WATER MANAGEMENT NOTE

SOIL MOISTURE MONITORING

AN OVERVIEW OF MONITORING METHODS AND DEVICES

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An Overview of Monitoring Methods and Devices

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How much water do I need to apply with my pre-plant irrigation? Should I water now or wait until next week? Can I skip this last watering and save $15 per acre, or will it cost me more in reduced yields?

These and many other questions go through a farmer's mind before and during each growing season. Making the right decision in many of these instances can be the difference between making a profit and losing money. How can a farmer gather the information necessary to make these important decisions? Soil moisture monitoring is one way.

There are numerous soil moisture monitoring methods and devices available which can help producers make informed water management decisions.

The Soil

In order to monitor soil moisture accurately, it is necessary to know a few things about the soil itself, such as the type of soil on your farm and its water-holding capacity.

Each type of soil has a different capacity to hold water, depending on its structure, texture, and other properties. The following chart describes four basic soil types and gives their range of water-holding capacity in inches of water per foot of soil.

Inches of Water Various Soil Types Will Hold At Field Capacity Which is Available to Plants

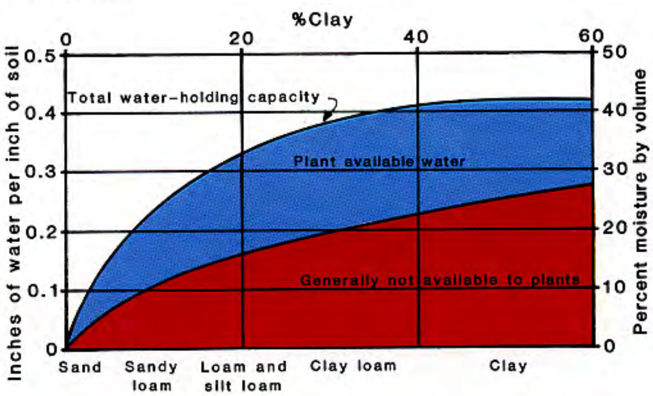
Dominant Texture	Per Inch of Soil	Per Foot of Soil
Fine sand and loamy fine sand	.06 - .10	.80 - 1.25
Fine sandy loam	.10 - 1.25	1.2 - 1.5
Sandy clay loam and loam	.12 - .16	1.4 - 1.9
Clay, clay loam or silty clay loam	.125 - .19	1.5 - 2.3

Soil Water

There are three categories of soil water. (1) "Gravity water" is that water in the soil which will drain into deeper soil layers as a result of the forces of gravity. After gravity drainage is complete, (2) "plant available water" is that water loosely held by surface tension between the soil particles. This water equals about one-half of the water-holding capacity of the soil and can be extracted by plants. The other one-half of the water-holding capacity of the soil is, (3) "molecular water." This water is strongly bound to the soil particles and is generally considered unobtainable by most agricultural crops.

Even though the molecular water bound to the soil particles is not generally available to plants, some of it can be removed from the upper part of the soil through evaporation. Evaporation losses are increased by cultivations, especially those which do not leave a protective surface mulch. Once removed, this water must be replaced before water which will be available to plants can accumulate in the small pore spaces between the soil particles.

The amount of water needed to refill the surface layer of soil dried by evaporation is almost twice that needed to refill the deeper layers of the soil which are not exposed to evaporation where only the water removed by plant use needs to be replaced.



The total water-holding capacity of different soils, as illustrated above, reveals what percentage of the total is available to plants. However, also note that a good percentage of the total is generally considered unobtainable by field crops.

METHODS OF MEASURING SOIL MOISTURE

Feel

The simplest method for measuring soil water content is the "feel" method. A person takes a handful of soil and makes observations on the appearance and feel of the sample. Soil samples should be taken from each foot of depth where soil moisture is to be considered.

A free pocket-sized soil moisture guide is available from the local offices of the High Plains Underground Water Conservation District and the Soil Conservation Service for each of the 15 counties served by the Water District. Each card identifies the major soils in the county, with the texture, depth and water-holding capacity. The card also provides a guide for estimating water content by the feel method.

GUIDE FOR JUDGING HOW MUCH MOISTURE IS AVAILABLE FOR CROPS

Dominant Texture	Fine Sand and Loamy Fine Sand	Fine Sandy Loam
Inches of water per foot soil will hold at field capacity	.60 - 1.25	1.2 - 1.5
Available soil moisture remaining	Feel or appearance of soil and moisture deficiency	
0 to 25 percent	Dry, loose, single grained, flows through fingers	Dry, loose, flows through fingers.
Inches per foot to be added:	1.25 - .60	1.5 - 1.0
25 to 50 percent	Appears to be dry, will not form a ball with pressure.	Appears to be dry, will not form a ball.
Inches per foot to be added:	.60 - .45	1.0 - .65
50 to 75 percent	Appears to be dry, will not form a ball with pressure.	Tends to ball under pressure but seldom holds together.
Inches per foot to be added:	.45 - .20	.65 - .30
75 to 100 percent	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not slick.
Inches per foot to be added:	.20 - 00	.30 - 00
At field capacity (100 percent)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.
Inches per foot to be added:	00	00

Dominant Texture	Sandy Clay Loam and Loam	Clay, Clay Loam or Silty Clay Loam
Inches of water per foot soil will hold at field capacity	1.4 - 1.9	1.5 - 2.3
Available soil moisture remaining	Feel or appearance of soil and moisture deficiency	
0 to 25 percent	Powdery dry, sometimes slightly crusted but easily broken down into powdery condition.	Hard, baked, cracked, sometimes has loose crumbs on surface.
Inches per foot to be added:	1.9 - 1.4	2.3 - 1.5
25 to 50 percent	Somewhat crumbly but holds together from pressure	Somewhat pliable, will ball under pressure.
Inches per foot to be added:	1.40 - 1.0	1.5 - 1.0
50 to 75 percent	Forms a ball somewhat plastic, will sometimes slick slightly with pressure.	Forms a ball, ribbons out between thumb and forefinger.
Inches per foot to be added:	1.0 - 0.5	1.10 - .55
75 to 100 percent	Forms a ball, is very pliable, slicks readily if relatively high in clay.	Easily ribbons out between fingers, has slick feeling.
Inches per foot to be added:	0.5 - 00	.55 - 00
At field capacity (100 percent)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.
Inches per foot to be added:	00	00

Gravimetric

A soil sample is taken from the field, weighed, dried by heating and reweighed. The difference in the weight before and after drying is the "percent moisture by weight." This method is accurate, but requires a set of sensitive scales, a method of drying, and a known or estimated bulk density value for converting the data from a weight to a volume basis. It is destructive in the sense that it requires removal of a soil sample. This makes it impossible to make another measurement at a future date at exactly the same point, eventually causing inaccuracy because of field variability from one site to another.

Moisture Blocks and Resistance Meters

Most soil moisture blocks are made by casting gypsum around a pair of stainless steel electrodes with lead wires trailing.

Here the gypsum has been cut-away to expose two stainless steel electrodes which form the core of the soil moisture block. Electrical resistance between these electrodes is an indication of soil moisture.

The blocks are buried in the soil at one foot intervals to a total depth of four feet with the lead wires extending above the land surface. These wires are then attached to a stake so that they can be easily found. Resistance to an electrical current is measured with a resistance meter. This reading translates directly to soil moisture.

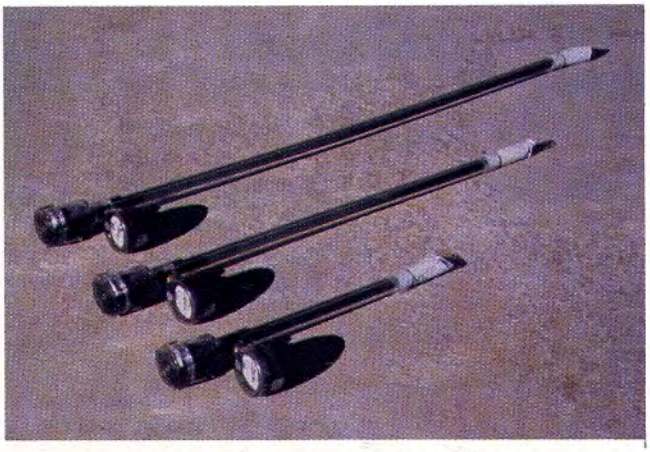
Resistance meters and gypsum blocks are inexpensive, simple to use and measure a wide range of moisture content. The blocks are not always accurate when soils are near field capacity, but give accurate moisture readings when soils are less wet.

Gypsum blocks work best when used with less water-sensitive crops such as cotton, grain sorghum and other small grains. The main disadvantage of the gypsum block is that the calibration changes gradually with time, and the "life" of the block is limited. New blocks should be installed each growing season, because the gypsum deteriorates. Lead wires are also commonly destroyed in tillage operations. On the whole, however, they produce a level of accuracy sufficient for making irrigation water management decisions which require information on soil moisture conditions.

The lead wires extending to land surface from the buried gypsum blocks are inserted into a hand-held resistance meter when readings are taken. The meter reading indicates the soil moisture condition at the depth of each block.

Tensiometers

A tensiometer measures soil water suction, which is similar to the process a plant root uses to obtain water from the soil. The instrument is a water-filled tube, with a special porous tip and vacuum gauge. Tensiometers are made in lengths ranging from 6 to 72 inches and can be installed in the soil to the desired depth.



Three tensiometers commonly used, from top to bottom, measure 36, 24 and 12 inches in length. Installation of these three would provide soil moisture information at the three, two and one foot depths.

This instrument requires maintenance in the field. It is successfully used in determining the need for irrigation when the soil moisture is kept above 50 percent of field capacity. The range of usefulness is dependent on the texture of the soil in which it is used.

In sandier soils, tensiometers will function properly down to 40 percent of field capacity. In this soil type, most crops, for maximum production, need additional irrigation water before 50 percent of the soil moisture is depleted.

In clayey soils, tensiometers lose their effectiveness when soil moisture reaches 75 percent of field capacity. Clay soils hold more water under tensions greater than the tensiometer can measure. Therefore, contact with the soil is lost and lower moisture levels cannot be determined.

Tensiometers are reusable and relatively inexpensive. They are simple to install and read, but periodic refilling with fluid is required to avoid erroneous readings caused by air entering the tube.

Neutron Moisture Meters

The neutron moisture meter uses a radioactive source and state-of-the-art electronics to measure soil water.

After a neutron probe is lowered into the soil through an access tube the neutron moisture meter will display the percent moisture by volume in the soil.

While this instrument is comparatively expensive, it is reliable and accurate. Possession and use require a license from the Texas Department of Health because the radioactive source could create a health hazard. Its use requires special storage, transportation and handling procedures.

Use of this device is not normally considered practical for on-farm use by the individual irrigator. However, large operators could use it satisfactorily and consultants often provide use of this instrument as a part of their service.

Further Information

More detailed information on any of the soil moisture monitoring devices and techniques described in this brochure may be obtained from the local offices of the High Plains Underground Water Conservation District No. 1 and Soil Conservation Service. The District office of the High Plains Underground Water Conservation District No. 1 is located at 2930 Avenue Q, Lubbock, Texas 79405, or phone (806) 762-0181.