Irrigation Scheduling Using the Flags

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The Flags

In the early 1990's, I worked for the Shoshone-Bannock Tribes Land Use Department, under an EPA Pollution Prevention grant, as their Research Agronomist where we studied groundwater quality as affected by farmer's potato fertilizer inputs and their irrigation scheduling practices. We also had a cooperative study with University of Idaho Agronomist's and Agricultural Engineers. The fertilizer and irrigation data from both studies were combined with 24 fields in Fort Hall and another 21 fields in the Aberdeen and Blackfoot area. The results were published in various sources by the University of Idaho.

During this time, I noticed that a few Agricultural Engineers were working on an engineering project called the Soil Moisture Sentry (SMS) where soil moisture content was displayed visually. If soil moisture was low, say 75% available soil moisture (75% ASM), or less, then the SMS display would show red. If above 75% ASM then the display would show white. The SMS system gives a visual display all day long based on the set points for soil moisture content.

Thus, soil moisture above 75% ASM is visually displayed as white. And below 75% is red. If the SMS is white and irrigation is going, then a person should 'double' check their soil moisture content to determine if an irrigation is necessary at that moment. The SMS colors can be seen visually 600 yards away. The SMS system reads soil moisture content every 15 minutes and updates the visual color if above or below the set points for soil moisture content.

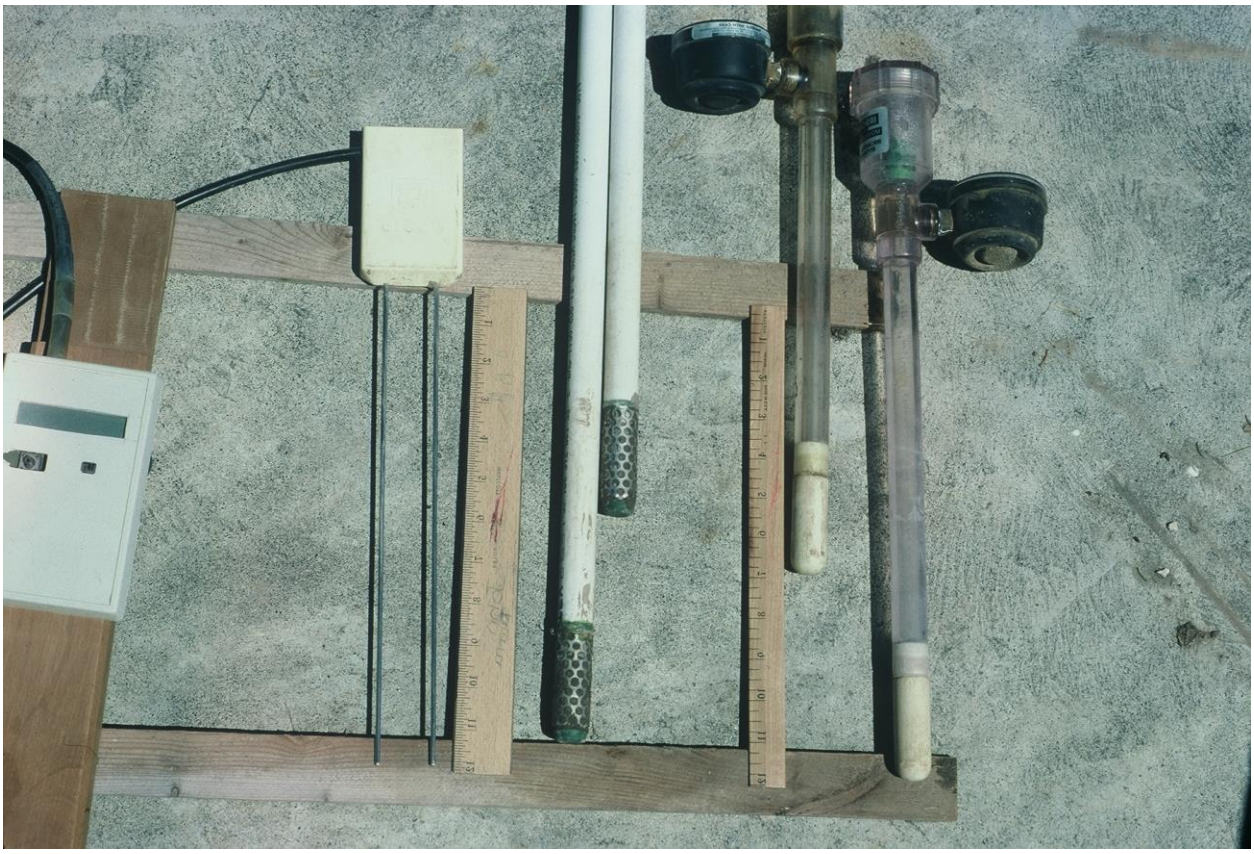
The SMS system is powered by solar panels and soil moisture content is read by Time Domain Reflectometry (TDR). TDR provides a simple but very accurate measure to soil water content. TDR has two parallel probes that are 10-12 inches in length. The parallel probes act as a wave guide to the applied signal that travels to the end of the rods and then reverses the direction of travel back to the reading display. The quicker the travel, the drier that the soil is. The slower the travel, then the soil has a higher soil moisture content. The measurement reflects the average soil water content over the length of the rods (see photo on page 3).

TDR measures soil water through volumetric soil water. This is the most accurate way to measure true soil water content, other than the neutron method. The nice thing about TDR is that it accounts for soil types, bulk density, and soil water content as shown in formula below:

$$P_V = P_W \times BD$$

Where **Pv** is the percent volumetric soil water content. **Pw** is the percent soil water content using the oven dry method (gravimetric analysis) of wet soil sample subtracting the weight of oven dried soil sample *(Wet weight of soil – Dry weight of soil)/(Dry weight of soil) x 100*. **BD** stands for bulk density of the soil. TDR measures all of these variables automatically.

In the early days, we compared TDR with Water Mark sensors and tensiometers. We compared all three methods with gravimetric soil water analysis. TDR was the best. The other two methods gave adequate results. But TDR averages soil water content across the entire length of the probes, 12-inches in this case. Whereas, water-marks and tensiometers covered most of the soil profile, but did leave around 4-6 inches not measured in a one-foot depth profile.



From our earlier research, we found that TDR probes are very accurate and reliable in giving soil moisture content. We decided to upgrade the idea of the SMS and make it a three phased soil moisture system where red is 75% ASM or less, blue is 76% to 90% ASM, and white is 91% ASM or higher. We changed the name from SMS to Flags.

The Flags and SMS systems were not designed to tell farmers when to irrigate; but were designed as a visual soil moisture monitoring system that compliments a farmers daily checking of his fields' soil moisture content. The Flags and SMS are a system that monitors soil moisture visually 24 hours a day, seven days per week.

White color indicates soil moisture content at 91% ASM or higher. The longer time period that the Flag remains white indicates a 'pretty' wet soil.

Blue colored Flags indicates soil moisture content between 76-90% ASM.

Red colored Flags indicates driers soils of 75% ASM or less.

A potato field with adequate moisture, but one red Flag shows that an irrigation event is near.

Irrigation event going with two red Flags and one blue Flag. A manager can adjust the hours needed for proper irrigation needs based on soil moisture content.

Solid set irrigation systems can be adjusted based on Flag colors and soil moisture content when the farmer digs in his field. Obviously, if all three Flags turn white after only 4 hours of irrigation, then that could be an indicator that less water is needed at that time. If all three Flags are white and the center irrigation pivot is approaching the Flags, then the farmer may want to check his soil moisture again to assure that he is not about to over-water.

The 'set points' for the Flags are set by either the farmer, farm manager, or consultant. Set points are derived through soil moisture digging using the 'feel' method, or can be done by having a tensiometer in the field near the Flags as an indicator of soil moisture status. From this, the set points for red, blue, and white are derived. Once set, the Flags will monitor soil moisture status and update its 'colors' based on soil moisture content and the set points placed.

What good is this? Real simple. Farmers check their soil moisture once or twice a day. The Flag system can provide the soil moisture status throughout the working day when not being checked by the farmer, farm manager, or crop consultant. When a farmer drives by his field, he can quickly look and immediately see the status of the field's soil color. This gives a quick, warning status of soil moisture content throughout the day and indicate if irrigations systems should be on or off. Basically, it is a quick double-check system throughout the day.

A linear irrigation system where 3 Flags in front are red. This could indicated too dry, or ASM at 75% or less. This is a visual monitoring system showing soil moisture status as the irrigation system approaches the Flags.

Unfortunately, the SMS and Flags died a slow death by year 2004. There were several reasons for this. First, it was the 1990's and we were ahead of ourselves for that time period. Second, all people involved had other jobs, obligations, and research projects. Third, this project was mostly 'self' funded by those involved. The project just didn't grow fast enough to energize investments into the SMS or Flag systems. Fourth, with time, and time does go by fast, we aged and other projects had top priority. Priority on top of priority.

Is this someone else's future project? This was not my original idea, but definitely a good one by others. Nothing was patented, so why not? Fortunately, we were able to receive grant monies to research the SMS or Flag system and this data was published in a 'peer' reviewed journal. I have placed the publication on this website under the **Flag Manuscript**.

Hopefully, in the near future, some young engineers and agronomists can see the value of the SMS or Flags, perfect it, and move it forward. There are many crops where the Flag system could fit well, such as hops, orchards, vineyards, sugar beets, grains, and potatoes.

(PS. If this writing looks about 8th grade level, it probably is. I wrote it and did not have an editor look at it. Rule #1 in writing—hire an editor).