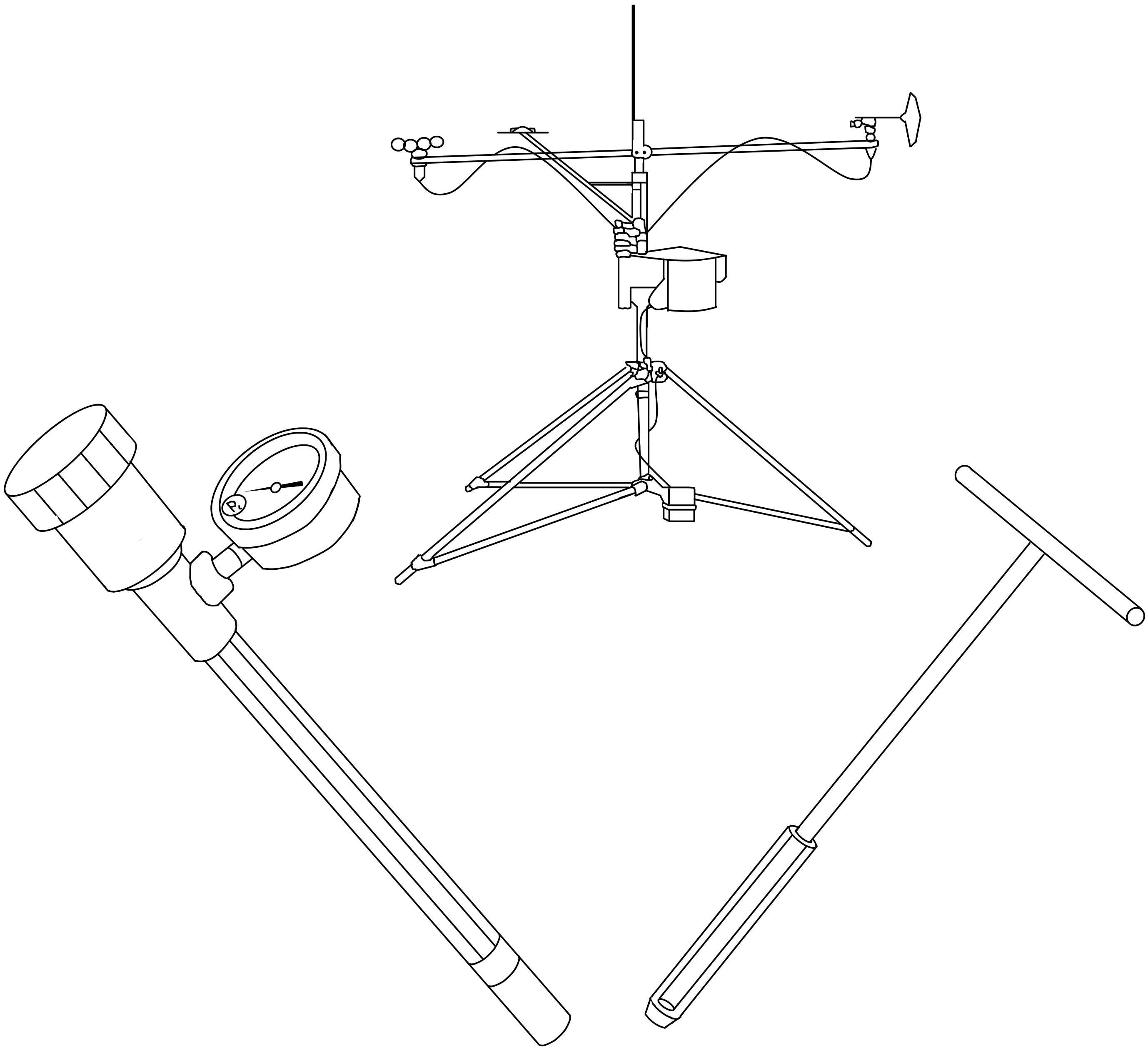

Practical Irrigation Scheduling

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Whether you know it or not, your irrigation system consists of two distinct components. The first is your system's *hardware*; the pipes, valves, pumps and sprinklers that move and apply water. If your system is well designed and maintained, it will allow you to apply water evenly and at a rate that is compatible with your soil type and crop. Poorly designed and maintained systems apply water unevenly and can restrict your crop's growth and yield potential.

The second component is the system's *software*. Better known as irrigation scheduling, this software is the method or methods you use to determine how much water to apply to your crop and how often it should be applied. Without sound irrigation scheduling, even the most technologically advanced irrigation hardware available will yield poor results.

Water Use

The principle of irrigation scheduling is to replenish soil moisture that has been used by the crop you are growing. Water use can be broken down into *beneficial use* and *non-beneficial use*. Beneficial use of irrigation water includes water incorporated in the plant's structure, transpiration losses, water held in the soil, water used for leaching salts, etc. Non-beneficial use of irrigation water is any water you have purchased that does not directly benefit your crop. This includes water lost to surface runoff, sub-surface runoff, deep percolation and on farm conveyance losses (pipe leaks, etc.).

Why bother with irrigation scheduling? Effective irrigation scheduling will allow you to maximize your beneficial water use. This can provide for:

- √ Reduction in water usage
- √ Better crop quality
- √ Pest mitigation
- √ Better yields
- √ Lower per unit cost
- √ Better nutrient use

Effective irrigation scheduling can also help reduce non-beneficial water usage by providing for:

- √ Less water loss to runoff
- √ Less water loss to deep percolation
- √ Reduced leaching off of nutrients and pesticides into groundwater supplies

On Farm Irrigation Scheduling

All farms and fields are different. So, what works well for your neighbor down the road might not necessarily work well for you. Irrigation scheduling is most effective when it is tailored to specific crop/field situations. To start, you need to find out the following:

- ≈ What is your crop's average annual water requirement?
- ≈ How mature is your crop and what is its stage of growth?
- ≈ Is your crop salt sensitive? If so, how good is your irrigation water?
- ≈ How much soil area gets wet during each irrigation set?
- ≈ How uniform is your irrigation system and at what rate does it apply water?
- ≈ What are your climatic conditions?
- ≈ What are your soil characteristics?
  - ~ How deep is your soil and how much water can it hold?
  - ~ Are there pan layers that could resist root growth or drainage?
  - ~ Does your soil have problems with its chemistry such as excess sodium, abnormal pH, etc.?

If you don't have a good handle on this information, you should. Enlist the help of your farm advisor, the Natural Resources Conservation Service, professional crop consultant or mobile irrigation laboratory. Without this information, irrigation scheduling is guess work at best.

Crop Water Use Estimates

Since no one has yet figured out a way of asking plants directly if they need water or not, you must rely on various methods of *estimating* your crop's need for water. Experiment. Find out which methods work for you and which do not. Above all else, keep in mind there is no single fool proof irrigation scheduling method. All irrigation scheduling methods have their strong points and their weak points. Thus, the best strategy is to use a combination of methods. Common irrigation scheduling methods include:

The Calendar Method is by far the crudest irrigation scheduling technique of all. Using the calendar to schedule irrigation events is always arbitrary and seldom successful. The calendar method considers the needs of the farm manager, irrigator or water district rather than the needs of the crop. It is a known fact that plants continue to transpire and need moisture after five o'clock, on weekends and on holidays

Soil Moisture Measurement monitors the reservoir that holds moisture for crop use. If this reservoir is allowed to fall below an acceptable level, crop stress and possible yield reduction can occur. By monitoring how fast soil moisture is depleted, you can determine how often to irrigate. By monitoring different areas and different depths, you can determine how long to irrigate.

The Feel Method is the simplest method of soil moisture measurement. It requires nothing more than a soil probe or shovel and a little leg work. Soil samples are taken at various depths within the crop's root zone and the moisture content judged by how the soil feels and looks.

While being the simplest method of soil moisture measurement, the feel method is also the most subjective. Some subjectivity can be eliminated by using standard descriptions of how different soils feel and appear at different moisture levels available from UC Cooperative Extension (http://ucanr.org) and the Natural Resources Conservation Service (http://www.nrcs.usda.gov). Competency in judging soil moisture by feel will allow you to spot check the accuracy of other irrigation scheduling methods being used or specific areas that are troublesome. If you don't already know how to judge soil moisture by feel, LEARN!

Tensiometers are essentially mechanical roots. A tensiometer consists of a tube fitted with a porous ceramic tip at one end and a vacuum gauge at the other. The tube is filled with water, sealed and placed into the soil. If the adjacent soil is drier than the saturated ceramic tip, the soil extracts water from the tip. Since the tube is sealed, this suction or tension will cause the gauge to move. The drier the soil is, the harder it tries to pull water out of the tip leading to higher gauge readings. If the soil has more moisture than the tip, there will be little or no suction and the gauge will give low readings. Tensiometer gauges read in centibars (cb).

Placement of your tensiometers in respect to the crop's root zone is critical if you want accurate information. Since a tensiometer reads soil moisture conditions only at the tip, the tip needs to be placed in an area of active root growth or other area that you want to monitor moisture.

Limitations of tensiometers include the need for periodic maintenance, poor readings in rocky or very heavy soils and a loss of suction in the 80 to 100 cb range. However, for moisture monitoring in the 10 to 15 cb range (preferred by shallow rooted trees such as avocados), tensiometers are the instruments of choice.

Gypsum Blocks have been around since the 1930s - about as long as tensiometers. They detect soil moisture by measuring low voltage electrical resistance between two electrodes embedded in a block of gypsum. Gypsum blocks are placed into the soil at the desired depth and wires connected to the electrodes are run to the soil surface. The block's resistance levels are then read with a portable meter. As the gypsum housing the electrodes absorbs moisture from the surrounding soil, the block gives low readings. As the soil and the gypsum dry, higher readings are given. Data from gypsum blocks is usually read in or converted to centibars. Gypsum blocks give their best data at readings of over 50 cb and when they are used in medium to heavy textured soils.

Gypsum blocks have certain limitations that can make them less useful in certain situations. The main drawback is that they need to be individually calibrated due to variations from sensor to sensor. Gypsum (calcium sulfate) is soluble in water. Because of this, gypsum blocks dissolve and change calibration over time and need to be replaced. Average life is one to three years. Also, gypsum blocks may give inaccurate readings in very saline soils where a high salt load can affect electrical resistance.

Crop Water Use Estimates continued

Improved Gypsum Blocks do not dissolve over time like conventional gypsum blocks and have overcome the major limitations previously described. Unlike conventional gypsum block, improved gypsum blocks have their electrodes embedded in a non-dissolving material. While the blocks can give readings from 10 to nearly 200 cb, the first 15 to 20 cb of resolution is not as good as a tensiometer. Season to season consistency is quite high, thus individual calibration is not needed.

Although not as accurate as tensiometers, improved gypsum blocks closely correlate to tensiometers on a consistent basis. They also do not require the periodic maintenance of a tensiometer and can be left in the soil over winter in freezing climates.

Neutron Probes are out of the scope of most farmers due to their high cost. They produce information on soil moisture conditions by emitting fast neutrons into the soil profile. When fast neutrons strike hydrogen atoms (which make up 2/3 of a water molecule), they lose speed and become slow neutrons. The higher a soil's moisture content, the more slow neutrons it will produce. A counter on the probe tallies the number of slow neutrons detected over a given period of time. The subsequent reading produced is meaningless however, unless the probe is calibrated to the particular soil type it is being used in. Once calibrated, neutron probes provide a quick and accurate picture of soil moisture conditions.

Evapotranspiration Estimates gauge crop water use by daily weather conditions. Factors such as temperature, day length, humidity, wind intensity, etc., have a significant impact on crop water use.

Evaporation Pans go back a long way - the State has evaporation records that date to the 1880s. At one time, there were nearly 500 evaporation pans being monitored throughout California.

You can make a good estimate of evaporation and evapotranspiration rates specific to your farm by reading the daily water level changes in a pan or other open, straight sided container filled with water. If you farm in an area that has numerous micro climates, evaporation pans will allow you to look at subtle climatic differences from area to area. However, to obtain good data, evaporations pans should be read and refilled daily (a lot of work!). Off readings can be caused by birds, dogs, squirrels, etc., drinking or taking baths in your pan(s).

CIMIS is an acronym for the California Irrigation Management Information System. CIMIS consists of a series of weather stations located throughout the State that are linked to a central computer in Sacramento. Using a mathematical model, CIMIS reports data in the from of ET_o or reference evapotranspiration. ET_o is an estimate of the amount of moisture an uncut, non-moisture stressed, cool season pasture uses in a given amount of time. Unless you happen to be growing cool season irrigated pasture, ET_o is of little use. To convert ET_o into useful data, it must be factored by a crop coefficient or K_c. Crop coefficients account for the difference in water use between your crop and area and CIMIS reported ET_o.

In these days of ever tightening water supplies, we often hear about irrigation scheduling as a "water conservation" method. However, irrigation scheduling is not about conserving water - it's about using water correctly. It's about making the irrigation water you purchase do as much for your crop as possible. It's about providing your crop with an environment that will allow it to yield to its fullest potential. And, it's about being a responsible steward of our State's water resources, by using water for a beneficial end use for which you can be proud. Anything less is truly a waste of water.

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