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Basic Surface Irrigation Theory in Irrigated Pasture

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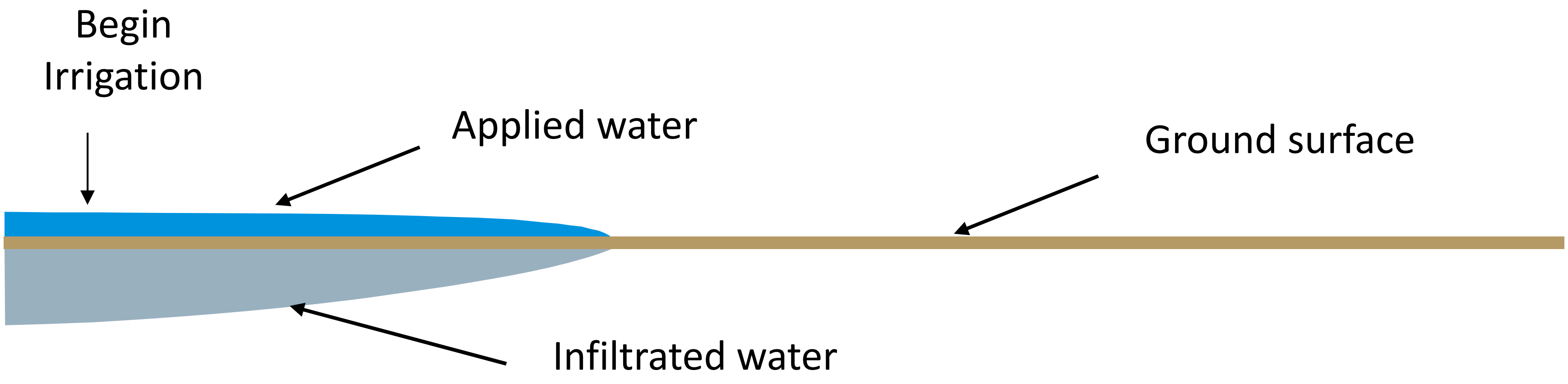
Questions

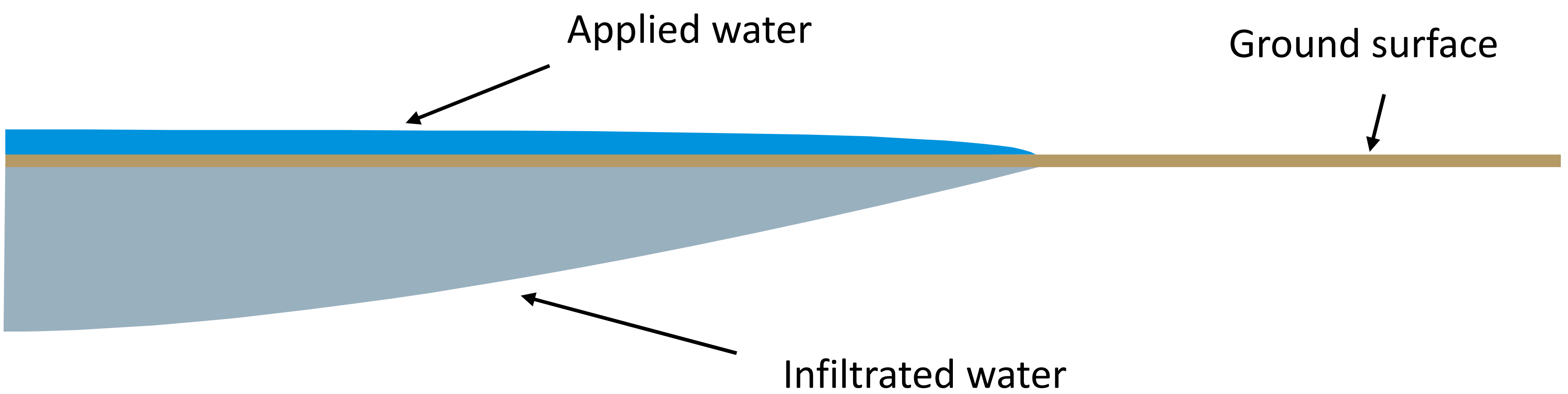
- Am I flood irrigating my pastures efficiently?
  - How do I recognize an inefficient flood system from an efficient system?
  - Is the current flood system design and operation efficient and productive?
  - If not, what types of improvements might I consider?

Concept: Uniform and Efficient Flood Irrigation

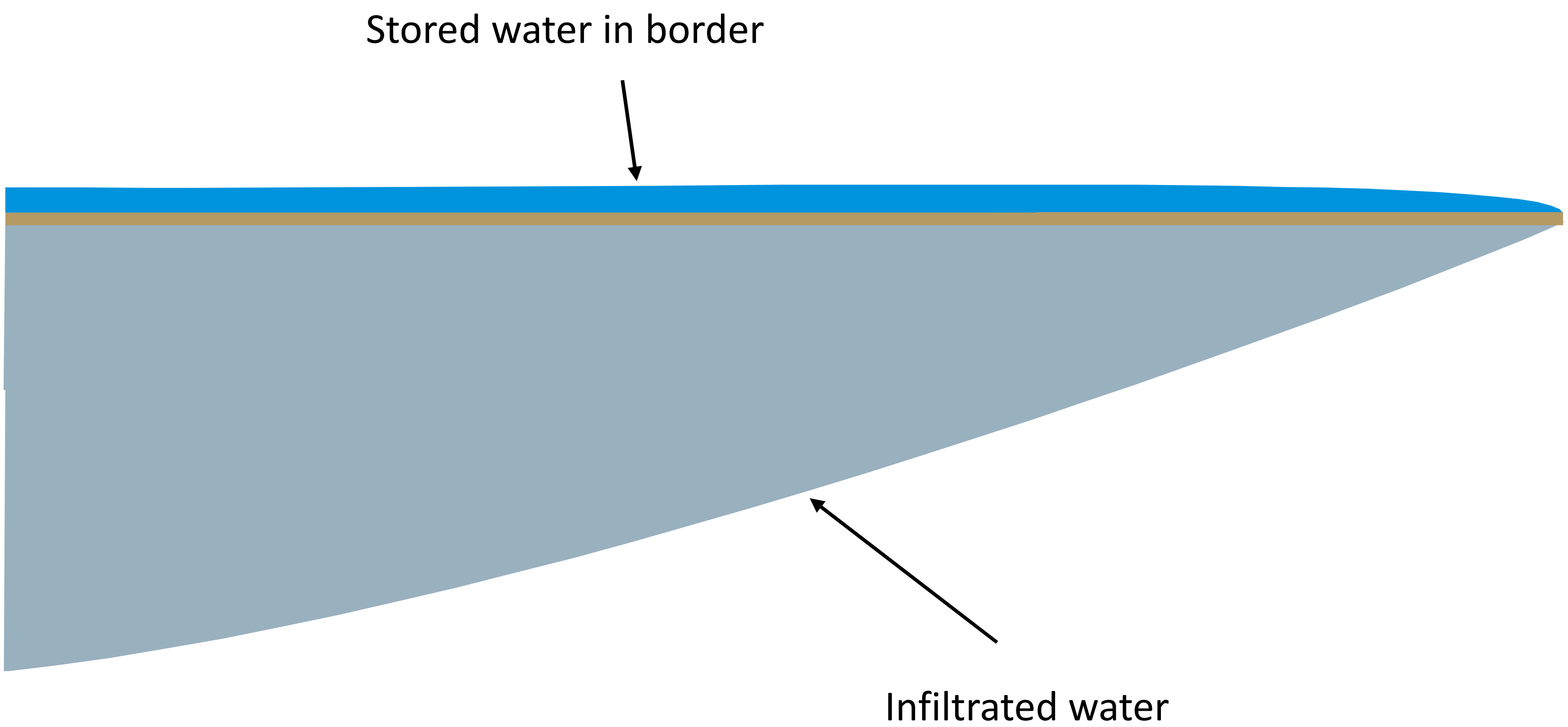
Concept: Distribution of Flood Irrigation Water



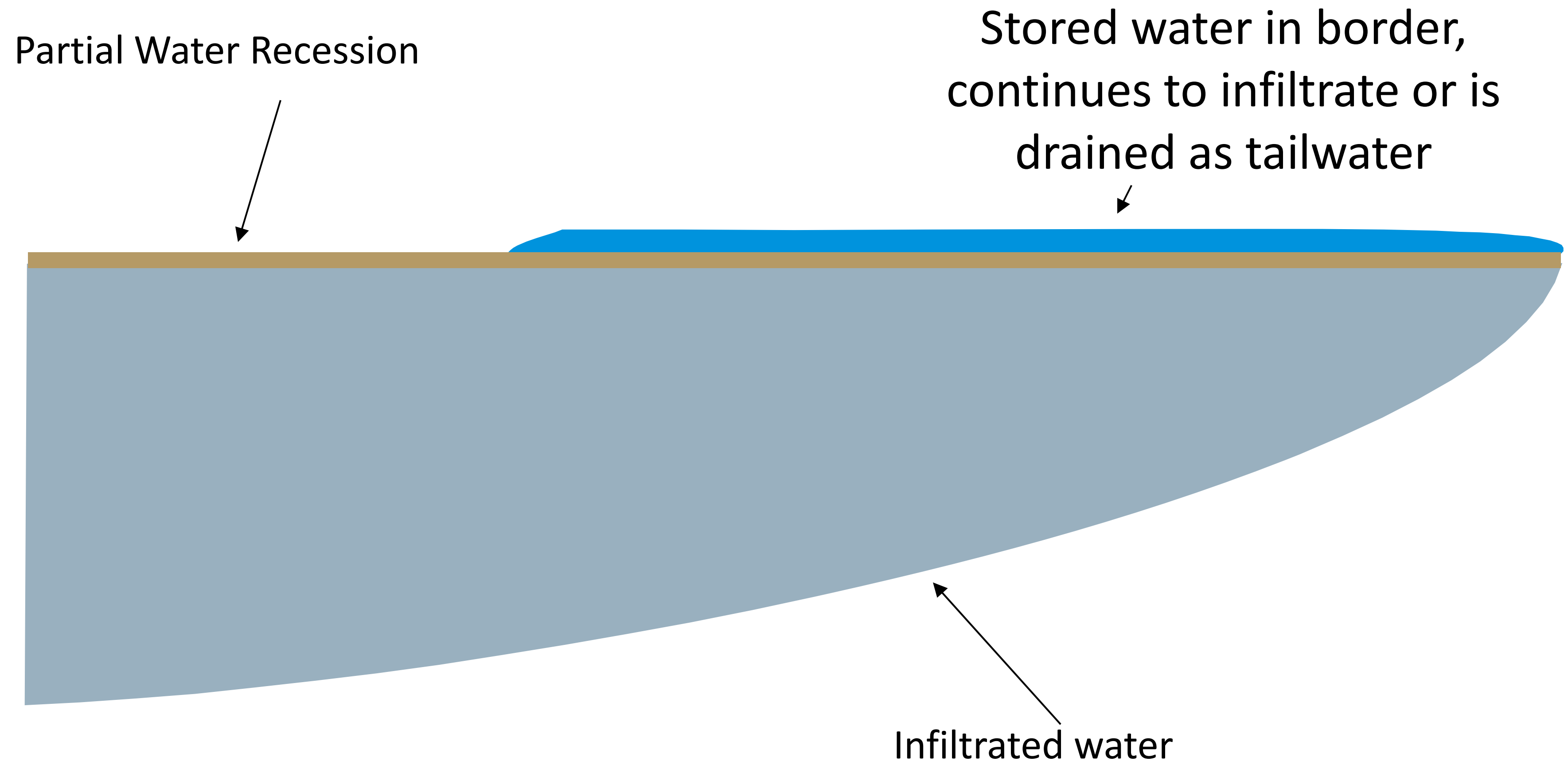
Concept: Water Distribution Midway in the Irrigation Set



Concept: Water Distribution at Irrigation Cutoff



Concept: Water Distribution soon after Irrigation Cutoff



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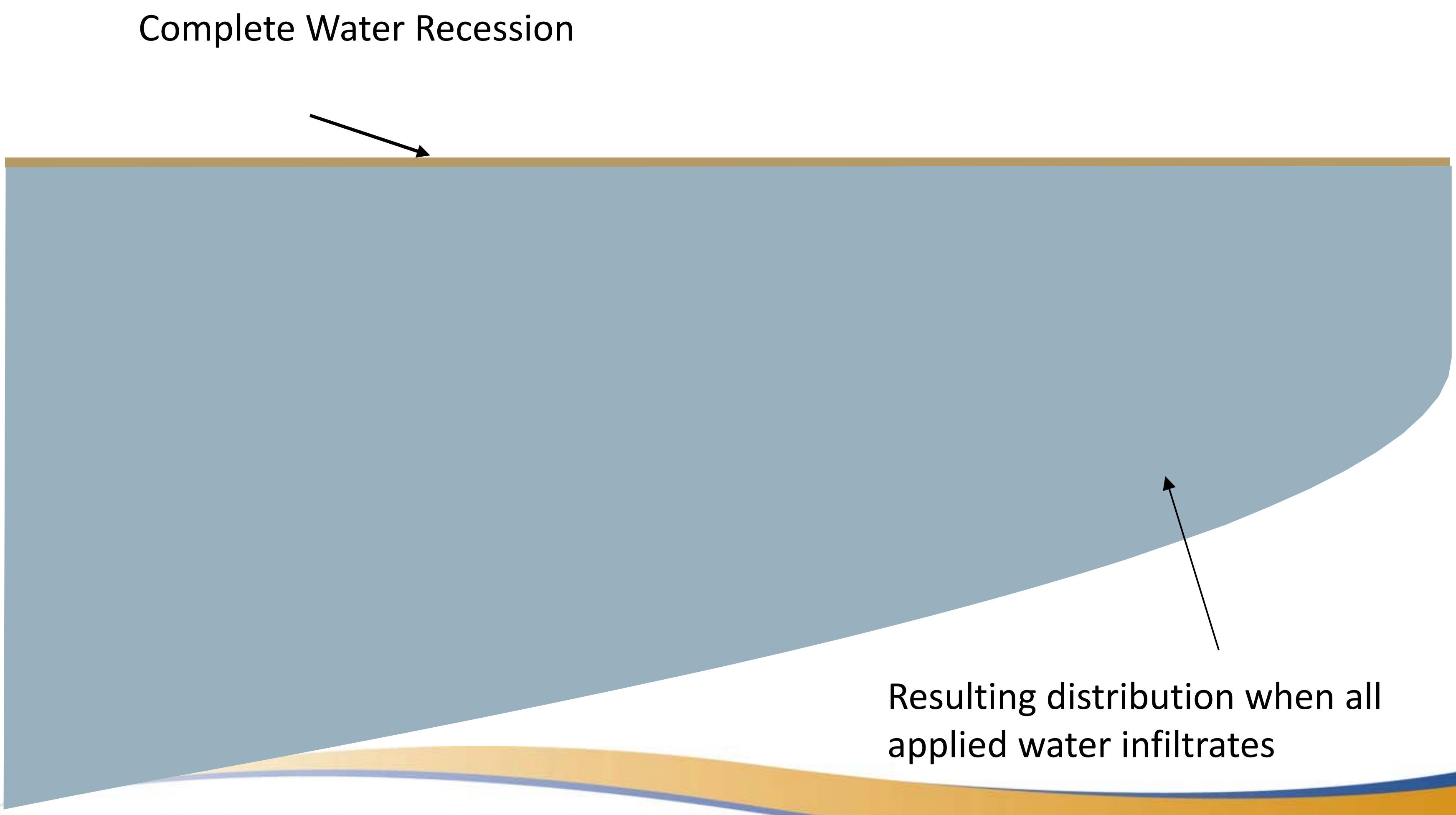
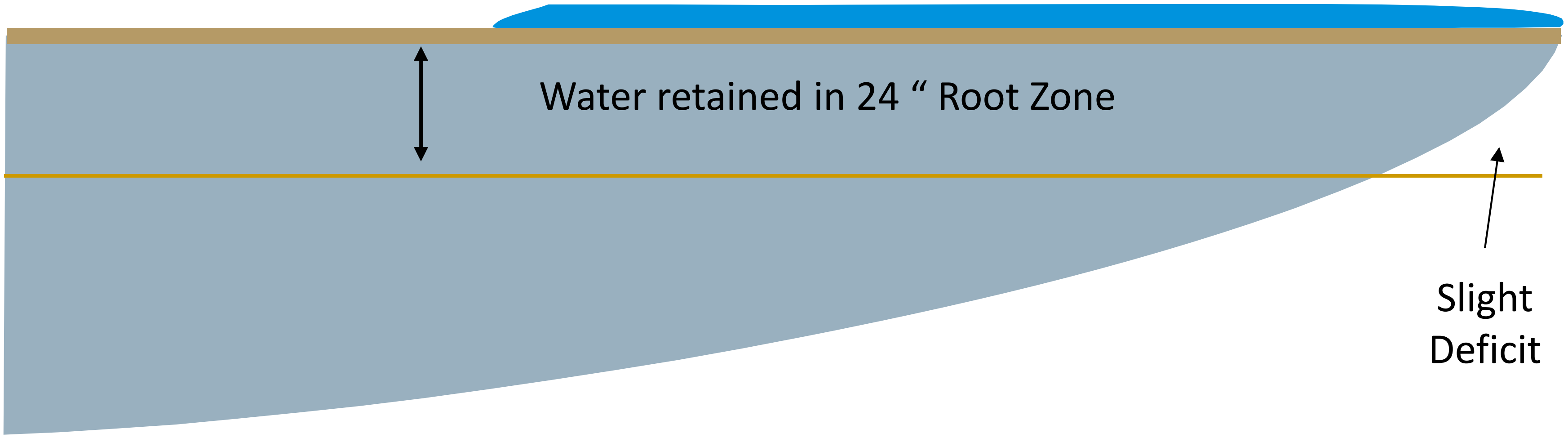
Concept: Water Distribution Hours After Irrigation Cutoff

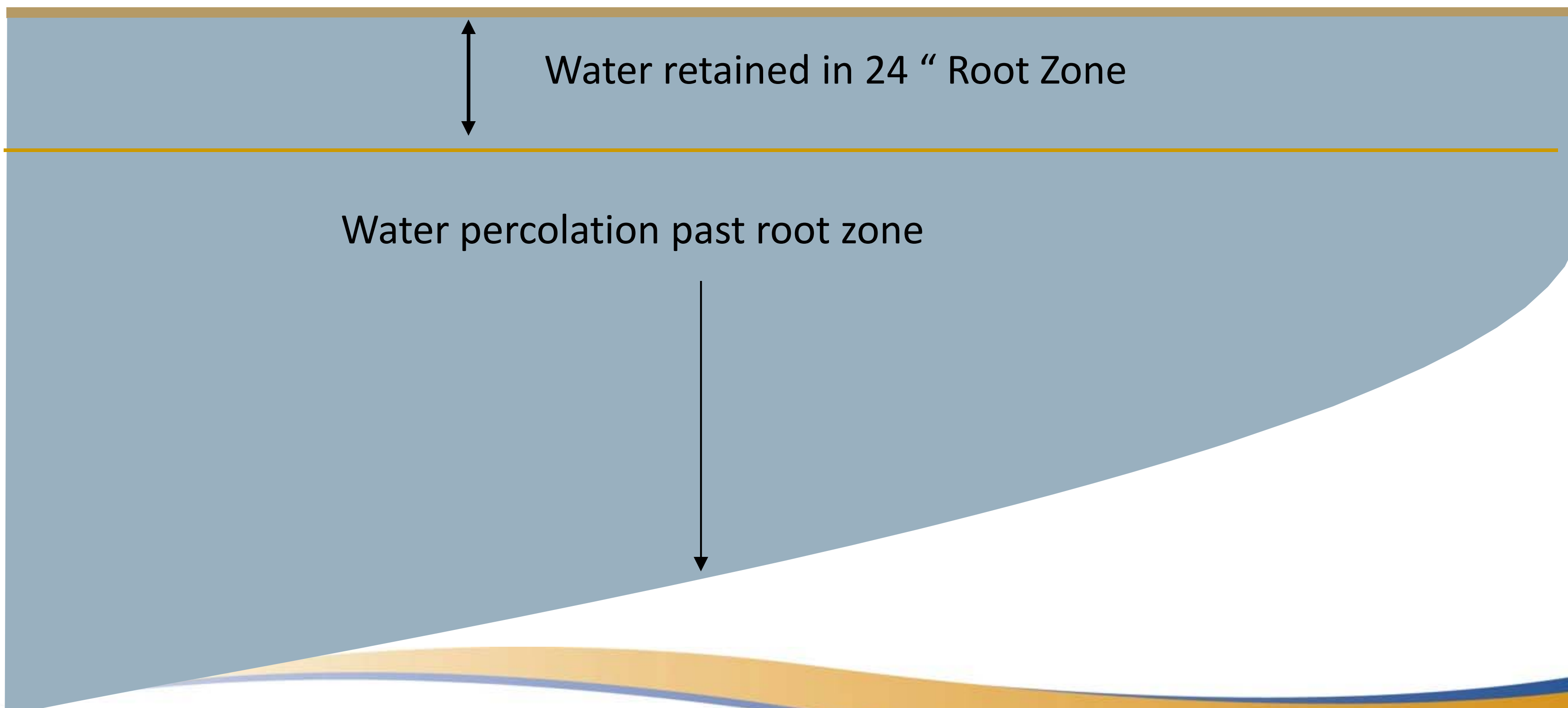


Example of semi-efficient flood irrigation (50-60 %)



Example of low flood irrigation efficiency

(20 – 30 %)



Consequences of low irrigation efficiency:

- Delayed water district delivery rotation among its users
- Negative effects on forage yields and forage composition due to extremes in growing conditions
  - Prolonged standing water after irrigation
  - Excess crop stress prior to next irrigation
- Higher electric bills, if using groundwater

Benefit of low irrigation efficiency:

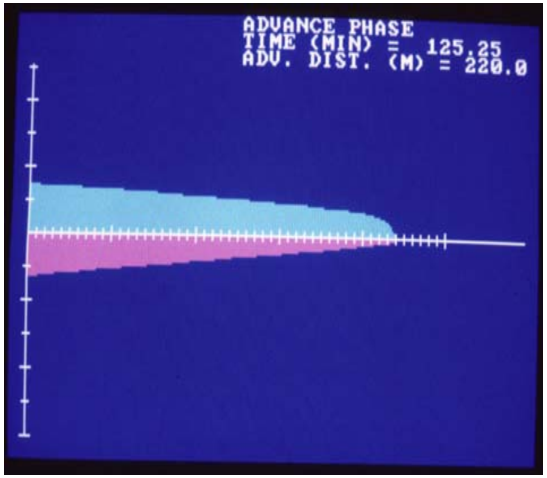
- Groundwater recharge but only if irrigating with surface water
- Need to be alert about leaching nitrates, etc…

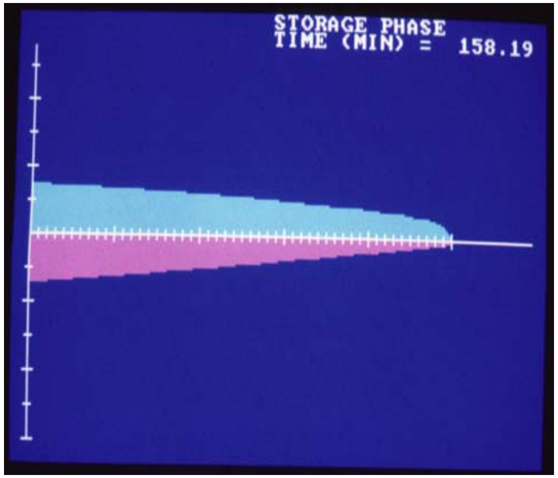
Recognizing Uniform and Non-Uniform Flood Irrigation

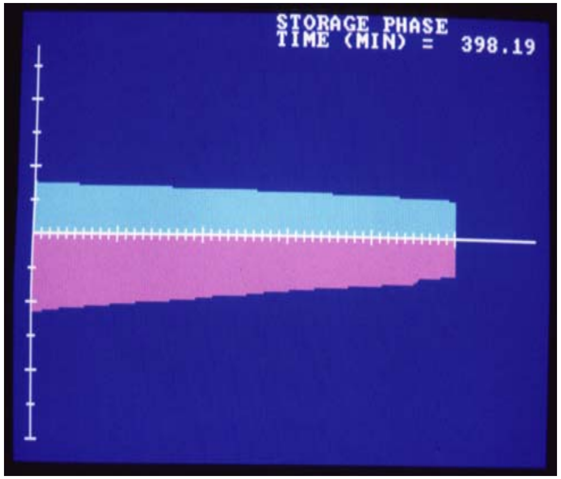
Irrigation systems that apply water uniformly have a chance of being efficient

Advance Ratio > 2 indicates reasonable uniformity

$$\frac{\text{Total time the water ran on an irrigation set}}{\text{Time it takes for water to first reach the end of the field}}$$







Advance Ratio = 398 minutes ÷ 158 minutes = 2.5

How to determine how much water has been applied.

$$\frac{(Q \div 449) \times T}{A} = D$$

Q = gpm (gallons per minute) flow rate

T = hours irrigation set time

A = acres in irrigation set

D = depth (inches) of water applied

(How close to 4 inches is it?)

If flow is measured in cfs, no need to divide by 449 in equation.

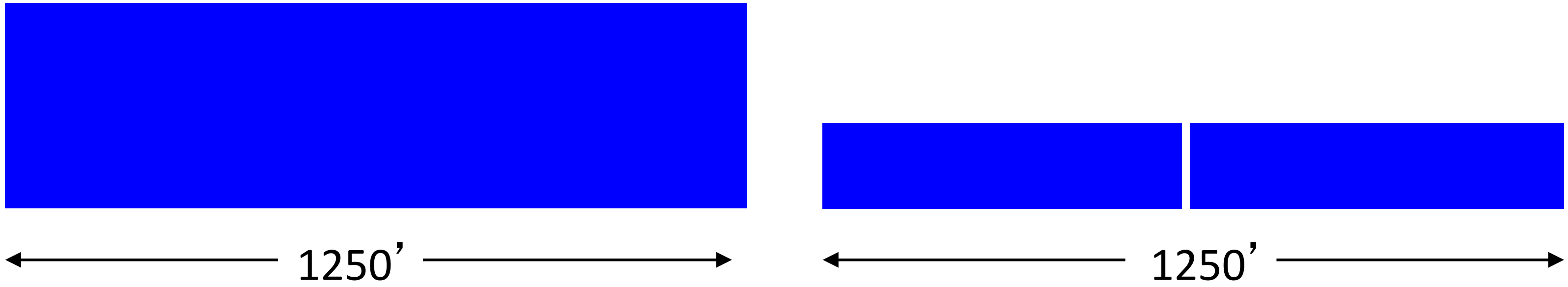
What types of flood irrigation improvements might be considered?

- Reduced check length
- Tailwater reuse
- Increased flow per foot of check
  - More flow, narrower check
- Increased field slope
- Border check maintenance

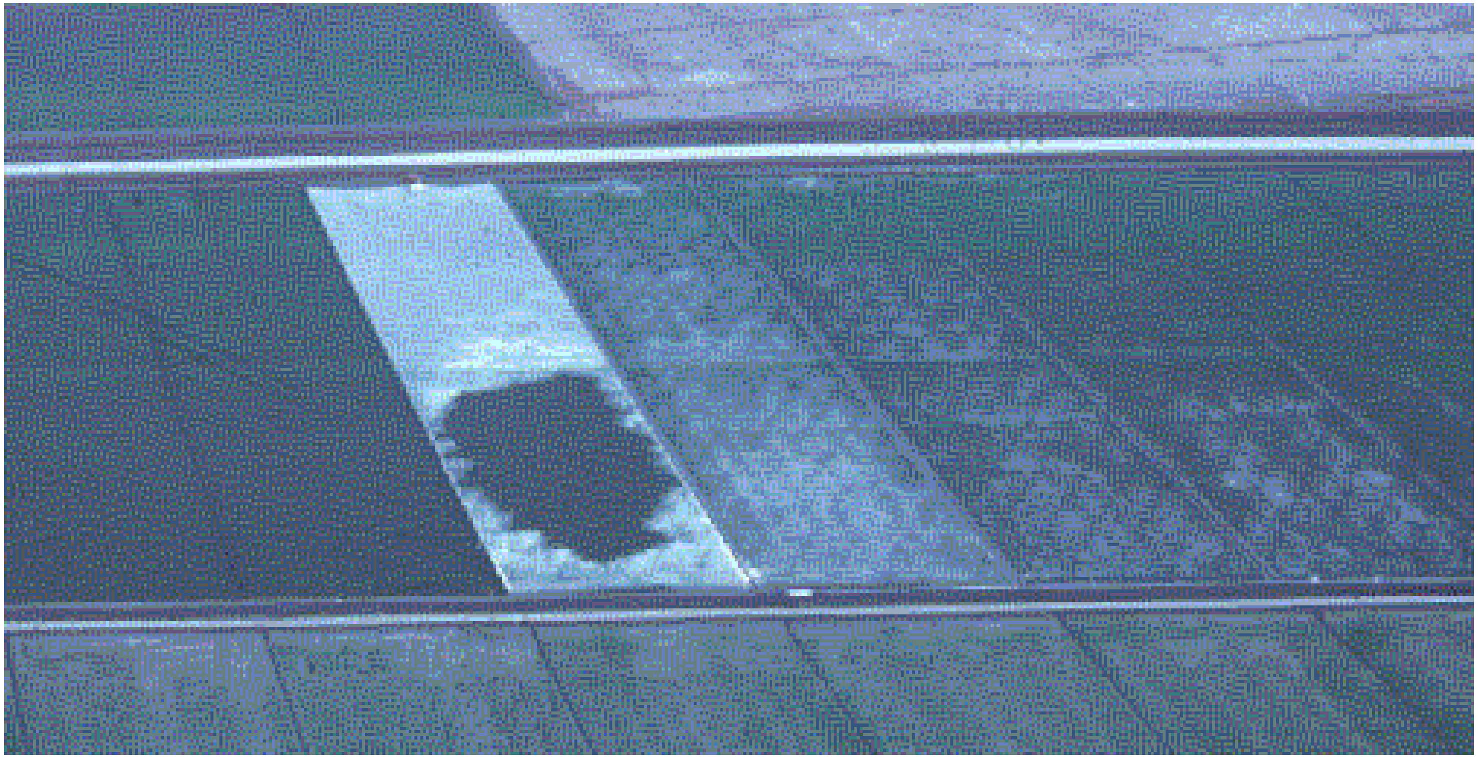
Reduce check length

- Often the most effective option
- Also often the least popular option

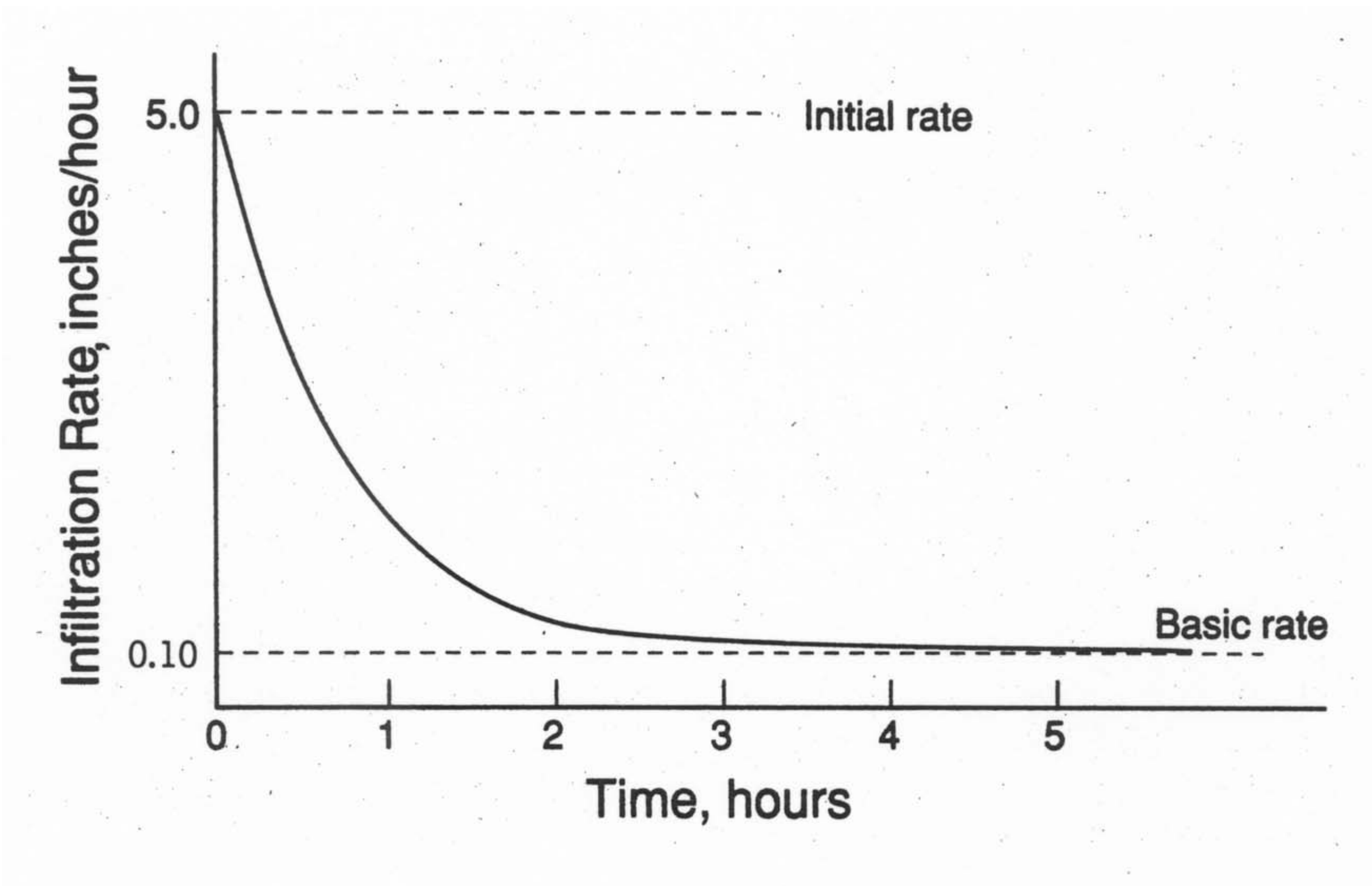
Field	1250' Field	600'
Irrigation Amount	9.1"	5.4"



Why does reducing check length improve irrigation efficiency?



Infiltration rate of soil



Tailwater Return System

- Accept tailwater over deep percolation
- Be prepared to manage tailwater

Increase the flow per foot of border check

Case study: More flow per foot of check width.

- Narrow checks
- Increase flow

	Wide check (200')	Narrow check (100')
Irrigation Applied	**5.1"**	**4.3"**

Increase the field slope & maintain checks

	0.001 slope	0.002 slope
Irrigation Applied	5.1”	4.8”

Which irrigation system improvements make the most sense?

- It depends upon your situation
  - How efficient or inefficient is the existing system
  - Economics
    - Costs of irrigation improvement
    - Opportunity for improved pasture performance and grazing capacity

The role of soil moisture monitoring and evapotranspiration (ET) information?

- Insight about when to irrigate
- Information about how much water to apply

Soil Moisture Resistance Blocks (Watermark)

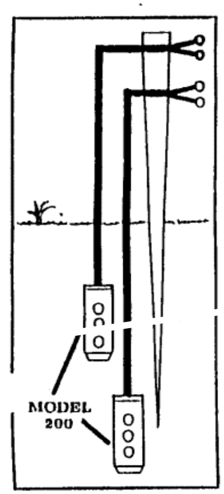


FIG. 1

AS A GENERAL GUIDE, THESE READINGS TELL YOU:

0-10 centibars =	Saturated Soil
10-20 centibars =	Soil is adequately wet (except coarse sands which are beginning to lose water)
30-60 centibars =	Usual range for irrigation (except heavy clay soils)
60-100 centibars =	Usual range for irrigation for heavy clay soils
100-200 centibars =	Soil is becoming dangerously dry for maximum production. Proceed with caution!

Cost:

-About $350 for meter

-About $40 per sensor

Numerous Retailers:

-http://www.irrometer.com/

-http://www.benmeadows.com/

-http://www.forestry-suppliers.com/

-http://www.grainger.com/

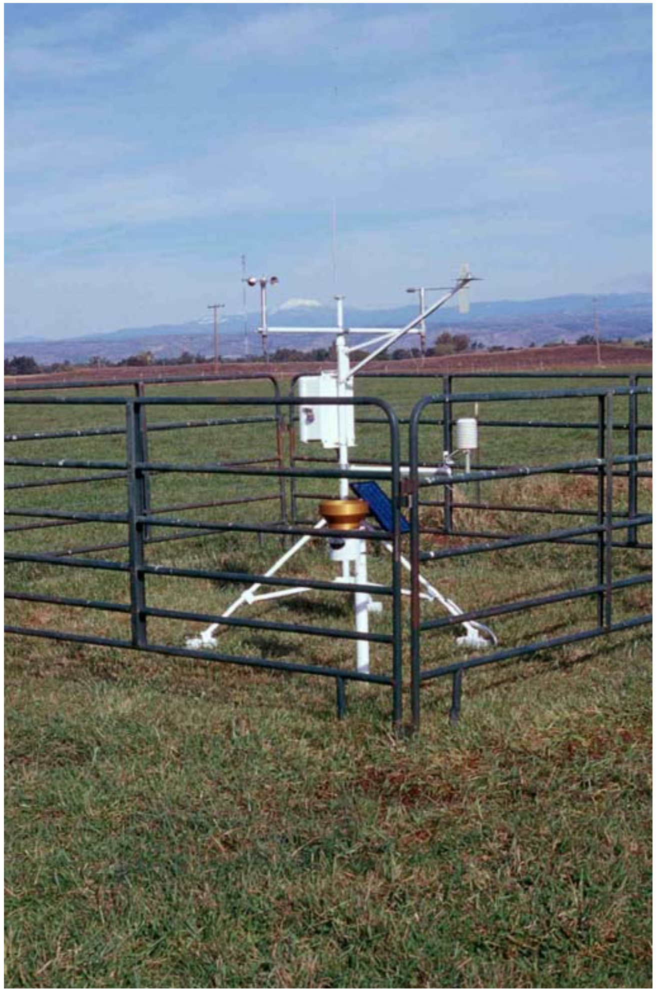
Field Observation of Soil Moisture – NRCS Handout

Sandier → More Clay

Wetter

Drier

Real-time evapotranspiration (ET) information



WEEKLY SOIL MOISTURE LOSS IN INCHES

(Estimated Evapotranspiration)

03/28/14 through 04/03/14

West of Sacramento River				East of Sacramento River		
Past Week of Water Use	Accum'd Seasonal Water Use	NOAA Forecasted Week of Water Use	**Crop (Leafout Date)**	Past Week of Water Use	Accum'd Seasonal Water Use	NOAA Forecasted Week of Water Use
0.49	7.88	1.14	Pasture	0.48	6.84	1.12
0.49	7.96	1.11	Alfalfa	0.48	6.87	1.08
0.39	6.03	0.86	Olives	0.37	5.21	0.85
0.33	5.18	0.75	Citrus	0.32	4.51	0.72
0.36	2.96	0.87	Almonds (2/12) *	0.35	2.76	0.86
0.36	1.41	0.91	Prunes (3/15) *	0.35	1.34	0.90
0.13	0.13	0.60	Walnuts (4/1) *	0.15	0.15	0.59
0.45	5.48	1.20	Urban Turf Grass	0.45	4.79	1.18

Accumulations started on February 12, 2014 or on the approximate leafout date for a specific orchard crop as indicated in parentheses. Criteria for beginning this report are based on the season's last significant rainfall event where the soil moisture profile is estimated to be near its highest level for the new season.
* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum growth."

West		East
1.11	**Past Seven days Precipitation (Inches)**	**1.05**
5.29	**Accum'd Precip (Inches)**	**5.13**

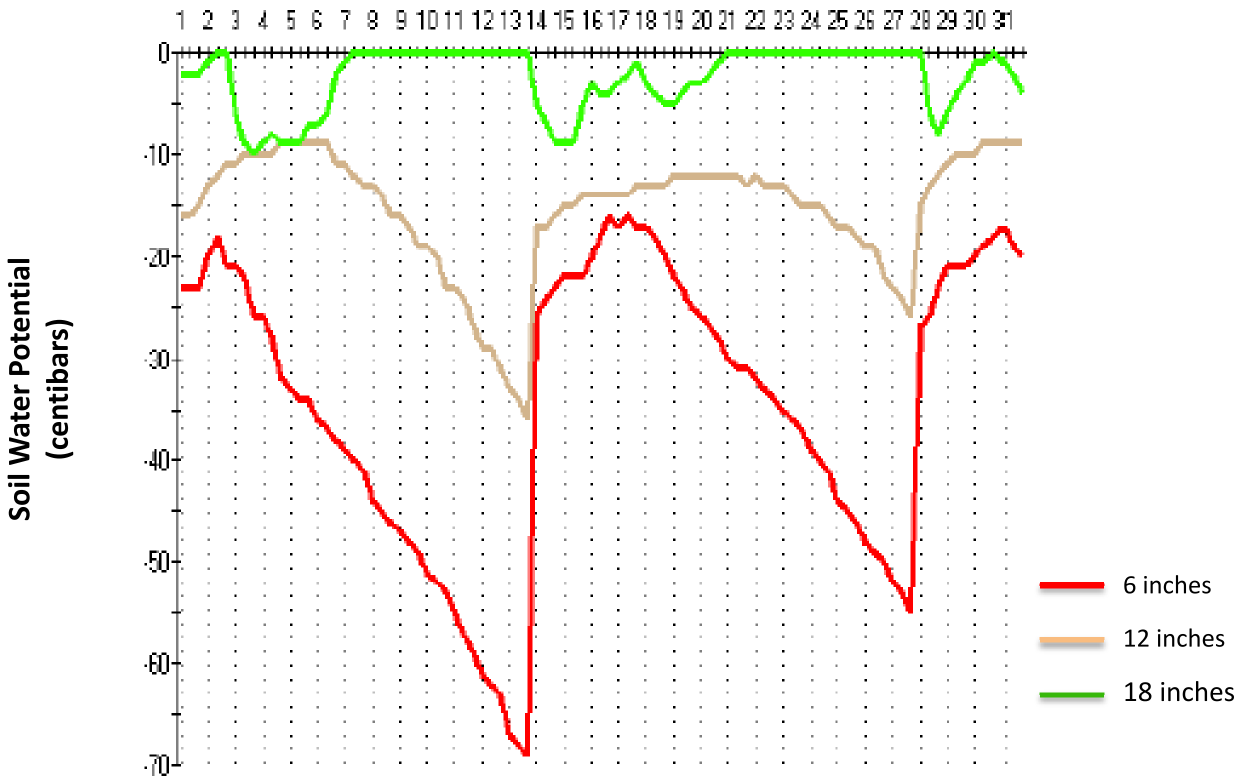
PAST WEEKLY APPLIED WATER IN INCHES, ADJUSTED FOR EFFICIENCY[1]

50%	60 %	70%	80 %	90%	Efficiency	50 %	60 %	70 %	80 %	90%
0.8	0.7	0.6	0.5	0.4	Olives	0.7	0.6	0.5	0.5	0.4
0.7	0.6	0.5	0.4	0.4	Citrus	0.6	0.5	0.5	0.4	0.4
0.7	0.6	0.5	0.5	0.4	Almonds (2/12)	0.7	0.6	0.5	0.4	0.4
0.7	0.6	0.5	0.5	0.4	Prunes (3/15)	0.7	0.6	0.5	0.4	0.4
0.3	0.2	0.2	0.2	0.1	Walnuts (4/1)	0.3	0.3	0.2	0.2	0.2

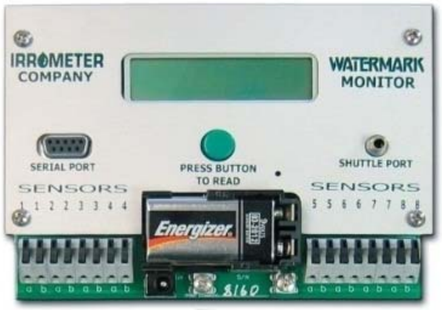
[1] The amount of water required by a specific irrigation system to satisfy evapotranspiration. Typical ranges in irrigation system efficiency are: Drip Irrigation, 80%-95%; Micro-sprinkler, 80%-90%; Sprinkler, 70%-85%; and Border-furrow, 50%-75%.

For further information concerning all counties receiving this report, contact the Tehama Co. Farm Advisor's office at (530) 527-3101.

Example Watermark Soil Moisture Levels in Pasture, July – Tehama County



Watermark Dataloggers



Summary

- Greatest opportunity to achieve better pasture production in irrigated pastures may start by improving irrigation system efficiency (target about 4 inches per irrigation).
- Once irrigation system applies water efficiently, then ask if it is possible to improve forage production and quality with better timing of irrigations.

Thank You!

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