YOUR IRRIGATION AND SOIL HEALTH PRACTICES

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(USDA-NRCS)

- SOIL HEALTH- WHAT IS IT, AND WHY SHOULD I CARE?
- BENEFITS OF IRRIGATION WATER MANAGEMENT
- CO-MANAGING NITROGEN AND WATER
- IRRIGATION WATER MANAGEMENT TECHNOLOGY AND TECHNIQUES
- CHALLENGES AND ASSISTANCE AVAILABLE

WHAT IS SOIL HEALTH?

…THE CONTINUED CAPACITY OF SOIL TO FUNCTION AS A VITAL LIVING ECOSYSTEM THAT SUSTAINS PLANTS, ANIMALS, AND HUMANS.

Organic Matter Added To Soil

Primary Effects

OM as food source for soil fauna increases microbial diversity and activity

If as mulch – protect soil from solar energy and rain drops

Coarse OM loosens soil, provides macropores & channels

Secondary Effects

Enhanced microbial functions such as N fixation, decomposition

Production of humic substances

Production of polysaccharides and other nonhumic compounds

Subsequent Effects

Increased

- Buffering capacity
- Water holding capacity
- Available water
- Pests/disease resiliency
- Aggregate stability
- Macro porosity
- Mineralization
- Water infiltration
- Retention of nutrient
- pH stability
- Soil aeration

Reduced

- Surface runoff
- Soil erosion
- Al toxicity (acid soils)

Slide by Karen Lowell

Environmental Benefits

- Less irrigation water and fertilizer needed
- Less flooding
- More even stream flows
- Reduced pesticide use
- Groundwater recharge
- Improved water quality
- Better plant production
- C sequestration

From Weil and Brady *The Nature and Properties of Soils*

USDA NRCS
U.S. Department of Agriculture
Natural Resources Conservation Service

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PHYSICAL PROPERTIES OF SOIL THAT AFFECT WATER AND NUTRIENT MANAGEMENT

- WATER HOLDING CAPACITY
  - SOIL TEXTURE
  - SOIL ORGANIC MATTER
- INFILTRATION
  - SOIL STRUCTURE
- COMPACTION
- CATION EXCHANGE CAPACITY

MANAGEMENT PRINCIPLES FOR SOIL HEALTH

Disturb the soil less:

Reduced tillage

Feed the soil food web:

Add organic matter and keep living roots in the soil

Cover the soil more:

Grow vegetation and leave mulch on the surface

Diversify the system:

Add different kinds of plants to the system in open times or spaces

PRACTICES THAT BUILD SOIL HEALTH

- REDUCED TILLAGE
- RESIDUE MANAGEMENT
- COVER CROPS
- COMPOST (OR OTHER ORGANIC MATTER) ADDITION

HEALTHY SOIL HAS PROPERTIES THAT ENHANCE WATER AND NUTRIENT AVAILABILITY TO YOUR CROPS

BUT YOU STILL HAVE TO MANAGE WATER AND NITROGEN CAREFULLY

Q. WHY DO WE HAVE TO CO-MANAGE NITROGEN AND WATER?

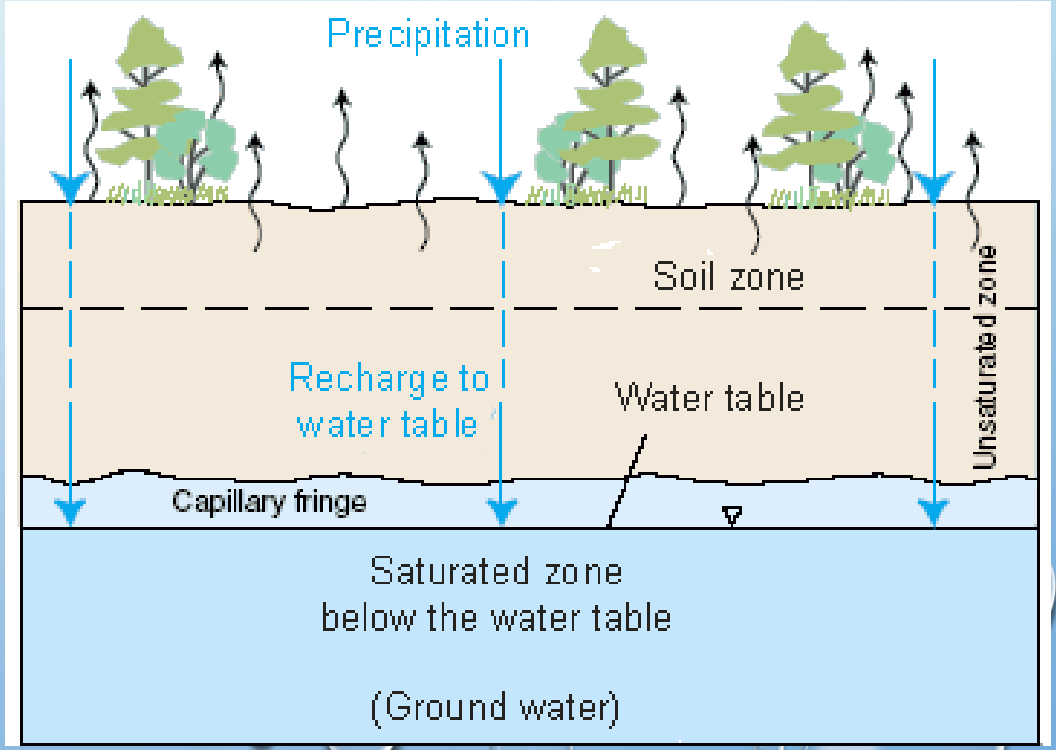
Q. WHY DO WE HAVE TO CO-MANAGE NITROGEN AND WATER?

A. TO PREVENT NITRATE LEACHING.

WHY IS N LEACHING AN ISSUE?

- Nitrate in drinking water causes “blue baby syndrome” (methemoglobinemia)

- Agriculture uses a lot of N fertilizer
- Nitrate moves through soil in water
- Agricultural nitrates end up in drinking water wells



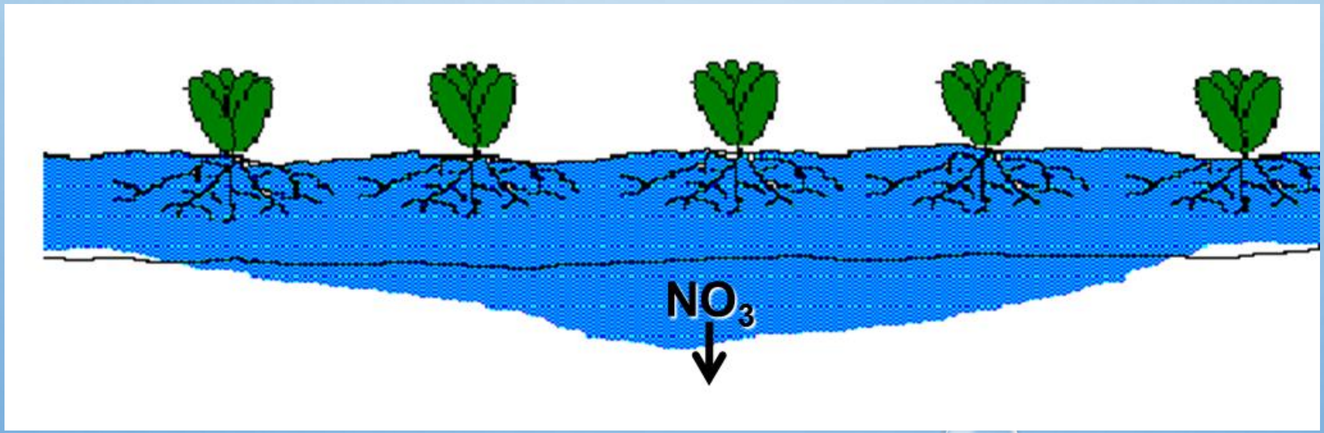
WHY DOES NITRATE (NO_3) LEACH?

- NO_3 IS A NEGATIVELY-CHARGED ION (OR "ANION")
  - DOES NOT "STICK" TO SOIL (ALSO NEGATIVELY CHARGED)
  - GOES ANYWHERE WATER GOES
- NO_3 IS APPLIED IN EXCESS OF CROP UPTAKE
- EXCESS IRRIGATION WATER MOVES NO_3 PAST THE ROOT ZONE INTO WATER TABLE
- TIMING OF APPLICATION DOES NOT MATCH CROP DEMAND

NITRATE LEACHING PRINCIPLES

FOR NITRATE LEACHING TO OCCUR:

- NITRATE MUST BE PRESENT IN THE SOIL
- SOIL MUST BE PERMEABLE TO WATER MOVEMENT
- WATER MUST BE MOVING THROUGH THE SOIL



STRATEGIES TO CONTROL NITRATE LEACHING

FOR NITRATE LEACHING TO OCCUR:

- *NITRATE MUST BE PRESENT IN THE SOIL*

To reduce the nitrate source:

- Use a nitrogen budget
- Add nitrate in irrigation water to your N budget
- Split applications of N
- Don’t apply N when plants are absent or dormant
- Use scavenger crops post-harvest

CREATING A NITROGEN BUDGET

- DATA NEEDED
- 4R NUTRIENT STEWARDSHIP
- FILLING OUT THE FORM FOR ILRP

FOUR R'S OF NUTRIENT MANAGEMENT

- Right Source
- Right Rate
- Right Place
- Right Time

Considerations:

- Organic or synthetic
- Liquid or dry
- Composition
- Availability

FOUR R'S OF NUTRIENT MANAGEMENT

- Right Source
- Right Rate
- Right Place
- Right Time

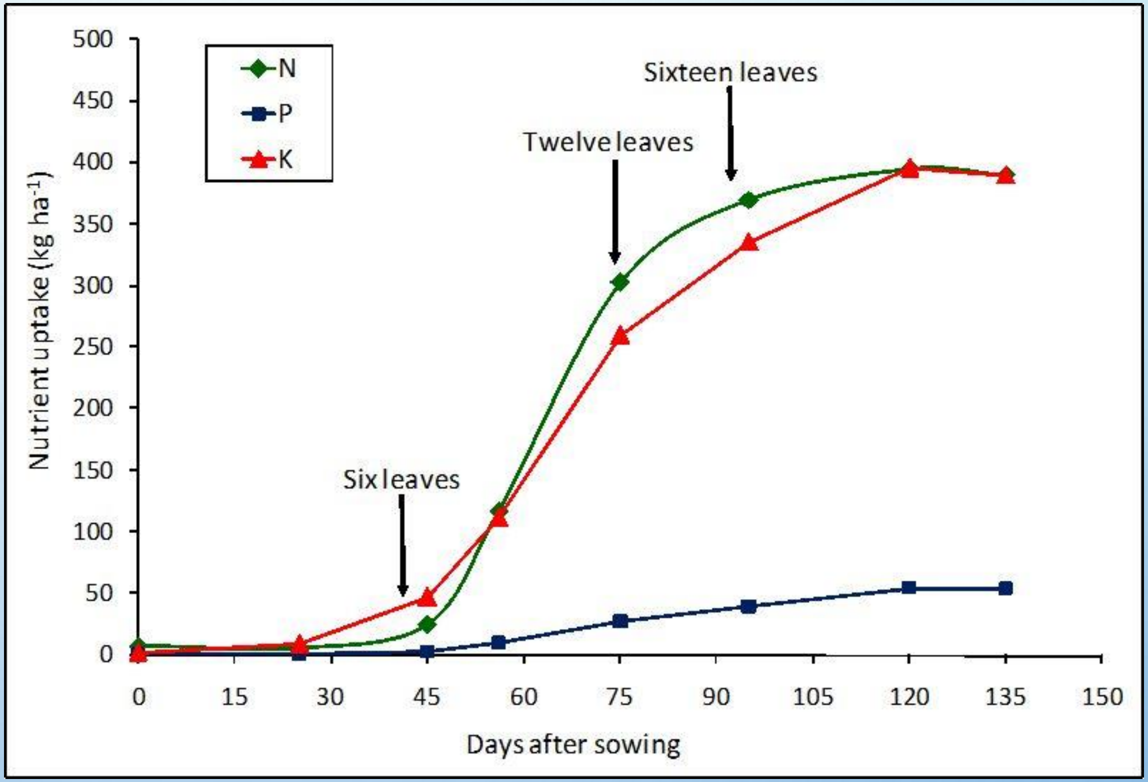
Broadcast application with water incorporation

Sidedress application

Where are the roots?

FOUR R'S OF NUTRIENT MANAGEMENT

- Right Source
- Right Rate
- Right Place
- Right Time



Match the growth curve of crop

Don't apply out of season

FOUR R'S OF NUTRIENT MANAGEMENT

- Right Source
- Right Rate
- Right Place
- Right Time

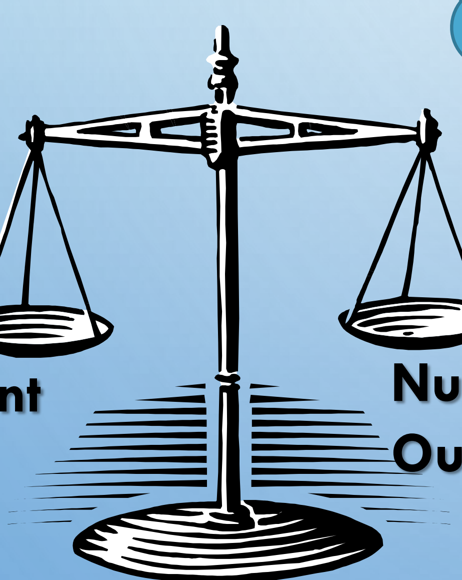
How much to apply?

Plant nutrient demand

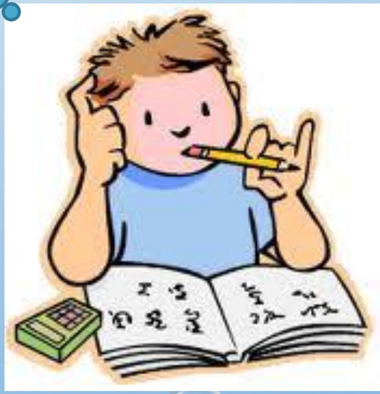
Soil supply

Persistence

Nutrient Inputs



Nutrient Outputs



BUDGET DATA

NITROGEN NEEDED

- CROP N DEMAND
- UPTAKE EFFICIENCY

NITROGEN SUPPLY

- FERTILIZER- SYNTHETIC AND ORGANIC
- SOIL ORGANIC MATTER MINERALIZATION
- SOIL RESIDUAL N
- IRRIGATION WATER

ILRP N BUDGET FORM

NITROGEN MANAGEMENT PLAN WORKSHEET

NMP Management Unit: ______________

1. Crop Year (Harvested):	
2. Member ID#	
3. Name:	

4. APN(s):	5. Field ID (s)	Acres

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	
7. Production Unit	
8. Projected Yield	
9. N Recommended	
10. Acres	
POST PRODUCTION ACTUALS	
11. Actual Yield (Units/ac)	
12. Total N Applied (lbs/ac)	
13. ** N Removed (lbs N/ac)	
14. ***Notes:	

N APPLICATIONS/CREDITS	15. Recommended/ Planned N	16. Actual N
17. NITROGEN FERTILIZERS APPLIED		
18. Dry/Liquid N (lbs/ac)		
19. Foliar N (lbs/ac)		
20. ORGANIC MATERIAL N		
21. Available N in Manure/Compost (lbs/ac estimate)		
22. Total N Applied + Available (lbs per ac) (Box 18+19+21)		
23. NITROGEN CREDITS (EST)		
24. * Available N carryover in soil; (annualized lbs/ac)		
25. * N in Irrigation water (annualized, lbs/ac)		
26. Total N Credits (lbs per ac) (Box 24+25)		
27. Total N Applied + Available + Credits (Box 22+26)	Transfer to Box 9	Transfer to Box 12

P L A N C E R T I F I C A T I O N

28. CERTIFIED BY:	29. CERTIFICATION METHOD	
	30. Low Vulnerability Area, No Certification Needed	
	31. Self-Certified, approved training program attended	
DATE:	32. Self-Certified, UC or NRCS site recommendation	
	33. Nitrogen Management Plan Specialist	

* 24. and 25. Recommended Not Required

** 13. Your Coalition will provide the method to be used to estimate N Removed.

*** 14. Anything that might change what you apply.

(yellow)	Fill out at the beginning of year with projected N application and projected yeild.
(pink hatched)	Fill out after final N application and harvest with actuals, keep on farm

3.2016

BUDGET DATA

NITROGEN NEEDED

- CROP N DEMAND
- UPTAKE EFFICIENCY

CROP NITROGEN MANAGEMENT PLANNING	
6. Crop	
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BUDGET DATA

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NITROGEN SUPPLY

- FERTILIZER- SYNTHETIC AND ORGANIC
- SOIL ORGANIC MATTER MINERALIZATION
- SOIL RESIDUAL N
- IRRIGATION WATER

STRATEGIES TO CONTROL NITRATE LEACHING

FOR NITRATE LEACHING TO OCCUR:

- *SOIL MUST BE PERMEABLE TO WATER MOVEMENT*
- *WATER MUST BE MOVING THROUGH THE SOIL*

To keep water and nitrate in the root zone:

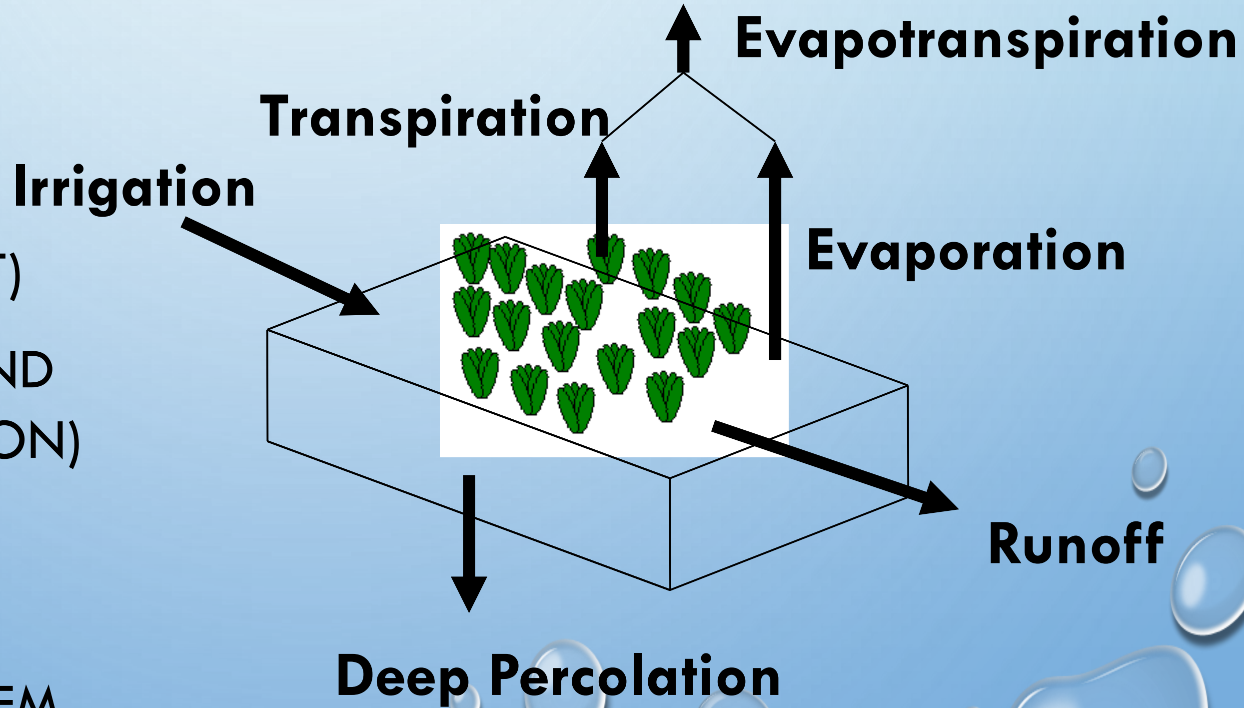
- Monitor soil water profile
- Maximize uniformity and efficiency of your system
- Use field-specific data for irrigation decisions
- Time fertigation events well

5 MIN BREAK ☺

CONCEPTS OF IRRIGATION WATER MANAGEMENT (IWM)

HOW MUCH WATER SHOULD I APPLY?

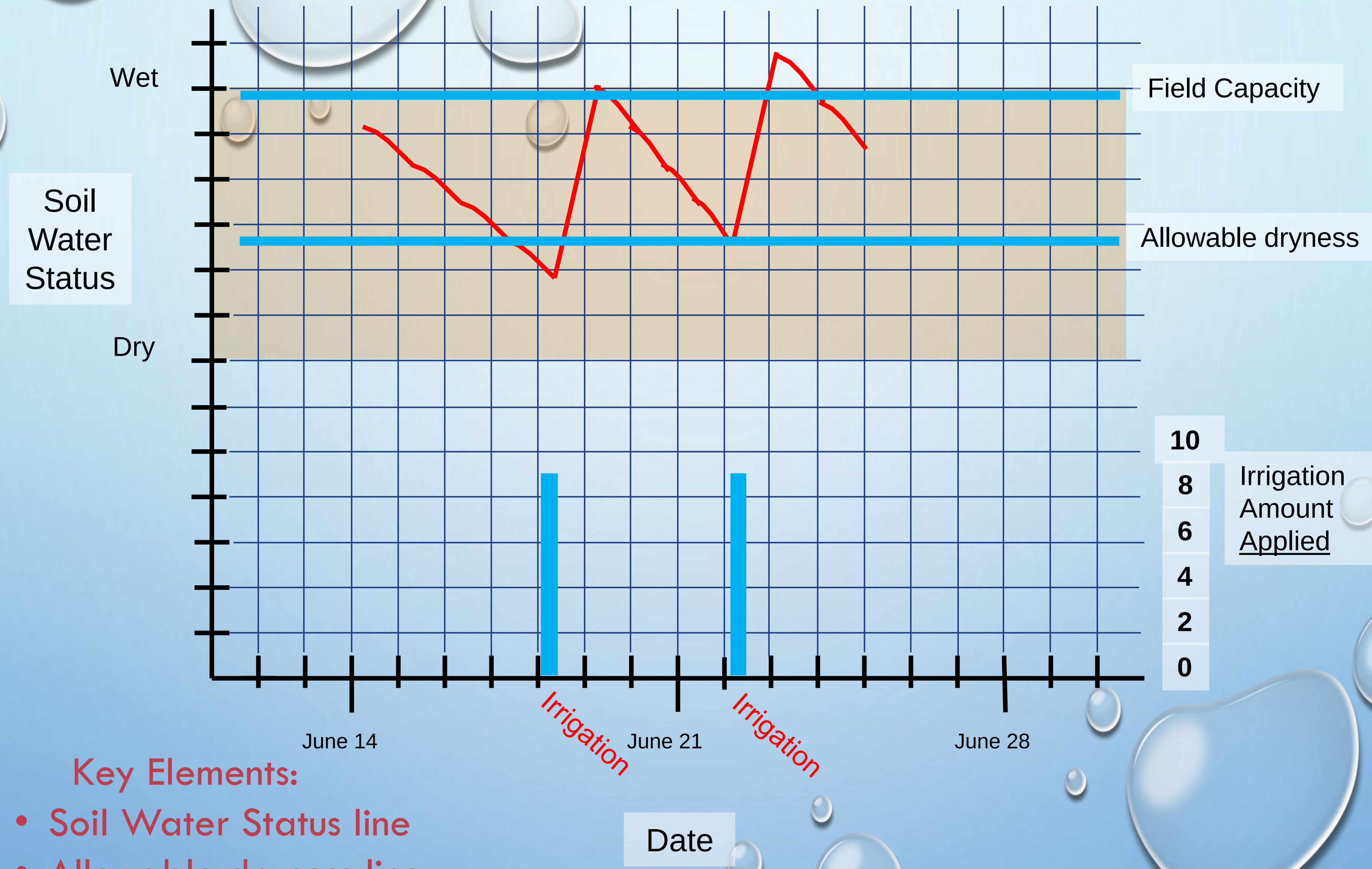
- WATER IN THE SOIL
- WATER AVAILABLE (PUMP CAPACITY, IRRIGATION DISTRICT)
- CROP WATER DEMAND (EVAPOTRANSPIRATION)
- IRRIGATION SYSTEM APPLICATION RATES
- EFFICIENCY OF SYSTEM



CONCEPTS OF IRRIGATION WATER MANAGEMENT (IWM)

WHEN SHOULD I APPLY WATER?

- TIME SINCE LAST IRRIGATION
- SOIL MOISTURE STATUS
- CROP WATER USE SINCE LAST IRRIGATION (EVAPOTRANSPIRATION)
- LENGTH OF TIME NECESSARY TO IRRIGATE



Key Elements:

- Soil Water Status line
- Allowable dryness line
- Field Capacity line
- Irrigation events

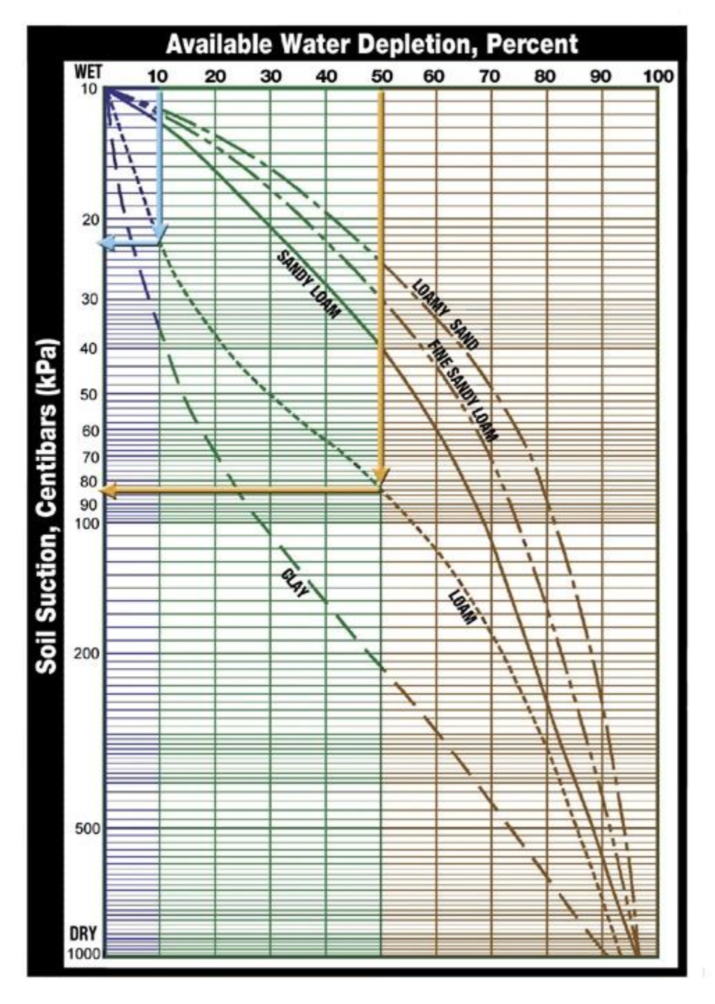
IWM Planning Graph

THRESHOLDS: WHERE TO START?

Choose your thresholds by crop stage and soil type. Then convert the % of AWC to your sensor's units for your graph lines.

Table 3–3 Recommended Management Allowable Depletion (MAD) for crop growth stages (% of AWC) growing in loamy soils [1/,2/]

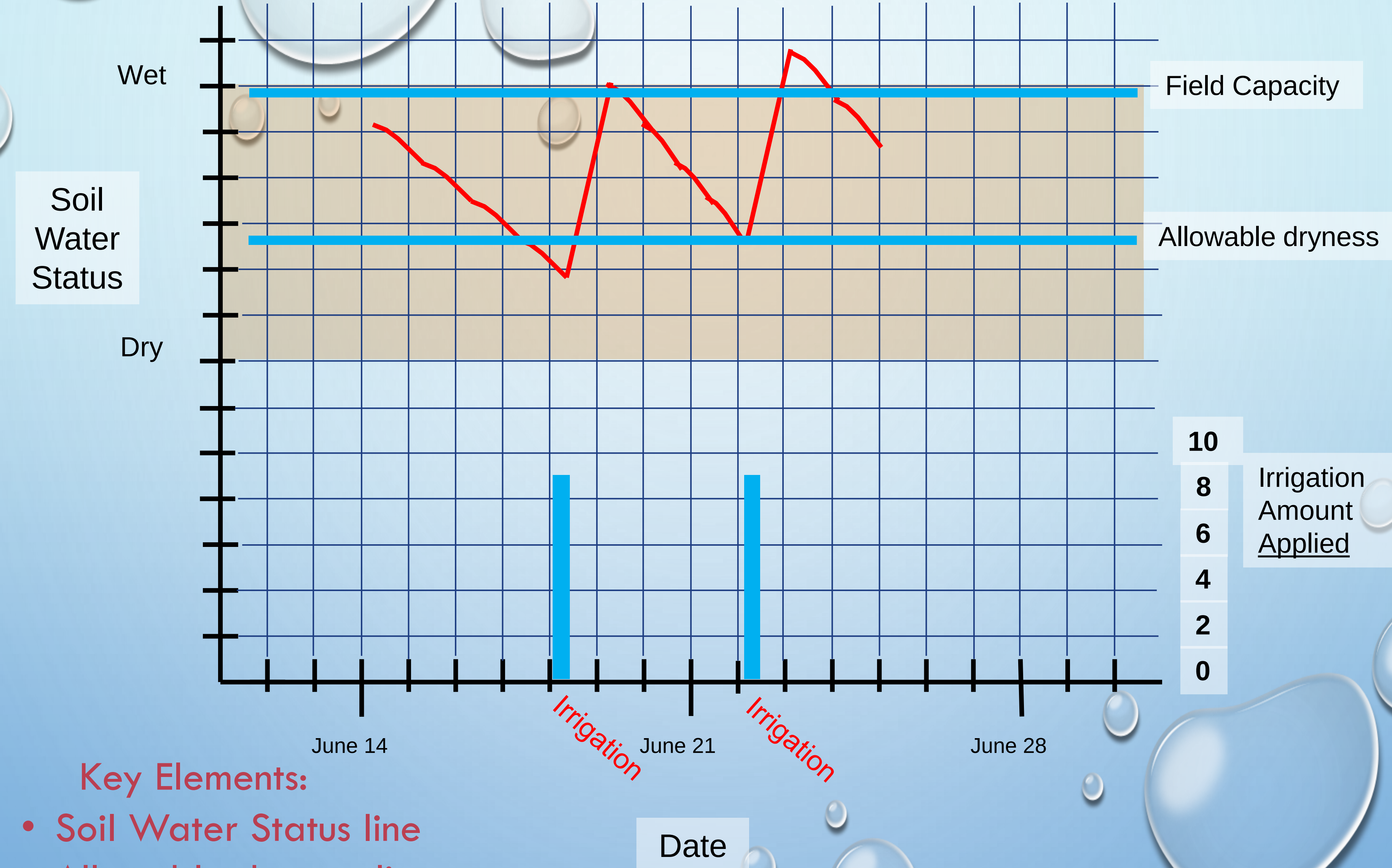
Crop	Crop growth stage: Estab-lishment	Vege-tative	Flowering yield formation	Ripening maturity
Grains, small	50	50	40 [3/]	60
Grapes	40	40	40	50
Grass pasture/hay	40	50	50	50
Grass seed	50	50	50	50
Lettuce	40	50	40	20
Milo	50	50	50	50
Mint	40	40	40	50
Nursery stock	50	50	50	50
Onions	40	30	30	30
Orchard, fruit	50	50	50	50
Peas	50	50	50	50
Peanuts	40	50	50	50
Potatoes	35	35	35	50 [4/]
Safflower	50	50	50	50
Sorghum, grain	50	50	50	50
Spinach	25	25	25	25
Sugar beets	50	50	50	50
Sunflower	50	50	50	50
Tobacco	40	40	40	50
Vegetables				
1 to 2 ft root depth	35	30	30	35
3 to 4 ft root depth	35	40	40	40



Recommended MAD values by soil texture for deep rooted crops are:

- Fine texture (clayey) soils 40%
- Medium texture (loamy) soils 50%
- Coarse texture (sandy) soils 60%

Table 3-3 source: NRCS Irrigation Guide, NEH Part 652, Sept 1997.
Tensiometer Readings Table source: http://www.irrometer.com/basics.html



Key Elements:

- Soil Water Status line
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IWM Planning Graph

INDIRECT BENEFITS OF IWM

- CROP HEALTH/PRODUCTIVITY
- REDUCE NITRATE LEACHING
- REDUCE FERTILIZER COSTS (?)
- WATER USE REDUCTION (?)
- LOWER ENERGY OR WATER BILLS (?)

IWM CONSIDERATIONS

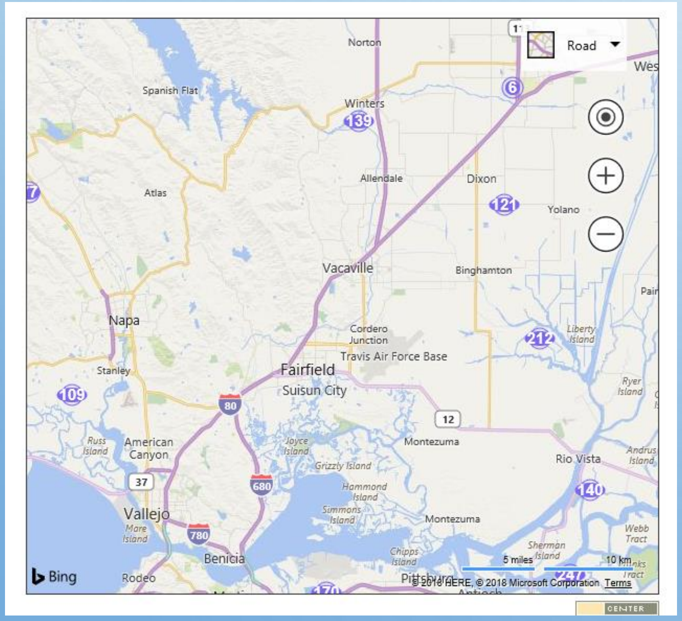
- INCREASED TIME FOR FARM MANAGERS TO ENTER AND EVALUATE THE DATA
- ADDITIONAL EDUCATION FOR FIELD STAFF
- BUDGET FOR REPLACEMENT SENSORS
- WATER USE MAY INCREASE!

IWM TOOLS

- COMMON:
  - FLOW METER
  - EVAPOTRANSPIRATION DATA (ET_0) FROM CIMIS* OR OTHER SOURCE (SID)
  - VISUAL INSPECTION

Monthly Average Reference Evapotranspiration by ETo Zone (inches/month)

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	33.0
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.79	1.80	1.24	39.0
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.10	1.50	0.93	43.9
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.79	1.20	0.62	43.4
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.41	1.80	0.93	49.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.03	2.70	1.86	55.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.72	2.10	1.55	53.0
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.72	1.80	0.93	53.3
13	1.24	1.96	3.10	4.80	6.51	7.80	8.99	7.75	5.70	3.72	1.80	0.93	54.3
14	1.55	2.24	3.72	5.10	6.82	7.80	8.68	7.75	5.70	4.03	2.10	1.55	57.0



* California Irrigation Management Information System, CA DWR

- LESS COMMON:
  - VARIABLE FREQUENCY DRIVES (VFD)
  - PLANT-BASED MONITORING
  - SOIL MOISTURE METERS

VFD (VARIABLE FREQUENCY DRIVE)

- PURPOSE:
  - REDUCTION IN ENERGY COSTS
    - REDUCED PEAK LOAD DEMAND
  - OTHER POTENTIAL SAVINGS IN REDUCED NEED FOR MANPOWER AND TRAVEL TO THE SITE
  - ALLOW FOR DIFFERENT BLOCK WATER NEEDS TO BE IRRIGATED FROM THE SAME WELL (CONSTANT FLOW OR CONSTANT PRESSURE).
  - COMPENSATE FOR “OVER-DESIGNED” PUMPS
  - REDUCE WATER HAMMER & SUBSEQUENT SYSTEM DAMAGE
  - CAN EXTEND THE LIFE OF THE WELL IF TIME OF USE PUMPING IS ADOPTED

VFD (VARIABLE FREQUENCY DRIVE)

- CONSIDERATIONS:
  - VFD SPEEDS MUST MATCH YOUR PUMP CURVE AND IRRIGATION SYSTEM DEMANDS (FLOW AND PRESSURE)
  - USE AN REPUTABLE DEALER WITH EXPERIENCED STAFF

The shape of the pump curve also has an effect on the potential energy saved. Pumps with steeper curves have more potential to save more energy. Flat-curved pumps will have less energy savings (see Figures 12 and 13).

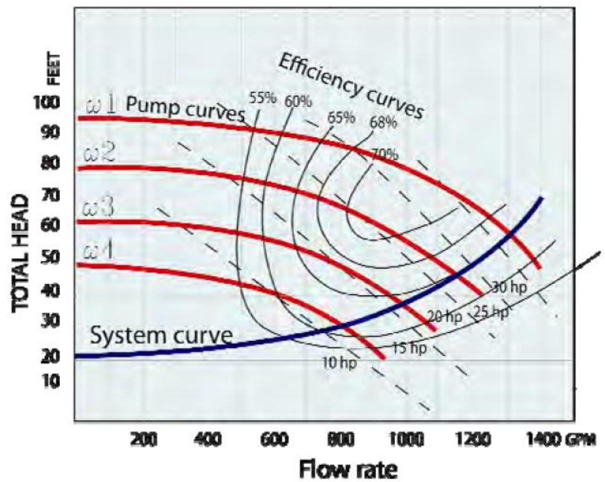


Figure 10 – System curve parallel with efficiency curves

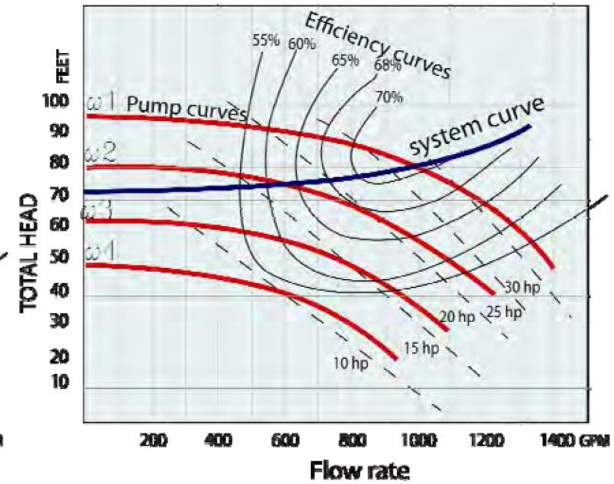


Figure 11 – System curve crosses efficiency curves

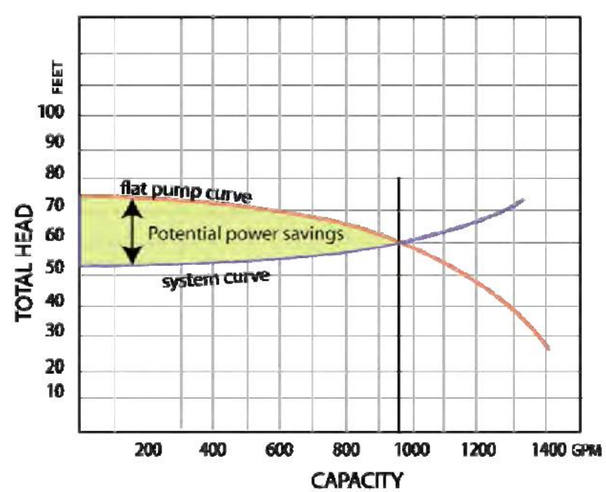


Figure 12 – Potential savings flat pump curve

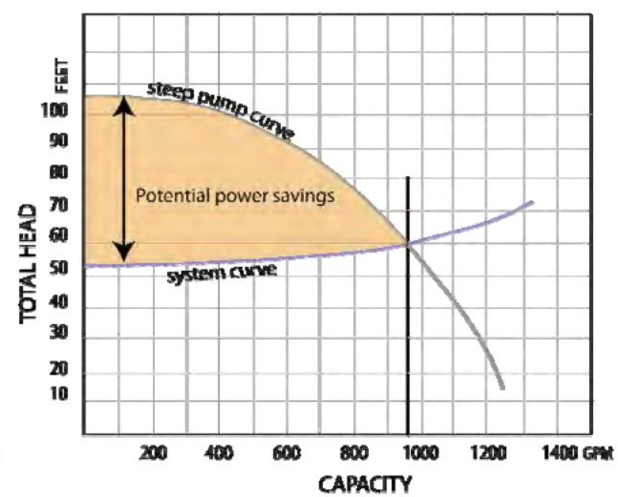
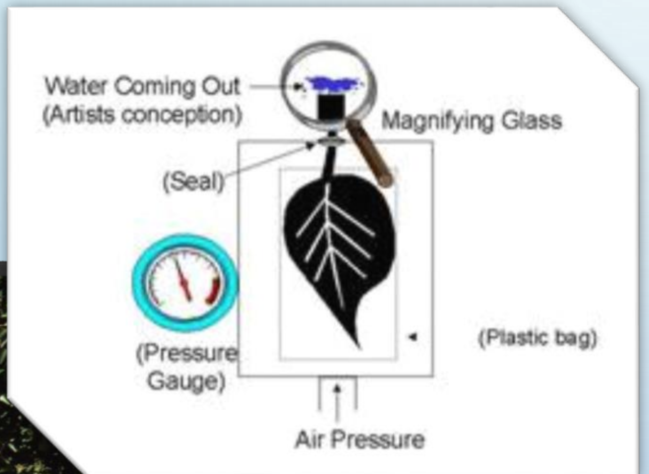


Figure 13 – Potential savings steep pump curve

Source: NRCS Montana Technical Note MT-14; Jan 2010.

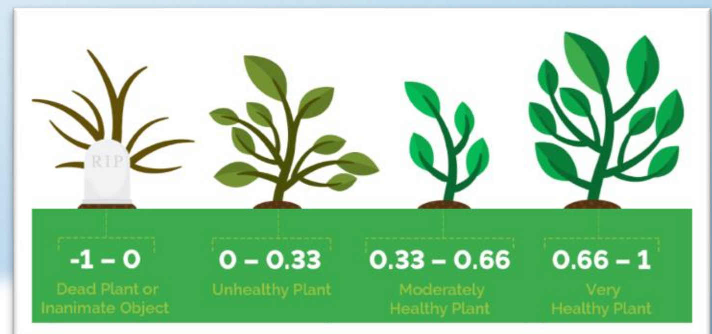
PLANT-BASED MONITORING

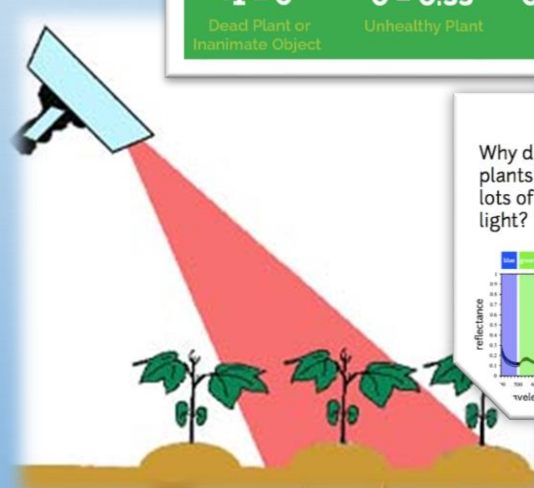


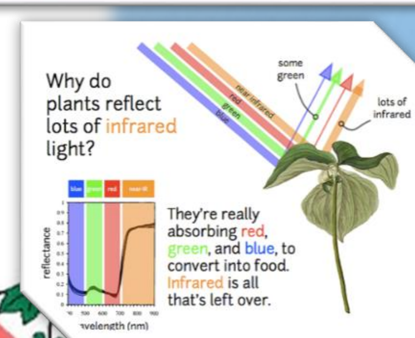
Pressure Chamber or "Bomb": measures the plant's "Blood Pressure"

Testing Procedure: http://fruitsandnuts.ucdavis.edu/pressure_chamber/

Normalized Difference Vegetation Index (NDVI): uses near-infrared reflectivity & red reflectivity to determine plant health







Graphics: Sentera & Public Lab

TYPES OF SOIL MOISTURE METERS

- TWO BASIC TYPES OF MEASUREMENT:
  - VOLUMETRIC – AMOUNT/% WATER IN THE SOIL
  - TENSIOMETRIC – PHYSICAL FORCE HOLDING WATER IN THE SOIL
    - MEASURES HOW EASY/DIFFICULT IT IS FOR A PLANT TO UPTAKE WATER FROM THE SOIL

VOLUMETRIC SOIL MOISTURE METERS

- NEUTRON MOISTURE PROBE
- HEAT DISSIPATION SENSORS
- DI-ELECTRIC SENSORS
  - DOMAIN REFRACTORY SENSORS (TDR)
  - TIME DOMAIN TRANSMISSIOMETRY SENSORS (TDT)
  - FREQUENCY DOMAIN REFRACTORY SENSORS (FDR)

- MOST EXPENSIVE TECHNOLOGY IN THE SENSORS
- NEED TO BE CALIBRATED BY SOIL AND SOIL SALINITY
- HIGH ACCURACY
- INSTANT DATA – DIRECTLY MEASURE THE AMOUNT OF WATER IN THE SOIL

CAPACITANCE & TDR SENSOR EXAMPLES

CAPACITANCE SENSORS

Capacitance sensors can use a pair of parallel stainless steel rods (wave guides) (Figure 8), a single-piece insert (Figure 6), or can also be fully contained within a PVC pipe (Figure 7) which is installed vertically into a soil bore hole. Systems using the PVC pipe design typically have multiple sensors mounted along the length of pipe, thus allowing simultaneous soil moisture measurement at several depths. Capacitance sensors require a data logger and/or display unit.

- **Requires electronic reader or data logger costing about $400-600**
- **In-soil single sensor unit cost about $100**
- **Multi-sensor units cost $1,000 and up**
- **Displays percent volumetric soil moisture**
- **Can remain in soil through winter**
- **Accuracy: ±3 to 5% volumetric moisture**

Figure 6
Capacitance-type soil moisture sensors

a) Spectrum SM100 Waterscout®
b) Decagon Echo® EC-5

Figure 7
Multi-depth capacitance soil moisture sensor in PVC pipe

Systems using the PVC pipe design typically have multiple sensors mounted along the length of pipe, 48 inches long in the above example (the cut-out shows sensors inside), thus allowing simultaneous soil moisture measurement at several depths.

TIME DOMAIN REFLECTOMETRY (TDR)

The in-soil part of a TDR sensor for both the in-place and handheld units look the same and are typically a pair of wave guides which are connected to a data logger and/or a display unit (Figure 8). Wave guide rods are available in various lengths from 1 to 8 inches (short for shallow-rooted crops such as turf and longer for deeper-rooted crops). You can change the wave guides but this requires recalibratiing the reader by taking one reading with the rods in the air and another in distilled water. To get a value for a location at a specific depth, the rods should be installed horizontally at that depth.

- **Requires electronic reader or data logger costing about $800-1,200**
- **In-soil portion of sensor costs about $60**
- **Displays percent volumetric soil moisture**
- **Can remain in soil through winter**
- **Accuracy: ±1 to 3% volumetric moisture**

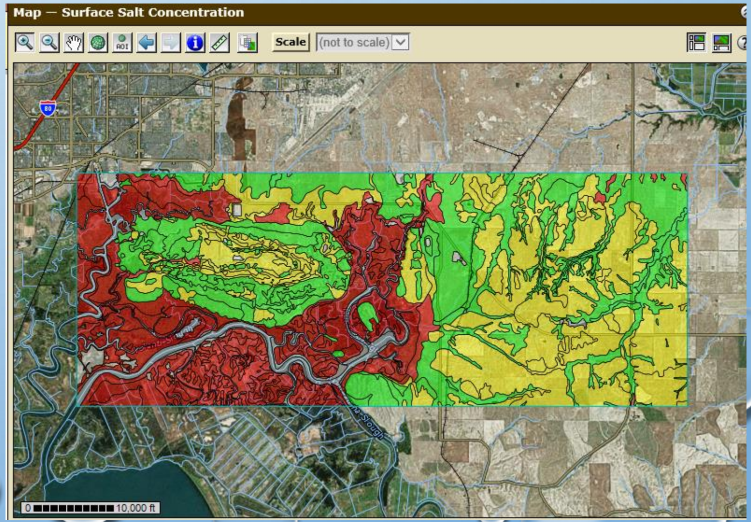
Figure 8
In-soil wave guides for the Spectrum TDR 300® soil moisture sensor

Source: Methods to Monitor Soil Moisture
Authors: John Panuska, Scott Sanford, and Astrid Newenhouse
Department of Biological Systems Engineering, College of Agricultural and Life Sciences, University of Wisconsin-Madison,
and University of Wisconsin–Extension, Cooperative Extension. 2015

TENSIOMETRIC SOIL MOISTURE METERS

- TENSIOMETERS – MEASURE THE TENSION BETWEEN THE SOIL PARTICLES AND WATER MOLECULES
- DO NOT NEED CALIBRATED BY SOIL TYPE
- ONGOING MAINTENANCE: SENSORS NEED TO BE REFILLED AND CLEANED
- SENSORS NEED TO BE REMOVED ANNUALLY IN COLD CLIMATES
- DO NOT WORK WELL IN DRIER SOIL CONDITIONS; SOIL SALINITY CAN SKEW READINGS (>= 6.0 dS/m in a saturated soil solution*)

- SOLID STATE SENSORS:
  - GYPSUM BLOCKS
  - GRANULAR MATRIX



* Source: Gypsum blocks for measuring the dryness of soil: http://agriculture.vic.gov.au/agriculture/farm-management/soil-and-water/soils/gypsum-blocks-for-measuring-the-dryness-of-soil

SOLID STATE SENSORS

TENSIOMETERS

- Mechanical sensor cost is about $80-160
- One-time cost of hand-operated vacuum pump used for device installation is about $86
- Insert in crop row or field
- Displays vacuum in centibars/kilopascals
- Must be removed from soil over the winter
- May require refilling with water periodically
- Reads vacuum using a mechanical gauge or optional electronic gauge or vacuum transducer and data logger

Figure 4
Irrometer™ tensiometer

WATERMARK™ SENSOR

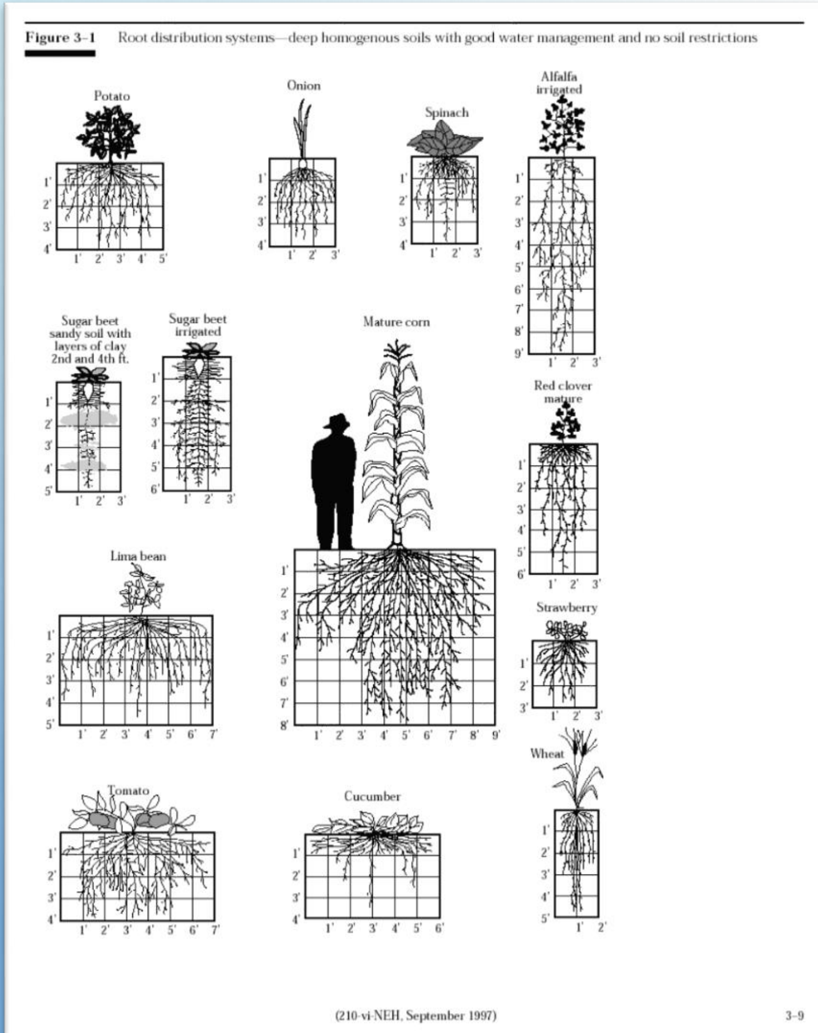
- Sensor cost is about $35–60
- An electronic tensiometer measures electrical resistance and converts to read in vacuum in centibars/kilopascals like a tensiometer
- Requires a data logger/reader – cost is about $300
- According to Chávez et al. (2011), the accuracy is ±11% volumetric moisture content
- Can be permanently installed (through winter) in soil, no water refilling needed
- Egert et al. (1992) report that readings can vary between sensor units, so this sensor is better suited for relative, not absolute, moisture readings

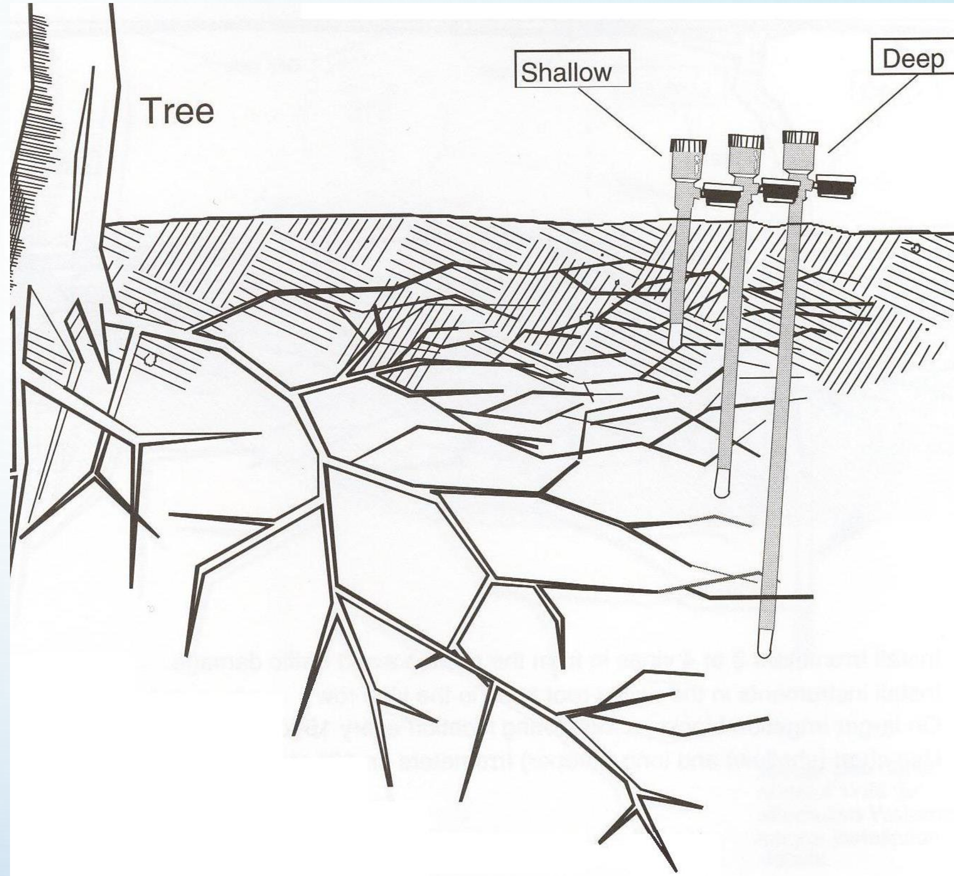
Figure 5
Watermark™ sensor

John Panuska photos

Source: Methods to Monitor Soil Moisture
Authors: John Panuska, Scott Sanford, and Astrid Newenhouse
Department of Biological Systems Engineering, College of Agricultural and Life Sciences, University of Wisconsin-Madison, and University of Wisconsin–Extension, Cooperative Extension.
2015

SOIL MOISTURE SENSORS DEPTHS





USE MULTIPLE DEPTHS TO LOOK AT THE ACTIVE ROOT ZONE AND MONITOR DEEP PERCOLATION

SUGGESTED SENSOR DEPTHS BY CROP

CHECK WITH YOUR VENDOR AND INDUSTRY PROFESSIONALS BEFORE PLACING YOUR SENSORS

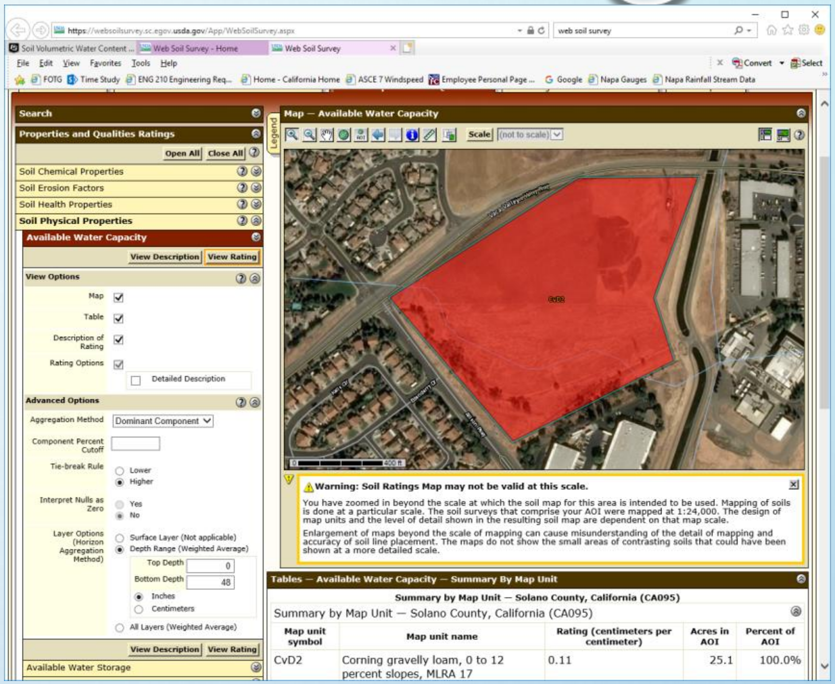
CROP	1st sensor	3rd sensor	4th sensor
ALFALFA	18-24	36-48	60-70
ALMONDS	24	48	72
APPLES	20	40	60
APRICOTS	24	48	72
ARTICHOKES	18	36	
ASPARAGUS	18-24	36-48	
AVOCADOS	12	24	36
BANANAS	12	24	
BARLEY	18	36	
BEANS (bush)	10		18
BEANS (Lima)	18	36	
BEANS (Pole)	18	36	
BEETS (sugar)	18	36	
BEETS (table)	12-18	24-36	
BLUEBERRIES	12	24	
BROCCOLI	12	20	
CABBAGE	12	20	
CANAIGRE	18	36	48
CANTALOUPE	18	36	
CARNATIONS	4-6		
CARROTS	12	24	
CAULIFLOWER	12	24	
CELERY	10	20	
CHARD	12	24	
CHERRIES	24	48	
CHRISTMAS TREE	12	24	
CITRUS: Orange, Lemon, Grapefruit	18	36	
COFFEE	18-24	36-48	
CORN (sweet)	12	30	
CORN (field)	18	36	
COTTON	18	36	48
CRANBERRIES	18	36	
CUCUMBERS	18	36	
DATE PALM	24	48	60
EGGPLANT	12	24	
FIGS	18	36	
GARLIC	12	24	
GRAIN and FLAX	18	36	
GRAPES	24	48	60
HOPS	24	48	60
JOJOBA	18	36	
KIWI	18	36	48
LADINO CLOVER	10	20	
LETTUCE	12		
MACADAMIAS	12	24	36
MAIZE	18	36	

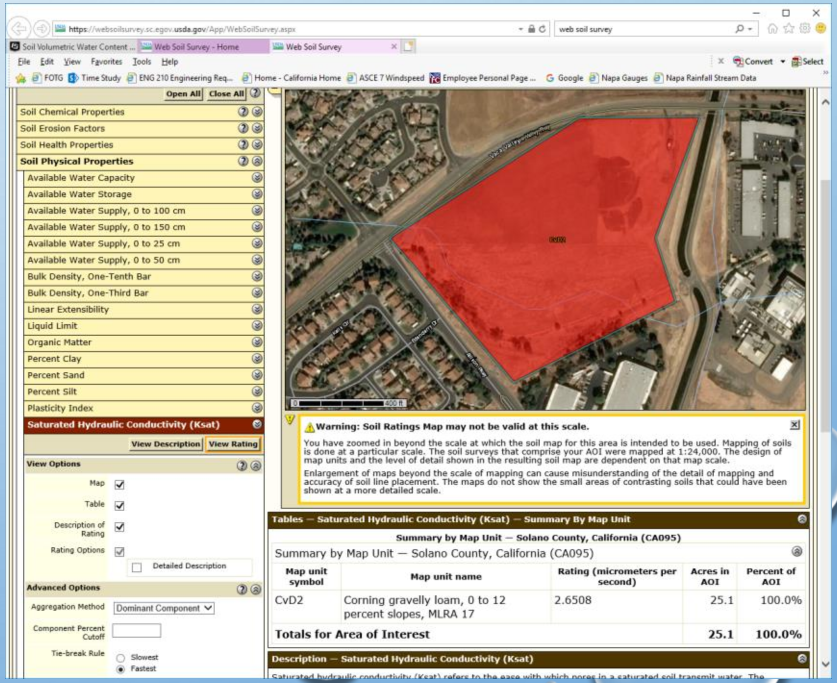
CROP	SHALLOW INSTRUMENT (INCHES)	DEEP INSTRUMENT (INCHES)	FOR EXTRA DEPTH, SET AT (INCHES)
MELONS	18	36	
MILO	24	48	
MINT	12	24	
MONTEREY PINES, FIRS	12	24	
MUMS	4-6		
MUSTARD	18	36	
NECTARINES	18	36	
OATS	18	36	
OKRA	18	36	
OLIVES	24	48	60
ONIONS	12		
PAPAYA	12	24	
PARSNIPS	18	36	
PEACHES	18	36	60
PEANUTS	12	24	
PEARS	18	36	48
PEAS	18	36	
PECANS	18	36	48
PEPPERS	15	30	
PERMANENT PASTURES	8-15		24-30
PERSIMMONS	18	36	
PINEAPPLE	15	30	
PISTACHIO NUTS	24	48	60
POMEGRANATES	18	36	
POTATOES (Irish)	8-10	18	
POTATOES (sweet)	18	36	
PLUMS	24	48	72
PRUNES	24	48	72
PUMPKIN	18	36	48
RADISHES	12		
RASPBERRIES	18	36	
SORGHUM	18	36	
SOY BEANS	18	36	60
SPINACH	12	24	
SQUASH (Summer)	15	30	
STRAWBERRIES	6	12	
SUDAN GRASS	18-24	36-48	
SUGAR CANE	18	36	
SUNFLOWERS	24	48	60
TEA	12	24	
TOBACCO	8-15	30	
TOMATOES	18	36	
TURNIPS	18	36	
WALNUTS	24	48	72
WATERMELON	18	36	48
WHEAT, HAY	18	36	

Table source: Irrometer.
http://www.irrometer.com/basics.html

PLACEMENT OF SOIL MOISTURE SENSORS

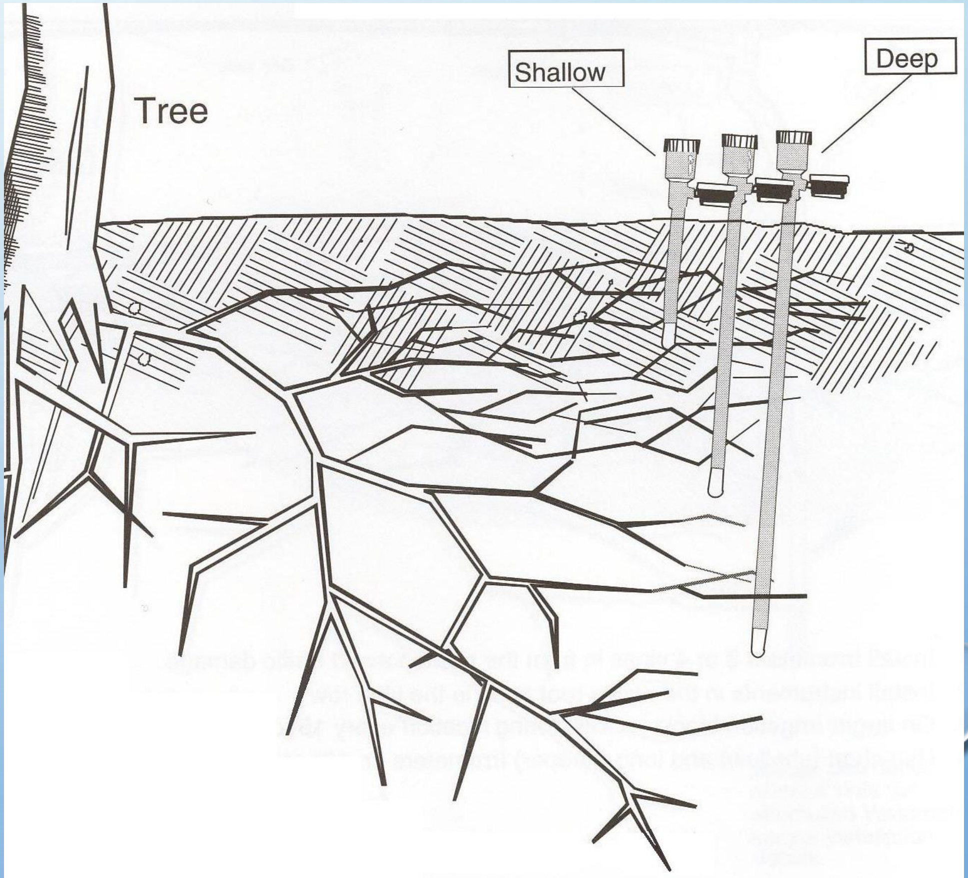
- IF YOUR FIELD HAS MULTIPLE SOILS, HOW MANY SENSOR STATIONS ARE NEEDED?
  - DESKTOP ANALYSIS: USE WEB SOIL SURVEY TO LOOK AT WATER INFILTRATION RATES <u>&</u> WATER HOLDING CAPACITY
  - DO YOU HAVE THE CAPACITY TO MANAGE MULTIPLE ZONES?
  - DOES YOUR CURRENT SYSTEM ALLOW YOU TO IRRIGATE WITH MULTIPLE ZONES WHERE THE CROP/SOIL LIMITATIONS EXIST?
  - DO YOU HAVE EXISTING DRAINAGE FEATURES TO HELP MANAGE WATER IN HEAVIER SOILS? IF SO, DOES THE DRAINAGE ALLOW THE SOIL TO ACT LIKE THOSE AROUND IT?





PLACEMENT OF SOIL MOISTURE SENSORS

- AT LEAST ONE PER SET (MANAGEMENT ZONE)
- CHECK MANUFACTURER RECOMMENDATIONS FOR MAXIMUM ACREAGE. TYPICAL RECOMMENDATION IS 1 PER 20 ACRES
- PLACE SENSOR STATION IN THE ACTIVE ROOT ZONE
- AVOID PLACING THE STATION IN A COMPACTED AREA BUT MAKE IT EASILY ACCESSIBLE BY FIELD STAFF



PLACEMENT OF SOIL MOISTURE SENSORS

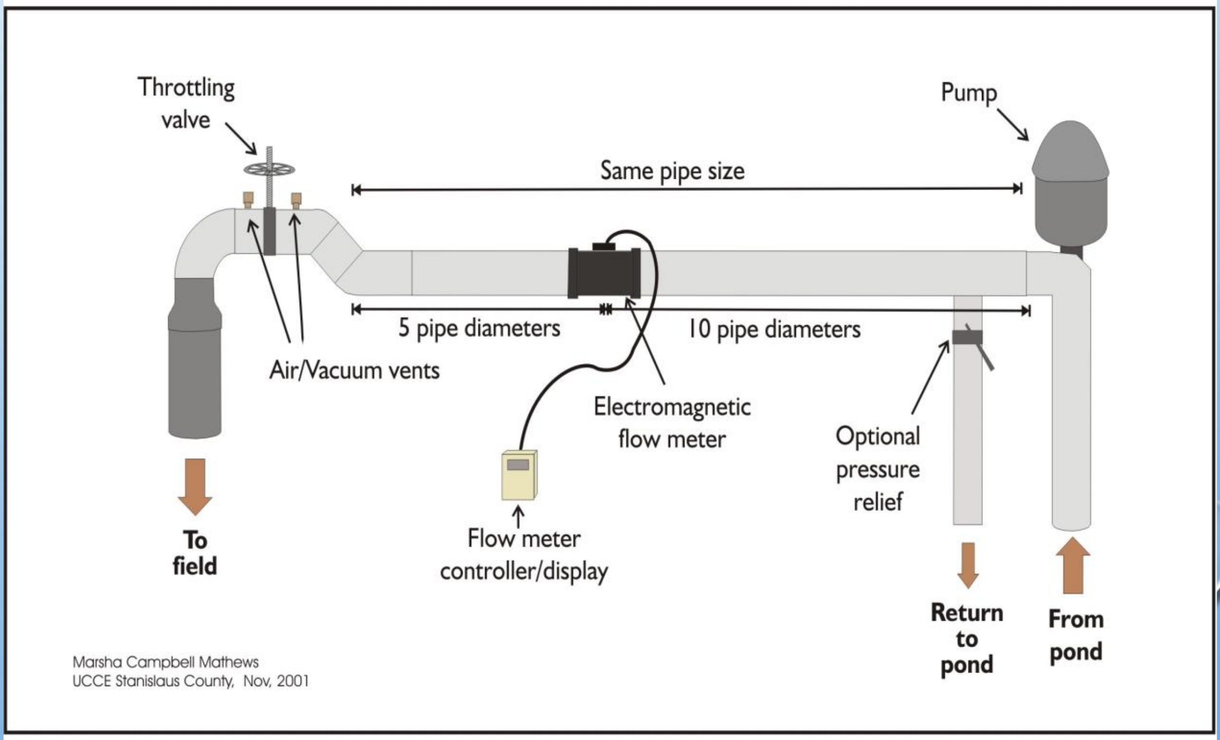
*CONSIDER USING AN ANGLED TRENCH TO PREVENT PREFERENTIAL FLOW – IF SOIL MOISTURE SENSOR ALLOWS THIS FLEXIBILITY

MEASURING WATER APPLIED

- MOST COMMON DEVICE IS A FLOW METER (PROPELLER & MAGNETIC)
- WHY USE A WATER MEASUREMENT DEVICE INSTEAD OF/IN ADDITION TO USING TIME ESTIMATES?
  - CROSS CHECK THAT THE WATER APPLICATION RATE IS WHAT YOU THINK IT IS
  - MORE CLOSELY MANAGE WATER APPLICATIONS

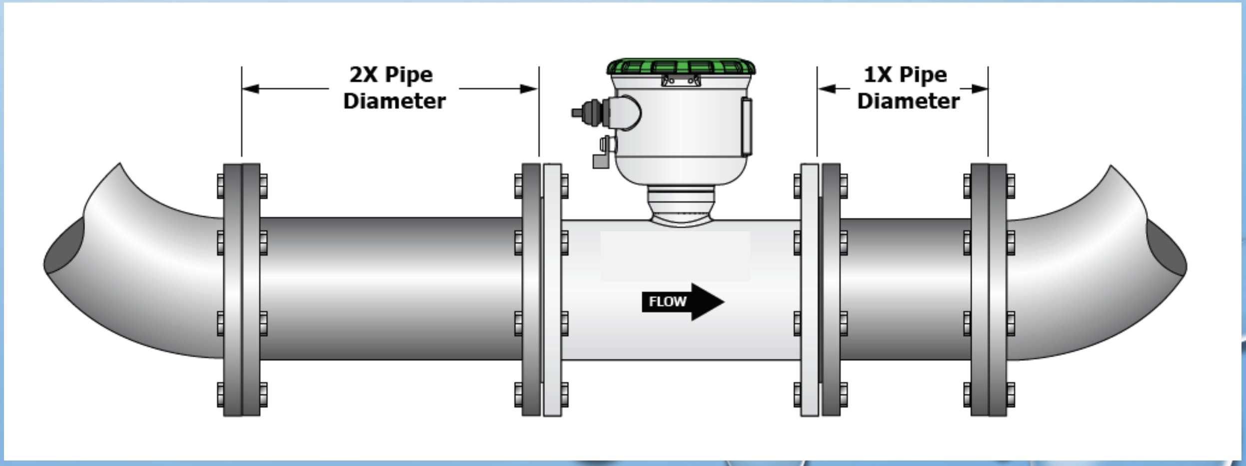
FLOW METER: PROPELLER TYPE

- MORE ECONOMICAL DEVICE
- REQUIRES LONG STRAIGHT LENGTH OF PIPE TO ACCURACY
- NO SENSORS TO GET COVERED BY SEDIMENT OVER TIME



FLOW METER TYPES

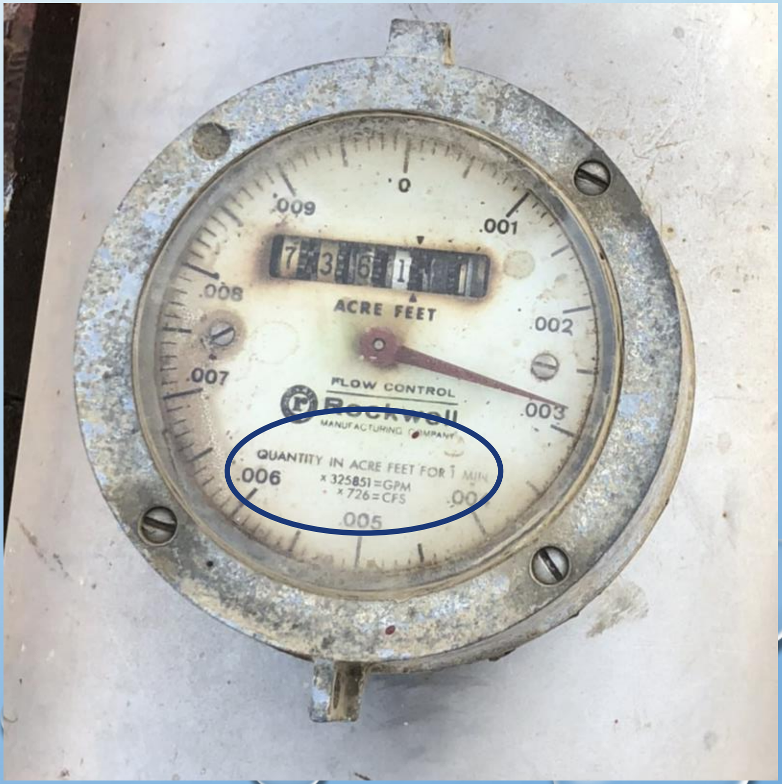
- MAGNETIC METER (MAGMETER)
  - MUST BE PROPERLY GROUNDED TO FUNCTION
  - CHECK FACTORY DISPLAY UNITS TO MAKE SURE THEY ARE COMPATIBLE WITH YOUR MANAGEMENT NEEDS. THEY CAN BE CHANGED.



RECORDING FLOW METER DATA (RATE VS VOLUME)

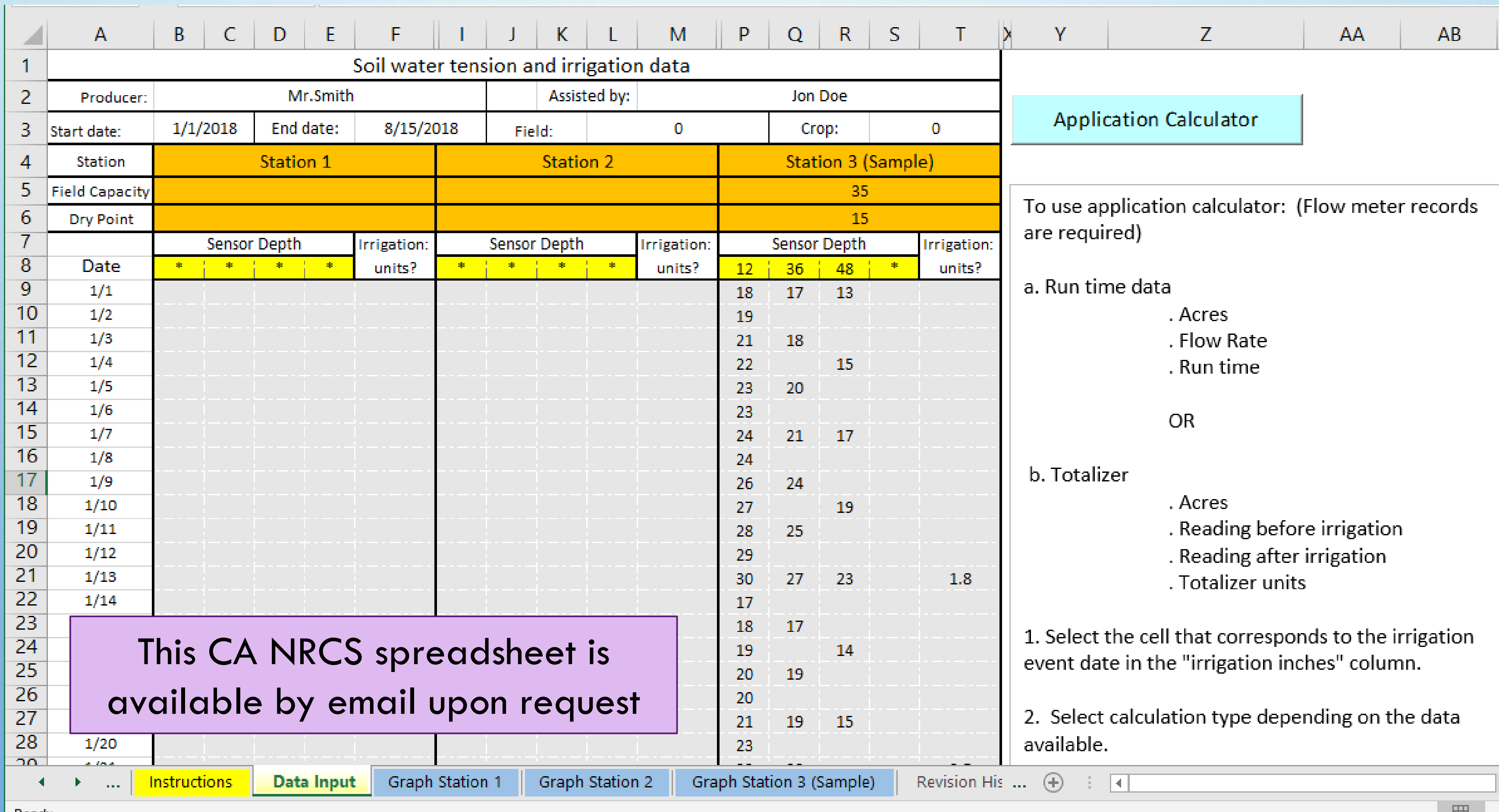
- FLOW RATE: GALLONS PER MIN (GPM) – MOST COMMON
  - EQUIVALENT TO A CAR SPEEDOMETER
- FLOW VOLUME (TOTALIZER): GALLONS, GALLONS X 1000, ACRE-FEET, ACRE-IN
  - EQUIVALENT TO A CAR ODOMETER
- USEFUL TOTALIZER CONVERSIONS:
  - (GPM) X 448.83 EQUALS CUBIC FEET PER SECOND (CFS)
  - (GALLONS X 1,000) X 0.00306 EQUALS ACRE FEET
  - (GALLONS X 100) X 0.000306 EQUALS ACRE FEET
  - (ACRE INCHES) X 0.083 EQUALS ACRE FEET

Top: Total Vol
Bottom: Rate
Screen: Fwd Total



SCHEDULING IRRIGATION

- INPUT DATA INTO SCHEDULING TOOL
  - WATCH UNITS
  - PLOTTING OPTIONS: GRAPH PAPER, EXCEL, & PROPRIETARY SOFTWARE



Soil water tension and irrigation data

Producer:	Mr.Smith	Assisted by:	Jon Doe	
Start date: 1/1/2018	End date: 8/15/2018	Field: 0	Crop: 0	

Station	Station 1					Station 2					Station 3 (Sample)				
Field Capacity											35				
Dry Point											15				
	Sensor Depth				Irrigation: units?	Sensor Depth				Irrigation: units?	Sensor Depth				Irrigation: units?
Date	*	*	*	*		*	*	*	*		12	36	48	*	
1/1											18	17	13		
1/2											19				
1/3											21	18			
1/4											22		15		
1/5											23	20			
1/6											23				
1/7											24	21	17		
1/8											24				
1/9											26	24			
1/10											27		19		
1/11											28	25			
1/12											29				
1/13											30	27	23		1.8
1/14											17				
											18	17			
											19		14		
											20	19			
											20				
											21	19	15		
1/20											23				

This CA NRCS spreadsheet is available by email upon request

Application Calculator

To use application calculator: (Flow meter records are required)

a. Run time data
. Acres
. Flow Rate
. Run time

OR

b. Totalizer
. Acres
. Reading before irrigation
. Reading after irrigation
. Totalizer units

1. Select the cell that corresponds to the irrigation event date in the "irrigation inches" column.

2. Select calculation type depending on the data available.

Instructions | Data Input | Graph Station 1 | Graph Station 2 | Graph Station 3 (Sample) | Revision His ...

Ready

FLOW METER DATA & SCHEDULING IRRIGATIONS

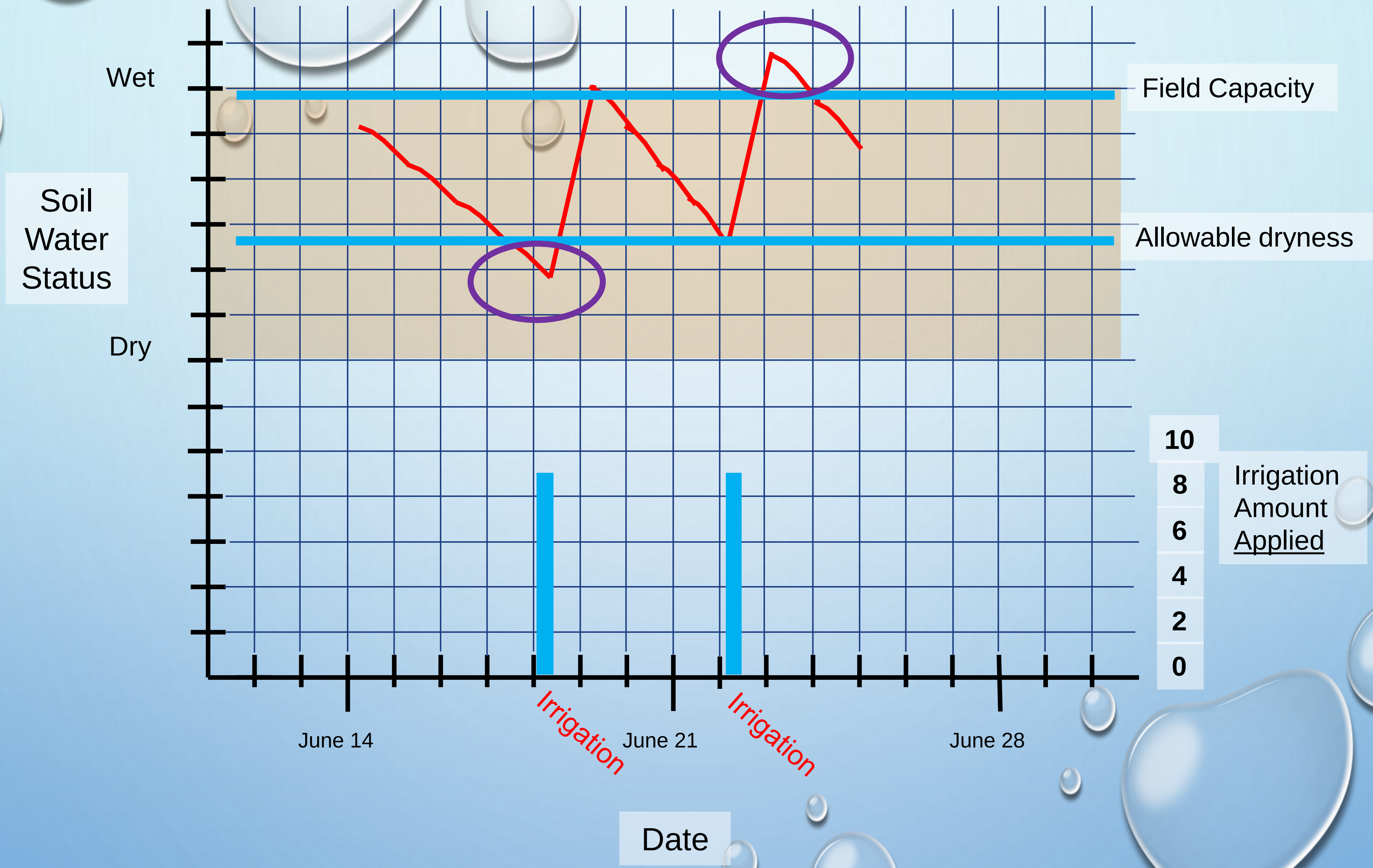
- MANAGING MULTIPLE CROPS IN ONE FIELD
  - WHICH CROP SHOULD YOU RECORD DATA FOR?
    - MOST WATER INTENSIVE, AND MOST LIMITING SOIL
  - DOES YOUR IRRIGATION SYSTEM ALLOW YOU TO MANAGE FOR MORE THAN ONE CROP?
    - IF THE CROPS HAVE SIGNIFICANTLY DIFFERENT WATER NEEDS, YOU MAY WANT TO RETROFIT YOUR IRRIGATION SYSTEM WITH DIFFERENT ZONES OR AT LEAST GATE/BALL VALVES TO MANUALLY CONTROL WATER TO THE DIFFERENT CROPS.

SOIL MOISTURE SENSORS & SCHEDULING IRRIGATIONS

- MANAGING SOIL VARIATION IN ONE FIELD
  - DOES YOUR IRRIGATION SYSTEM ALLOW YOU TO MANAGE FOR MORE THAN ONE SOIL TYPE?
    - IF THE SOILS HAVE SIGNIFICANTLY DIFFERENT WATER INFILTRATION RATES OR HOLDING CAPACITIES, YOU MAY WANT TO DESIGN/RETROFIT YOUR IRRIGATION SYSTEM WITH DIFFERENT ZONES TO ALLOW YOU TO IRRIGATE BY SOIL TYPE.
  - WHICH SOIL SHOULD I INSTALL THE SOIL MOISTURE SENSOR IN?
    - EITHER THE MOST REPRESENTATIVE SOIL – OR –
    - THE MOST LIMITING SOIL

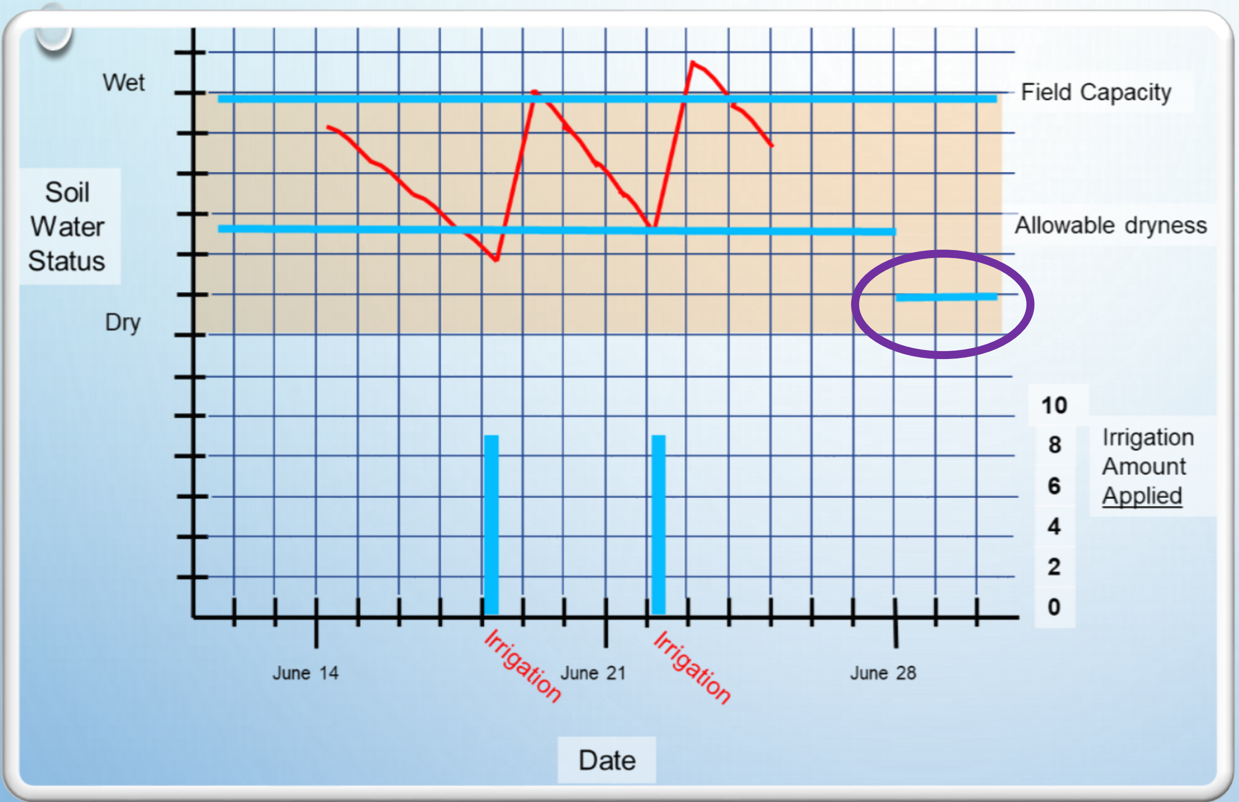
ADJUSTING IRRIGATION BASED ON IWM GRAPH RESULTS

- A BASELINE IRRIGATION SEASON IS HELPFUL PRIOR TO MAKING SIGNIFICANT CHANGES TO THE FIELD CAPACITY AND ALLOWABLE DRYNESS THRESHOLDS
- CONSIDER CHANGING THRESHOLDS WHEN CHANGING CROPS
- IS YOUR CROP YIELD AND HEALTH WHAT YOU EXPECTED THEM TO BE?
  - DO YOU NEED TO ADJUST YOUR THRESHOLDS FOR THE NEXT CROP IRRIGATION SEASON?
- IS YOUR PLANT ROOT ZONE CHANGING FOR THE NEXT IRRIGATION SEASON (I.E. YOUNG PERMANENT CROPS)?
  - CONSIDER CHANGING YOUR FIELD CAPACITY THRESHOLD ANNUALLY UNTIL THE CROPS ARE MATURE.



Scheduling with the IWM Graph

SCHEDULING IRRIGATION



- WHAT DO YOU DO WITH THE SCHEDULING DATA?
  - DO YOU CHANGE FREQUENCY/ INTERVALS OR DURATION?
  - FLOOD/FURROW: CHANGE FLOW RATE (GATE VALVE/# OF CHECKS OPEN/# OR SIZE OF SIPHONS)
- CONSIDER DEFICIT IRRIGATION AND ITS IMPACT ON THRESHOLDS THROUGHOUT THE GROWING SEASON

FINANCIAL ASSISTANCE THROUGH USDA-NRCS: ENVIRONMENTAL QUALITY INCENTIVE PROGRAM (EQIP)

- ENERGY AUDIT
- VFD*
- IWM**
- FLOW METERS
- SURFACE AND SUBSURFACE IRRIGATION SYSTEMS***
- SOIL HEALTH PRACTICES INCLUDING:
  - REDUCED TILLAGE
  - COVER CROPS
- NUTRIENT MANAGEMENT

* Requires an approved Energy Audit so plan ahead.

** Must be a partially or fully automated method, and flow measurement, to qualify for payment

*** The land must have an irrigation history and the new system must be more efficient than the previous one.

QUESTIONS?

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