Soil Moisture

(1) Preamble

While poor irrigation practices cause a host of environmental problems, irrigation can also be a sustainable practice, at times and places where it does not deplete or degrade surface water, groundwater, or soils. In times of high energy and water costs, efficient irrigation is essential to the viability of many farms and ranches. In the next few decades, more efficient irrigation may offer the best hope of feeding the world’s growing population.

Given the importance of irrigation efficiency, it’s unfortunate that irrigation water management is often presented as a series of complicated mathematical calculations that only an engineer could love. Irrigation management is nothing more mysterious than maintaining a suitable environment for growing crops, mainly by keeping soils from becoming too wet or too dry. There are many ways to achieve this goal, including some that require no calculations at all. This publication describes several ways that you can check the soil moisture levels in your fields, using your hands, inexpensive probes, or new electronic devices. Of course, there’s more to irrigation management than just checking soil moisture levels. You should follow general irrigation guidelines for the crops you are growing, and you should track crop water use (Evapotranspiration) as the season goes by.

No one knows as much as you do about your fields, crops, and irrigation system. So adjust, adapt, or reject any suggestion in this publication that doesn’t fit your situation or doesn’t seem to be working. Use every kind of information you can find about how your soils and crops are responding, proceed cautiously, and test every recommendation with direct observations in the field.

(2) How Soils Hold Water

The water-holding capacity of a soil depends on its type, organic matter content, and past management practices, among other things. Soils are classified into one of about a dozen standard texture classes, based on the proportions of sand, silt, and clay particles. Sand particles are larger than clay particles, with silt particles falling in between. For example, a soil that is 20 percent clay, 60 percent silt, and 20 percent sand (by weight) would be classified as silt loam. Other texture classes are sand, loamy sand, sandy loam, loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silt clay, and clay. Coarse-textured soils have a high percentage of sand, and fine-textured soils have a high percentage of clay. Fine-textured soils generally hold more water than coarse-textured soils, although some medium-textured soils hold as much or more plant-available water than some clay soils. Besides their texture classification, soils are also classified into soil types or soil series, based on soil-building factors such as geology, chemistry, age, and location. The full description of a soil series includes a number of layers or horizons, starting at the surface and moving downward. To identify the soil types or series in your fields, refer to a soil survey. Soil surveys are generally available from your local Extension office.
Figure 1. Determining Soil Texture by the “Feel Method”

1. Place a tablespoon of soil in your palm. Add water drop by drop and knead to break up aggregates. Add water and knead until the soil is the consistency of moldable putty.

   Does soil stay in a ball when squeezed? [Yes/No]

   If Yes: Is the soil too dry? [Yes/No]
   - If Yes: Is the soil too wet? [Yes/No]
     - If Yes: SAND
     - If No: SAND or LOAMY SAND
   - If No: Add dry soil to soak up water.

   If No: Add dry soil to soak up water.

2. Place half of soil between thumb and forefinger; gently pack soil with your thumb, squeezing upward into a ribbon. Form a ribbon of uniform thickness and width. Allow ribbon to emerge and extend over the forefinger, breaking from its own weight.

   Does soil form a ribbon? [Yes/No]

   If Yes: Does soil make a weak ribbon less than 1 inch long before breaking? [Yes/No]
   - If Yes: Excessively wet a small pinch of soil in palm and rub with forefinger.
   - If No: Excessively wet a small pinch of soil in palm and rub with forefinger.
   
   Does the soil feel very gritty? [Yes/No]
   - If Yes: SANDY LOAM
   - If No: SANDY CLAY
   
   Does the soil feel very smooth? [Yes/No]
   - If Yes: SILT LOAM
   - If No: SILT CLAY

   Does soil make a medium ribbon 1 to 2 inches long before breaking? [Yes/No]
   - If Yes: Does soil make a strong ribbon 2 inches or longer before breaking? [Yes/No]
     - If Yes: SANDY CLAY
     - If No: SILTY CLAY
   - If No: Excessively wet a small pinch of soil in palm and rub with forefinger.

   Does soil feel very gritty? [Yes/No]
   - If Yes: SANDY LOAM
   - If No: SANDY CLAY

   Does soil feel very smooth? [Yes/No]
   - If Yes: SILT LOAM
   - If No: SILT CLAY

3. Neither grittiness nor smoothness predominates.

   LOAM
   CLAY LOAM
   CLAY
As water infiltrates soil, it fills the porespaces between the soil particles. When the pores are completely saturated, some of the water — known as gravitational water — percolates down through the soil profile and below the root zone. Gravitational water may take a few hours to drain away in sandy soils, or days or even weeks in clay soils. Evaporation at the soil surface pulls water upward through capillary forces, while capillary forces also hold water around the soil particles. When a balance is reached between gravitational and capillary force, water stops moving downward and is held by surface tension in the soil — a condition known as field capacity. Capillary water stored in the root zone is the most important water for crop production, but not all capillary water is available for plants to use. The water-holding force of soil, or soil water tension, is affected by soil texture. For example, clay soils have small pores and hold water more tightly than silt soils, with their larger pores. As soil water is depleted, the films of water remaining around the soil particles become thinner, until they are eventually held in the soil with more tension than plants can overcome, and the plants begin to wilt. Available water capacity is the amount of water a soil can make available to plants, generally defined as the difference between the amount of water stored in a soil at field capacity and the amount of water stored in the soil at the permanent wilting point.

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**Figure 2. Saturation, Field Capacity, and Permanent Wilting Point.**

**Figure 3. Effective Root Zone**