT DETAILS

The project supervisor is the person responsible for the overall project

Title:	**First Name:**	**Surname:**
Mrs	Felicity	Turner

Organisation:
MacKillop Farm Management Group
Mailing address:

Telephone:	**Facsimile:**	**Mobile:**	**Email:**

ADMINISTRATION CONTACT DETAILS

The Administration Contact is the person responsible for all administrative matters relating to the project

Title:	**First Name:**	**Surname:**
Ms	Meg	Bell

Organisation:
MacKillop Farm Management Group
Mailing address:

Telephone:	**Facsimile:**	**Mobile:**	**Email:**

PROJECT REPORT

Executive Summary
Automated soil moisture and weather data from across the region has been placed in a common portal with the data being developed to be more user friendly and to provide additional calculated indices (eg. Fire Danger Index). Monthly monitoring at the soil moisture probe sites during the season has allowed ground-truthing of the soil moisture data being generated and provided additional confidence in both its use and relevance across the south east region of South Australia. This monitoring included the use of a penetrometer where at the majority of sites the soil wetting front as a result of rainfall events observed in the probe data correlated well with the changes in penetrometer resistance (and therefore the capacity of roots to penetrate the soil). The importance of long-term data in understanding how wet or dry the profile is has been highlighted with these highs and lows not always being captured due to seasonal variability. Furthermore, in the lower South East (SE) the impact of the water table on either inhibiting crop growth or providing additional soil moisture (depending on soil type) to finish the crop has also been observed. Growers have been shown how to utilise the data and interrogate it to enable them to utilise historical data and knowledge to make more informed decisions going forward.
Project Objectives
The project aims to provide grain growers across the SE region with access to real-time soil moisture data through a website that pulls together information from the existing MacKillop Farm Management Group (MFMG) network and the Limestone Coast Landscape Board (LCLB) (formerly the South East Natural Resource Management Board) weather station network. Availability of this information in an easy to use and access format will allow for more informed decisions around crop management.

Key project aims are:

- To develop and provide a more consistent soil water reporting system across the South East to assist in more accurate crop management decisions for farmers and industry;
- To better utilise the existing moisture probe and weather station infrastructure that MFMG currently owns and operates;
- To calculate plant available water (PAW) and other key crop management indicators by monitoring soil moisture, associated climate data and crop performance monthly at each site over two seasons; and
- To develop fact sheets and a short 3-minute film on interpreting information from the soil moisture monitoring sites, understanding the information and associated graphs derived from the downloaded data.

This will be done through:

- Website development to link LCLB data and MFMG probe data to outline key dashboard indices;
- 16 x monthly crop and soil moisture reports (2019 and 2020 seasons)
- Short video linking data interpretation with farm management decisions;
- Fact sheet linking data interpretation with farm management decisions; and
- Fourteen presentations to growers throughout the project.

Overall Performance

The soil moisture probe and weather data was moved across to the Wildeye platform and re-designed to show dashboard indices and make the data more usable in both tablet, phone and desktop platforms.

Calculated weather derivatives were also added to the dashboard with fire danger index and Delta-T both being added where weather data was present, allowing for more localised decisions around harvest and spraying operations.

Direct links were created allowing farmers to save data of interest to their desktop or phone screen so the data could be viewed without going through a website and password process.

Crops were monitored by Alpha Group Consulting during the 2019 and 2020 seasons monthly with reports being produced and included in emails to members. This monitoring also provided an opportunity to ground-truth the crops with penetrometer readings being taken at the same time. The rainfall data was also manually recorded to try and allow for calibration of the PAW.

The field-based calibration of the total water holding capacity (PAW) was unsuccessful. There was no accurate or reliable correlation between the probe data and its relationship to recorded rainfall events. Due to the lack of reliable correlation it was not possible to find a single corrective factor to adjust the entire summed data to more closely equate the rise in millimetres of the summed value attributable to rain events. Therefore, the total bucket should be thought of as percentage of full based on observed maximum and minimum soil water levels. This issue is discussed further in the technical information section and is based on correspondence from James DeBarro, Alpha Group Consulting..

Agronomist and farmer workshops and online sessions were run over the duration of the project discussing both accessing and utilising the data and some of the decisions that can be more informed by utilising the soil moisture and weather data by both James DeBarro and Shane Oster from Alpha Group Consulting.

Collaborative events were also run with the Tatiara District Council through its Drought Communities Funding, Coorong Tatiara LAP and the NLP funded and Southern Farming Systems led 'Building the resilience and profitability of cropping and grazing farmers in the high rainfall zone of Southern Australia' project to further improve knowledge and skills in understanding and interpreting the data and using it to make more informed decisions.

An unexpected outcome was the engagement with the South East CFS including the regional commander John Probert. The dashboard format developed as part of the project was able to be adapted specifically for the CFS, so that all available weather data from across the South East is displayed on their own platform.

A fact sheet was developed and is currently being formatted for release at the 2021 MacKillop Farm Management Group 2020 trial results days, where the final findings from the project will be presented to growers.

Due to COVID-19, online sessions were recorded in lieu of a video. A short video has recently been created and will be uploaded to the MFMG website to show growers how to access and interrogate the data.

Key Performance Indicators (KPI)

KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***
Development of real-time website for soil moisture data	Yes	
Update of real time website for soil moisture data	Yes	
Update of real time website for soil moisture data	Partial	Calibration of the probes was not able to be conducted in a manner that was accurate enough to allow for updating of PAWC (see below in technical information) so only full and empty were identified in the seasons that were monitored.

Technical Information (Not to exceed **three** pages)

Develop and provide a more consistent soil water reporting system across the South East to assist in more accurate crop management decisions for farmer and industry

This has been done through the upgrade of soil moisture probe and weather station data to the Wildeye platform. The Limestone Coast Landscape Board weather station data has also been accessed and now feeds in with a 'one stop shop' location for data all displayed in an easy to use and access format – available either by clicking on a location map or on a direct link. The dashboard (thumbnail) display format is shown below in Figure 1. A graph dashboard view is also available.

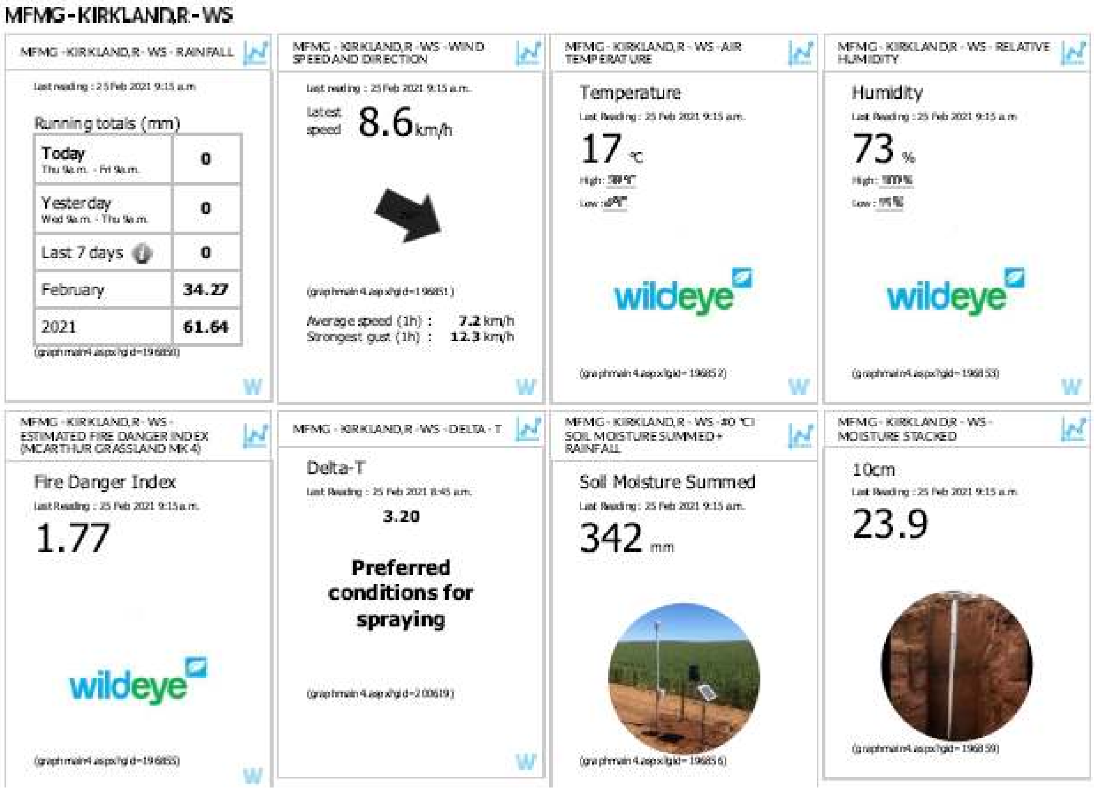

Figure 1. Example of thumbnail view of dashboard

To better utilise the existing moisture probe and weather station infrastructure that MFMG currently owns and operates

This has been done largely through the extension component of the project, but also through the ability to utilise probe data in other projects.

Monthly site monitoring was conducted and crop and soil moisture reports provided to improve awareness around the sites and some observations of what was happening to try and understand soil moisture at each of the locations.

Extension activities were conducted either face to face or online to show growers how to access and interrogate data at key times of the year when they are making decisions, with discussions around utilising the data for potential management decisions.

The long-term probe network has proved highly valuable in allowing the impacts of soil moisture and spring forecasts on end grain yield to be assessed as part of other projects with some really interesting results. In particular, the importance of current soil water content, soil type and climate on wheat yield was highlighted (refer to attached document "Drivers of wheat yield across the south east of South Australia)[1].

To calculate plant available water (PAW) and other key crop management indicators by monitoring soil moisture, associated climate data and crop performance monthly at each site over two seasons

PAW and field based calibration of total water holding capacity (information provided by James DeBarro, Alpha Group Consulting)

The probe data was assessed and its relationship to recorded rainfall events in situ to find that there was no accurate or reliable correlation. With the lack of reliable correlation it was not possible to find a single corrective factor to adjust the entire summed data to more closely equate the rise in millimetres of the summed value attributable to rain events. The process undertaken and possible reasons for the variability is shown below.

The rainfall data recorded by the electronic rain gauges was field calibrated by manual rainfall collection at each site. The automated data was modified by the calibration factor.

The millimetre rises in both the summed and stacked moisture data was compared to each recorded rain event. In rain events where moisture rises were confined to within the measured depth by the probe there was considerable variation in the summed probe value (mm) compared to the rainfall (mm). The variations were too large to determine a reliable conversion factor that didn't skew the data considerably either up or down in measured value. Equally there were circumstances at specific sites where the summed soil moisture rose or receded due to non-localised non rainfall events. These events were caused by rise and fall of ground water that confounded attempts to develop a global conversion factor. On occasions the soil moisture content in the probe measurement zone was at full point. In these circumstances the summed soil moisture didn't significantly alter when exposed to rain events. In this circumstance the soil acts like a completely wet sponge and any additional water passes straight through without adding to the total moisture status.

It is possible that specific on-site soil moisture calibrations for the probe data could aid the convergence of the summed soil moisture values and rainfall events but there are other factors that influence the existence of a simple direct relationship between the two. Such factors include the aforementioned ground water influence as well the surface movement of the rainfall around the probe site. Such movement is influenced by soil surface topography and compaction including press wheel furrows, stock footfall and wheel tracks. Biomass production through the season also has impacts on the addition of rainfall to the soil. These factors serve to direct rainfall to infiltration sites and increase or decrease infiltration depending on their nature. The element of chance in the positioning of the probe in relation to the impacts of these factors influences the relationship between soil moisture readings and rainfall events.

Upon assessment the hypothesis that there could be a directly consistent quantifiable relationship between the rise of summed soil moisture data recorded by the probe and the quantity of rainfall delivered can't be accepted.

The data shows us the likelihood of variability in rainfall movement into the soil and the impact of soil surface to infiltration. The use of press wheels to harness water to the seed zone and probe positioning in relation to this is likely to create significant impacts to the recorded data. Equally, flatter soil surfaces with their characteristics (e.g. non wetting) also impacts on the movement of rain into the soil and around the probe site.

The relationship between a single probe and rainfall is becoming a conundrum for users of this technology in both dryland and irrigation production. There is a desire for a simple direct relationship. At present this relationship is not apparent and requires specific dedicated research to determine how and if it's possible.

Therefore, the data should be looked at as percentage full based on observed fullest and driest data, which has been included on graphs. It is also important to note that these observations are taken (in general) from 0-90cm and the rooting depth of crops may extend beyond this.

Penetrometer readings were taken as part of the monthly monitoring and the soil wetting front as a result of rainfall events was readily observed on the soil moisture probe data. This correlated well with the changes in penetrometer resistance and the capacity for the roots to penetrate the soil (root exploration starts to be restricted when the soil penetration resistance is approximately 2000kPa)across the majority of sites giving confidence in the soil moisture probe data being generated. Figure 2 shows the changes in penetrometer resistance over the season. Once the roots had penetrated to depth, they were able to continue to extract moisture from depth until it ran out (NB. Penetrometer only measures to 60cm – this is not maximum rooting depth; roots are likely to explore further than this once they reach it).

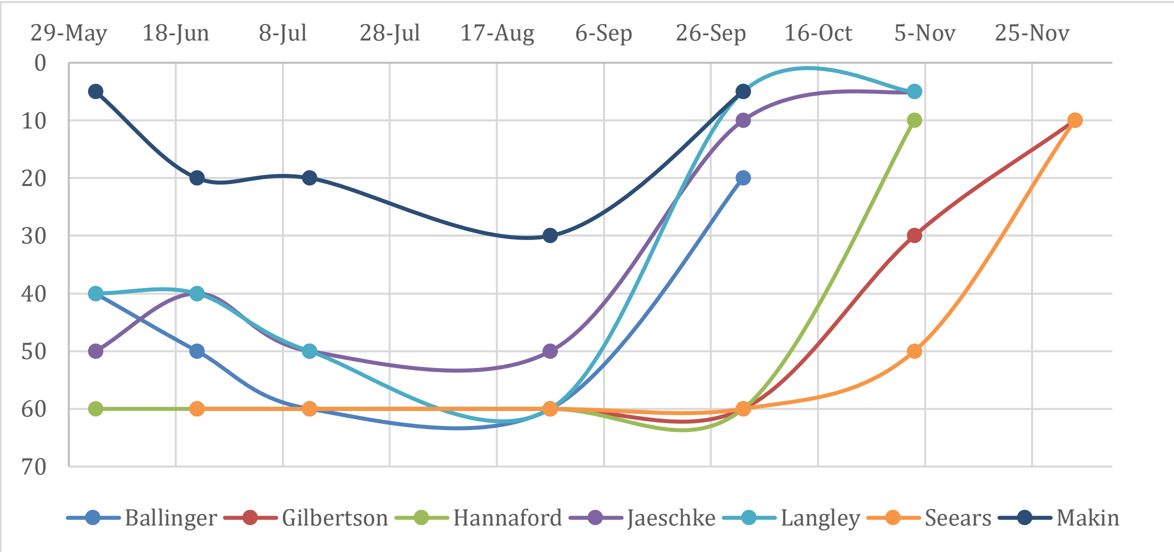

Figure 2. Depth where penetration resistance exceeded 2000kPa in 2020

To develop fact sheets and a short 3-minute film on interpreting information from the soil moisture monitoring sites, understanding the information and associated graphs derived from the downloaded data.

Key times of the year when growers make decisions were identified and some of the decisions that they are likely to make at those times was linked to how the soil moisture probe data may be able to assist in those decisions.

How much soil water, but also where it is located, are critical factors particularly at seeding time (across all environments). In spring, the importance of stored soil moisture is greater in some environments (upper South East) and soil types with a reduced soil water holding capacity, when compared with those with a greater soil water holding capacity. However, the depth of the soil moisture will give an indication as to how easily that moisture can be extracted and the ability of the crop to handle heat stress events and retain green leaf area.

The soil moisture probe data collected has also given us greater insight into how the water table interacts and impacts on crop production in the lower South East

(Conmurra and Millicent) with these sites having very different responses to the water table.

Conclusions Reached &/or Discoveries Made (Not to exceed one page)

The soil moisture probes should be used to determine how wet or dry the soil is as a percentage as opposed to being used as an absolute value with a PAW not being able to be consistently calculated. Soil moisture probes are also extremely useful at identifying where the soil moisture is located and the impact of rainfall events in penetrating to depth (particularly pre-seeding and summer rainfall events).

The ability to make management decisions in cropping systems will vary based on the environment (medium rainfall zone (MRZ) vs high rainfall zone (HRZ)) with the greatest benefits in using the data being observed in the MRZ where the soil moisture levels in early spring may be critical in determining grain yield (particularly where the spring rainfall outlook is below average).[2]

In the lower south-east (HRZ) the moisture probes are likely to provide information around moisture levels at seeding (particularly if there is a later break), and can be used to monitor for waterlogging in winter (and avoid nitrogen application in waterlogged conditions), and drier conditions in spring which may impact on late fungicide applications. The majority of management decisions are likely to be made based on factors other than soil moisture probe data.

The impact of the water table in the lower South East was also observed with significant site differences (the Conmurra site showed the ability to utilise this water whereas the Millicent site didn't appear to access the water table, and roots waited for the water table to subside before they penetrated deeper into the soil).

The presence of limestone and some of the 'hard to characterise soils' still appear to confound the soil water story quite a bit with the ability of plants to chase moisture down through rock fractions still not fully understood.

[2] Modelling work generated as part of the NLP Building Farm Resilience program that has been utilising soil moisture probe and climate data from the MFMG probes in the SAGIT project.

Intellectual Property

No IP was generated as part of this project.

Application / Communication of Results

- Soil and weather data from across the South East region has been collated and put on a common easy to use portal
- The soil wetting front as a result of rainfall events observed in the probe data correlated well with changes in penetrometer resistance and root growth through the soil profile.
- There was no accurate or reliable correlation between the probe data and its relationship to recorded rainfall events. Therefore, the total bucket should be thought of as percentage full based on observed maximum and minimum soil water levels.
- Extraction levels will depend on crop type so knowing what crop is planted and therefore extracting from the soil moisture probe is important – particularly in dry springs.

- Understanding the depth from which the plants are accessing moisture will improve understanding around the ability of the plant to withstand stress (eg. heat stress).
- Crops roots are often exploring the soil beyond 90cm, so there is a need to consider the use of deeper probes in broadacre cropping systems to capture full water use.
- The greater the amount (length of time) that data that has been captured, the more powerful it becomes in aiding decision making

Published material – available on MFMG website:

MFM_218 SAGIT 2020 Trial Results Book Report

MFM_218 SAGIT 2019 Trial Results Book Report

MFM_218 SAGIT 2018 Trial Results Book Report

MFM_218 SAGIT Probes Fact Sheet

[2] Drivers of wheat yield across the South East of South Australia

POSSIBLE FUTURE WORK

- Impact of the soil water table on cropping systems in the HRZ of South Australia
- Understanding the variability of the limestone fraction in soils of the South East and how much of this soil water contributes to crop growth