Soil moisture probes. Their uses and limitations in the farming system on the Eyre Peninsula.

Jacob Giles and Andrew Ware, EPAG Research.

Key messages

- Soil moisture probes installed across a range of Eyre Peninsula environments have demonstrated their value as tools, helping farmers to make more informed predictions of yield potential, helping them manage inputs to match.
- Accurate interpretation of soil moisture probe outputs often requires some level of training, experience, and regular use.
- Soil moisture probes must be functioning properly to allow their outputs to be effectively used. Understanding what probe outputs to look for when the probe is functioning properly can help.

Introduction

The use of soil moisture probes in dryland agriculture has evolved from the irrigation industry, where their use aided more effective scheduling of irrigation requirements. For dryland growers having a 'live' reading of soil water offers the potential to refine management strategy throughout the growing season to match the amount of soil moisture present.

Soil moisture probes are installed into placed pre-drilled hole in the soil, where most of the probe stays in the ground for the span of its life. This is typically buried 20cm below the soil surface to allow seeding equipment to pass over and continues down to a meter. An additional sensor is taken out at seeding and replaced after to account for a reading at 10cm. The soil moisture probes typically used in dryland agriculture measure the electrical conductivity (EC) of the soil. Soil moisture is interpolated through an understanding how electrical current travels through water, the higher the EC reading, the higher the moisture content of the soil the higher the moisture content of the soil.

Most of the probes used in the Resilient Eyre Peninsula project can measure soil moisture and temperature. The probe has sensors every 10cm to give a total of 10 readings to a meter. Sensors can be read individually to give the user a better understanding of where the moisture lays in the soil profile or as a summed reading to give a total from any number of the sensors.

What we did

The Resilient Eyre Peninsula project used a collection of soil moisture probes located across a broad spectrum of rainfall and soil types on Eyre Peninsula to help producers in the region become more resilient and adapt to a changing climate through better understanding of how their soils hold moisture, how it is available to plants and then use this knowledge to improve water use efficiency and/or profitability on farm.

By the conclusion of the project 42 soil moisture probes from across the Eyre Peninsula were used to collect information on soil moisture and how that related to physical soil measurements collected by the SARDI team based in Minnipa. A group of farmers and consultants from across the Eyre Peninsula were utilized to guide the progress and outcomes of the project. Eight focus paddocks were selected in key areas to monitor closely to be able to draw conclusions from the use of the probes in an on-farm context. The farmers of these paddocks were closely involved in the project and discussion groups were held at these paddocks, in-crop, once a year with other growers from the area. This allowed growers, consultants and researchers to come together and discuss the reality of the information we had at hand, how useful it was (or wasn't) and how they as growers and consultants could use the information at hand to improve on farm decision making.

What decisions can soil moisture probes can be used to improve?

Decisions that can be refined through an improved understanding:

- Inputs (how much and when)
- Choice of crop
- Confidence in grain marketing
- Knowledge of harvest logistical requirements

How to convert soil moisture probe outputs into a profitable decision.

After using a soil moisture probe for a number of seasons it is possible to determine the crop lower limit (lowest point plant roots can dry the soil to) and drained upper limit (the maximum amount of soil moisture the soil can hold). This allows the user to determine their relative position at any time during the year.

It is also possible to see where the soil moisture is in the profile, i.e. close to the surface or below 40cm. This may be useful in seeing understanding if a crop such as a legume has left more moisture for a following crop compared to a cereal and the effect of that on yield potential.

Some of the value of using soil moisture probes comes from being able to compare the relative soil moisture outputs from season to season. For example, seeing soil moisture value at the start of July is higher compared to previous years when yields were above average can provide confidence that high yields are probable and provide confidence that applying higher nitrogen rates may be profitable.

One of the advantages of soil moisture probes is they can capture the effect that changes in soil chemistry have on root growth. For example, after large rainfall events in Summer 2022 some flushing of toxic elements such as boron and salt down the soil profile occurred. This effectively increased the amount of soil the roots have available to grow in by 10-15cm and increased yield potential on these soils.

What to watch out for

The Resilient EP project sort to add value soil moisture probe outputs by quantifying the amount of plant available soil moisture that was present at each probe site and attempting to extrapolate soil moisture across the landscape.

The soil moisture probes commonly used in dryland agriculture measure soil moisture content by emitting an electric field from each sensor in the soil. The frequency of this electric field changes in response to the soil's ability to conduct or insulate electrical current, providing measurements that are calibrated into volumetric water content.

Initial efforts to correlate soil moisture probe outputs with physical soil cores collected from near the probe proved challenging. Often increases in soil probe outputs weren't matched with increases in the amount of moisture measured from physical soil samples.

We found that some probes showed increasing 'soil water' during summer when no rain had fallen. This was explained by increases in soil temperature having an influence on the probe output. Probes located in soils that had higher soil electrical conductivity (EC) or chloride levels appeared to be more heavily influenced.

Calibration factors can be used to help account for the changes in temperature over summer, but these need to be discussed with the probe manufacturer or their agent. We also observed that soil moisture probes installed in recent years have improved their ability to account for increasing soil temperature that typically occurs over summer compared to probes installed 5-6 years ago.

By the conclusion of the Resilient EP project 24 of the soil moisture probes used by project have been calibrated to have a plant available water content (mm) match the soil moisture probe output. These data can be found at https://probes.airep.com.au. Confidently being able to predict plant available soil water, without having to physically having to dig out and dry the soil helps rapidly link the soil moisture probe output to a potential yield.

As a soil moisture probe is located in a stationary position for many years, it is only able to take measurements in the soil immediately around the probe's position. Changes in soil texture, soil chemistry and other factors the influence a plants ability to utilise stored soil moisture can change dramatically and rapidly across a paddock. Making decisions that relate to a whole paddock based on what is occurring point where the soil moisture probe is located can be challenging.

The Resilient EP project explored a range of methods to extrapolate soil moisture across the paddock, using the soil moisture probe as a reference point. While some of these methods are showing promise, the error in the models still equates to at least 25mm of soil moisture. This error figure is larger than many of the trigger points to change a management decision, making current outputs difficult to drive practice change. This work is on-going and is expected to increase in accuracy over coming years with advances in increased computer power and AI technology.

However, many growers have expressed value in extrapolating soil moisture across a paddock through having a good understanding of the productive capacity of the soil where the probe is located and how that relates to the surround paddock and are adjusting strategies such as the quantity of nitrogen applied to match.

As with all man-made devices working in the elements, occasionally soil moisture probes stop functioning as they should. Over the three years the Resilient EP project there were instances where probes would go off-line or some of the hardware would fail. Manufacturers are in a continuously improving their products' durability and ability to report faults back to the user. However, occasionally these can go un-noticed, leading to misinterpretation of data. Discussion between the probe owner and the selling agent about how to identify if a soil moisture probe is mis-functioning and what can be done to fix it, should occur prior to installation.

If a soil moisture probe needs replacement most of the historical data collected by the old probe (wettest and driest points measured) will usually become ineffective. Most replacement probes will have a slightly different calibration and the measurements between the old and new probes will not be comparable.

Conclusions

Soil moisture probes have the potential to be effective tools that can help provide confidence in decision making at various stages of the cropping cycle. However, it is important the user understands the limitations of this technology.

Thanks

NLP

EPAG

Landholders

Mark Stanley

AIREP

Project Funders

Project Proponents

Project Partners