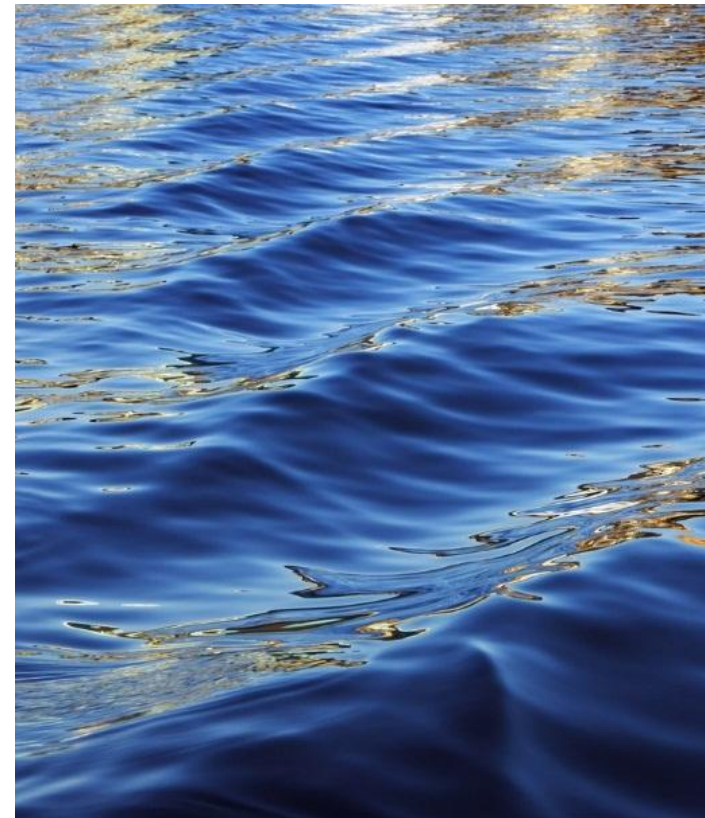




Adequate Soil Moisture Content, Money in the Bank

Managing soil moisture to achieve high crop yield.

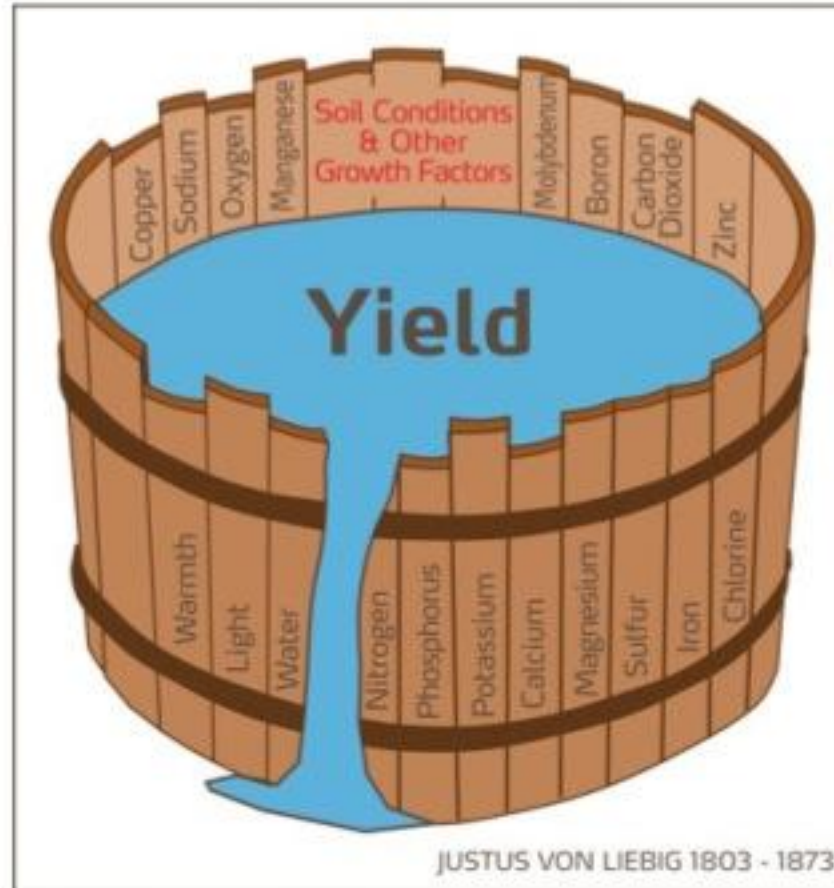


- Manuel Díaz González, Civil/Agricultural Engineer, Amherst, MA

Why should I care about soil moisture? Because Liebig's Law of Minimum

**Justus von Liebig's
"Law of the Minimum"
published in 1873**

"If one growth factor/nutrient is deficient, plant growth is limited, even if all other vital factors/nutrients are adequate...plant growth is improved by increasing the supply of the deficient factor/nutrient"



I visit about 100 farms per year, and most often the limited growth factor I see is:

Water!

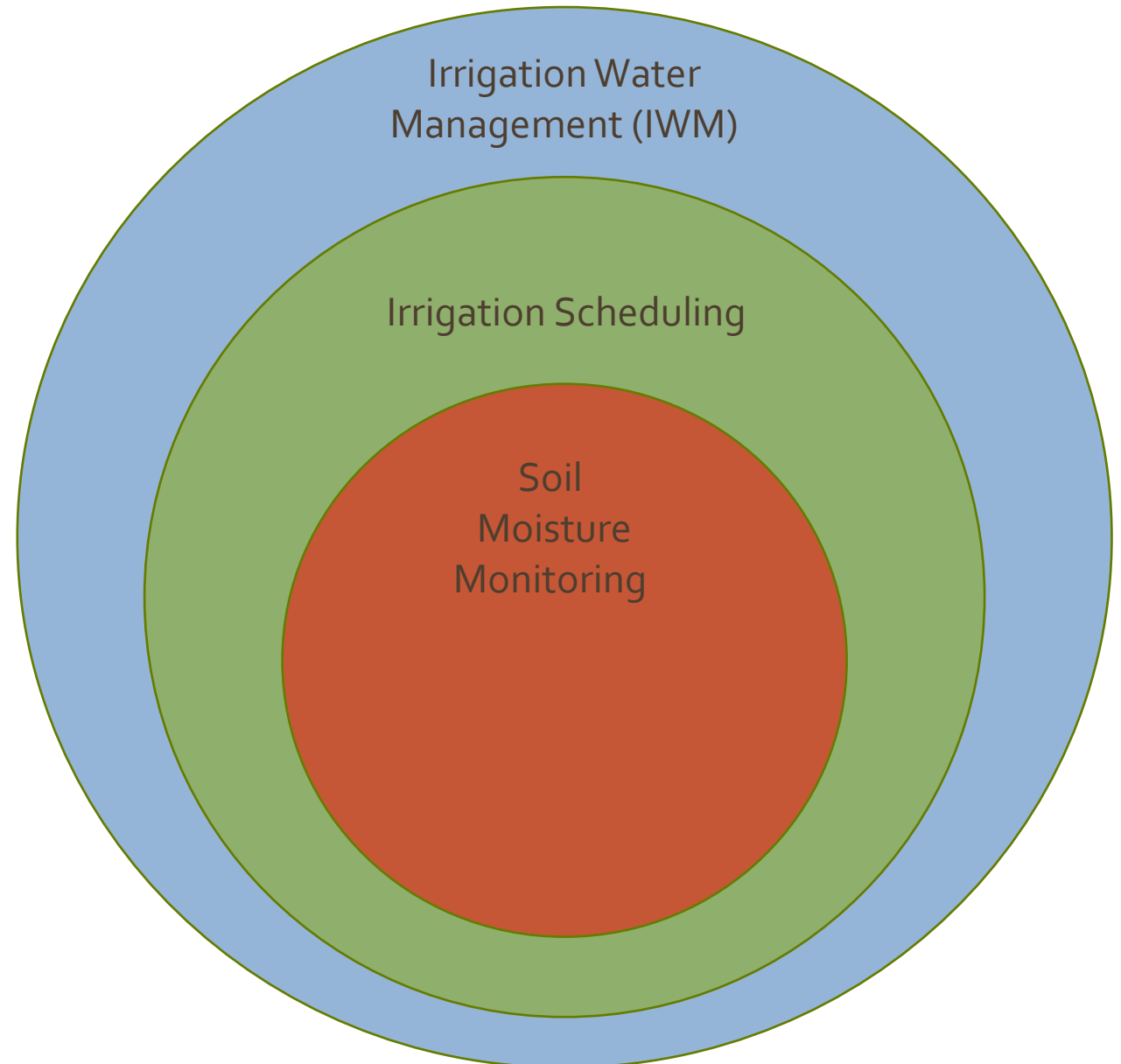
Even on farms that have adequate water availability and infrastructure to effectively irrigate.

The greater scheme.

Irrigation Water Management (IWM): is the process of determining and controlling the volume, frequency, and application rate of irrigation water.

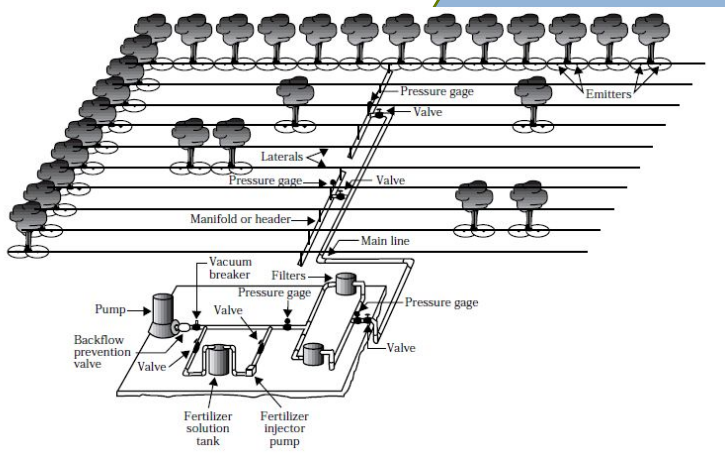
Irrigation scheduling: is determining and implementing how much water to apply and when to apply it.

Soil moisture monitoring: is the process of directly or indirectly measuring soil water content and using this information in the irrigation scheduling regime and in the greater irrigation water management plan.



Irrigation System

Soil-Plant-Water Relationships



IWM



Monitor Moisture



Adobe Acrobat Document



Adobe Acrobat Document

System factor that affect the IWM plan: The application system and its efficiency.

**Microirrigation; tape, tubing, micro
sprinkler: 90% efficient**



How Do Irrigation Systems Work? - DripWorks
dripworks.com

**Solid Set Irrigation with impact
sprinklers: 65% efficient**



Sprinkler Irrigation System – Types, Uses & Advantages Sprinkler
civilmint.com

System factor that affect the IWM plan: Application uniformity.



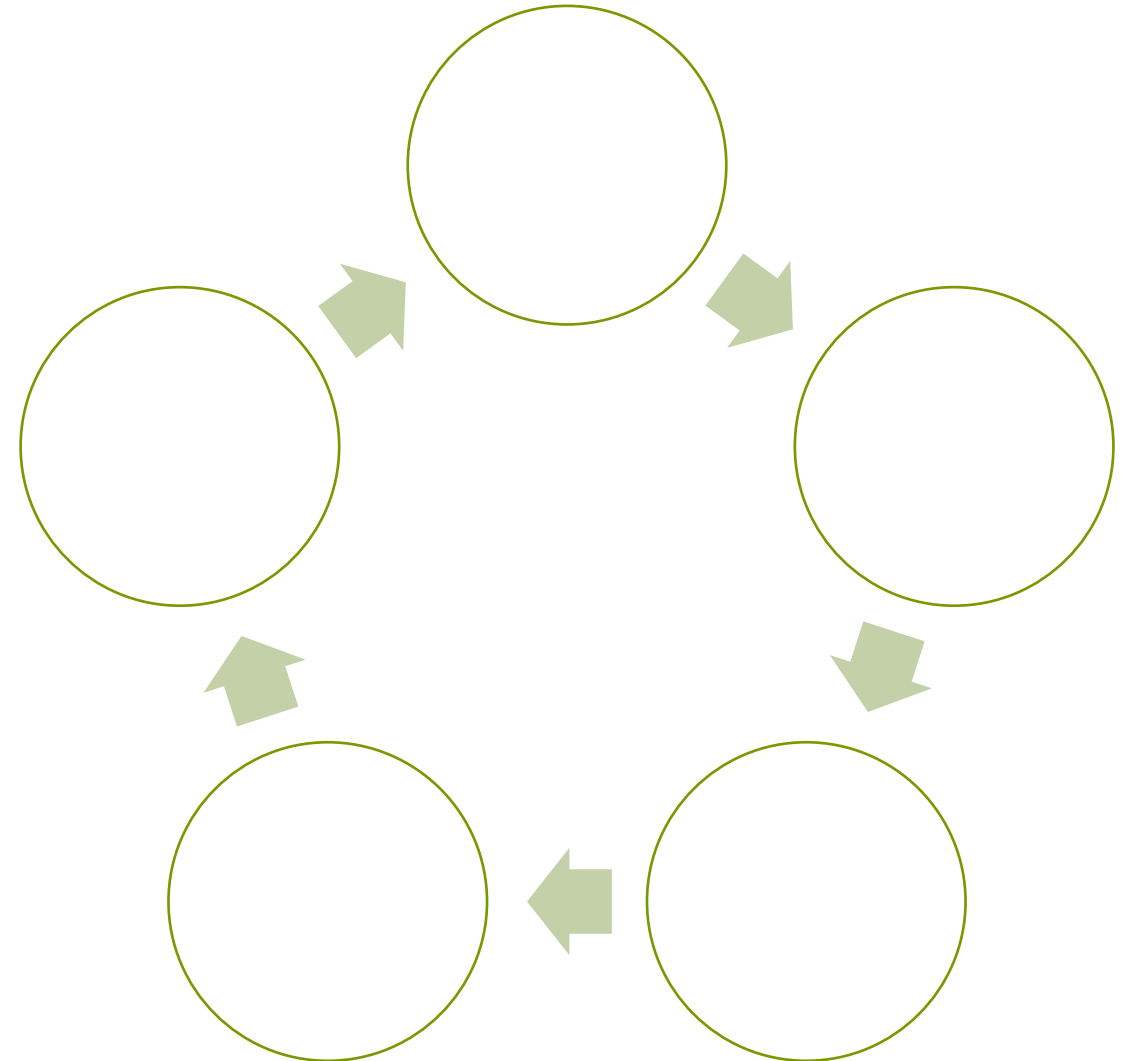
Low application uniformity resulting in dry spots and “doughnut” shaped wet pattern on highly efficient MegaNet rotator system.

Uneven growth on drip irrigation affecting plant productivity and health.



Soil moisture monitoring and soil moisture-based irrigation schedule.

1. **Soil Texture & Management Depth**
Needed to know maximum available soil moisture and soil field capacity.
2. **Set Soil Moisture Maximum Allowable Depletion**
Typically, 50% of the maximum available soil moisture.
3. **Monitor Soil Moisture Changes**
Depletion due to evapotranspiration and gains due to precipitation and irrigation.
4. **Start Irrigating as Soil Moisture Approaches MAD**
Irrigate before the plant begin stress.
5. **Stop Irrigating as Soil Moisture Approaches Field Capacity**
Stop before wasting water.



What is soil moisture to begin with?

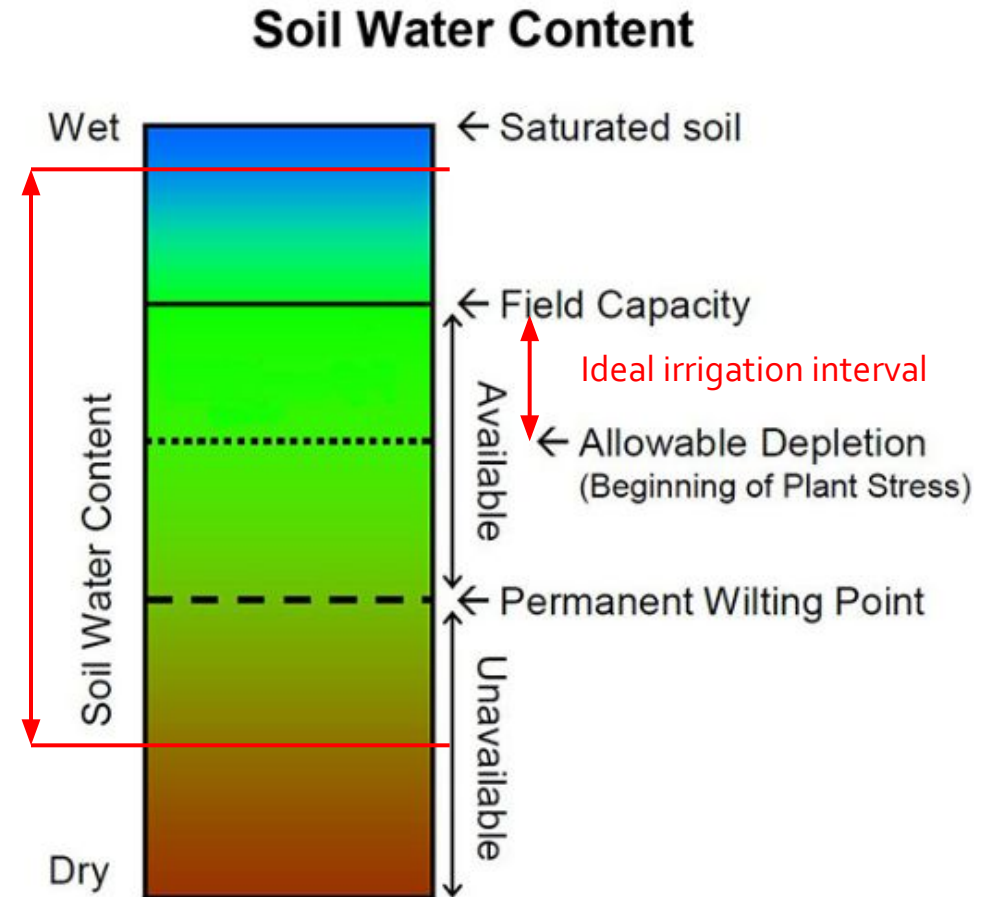
Is the amount of soil water that will produce the desired crop response.

- Most often, adequate soil moisture is related to available soil moisture.
- Available soil moisture is strictly dependent on:

1. Soil texture
2. Soil water management depth

Soils hold a lot of water, but most of it is unavailable.

What I most often see for irrigation interval.



Orchard Irrigation: Soil Water Content
<https://intermountainfruit.org/orchard-irrigation/swc>

What do you mean by: Soil Texture and Soil Water Management Depth?

Soil texture

- Fine sand
- Sand
- Loamy sand
- Sandy loam
- Loam
- Silt
- Silt loam
- Silty clay loam
- Clay loam
- Sandy clay loam

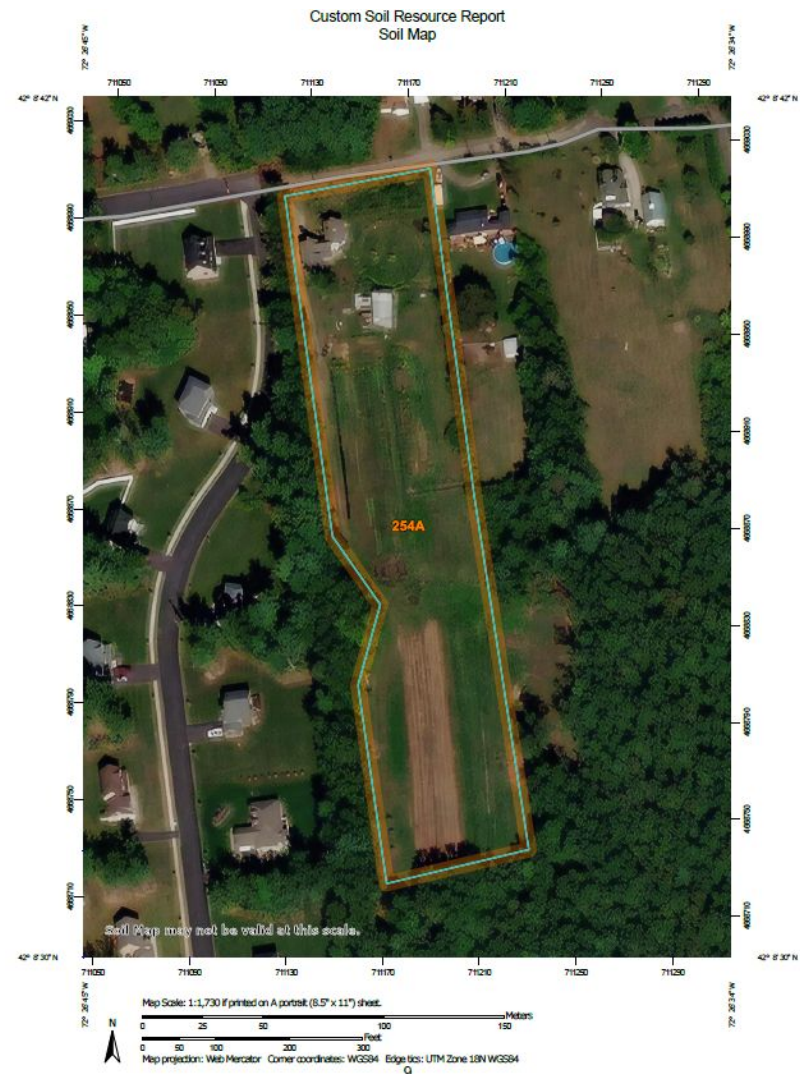
Soil water management depth

- Root depth
- The depth to a restrictive soil feature such as:
 - Hard pan
 - Plow pan
 - Glacial till
 - Clay
- How to I know my soil texture and depth to restrictive feature:
 - Web Soil Survey
 - Site evaluation with a soil scientist

How to get the soils information I need from the Web Soil Survey?

<https://websoilsurvey.sc.egov.usda.gov/>

- Soil Data Explorer
 - Soil Reports
 - Soil Physical Properties
 - Physical Soil Properties
 - Typical profile
 - Sand, silt, loam, clay
- Properties and qualities
 - Depth to restrictive feature
 - Drainage class
 - Ksat of the most limiting layer
 - Depth to water table



What a restrictive feature looks like?



Picture by:
Joseph Ayotte
Supervisory Hydrologist
USGS New England Water Science Center
Pembroke, NH

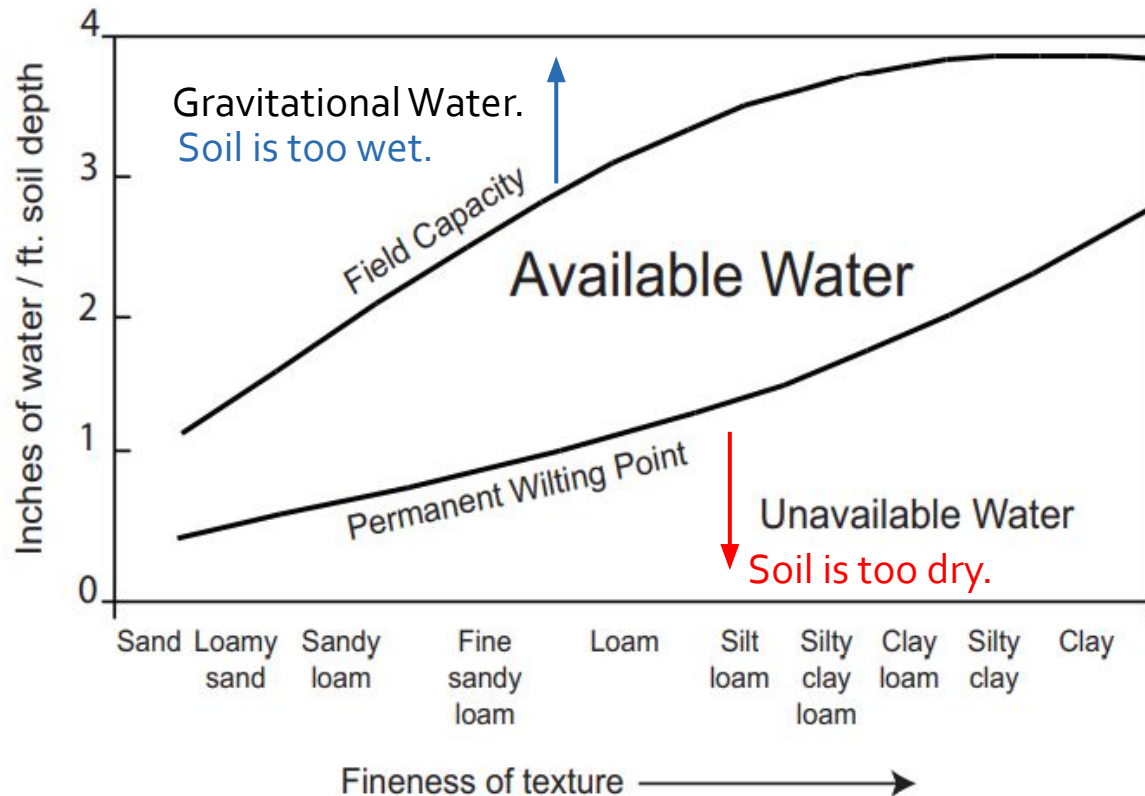
How much water does my soil can hold? Of that, how much is available to plants? Then, how much is readily available?

Approximate maximum soil water content, soil plant available water and plant readily available water per soil texture.

Soil Texture	Soil Water Content (inch/foot)	Plant Available (inch/foot)	Readily Available (inch/foot)
Sands/ fine sands	1	0.75	0.37
Loamy sand	1.25	1.0	0.5
Sandy loam	2.0	1.5	0.75
Loam	3.0	2.0	1.0
Silt loam, silt	3.75	2.0	1.0
Silty clay loam	4.0	2.0	1.0
Sandy clay loam	4.0	2.0	1.0

I don't get it. Can you explain it a different way?

Available soil moisture changes with texture.

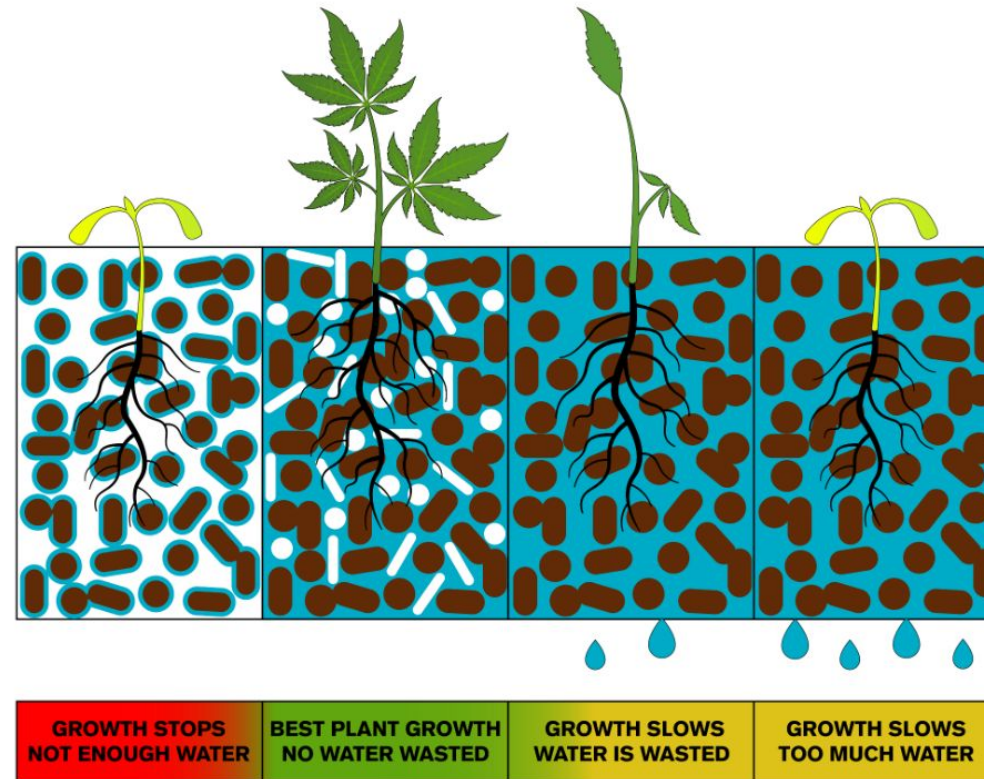


Soil moisture and management depth affects how you irrigate.

Same crops under similar growth stage and climate, but planted on different soil texture require the same amount of water, but this water is applied on a different schedule:

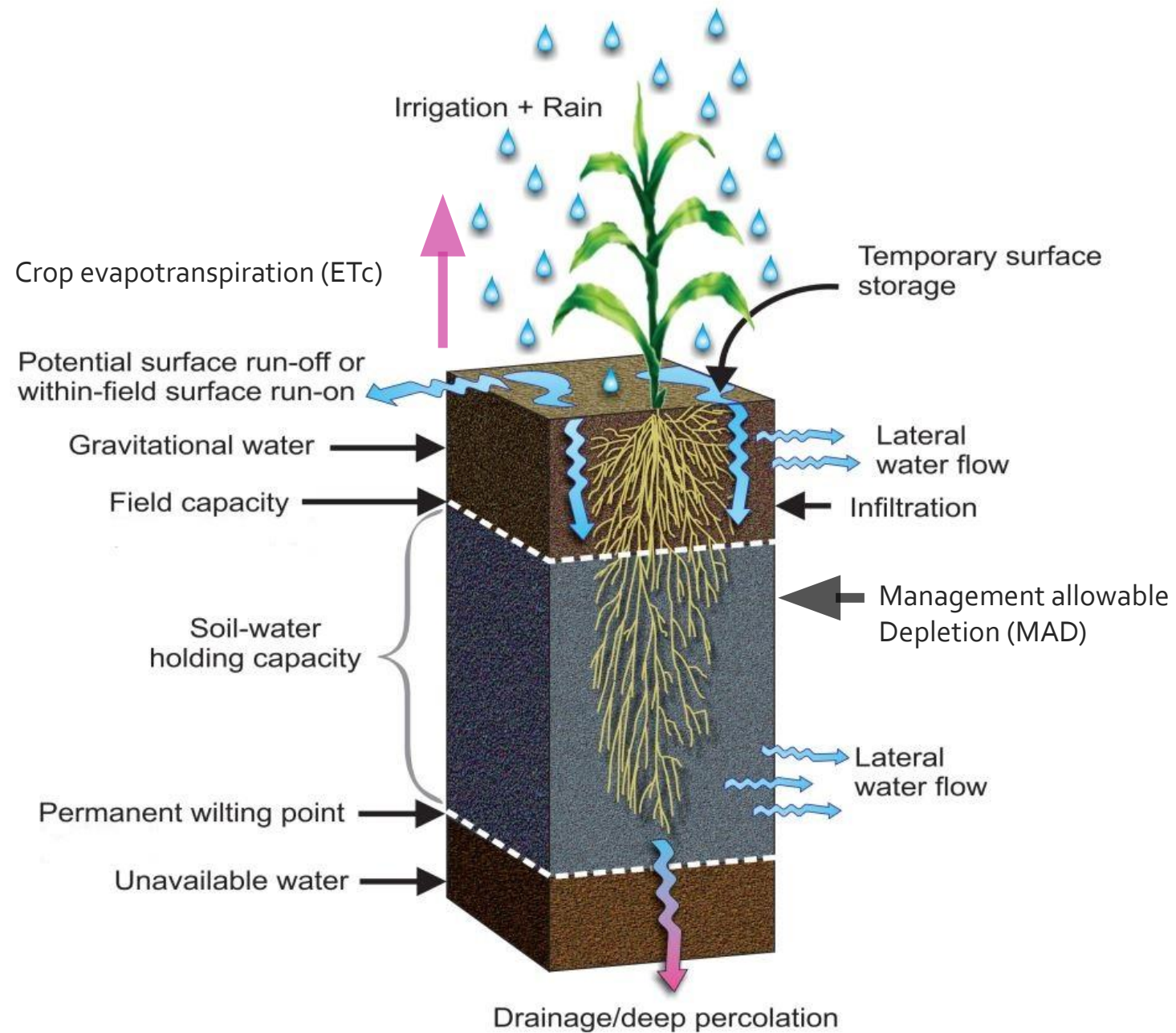
- Sandy soils use small irrigation events, applied more often.
- Silty, clay and loam soils use larger application events, less often.

Plant Available Water



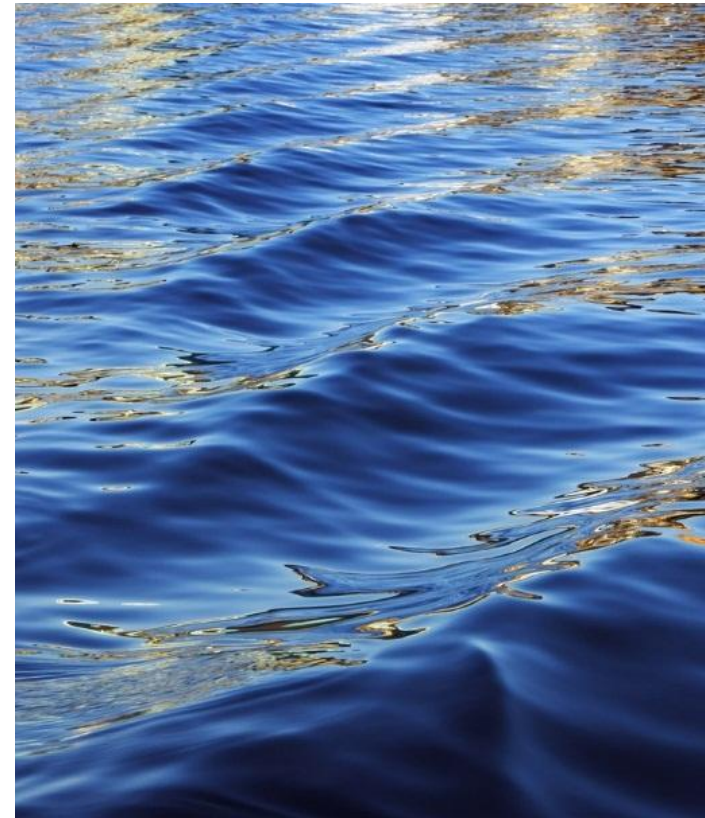
Plant Available Water: Determining Field Capacity and Wilting Point
<https://floraflex.com/CAD/blog/post/plant-available-water-determining-field-capacity-and-wilting-point>

Soil Water Dynamics



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

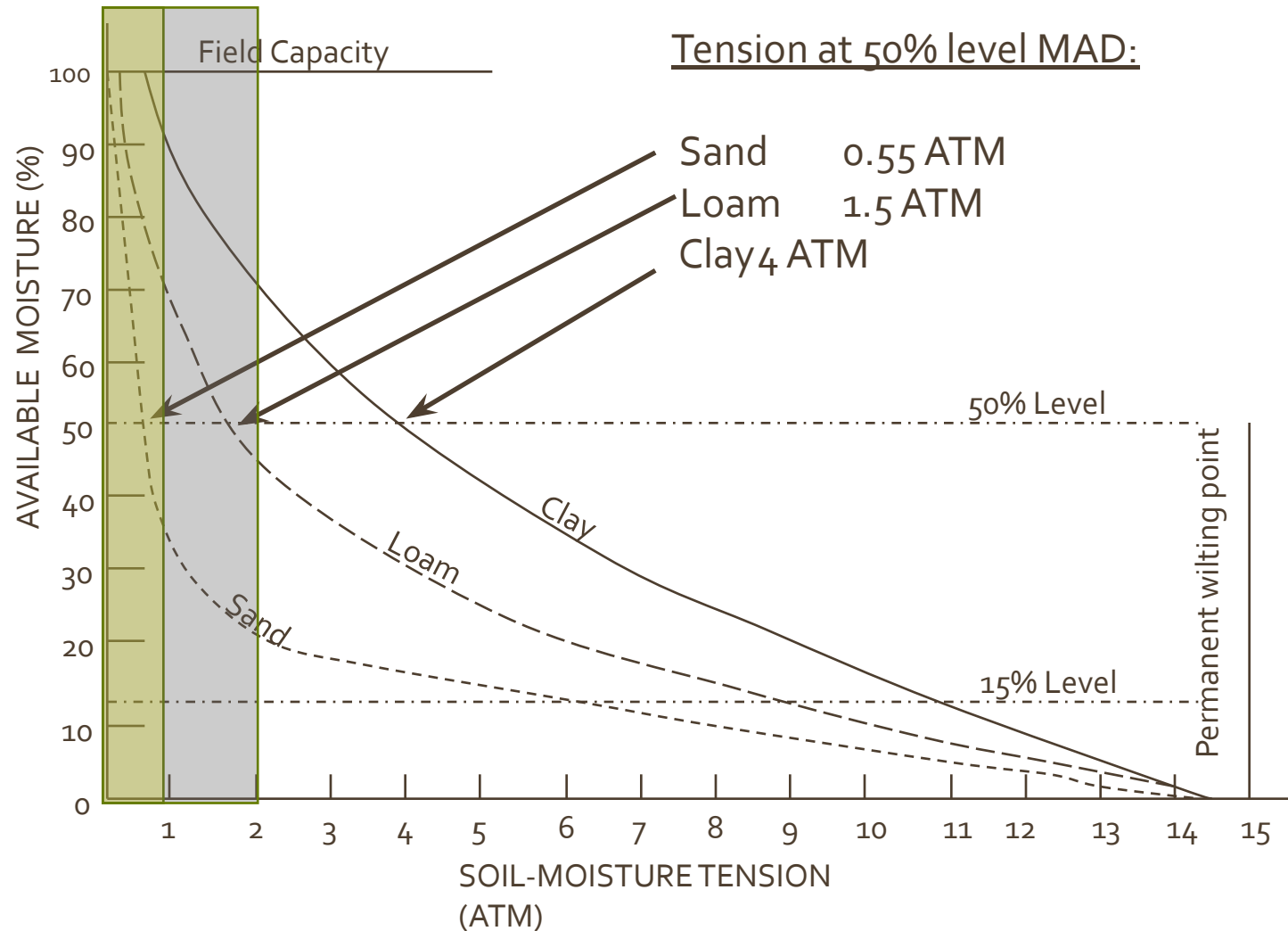
Comparing Sand, Loam and Clay Soils:

Sandy soils:

- Lowest plant available water capacity
- Create the lowest tension as they 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.



Soil tension has measuring units of pressure:

Atmosphere (ATM)

Centibars (cb)

Kilopascals (kPa)

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

Direct soil moisture measuring often have units of:
Percentage (%)
Volumetric (in³/in³)
Volumetric (in/in or in/ft)

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

22%? Nothing

18%? Irrigate

13%? I messed up!

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?