

# Soil Moisture Monitoring:

A GUIDE TO GOOD AND BEST MANAGEMENT PRACTICES



## GOOD MANAGEMENT PRACTICE (GMP)

This refers to the *minimum* standard required to achieve good decision making from soil moisture monitoring.

### Definitions

An irrigation system is defined as: irrigation application methods of the same type that can be managed together (i.e. apply the same depth at the same time).

The definition of 'crop type' is: crops of similar water requirements, rootzones and growth stages.

### Sites

- ▶ One soil moisture monitoring site per irrigation system and/or crop.
- ▶ The site is located in the soil type with the lowest water holding capacity, but that soil type is representative of at least a quarter of the irrigated area.

### Depths

- ▶ Each site collects data from either one depth (for shallow-rooted plants and pasture) or two depths (for permanent crops) within the rootzone.

### Set up

- ▶ Soil moisture data must be set up with soil moisture parameters [Field Capacity and Stress Point] relevant to the soil moisture data.

### Data

- ▶ Collected data should allow for calculating the soil moisture deficit.
- ▶ Soil moisture data is not averaged across a depth nor across a time period.
- ▶ Sensor data is graphed to identify trends for use in irrigation scheduling.

### Maintenance

- ▶ The soil moisture monitoring site is maintained regularly (e.g. charging batteries, cleaning solar panels) and protected to ensure data quality and to prevent soil conditions from deteriorating, which could impact sensor functionality and data accuracy.

### Training

- ▶ The operator receives some basic training in interpreting the soil moisture data and its implementation in irrigation scheduling.



## BEST MANAGEMENT PRACTICE (BMP)

This refers to the standard that would allow the *maximum* benefit to decision making from soil moisture monitoring.

<b>Definitions</b>	<p>An irrigation system is defined as: irrigation application methods of the same type that can be managed together (i.e. apply the same depth at the same time).</p> <p>The definition of 'crop type' is: crops of similar water requirements, rootzones and growth stages.</p>
<b>Sites</b>	<ul style="list-style-type: none"><li>▶ One soil moisture monitoring site per irrigation system and/or crop.</li><li>▶ The site is located within the soil type with the lowest water holding capacity, but that soil type is representative of at least a quarter of the irrigated area.</li></ul>
<b>Depths</b>	<ul style="list-style-type: none"><li>▶ Each site collects data from at least two depths for shallow-rooted plants and pasture, or from three to five depths for permanent crops, within the rootzone.</li><li>▶ An additional sensor located below the active rootzone to monitor drainage events.</li><li>▶ Accurate identification of the rootzone to enable precise irrigation management.</li></ul>
<b>Set up</b>	<ul style="list-style-type: none"><li>▶ Soil moisture data must be set up with soil moisture parameters [Field Capacity and Stress Point] relevant to the soil moisture data.</li><li>▶ The soil moisture parameters are assessed by an industry expert.</li></ul>
<b>Data</b>	<ul style="list-style-type: none"><li>▶ The collected data should allow for the calculation of the soil moisture deficit.</li><li>▶ Soil moisture data is not averaged across a depth nor across a time period.</li><li>▶ The data collected from various depths within the rootzone is combined to provide a total sum of soil moisture content, rather than being averaged.</li><li>▶ The soil moisture data used for irrigation scheduling is no more than 24 hours old.</li><li>▶ The data from the sensor is graphed so trends and daily water use can be identified and implemented in irrigation scheduling.</li></ul>
<b>Maintenance</b>	<ul style="list-style-type: none"><li>▶ The soil moisture monitoring site is properly maintained (e.g. charging batteries, cleaning solar panels) and protected to ensure quality data and prevent deterioration of soil conditions that could jeopardise sensor functionality and data accuracy.</li></ul>
<b>Qualifications</b>	<ul style="list-style-type: none"><li>▶ The soil moisture monitoring site is installed by a suitably qualified person<sup>1</sup>.</li></ul>
<b>Training</b>	<ul style="list-style-type: none"><li>▶ The operator receives comprehensive training in interpreting the soil moisture data and its implementation in irrigation scheduling.</li><li>▶ All staff in charge of irrigation management receive ongoing upskilling in irrigation management and soil moisture monitoring, such as an industry approved training course, where participants earn a certificate of completion.</li></ul>

<sup>1</sup>This is a specialist area, ideally the person installing the equipment can show some credentials.

## Reading Points Per Soil Moisture Site

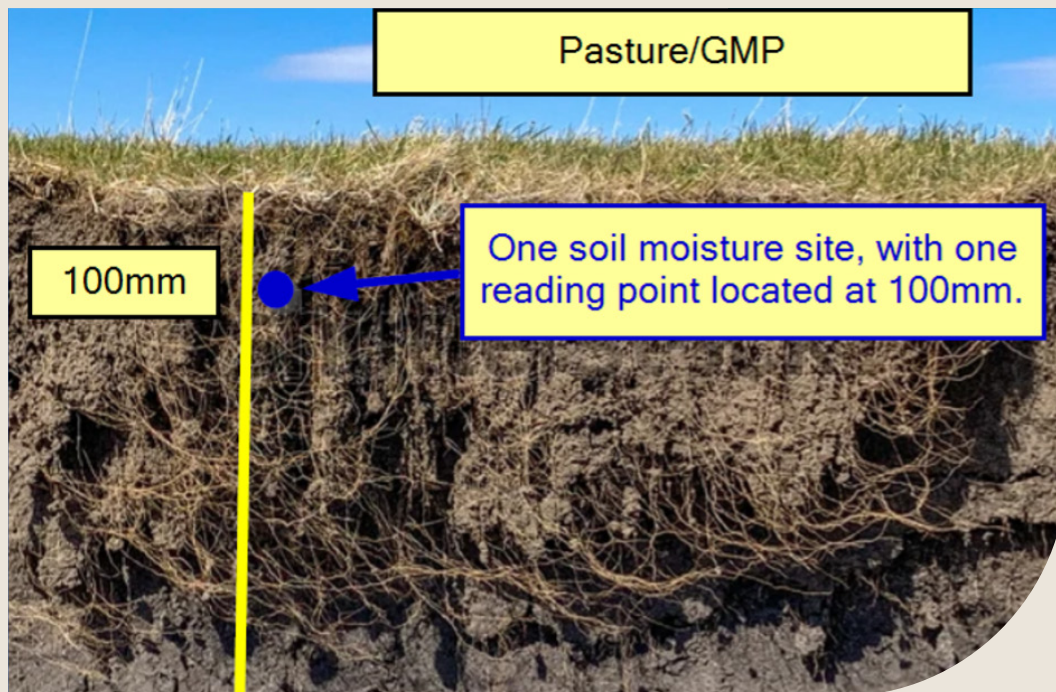
This section outlines the data collected from each soil moisture site, focusing on the number of reading points and their installation depths within the rootzone.

The number of reading points per soil moisture site varies between Good Management Practice and Best Management Practice.

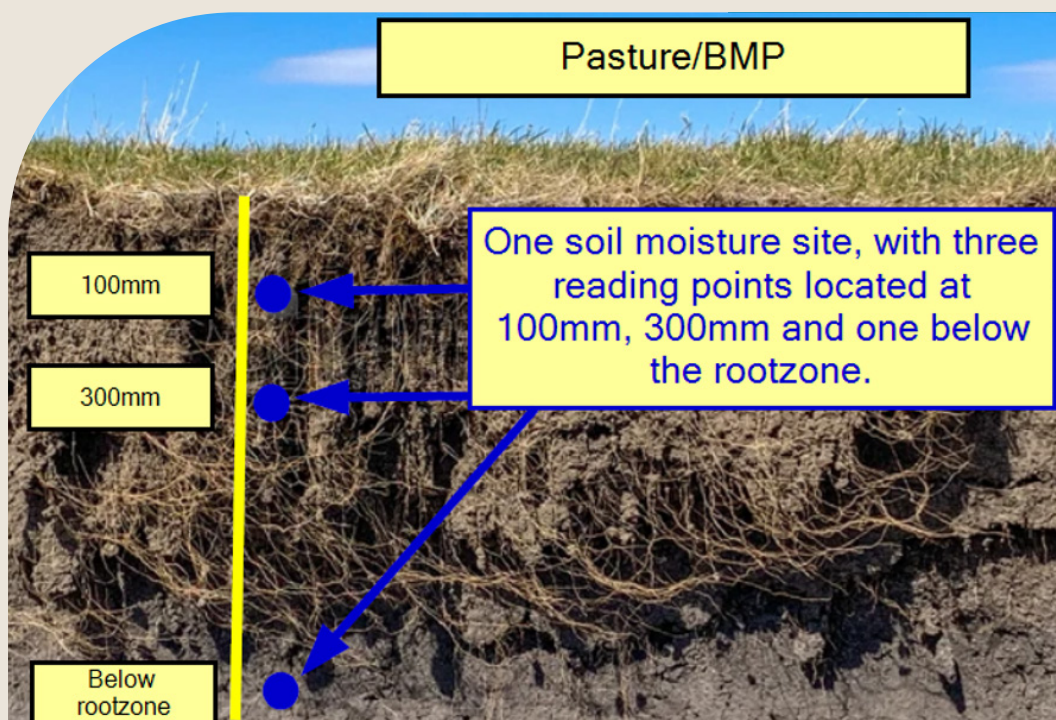
The placement of these points is determined by the crop's root depth and is designed to provide insights into soil moisture deficit across the rootzone and the effectiveness of irrigation events.

Proper placement and the number of reading points assist operators in determining the correct irrigation application depth and timing.

Reading points are categorised by crop types: Pasture, Arable Crops, and Trees and Vines. The optimal location for each reading point is specified, for example, since most sensors can measure temperature, it makes sense to position them at a depth of 100mm, which is the standard measuring depth for soil temperature. This data can be valuable for other farm management decision-making processes.



This is an example of the location of a soil moisture site in a pasture situation. This example meets Good Management Practice as there is a minimum of one reading point and it is located at 100mm.



This is an example of the location of a soil moisture site in a pasture situation. This example meets Best Management Practice as there is a minimum of three reading points, located at 100mm, 300mm and below the rootzone.

## NUMBER OF SENSOR READINGS POINTS PER SOIL MOISTURE SITE AND INSTALLATION DEPTH – GMP

	How many	Where	Comments
<b>Pasture</b>	Minimum of 1 soil moisture reading sites.	The first sensor located at 100mm.	Can be used for farm management as this is the standard measuring depth for soil temperature.
<b>Arable crops</b>	Minimum of 1 soil moisture reading sites.	The first sensor located at 100mm.	Ensure the logger (if using) can accommodate several sensors (if using multiple individual sensors).
<b>Trees and Vines</b>	Minimum of 2 soil moisture reading sites.	The first located at 100mm, the additional sites spaced 100mm to 200mm deeper.	Do a cost comparison between vertical sensor probes with multiple sensor sites vs multiple individual sensors installed at different depths.

## NUMBER OF SENSOR READINGS POINTS PER SOIL MOISTURE SITE AND INSTALLATION DEPTH – BMP

	How many	Where	Comments
<b>Pasture</b>	Minimum of 3 soil moisture reading sites.	The first sensor located at 100mm, subsequent 100 – 200mm below.	The temperature reading from the 100mm sensor can be used for farm management as this is the standard measuring depth for soil temperature.
		Last sensor located below rootzone (dig hole to determine rootzone).	Ensure the logger (if using) can accommodate several sensors (if using multiple individual sensors).
<b>Arable crops</b>	Minimum of 3 soil moisture reading sites.	The first sensor located at 100mm, subsequent 100 – 200mm below.	Do a cost comparison between vertical sensor probes with multiple sensor sites vs multiple individual sensors installed at different depths.
		Last sensor located below rootzone (dig hole to determine rootzone).	
<b>Trees and Vines</b>	Minimum of 4 soil moisture reading sites.	The first located at 100mm, the remaining sites at 100mm – 200mm spacing.  Last sensor located below rootzone (dig hole to determine rootzone).	

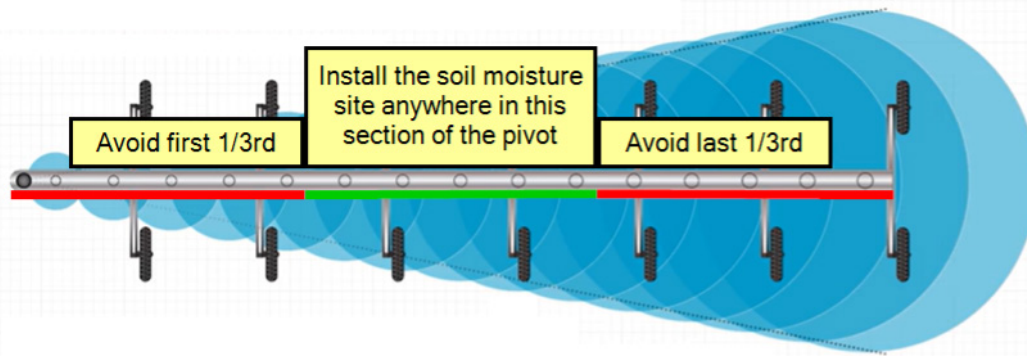
# Location Of The Soil Moisture Site Within The Irrigation System

The location of the soil moisture site will depend on the irrigation system it is installed within. This is to allow for common uniformity issues that occur across irrigation systems. For example, the end of a gun run may receive a different amount of water than the middle of the run.

Similarly, the outer edges of the wetted strip are more prone to distribution uniformity issues and should be avoided. The location guide assists in selecting the most accurate and useful position within each irrigation system type.

## Location example

Below is an example of the ideal location of a soil moisture site under a pivot.

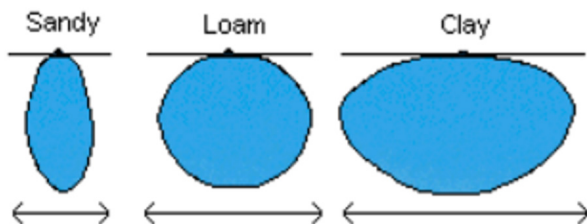


On a 400m pivot the last tower travels approximately seven times faster than the first tower. To ensure the application depth is the same across the length of the pivot, the application rate (mm/hr, or how fast water arrives at the soil surface) increases with the length of the pivot. The inner spans have a low application rate and should be avoided as a soil moisture monitoring site.

On long pivots the application rates on the outer spans can be greater than what the soil can accommodate. For this reason, it is advised to avoid the last 1/3rd of the spans. The distribution uniformity is generally less on corner arms, overhangs and end guns - for this reason it is advised to avoid these locations for soil moisture monitoring sites.

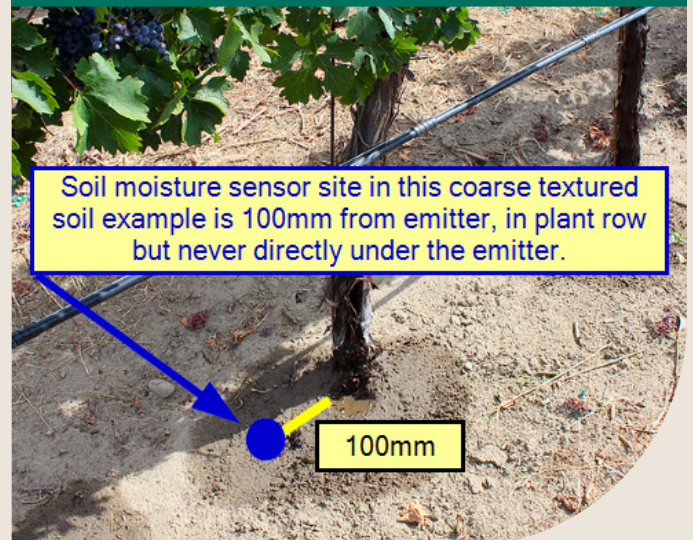
## Location example

Below is an example of the ideal location of a soil moisture site under drip irrigation.



Unlike surface and sprinkler irrigation, drip irrigation only wets part of the soil rootzone. The wetting patterns which develop from drip irrigation onto the soil depend on soil type. Water moves downward by gravity and horizontally by capillary action when dripped onto the soil. Fine-textured soil has a greater ability to move water via capillary action than coarse-textured soil. Thus, water is more likely to move horizontally in clay soils than in sandy soils.

As water behaves differently in different soil types, the location of the soil moisture site must accommodate this in order to get the most accurate and useful data. Coarse textured soils require the site to be closer to the emitter (100mm), while fine textured soils allow it to be further away (300mm).



## LOCATION GUIDE

### LOCATION WITHIN THE IRRIGATION SYSTEM

	Correct location	What to avoid	Comments
<b>Centre pivots</b>	Install site about 2/3 of the length of the pivot.	Not in first 1/3 of spans, not in last 1/3 of spans, not in overhang, corner arm or gun.  Make sure you avoid wheel tracks.	Always install it in an area where the plants are healthy and representative of the irrigated crop.
<b>Variable rate</b>	A site per key management zone.	Use the above as a site selection guide but primary focus is management zones.	Always install it in an area where the plants are healthy and representative of the irrigated crop.
<b>Micro irrigation (drip and sprinkler)</b>	100mm - 300mm from emitter. Site must be in crop row/mound.	Never install directly under emitter. Don't install interrow.	Coarse textured soils require it to be closer (100mm) to the emitter while fine textured soils allow it to be further away (300mm).
<b>Fixed grid and overhead irrigation</b>	Within overlap (wetted area of more than one sprinkler).	Avoid area directly under a sprinkler stand. Avoid outside row of sprinklers	In orchard setting, it is not necessary to locate it in the tree row, provided there is evidence of root growth in the selected site.  Water redistribution as a result of the impact of wind is a common issue for these systems. If possible, select a sheltered site.
<b>Multiple sprayline systems (e.g. K-line)</b>	Between pods and 1/2 way of wetted radius.	If the soil moisture monitoring site protrudes above ground, ensure it does not interfere with the movement of pod lines.	Always install it in an area where the plants are healthy and representative of the irrigated crop.
<b>Lateral</b>	Select a site along the length of the lateral.	Avoiding wheel tracks, hydrants, overhang and gun.	Always install it in an area where the plants are healthy and representative of the irrigated crop.
<b>Travelling irrigator (guns and rotorainers)</b>	The site must be more than wetted diameter away from the end or start of the run and no closer to the edge of the wetted footprint than 20m.	Avoid ends of run, avoid overlap areas. If the soil moisture monitoring site protrudes above ground, ensure it does not interfere with the movement of the irrigator.	Always install it in an area where the plants are healthy and representative of the irrigated crop.

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