UNIVERSITY of CALIFORNIA
COOPERATIVE EXTENSION

Forage Production Strategies with Limited Water Supplies

2015 Kearney Alfalfa and Forage Field Day

Parlier, CA September 18, 2015

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Forage Production with Reduced Water

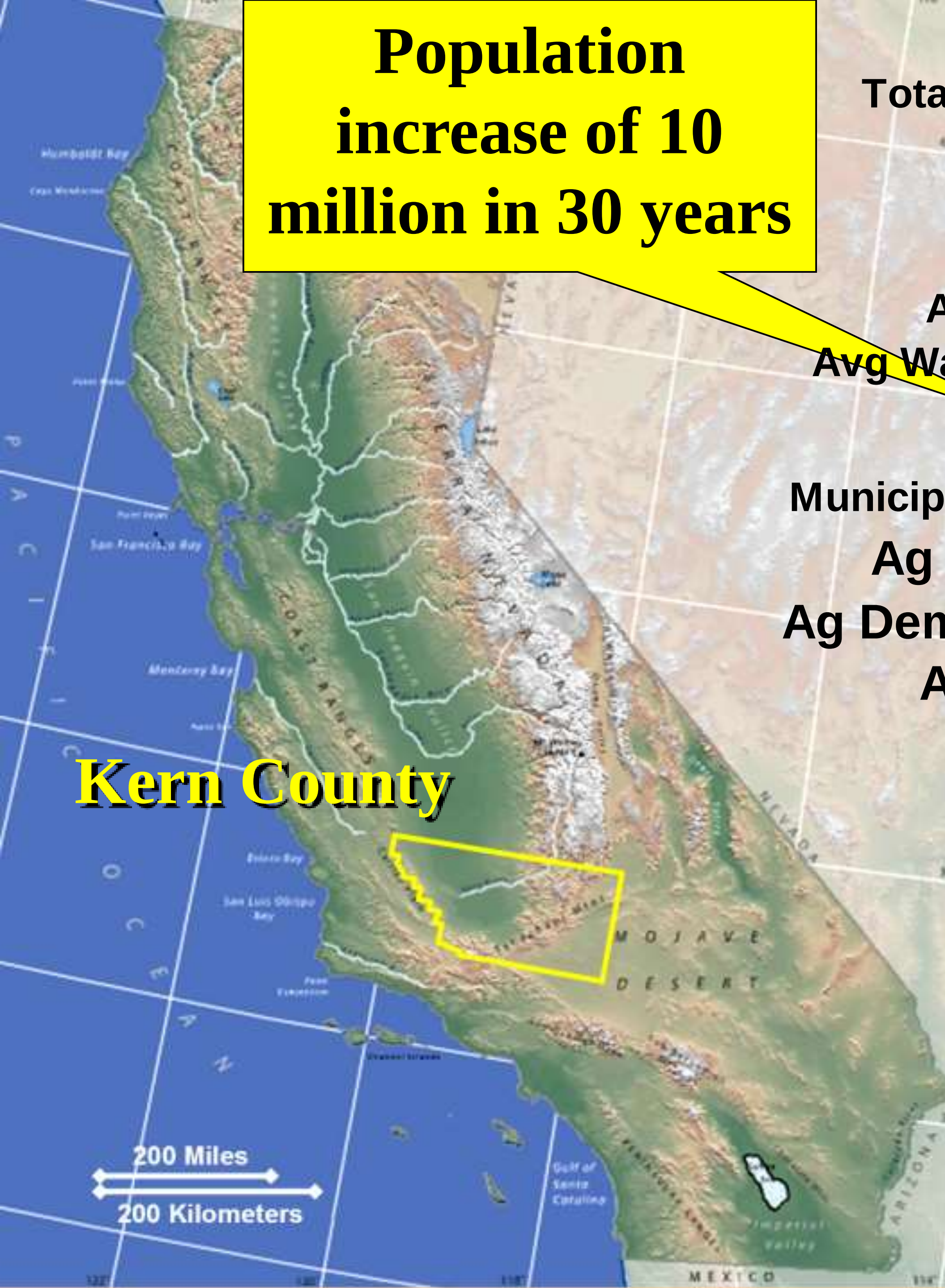
Why would anyone come up with such a hair-brained idea?

California is not building more dams. Meeting increased water demand is going to come through conservation and shifting water supply to "higher value" uses.

Irrigated Acreage & Water Demand in California 1970 to 2000

Population increase of 10 million in 30 years

Year	1970	2000
Total Irrigation (MAc):	8.7	9.6
Gravity	7.2	5.1
Sprinkler	1.5	2.8
Micro	0.0	1.7
Ag demand (MAF):	26.0	25.0
Avg Water Cost ($/ac-ft):	$18	$85
Population:	25.1	35.4
Municipal demand (MAF):	5.0	6.4
Ag Demand/Total:	84%	80%
Ag Demand (ac-ft/ac):	3.00	2.60
Ag Savings (%):	Base	13%



Forage Production with Reduced Water

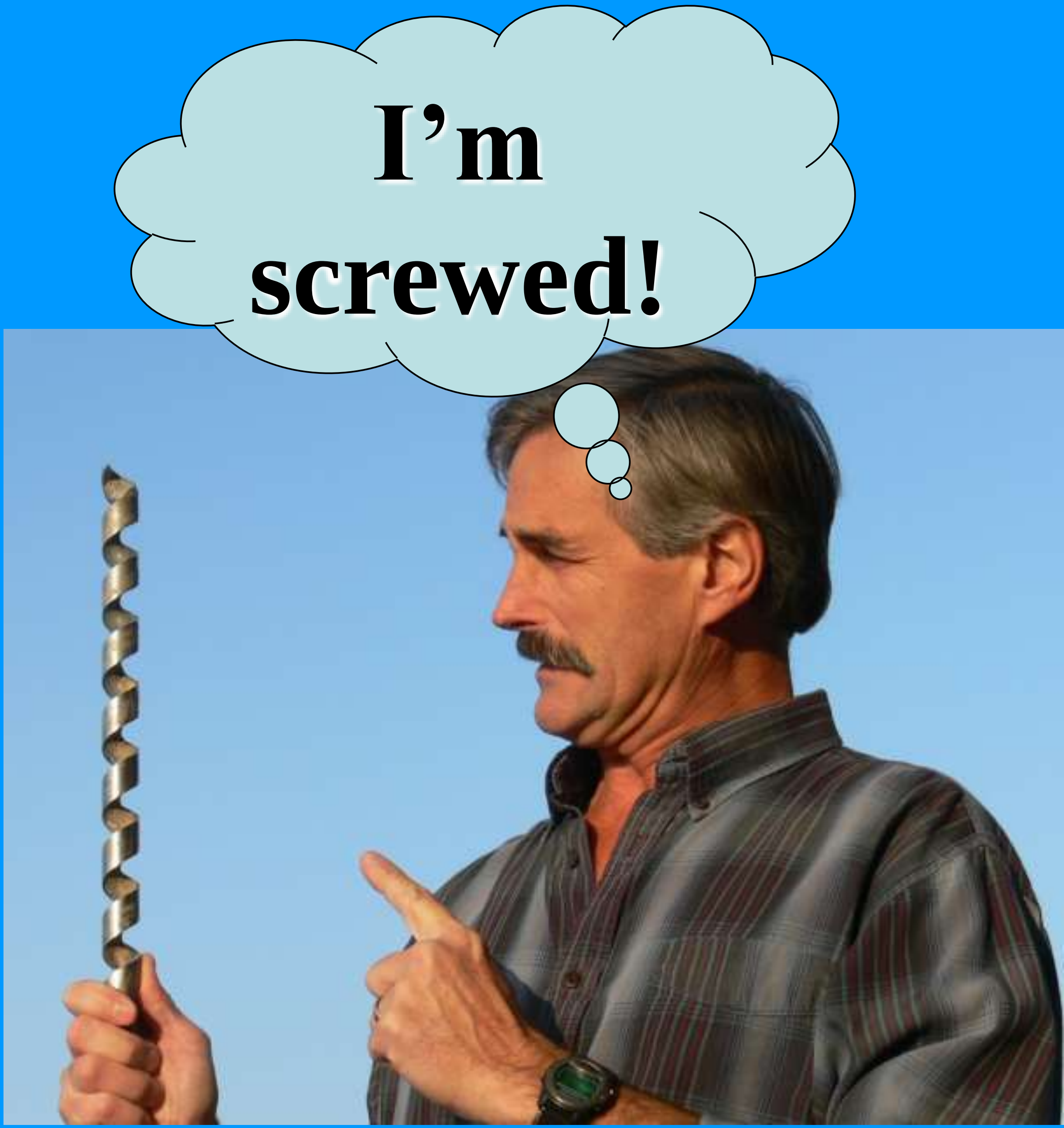
First: a public service message …

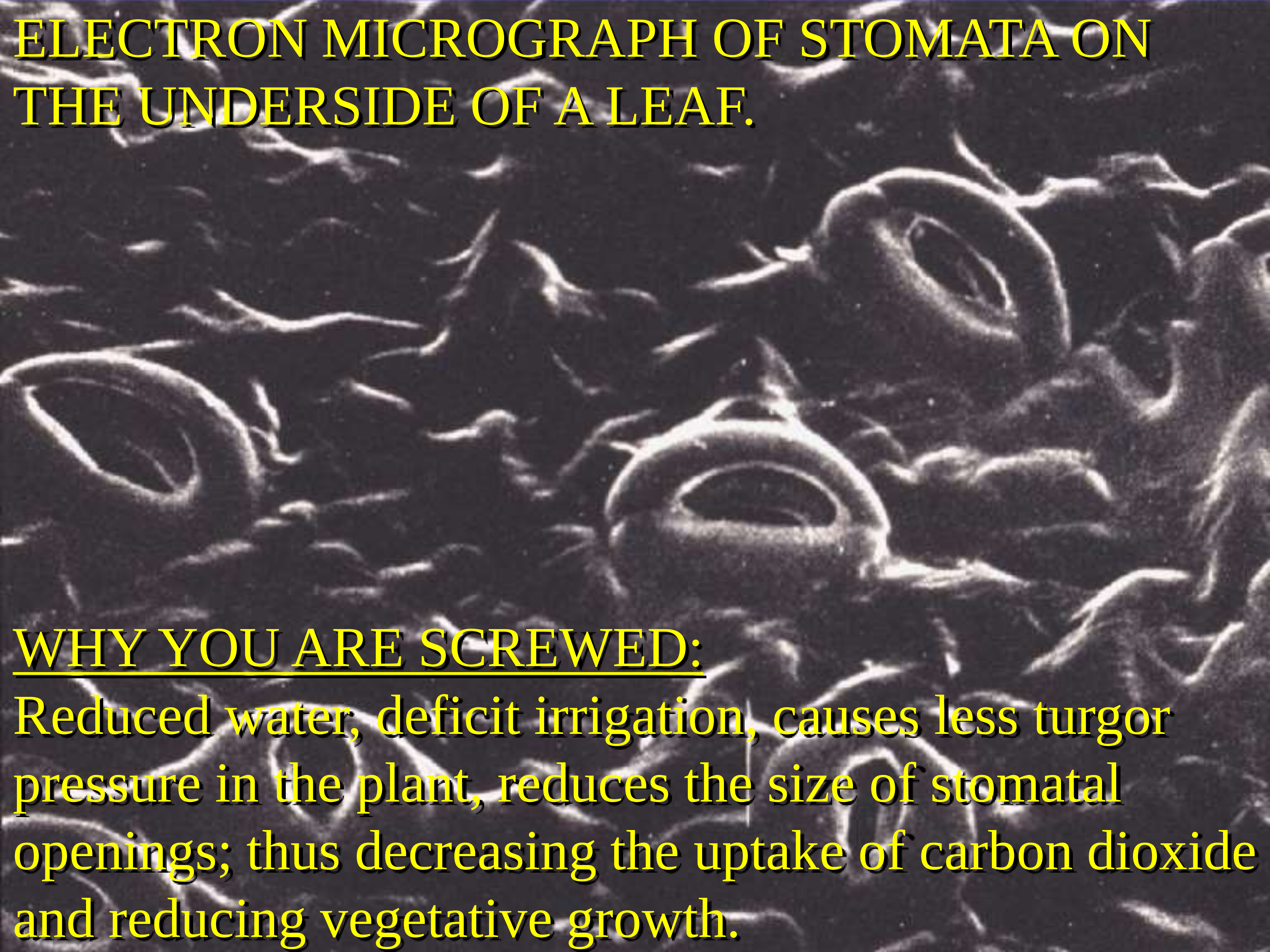
This is your forage.

Forage Production with Reduced Water

This is your forage on reduced water.

Any questions?

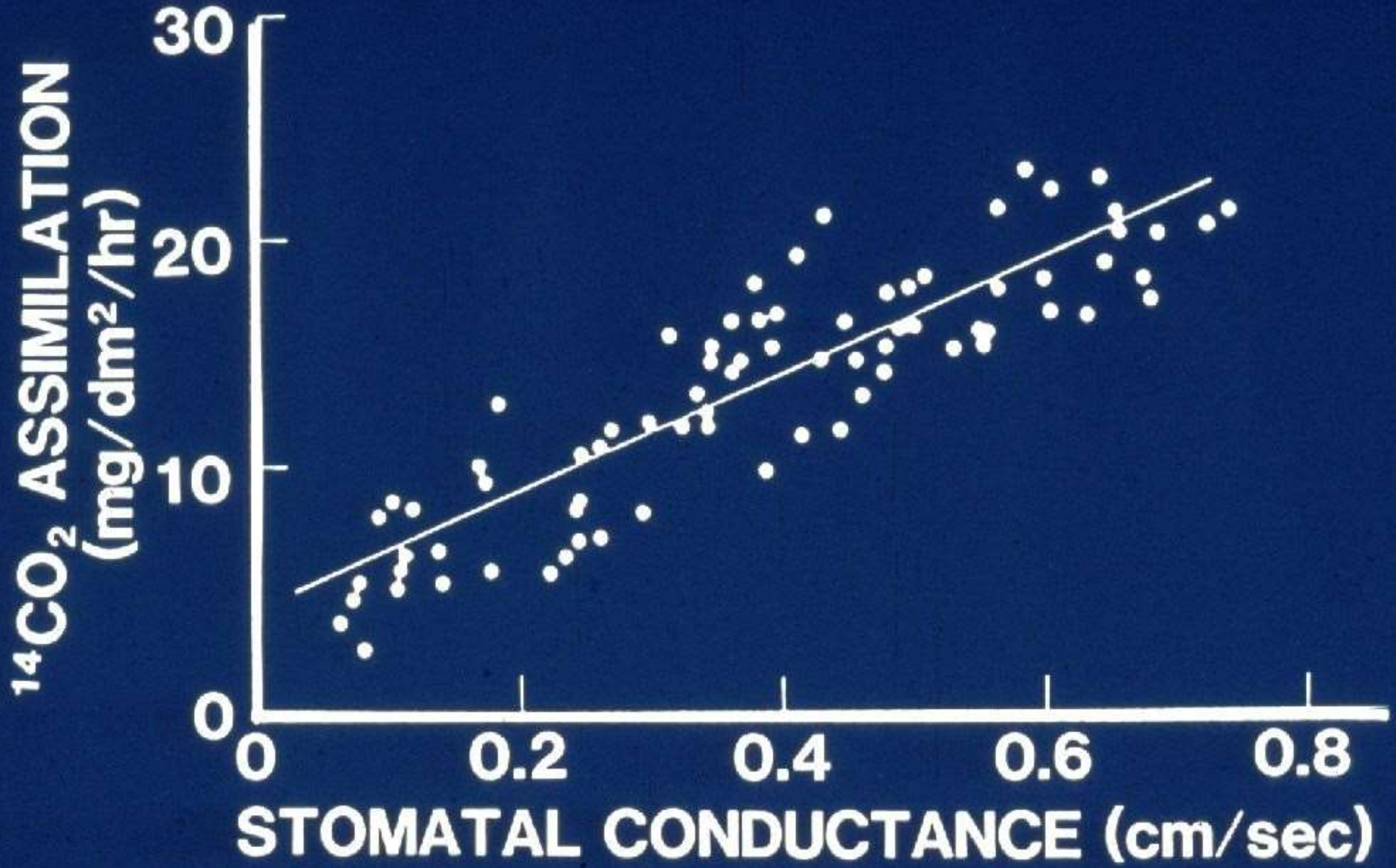




ELECTRON MICROGRAPH OF STOMATA ON THE UNDERSIDE OF A LEAF.

WHY YOU ARE SCREWED:

Reduced water, deficit irrigation, causes less turgor pressure in the plant, reduces the size of stomatal openings; thus decreasing the uptake of carbon dioxide and reducing vegetative growth.

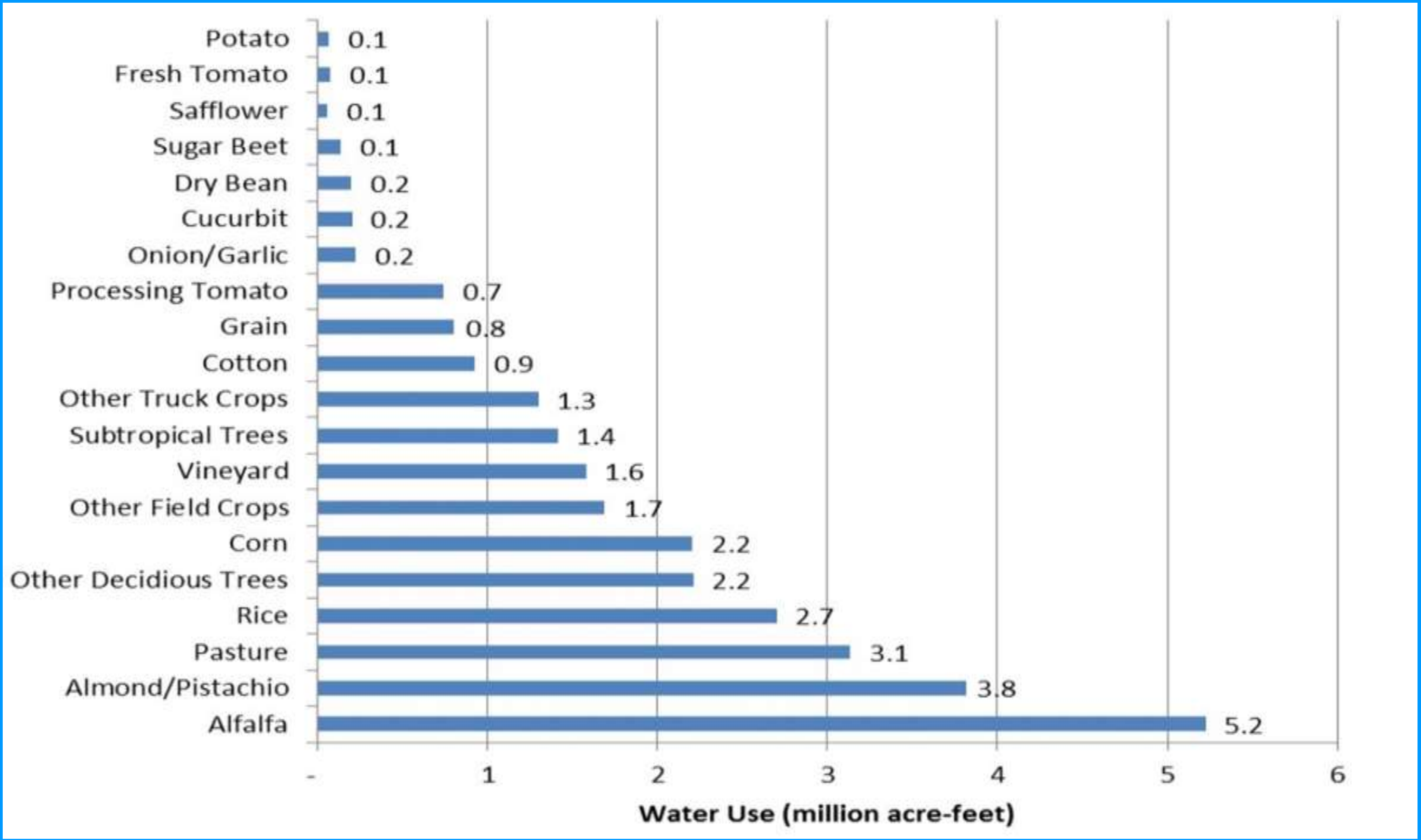


30
20
10
0
$^{14}CO_2$ ASSIMILATION
(mg/dm²/hr)
0
0.2
0.4
0.6
0.8
STOMATAL CONDUCTANCE (cm/sec)

Google (images): “statewide alfalfa water demand”

Here’s what you come up with – the thirstiest guy on the planet!

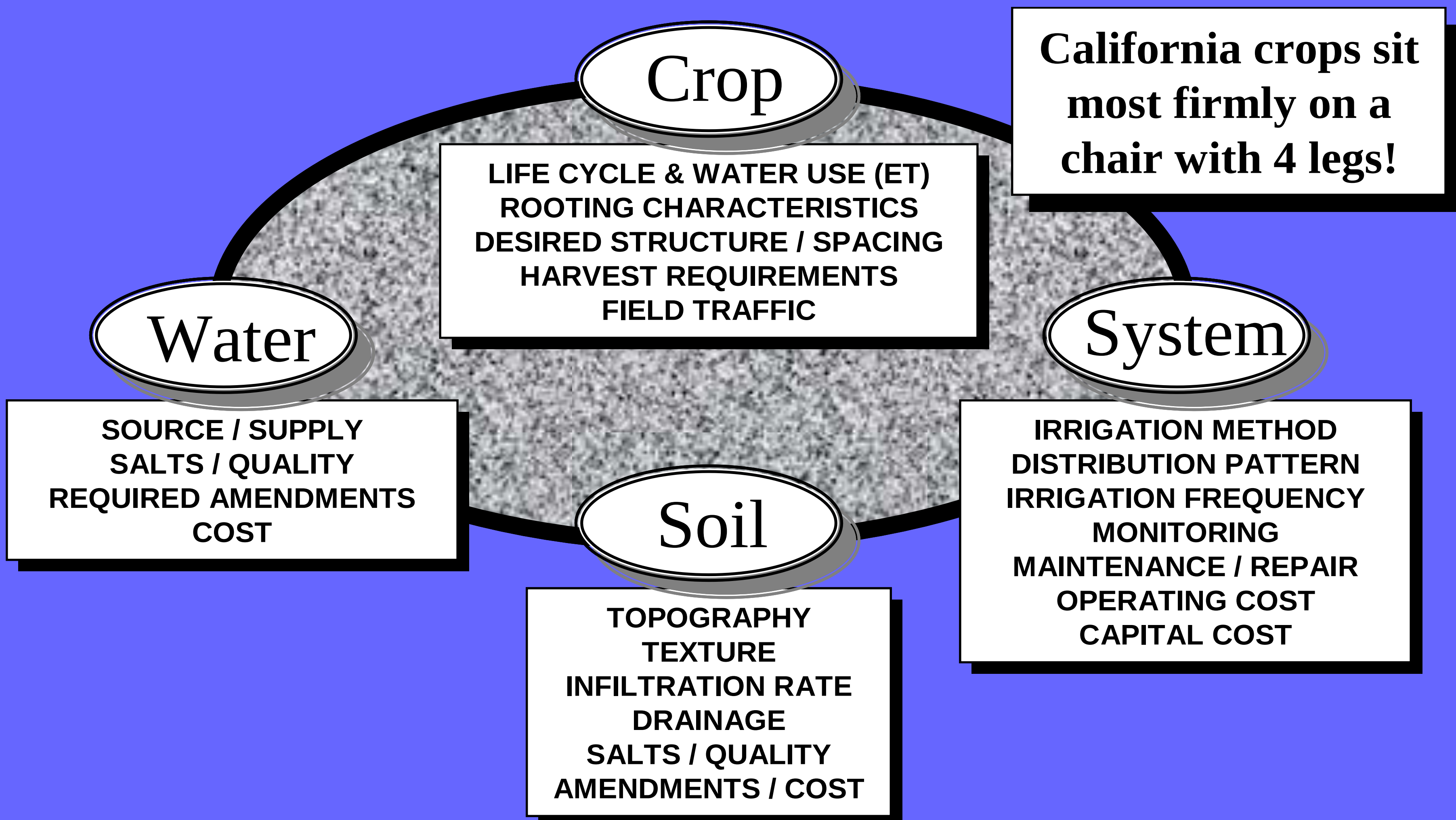
At least he found his boat when the reservoir went dry!



Annual alfalfa water demand: 4 to 5.5 MAC

(Source: California Department of Water Resources, above figure from Pacific Institute 2012)

The irrigation method / system is the "ESSENTIAL" integrating factor for California farming.



~~4~~ 3-point sermon:

- Understanding soil water holding characteristics
- Crop water requirements (ET), CIMIS
- Monitoring soil moisture & irrigation uniformity
- ~~Forage crop salinity tolerance~~

Check your dirt!

SOIL PROFILE

–SOIL TEXTURE

Analysis:

SP 48 -- saturation %

pH 7.8

EC_e 2.0 dS/m

Texture Silty Clay Loam

SOIL SURVEY

BACKHOE PITS

AUGER, PUSH PROBE

mottles, dark yellowish brown (10YR 4/6) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine roots; common very fine and few fine tubular pores and many very fine interstitial pores; neutral; clear wavy boundary.

IIIC8—48 to 56 inches; white (10YR 8/1) silt loam, gray (10YR 5/1) moist; common medium prominent brownish yellow (10YR 6/8) mottles, dark yellowish brown (10YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine and common fine roots; many very fine and common fine tubular pores and common very fine interstitial pores; neutral; clear wavy boundary.

IXC9—56 to 65 inches; very pale brown (10YR 8/3) sand, grayish brown (10YR 5/2) moist; few fine prominent brownish yellow (10YR 6/8) mottles, dark yellowish brown (10YR 4/6) moist; single grain; loose, nonsticky and nonplastic; many very fine interstitial pores; neutral.

The soil is noneffervescent below a depth of 11 to 20 inches.

The A horizon has dry color of 10YR 5/2, 5/3, 6/2, or 6/3 and moist color of 10YR 4/2, 4/3, or 5/3. Clay content is 10 to 18 percent.

The C horizon has dry color of 10YR 6/2, 6/3, 6/6, 7/2, 7/3, 8/1, or 8/3 or 2.5Y 6/2 and moist color of 10YR 3/2, 3/3, 4/2, 4/6, 5/1, 5/2, or 5/3 or 2.5Y 4/2 or 5/2. Mottles have dry color of 10YR 5/6, 6/6, 6/8, or 8/3 or 7.5YR 5/4 and moist color of 10YR 3/6, 4/6, or 5/3 or 7.5YR 5/4. Texture is stratified sand, loamy sand, loamy fine sand, sandy loam, fine sandy loam, loam, or silt loam. Clay content is 10 to 18 percent. Reaction is slightly acid to moderately alkaline.

Exeter Series

The Exeter series consists of moderately deep, well drained soils on broad alluvial terraces. These soils formed in alluvium derived dominantly from granitic rock. Slope is 0 to 9 percent.

Soils of the Exeter series are fine-loamy, mixed, thermic Typic Durixeralfs.

Typical pedon of Exeter sandy loam, 0 to 2 percent slopes (fig. 4); on an alluvial terrace where slopes are 1 percent; about 3 miles west of Highway 65 on Highway 155, 150 feet north and 200 feet west of the southeast corner of sec. 7, T. 25 S., R. 27 E.; Richgrove Quadrangle.

Ap—0 to 4 inches; pale brown (10YR 6/3) sandy loam, dark brown (10YR 3/3) moist; weak very coarse platy structure; very hard, friable, nonsticky and nonplastic; common very fine roots; many very fine interstitial pores and few very fine tubular pores; neutral; clear smooth boundary.

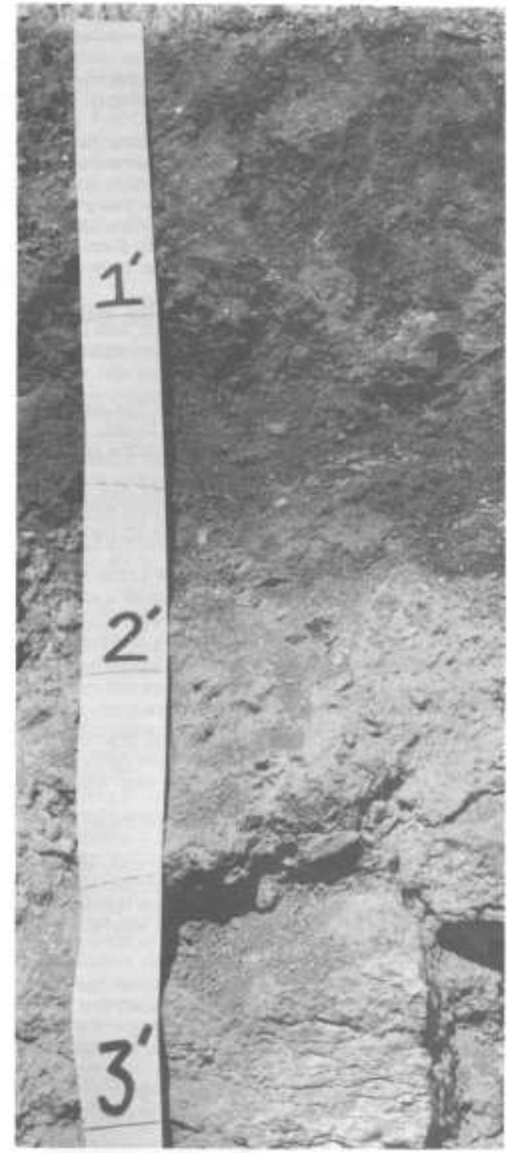


Figure 4.—Profile of Exeter sandy loam, 0 to 2 percent slopes. A duripan is at a depth of about 24 inches.

Backhoe Pits – the Worm’s Eye View!

Check your dirt! It has more secrets than the CIA.

The "dirt" is the thing. Know your soil!

Soil Texture	Field Capacity (in/ft)	Wilting Point (in/ft)	Available Soil Moisture (in/ft)	Avg Drip Subbing Diameter from 1 to 4' Depth (ft)	*Moisture Reserve (gals)
Sand	1.2	0.5	0.7	2	4
Loamy Sand	1.9	0.8	1.1	3	16
Sandy Loam	2.5	1.1	1.4	4	35
Loam	3.2	1.4	1.8	5	70
Silt Loam	3.6	1.8	1.8	6	102
Sandy Clay Loam	3.5	2.2	1.3	7	100
Sandy Clay	3.4	1.8	1.6	7	123
Clay Loam	3.8	2.2	1.7	8	170
Silty Clay Loam	4.3	2.4	1.9	9	241
Silty Clay	4.8	2.4	2.4	9	305
Clay	4.8	2.6	2.2	10	345

*This is the maximum gallons of water stored to a 4' depth beneath a single drip emitter. In fine textured soils, the wetted volume of one emitter merges with another on the same hose and final gallons of moisture reserve per emitter will be less than the number shown in the table. Plant stress will usually be seen when about 50% of this reserve has been used.

Ref: Ratliff LF, Ritchie JT, Cassel DK. 1983. Field-measured limits of soil water availability as related to laboratory-measured properties. Soil Sci Soc Am. 47:770-5.

So what's the big deal with about monitoring soil moisture? Doesn't the field always take in the same amount of water?

One answer:

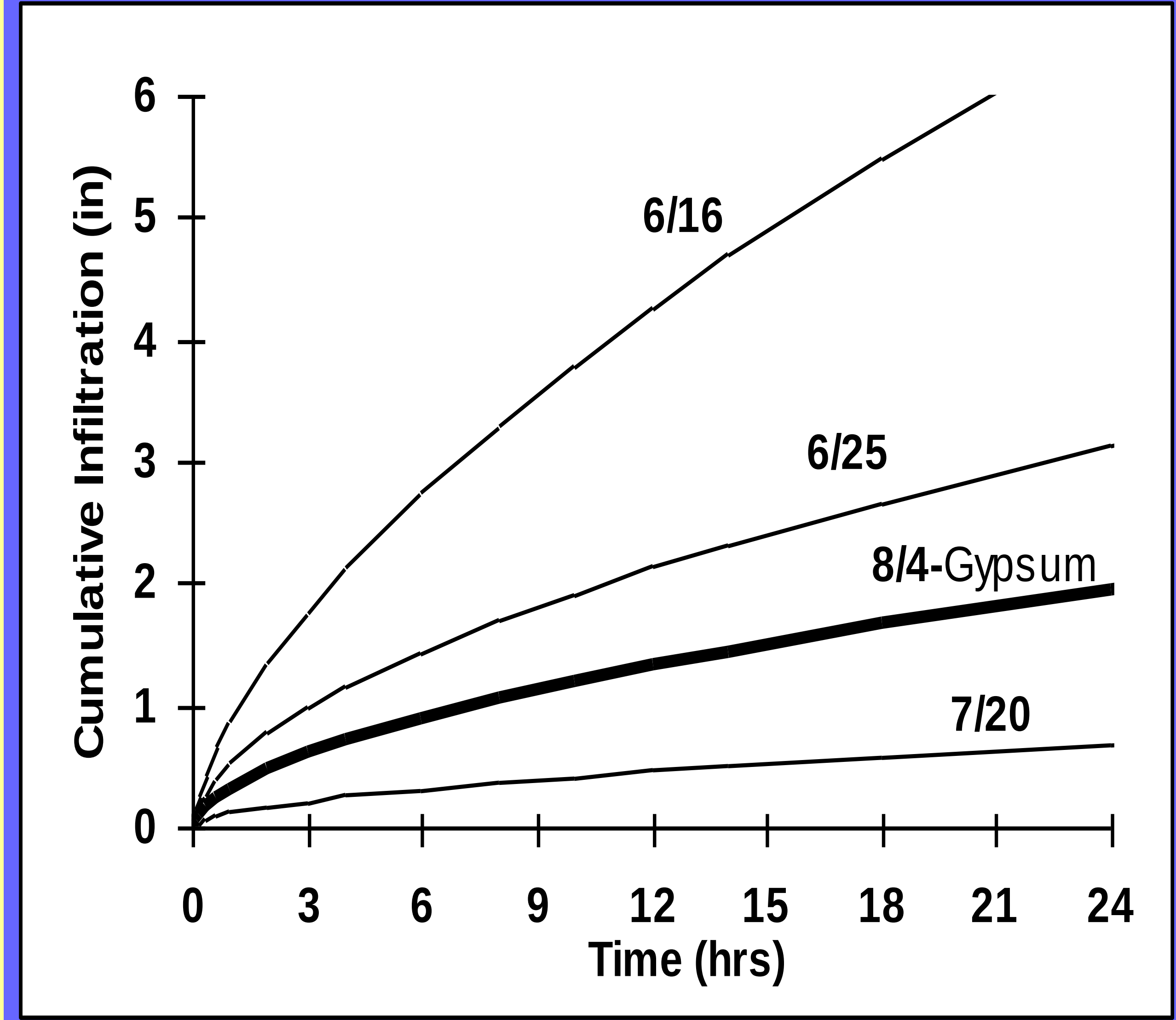
Each field, crop, climate and grower has unique characteristics. The majority of acreage in CA is still flood irrigated. Infiltration is often uncertain – maybe 1.5 inches up to 12 inches depending on the mix of soil and water chemistry.

Many Class I sandy loam soils planted to almonds in Kern County have water penetration problems due to low aggregate stability from loss of clays at the surface and irrigation with extremely low salinity water.

COMBINED CRUSTING AND DISPERSION AFTER LAYBY IN COTTON

After layby cultivation infiltration over a 12 hour set went from 4.3” to 0.4” from 6/16 to 7/20/96. Water run gypsum on 8/4 improved infiltration to 1.3”.

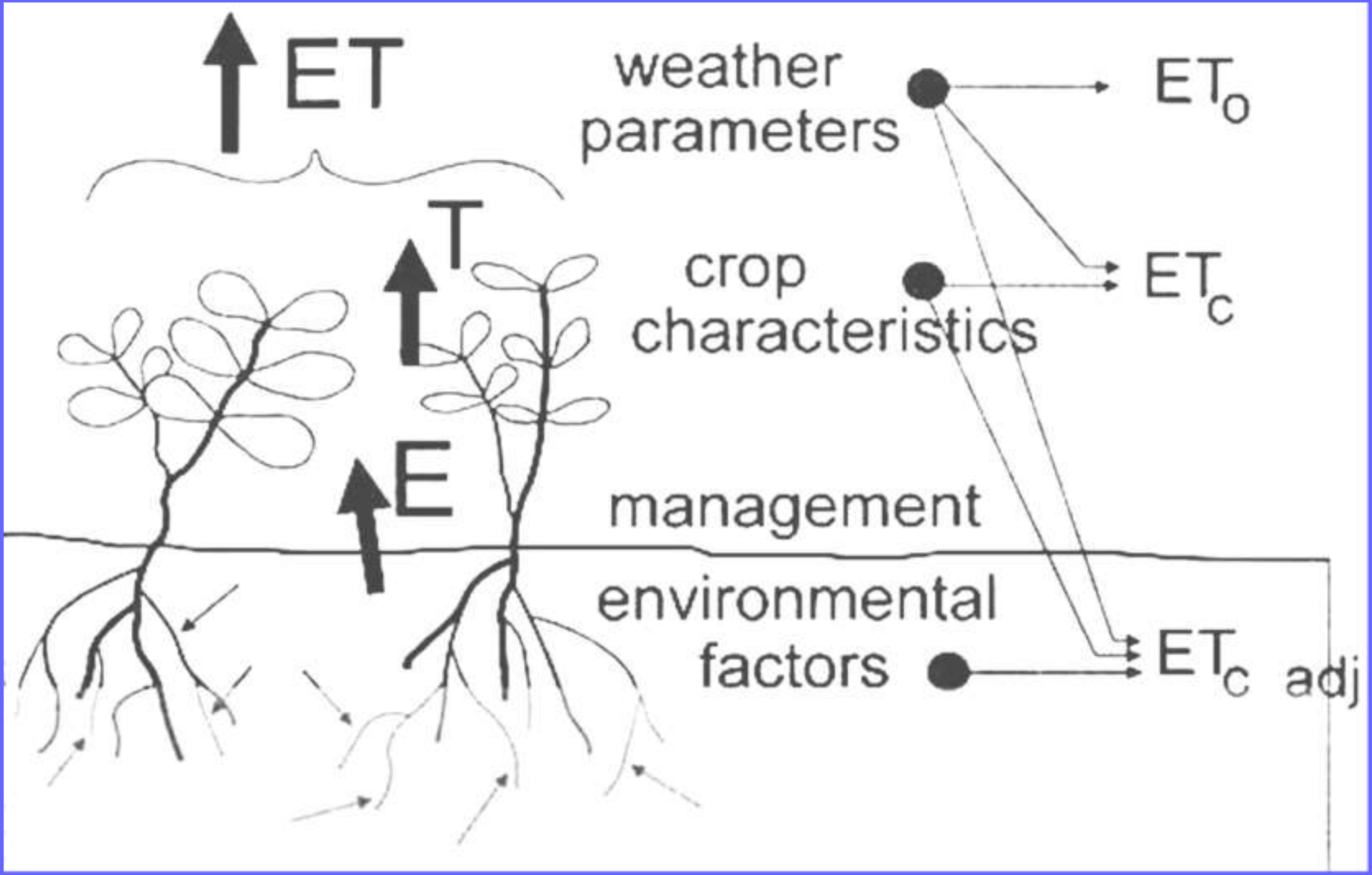
Wasco Sandy Loam
(Shafter Field Station)



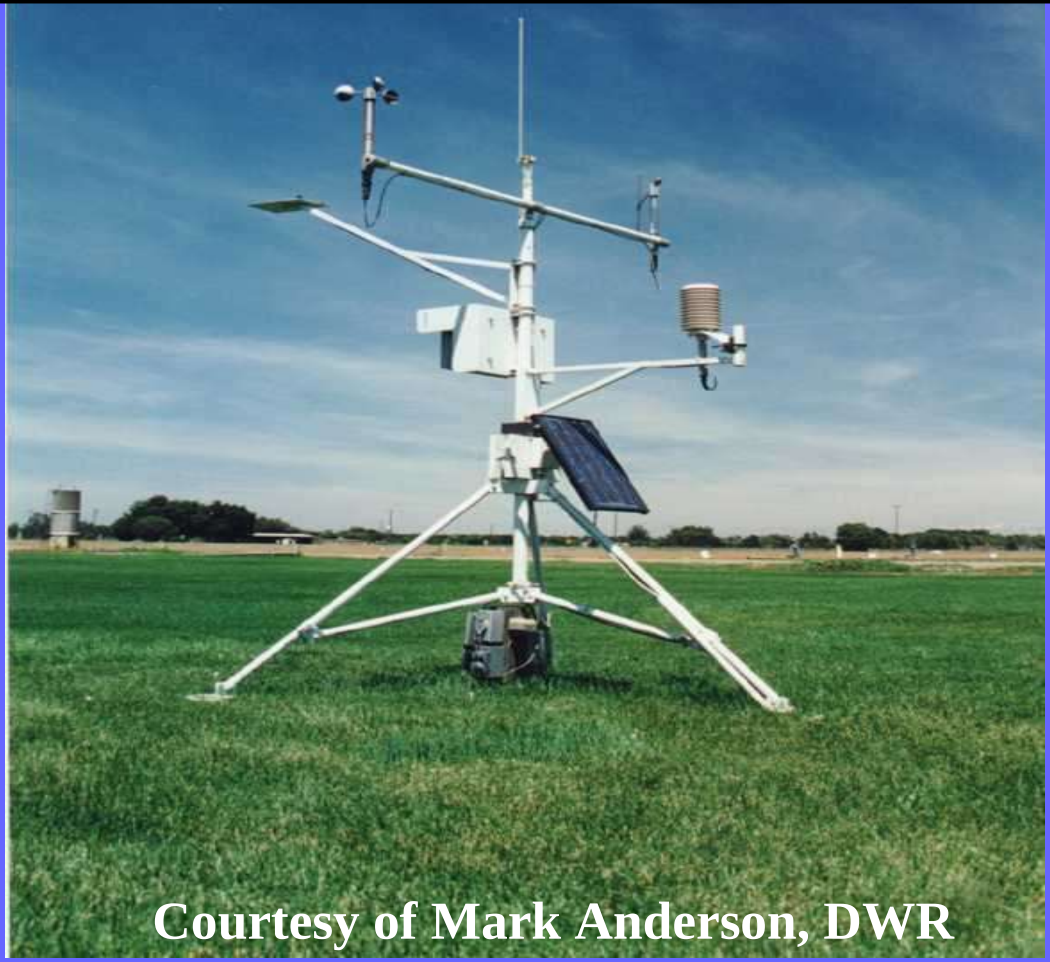
3-point sermon:

- Understanding soil water holding characteristics
- **Crop water requirements (ET), CIMIS**
- Monitoring soil moisture, & irrigation uniformity

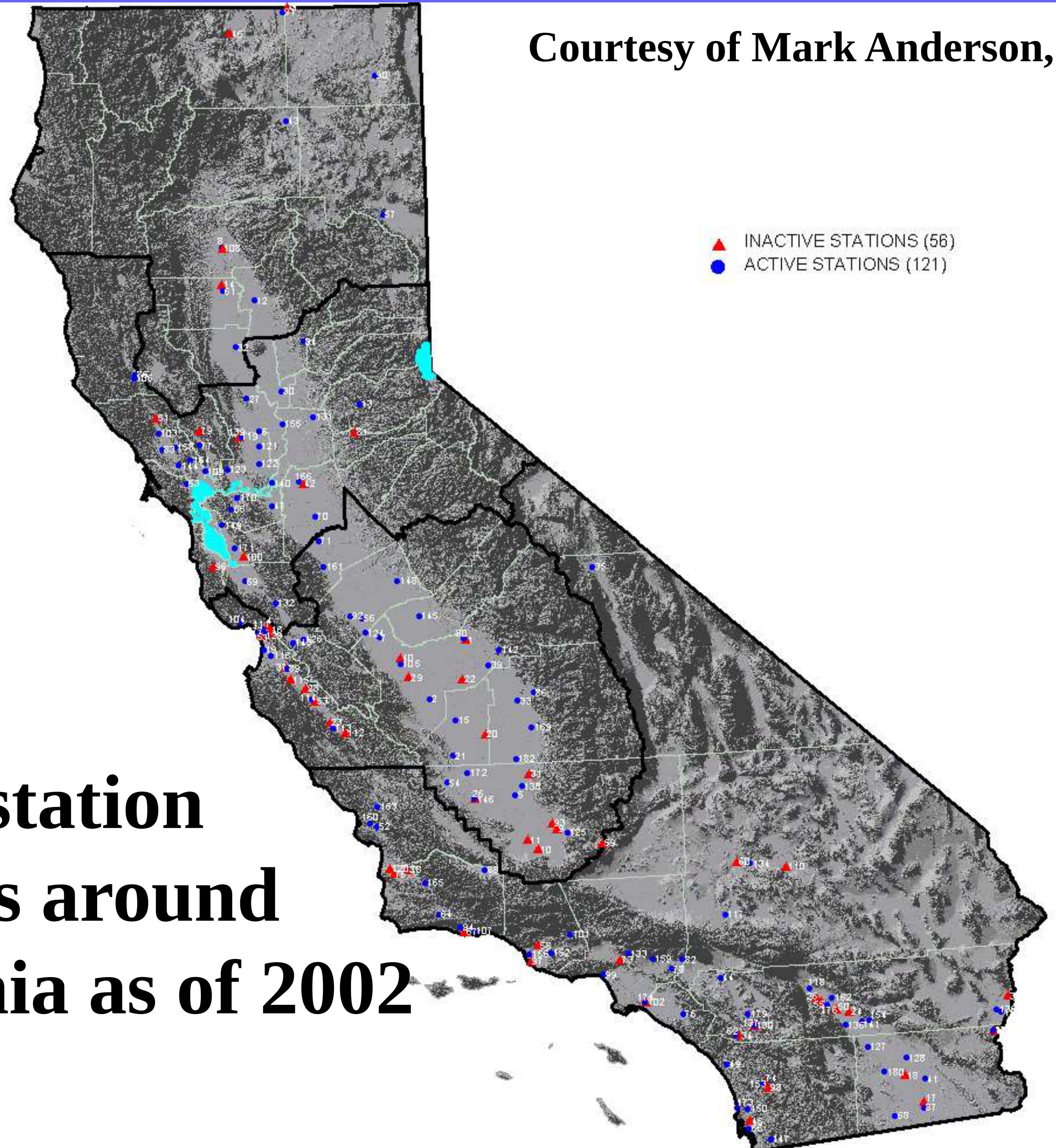
Crop water use is made up of EVAPORATION (E) from the wet soil and leaves and TRANSPIRATION (T), hence ET



CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SERVICE


Courtesy of Mark Anderson, DWR

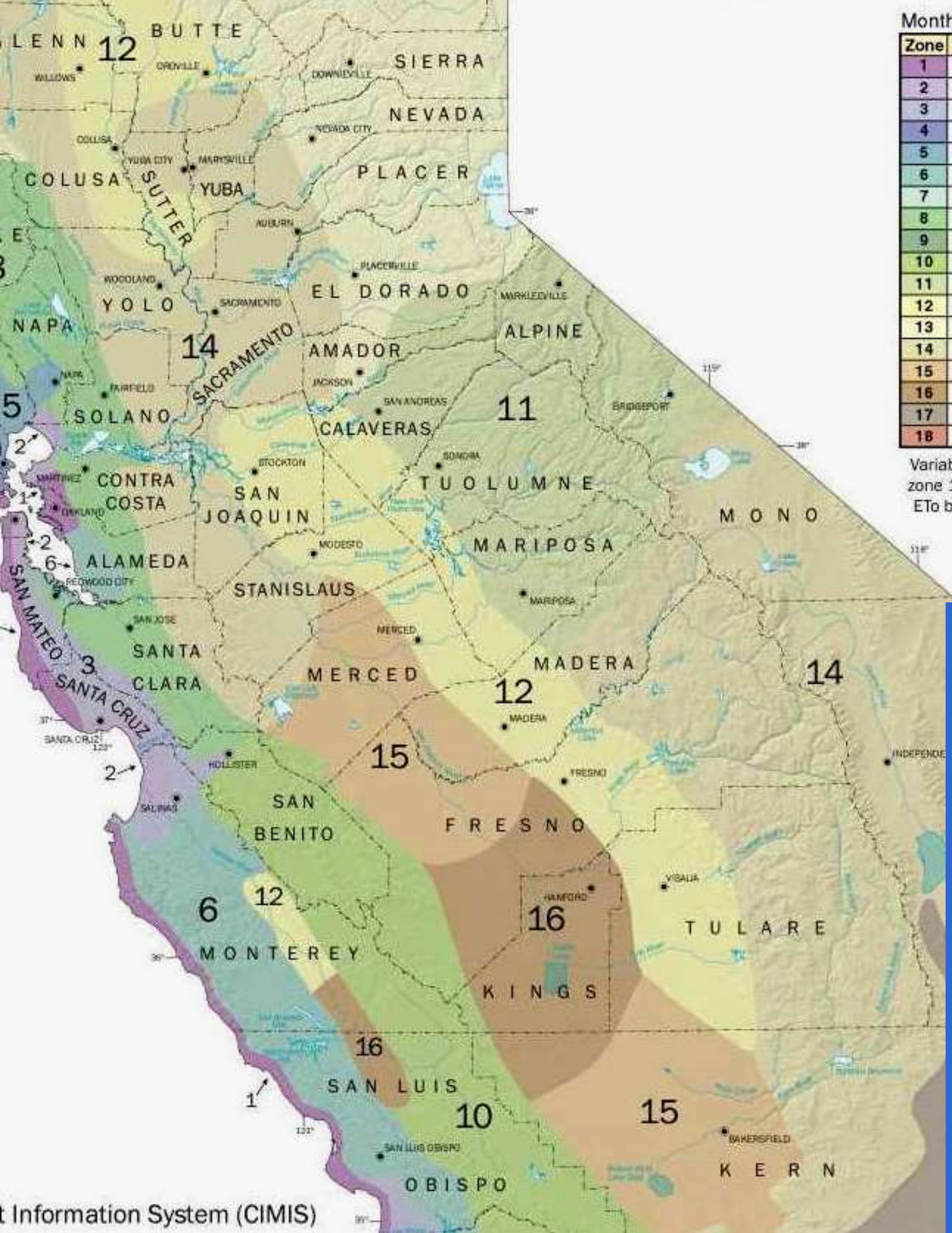
Courtesy of Mark Anderson, DWR



CIMIS station locations around California as of 2002

CIMIS Map of California Climate Zones and Monthly ETo

http://cimis.water.ca.gov



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
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.75	5.70	4.03	2.10	1.24	57.9
16	1.55	2.52	4.03	5.70	7.75	8.70	9.30	8.37	6.30	4.34	2.40	1.55	62.5
17	1.86	2.80	4.65	6.00	8.06	9.00	9.92	8.68	6.60	4.34	2.70	1.86	66.5
18	2.48	3.36	5.27	6.90	8.68	9.60	9.61	8.68	6.90	4.96	3.00	2.17	71.6

Variablity between stations within single zones is as high as 0.02 inches per day for zone 1 and during winter months in zone 13. The average standard deviation of the ETo between estimation sites within a zone for all months is about 0.01 inches per day for all 200 sites.

The whole Central Valley covers Zones 12 to 16: for an "normal year" ETo of 53.3 to 62.5 in/yr, with most area @ 53 to 58 inches.

Calculating ET for crops:

$$ET_{crop} = ET_o * K_c * E_f$$

ET_o = **reference crop** (tall grass) ET

K_c = **crop coefficient** for a given stage of growth as a ratio of grass water use. May be 0 to 1.3, standard values are good starting point.

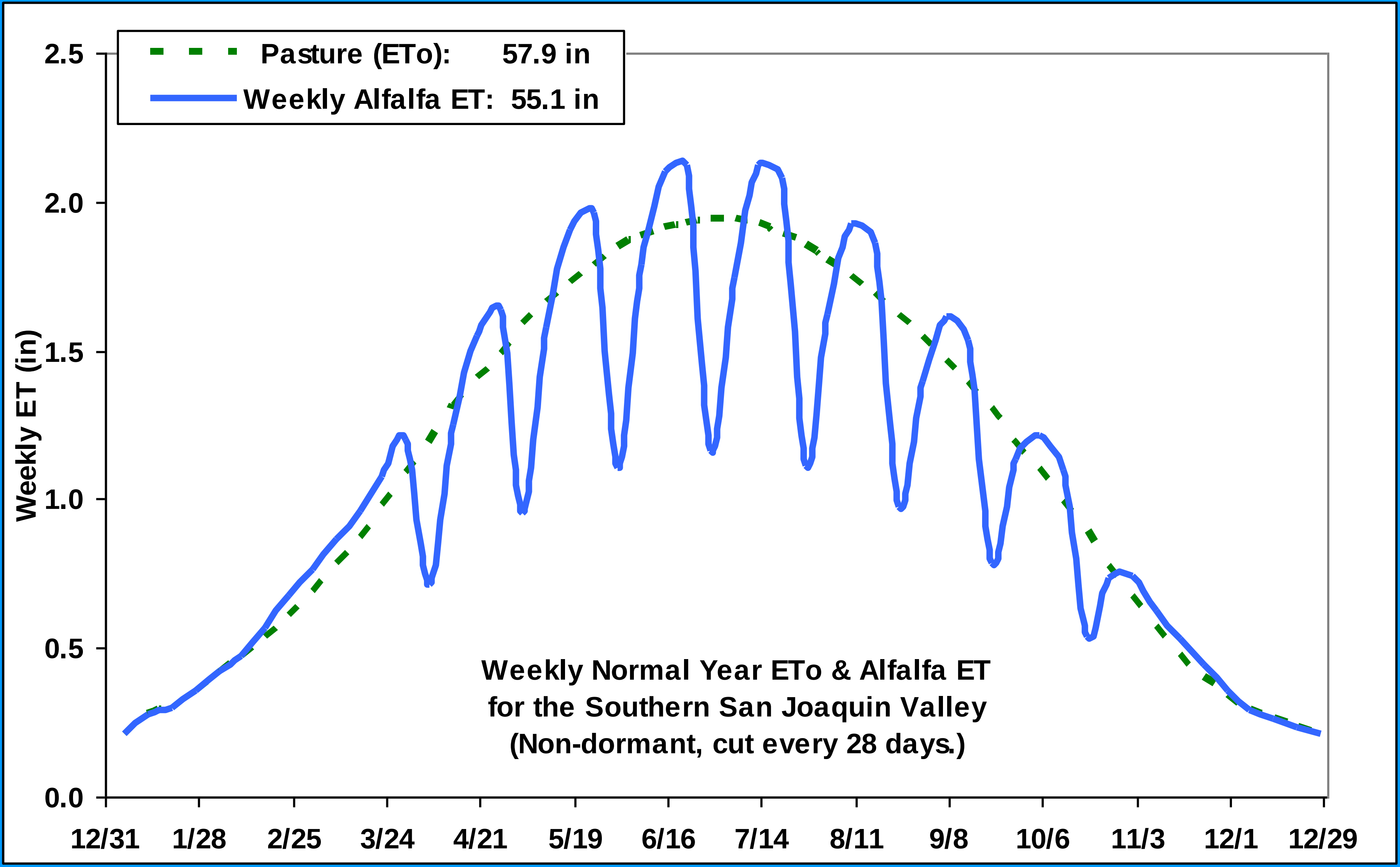
E_f = an "**environmental factor**" that can account for immature permanent crops and/or impact of salinity. May be 0.1 to 1.1, determined by site.

"Normal Year" grass potential evapotranspiration (ETo), forage crop coefficients and ET for the southern San Joaquin Valley

DATE	Pasture *ETo (inch)	[1]Crop Coefficient Values (Kc) [2]Alfalfa	Silage 4/1-8/25	Silage 6/15-10/15	[3]Sudan	Winter Forage	Triple Crop	[4]Normal Year Crop ET (inches) [2]Alfalfa	Silage 4/1-8/25	Silage 6/15-10/15	[3]Sudan	Winter Forage	Triple Crop
1/15	0.54	0.95				0.62	0.62	0.51				0.33	0.33
2/1	0.70	0.95				0.80	0.80	0.67				0.56	0.56
2/15	0.98	0.95				0.95	0.95	0.93				0.93	0.93
3/1	1.26	0.95				1.15	1.15	1.20				1.45	1.45
3/15	1.64	0.95				1.15	1.15	1.56				1.89	1.89
4/1	2.08	0.95	Plant			1.20	1.20	1.98	*1.04*			2.50	2.50
4/15	2.55	0.95	0.14			1.20	Silage90	2.42	0.35			3.06	*1.28*
5/1	3.15	0.95	0.18		Plant	1.15	0.14	2.99	0.55		*1.58*	3.62	0.44
5/15	3.50	0.95	0.31		0.58		0.22	3.33	1.09		2.03		0.77
6/1	3.79	0.95	0.94	Plant	0.80		0.45	3.60	3.55	*1.90*	3.03		1.71
6/15	4.00	0.95	1.14	0.14	0.95		1.00	3.80	4.55	0.55	3.80		4.00
7/1	4.25	0.95	1.18	0.25	1.05		1.10	4.04	5.02	1.06	4.46		4.68
7/15	4.35	0.95	1.18	0.56	1.10		1.20	4.13	5.13	2.45	4.79		5.22
8/1	4.33	0.95	1.15	1.00	1.10		Sudan	4.11	4.98	4.33	4.76		*2.17*
8/15	4.11	0.95	1.06	1.15	0.60		0.60	3.90	4.36	4.72	2.46		2.46
9/1	3.64	0.95	0.98	1.20	1.10		0.90	3.46	3.55	4.37	4.01		3.28
9/15	3.10	0.95		1.20	1.10		1.05	2.95		3.72	3.41		3.26
10/1	2.70	0.95		1.06	0.60		1.10	2.57		2.87	1.62		2.97
10/15	2.20	0.95		0.98	1.10		0.60	2.09		2.16	2.42		1.32
11/1	1.73	0.95			1.10		1.10	1.65			1.91		1.91
11/15	1.20	0.95			1.00	Plant	TriGrain	1.14			1.20	*0.60*	*0.60*
12/1	0.88	0.95				0.25	0.25	0.84				0.22	0.22
12/15	0.70	0.95				0.36	0.36	0.67				0.25	0.25
12/31	0.52	0.95				0.52	0.52	0.49				0.27	0.27
TOTALS	57.90							55.01	34.18	28.12	41.47	15.68	44.45

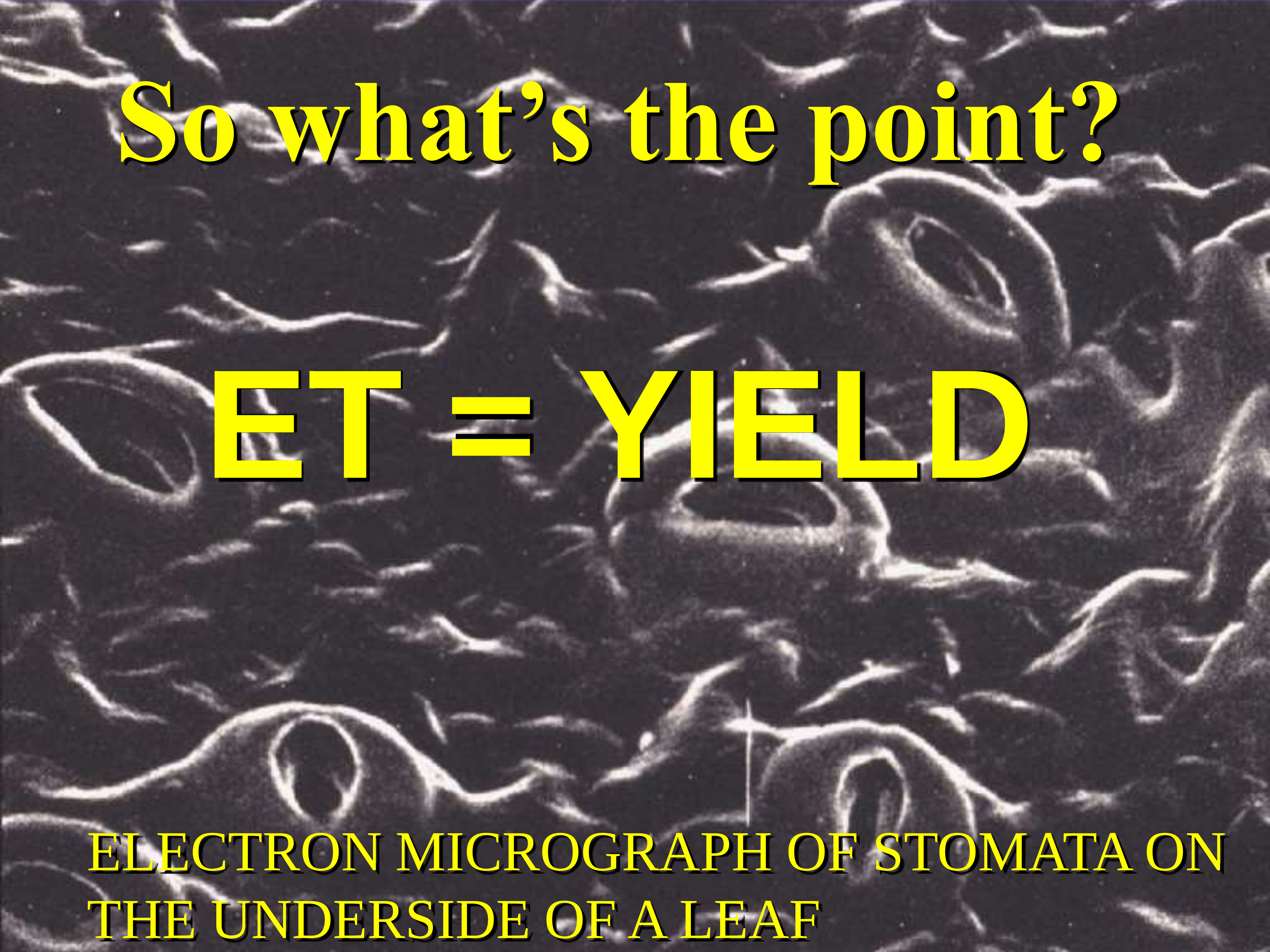
Forage Production with Reduced Water

Normal Year Alfalfa ET (dips indicate cutting schedule)



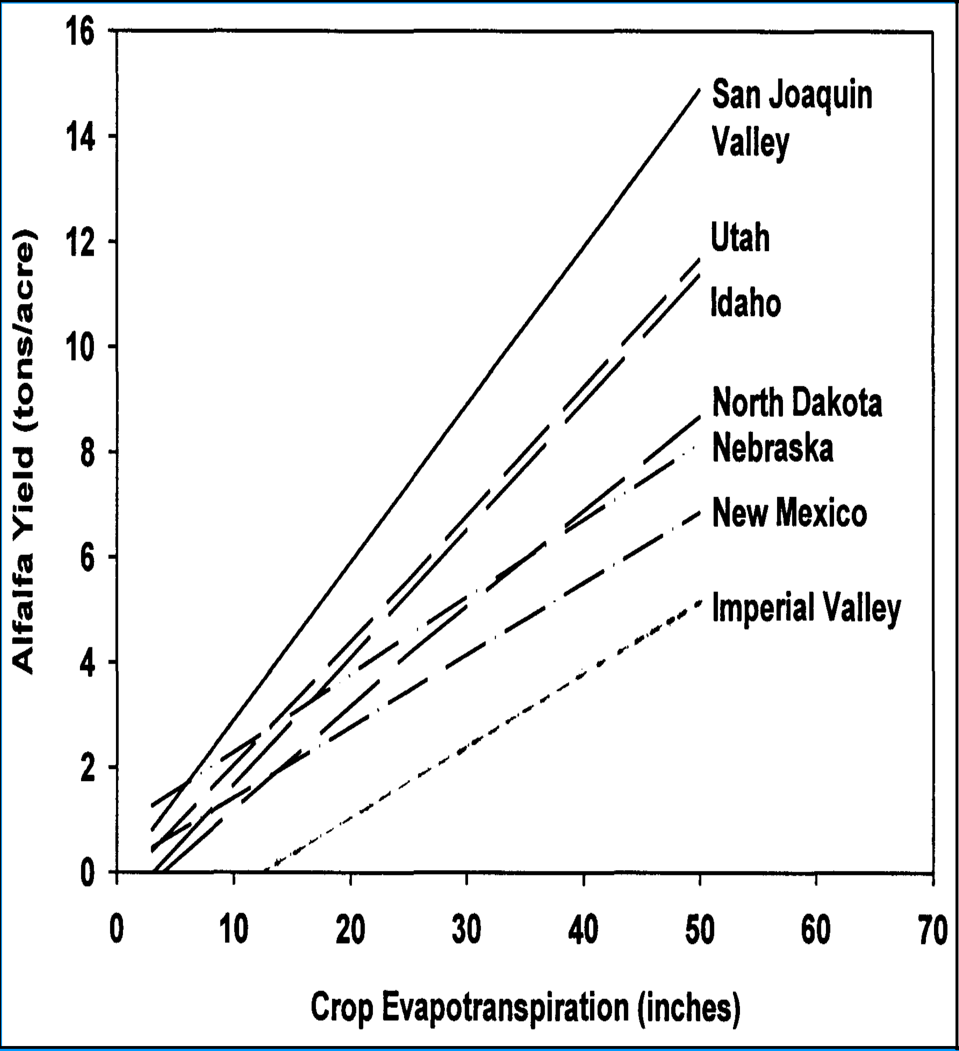
So what's the point?

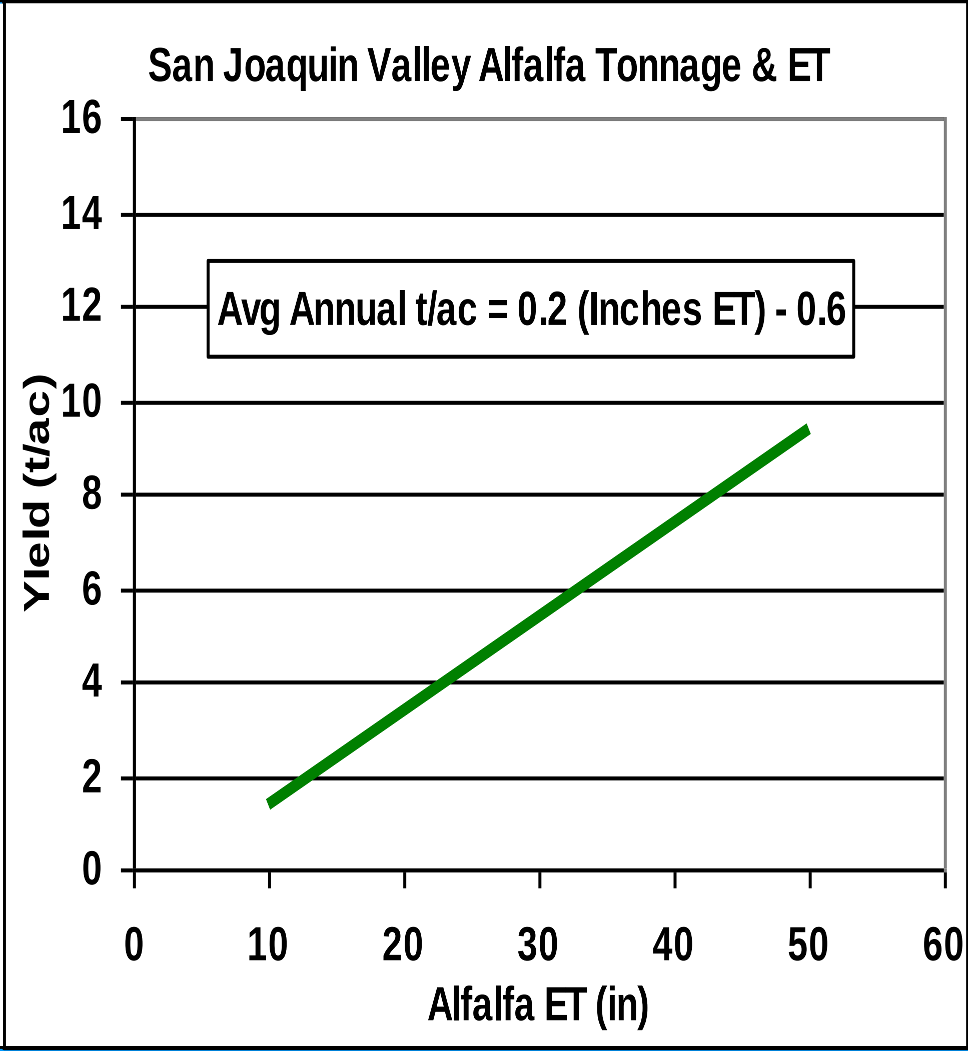
ET = YIELD



ELECTRON MICROGRAPH OF STOMATA ON THE UNDERSIDE OF A LEAF

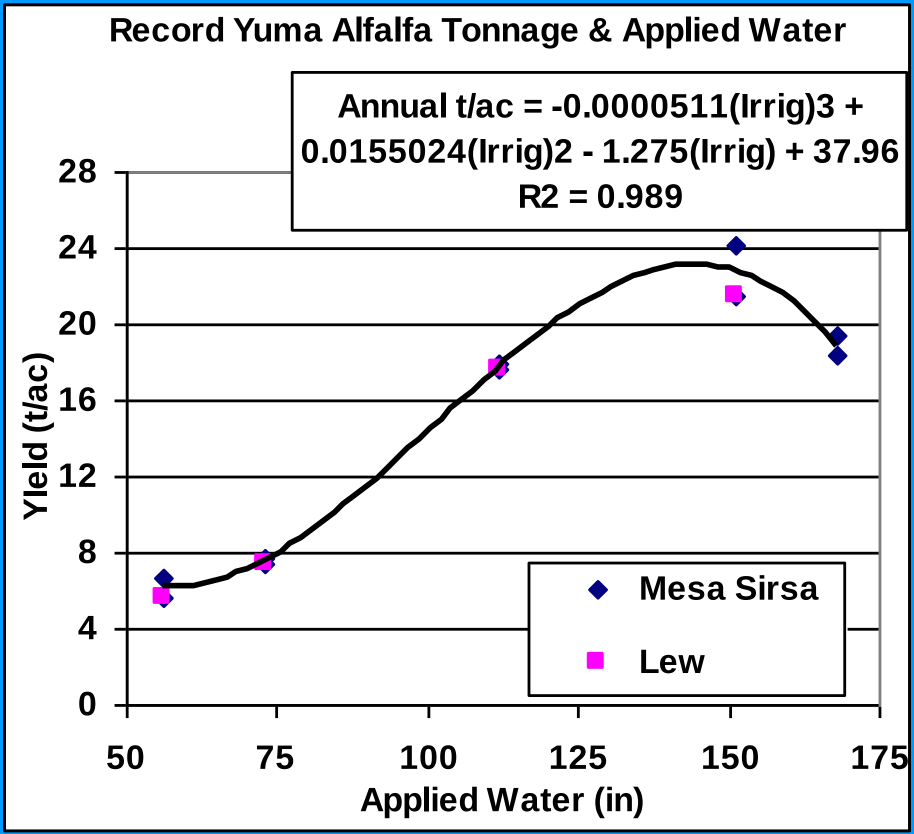
Alfalfa Yield/ET Production Functions for Various Regions



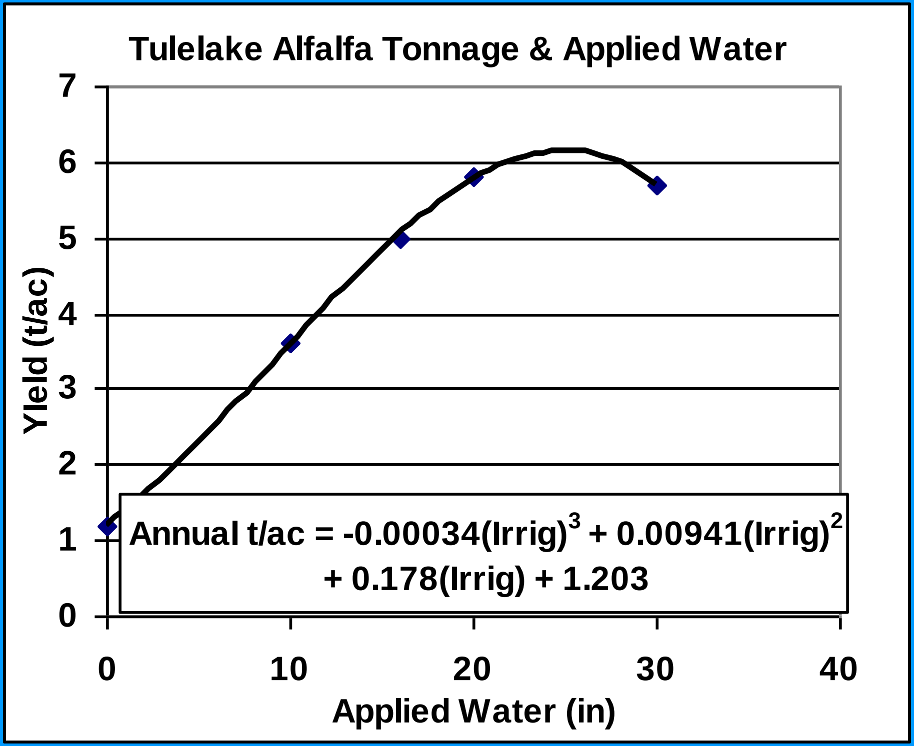


Production Functions for …

Record Yuma, AZ: 24.1 t/ac @ 151 inches



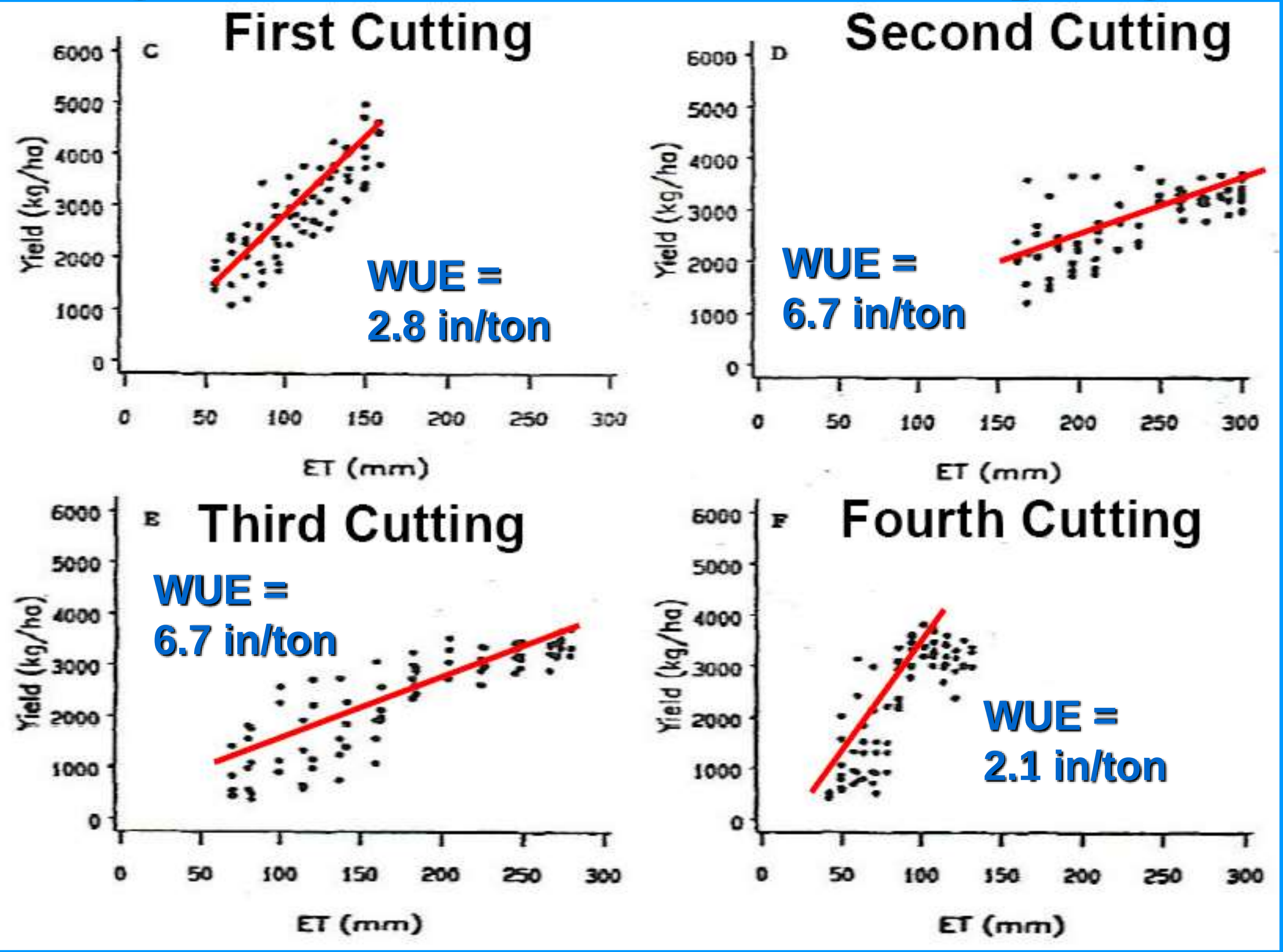
Typical Tulelake: 6 ton production



Yuma: 140 / 23 = 6.1inch/ton

Tulelake: 25 / 6.2 = 4.0 inch/ton

Changes in Mid-west Alfalfa WUE Spring to Fall



Undersander, 1987   Courtesy B.R. Lindenmayer, CO State Univ

Water Use Efficiency (WUE):

$$= \frac{\text{Water Beneficially Used}}{\text{Total Water Applied}}$$

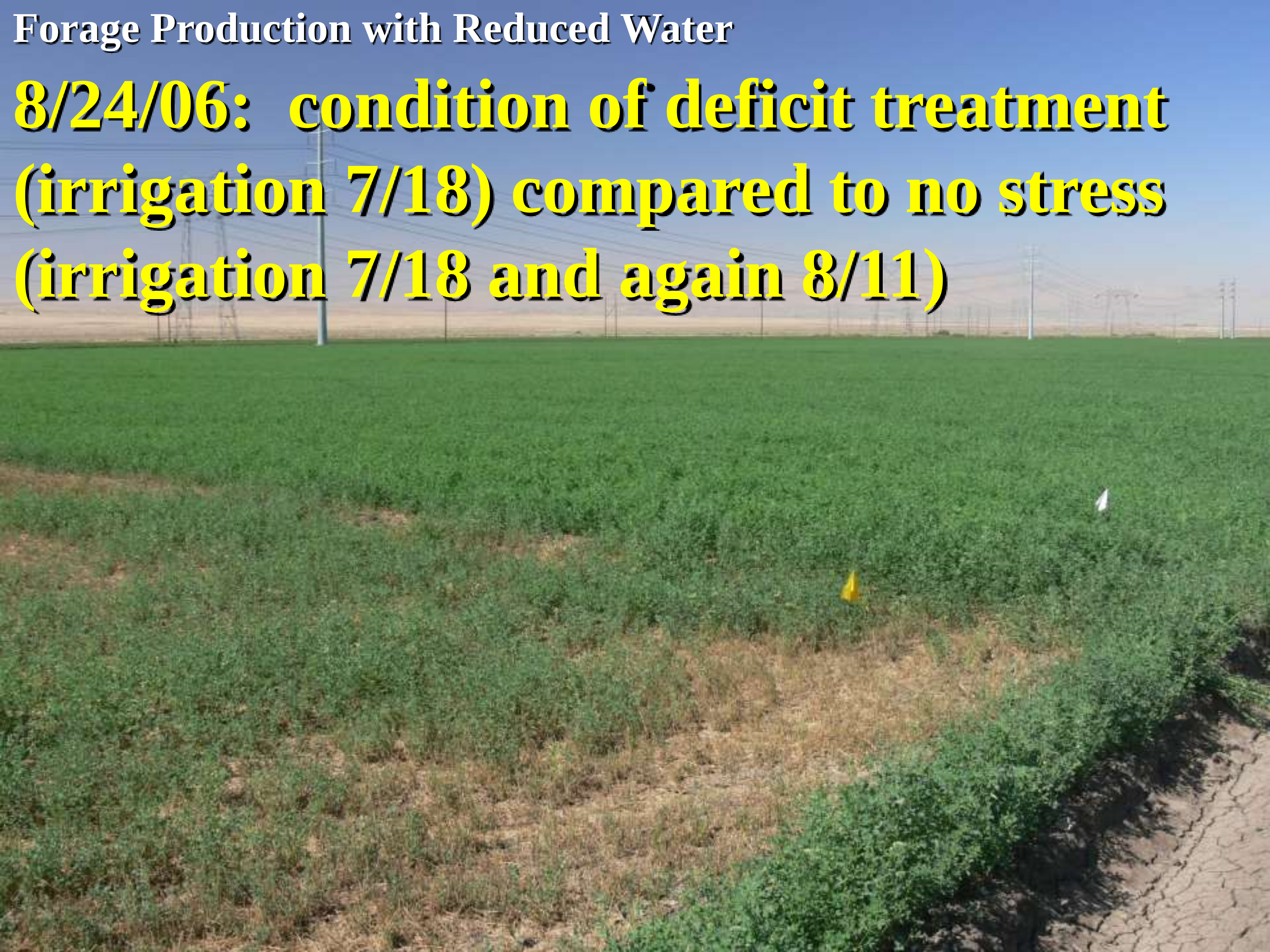
$$= \frac{\text{Yield}}{\text{Applied (ET+leaching)}} = \frac{\text{Crop}}{\text{Drop}}$$

WUE can vary by season, variety, field fertility level and % available moisture.

Forage Production with Reduced Water

Alfalfa Deficit Irrigation, Kern County

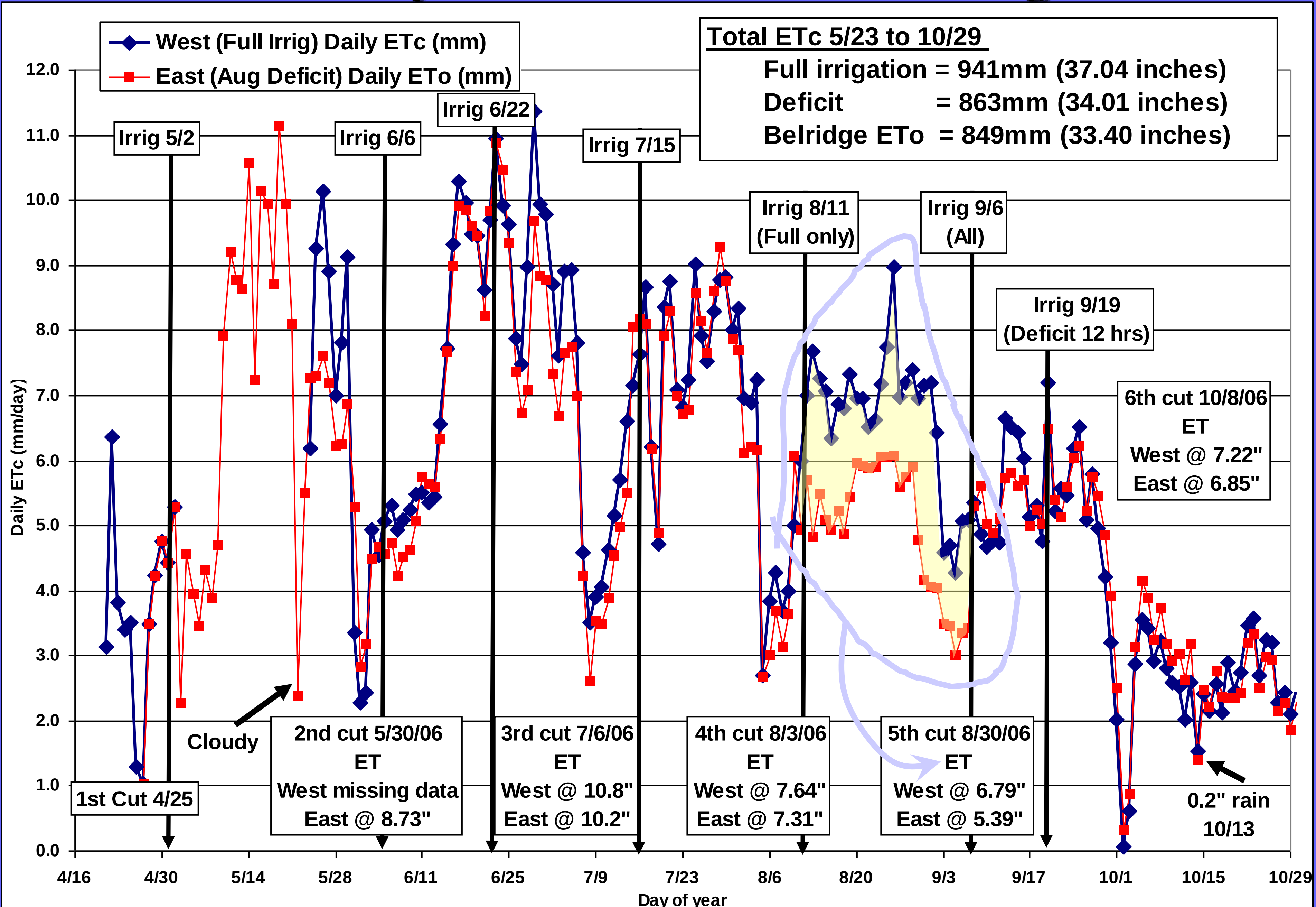
Loggers have to be downloaded every 3 weeks and instrument area hand cut with each cutting


Forage Production with Reduced Water
8/24/06: condition of deficit treatment (irrigation 7/18) compared to no stress (irrigation 7/18 and again 8/11)

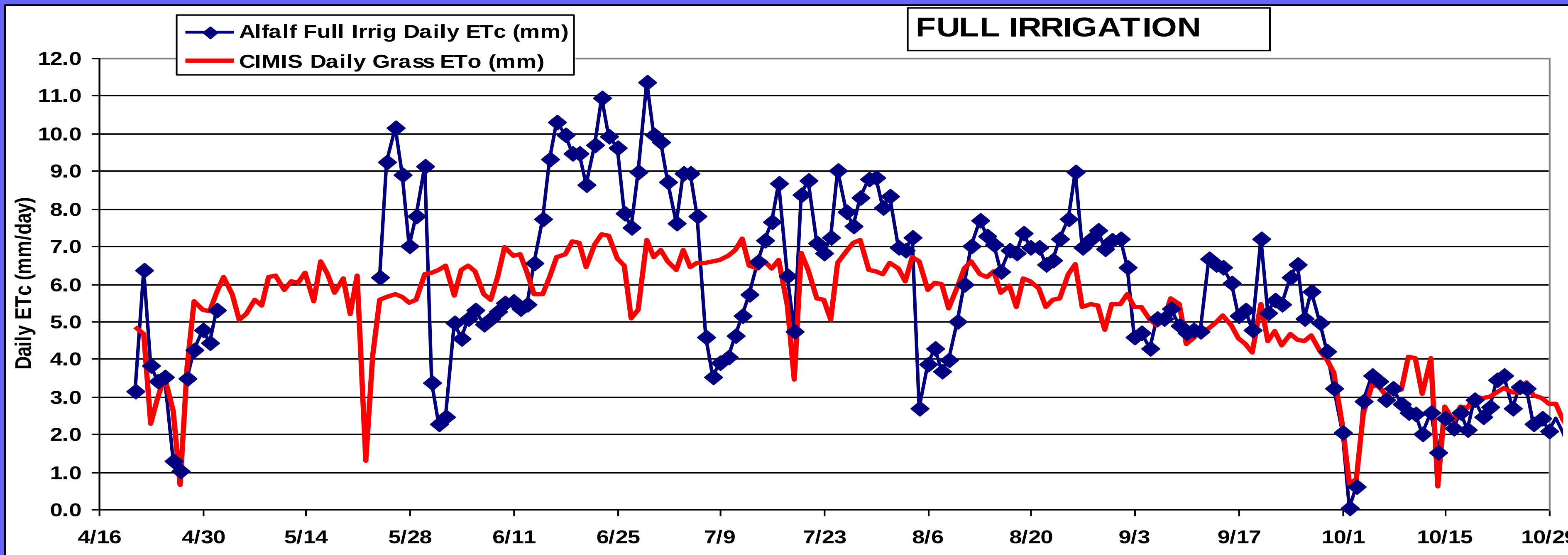
Forage Production with Reduced Water

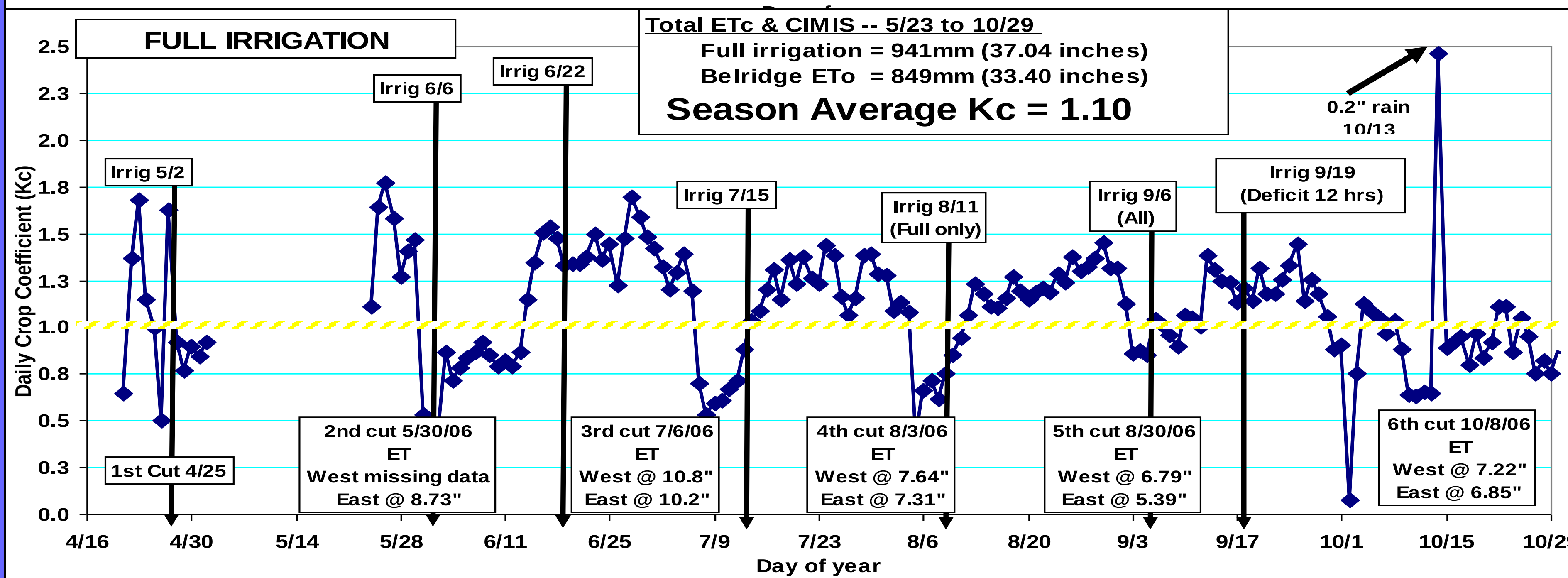
8/24/06: condition of deficit treatment (irrigation 7/18) compared to no stress (irrigation 7/18 and again 8/11)

Alfalfa Daily ETc for Full & Deficit Irrigation



Alfalfa Full ETc & CIMIS Potential Grass ETo





Forage Production with Reduced Water

Kern County Deficit Irrigation Trial

Irrigation off 20 days

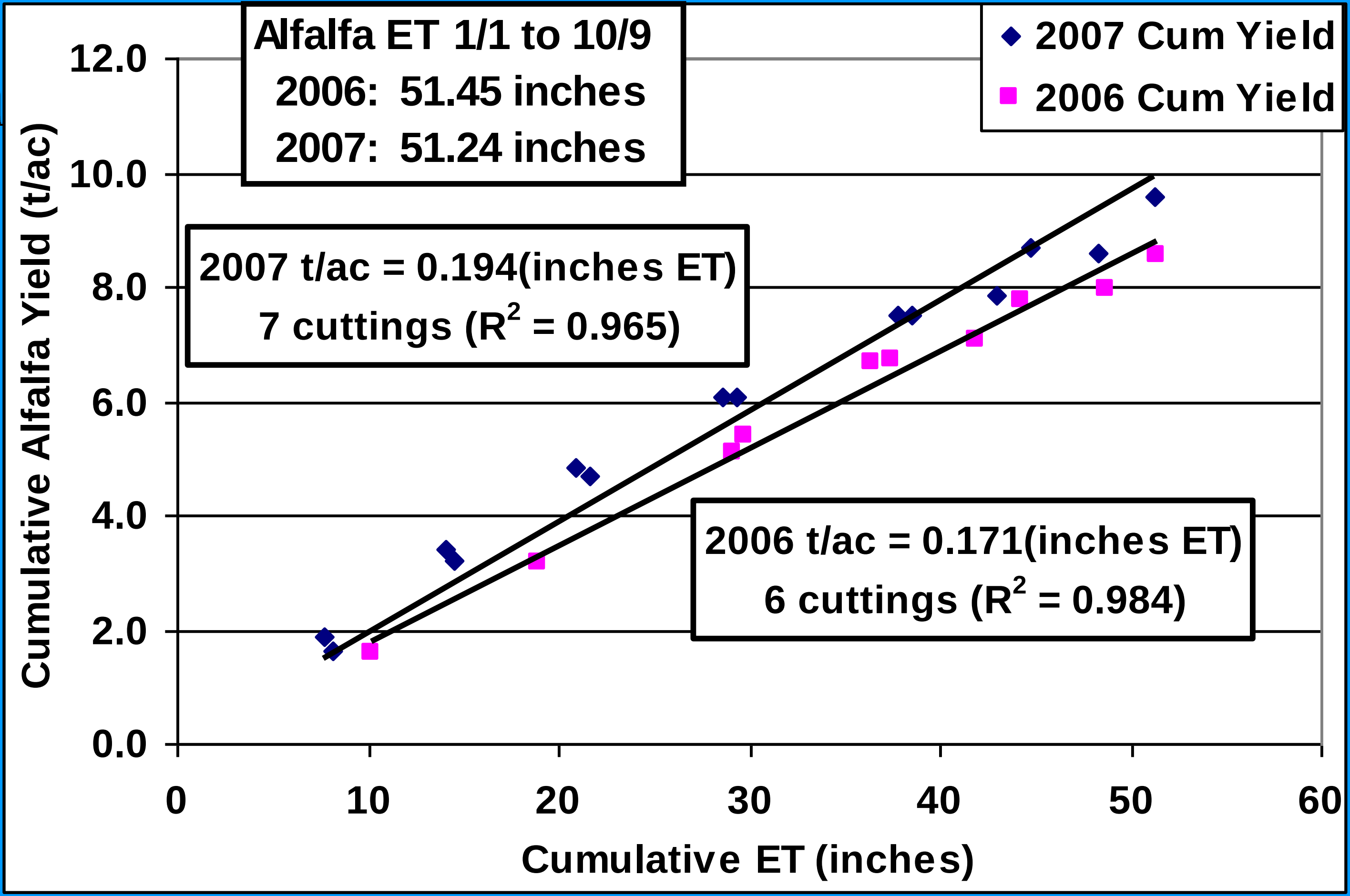
Pictures 8/30/07

Hay cut 8/29

Water back 9/5

Irrigation off 45 days at cutting. Total 50 days off.

Production Functions for Kern County Alfalfa Deficit Irrigation Trial



2006: 5.8 inches ET/ton alfalfa

2007: 5.2 inches ET/ton alfalfa

Increased WUE of 15% over 2006

3-point sermon:

- Understanding soil water holding characteristics
- Crop water requirements (ET), CIMIS
- **Monitoring soil moisture, & irrigation uniformity**

Equipment for checking soil Moisture

- Most Common Method

Tulelake irrigation consultant with soil probe

3 foot push or slide hammer probe ($150-$250)

Hand-powered twist augers ($150 - $300)

SOIL TEXTURE DETERMINES AVAILABLE WATER HOLDING CAPACITY

SOIL TEXTURE “FEEL METHOD”

$$\text{AWHC} = \%\text{Volume} = \frac{\text{inch depth of water}}{\text{1 foot depth of soil}}$$

Guide for Estimating Actual Available Field Soil Moisture by the "Feel" Method.

SOIL TEXTURE CLASSIFICATION								
Coarse (loamy sand)		**Sandy (sandy loam)**		**Medium (loam)**		**Fine (clay loam, silty clay loam)**		
Available Water (AW) in the Soil by Appearance (inches/foot soil)								
0.6-1.2 in/ft *AW@FC		**1.2-1.8 in/ft AW@FC**		**1.4-2.2 in/ft AW@FC**		**1.7-2.4 in/ft AW@FC**		
	AW		**AW**		**AW**		**AW**	**Deficit**
Leaves wet outline On hand when	**1.0**	Appears very dark leaves wet outline	**1.6**	Appears very dark leaves wet outline	**1.9**	Appears very dark, leaves slight moisture	**2.2**	0
squeezed. Appears moist,	**0.7**	on hand, makes a short ribbon (0.5-0.75 inch)		on hand , will ribbon about 1 – 2 inches.	**1.7**	on hand when squeezed, will ribbon > 2 inches.		0.2
Makes a weak ball. Appears slightly		Quite dark color makes a hard ball.	**1.2**	Dark color, forms a plastic pall, slicks when rubbed.	**1.4**	Dark color will feel slick And ribbons easily	**1.8**	0.5
moist, sticks together slightly.	**0.4**	Fairly dark color, makes a good ball	**1.0**	Quite dark, forms a hard ball	**1.2**	Quite dark, will make		0.7
Dry, loose, flows thru fingers. (wilting point)	**0**	Slightly dark color makes a weak ball	**0.7**	Fairly dark, forms a	**1.0**	thick ribbon may slick when rubbed.	**1.4**	1.0
		Lightly colored by moisture, will not	**0.4**	a good ball		Fairly dark, makes a good ball.	**1.1**	1.2
		ball. Very slight color	**0**	Slightly dark, forms weak ball	**0.6**	Will ball, small clods will flatten out rather	**0.7**	1.4
		due to moisture. (wilting point)		Lightly Colored, small clods crumble	**0.2**	Slightly dark, clods	**0.4**	1.7
				Fairly easily. Slight color due to		Crumble. Some darkness due to		1.9
				moisture, small colds hard (wilting point).	**0**	unavailable moisture, clods are hard, cracked (wilting pt)	**0**	2.2

* **AW@FC:** Available Water @ Field Capacity = the available water a soil can store against gravity after irrigation and drainage.

Adapted from: Merriam, J.L. 1960. Field method of approximating soil moisture for irrigation. Am. Soc. Agri. Engr. Vol. 3. No.1

Watermark blocks estimate soil moisture tension (matric potential) using electrical resistance and require no maintenance (~$30). However, a separate meter or logger ($200+) is needed to read the device.

Loggers used in Kern County irrigation projects

Typical field layout for flood systems.

Total soil moisture monitoring system cost: $850

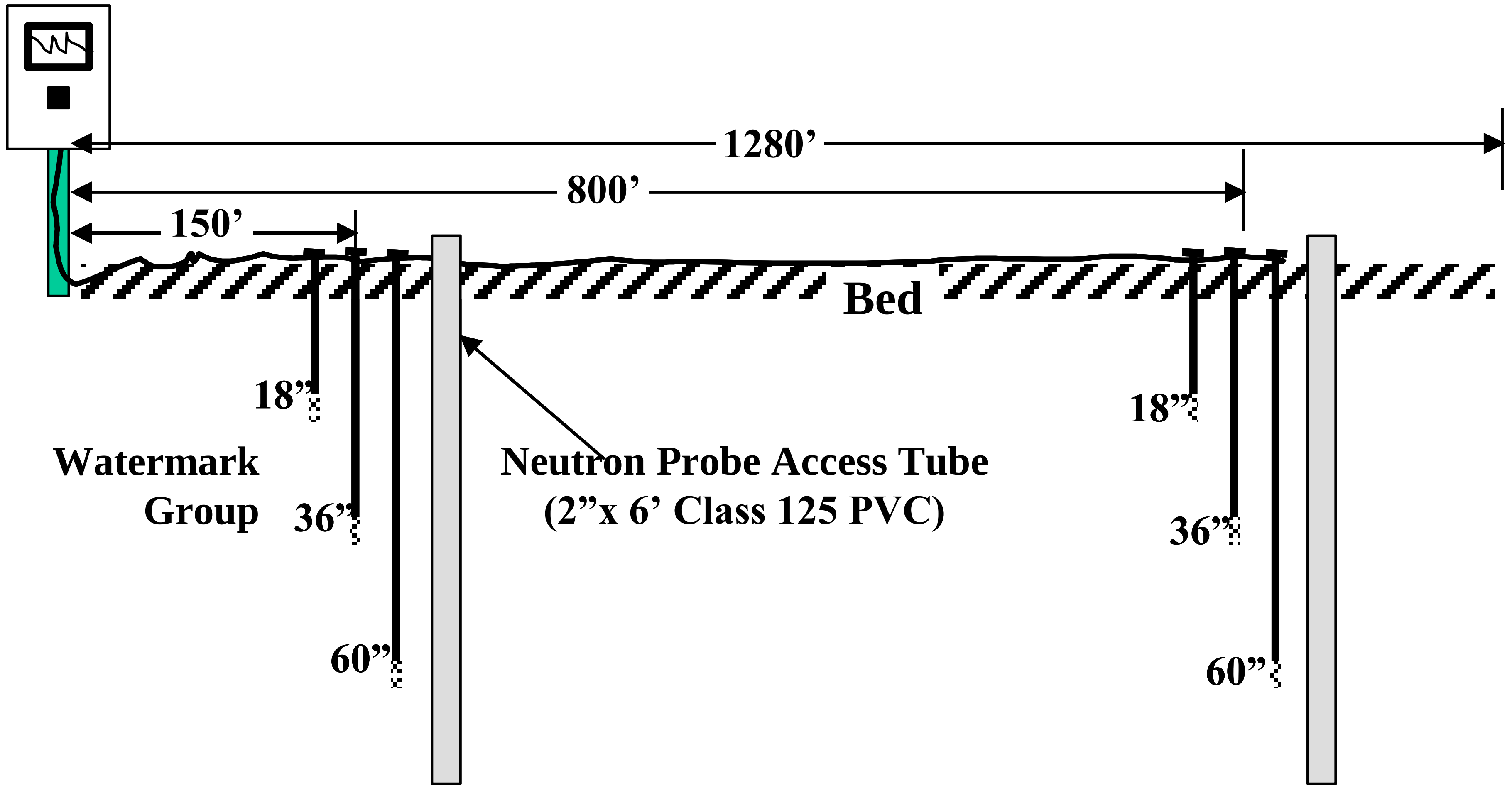
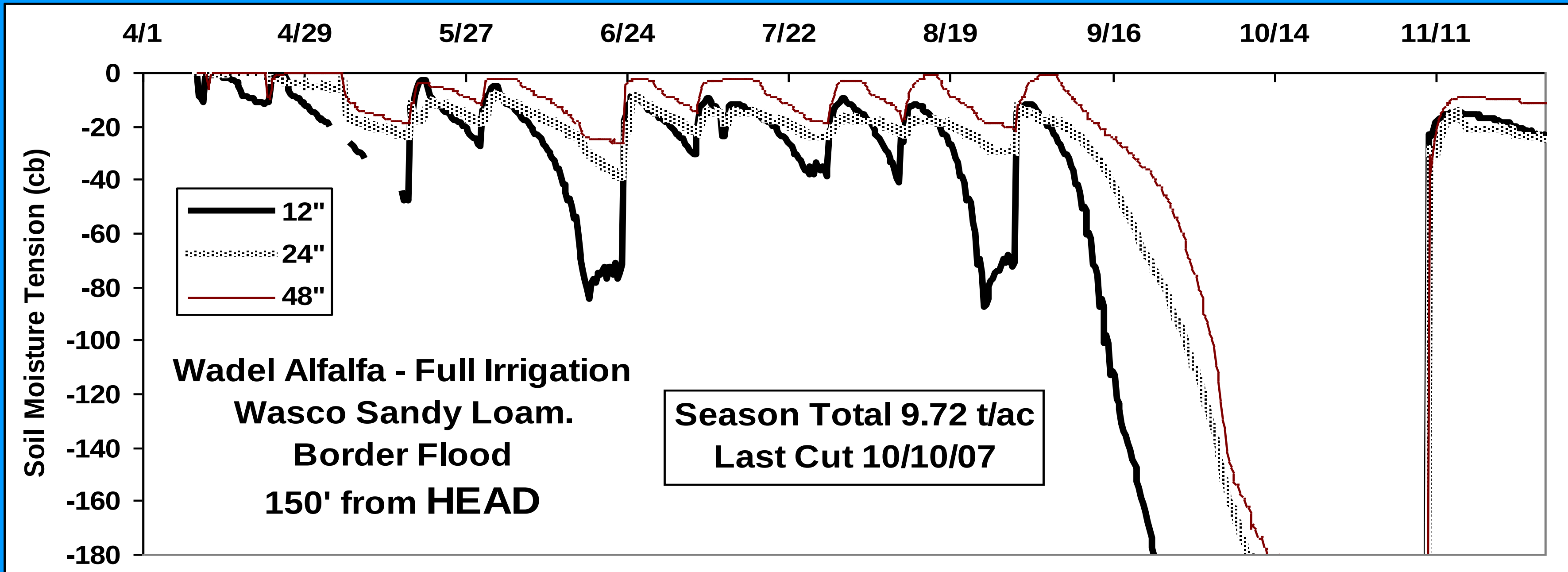
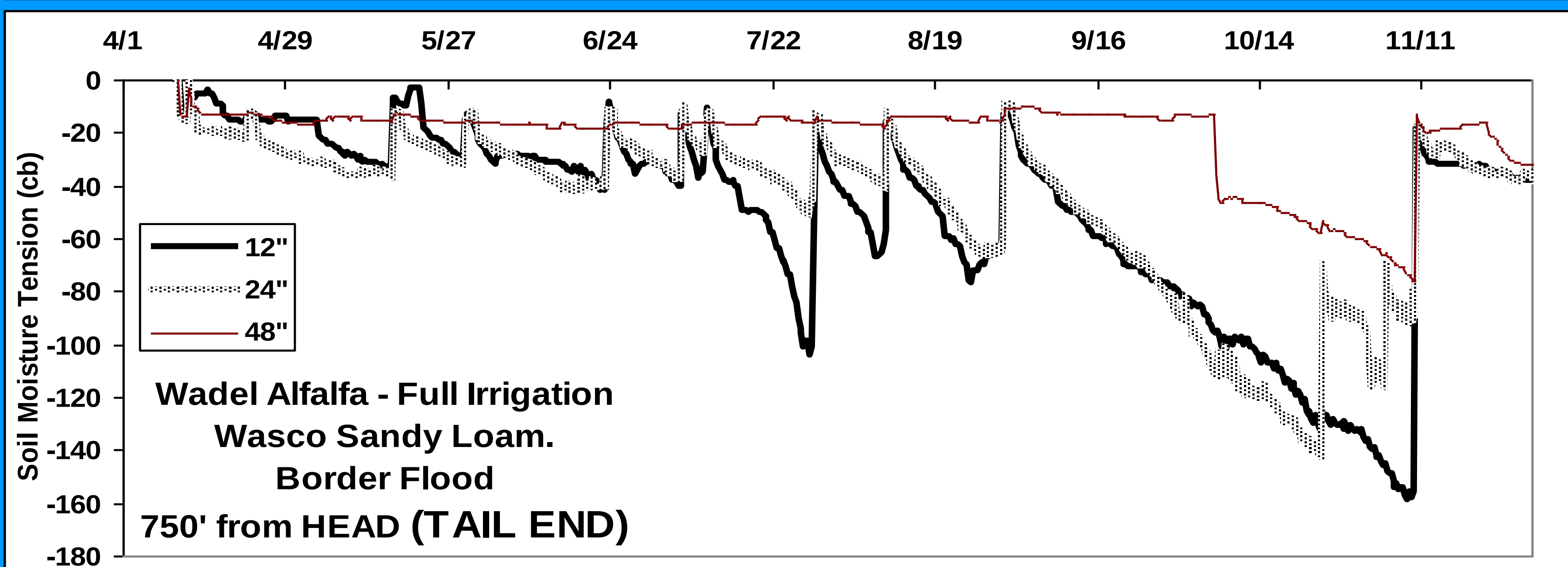


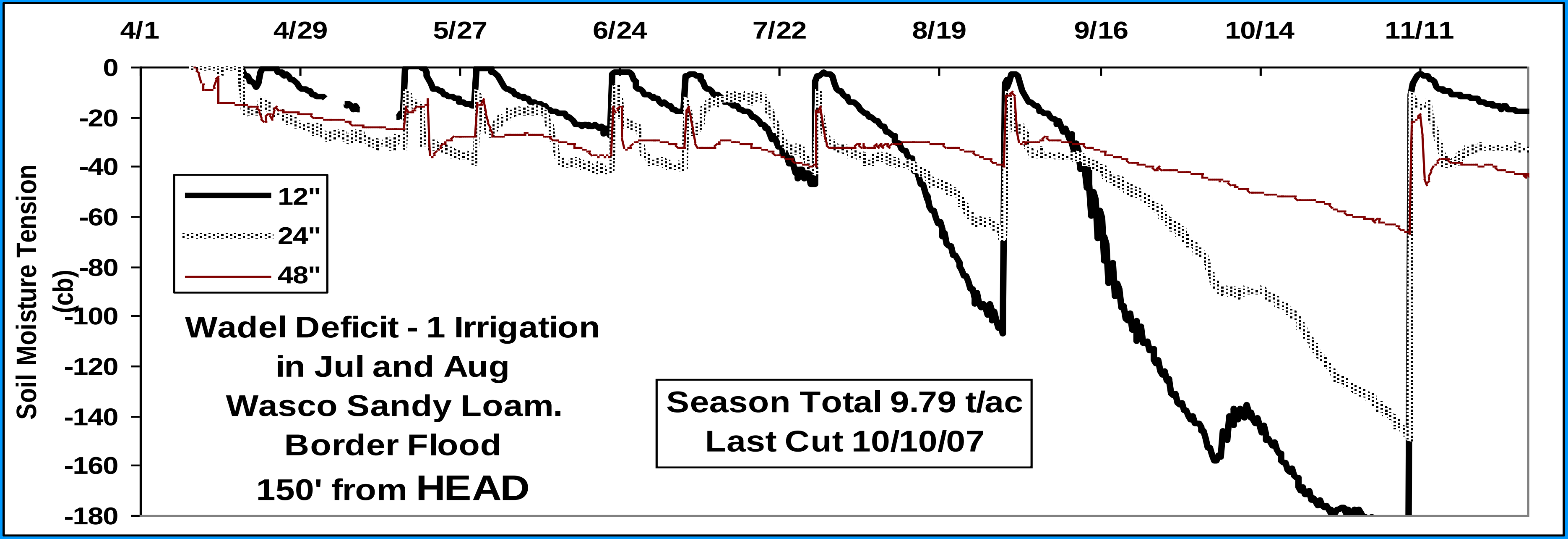
Fig. 1. Typical field layout of monitoring sites with surface irrigation. Spacing of Watermark sensor groups varied according to irrigation system, but usually set @ 18, 36 and 60 inch depths. (Not to scale.)

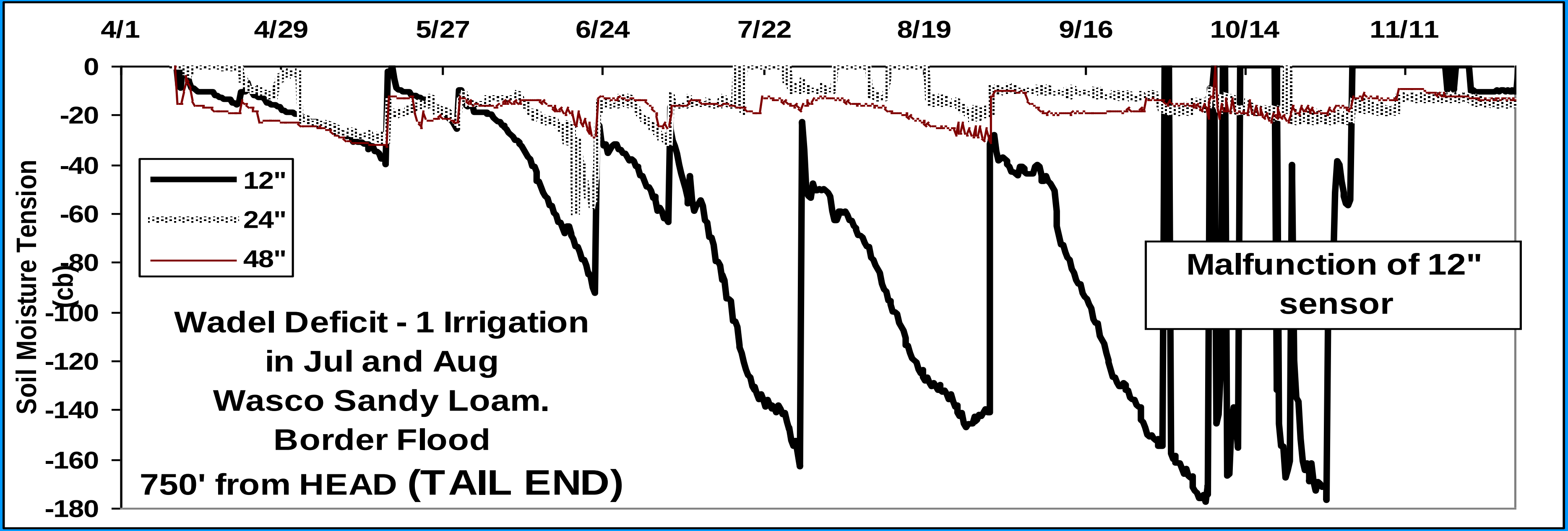
Watermark Readings: “Full Irrigation” Sandy Loam Alfalfa
2 Irrigations per cutting peak season





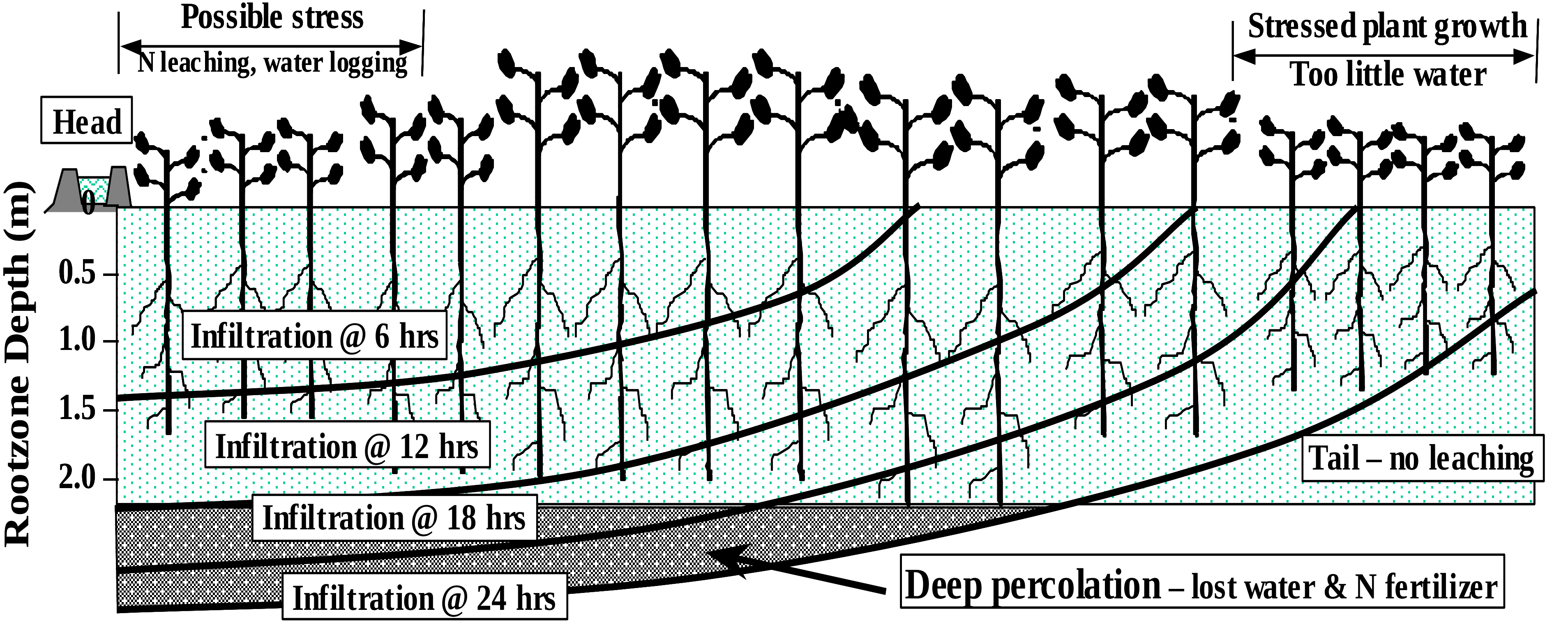
Watermark Readings: "Deficit Irrigation" Sandy Loam Alfalfa
1 Irrigation only for July and August cuttings





Irrigation distribution uniformity (DU) determined by soil infiltration rate, flow down the check and set duration.

$$DU\ (\%) = 100 * \frac{\text{"low quarter" infiltration}}{\text{Average field infiltration}}$$

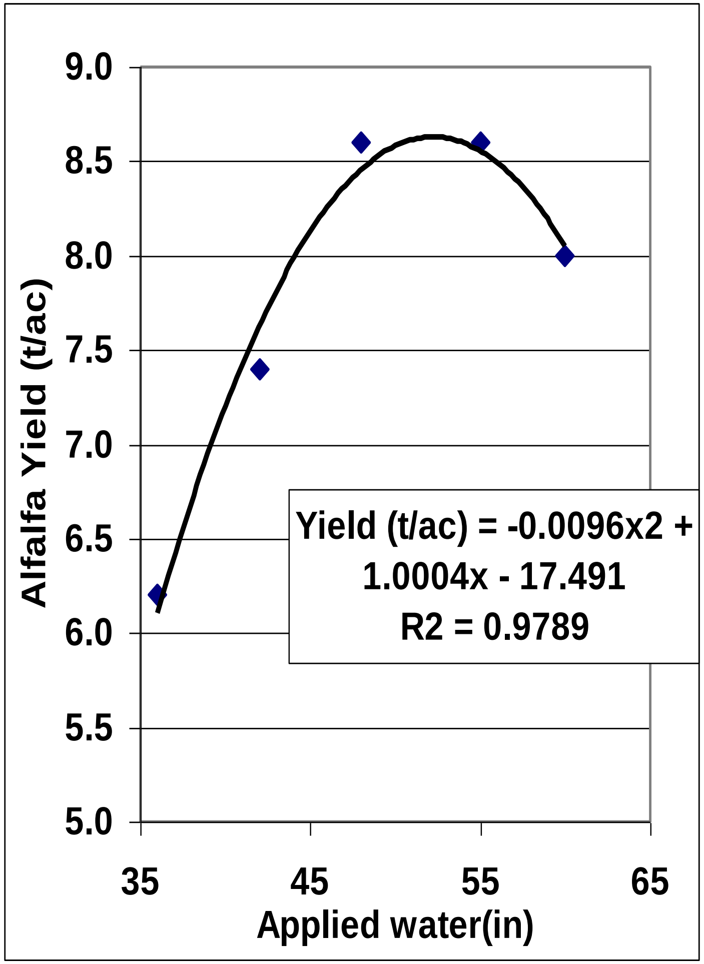



Uniform stands with high irrigation efficiency require large/fast heads of water and usually a tail water return system.


Irrigation non-uniformity can have
severe impacts on water use and yields

Impact of irrigation distribution uniformity (DU) on field applied water and alfalfa yield

Field Qtr	Qtr Irrig by Avg Depth (in)				Qtr Yield by Avg Depth (t/ac)			
70% DU	**42**	**48**	**54**	**60**	**42**	**48**	**54**	**60**
Wettest	55	62	70	78	8.5	7.6	6.0	5.0
Wet	46	53	59	66	8.2	8.6	8.1	6.7
Drier	38	43	49	54	6.6	7.8	8.5	8.5
Dry	29	34	38	42	3.6	5.3	6.6	7.6
	Field Average Yield (t/ac):				**6.7**	**7.3**	**7.3**	**7.0**
80% DU	**42**	**48**	**54**	**60**	**42**	**48**	**54**	**60**
Wettest	50	58	65	72	8.5	8.3	7.0	5.9
Wet	45	51	58	64	8.1	8.6	8.3	7.2
Drier	39	45	50	56	7.0	8.1	8.5	8.4
Dry	34	38	43	48	5.3	6.8	7.8	8.4
	Field Average Yield (t/ac):				**7.2**	**7.9**	**7.9**	**7.5**
90% DU	**42**	**48**	**54**	**60**	**42**	**48**	**54**	**60**
Wettest	46	53	59	66	8.2	8.6	8.1	6.7
Wet	43	50	56	62	7.8	8.5	8.4	7.6
Drier	41	46	52	58	7.3	8.3	8.6	8.2
Dry	38	43	49	54	6.6	7.8	8.5	8.5
	Field Average Yield (t/ac):				**7.5**	**8.3**	**8.4**	**7.8**



Impact of Distribution Uniformity (DU) on Water Applied to the Field and Final Alfalfa Yields

Field Qtr	Qtr Irrig by Avg Depth (in)				Qtr Yield by Avg Depth (t/ac)			
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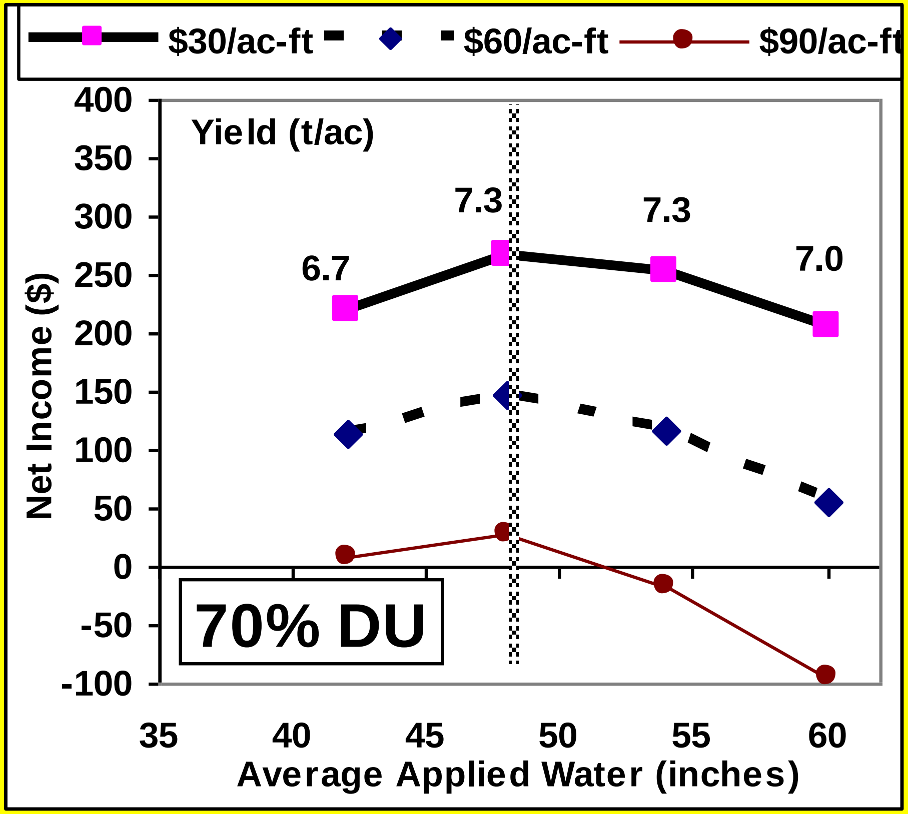
	Field Average Yield (t/ac):				**7.5**	**8.3**	**8.4**	**7.8**

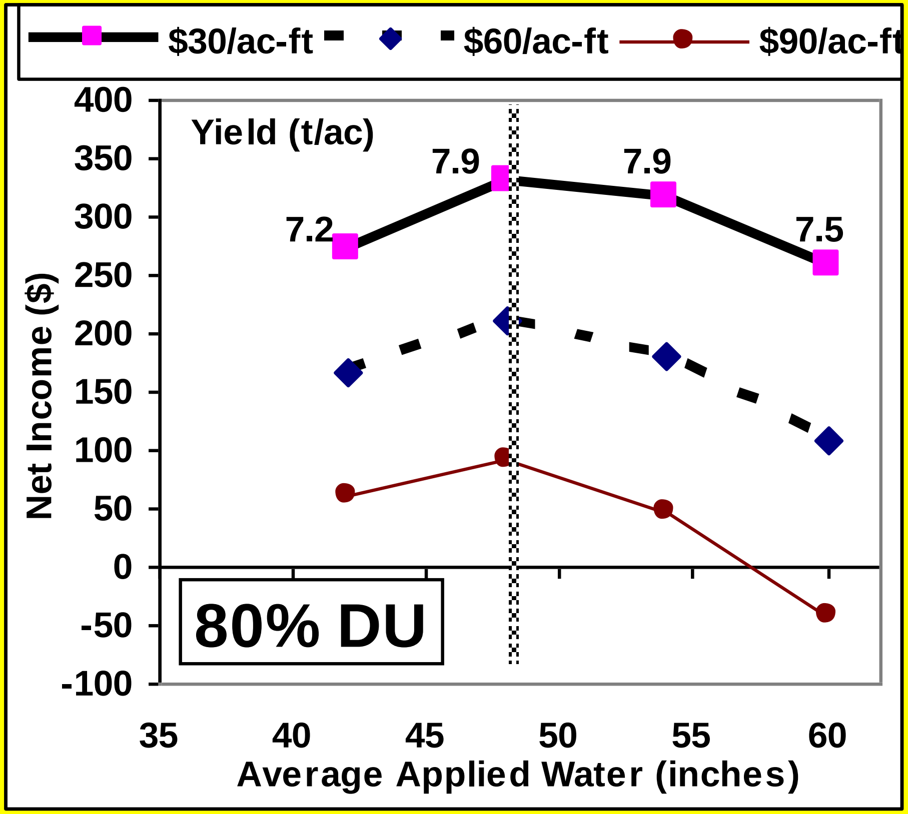
Net Revenue for Average SJV Alfalfa Yields for $30, $60 and $90/ac-ft Water Costs and Different Field Irrigation Uniformities

Assumptions:

All base costs without water ($/ac):	$300.00
No. of cuttings:	8
Cost of cut and rake ($/ac/cutting):	$12.00
Custom bale ($/ton):	$10.25
Harrow bed ($/ton):	$4.00
Hay price ($/ton):	$120.00

Improving DU from 70 to 80% increases net income by $63 @ 48 inches applied water and $60/ac-ft.





Assess "Water Productivity" in terms of most $/ac-ft return when water supply is the most limiting factor.

	ET (inches)	Yield (ton/ac)	Price ($/ton)	Gross ($)	Water Productivity ($/in)	Water Value ($/ac-ft)
Alfalfa (7 cuts)	55	9	$180	$1,620	**$29.45**	**$353**
Silage 4/1-8/25	34	30	$28	$840	**$24.57**	**$295**
Silage 6/15-10/15	28	25	$28	$700	**$24.89**	**$299**
Sudan (3 cuts)	41	10	$120	$1,200	**$28.93**	**$347**
Winter Forage	16	17	$24	$408	**$26.02**	**$312**
Wheat grain	21	3.2	$220	$704	**$33.52**	**$402**

CONCLUSIONS:

- Use “Normal Year” ET schedules to estimate forage crop water consumption
- Understand AND CHECK the depth of infiltration during irrigation events
- Knowing this depth and “normal” ET, check head and tail soil moisture to best schedule the next irrigation…

CONCLUSIONS (continued):

- Increasing DU from 70 to 80% can return a SJV grower $60/ac @ hay prices of $120/ton. Increasing DU from 70 to 90% will return $90 to $110/ac
- Alfala ET in the SJV uses about 5.5 inches/ton. Summer fallow of hay will cost you 2 to 3 tons/ac to save a foot of water, but the stand will be fine if you rewater for a fall cutting. This is not the case for…

Imperial Valley

“Where’d my stand go?!”

(Excessive heat scorches crowns and hurts stand when cover and ET decrease)

CONCLUSIONS (concluded … at last):

- Total water use is least with winter grain/forage crops and provides high water productivity ($/inch).
- Organize all data for each field in a water balance spreadsheet.
- Install a tailwater return system to improve DU, avoid scald and phytophthora
- Stay profitable so you can make it to the next CA Alfalfa Symposium and buy Dan a drink!