ET-based irrigation scheduling of lettuce, broccoli, (…and other cool season vegetables)

<u>Investigators:</u>
CSUMB/NASA
UC Coop. Extension
USDA-ARS

<u>Comm'l cooperators:</u>
Chiquita/Fresh Express
Tanimura & Antle
Sakata, Enza, Seminis

<u>Sponsor:</u>
Calif. Dept. Food Agric.
(Specialty Crop Block Grant Pgm)

Presenter: Lee Johnson, CSUMB/NASA; 650-604-3331

Improving irrigation efficiency

- **Agronomic** (conservation till, plant spacing…)
- **Engineering** (reduce applic. loss, improve DU…)
- **Institutional** (irrigation district improvements, water pricing, legal incentives…)
- **Managerial** (demand-based scheduling, RDI…)

From: Howell, T., Agron. J. 93:281-289 (2001)

Some definitions

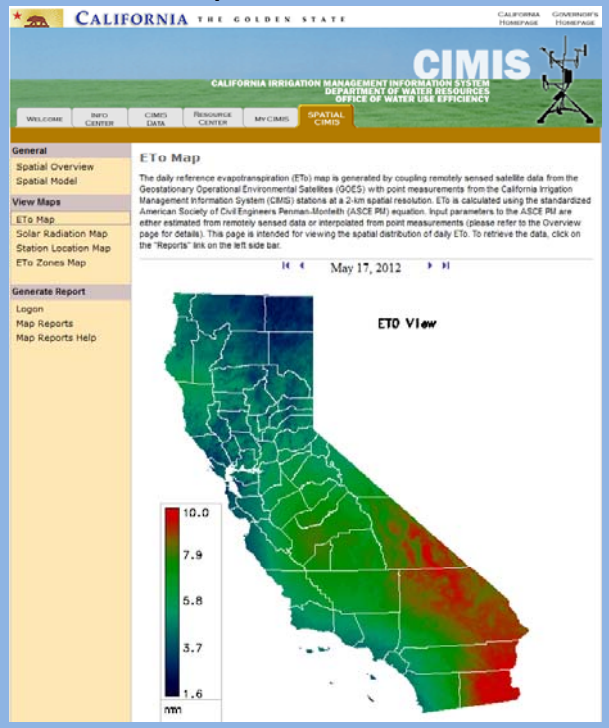
- **Evapotranspiration [ET]**; water consumed (lost to atmosphere) by combined processes of soil Evaporation & plant Transpiration
- **Reference ET**; well-watered grass surface ET
- **Crop coefficient**; crop ET expressed as a proportion of reference ET
- **Fractional cover**; proportion of field covered by crop (vs. bare soil) as viewed from above

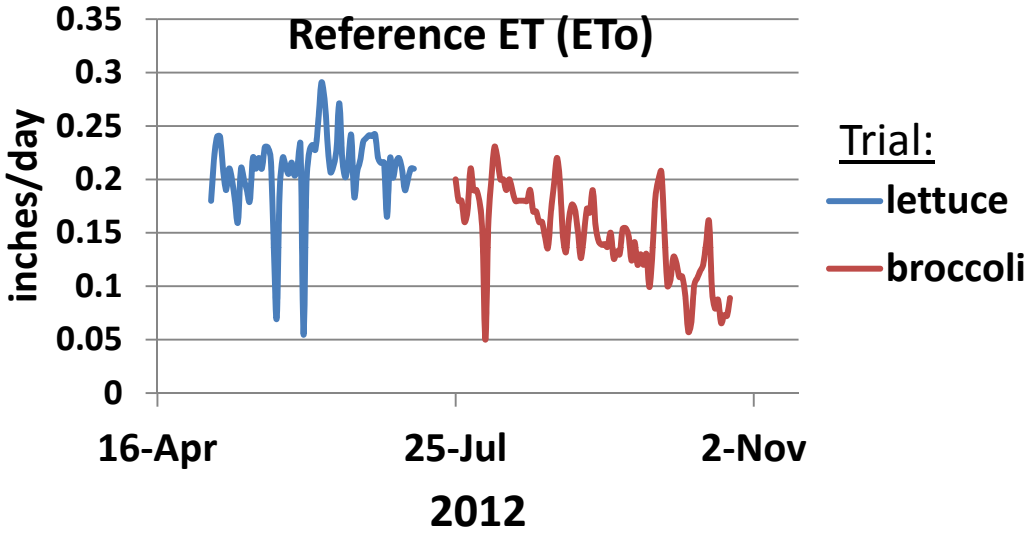
Project goals

- Replicated irrigation trials for head lettuce & broccoli during 2012, 2013
- Demo use of ET-based irrigation scheduling, using CIMIS Reference ET data
- Evaluate any tradeoffs of water reduction vs. yield/ quality

CIMIS Reference ET

"Spatial" CIMIS

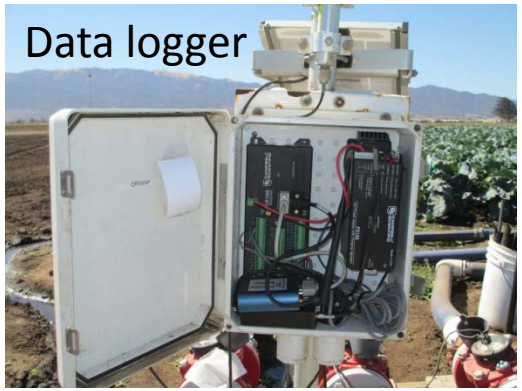




*Challenge: how to translate into "actionable" info?

Strategy

- Lettuce, broccoli
- Crop establishment by sprinkler
- Treatments applied by surface drip
- Equal inputs other than water (ie, fertilizer, pest control, etc.)



Irrigation treatments

CropManage model (100% ET replacement)

SIMS model (100% ET replacement)

Standard practice (150% ET replacement)

CropManage model

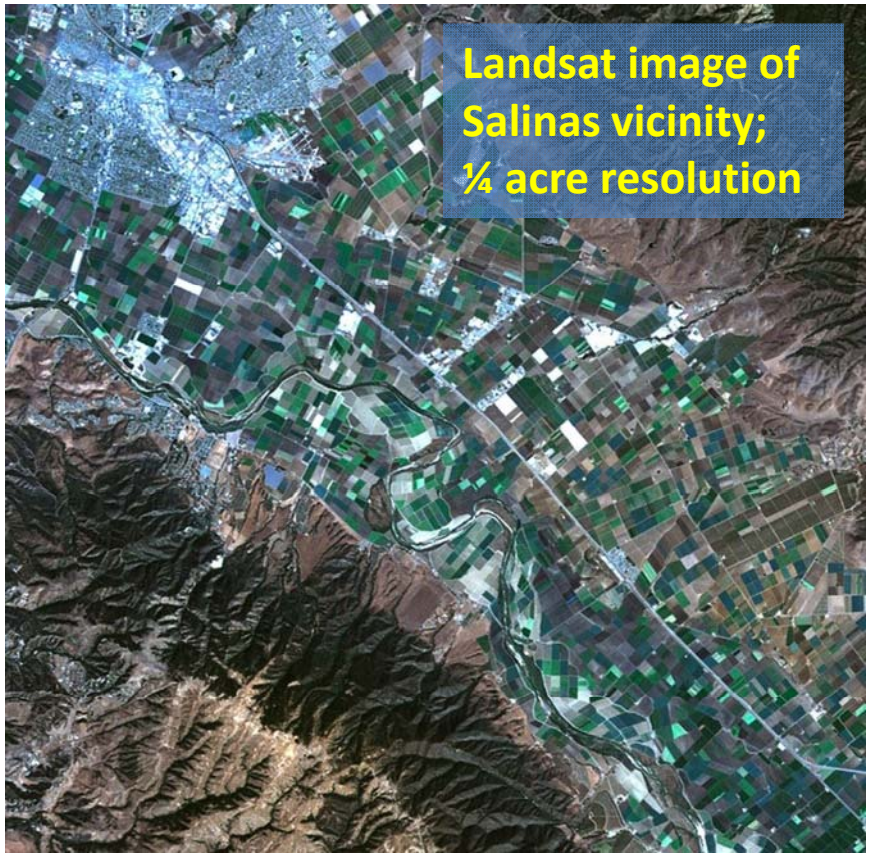
Irrigation Summary

Show / Hide Columns | Show Previous Columns

Water Date	Irrigation Method	Recommended Irrigation Interval (days)	Recommended Irrigation Amount (inches)	Recommended Irrigation Time (hours)	Irrigation Water Applied (inches)	Kc	Canopy Cover (%)	Average Reference ET (inches/day)
8/28/13	Drip	15.6	0.17 in	1.01 hrs	0.34 in	0.15	7	0.20
8/30/13	Drip	11.4	0.10 in	0.59 hrs	0.31 in	0.22	9	0.19
9/3/13	Drip	15.3	0.16 in	0.97 hrs	0.49 in	0.22	13	0.16
9/6/13	Drip	11.3	0.18 in	1.05 hrs	0.54 in	0.27	17	0.19
9/9/13	Drip	11.3	0.19 in	1.13 hrs	0.53 in	0.32	23	0.17
9/13/13	Drip	12.6	0.25 in	1.45 hrs	0.61 in	0.41	31	0.13
9/16/13	Drip	10.2	0.24 in	1.43 hrs	0.48 in	0.52	38	0.13
9/19/13	Drip	9.1	0.29 in	1.69 hrs	0.55 in	0.61	46	0.13
9/23/13	Drip	8.5	0.38 in	2.24 hrs	0.65 in	0.72	57	0.13

*UC Cooperative Extension
*web-based tool for growers
*combines weather, soil and plant-based info

SIMS model



NASA/CSUMB

Satellite
Landsat OLI/TM/ETM+
MODIS MOD09Q1
TOMS/TOVS ozone

SIMS
At sensor radiance
LEDAPS
Surface reflectance
NDVI
Tiling / Masking
Gap-filling
Fractional cover
Crop coefficient (K_{cb})
Basal crop ET (ET_{cb})

NCEP/NCAR Reanalysis Data

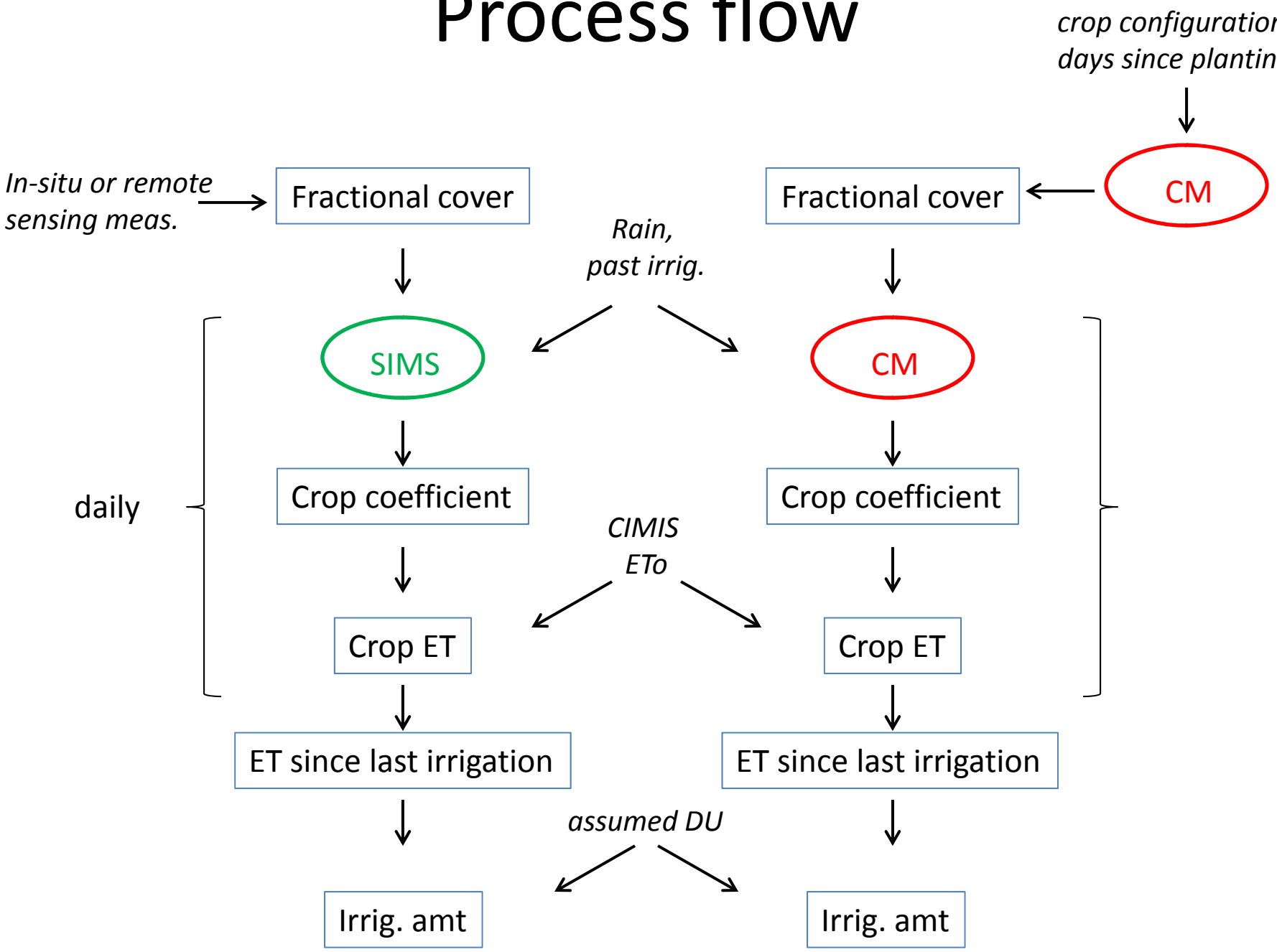
CIMIS
Satellite: GOES cloud cover
Surface: T_{air}, RH, Wind speed
Spatial CIMIS ET_0

(OPeNDAP)

Web interface
Web services

User

Process flow



Monitoring

Nutrient

Fractional cover

Soil moisture

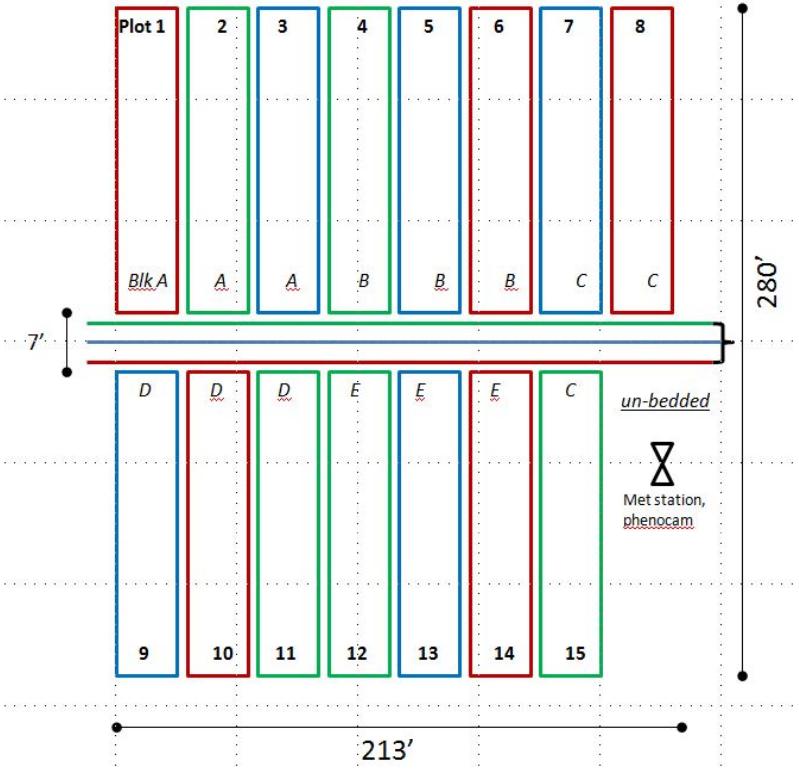
Drainage sub-surface

Applied water

Lettuce trials

May 2 – July 11, 2012

April 30 – July 8, 2013

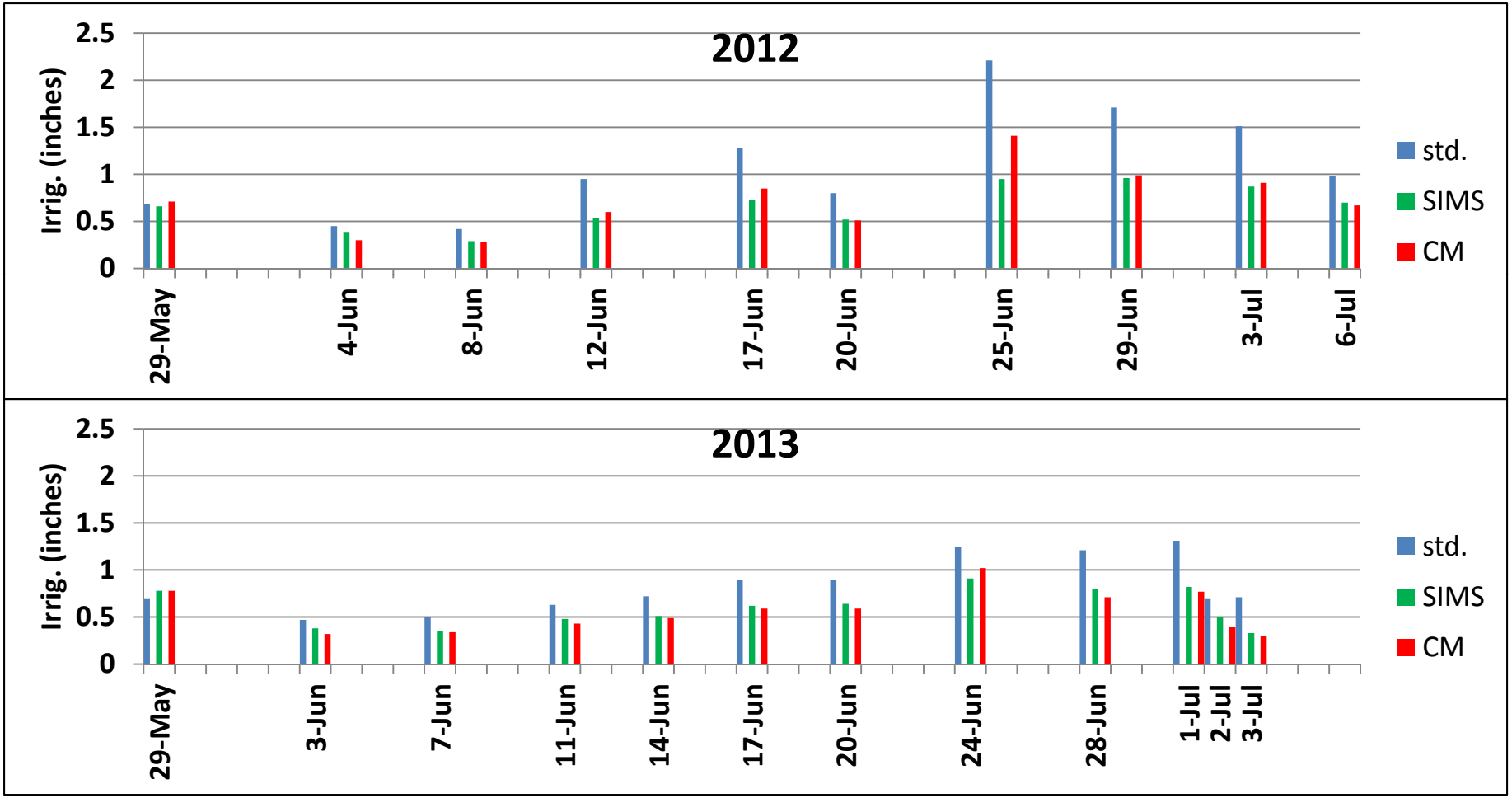


Treatments:

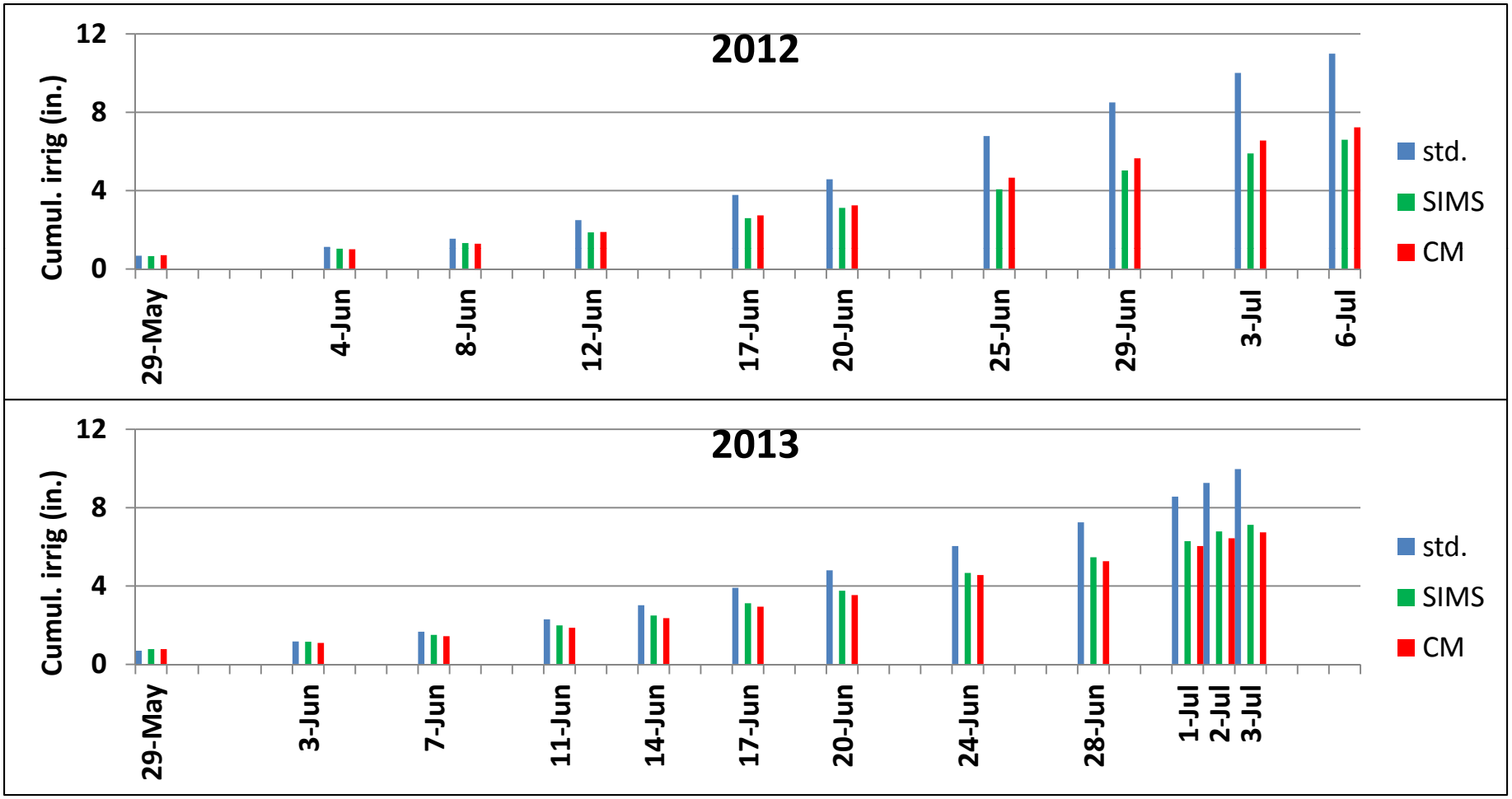
- Standard practice
- SIMS
- CropManage

*3 tmts, 5 reps, randomized block design
*total area: ~1.4 ac
*40” bed spacing, 2 seedlines/bed, thinned to 12” interval
*variety: Gabilan (2012), Telluride (2013)

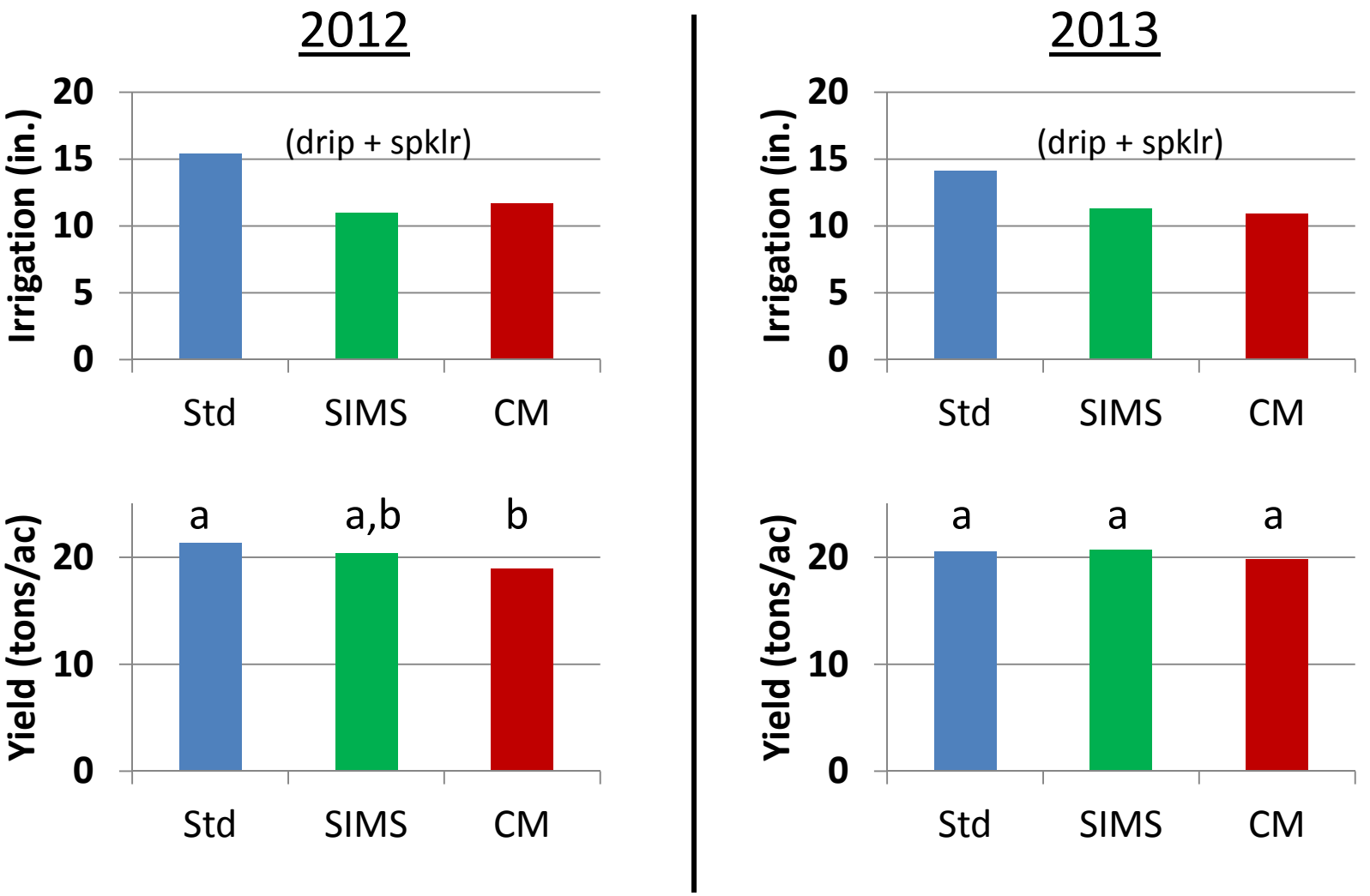
Drip irrigation events



Cumulative drip



Irrigation & yield totals, Lettuce



Water savings: 29%

Water savings: 23%

Quality metrics

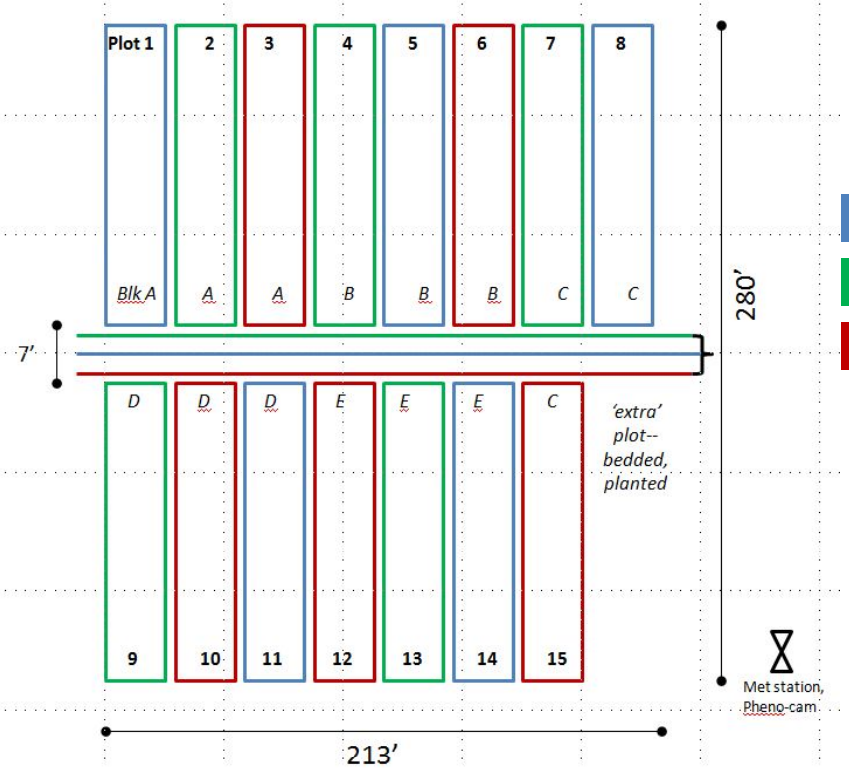
- Transport
- Refrigeration
- Packaging
- Storage
- Evaluation:
  - Flavor, physiological defects, decay, pinking, vascular discoloration, browning, tip burn, chunks
  - No significant difference between the standard & reduced water treatments

Courtesy Fresh Express

Broccoli trials

July 25-Oct 29, 2012

July 23 – Nov 4, 2013

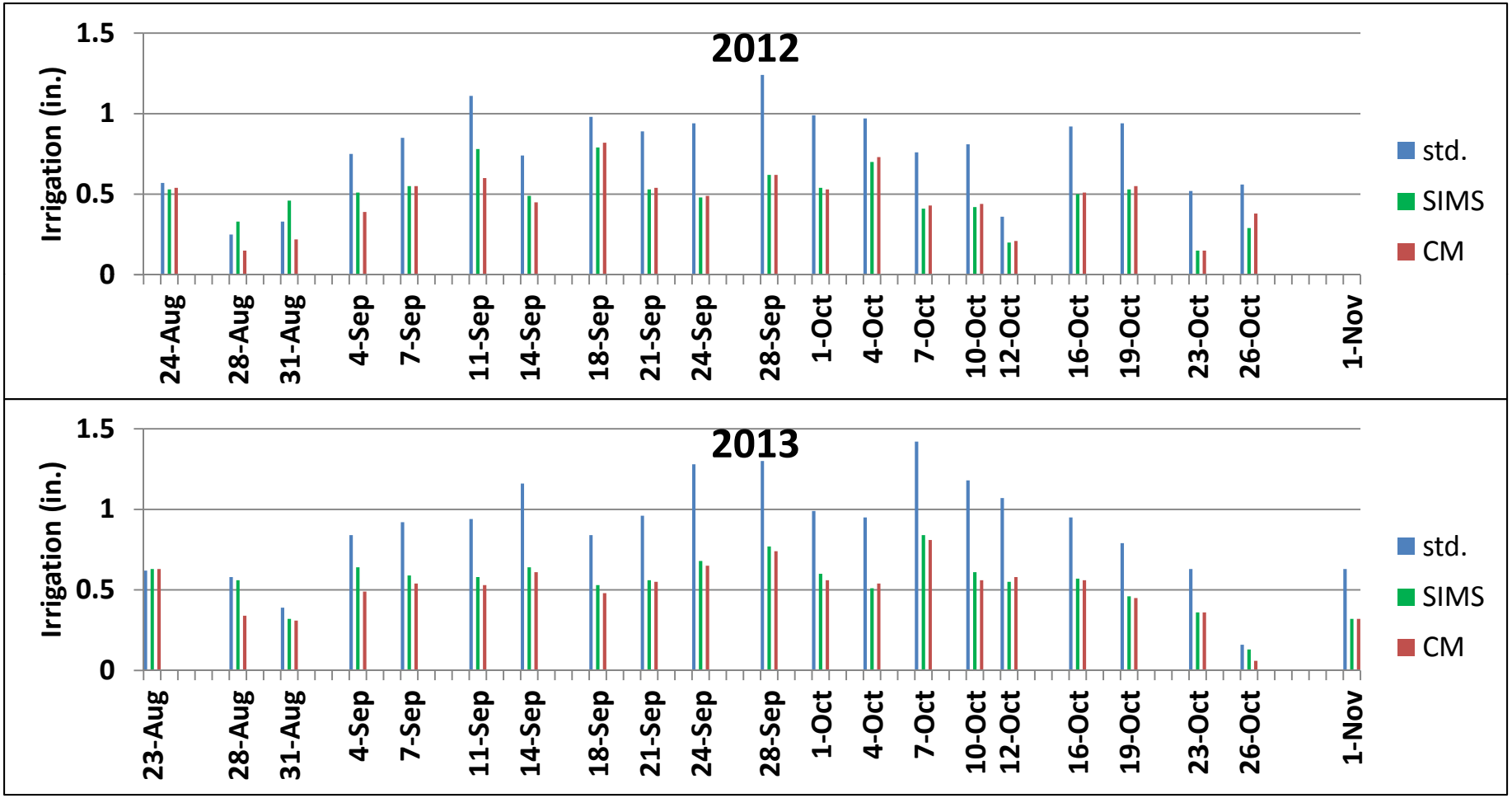


Treatments:

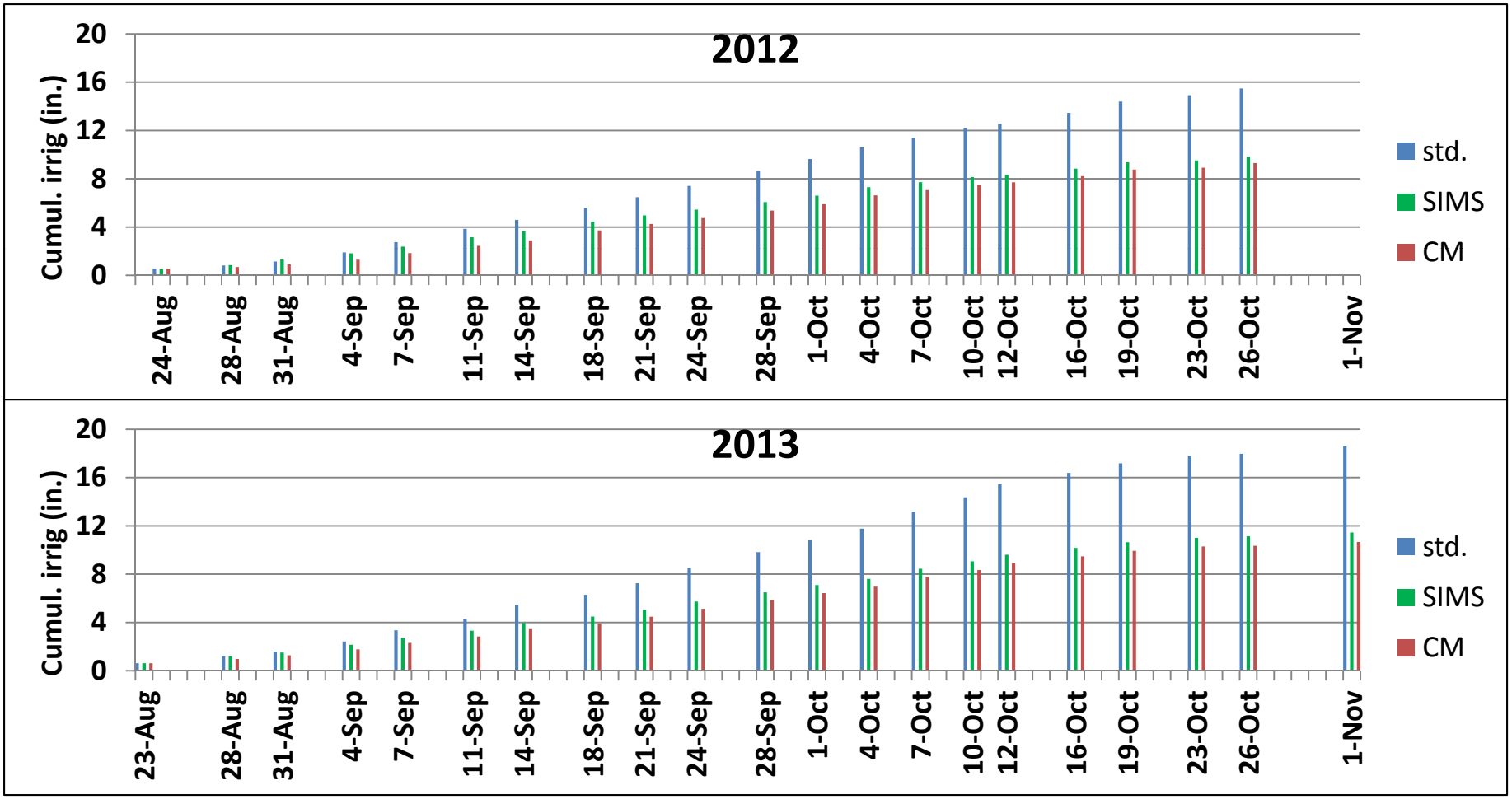
- Standard practice
- SIMS
- CropManage

*3 tmts, 5 reps, randomized block design
*total area: ~1.4 ac
*40" bed spacing, 2 seedlines/bed, 5" interval
*variety: Patron

Drip irrigation events

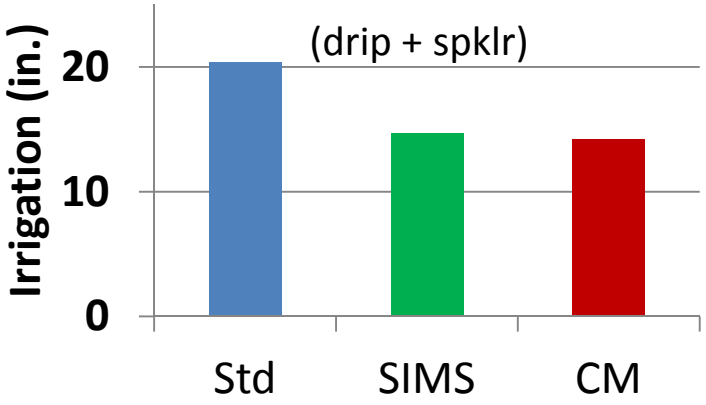


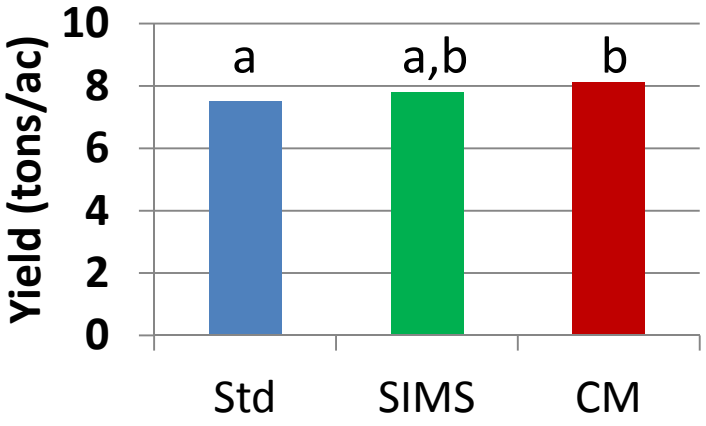
Cumulative drip



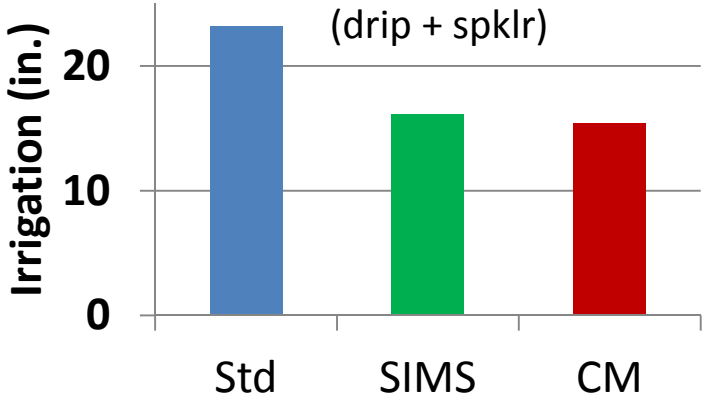
Irrigation & yield totals, Broccoli

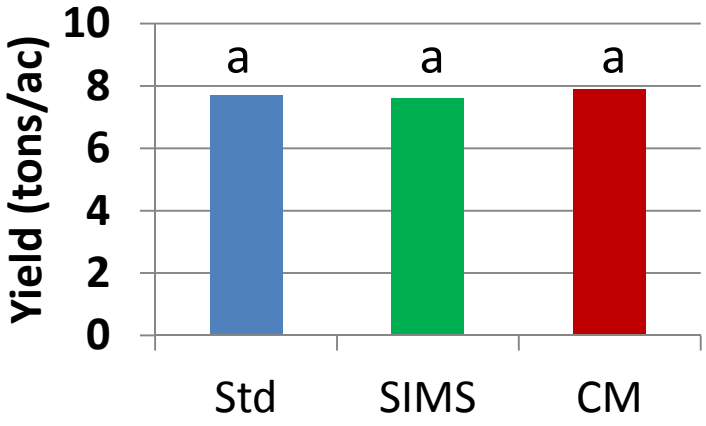
2012





2013





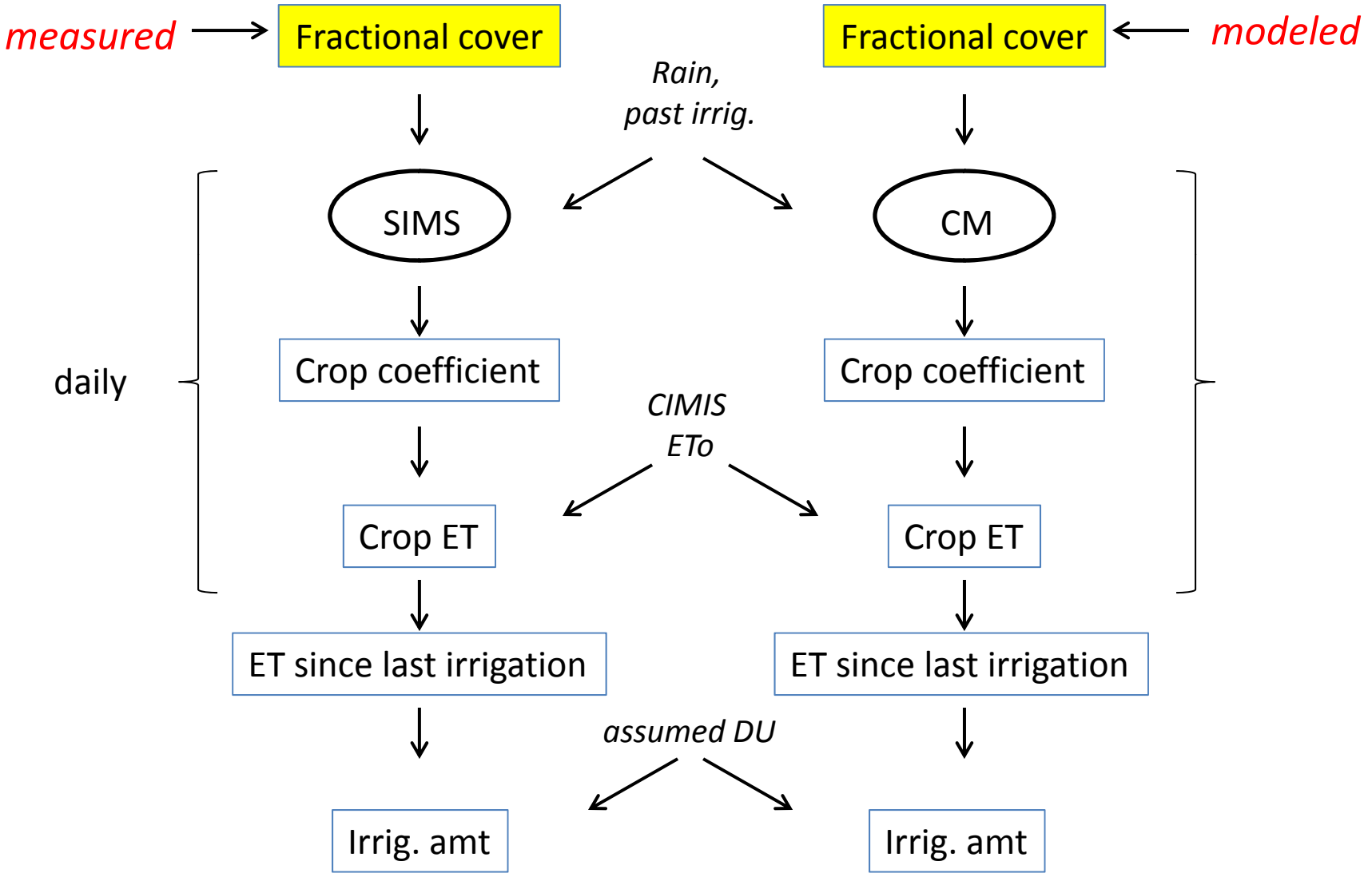
Water savings: 30%

Water savings: 34%

Summary

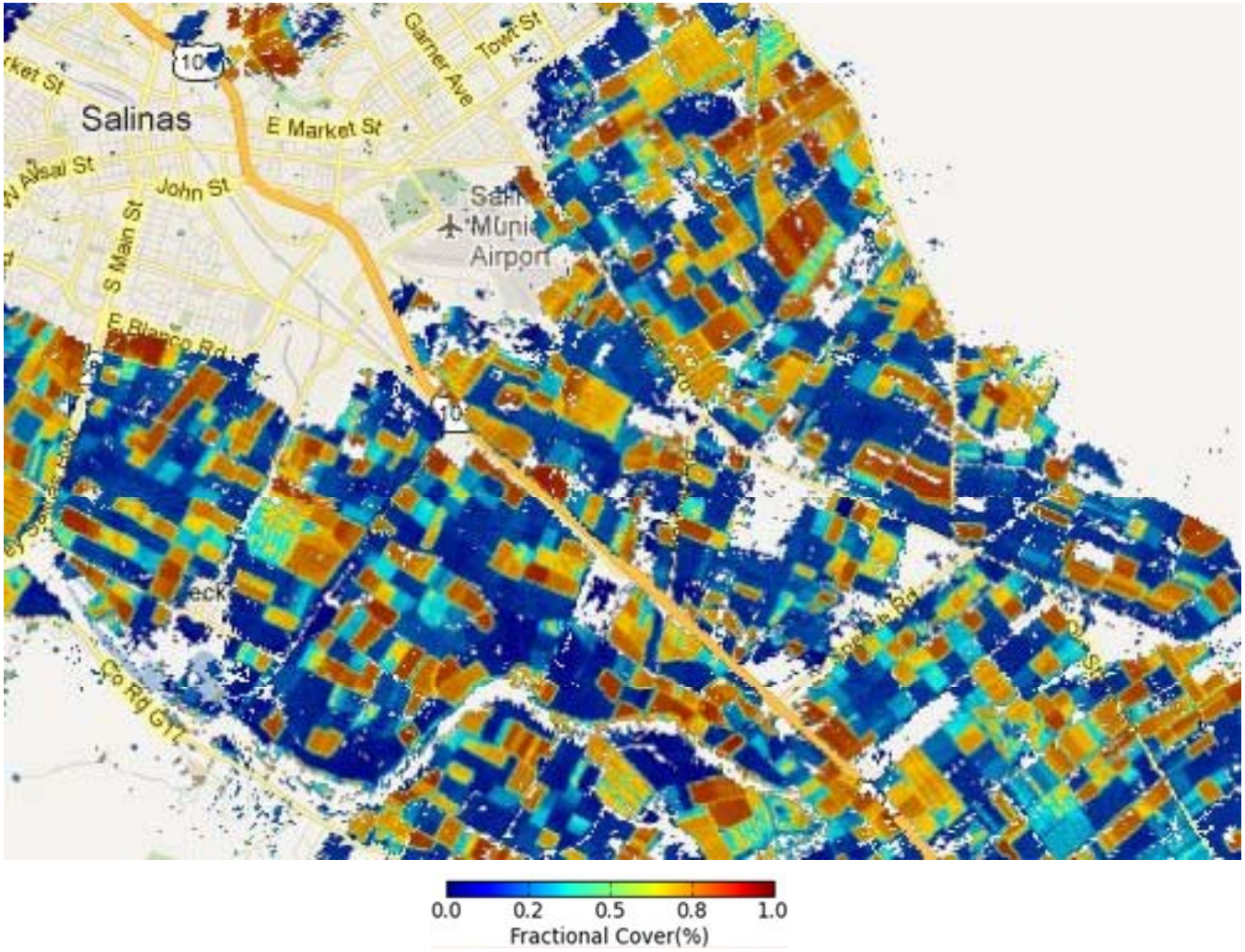
- ET-based scheduling; replicated trial conducted over 2 years
- Industry-average marketable yields realized throughout
- ET-replacement approaches represented 23-34% reduction in applied water

closing note about fractional cover…

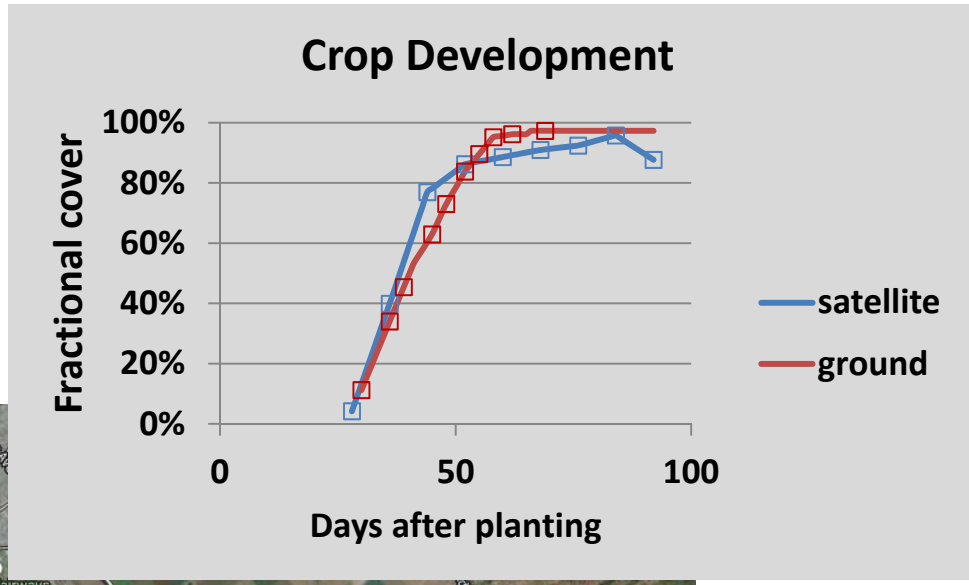


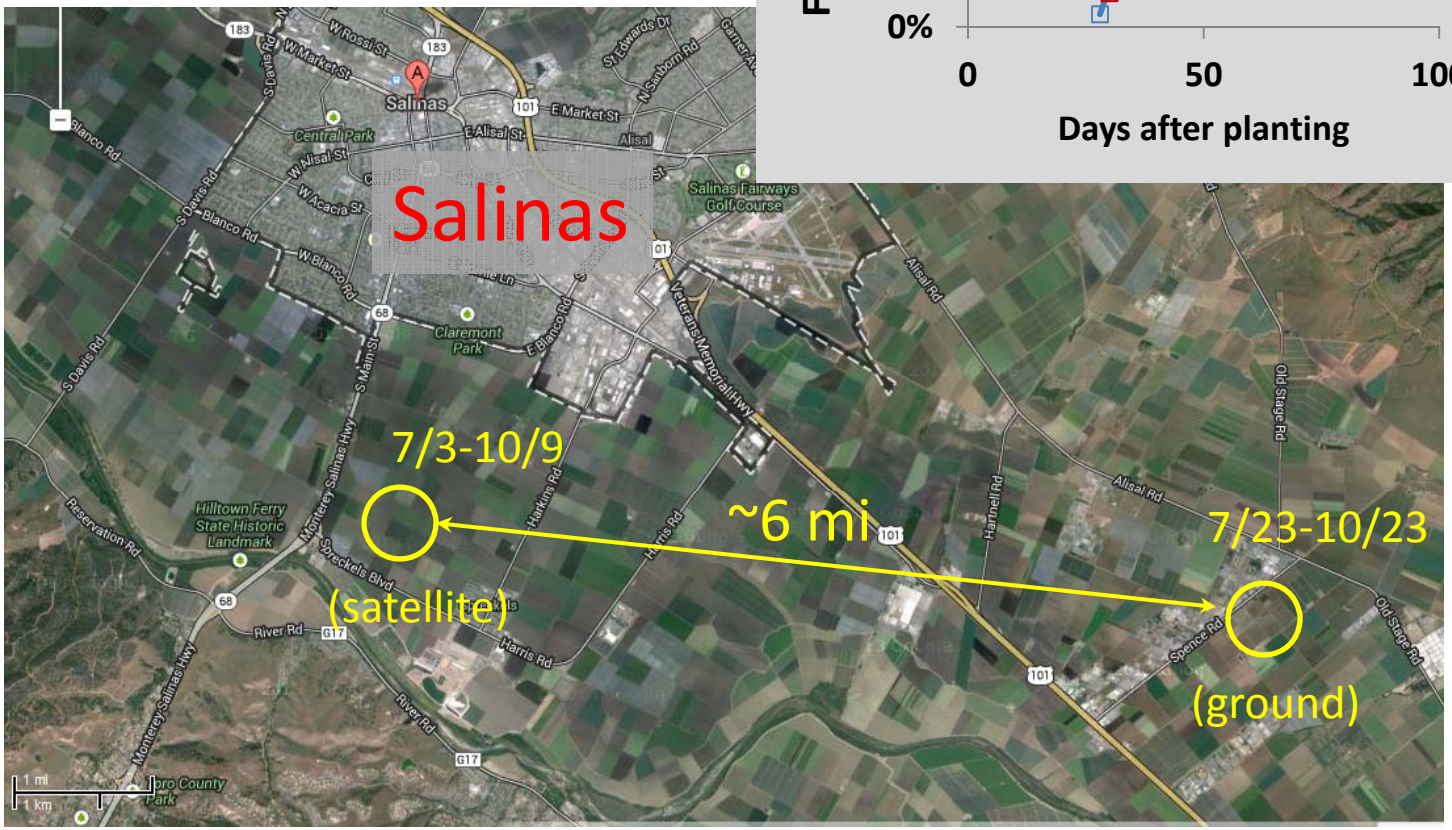
Satellite NDVI via SIMS

SIMS Fractional cover



Broccoli growth, ground vs. satellite 2013





Ongoing/future work

- CropManage: Cooperative Extension expanding to other cool-season veg's
- SIMS: Finalization of Salinas Valley datasets, processing stream, data delivery
- Linking CropManage, SIMS

Investigators

CSUMB: L. Johnson, F. Melton, K. Post, C. Lund, G. Miller, D. Hamblin, S. Phillips, C. Rosevelt, S. Kefauver, A. Purdy, W. Brandt, I. Harlen
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