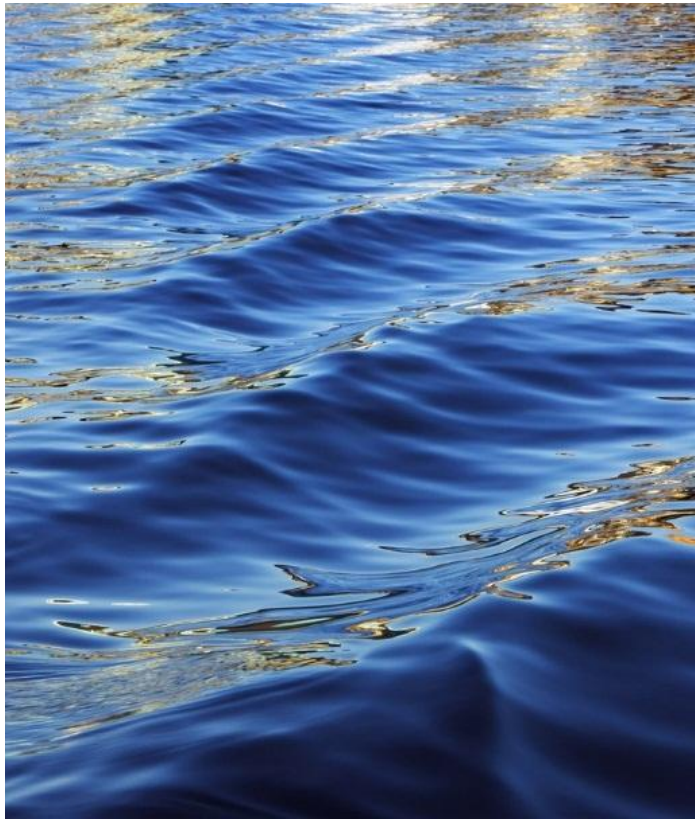
Soil moisture readings - What they mean and how to interpret them to make irrigation decisions

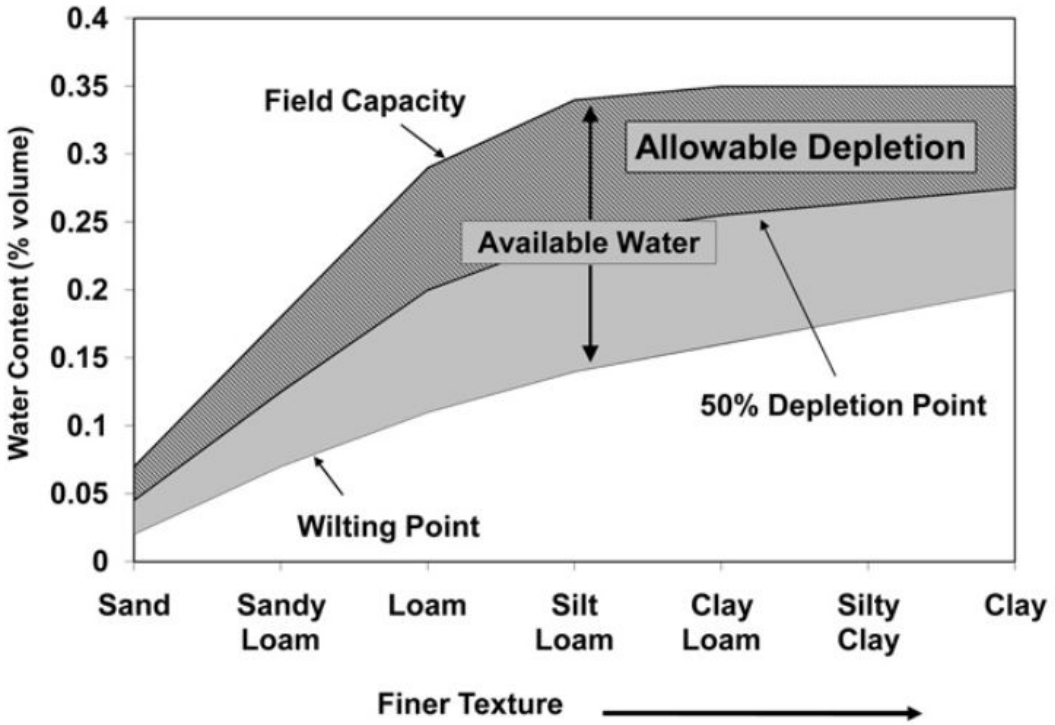
Managing soil moisture to achieve high crop yield.



- Manuel Díaz González, Civil/Agricultural Engineer, Amherst, MA

Topics to be covered

Plant available water is depending on soil texture and root depth.

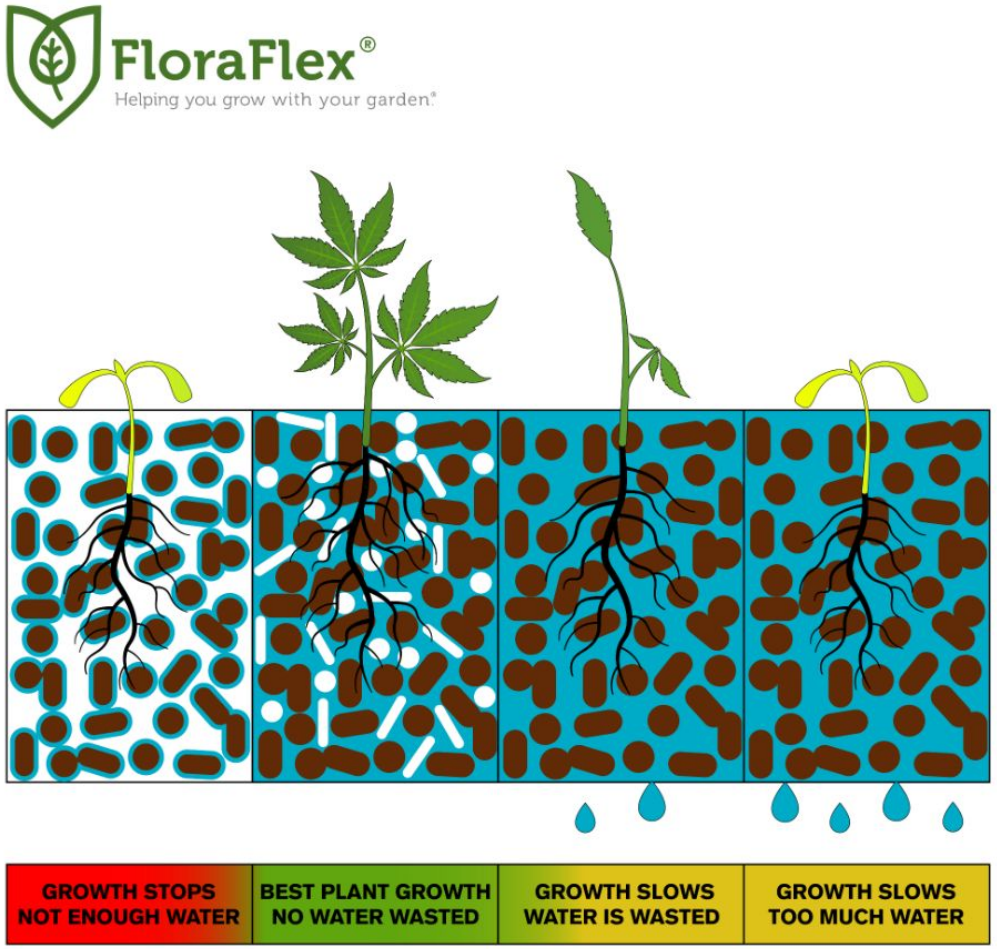


Orchard Irrigation: Soil Water Content
Https://intermountainfruit.org/orchard-irrigation/swc

Soil moisture monitoring and automation

- Plant Available Water
- Soil-Water-Plant Dynamics
- Soil Moisture Measurements
- Common Soil Moisture Monitoring Systems
- Relationship Between Soil Moisture Monitoring and Irrigation System Automation

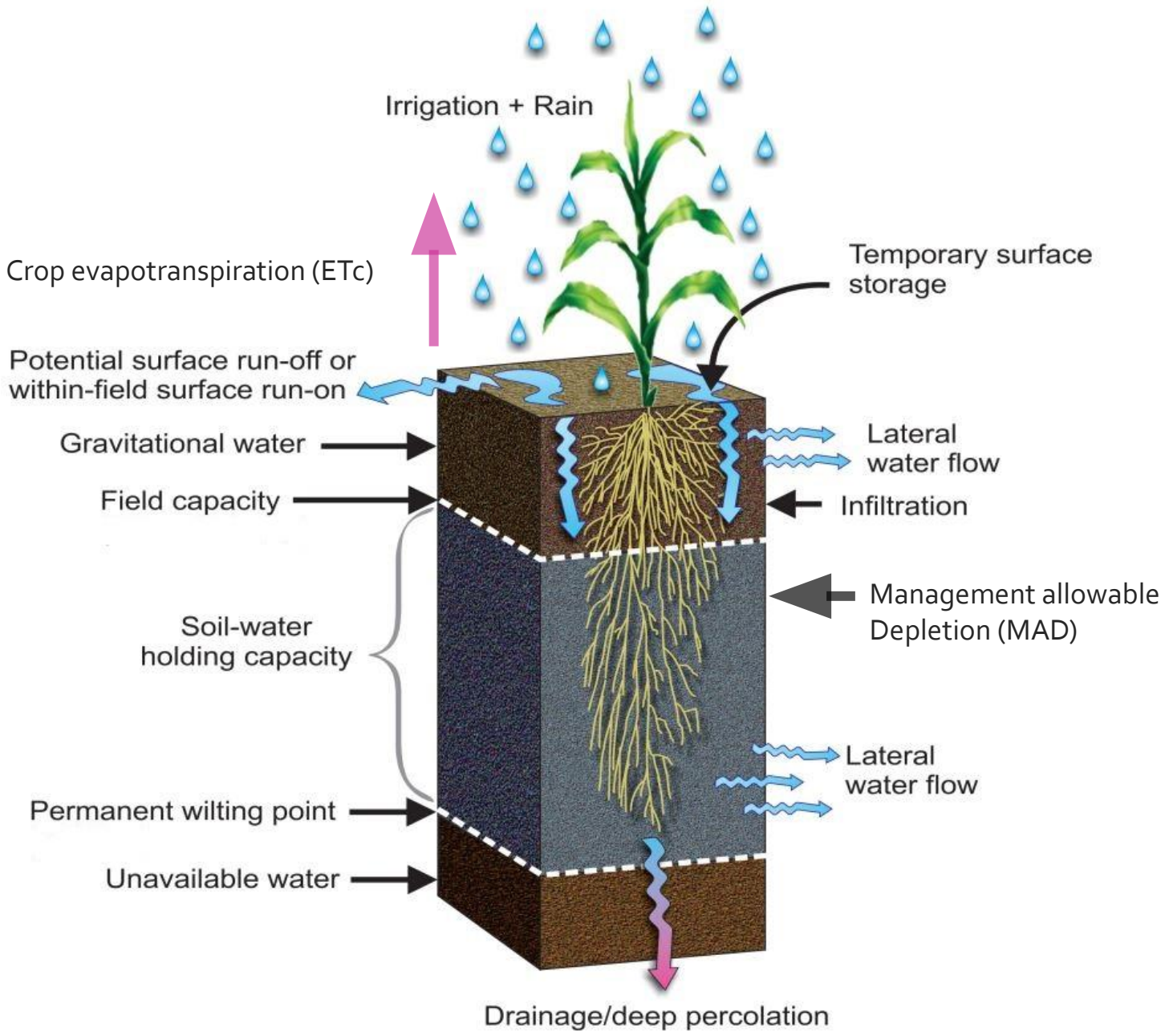
Plant Available Water



Plant Available Water: Determining Field Capacity and Wilting Point
https://floraflex.com/CAD/blog/post/plant-available-water-determining-field-capacity-and-wilting-point

The practical goal of IWM is to keep an adequate balance between water and void spaces (air) in the soil.

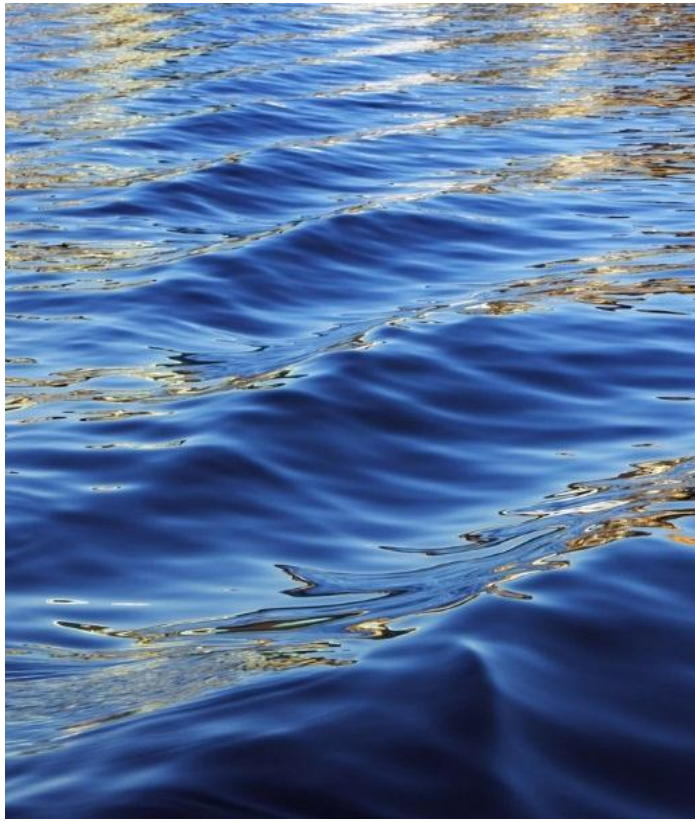
Soil Water Dynamics



The goal of any irrigation system is to deliver water to the root zone while minimizing losses.

Management Allowable Depletion (MAD)

- MAD is the level to which the irrigator will allow the soil moisture to be depleted before irrigating
- MAD is viewed as irrigation "set point"
- MAD depends on crop stage of growth
  - Flowering is more water sensitive than the vegetative stage.
- KEY: MAD sets irrigation timing and amount



Soil Moisture *versus* Tension Relationship

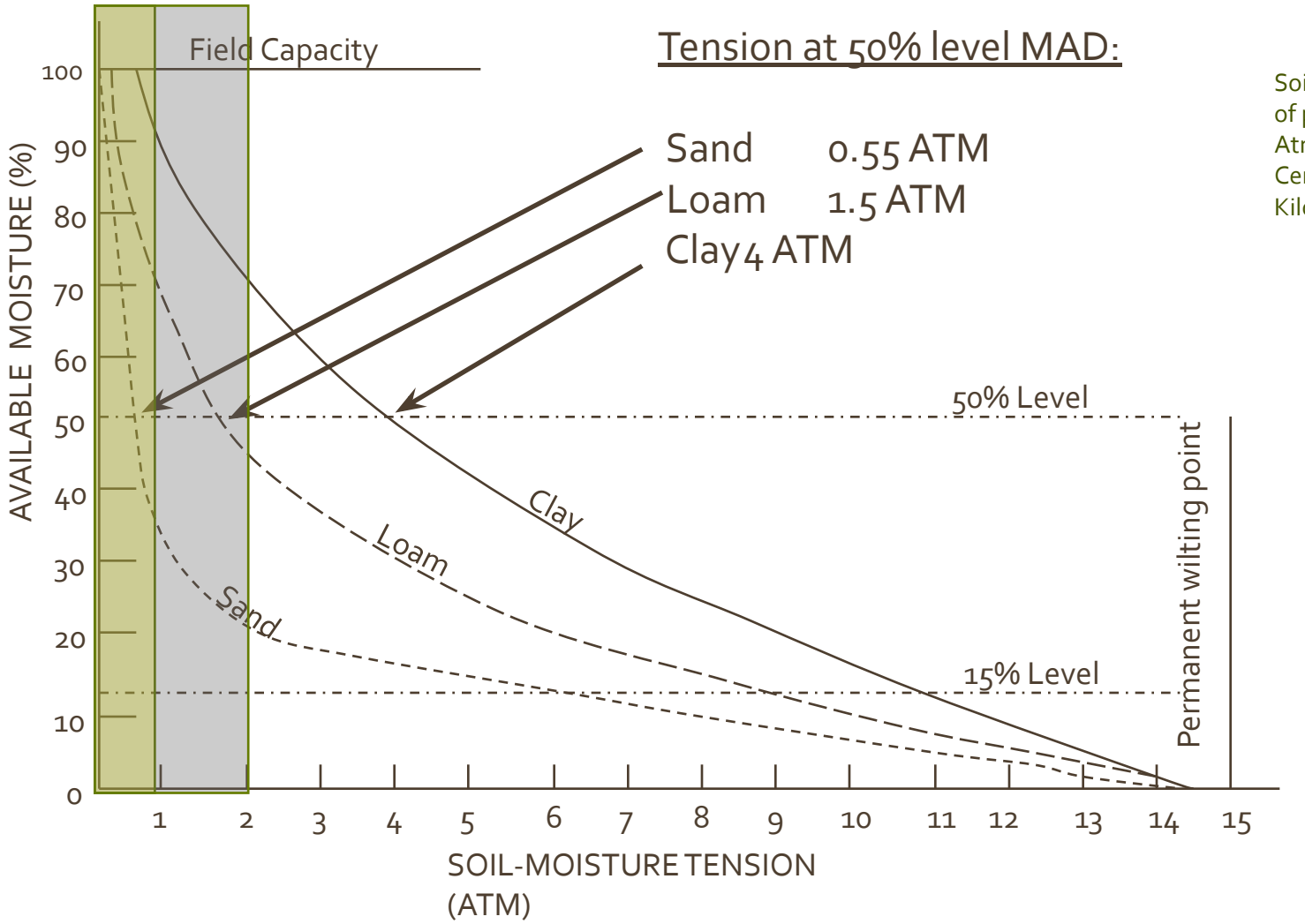
Comparing Sand, Loam and Lay Soils:
Sandy soils:

- Lowest plant available water capacity
- Create the lowest tension as the dry
- Lowest MAD
- Need irrigation periods in shorter intervals.

Clay soils:

- Highest plant available water capacity
- Create the highest tension as they dry
- Highest MAD,
- Need irrigation less often.

*** Irrigation water needs is independent of soil texture and dependent on crop characteristics and environmental conditions. Sandy soils and clay soils need the similar amount of irrigation water for similar crops and environments, but that water is applied in different schedules.



Soil tension has measuring units of pressure:
Atmosphere (ATM)
Centibars (cb)
Kilopascals (kPa)

Plant available soil moisture and measurable soil tension varies greatly according to soil texture.

Field Capacity, Wilting Point, and MAD

Soil Texture	Field Capacity (%)	Wilting Point (%)	Moisture content at 50% MAD
Coarse Sand	10	5	7.5
Sand	15	7	11
Loamy Sand	18	7	12.5
Sandy Loam	20	8	14
Loam	25	10	17.5
Silt Loam	30	12	21
Silt Clay Loam	38	22	30
Clay Loam	40	25	32.5
Silt Clay	40	27	33.5
Clay	40	28	34

Example: Loam Soil – What would you do if soil moisture content is:

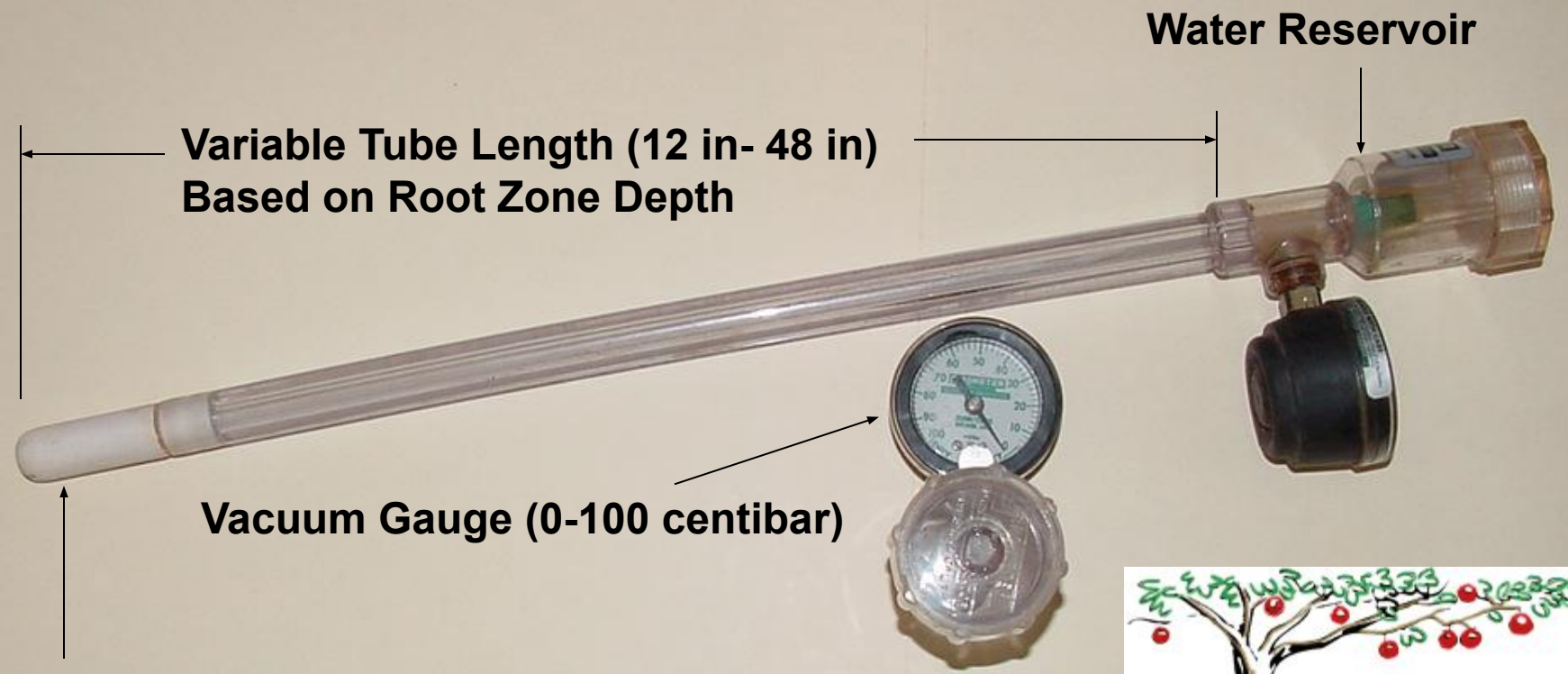
22%? Nothing

18%? Irrigate

13%? I messed up!

SENSOR BASED AGRICULTURE

Tensiometer



- Measure soil moisture potential (tension)
- Practical operating range is about 0 to 0.75 bar of tension (this can be a limitation on medium- and fine-textured soils)

Soil Moisture Measurement

- Most sensors are reasonably accurate for field use
- #1 problem with poor reading is installation
- Other important factors are:
  - Sensor type and selection
  - Monitoring site(s) selection and depths
  - Sensor and access tube installation
  - Soil profile placement (orientation)
  - Data recording and retrieval (manual, edge of field, online)
  - Calibration and maintenance
  - Cost
  - See CPS 434

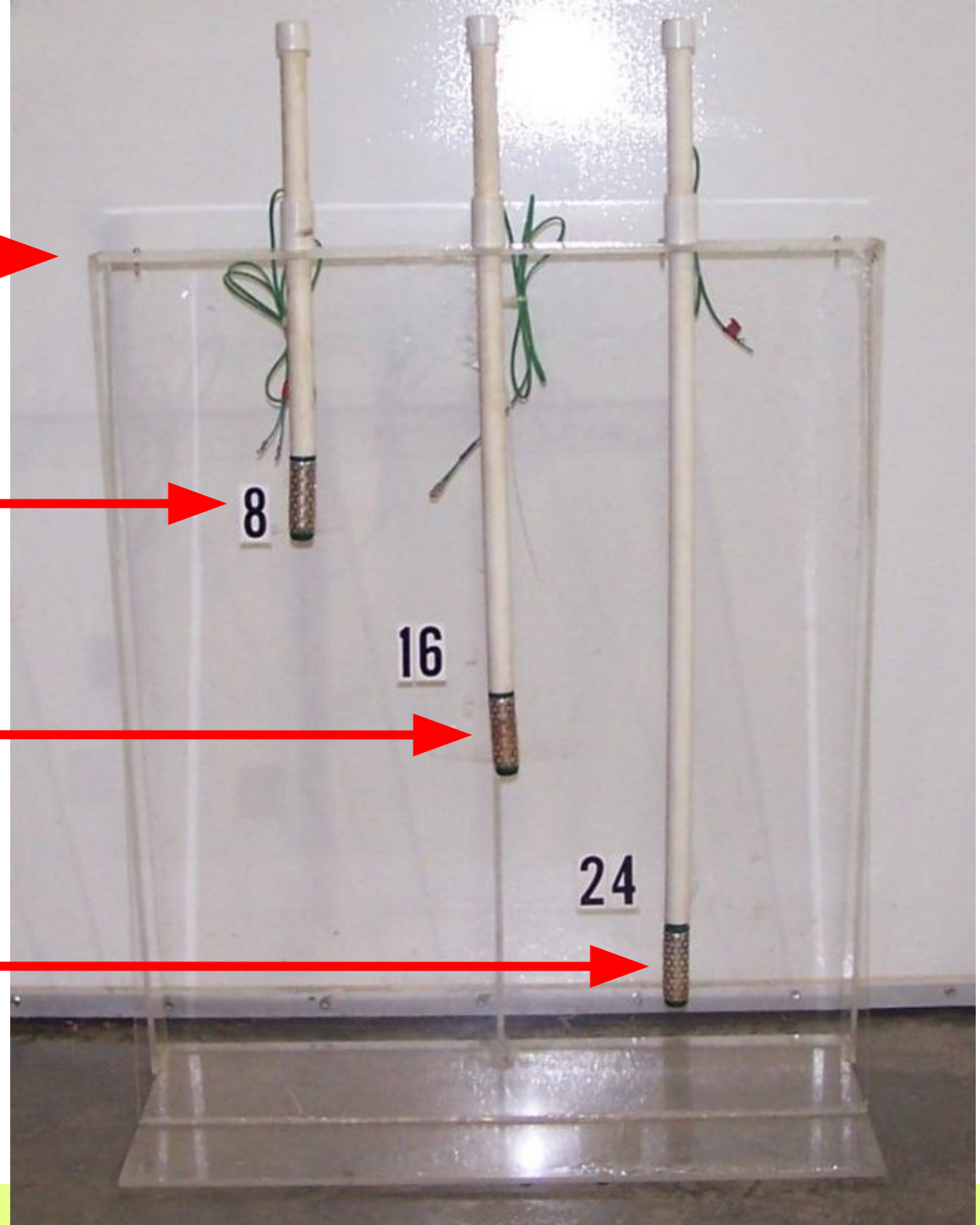
Soil moisture monitoring and irrigation automation: The most common tool, tensiometer.

Watermark Soil Moisture Sensor

Granular Matrix Sensor,
Also called Watermark gypsum block

- Electronically reads the amount of moisture absorbed through a unique mix of precisely composed materials, or granular matrix.
- Easy to install.
- Reliable
- It measures soil/water tension, not direct soil moisture.

Sensor Profile Placement



Take readings and make data entry

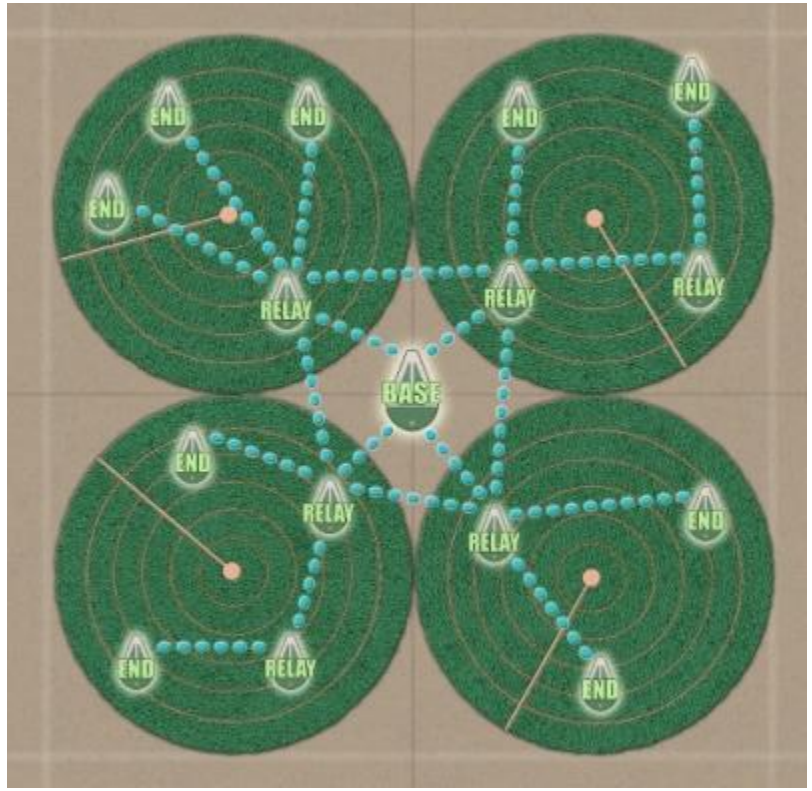
Wireless transmitter

Three sensors

Watermark soil moisture sensor

Centibars (kPa)	Indication	Soil Texture
0 - 10	Saturated	
10 - 15	Adequate Water	Sand, Sandy Loam
15 - 20	Adequate Water	Loams, Silt, Clay
20 - 30	Irrigation Range	Sand, Sandy Loam
30 - 50	Irrigation Range	Silt Loam, Silt
50 - 60	Irrigation Range	Loamy Clay, Clay
80 - 200	Excessively Dry	

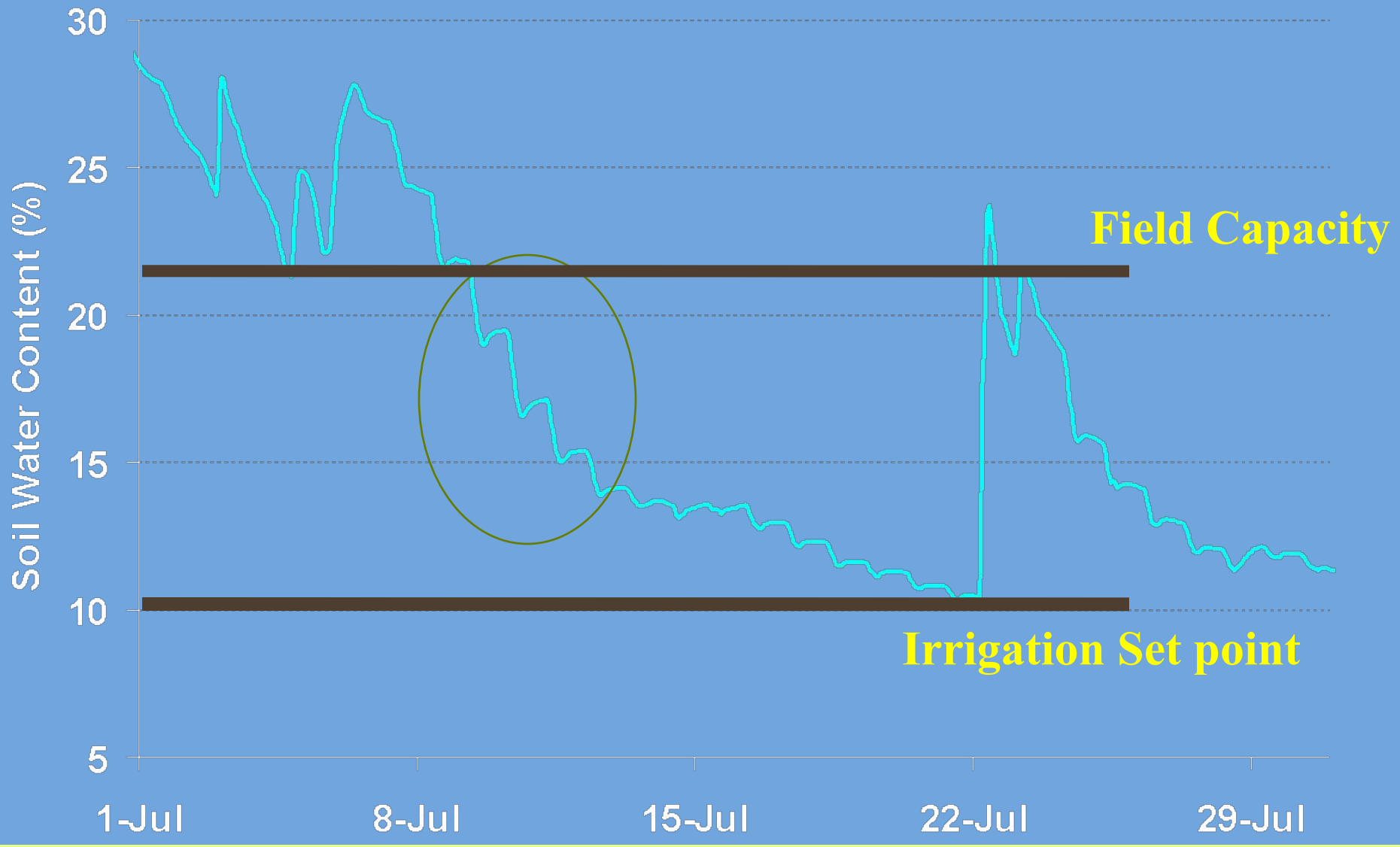
Where to install soil moisture sensors?



- Install at representative locations taking into consideration:
  - Crop type and diversity
  - Soil texture
  - Field or farm size
  - Accessibility to manual readings
  - Accessibility to automated readings

Locating the soil moisture sensors is a game between field/farm size, diversity of soil textures across fields and crop types.

Continuous Soil moisture Content Measurement
(wireless capable & internet deployable)



Soil moisture monitoring and irrigation automation: Field Crops

Toro Tempus Ag

Cell phone enabled, 1 mile radius. Wi-Fi, Bluetooth, Radio

- Combine measured environmental factors (tensiometer, thermometer, anemometer, humidity sensor & pluviometer) with irrigation system hardware (flow meter and pressure transducers) to implement a predetermined irrigation scheduling by manipulating pump controls and solenoid valves.
- Probably work best for farmers who want hands off irrigation scheduling.

Web deployed. Cloud storage.

Take Home Messages

Rely on measurements of soil moisture to schedule irrigation events.

Embrace the technology, try a sensor.

If you already have a handheld meter:

Stop chasing sensors in the field. GO wireless with online deployment.

Practice tactical (real-time) scheduling for greater management control and flexibility.

Questions?