# New probe configuration to improve utility in grain production

GRAEME JENNINGS

New probe installation technology is expected to increase the use of soil moisture probes in rain-fed cropping systems.

The new technology, developed by Sentek Technologies, uses a gently tapered probe that fits snugly into a hole drilled to the same size and profile.

This has the dual benefits of ensuring the probe is in direct contact with undisturbed soil and enabling it to be set at a depth that ensures it and the cable connecting it to the associated communications module, usually mounted on a nearby fence line, are well below cultivation depth.

According to Peter Buss, co-founder and R&D manager of Sentek, being able to install probes accurately at depth opens the way for them to be used wherever they will provide the most valuable information, even if that is in the centre of a cropping paddock, and left in place year-round because the probe and cable are set deeper than the seeder works.

And installing the probe into undisturbed soil means the moisture and other readings taken by the sensors it carries are accurate from the outset.

Each probe carries moisture, temperature and 'salinity' sensors that are typically spaced at 10cm intervals along the probe, Mr Buss said.

THIS EXCAVATION HAS EXPOSED THE FULL LENGTH OF THREE OF THE NEW-GENERATION TAPERED PROBES AT A DEMONSTRATION SITE. NOTE THE LACK OF SOIL DISTURBANCE AROUND THE PROBES.

PETER BUSS [LEFT] AND ROBIN SHAEFER CHECK CROP GROWTH IN THE TRIAL SITE ON BULLA BURRA, WHERE THE DATA LOGGER WAS INSTALLED IN THE CROP RATHER THAN ON THE FENCE LINE.

'Salinity' in this instance refers to dissolved salts that, in a good cropping soil, are typically a reliable indication of nutrient availability because crops obtain nutrients from fertilisers and other sources of nutrition as mineral salts.

The keys to the new installation technology are the tapered profile of the probes and a purpose-designed auger that drills a hole to exactly fit the probe.

This precision installation method is easier and quicker than installation methods that require drilling an over-sized hole, positioning the probe within that larger hole then 'back filling' with a soil slurry to form a link between the probe and the soil profile, Mr Buss said. It also means the probe's sensors provide accurate readings from the time of installation because they are immediately in close, firm contact with the undisturbed soil profile, with no 'settling in' period required because there are no gaps or loose soil to corrupt the initial readings.

Once the location for a probe has been identified a 'tripod' – a flat plate comprising three 'legs' that lie flat on the soil surface, with a central hole at the junction of the three legs to stabilise the auger – is pegged in position and the auger used to drill a hole to the depth required to accommodate the probe, which is typically one metre to 1.2 metres in length.

The hole is drilled to the required depth, the auger removed and the probe pushed into the hole until it snugs into position, after which the tripod is removed, the cabling connected and the cable trench and space above the probe filled in.

The top of the probe is typically set 10 to 20cm below the soil surface, Mr Buss said. While that largely eliminates the risk of the probe being damaged by seeding or other cropping equipment, it also means it is not monitoring conditions in the top 10cm of soil, where most of a crop's roots and much, often most, available nutrients are located. Because of this he suggests using short – 30cm – probes in conjunction with longer, deep-set probes to ensure a complete picture of conditions in all soil strata including the topsoil.

While surface probes need to be removed ahead of seeding and replaced afterwards, their short length means that is a quicker and easier process than lifting and replacing long, sub-soil probes, and the value of the information they provide justifies the time and effort needed to remove and replace them as needed, he said.

Like the longer sub-soil probes, the new-generation short surface probes are designed to be pushed snugly into a hole

drilled to exactly accommodate them so the perimeter of the probe is in direct contact with undisturbed soil.

While the specifics can be adjusted to meet the needs of particular users, the probe-mounted sensors typically take a reading every 10 minutes, with data stored in a data logger and transmitted, usually via the mobile phone network, every two or three hours to Sentek's IrriMAX Live cloud, which uses purpose-designed software to log and display readings from the monitors.

The IrriMAX system can also be set up to receive data from an on-site weather station and overlay the weather data on the soil moisture graph.

Sentek recommends growers have a remotely monitored rain gauge mounted near each probe so they can relate soil moisture to rainfall and provide the client with an accurate picture of the real situation in the paddock.

Growers with probes on their properties are able to access their data remotely via the Web using computers or mobile devices including mobile phones. The system can be configured to meet users' individual needs but most opt for a 'dashboard' that shows the position of each probe on a property map and the current moisture status at each probe, Mr Buss said.

This 'dashboard', which appears when the user logs in to access his data, can incorporate a 'flag' mechanism that shows at a glance whether moisture levels are at or below a predetermined critical level. If there is a 'flag' on a particular site the user can 'drill down' into the data from that probe to get a more detailed picture of the situation in that paddock and soil type.

Grain-grower users typically use soil moisture data from their probes to determine whether there is enough moisture to sow, whether or not to apply in-crop fertiliser or enough moisture to fill grain, he said.

Soil moisture can also influence crop choice.

"A grower who knows he has good soil moisture to depth in the soil and a reasonable likelihood of adequate rainfall in the growing season might decide to increase the area of canola, for example, instead of a less moisture-sensitive, lower-value crop such as wheat or barley. Conversely, if the probe data shows soil moisture is very low they might decide to reduce some of their inputs and the area sown to riskier crops such as canola or legumes.

"Growers make this sort of decision every year but usually don't really know how much moisture they have in their soils, or how deep it is. A probe measures moisture, plus temperature and salinity levels, down the profile for the length of the probe, so the grower knows the actual conditions in the soil."

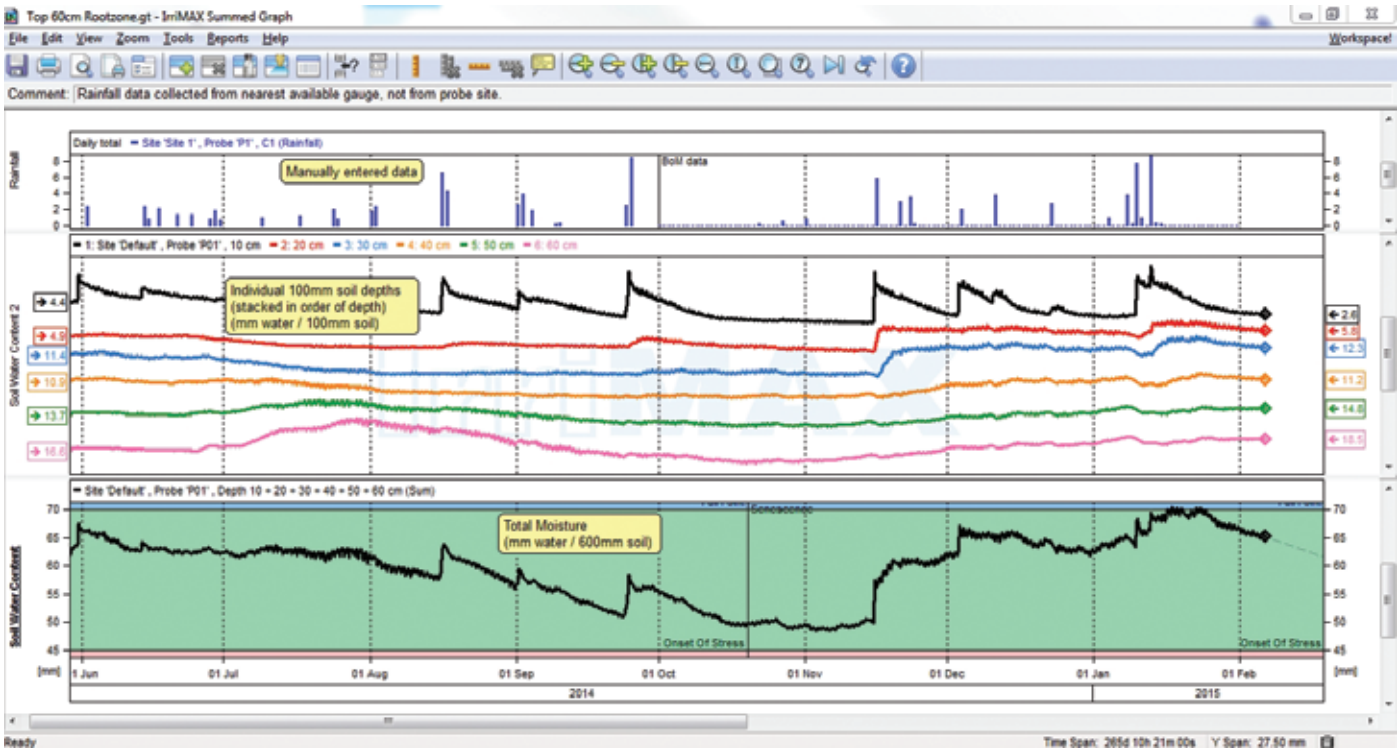
While information about soil conditions is valuable in the short term, Mr Buss believes the value of probe data increases over time.

"Soil monitoring is like yield monitoring. Each year of data builds on the previous years so you gradually build an ability to predict what is likely to happen in a paddock, based on the soil moisture data."

The probes can reveal far more than soil moisture levels, including the depth at which roots are extracting moisture.

Where there are active roots in the soil the sensors typically reveal faster moisture loss during daylight hours, when air temperatures are highest and plant transpiration fastest, than during the night; a phenomenon clearly revealed in typical 'steps' in line graphs of soil moisture readings where roots are active. Depending on the circumstances, a smooth graph with no steps can indicate there are no roots present, the roots present are not active because of temperature, for example, or there is no available moisture at that level.

Readings indicating root activity in the upper soil layers but no 'steps' despite good soil moisture at greater depth can indicate a 'hostile' physical or chemical barrier that roots can't penetrate, he said, while good soil moisture over a dry sub-soil is likely to indicate an impervious layer of clay or similar is preventing




GRAPHS GENERATED USING DATA FROM MOISTURE SENSORS IN THE PROBES SHOW WHERE THERE IS MOISTURE IN THE SOIL AND WHERE ROOTS ARE ACTIVE.

INSTALLING ONE OF THE NEW-GENERATION PROBES IS AS SIMPLE AS POSITIONING THE STABILISING TRIPOD AND DRILLING A HOLE WITH THE TAPERED AUGER.

moisture moving deeper down the soil profile.

Mr Buss suggests the ideal is to have a probe in each major soil type in each paddock but sees one or two probes in the dominant soil type on a property a good starting point, with a small installation enough to enable the grower to get a feel for the technology and develop an understanding of its capabilities and how to get the best value from it.

In many instances having access to accurate soil moisture data improved grower decision making to such an extent that the paddocks with probes became more profitable, enabling the grower to invest in probe installations in other areas or soil types.

There is no 'right' spacing, but one kilometre between probes is probably about the maximum if the aim is to maximise the benefit from the data they provide, he said.

As for where to start: "Focus on the major soil type, with the priority on soil texture, which has a major influence on moisture-holding capacity and plant availability of soil water."

Another option is to start with a probe in a 'problem' area with the aim of gaining insight to the soil moisture dynamics at play there and using those insights to improve management; reducing costs or improving profitability, he suggests.

"Knowing what is happening with moisture in your soils can improve profitability and make management easier.

"Start with one or two probes to learn about the technology, see what it is capable of and build on that initial step as you gain confidence in the data and understanding of the technology, and as funds become available."

That is the course Loxton-based grower Robin Schaefer hopes to follow.

Robin, general manager of the collaborative farming business Bulla Burra, has been trialling one of the new-technology Sentek probes on Bulla Burra, which crops 9,000ha of Mallee country.

The probe was installed in May last year, not long after he finished seeding.

A Nuffield Scholar with a particular interest in weather forecasting and how to make best use of forecasting in making management decisions, Robin had used probes in horticulture but had no experience with them in dryland cropping until last year, he said.

He found the probe on Bulla Burra provided some 'fascinating' information, but at this stage it probably raised more questions than answers.

During the growing season the monitors recorded the diurnal 'stepping' typical of crop use of soil water but as the crop started to mature and water use slowed the amount of moisture available at depth began to increase, raising the question of how that was occurring, since there had been no rain.

Possible explanations for the phenomenon include lateral movement of water through the sub-soil – the probe was installed on a low sandy rise on a heavy swale soil between two sand hills – or moisture moving up through the profile from deeper reserves as the upper layers dried out but at this stage they are no more than theories.

Robin also found the temperature data from the probe sensors revealing.

"We had a series of frosts in late July, with air temperatures as low as -4°C, but we were surprised by the depth to which soil temperatures were affected. The monitors showed cooling to depths of more than 60cm.

"There was a lot of above-ground frost damage, but then the crop stopped growing and the leaves went yellow. We're not certain, but we think that was due to the roots shutting down because of the low temperatures in the root zone."

He sees value in being able to access accurate soil moisture readings ahead of seeding because that would enable him to match seed and fertiliser rates to the available soil moisture.

And knowing soil moisture levels during the growing season could aid decisions around application of in-crop nitrogen, although that is likely to be less important in the Mallee than in other higher-rainfall districts with longer growing seasons, because Mallee growers needed to apply in-crop N early in the season, when soil moisture levels were similar to what they were at seeding, to get a yield benefit from top-dressing.

"We don't get a yield benefit from in-crop N if we leave it too late."

In some seasons knowing soil moisture levels could be important in making marketing decisions, too, he said.

"Moisture availability has a major influence on yield, so knowing how much moisture is available leading up to flowering and grain fill could be important in deciding how much grain to forward sell, for example.

"This technology has the potential to be a useful decision-making tool."

He can also see benefit from having access to salinity readings; in this case to keep track of sub-soil salinity, not nutrient concentrations.

"Transient salinity can limit productivity in some paddocks, particularly in the swales, with salt levels increasing as soil moisture evaporates then dropping as the concentrated salts are washed down through the profile by rainfall. It would be good to be able to get a clear picture of when salinity levels change in different soil types in different locations in the paddock."

Robin can see the benefits of having access to soil data from probes. However he doubts he will be able to afford to have a probe in each soil type in each paddock, something he would need to get maximum benefit from the technology, given the wide variation in soil types on Bulla Burra and the size of the property, which means some paddocks can get good rain while others remain dry.

He suggests a district-wide network of probes installed in representative soil types and paddock situations could be an alternative to private ownership of probes. Such a network would not provide the level of specific paddock detail growers could obtain from having their own probes in their own paddocks, he said, but could provide enough information to help all growers in the district make informed decisions, particularly in the lead-up to sowing.