Preliminary Findings on Water and Energy Use of Alfalfa Production under Border Check and Sub-surface Drip Irrigation

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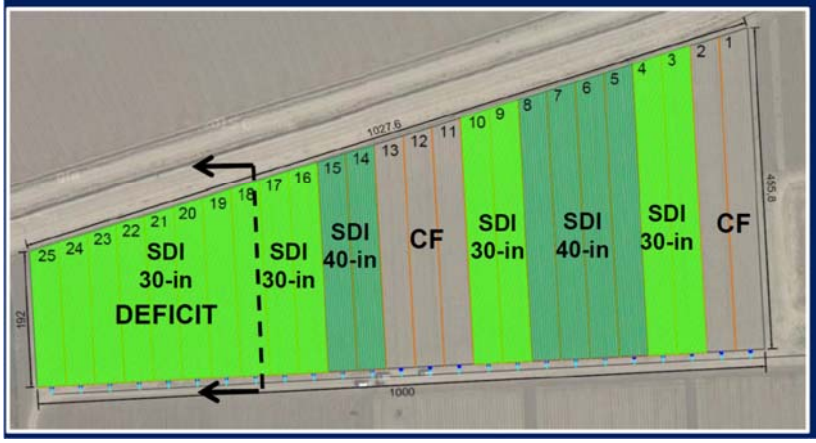
ALFALFA RESEARCH TRIAL on SDI @ RUSSELL RANCH - DAVIS



Area = ~ 8 acres

Established Jan 2016

5 Treatments

3 Replications

Groundwater supply

OBJECTIVES

Document comparative differences between Check Flood (CF) and SDI in:

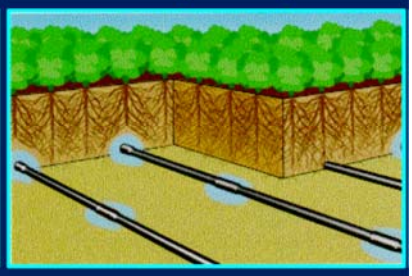
- ✓ Actual Crop Evapotranspiration (ETa)
- ✓ Hay Yield (HY)
- ✓ Water Productivity (WP)
- ✓ Energy usage (EU) and Energy Productivity (EP)

Motivations & Potential Impact

- ✓ State-wide, alfalfa is grown on 0.8 to 1.0 Million acres each year (depending on local & international markets, and available water supply)
- ✓ Alfalfa is a critical feed-supply to the Dairy & Livestock industry, which generates 11 Billion $/year (~ 20% of CA's agricultural revenue)
- ✓ **Strong interest to Sub-surface Drip Irrigation by:**
  - **A) Growers to obtain higher land and water productivity**
  - **B) Water agencies and regulators to pursue water savings**

CURRENT IRRIGATION PRACTICES IN CALIFORNIA

(>80%) (~16%) (< 2%)



- ✓ Surface irrigation methods (specifically check-flood) dominate in the Central Valley and Desert regions of California (>80% of the total California acreage)
- ✓ Sprinkler systems (center pivots, linear move, side rolls, etc.) dominate in the Intermountain region (16% of the total California acreage)
- ✓ Sub-surface Drip (SDI) is practiced on (20,000 acres or less than 2% of the total acreage).

MAIN DRIVERS FOR SHIFTING TO SDI IRRIGATION IN ALFALFA?

#) Prospect of increased yield

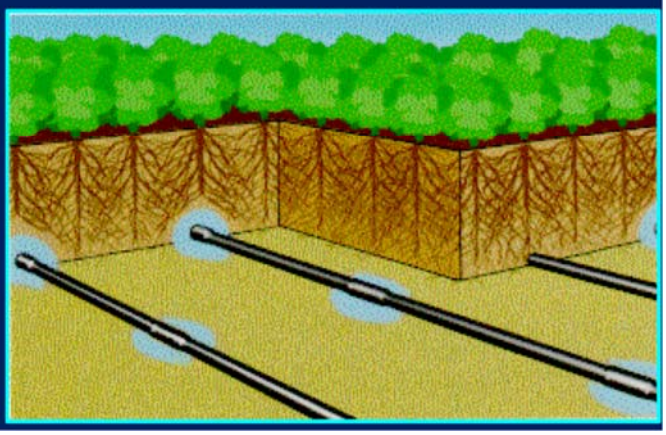
#) Higher land and water productivity

#) More control on irrigation & nutrients

✓Timing & amounts

✓Avoidance of deficits and stress

✓Excess & leach-outs

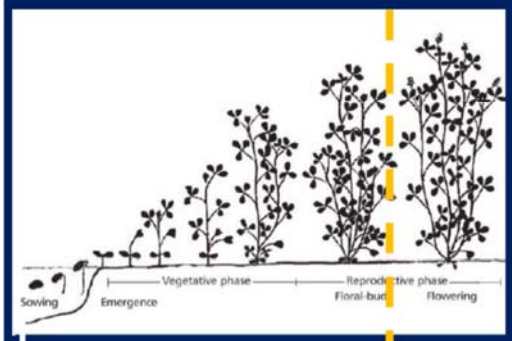


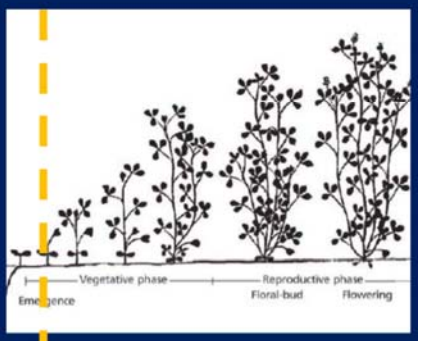
Better soil-water-air conditions

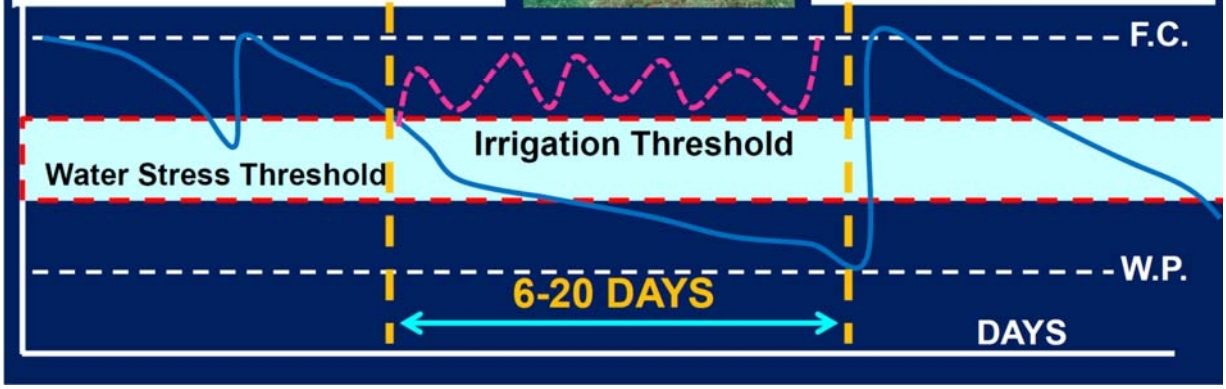
SPOON-FEEDING THE CROP RATHER THAN WETTING & DRYING =>> UNCERTAINTIES

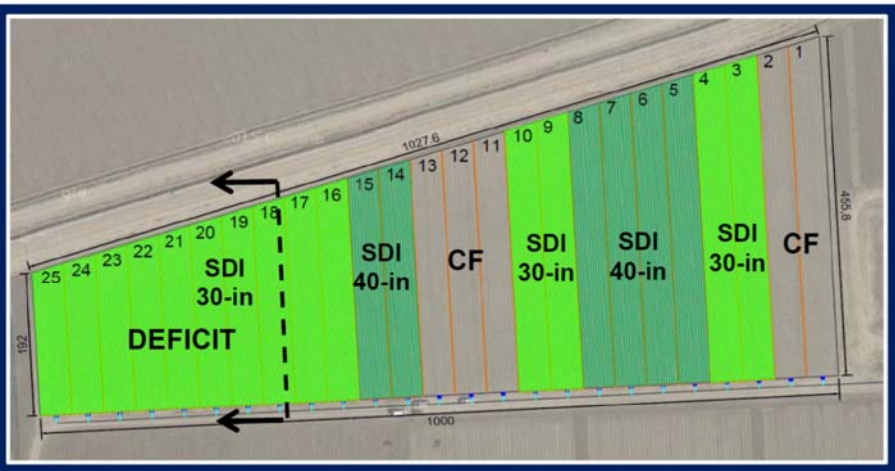
KEY ADVANTAGES OF SDI:

SHORTENING DRY-DOWN PERIODS → **SPOON-FEEDING THE ROOTS**





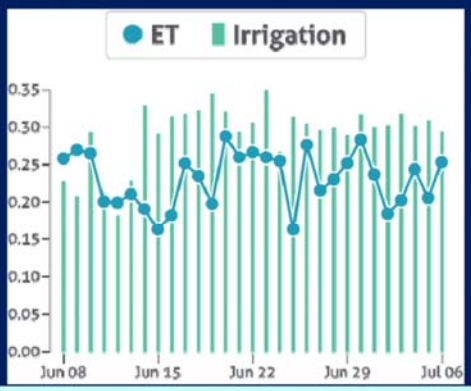




RESEARCH QUESTIONS (CF vs. SDI)

- ✓ Actual Crop Evapotranspiration (ETa): Water Saving with SDI?
- ✓ Hay Yield and Water Productivity (WP) under CF vs. SDI
- ✓ Energy usage and Energy Productivity (EP) under CF vs. SDI
- ✓ What growers need to pursue higher Yields and WP with SDI?

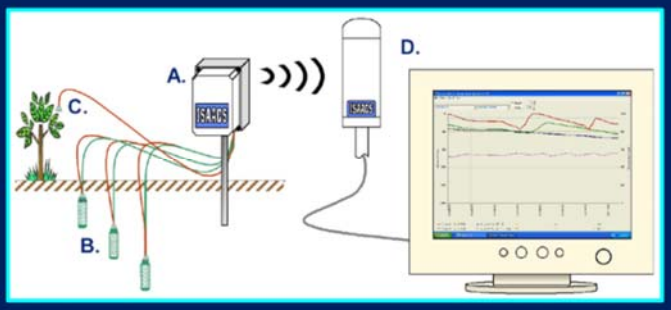
MEASUREMENTS CONDUCTED IN 2016

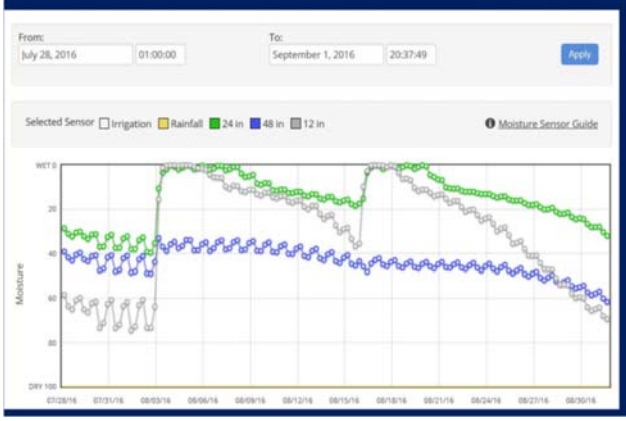


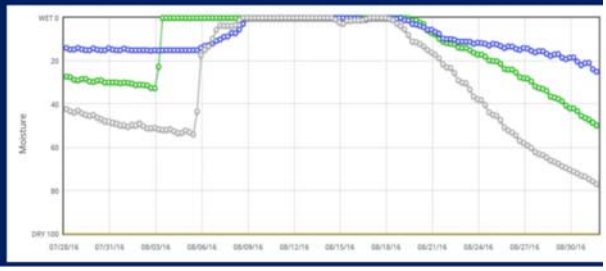
Actual crop evapotranspiration (ETa): with commercial surface renewal units (residual of energy balance method)

Applied water: with calibrated flow-meters

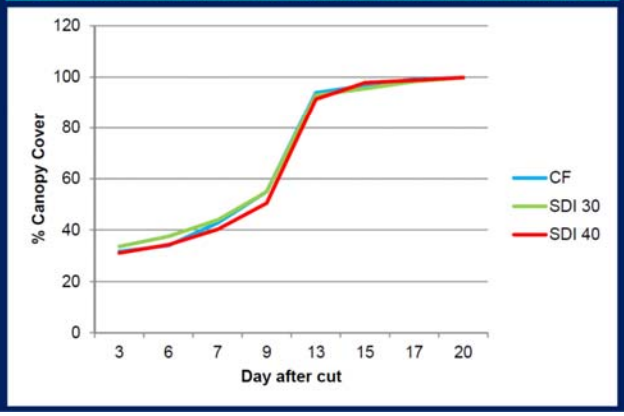
Soil moisture tension was monitored with Watermarks, data-loggers and telemetry along the entire crop season 2016







Canopy development curves were obtained from infrared pictures followed by photo-interpretation to derive fractional canopy cover



The control and treatment plots received similar water amounts using ET-based irrigation scheduling followed by feedback from monitoring Soil Moisture Tension and Applied Water

ET-based scheduling

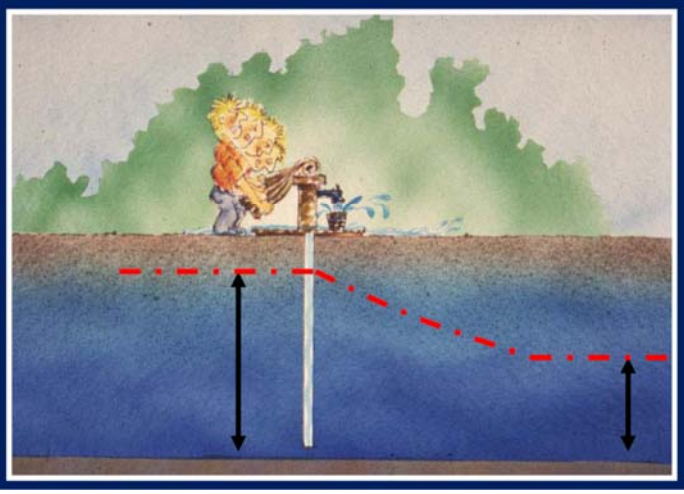
Check for Feedback

Monitoring soil water tension

Check applied water

Energy and GHG (CO_2) from groundwater pumping

1ST YEAR	CF	SDI 30-in	SDI 40-in
ETa (ac-in/ac)	32.8	33.6	32.6
YIELD (Ton/ac)	8.0	8.40	8.35
ENERGY (Kwh)	48.8	100.2	97.0
GHG (Ton-EqCO_2/ac)	0.034	0.070	0.068



Water Use and Yield

Surveyed growers reported:
A) 20-30% Water Saving; B) 10-30% Yield Increase

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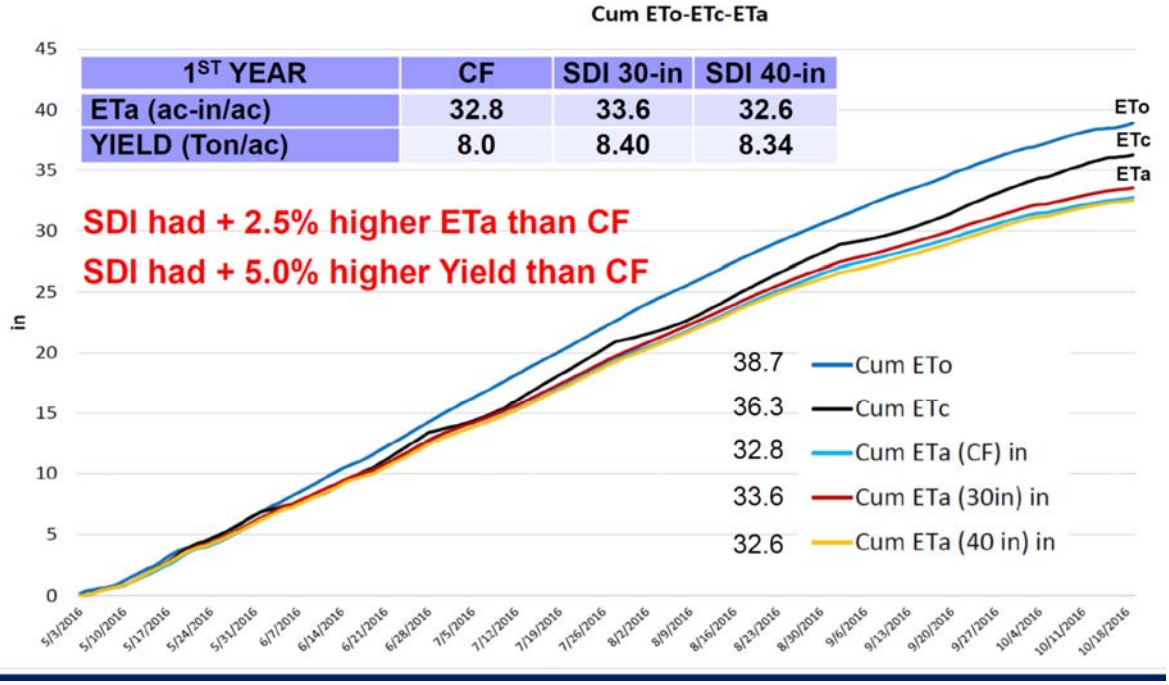
YIELD (Ton/ac)	8.0	8.40	8.34



Productivity of Water, Energy and GHG emissions from pumping

Water Productivity (Ton/in) = Biomass produced (Tons) / ET (in.)

Energy Productivity (Ton/Kwh) = Biomass produced (Tons) / EU (Kwh)

GHG Productivity (Ton/Ton-EqCO_2) = Biomass prod. (Tons) / GHG (Ton-EqCO_2)

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ENERGY (Kwh)	48.8	100.2	97.0
GHG (Ton-EqCO_2/ac)	0.034	0.070	0.068
WP (Ton/in)	0.24	0.25	0.25
EP (Ton/Kwh)	0.16	0.083	0.086
GHG-P (Ton/Ton-EqCO_2)	235.3	120	123

What is needed to pursue Yield and Water Productivity Gains?

With check-flood systems only 1 or 2 irrigations per cycle.

With SDI the more timely and precise water applications =>>key aspects for higher yield performance

Yield and Water Productivity gains are most likely related to:

1. Avoiding long wetting-drying cycles
2. Preventing water stress to plants during re-growth (sensitive growth stage)

- ✓ farm personnel more skilled in irrigation management
- ✓ ability for quick trouble-shooting and preventive maintenance
- ✓ advanced monitoring and control technologies deployed in the field