Why Can Fertigation Improve Potato Production?

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FertiGators for Horticultural Crops

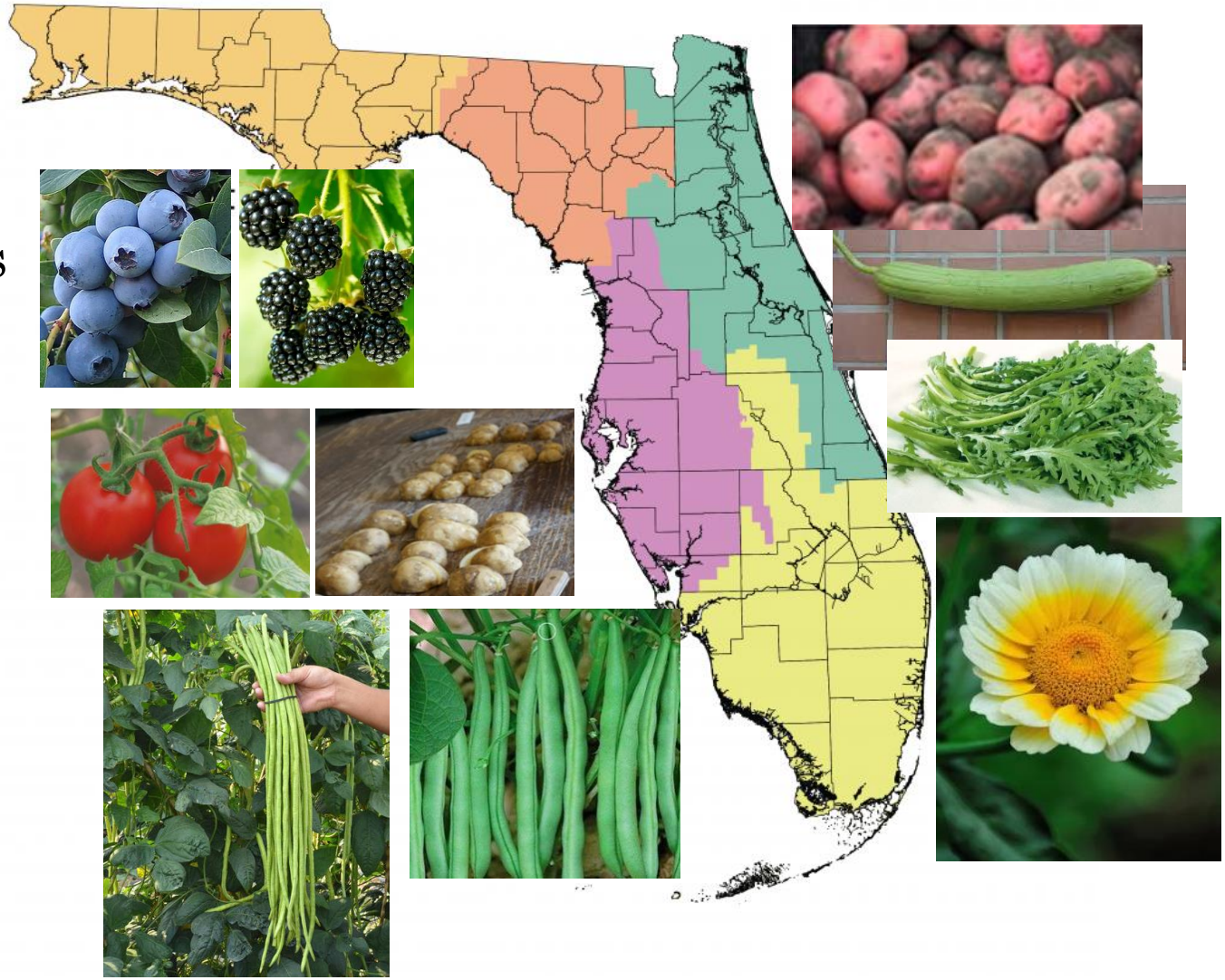
Vegetables:

- Asian veggies
- Potato
- Tomato
- Snap bean

Fruit crops:

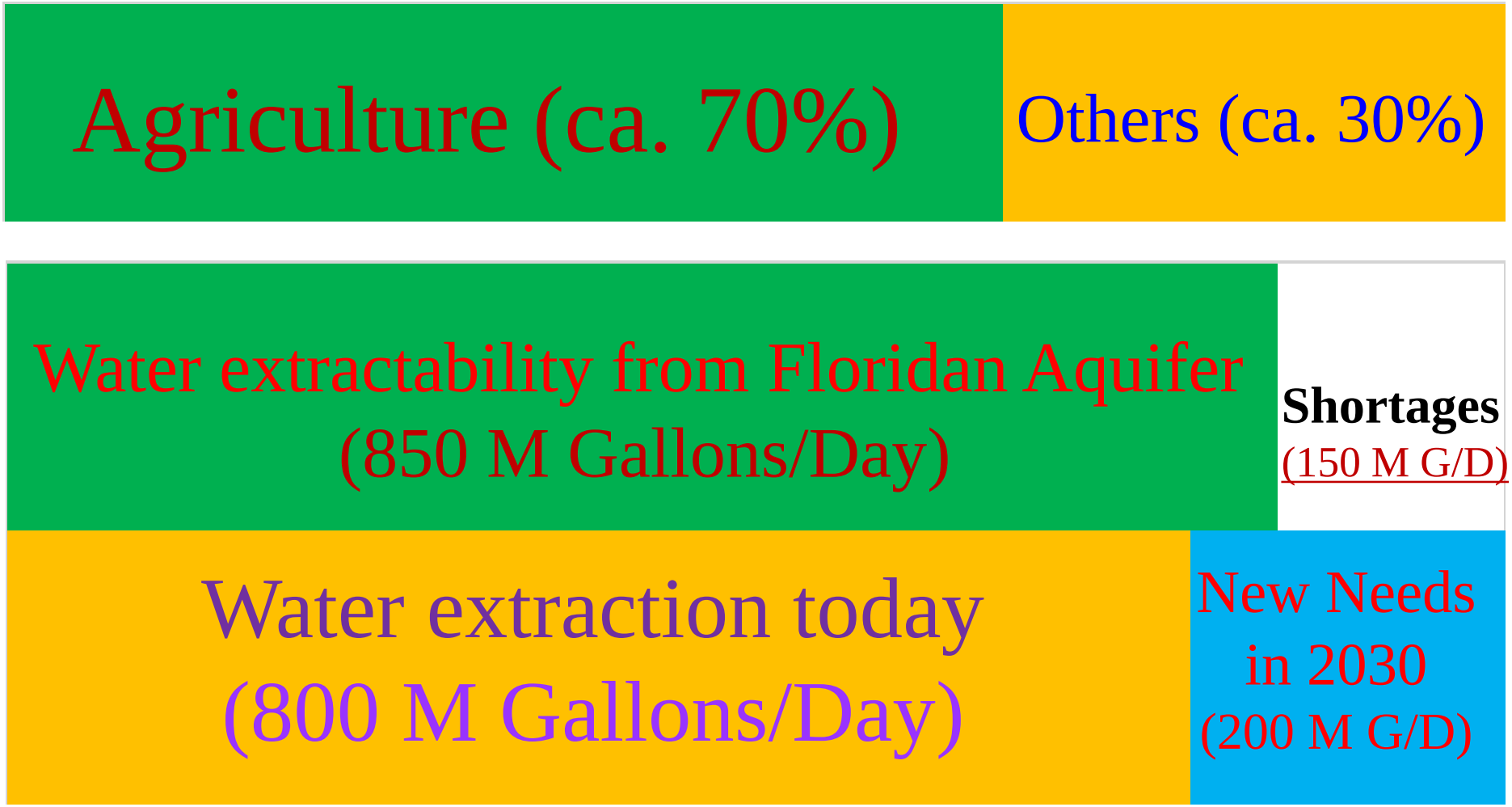
- Blueberry
- Blackberry

(artificial chilling)



Most soils in Florida are sandy by nature

Additional 200 M gallons/day needed in the Orlando area alone in 2030

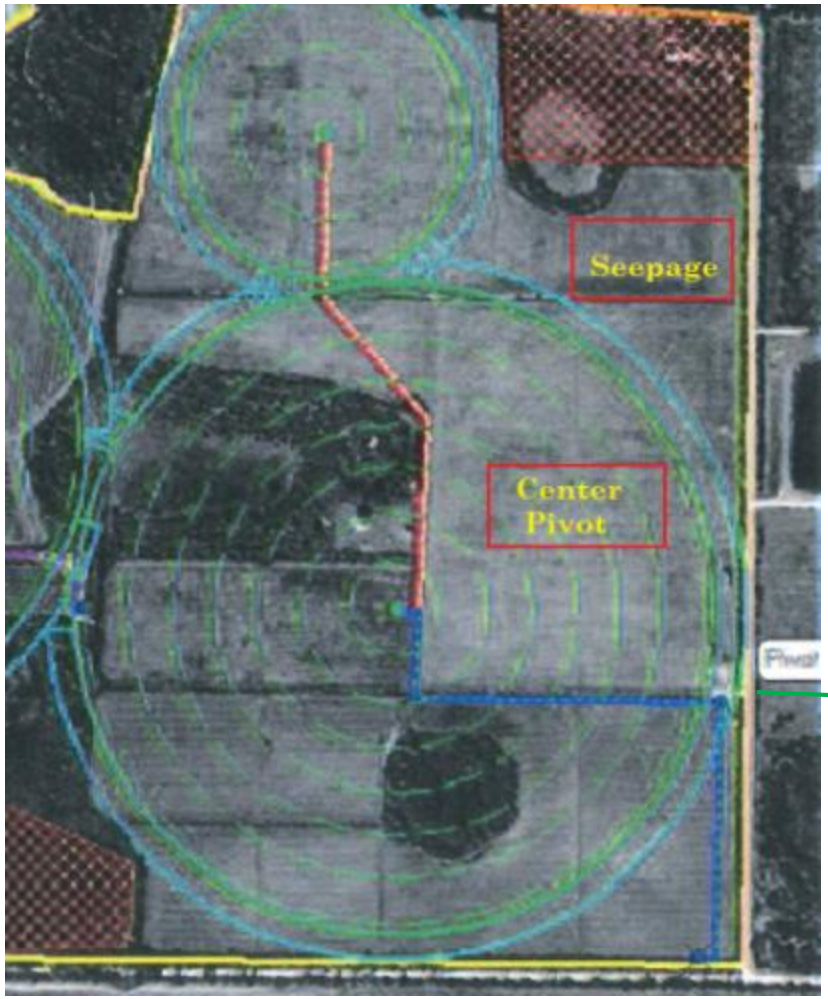


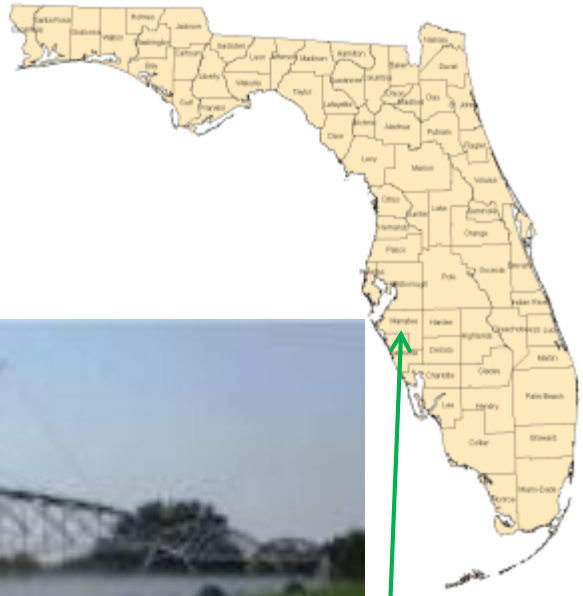
Our work in 2012-2015

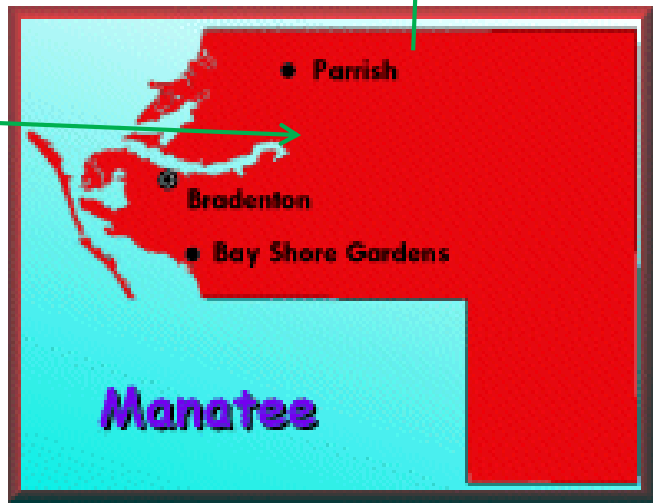
Water savings:

seepage → center-pivot irrigation

Trial locations







Devices used on the farms

Flow meters

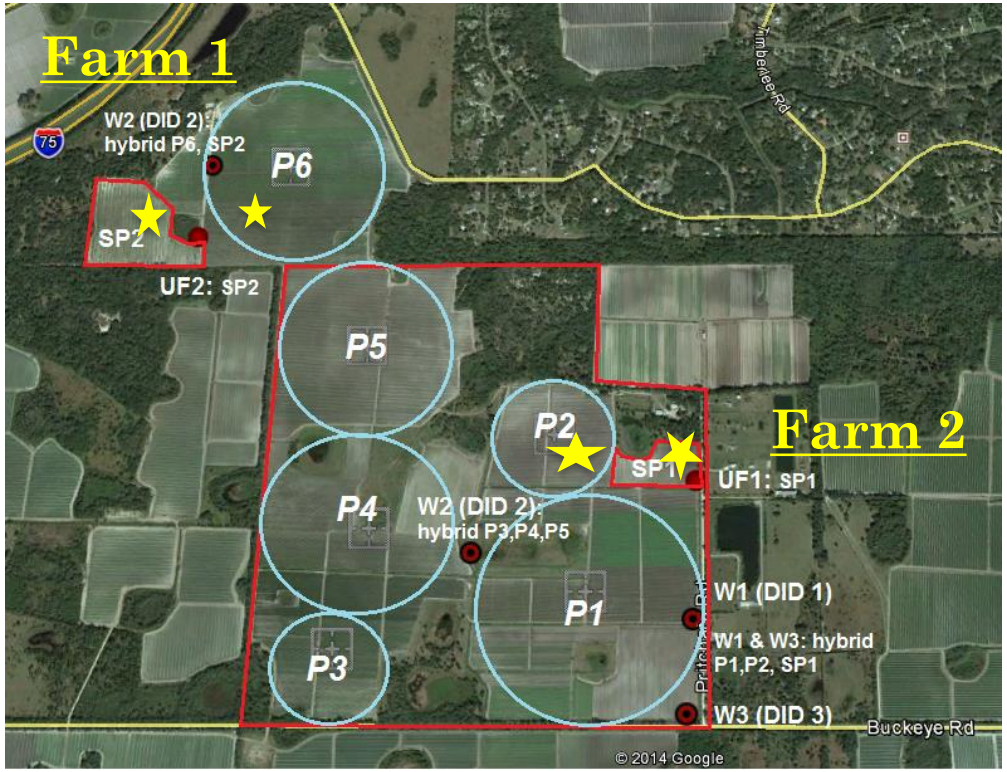
Trials from 2012 through 2015

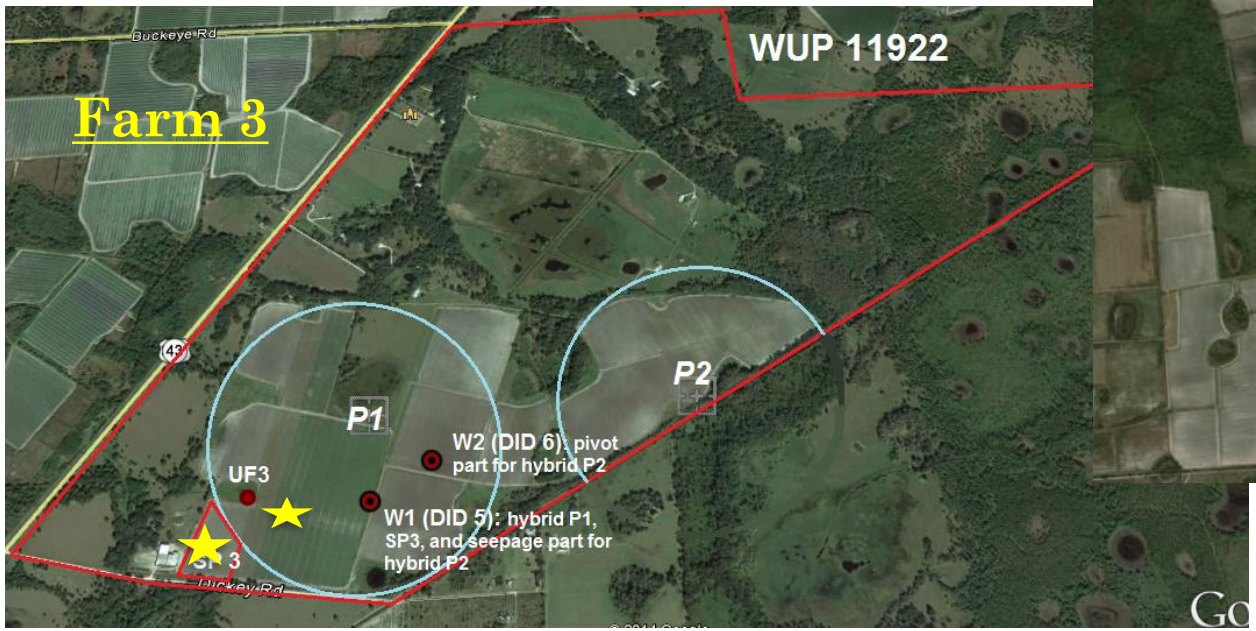
Farm	Irrigation	Acreage		
		2012-2013	2013-2014	2014-2015
1	Seepage	10	10	10
	Central Pivot	130	170	170
2	Seepage	25	25	25
	Central Pivot	142	142	142
3	Seepage	8	8	8
	Central Pivot	135	207	207
4	Seepage	140	140	140
	Central Pivot	300	580	300
Total	**2**	**890**	**1282**	**1002**

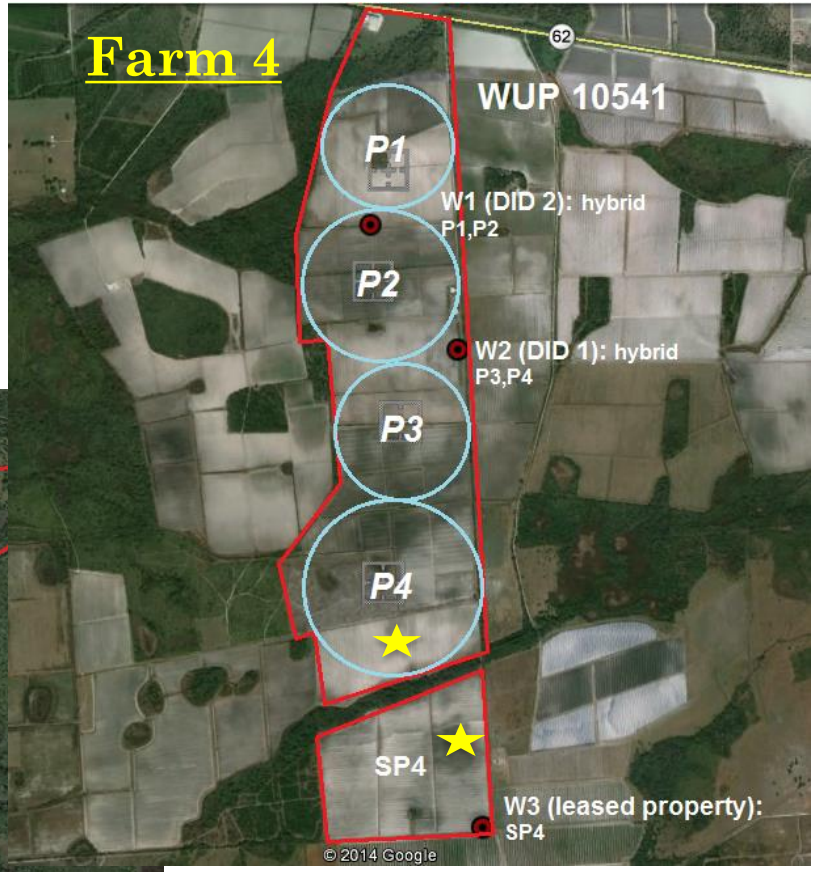
Seepage (SP) *vs.* center pivot (CP)

Water table indicator

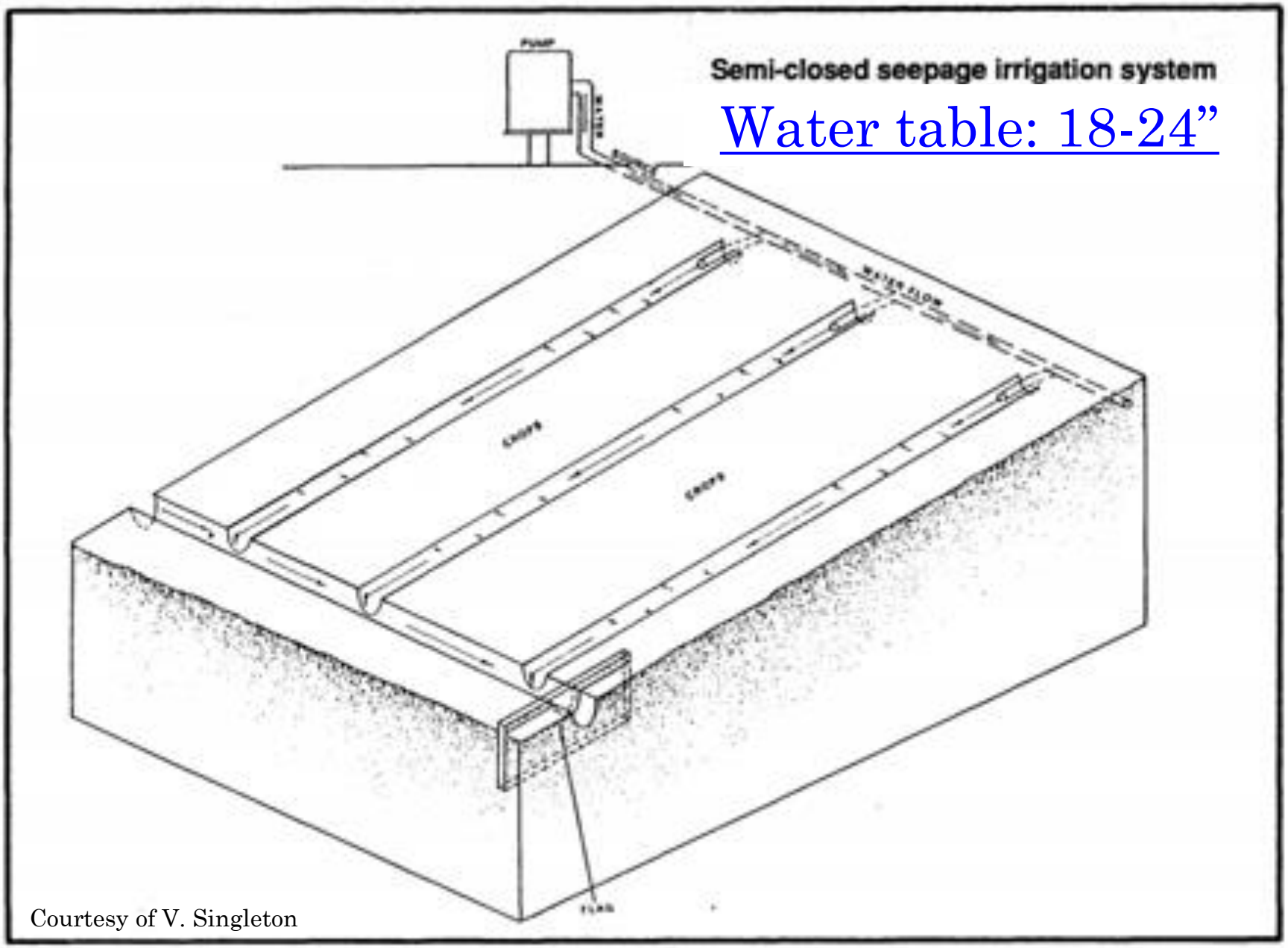
Farms with the trials







Seepage: *20” (12.0~29.6”) water*



Courtesy of V. Singleton

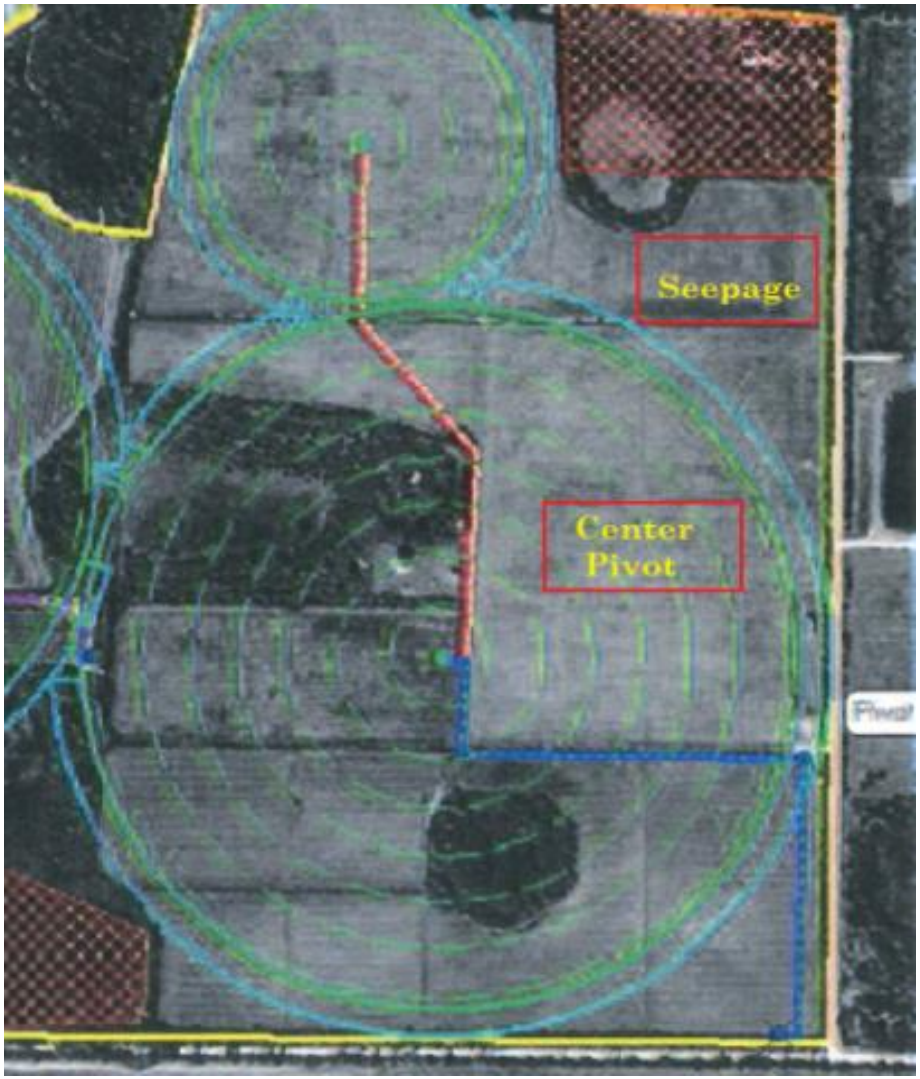
Varieties and acreage

- Chipping (Atlantic): 45%
- Tablestock (Red LaSoda): 55%

<u>4 farms, 890-1282 acres</u>

- Farm 1: 140-180
- Farm 2: 167
- Farm 3: 143-215
- Farm 4: 440-720

SP and CP are side by side



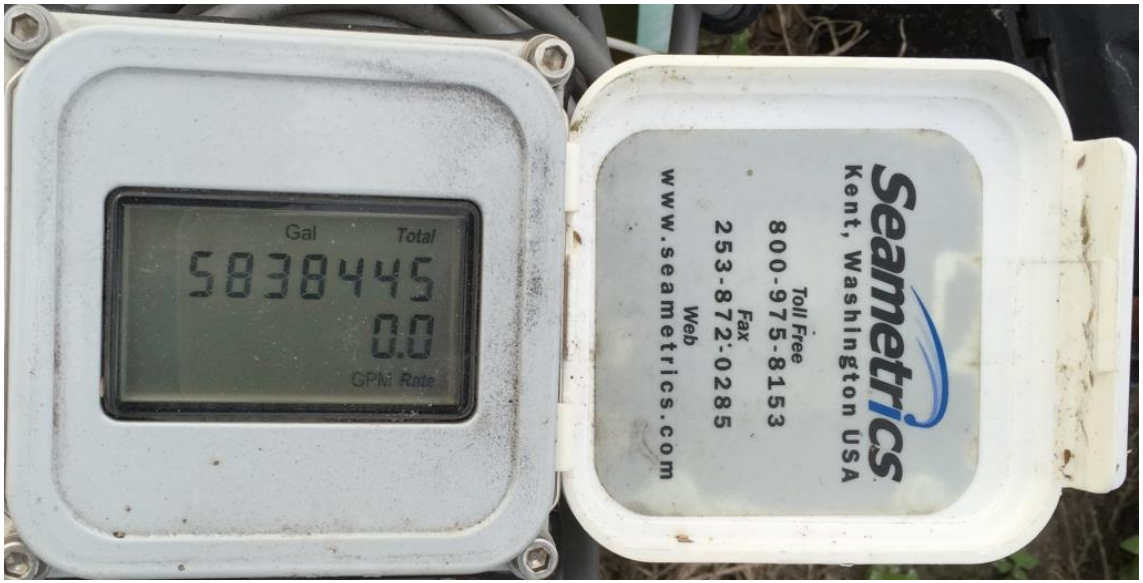
Or

Harvest methods

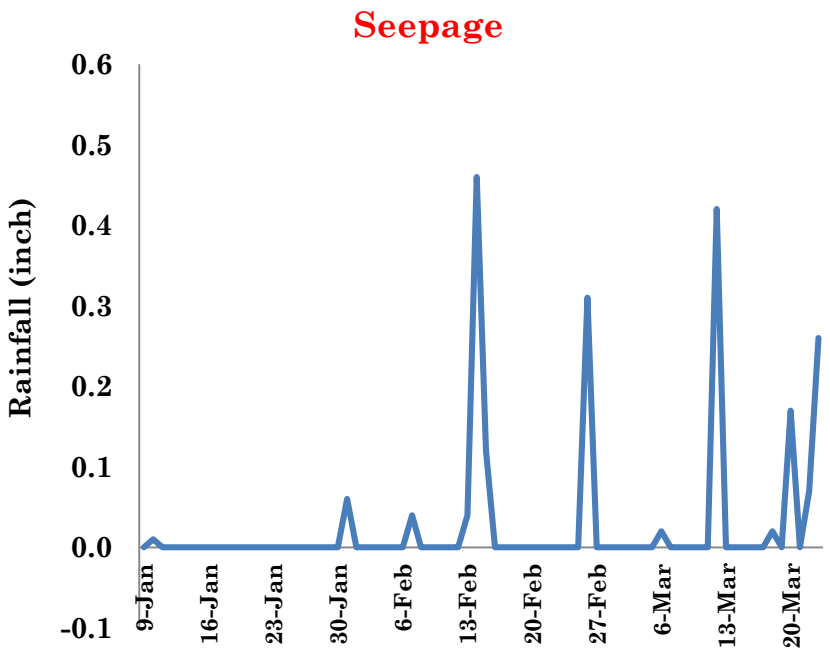
- Manually harvested
- 2 × 20 feet inside rows per plot
- 50 feet apart from the row ends

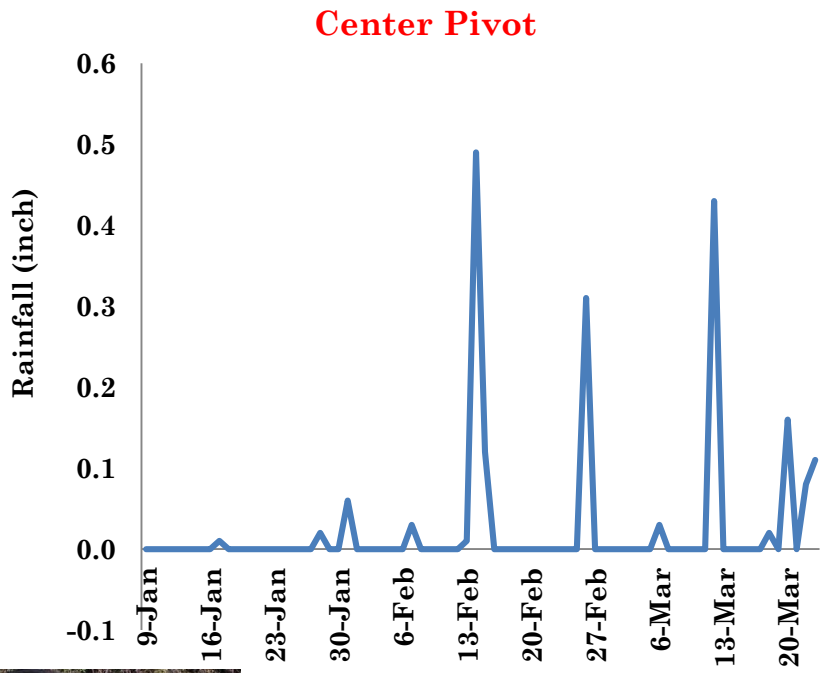
Water usage


0
100
900
01219000
GALLONS
800
200
700
300
600
400
500
WATER SPECIALTIES
PROPELLER METER
McCROMETER, INC.
HEMET, CA
POLY-2

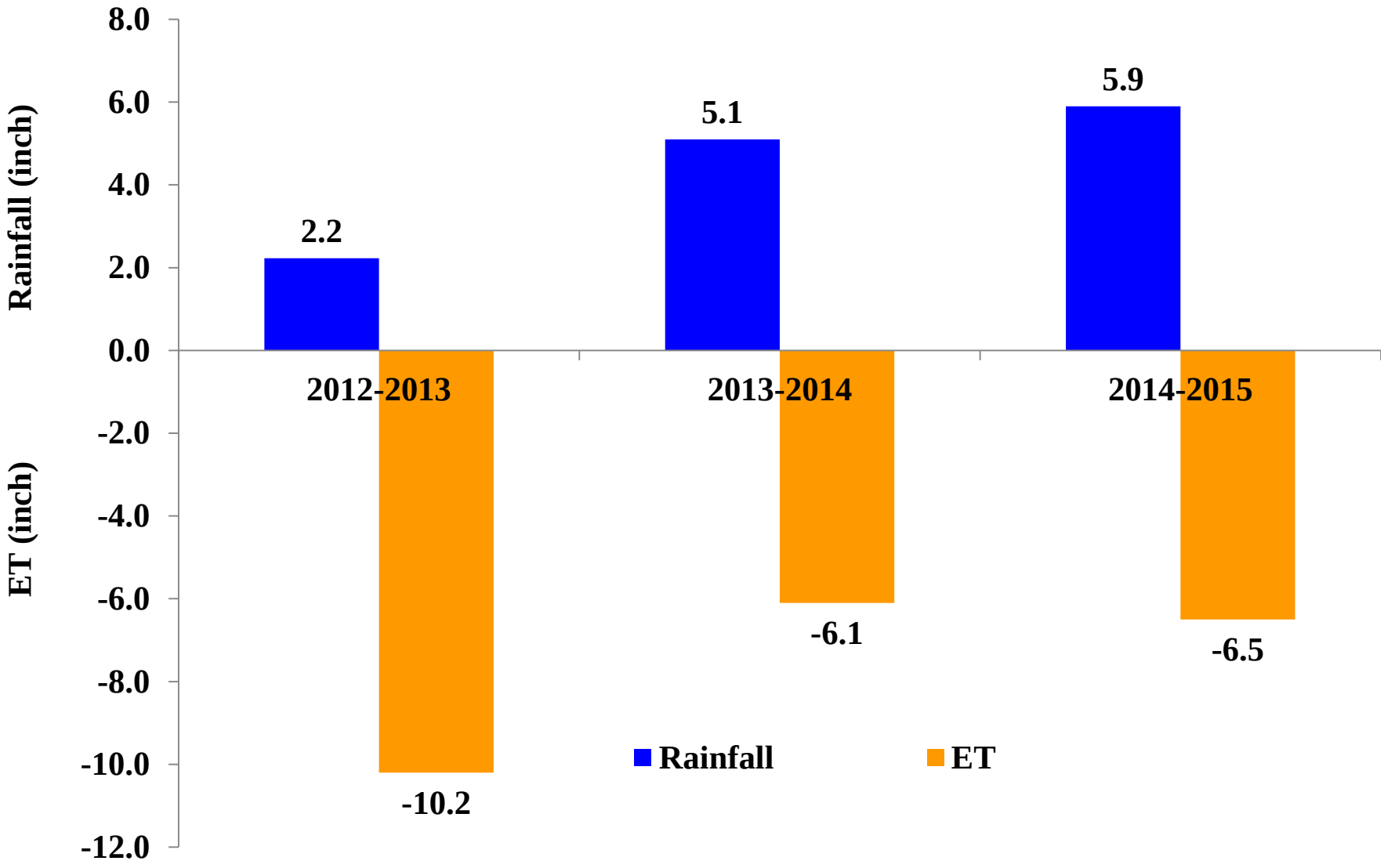

Gal
Total
5838445
0.0
GPM Rate
Seametrics
Kent, Washington USA
Toll Free
800-975-8153
Fax
253-872-0285
Web
www.seametrics.com

Rainfall

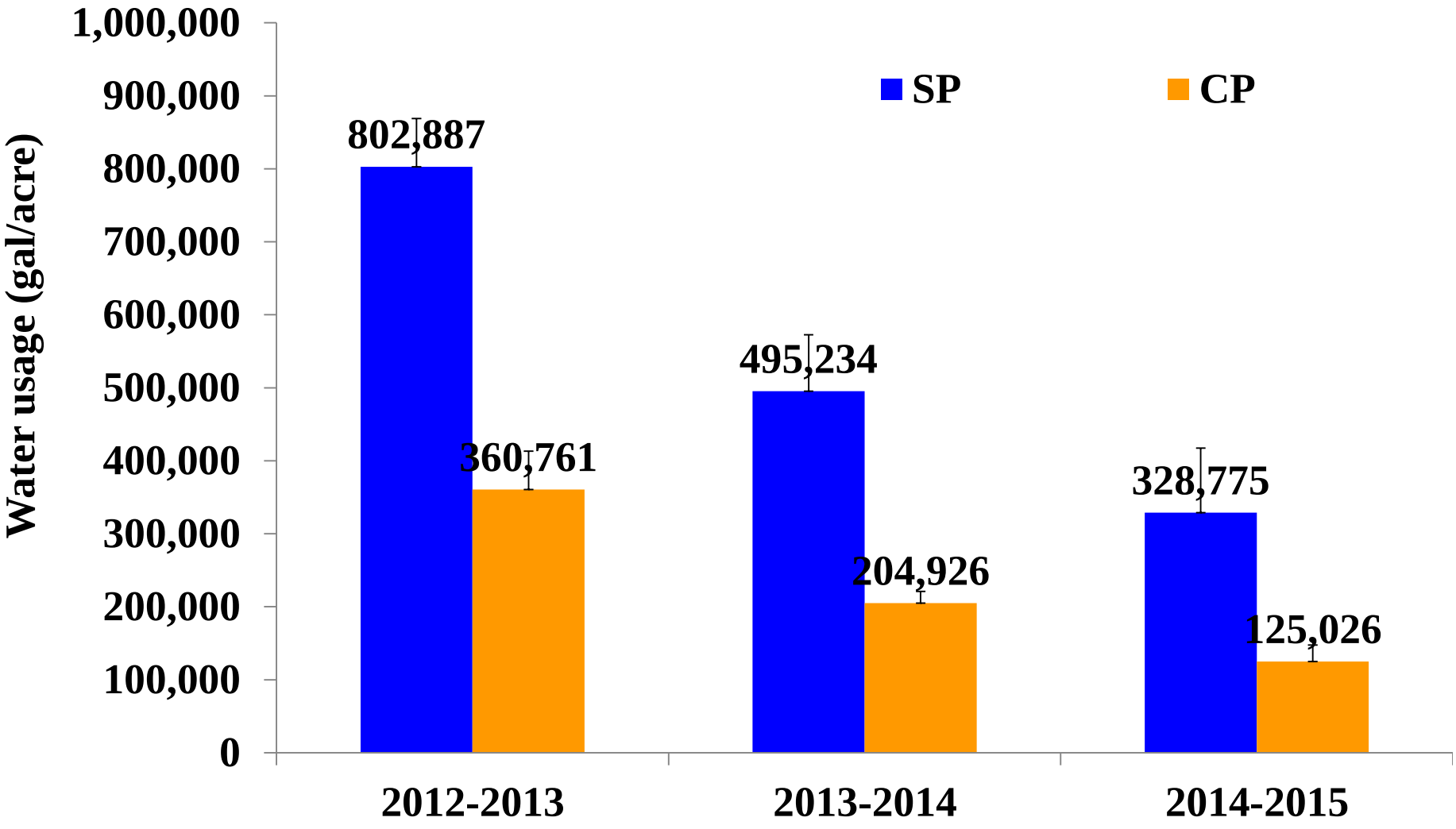

Seepage
Rainfall (inch)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
9-Jan
16-Jan
23-Jan
30-Jan
6-Feb
13-Feb
20-Feb
27-Feb
6-Mar
13-Mar
20-Mar


Center Pivot
Rainfall (inch)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
9-Jan
16-Jan
23-Jan
30-Jan
6-Feb
13-Feb
20-Feb
27-Feb
6-Mar
13-Mar
20-Mar

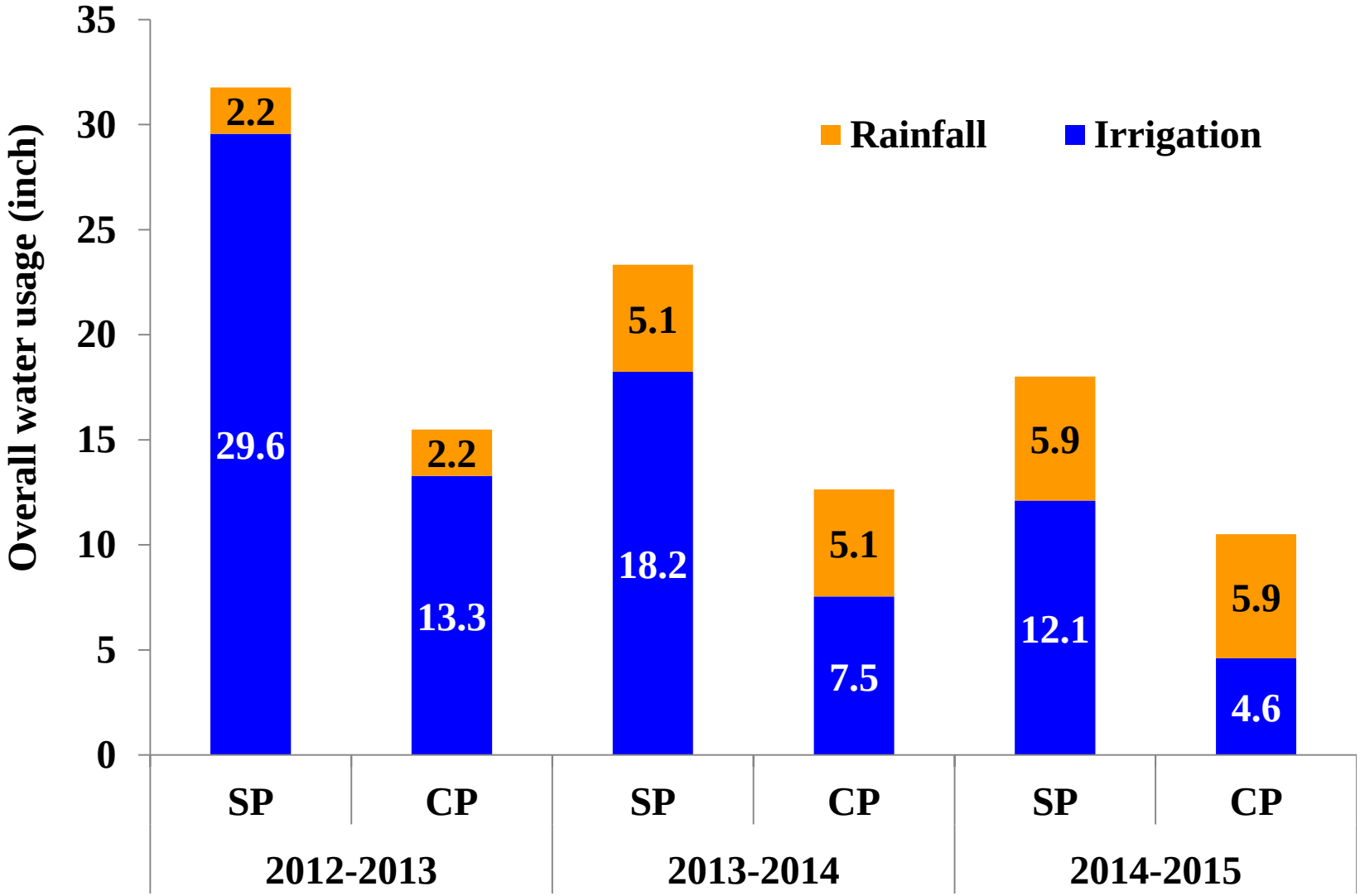
Rainfall and Evapotranspiration (ET)



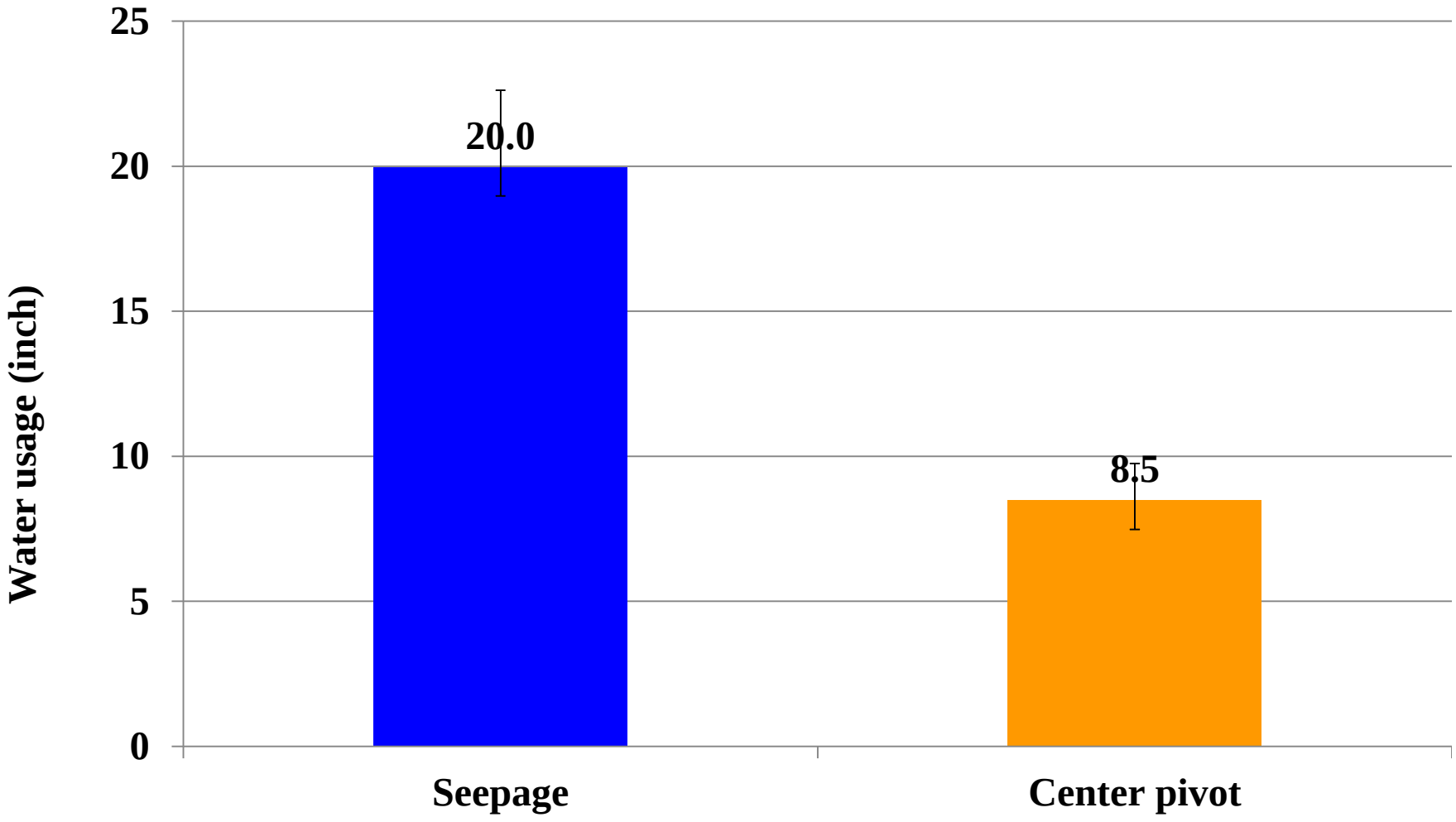
Irrigation water usage



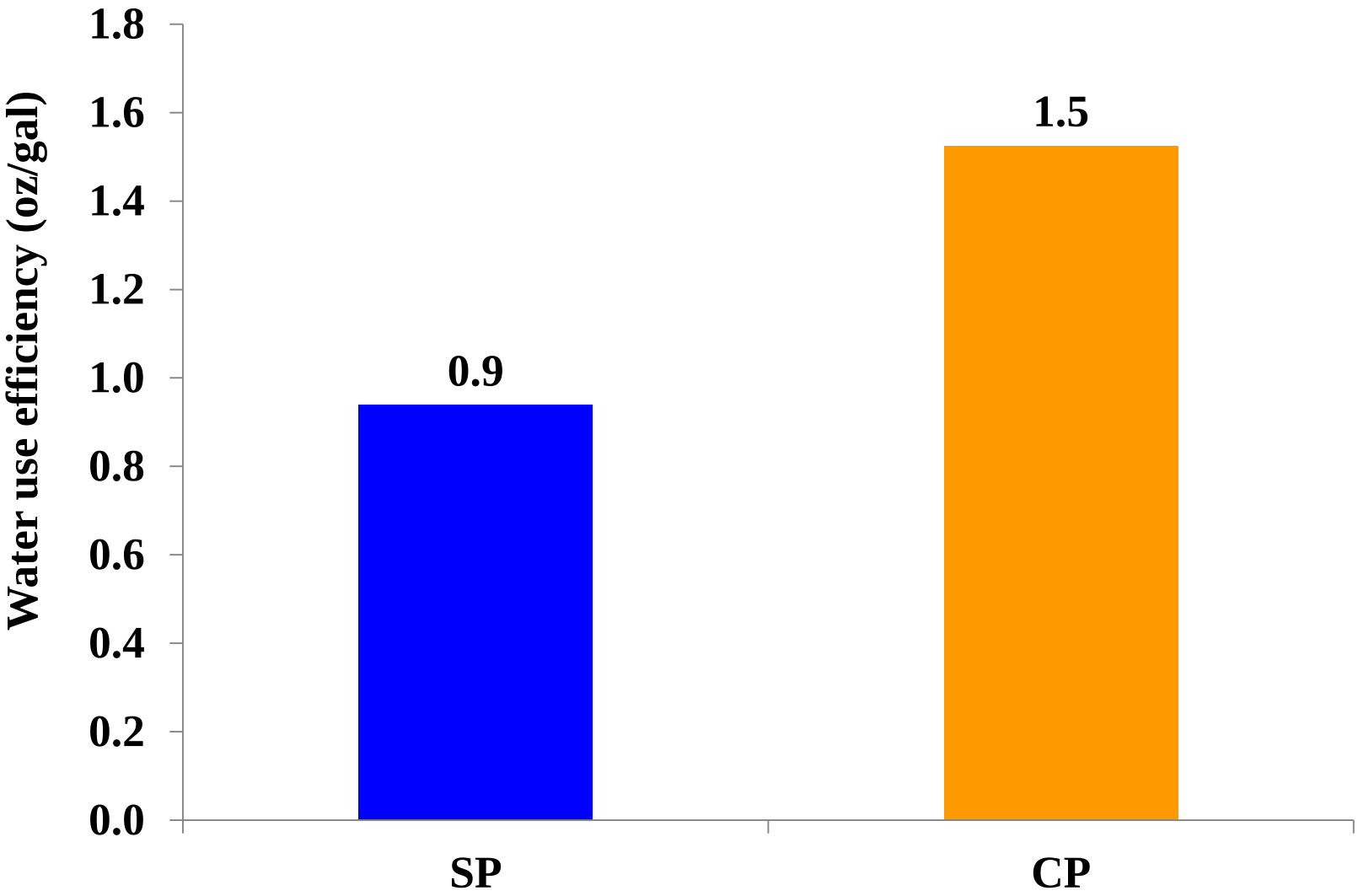
Overall water usage



Average water usage, 2012-15



Water use efficiency



Water savings

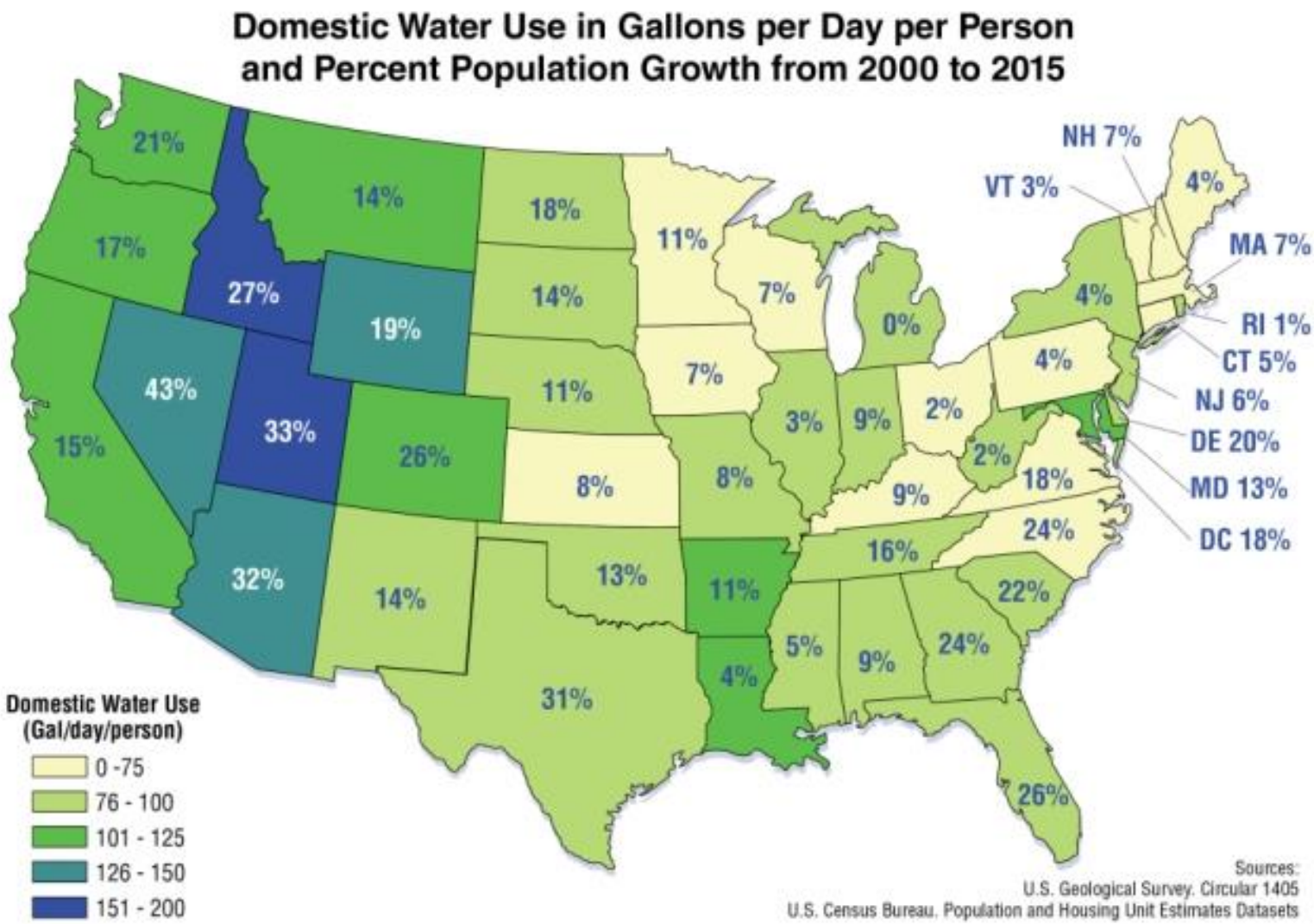
$$WS(\%) = \frac{WU_{SP} - WU_{CP}}{WU_{SP}} \times 100$$

Water savings:

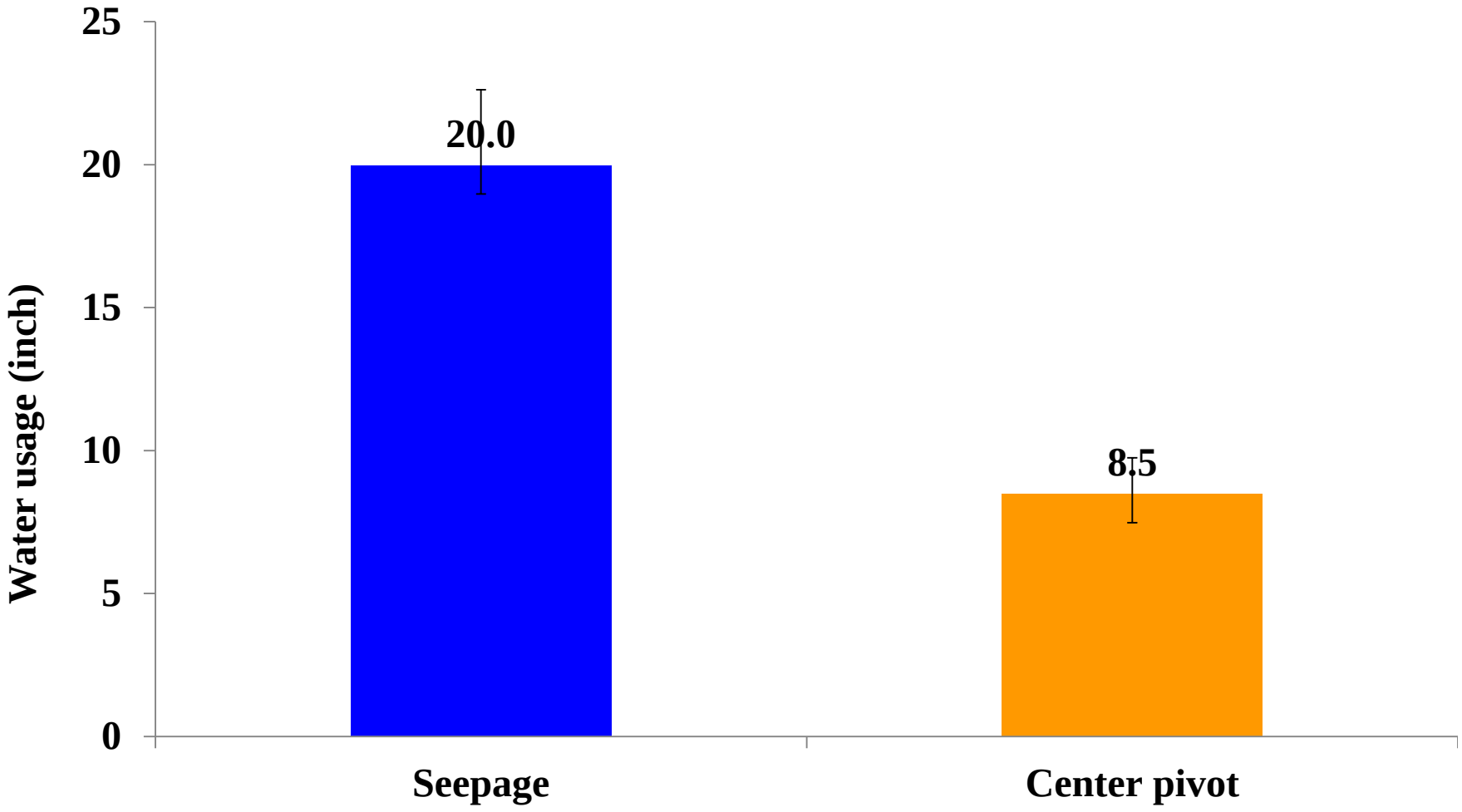
2.57 billion gallons!

Year	Acreage	Total water savings
		Gallons
2013	890	393,492,331
2014	1282	372,175,341
2015	1002	204,156,117
Total	**3174**	**969,823,789**

The water savings can be used by Gainesville for 8 months

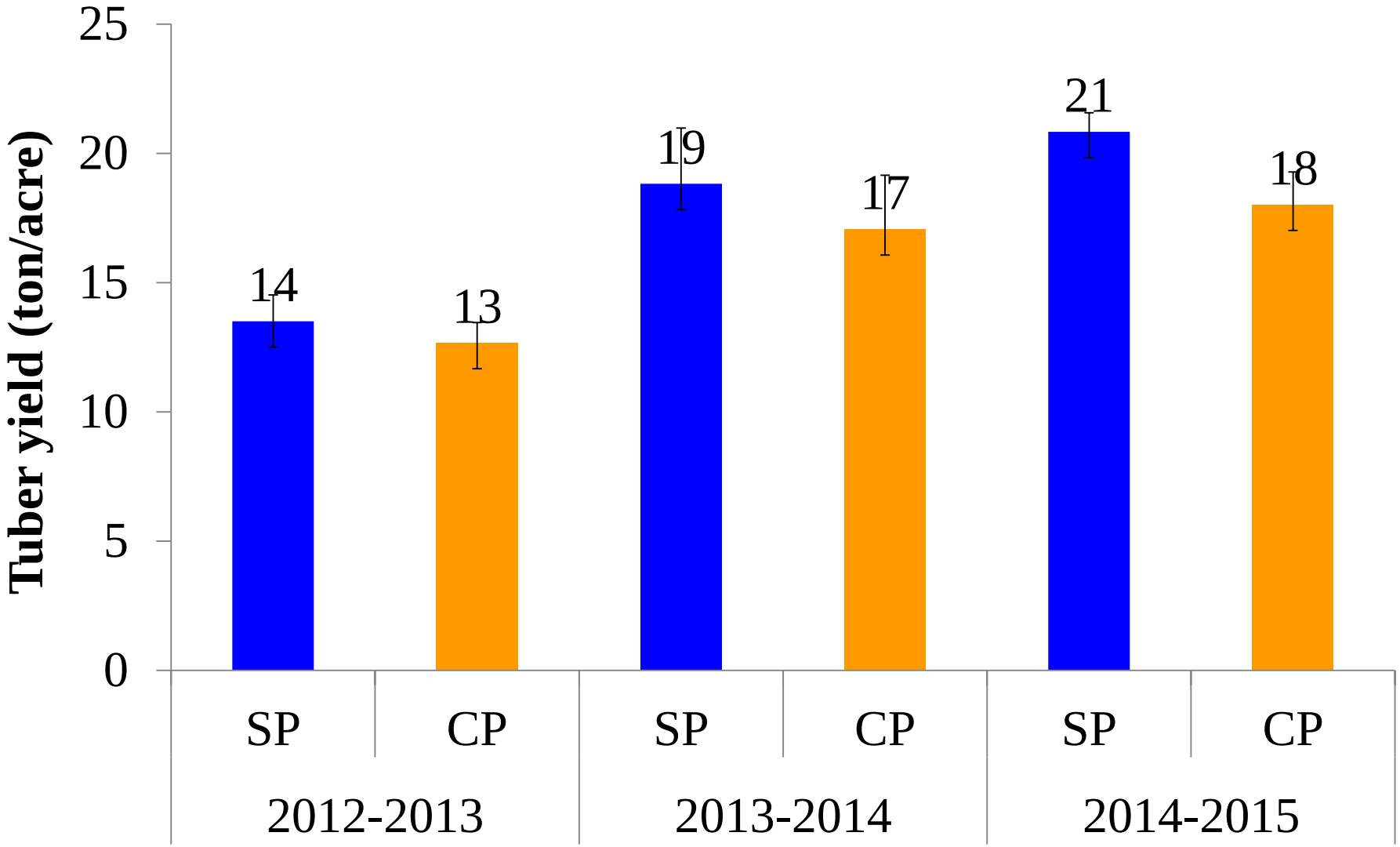


Water savings: 58%

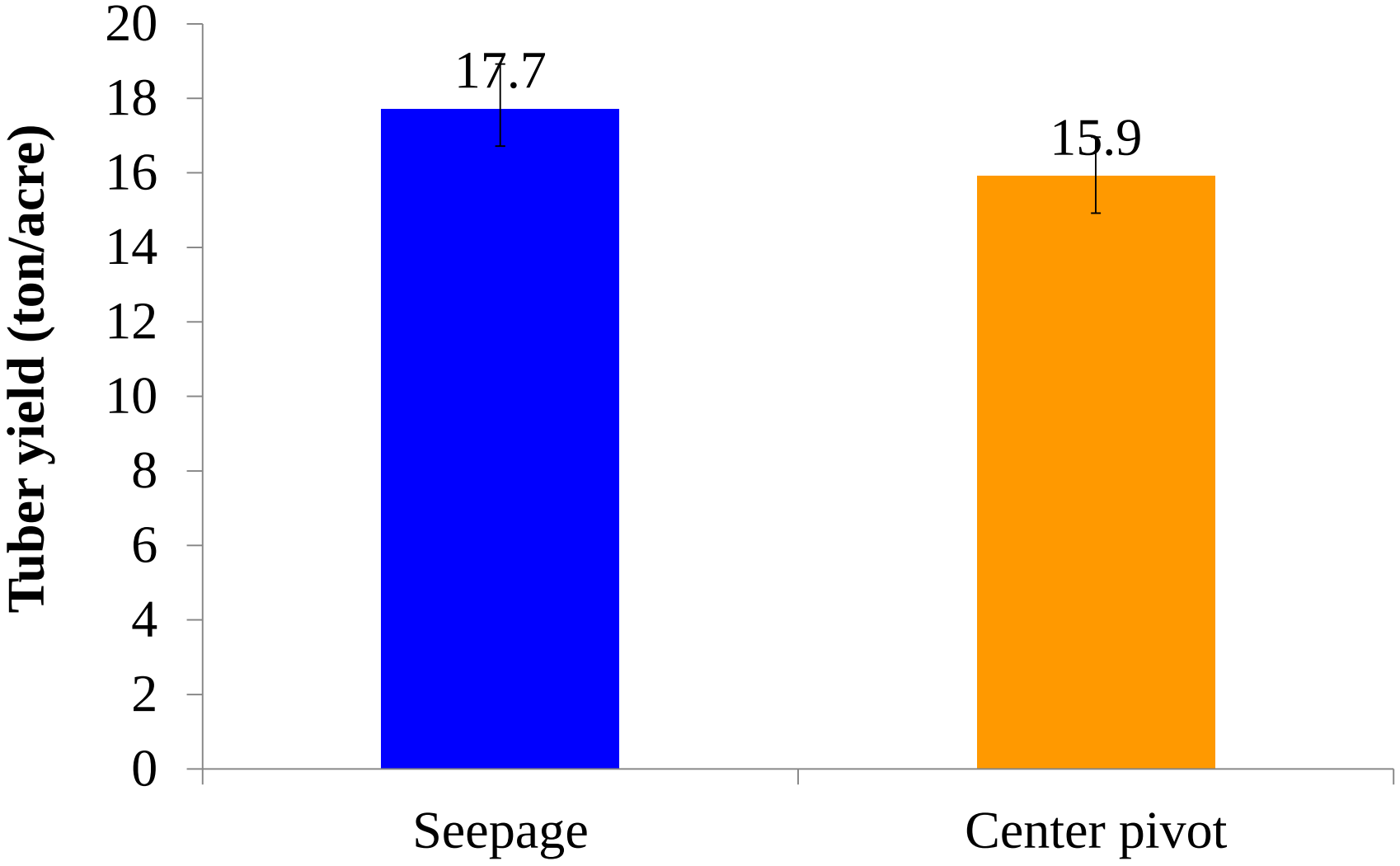


Potato tuber yields

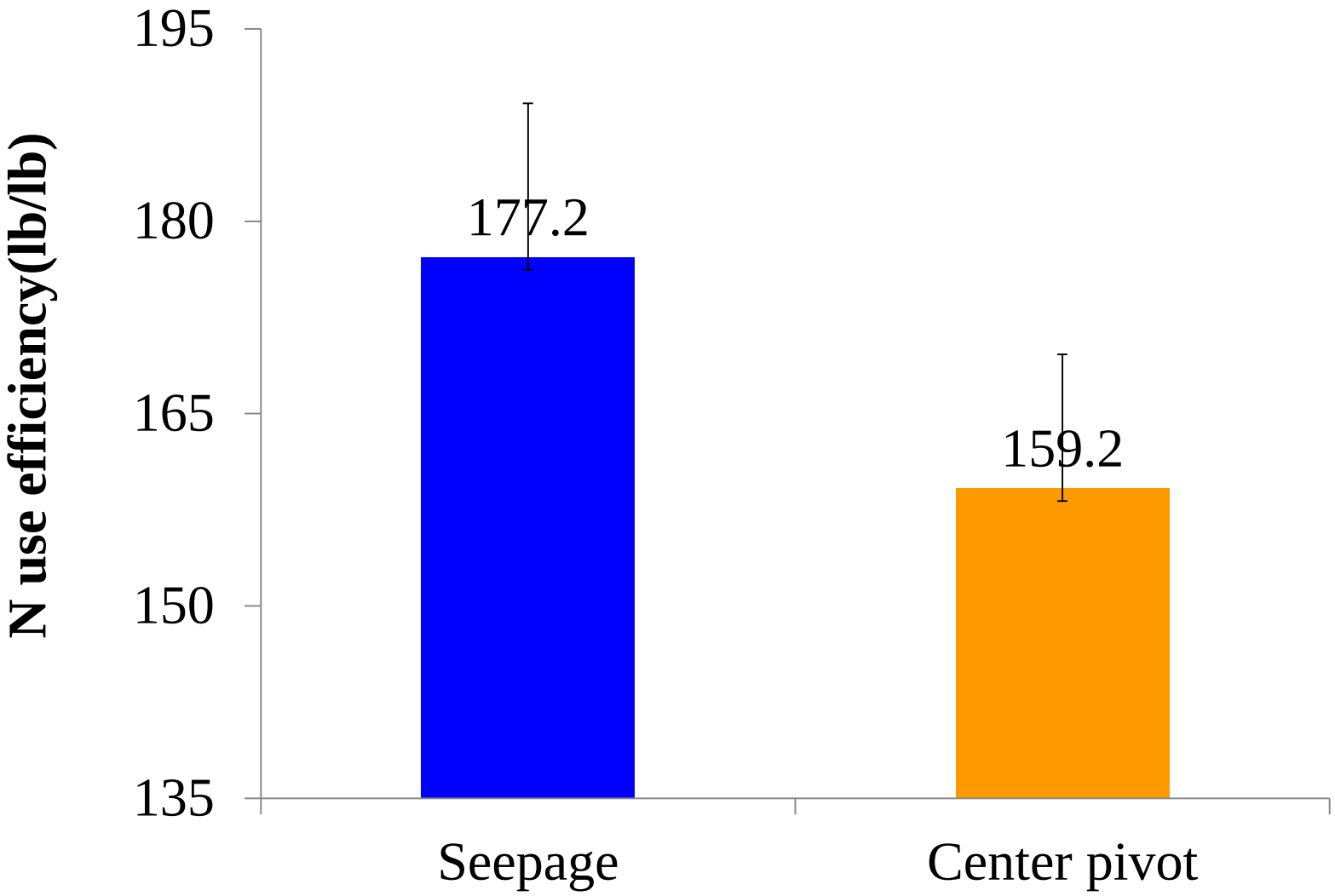
Average tuber yields



Average yields, 2012-15



Overall N use efficiency, 2012-15 (lb tuber per lb N)



Cover crop growth

August 5, 2013

Seepage

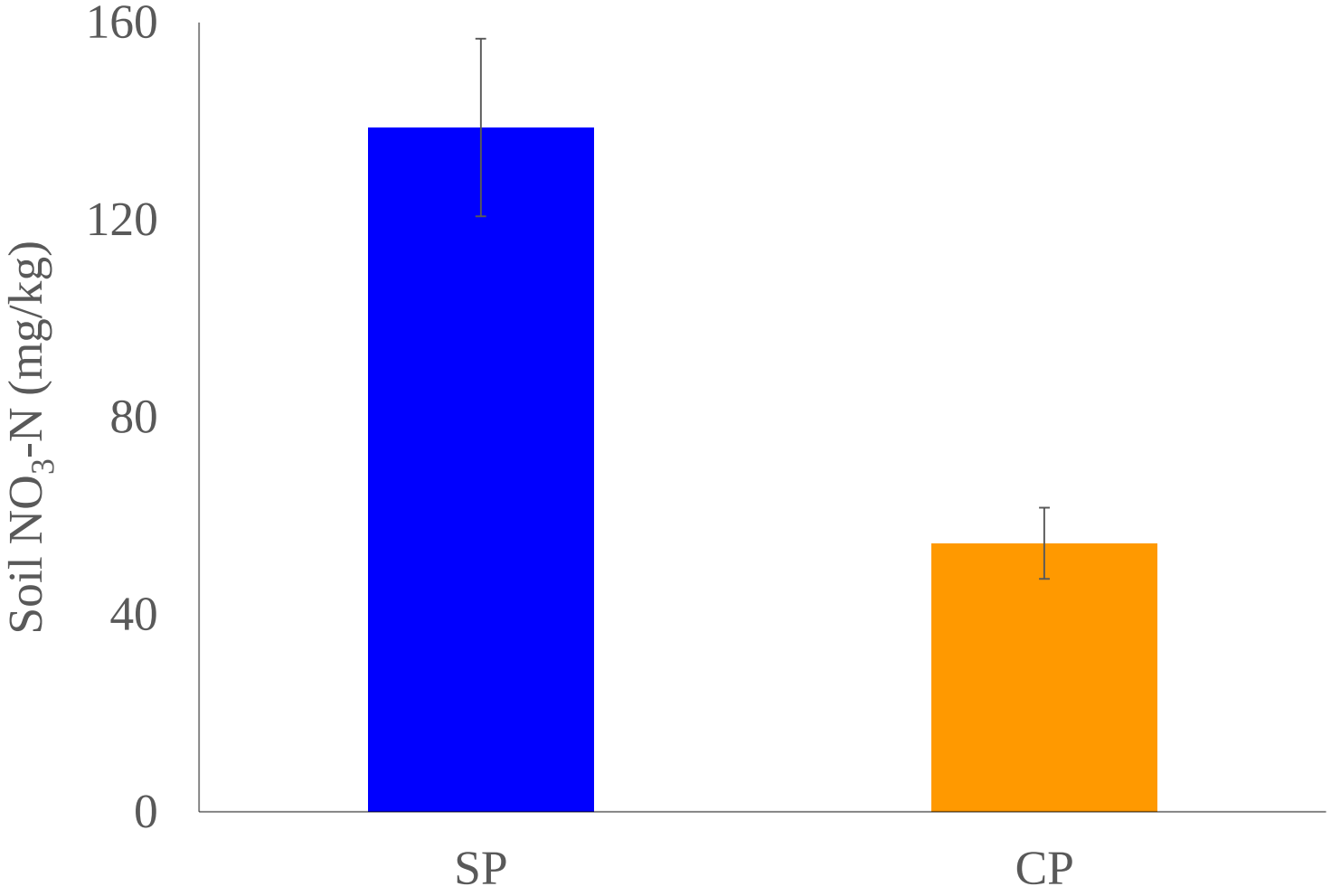
Center Pivot

Cover crop growth
July 8, 2014

Seepage

Center Pivot

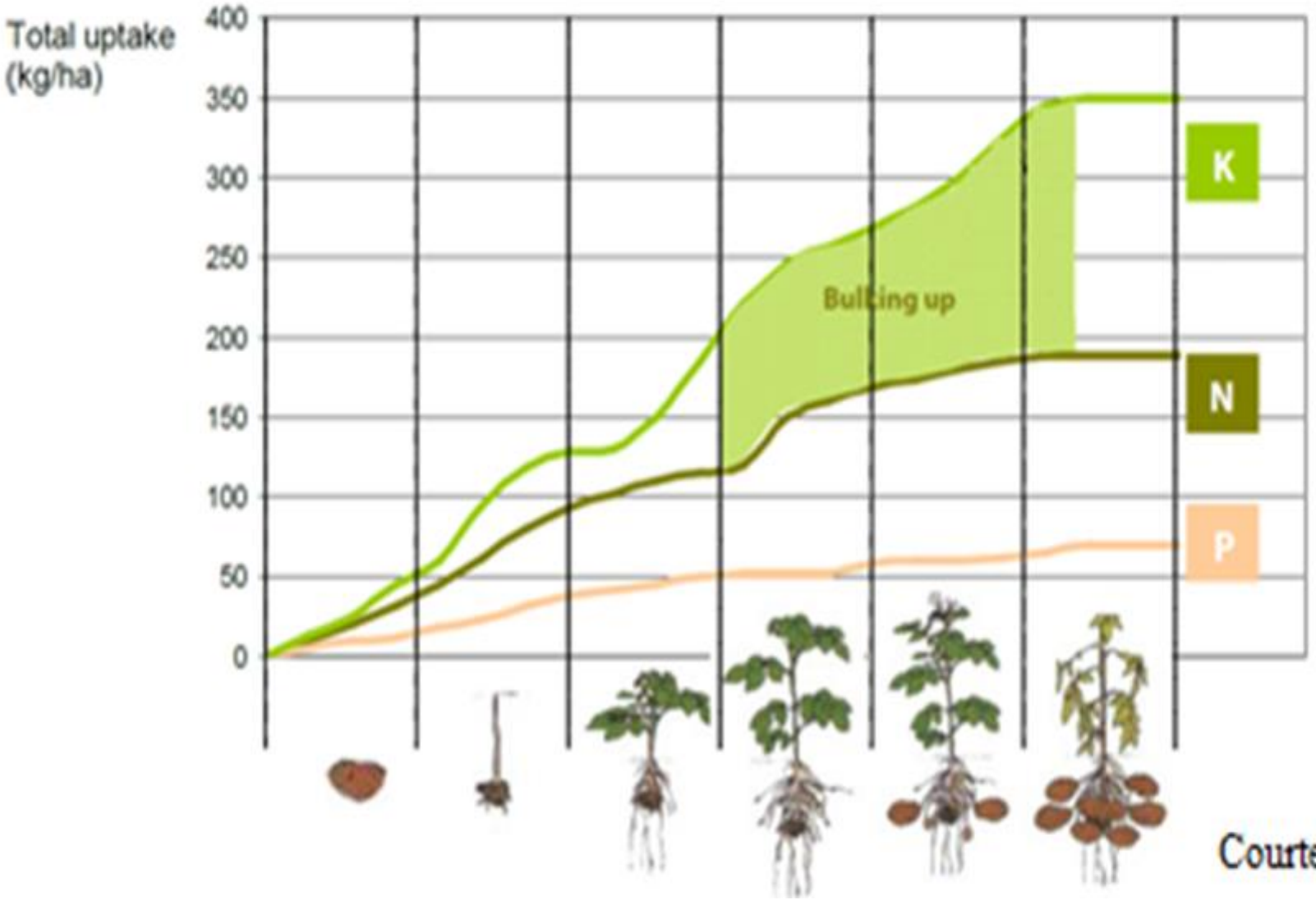
Soil NO_3-N level at harvest



Summary (2012~2015): tuber yield & water savings

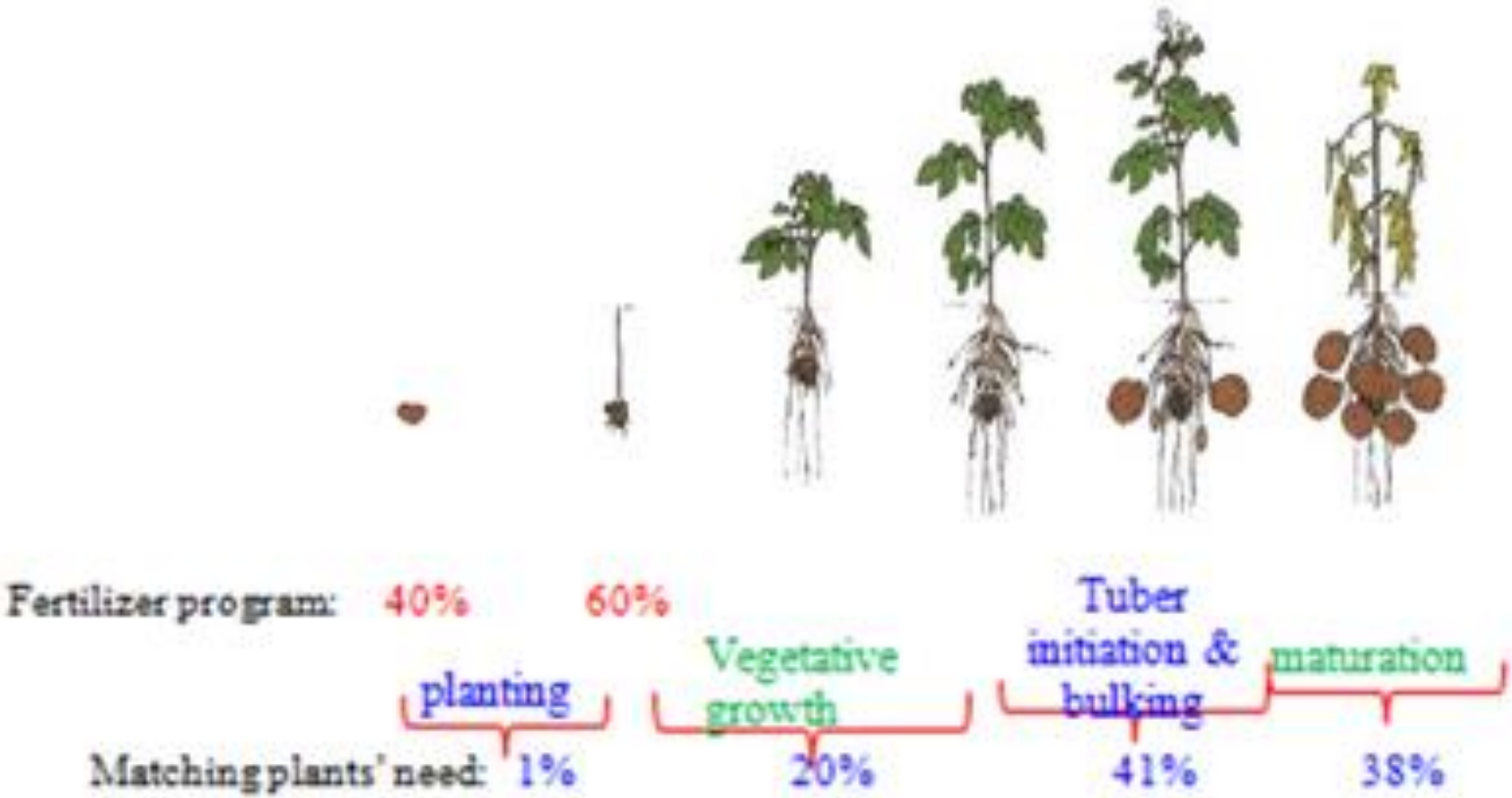
	Water			Tuber	
Irrigation	Usage (1000 gal/A)	Efficiency (oz/lb)	Savings (gal) of last 3 years	Yield (cwt/A)	N-use Efficiency (lb/lb)
Seepage	543	0.9	0	354	177
Overhead	231	1.5	1. 0 billion	318	159
+/- (%)	-58	66.7	(2012-2015)	**-11.3**	**-11.3**

Uptake of NPK by potato



Courtesy of Haifa

Dry fertilizer program



Fertigation

2015-2019

Fertigation N distribution at different stages

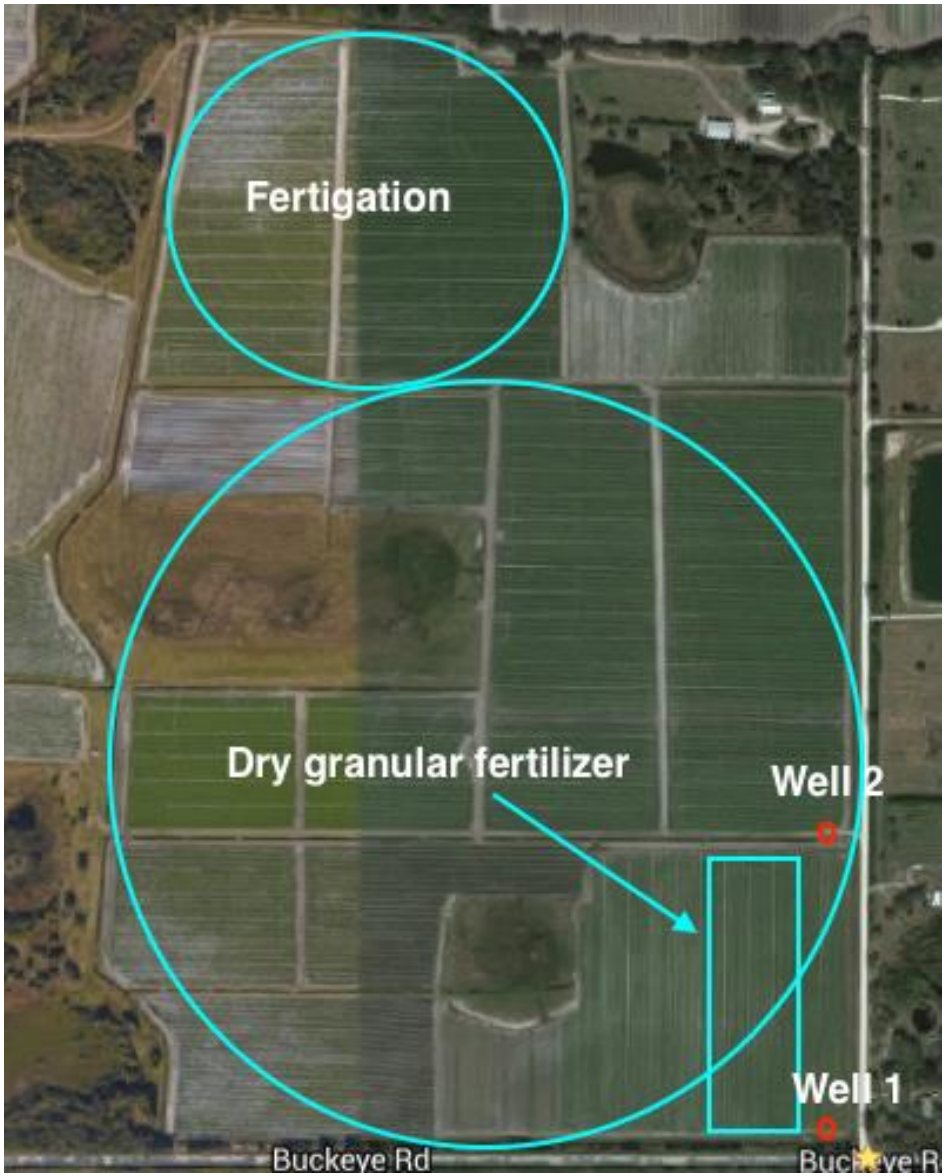
- ***Dry granular fertilization only:***

1. 25% pre-plant
2. 50% at emergence
3. 25% at tuber initiation

- ***Fertigation (dry fertilization + fertigation)***

1. 25% pre-plant
2. 50% at emergence
3. 25% at tuber initiation—5 events — 4 weeks after emergency: fertigation/week

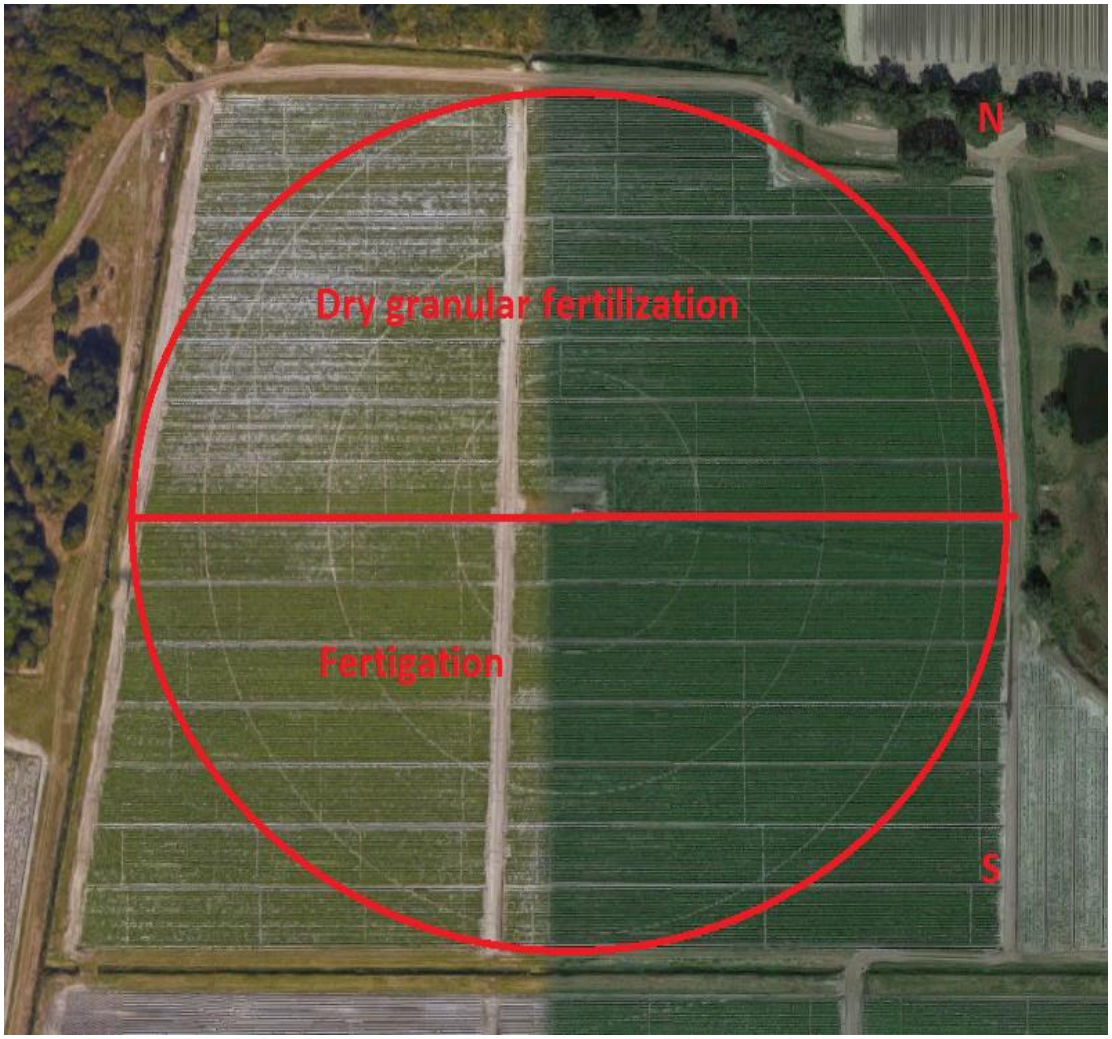
Fertigation in spring of 2016



Fertigation in spring 2016

Dry fertilization in spring 2016

Fertigation in springs of 2017-2019



The fertigation trial in springs of 2016-2017

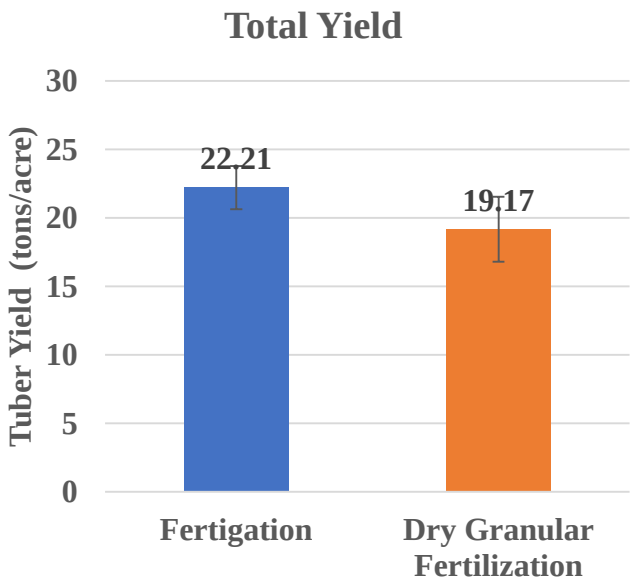
Treatment	Fertilization	Irrigation	Variety	Planting Date	Harvest Date
Fertigation	Dry fertilizer + Liquid fertilizer	Center pivot	Atlantic	12/20/2015	4/4/2016
			Red LaSoda	10/15/2016	2/8/2017
Dry granular	Dry fertilizer	Seepage + Center Pivot	Atlantic	12/20/2015	4/4/2016
			Red LaSoda	10/15/2016	2/8/2017

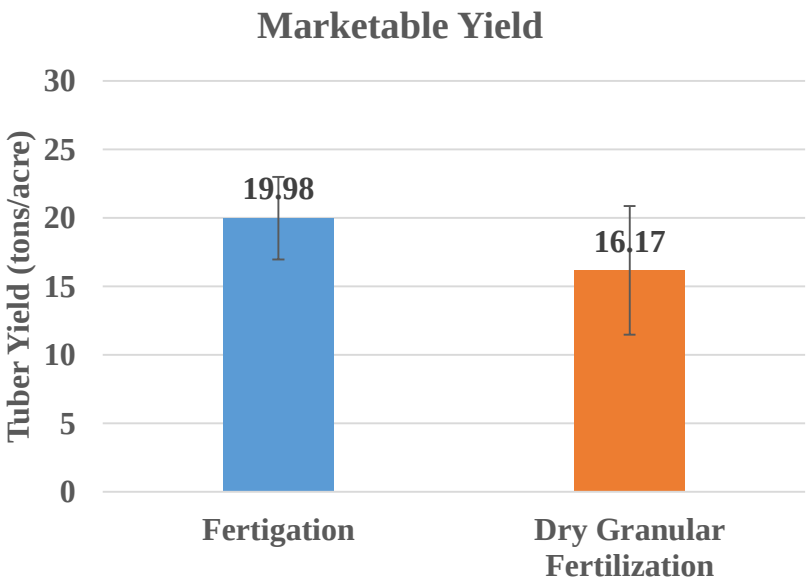
Fertigation Events in springs of 2016-2017

Date		Nitrogen rate (lbs/A)	
2016	2017	2016	2017
2/11	11/30	10	12
2/19	12/7	10	12
2/29	12/13	10	12
3/4	12/20	10	12
3/16	-	10	-

‘Atlantic’, 2015-2016

Fertigation and granular fertilization used the same amount of NPK



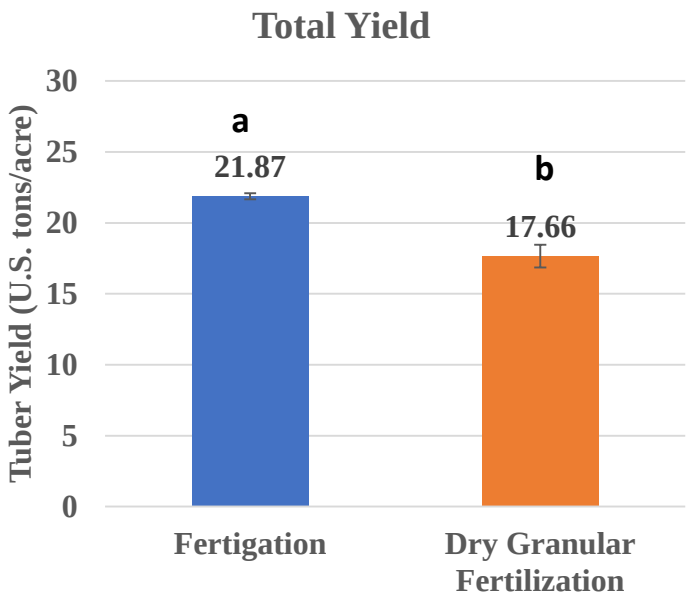


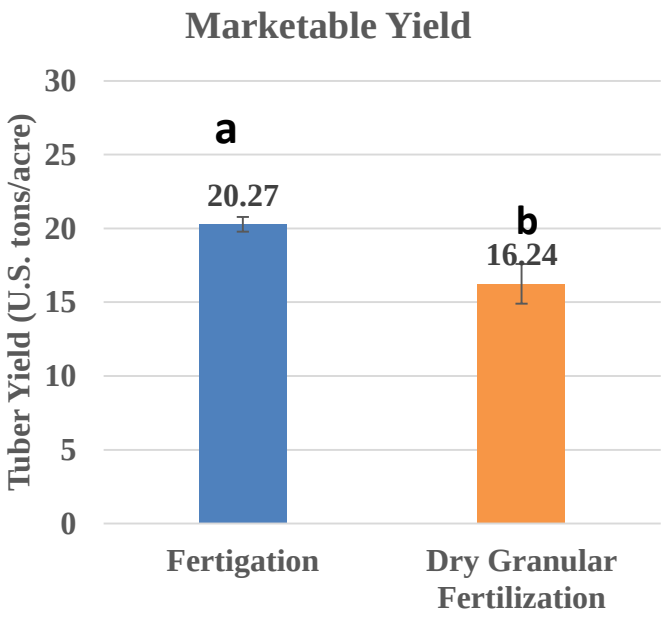
Yield increase: 116% 100%

124% 100%

‘Red LaSoda’, 2016-2017

Fertigation and granular fertilization used the same amount of NPK

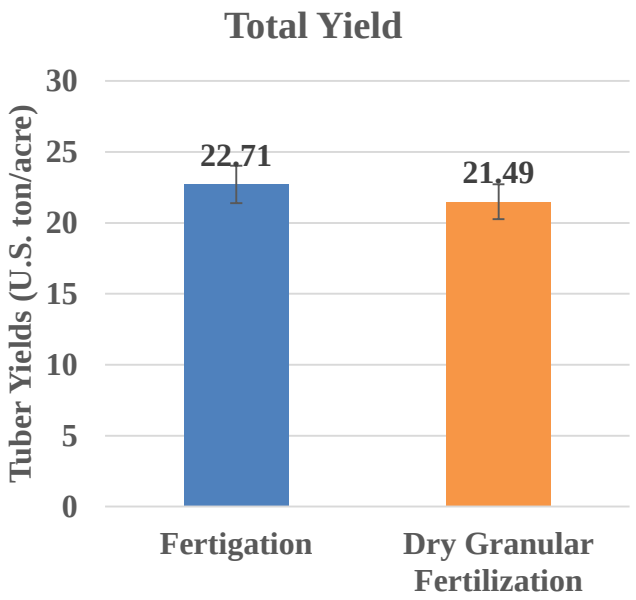


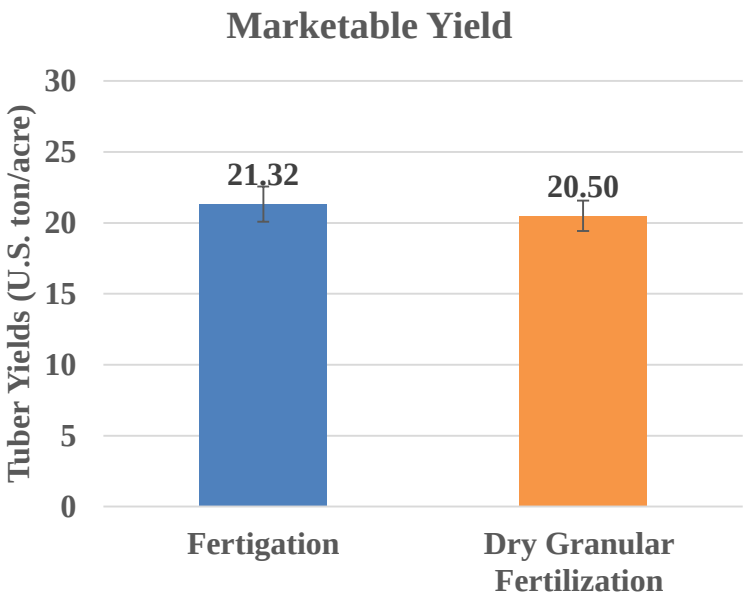


Yield increase: 124% 100% 125% 100%

‘Algeria’, 2017-2018

Fertigation used 70% N of that the control used





Yield increase: 106% 100% 104% 100%

External Quality

Growing Season And Cultivar	Treatment	External Quality Issues (% of total tuber yield)				
		Green Skin	Growth Cracks	Misshapen	Rotten & misc.	Total Culls
Season 1 ‘Atlantic’	Fertigation	0.68	0.14	0.86	0.27	1.95
	Dry Granular Fertilization	1.51	1.10	1.25	0.83	4.69
Season 2 ‘Red LaSoda’	Fertigation	1.2	1.2	0.2	0.1	2.7
	Dry Granular Fertilization	1.5	0.3	0.9	0.4	3.1
Season 3 ‘Algeria’	Fertigation	0.35	0.00	1.69	0.59	2.62
	Dry Granular Fertilization	0.33	0.00	0.47	0.76	1.56

Internal Quality

Growing Season And Cultivar	Treatment	Internal Quality Issues (% of total tubers)				
		Hollow Heart	Brown Center	Corky Ring Spot	Internal Heart Necrosis	Total
Season 1 'Atlantic'	Fertigation	2.5	0	0	0	2.5
	Dry Granular Fertilization	1.25	0	0	0	1.25
Season 2 'Red LaSoda'	Fertigation	1.25	1.25	1.25	0	3.75
	Dry Granular Fertilization	3.75	1.25	0	0	5.00
Season 3 'Algeria'	Fertigation	0	0	0	0	0
	Dry Granular Fertilization	0	0	0	0	0

Average Specific Gravity

Growing Season And Cultivar	Treatment	Specific Gravity
Season 1 ‘Atlantic’	Fertigation	1.077
	Dry Granular Fertilization	1.071
Season 2 ‘Red LaSoda’	Fertigation	1.060
	Dry Granular Fertilization	1.066
Season 3 ‘Algeria’	Fertigation	1.070
	Dry Granular Fertilization	1.072

Summary

Fertigation produced more tubers even with less fertilizer applied:

	Total	Marketable
2015-2016:	16%	24%
2016-2017:	24%	25%
2017-2018:	6%	4%

Fertigation saves water and nutrients.

Increased yield also indicated that fertigation had greater water use efficiency than dry fertilization.

Fertigation via Linear Pivot in Hastings

Materials and Methods

- Location: Hastings Agricultural Extension Center, UF/IFAS
- Growing seasons

  Season 1: 2017

  Season 2: 2018

  Season 3: 2019
- Treatments:

  4 Dry granular fertilization treatments

  8 Fertigation treatments
- Experiment Design: Strip plot design
- Data Analysis (Least Significant Difference)

Treatment Table

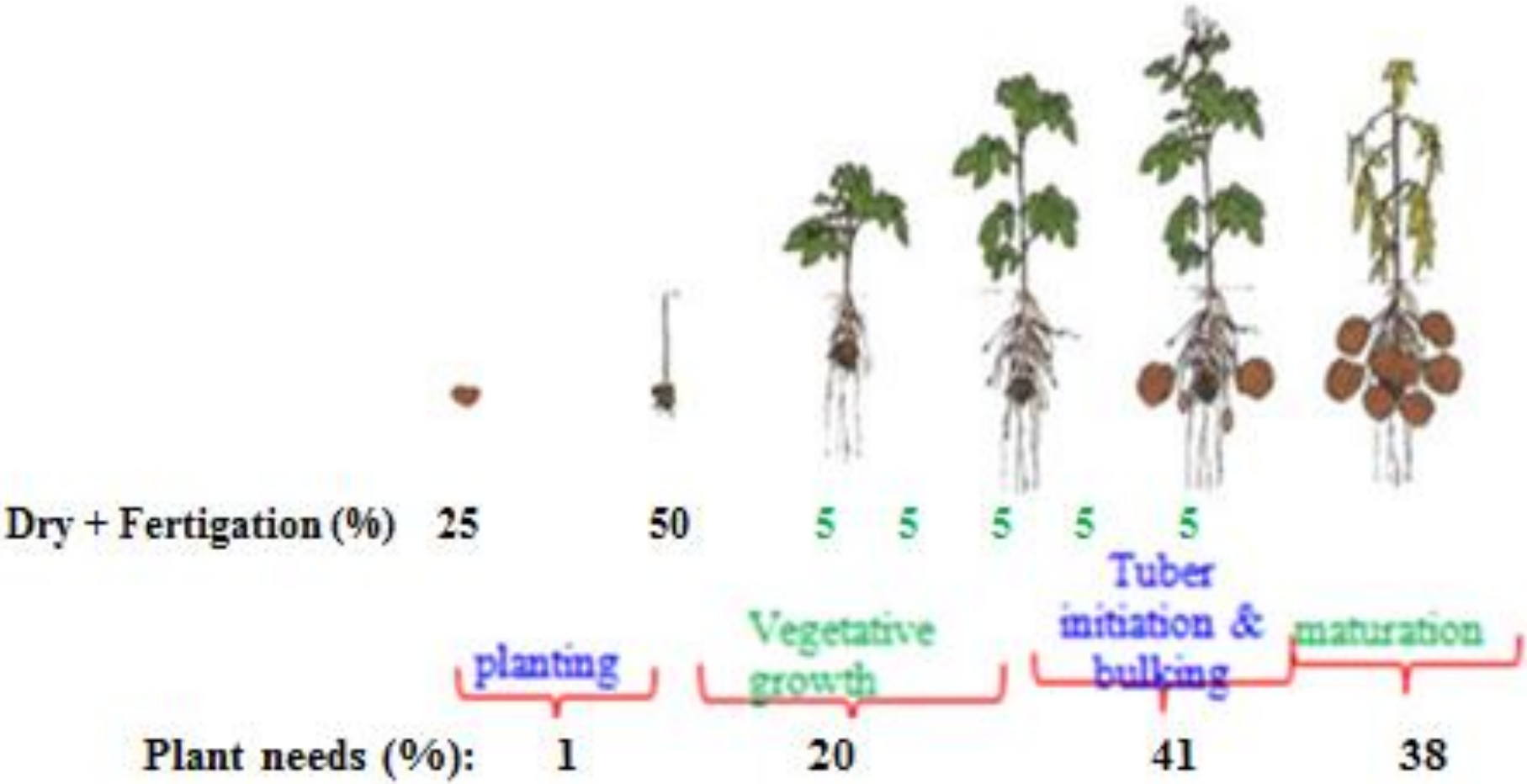
Treatment ID	Fertilizer Type	Pre-plant (lbs/A N)	Emergence (lbs/A N)	N Rate (lbs/A N) at Tuber initiation	Number of Applications	Total N Rate (lbs,/A N)
T1	Dry + Liquid	50	50	0	3 (Fer3)	100
T2	Dry + Liquid	50	50	50	3 (Fer3)	150
T3	Dry + Liquid	50	50	100	3 (Fer3)	200
T4	Dry + Liquid	50	50	150	3 (Fer3)	250
T5	Dry + Liquid	50	50	0	5(Fer5)	100
T6	Dry + Liquid	50	50	50	5(Fer5)	150
T7	Dry + Liquid	50	50	100	5(Fer5)	200
T8	Dry + Liquid	50	50	150	5(Fer5)	250
T9	Dry only	50	50	0	1	100
T10	Dry only	50	50	50	1	150
T11	Dry only	50	50	100	1	200
T12	Dry only	50	50	150	1	250

Total Yield in 2017, 2018, 2019

Fertilizer application	Yield (tons/acre)		
	2017	2018	2019
Dry granular fertilization	7.38b	11.07b	12.33a
3-time fertigation	9.00a	12.42a	12.91a
5-time fertigation	9.07a	11.42ab	12.71a
Average increase (%)	22.4	7.6	3.9

Fertigation program:

Synchronizing N Supply and N Demand of potato plants



4R Nutrient Stewardship

The 4R concept incorporates the:

- **Right fertilizer source** at the
- **Right rate**, at the
- **Right time** and in the
- **Right place**

RIGHT SOURCE

Matches fertilizer type to crop needs.

RIGHT RATE

Matches amount of fertilizer type crop needs

RIGHT TIME

Makes nutrients available when crops needs them

RIGHT PLACE

Keep nutrients where crops can use them.

Water savings in Hastings

	Water Usage (in)		Water Savings	
	Seepage	Pivot	Inch	%
2017	9.79	4.06	5.37	58.5
2018	12.38	8.10	4.28	34.6
2018	7.27	4.20	3.07	42.2
Average	9.81	5.45	4.24	43.2

Conclusions

- The center pivot irrigation with dry fertilization saved 58% water.
- Water use efficiency increased by 67%
- N use efficiency reduced 11.3%
- Tuber yield decreased 11.3%
- Fertigation can minimize leaching and increase total tuber yield by 20%

Acknowledgements

- Southwest Florida Water Management District
- HAEC Crew in Hastings
- Mr. Alan Jones, Mr. David Fleming, and Mr. Jesse Cavillo
- Miss Crystal Snodgrass, graduates, biologists
- Dr. Kelly Morgan

Thank You!