

What to do when you don't have enough....

Alfalfa Production Strategies under Drought Stress



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Key Takeaways....

- ❑ **It's not easy**
 - Triage, water most valuable crops
 - Deficit Irrigation of alfalfa
- ❑ **Start Early! Early irrigations count when water is limited**
- ❑ **Monitor soil moisture-what is going on below ground?**
- ❑ **Lengthen harvest schedules to maximize yield (ignore quality this year)**



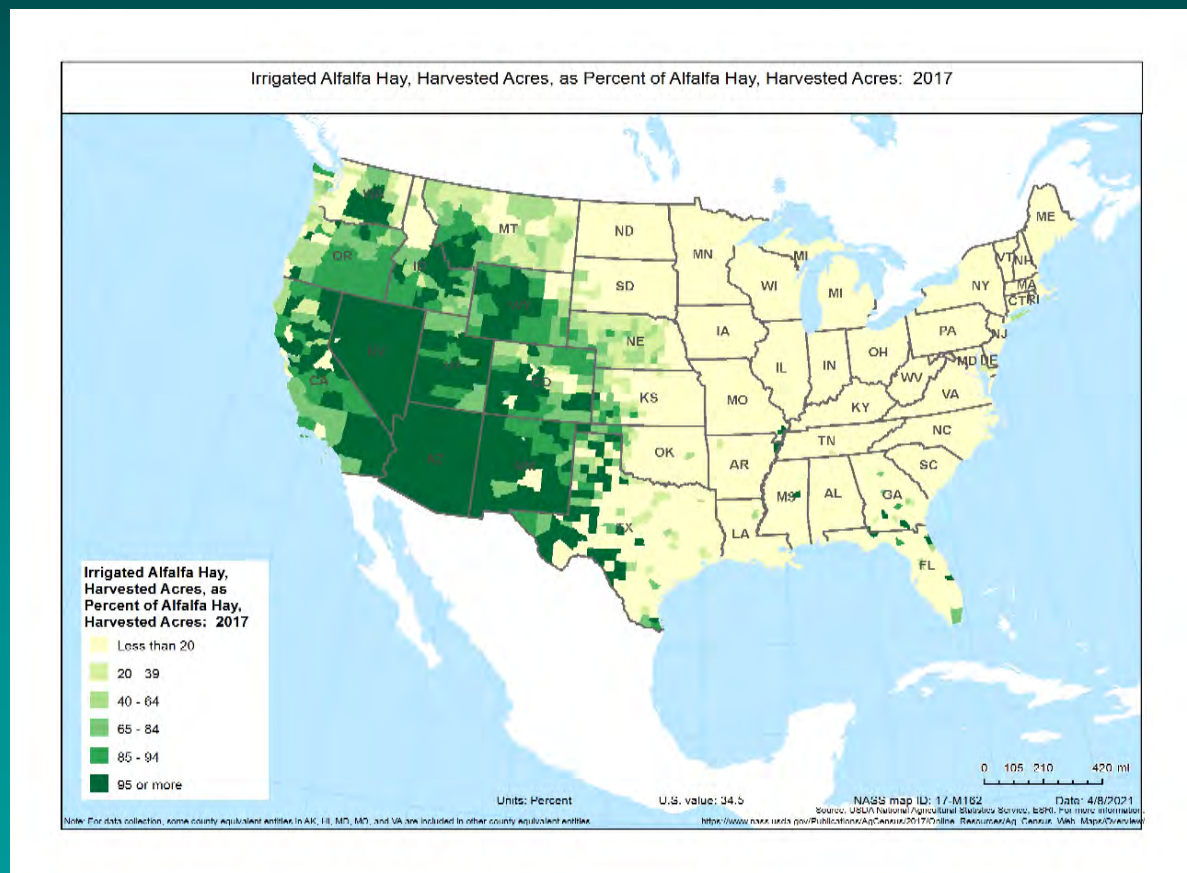
On your calendar?

- **Western Alfalfa Symposium (2021) Reno**
 - November 16-17-18, 2021
 - 11 Western States, Reno, NV
- **World Alfalfa Congress**
 - (Nov. 2022), San Diego
- **Alfalfa/Forages Blog: (google 'alfalfa blog')**
(<https://ucanr.edu/blogs/Alfalfa/>)
 - “Drought Coming – start irrigation early!”
 - “Organic hay cost study”
 - “Pre-plant weed control”
 - “Aphid Pest Management”



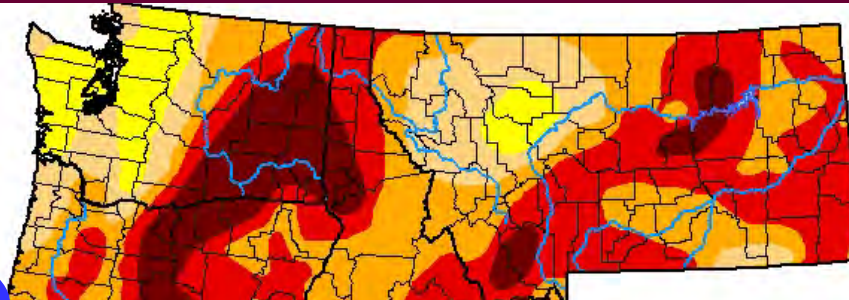
Irrigated Alfalfa

- 45 %-52 of US alfalfa is produced in irrigated regions
- Alfalfa is the #3 economic crop in the US
- Alfalfa is often the #1 water user in western states



Current Situation (May, 2021)

Severe



Exceptional



Extreme

Ok, so really bad

Source: USGS



Can We Produce...

- ❑ **Alfalfa with about $\frac{1}{2}$ the water?**
- ❑ **Sustainable forage production under highly variable water supplies?**
- ❑ **Alfalfa under increasingly saline conditions?**



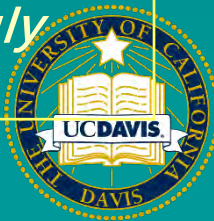
Today's discussion: premise

- ❑ No magic solutions
- ❑ Focus on alfalfa and possible strategies
- ❑ Likely a combination of actions may be helpful
- ❑ But not completely satisfactory
- ❑ Focus on the biology, not the politics



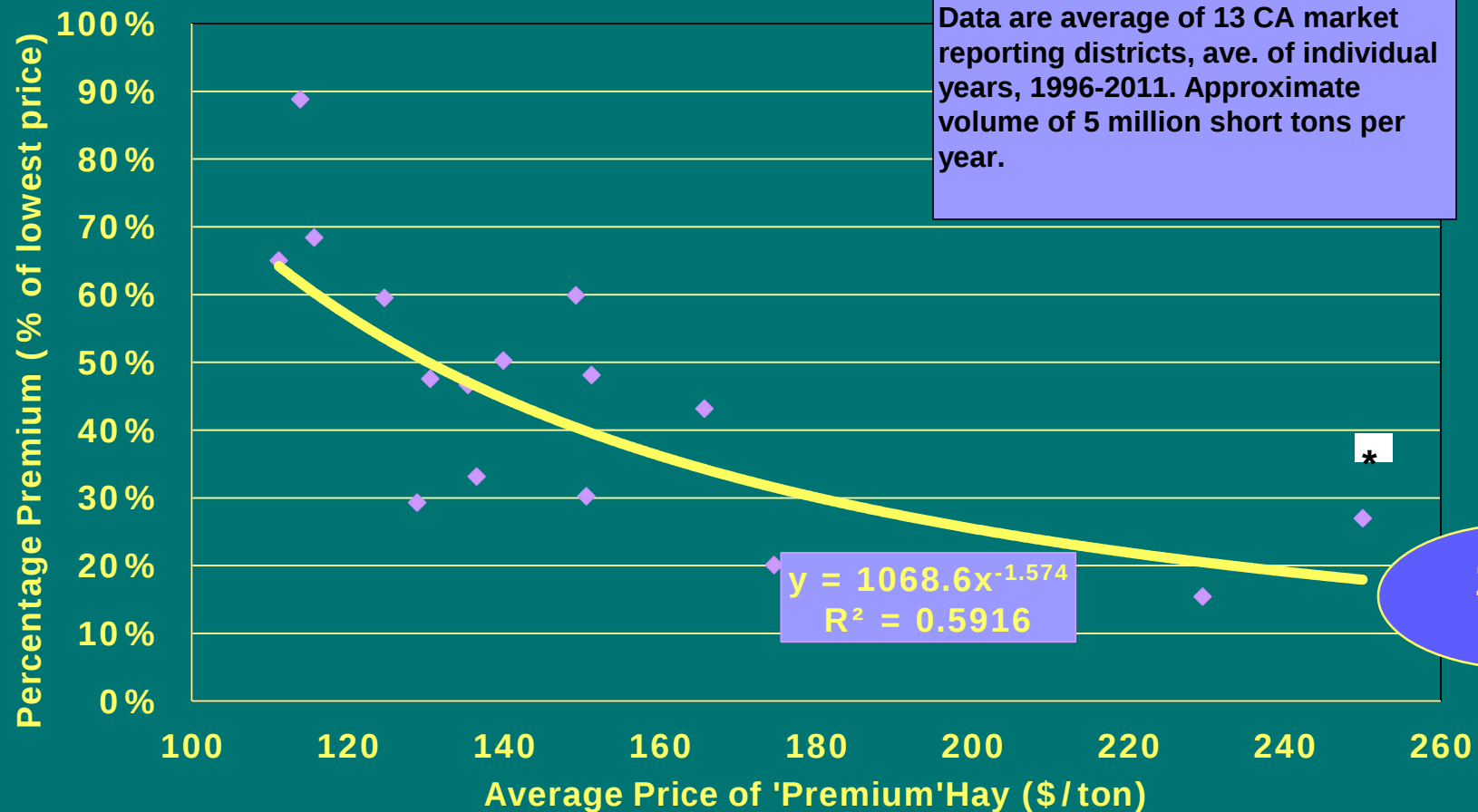
What about the Demand Side?

Hay Quality	July 23, 2021	Year Ago
<u>Tulare / Hanford Dairies (delivered)</u>		
Supreme	\$295-\$352	\$265-\$285
Premium	\$272-\$290	\$246-\$265
Good	\$260-\$275	\$215-\$238
Fair	\$245-\$265	\$185-\$205
<u>Idaho-(FOB Stack)</u>		
Supreme	\$240	\$165-\$180
Premium	\$225-\$240	\$150-\$170
Good	\$210-\$235	\$130-\$150
Fair	\$190-\$210	\$120-\$138
		<i>Hoyt Report – July 23/2021</i>

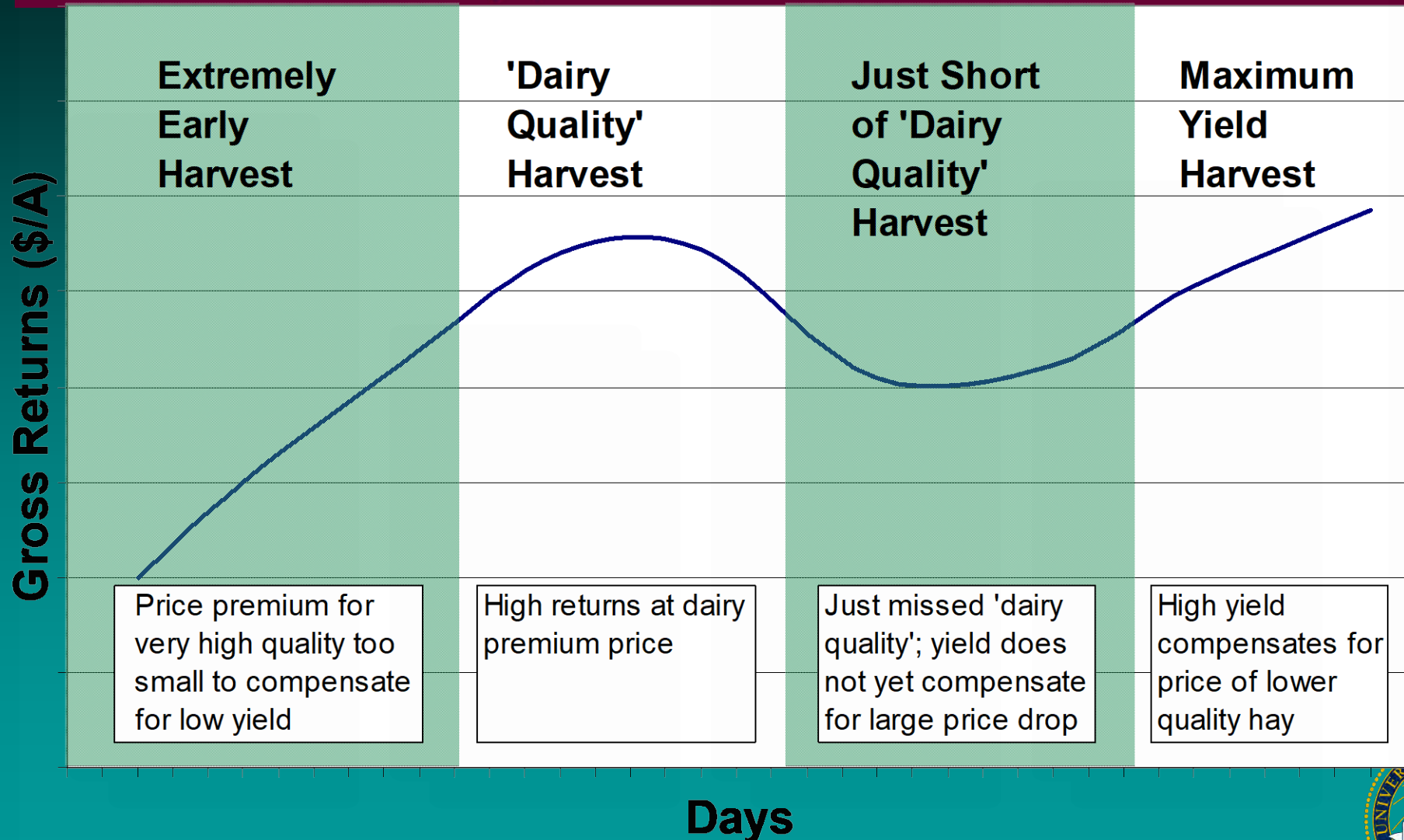


Quality is less important in a high price year!

Influence of Hay Price on Quality Price Premium (California Marketplace)



Common Hypothetical Return Curve





Alfalfa – the Best Crop for a Drought

- ❑ Very high “Water Productivity” – DM produced for each unit of water
- ❑ Deep roots – recovery of residual soil moisture
- ❑ Perennial (starts early)
- ❑ Can successfully ‘dry down’ alfalfa and still have economic returns (usually recovers)
- ❑ Consistent demand for hay (esp. in drought)
- ❑ Can accept degraded water (saline, waste)
- ❑ High flexibility

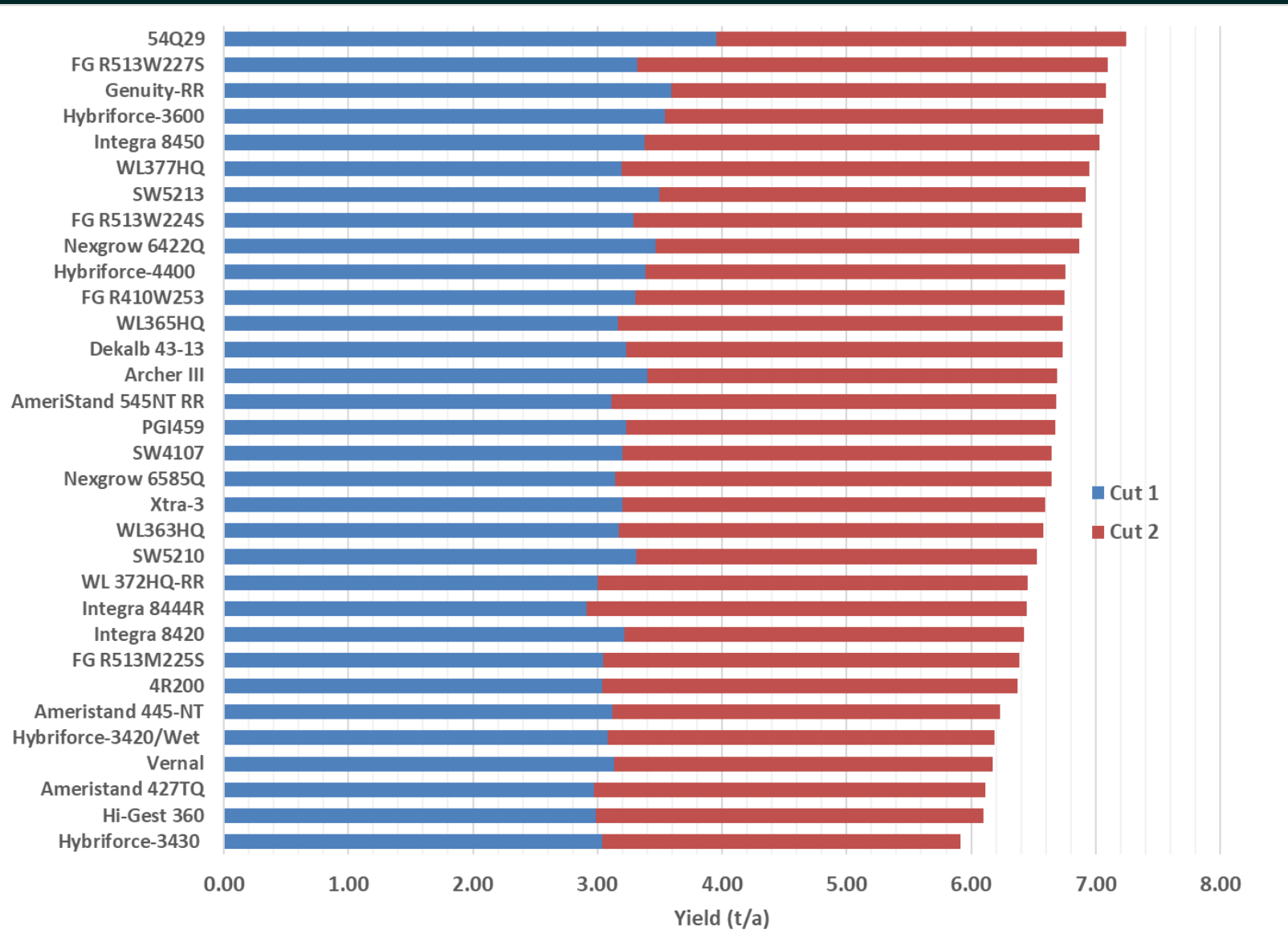


Tulelake, July 2021

▣ Two harvests without irrigation



Tulalake Yields (2 cuts, 2021) non-irrigated



What is happening below ground?



Nodulation at 34"





**Five-year old alfalfa
variety trial after
two years of
season-long
drought conditions
under high salinity
2013 and 2014
(Western Fresno
County, CA).**

**Photo taken Nov. 2014 after a
single irrigation – plants mostly
recovered**



Alfalfa's Ability to..

- ❑ Exhibit high early productivity
- ❑ Go Summer Dormant (in most cases)
- ❑ Extract moisture deep in profile
- ❑ Re-grow after extended drought (in most cases)

Important characteristics for a drought resistant crop.

Key is deep moisture



Caveats:

- ❑ Not all soils are as forgiving as Tulelake soils
- ❑ Mineral soils/sandy soils/soil impediments
- ❑ Depends upon subsoil moisture
- ❑ Understand your deep moisture
- ❑ Remember – soil profile will need to be refilled next year.



**Principle: More crop per drop.
Or
As much crop Per Drop as possible**



Strategies for a drought year

1. Selective Fallowing
2. **Technology Strategies** (improvements)
3. **Partial Season** Irrigation strategies
4. Use of **degraded (saline)** water
5. Modify Harvest Schedules



Technology Strategies (long term)

- ❑ **Application improvements (pivots)**
 - ❑ Closer spacings on drop hoses (DU)
 - ❑ Nozzle solutions appropriate for soil and stage
 - ❑ LESA-LEPA, dragging drip lines
- ❑ **Goal is to more carefully match ET, reduce losses**
- ❑ **Push moisture deep into root zone**
 - **Other options? Subsoil Drip Irrigation?**
 - ❑ Major limitations have been cost, gopher control
 - ❑ On certain soils, have proved to be viable
 - **Flood irrigation? (light soils with limited surface water, doesn't make sense)**



Overhead Improvements:

Linear Overhead Irrigation





Improvements

Configurations:

LESA
Low Elevation
Spray Applicators

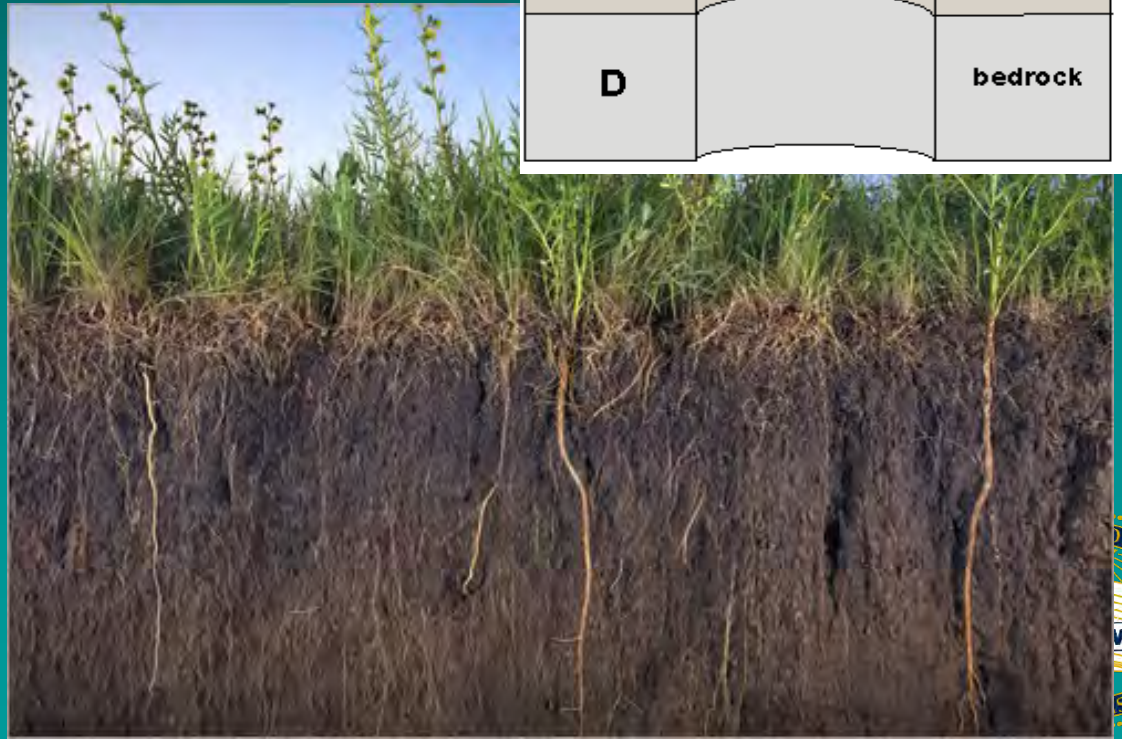
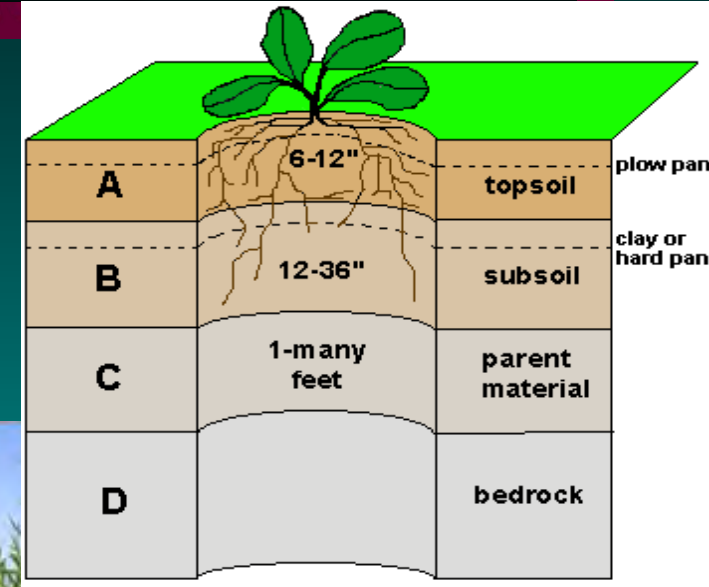
MDI
Mobile Drip
Irrigation



- Push water deep in profile?
- Follow ET?
- Minimize losses?



The Problem: What's REALLY Happening Below-ground?



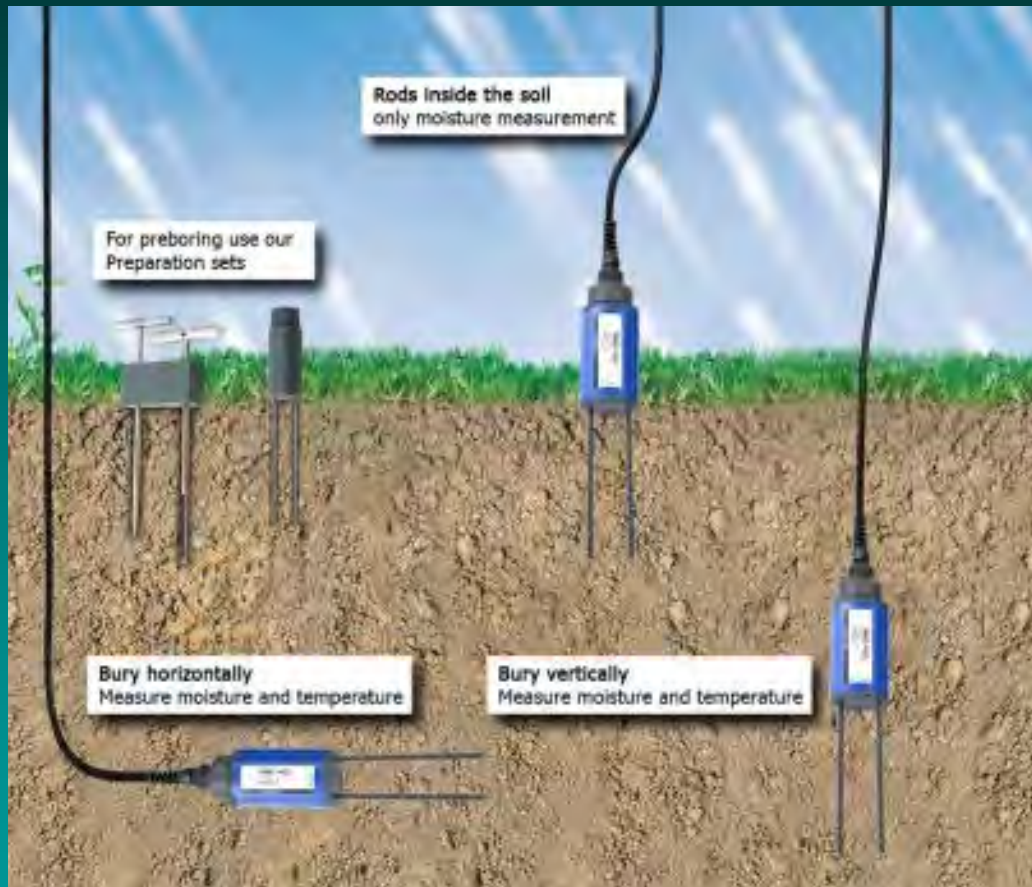
Soil Impediments...



Even on sands – layers occur



Soil Moisture Monitoring

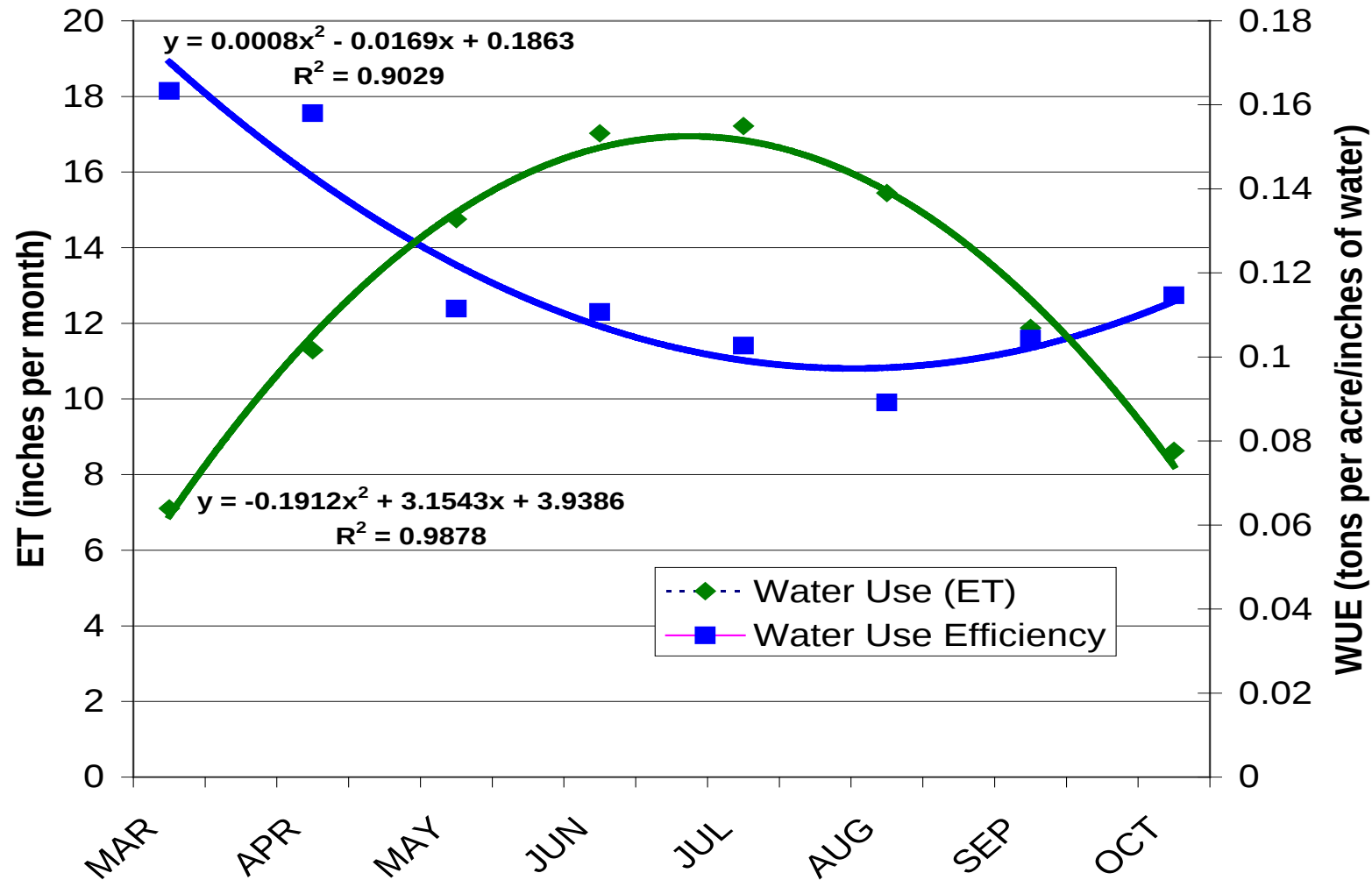


Deficit Irrigation Strategies

- ❑ Alfalfa can be deficit irrigated, but partial yields should be expected.
- ❑ **Start early!**
 - Fill Profile in early spring
 - “Cold turkey” not “starvation diet”
 - Water fully per cutting if possible
 - Curtail irrigation mid-late summer/fall
 - Re-fill profile in early spring

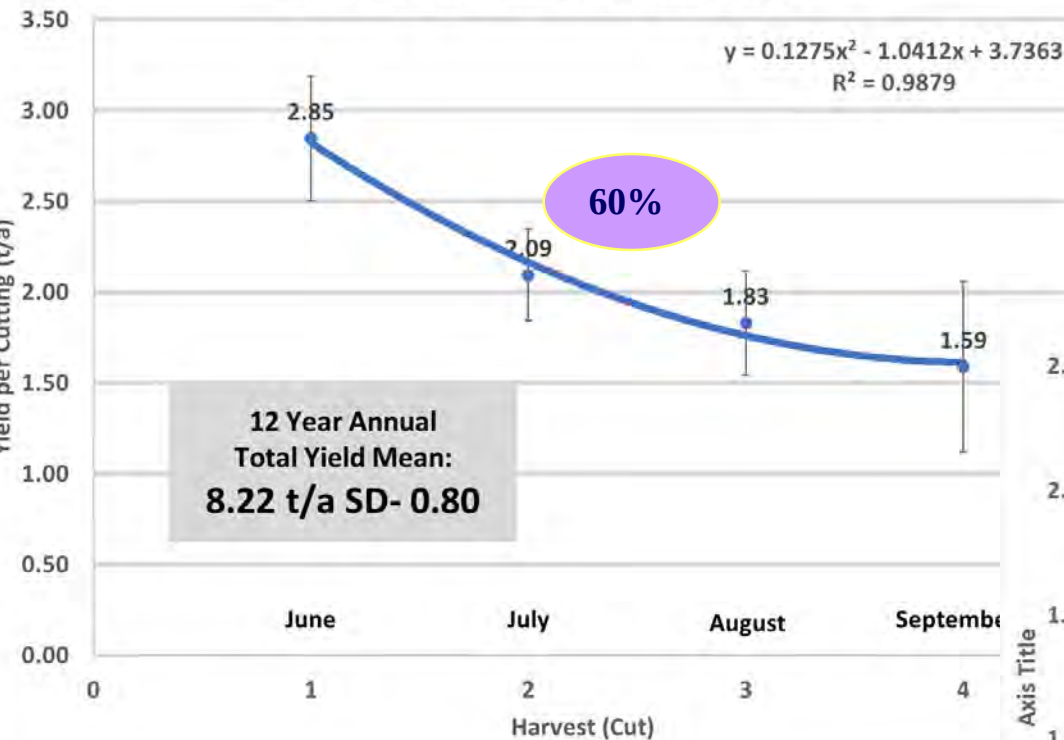


Water Productivity & ET



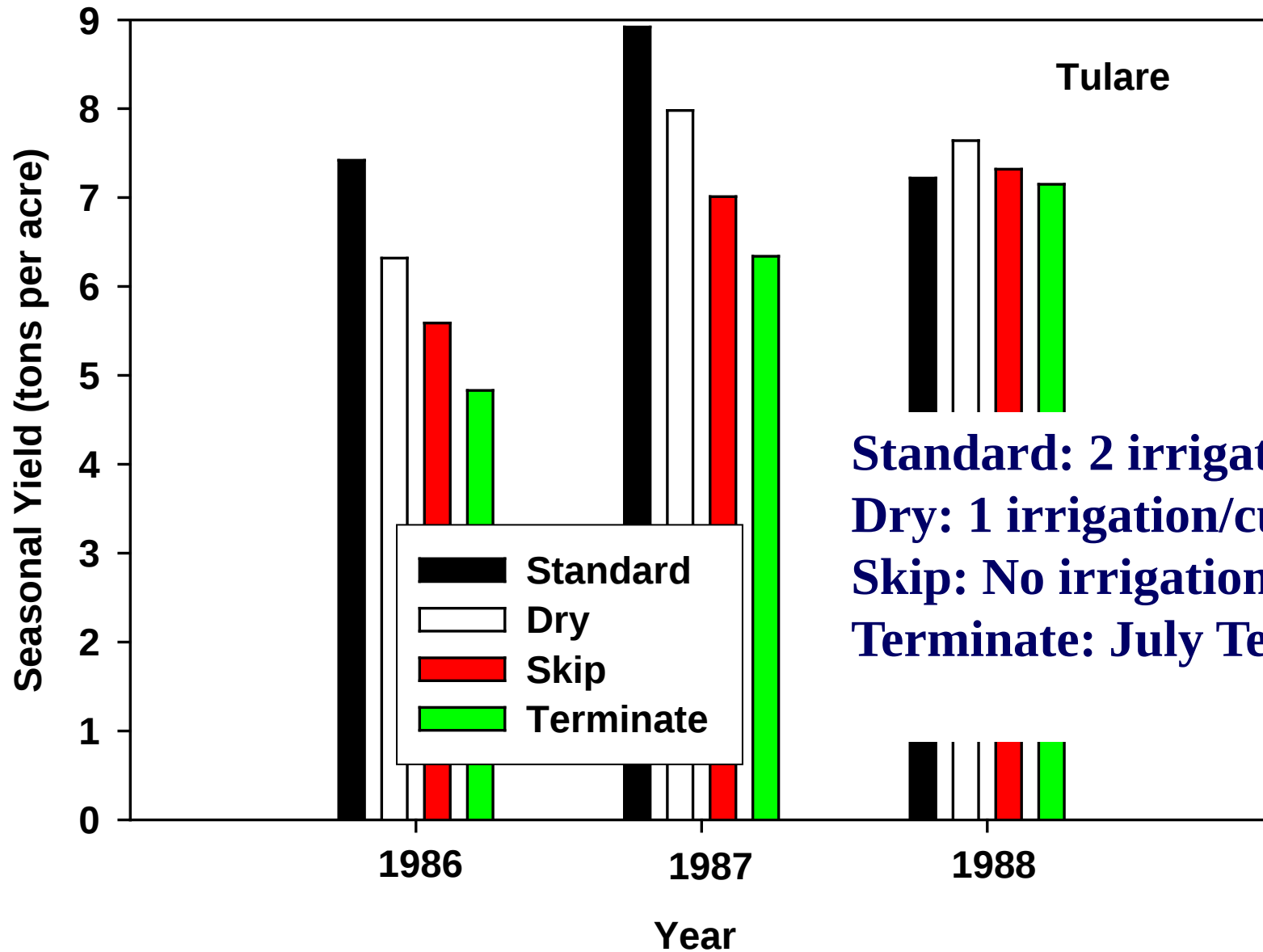
Alfalfa Yield Patterns

Tulelake, CA (Intermountain) - 12 trials



Parlier, CA (Mediterranean) - 12 trials





Standard: 2 irrigations /cut
Dry: 1 irrigation/cut
Skip: No irrigation July/Aug
Terminate: July Termination



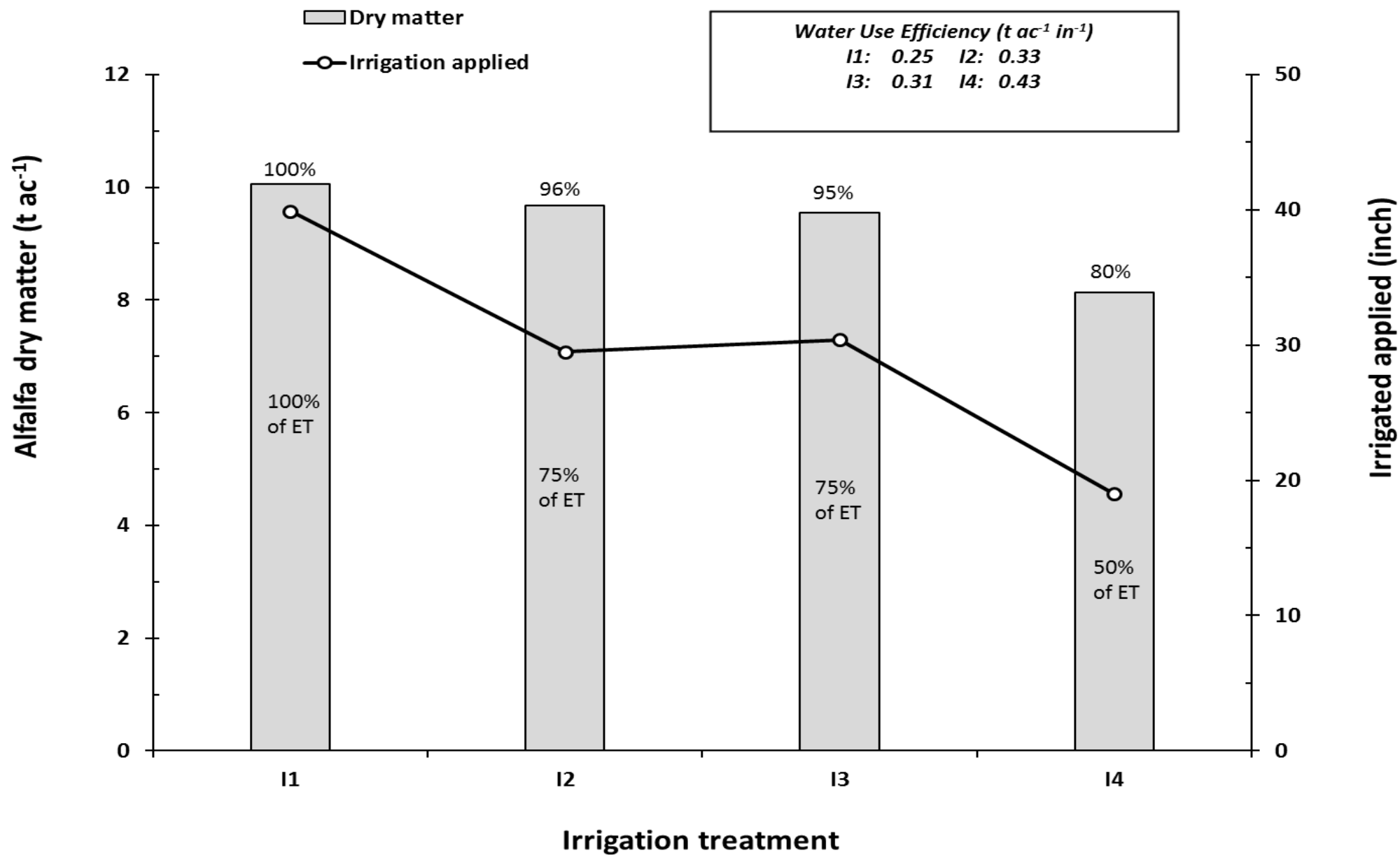
Water Savings

Table 1. Water applications (1986) Kearney Agricultural Center, Fresno Co. (Sandy Loam soil)

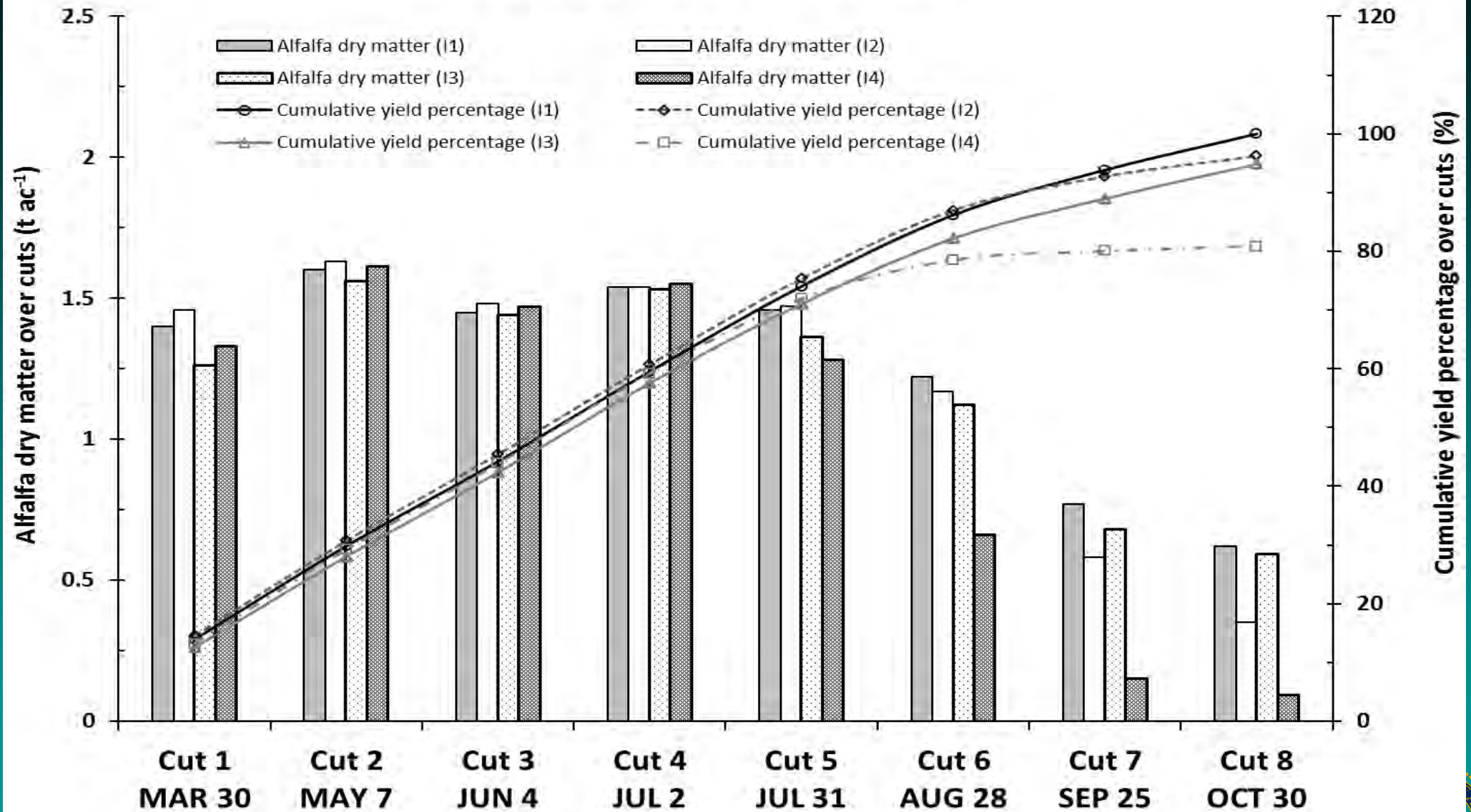
Treatment	Irrigation Water	Irrigation + Rain
Normal	37	51
Dry	23	37
Skip	19	33
Terminate	15	29

See: Frate & Roberts, 1992. California Alfalfa Symposium Proceedings (<http://alfalfa.ucdavis.edu>)





Alfalfa SDI Deficit Trail - Davis (2015)



Studies in grower's fields (2005-2012)

Hanson et al.

- Yields were reduced, but not to the same degree as water savings.
- Crop mostly recovered in following year



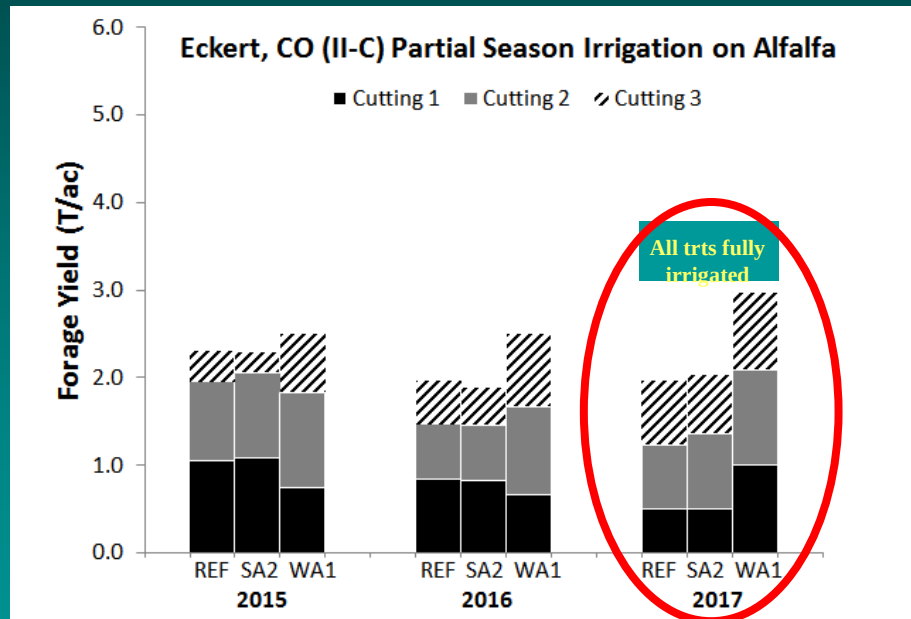
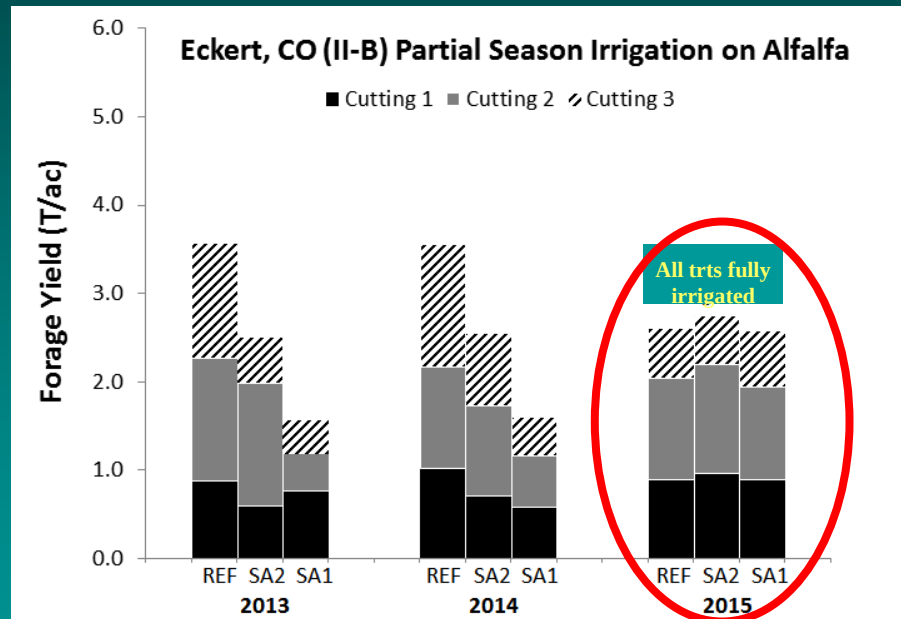
Fully irrigated

Deficit irrigated (no irrigation since the end of June)

Sacramento Valley – September 19, 2008



Impact of 2 Years of Treatment and 1 Year of Recovery on Alfalfa Yield – Eckert, CO



J. Brummer, 2017



Kearney Trials (sandy loam)

- ❑ Previous year deficits vs. fully irrigated
- ❑ Recharge with excess winter flooding >12 AF/acre flood
- ❑ Advantage: Contribution to aquifer, filling root profile

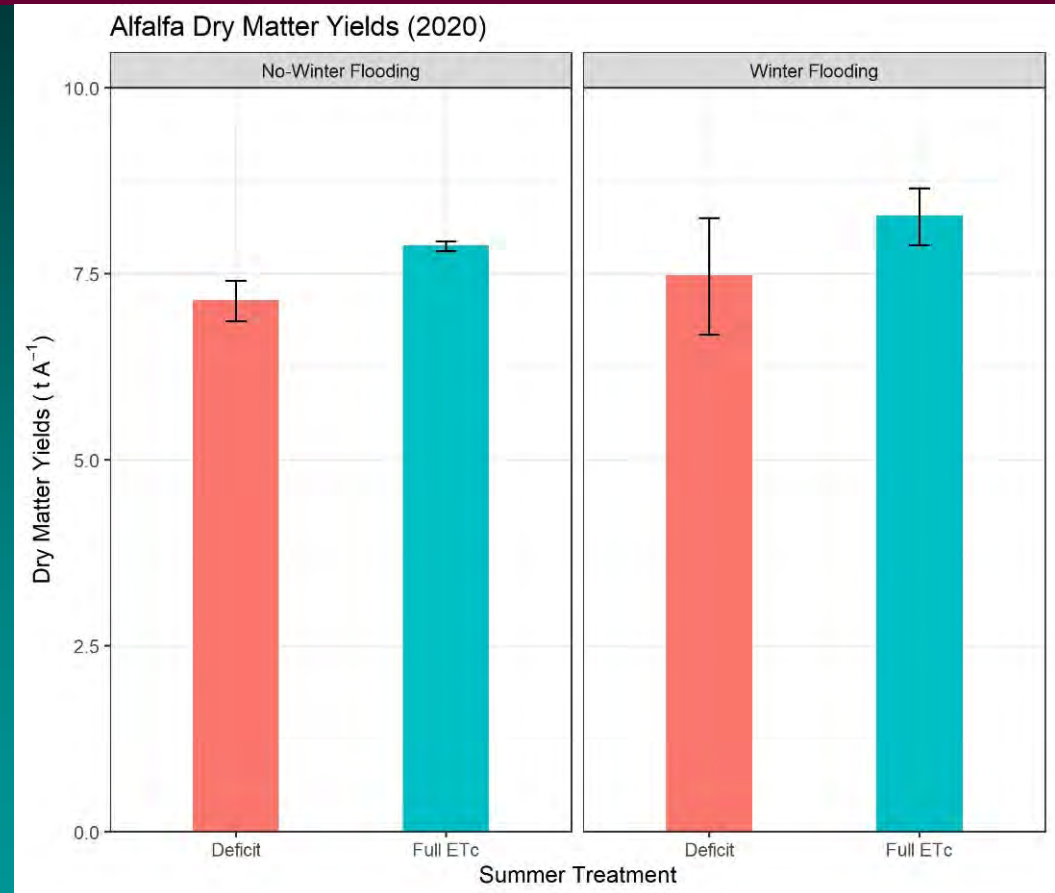


Figure 7. Effect of winter flood irrigation on 2020 alfalfa yields that were either fully irrigated or deficit irrigated in 2019.

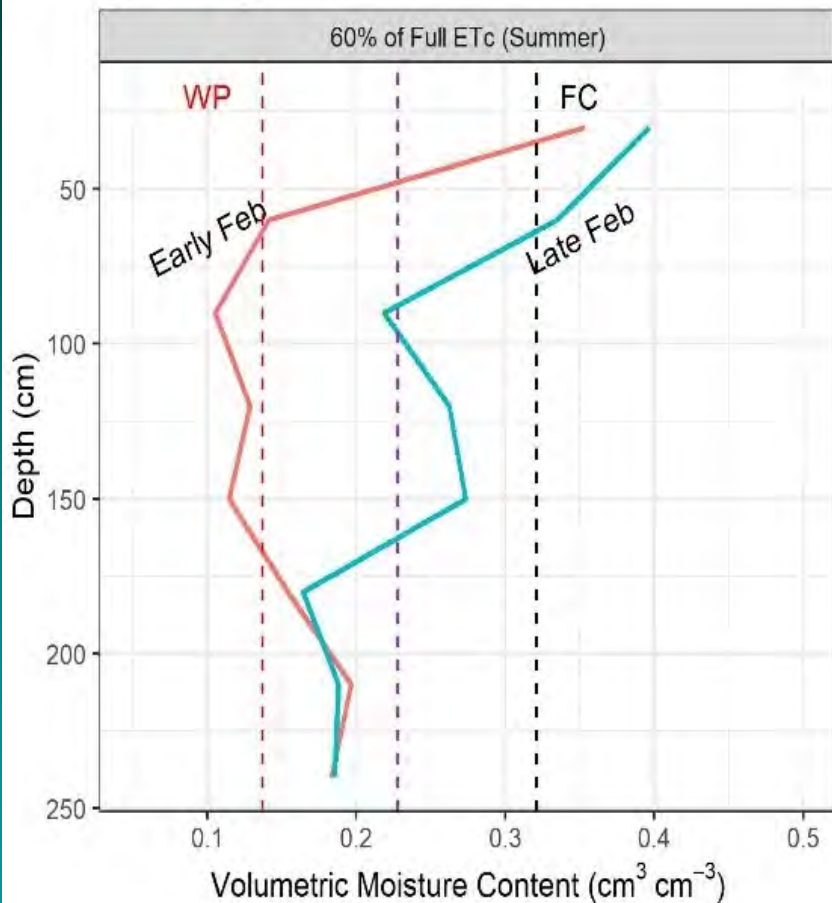
Value of Refilling the Profile Early (2021 trial)

- ❑ **Davis, CA**
- ❑ **Previous years (2020) Deficit Treatments were imposed vs. fully irrigated plots**
- ❑ **Sprinkler System (LESA) and Mobile Drip Irrigation (MDI).**
- ❑ **In 2021, divided into**
 - **1) Early season (pre-harvest) irrigation using flood irrigation**
 - **2) No early irrigation**

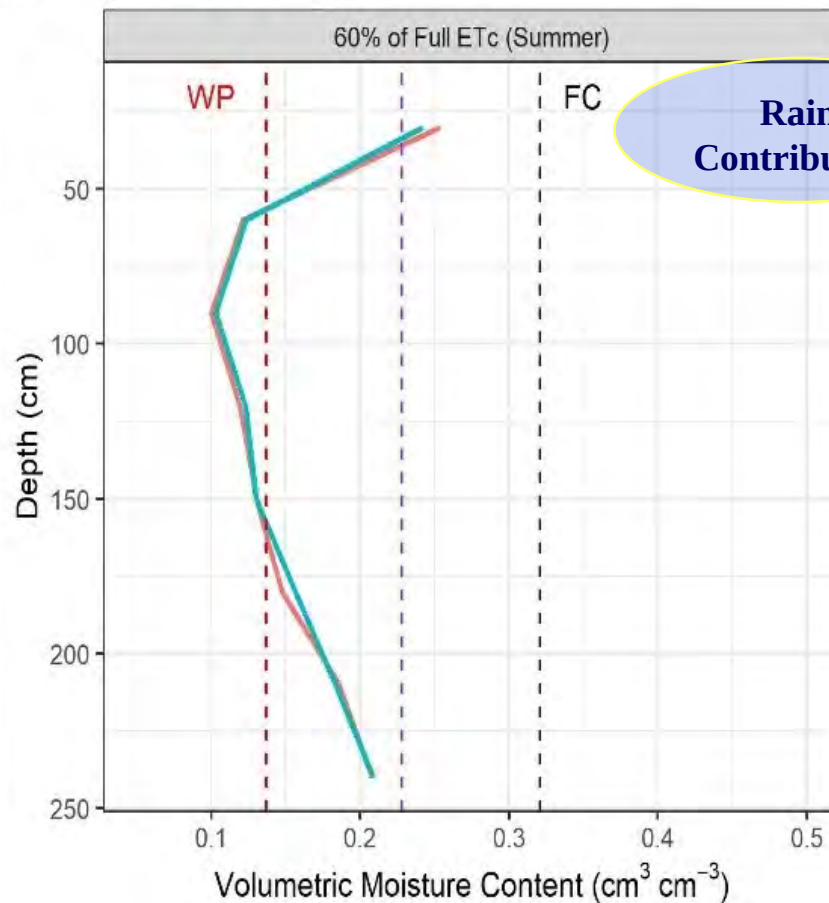


Effects of early irrigation:

C Winter Irrigation



D No Winter Irrigation

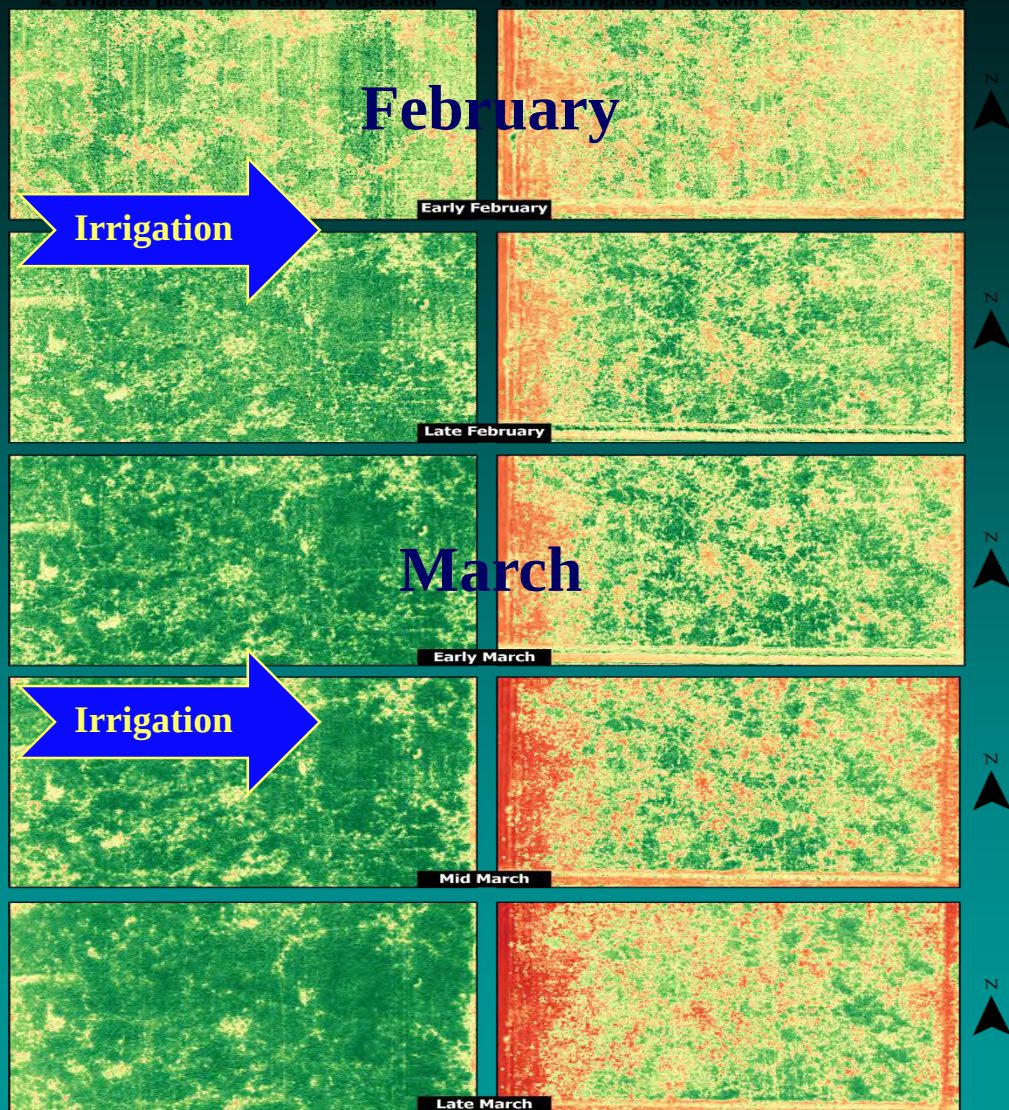


Importance of Early Irrigations:

- ❑ Early growth: access to subsoil moisture
- ❑ Important later when one cannot 'keep up'
- ❑ Subsoil helps with 'cutting drought' stress during harvest periods

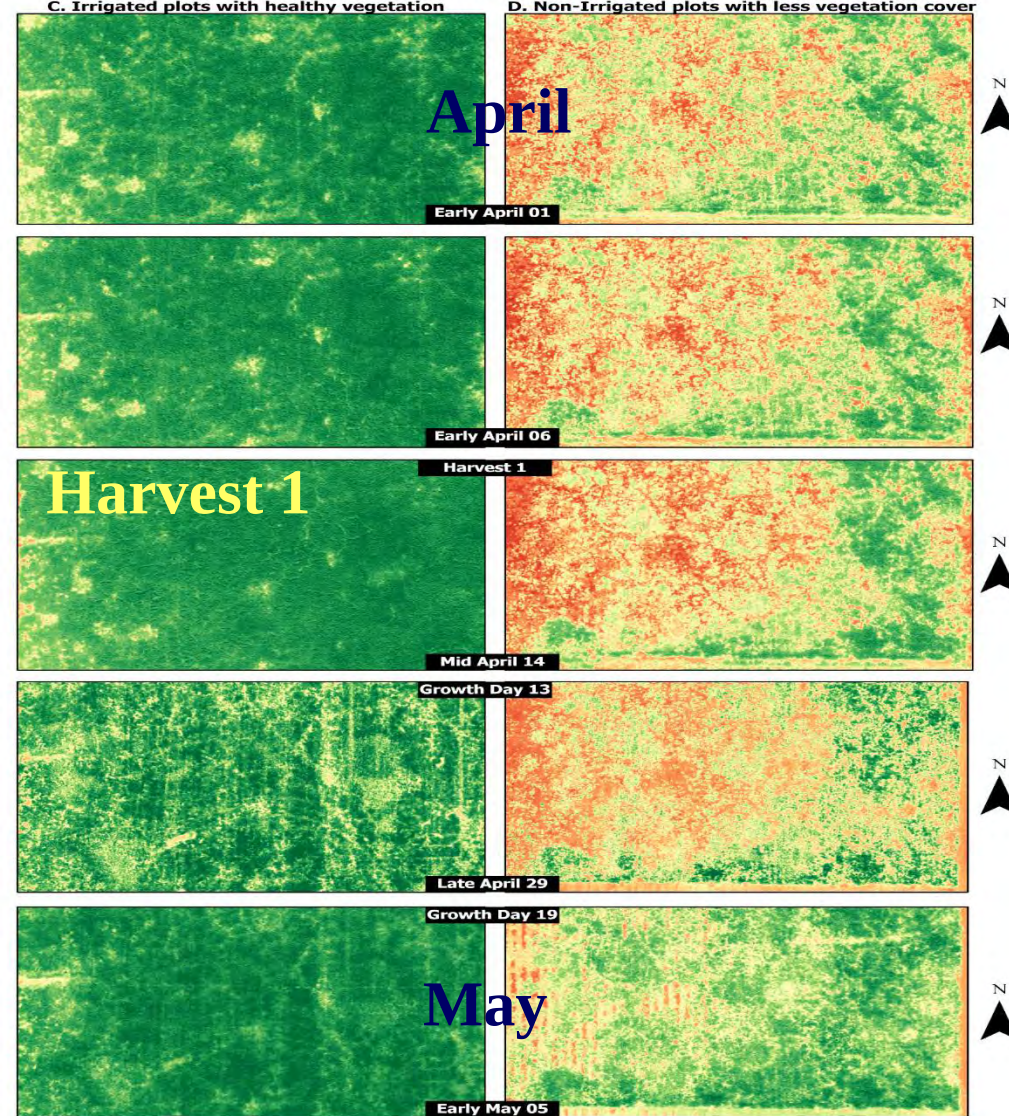


Davis Alfalfa Crop Growth during winter 2021 under winter irrigation and no-winter irrigation
 A. Irrigated plots with healthy vegetation B. Non-Irrigated plots with less vegetation cover



0 15 30 60 Feet

Davis Alfalfa Crop Growth during winter 2021 under winter irrigation and no-winter irrigation
 C. Irrigated plots with healthy vegetation D. Non-Irrigated plots with less vegetation cover



0 15 30 60 Feet





February Flood Irrigation (Buttonwillow, CA)
Subsurface Drip (SDI) during remainder of season
“Filling the Profile Early”



Strategies for water short years:

- ❑ Water early – fill profile
- ❑ Monitor soil moisture – how deep?
- ❑ Produce high yield crops early
- ❑ Lengthen early harvest schedules (maximize yield)
- ❑ Late summer/fall dry-downs
- ❑ Save on late-season costs
- ❑ Accept reduced yields



Many thanks!



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Wagner farm, WA state, photo