Dairy Australia

PRECISION DAIRY TECHNOLOGY

SOIL MOISTURE MONITORING

What is the technology?

A soil moisture sensor is an instrument which, when placed in a soil for a period of time, provides information on the soil water status of that soil (Cape 1997). Knowing the soil water status can help you plan when to irrigate and how much water to apply.

Why would you use soil moisture monitoring?

There has been increased interest in soil moisture monitoring (SMM). This is partly due to the rising cost of water but also the associated need to improve water productivity. It is also a result of upgrades to on-farm irrigation systems and modernisation of the irrigation supply network. Irrigators who have made these improvements are finding they have more control over water on their farm and are better positioned to utilise tools that help them match irrigation applications with the needs of the plants. SMM can be used to schedule irrigations to minimise plant stress and the economic losses that under-irrigation and over-irrigation may have on crop yield and quality.

SMM will also help you avoid the environmentally costly effects of over-irrigation including wasted water and energy, leaching of nutrients or agricultural chemicals into groundwater, and degradation of surface waters with contaminated irrigation runoff.

How do they work?

Commercially available SMM packages have changed noticeably over the last 10 years, particularly in the way the data is transmitted and displayed. Irrigators in the market now have a range of choices related to the type of moisture sensor they use, data transmission, data display and the over-all cost.

Soil moisture sensors

There are two main types of commercially available soil moisture sensors - suction based and volumetric based systems.

- Suction based sensors measure how tight water is held in the soil. This measurement is usually shown in kilopascals (kPa) and it relates directly to how hard the plant has to work to extract water from the soil. It is consistent across different soil types. Gypsum blocks and tensiometers are two commonly used suction based tools.
- Commonly used volumetric tools use a measurement of the soil 'dielectric' which reflects the capacity of a material to transmit electromagnetic waves or pulses. The dielectric of dry soil is much lower than that of water, so small changes in free soil moisture will have a large effect on the dielectric properties of the soil. Capacitance probes and total domain reflectometry (TDR) capacitance spikes are examples of commonly used volumetric monitoring tools.

Data transmission

Typically SMM devices can either be 'manual-read' where you observe readings directly from the device, or they can be 'screen-read.' Nowadays with 'screen-read' systems, the data is automatically logged, transmitted by wireless technology to your PC, mobile phone or tablet and can be viewed in a neat, adjustable graph format. With many devices the data can be shared and accessed anywhere in the world as long as the internet is available.

Some commercial systems use a central data transmission unit ('central hub') located on farm to transmit the data. Sets of moisture sensors located in different paddocks, feed data through 'field stations' to the central hub. Alternatively other SMM systems use less transmitting equipment on farm and have a lower up-front cost, but require an annual data transmission subscription fee for each set of sensors.

Data viewing

Commercial software packages offer many different data viewing and configuration options. Depending on the software it is possible to view soil moisture levels over time for different sensor depths in one graph. (Refer to the graph below.) Some software packages also offer display options that show total soil moisture that is averaged or summed from multiple depths.

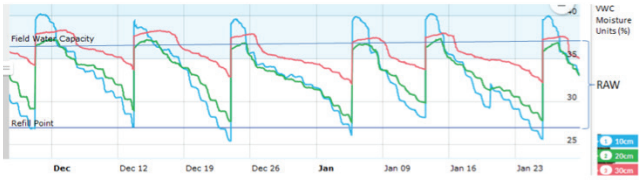
What information do they provide?

Primarily, soil moisture monitoring technologies provide soil moisture content values which can be from different depths and locations around the farm.

How can you use this information?

Essentially soil moisture data is used to assist with scheduling the next irrigation in order to optimise plant growth and water use efficiency. For surface irrigations this relates mainly to the timing of the watering, while for pressurised systems, soil moisture data is more likely to help with both irrigation timing and the amount to apply.

Typically irrigators use SMM systems to indicate whether they are in the zone of 'readily available water' (RAW). In the graph below, this 'zone of RAW' has been configured for pasture on this particular site to lie between the 'refill point' line and the 'field water capacity' line. In this particular situation, the irrigator has been regularly using this soil moisture data to schedule irrigations over the season with good results. In the graph below, it can be seen that soil moisture levels are largely maintained in the estimated 'RAW zone', enabling good plant growth and efficient water use.



Soil moisture at different depths under surface irrigated pasture measured with TDR capacitance spike sensors.

For suction based sensors, research has shown ryegrass-white clover pasture growth is optimised between 10 and 30kPa at 20cm depth. At 35kPa and above, pasture experiences difficulties extracting water and should be irrigated before reaching this critical point.

Irrigators with SMM devices report these tools provide particular value in autumn and spring when the weather and plant water use tend to be more variable. Soil moisture information is also of high value for scheduling the first and last irrigations in the season which can also be difficult to determine. The impact of rainfall, grazing or cutting hay on soil moisture and plant water uptake can also be better assessed with the use of these tools, enabling improved irrigation decisions.

Potential issues

Usually soil sensors only take moisture measurements from a very small amount of soil around the probe and care needs to be taken when extrapolating this information across a whole paddock. Like most other irrigation scheduling tools, SMM is only an aid for irrigation decision making and should not be used in isolation. Preferably SMM is used in conjunction with other scheduling tools and methods you already use on farm.

Soil variability needs to be taken into account when installing soil moisture sensors on farm. It's also very important that sensors are properly installed and protected from stock and machinery damage.

Choose a SMM system that comes with ongoing support and with a back-up service. In most circumstances some coaching will be required to understand how to use the data for scheduling decisions.

Suppliers and cost

There are many different SMM products on the market. Most irrigation suppliers are able to provide soil moisture monitoring equipment. For additional information about the types of products available and a checklist of features that can assist in selecting the right tool, Charlesworth (2005) provides a useful review of equipment (see below).

A manual read device such as a tensiometer or GDot visual display unit typically costs a few hundred dollars. A 'screen-read' system may cost a few hundred dollars or thousands of dollars, depending on the transmission equipment and number of moisture sensors involved. Annual data subscription fees are typically in the low to mid-hundreds of dollars.

FOR FURTHER INFORMATION

More detailed information on SMM is available from irrigation officers, consultants, on the web or in the following publications:

- P. Charlesworth (2005). *Soil water monitoring: An information package*. Irrigation Insights No. 1, Second Edition. CSIRO/CRC Irrigation Futures. ISBN 1 920 860 56 8 (print), 1 920 860 57 6 (online).
- Agriculture Victoria – **Choosing the right soil moisture monitoring device**
- J. Cape (1997). Development of value selection method for choosing between alternative soil moisture sensors. LWRRDC. Project No. AIT2, Canberra, ACT.

Soil moisture monitoring has seen many changes since these reports were written. They are a good guideline but growers should be encouraged to seek up-to-date information.

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