How much water can we save for potato production by using center-pivot irrigation?

G. David Liu, Ph.D.
Horticultural Sciences Department
University of Florida/IFAS

UF IFAS Extension UNIVERSITY of FLORIDA

IST training (IST#: 31110), Gainesville, 2-24-2016

Agriculture: the largest water user

- The 2nd largest industry with $120 billion
- Potato production uses up to 38 inches of water
- We have to face challenges of water shortages in the near future. Conservation agriculture is critical (*Commissioner Adam Putnam*).

Water consumption in Florida:

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

Primary water source:

Floridan Aquifer

- Water sources in Florida:

1. *Floridan Aquifer (90%)*
2. *River Water (10%)*

- Aquifer extraction:

➢ Orlando area: 800 × 10^6 gal/day, remaining: 50 × 10^6 gal/day

➢ Manatee County: 127 × 10^6 gal/day, Agriculture: 85 × 10^6 gal/day (67%)

--Hank Largin

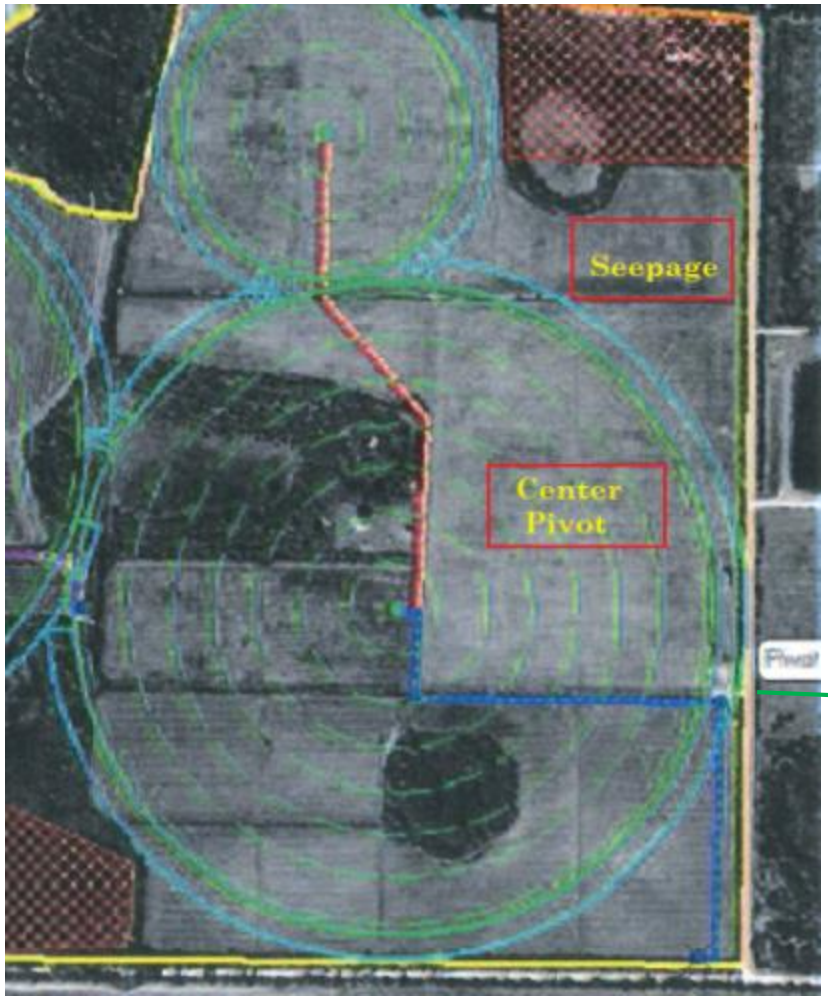
Saving water is our goal

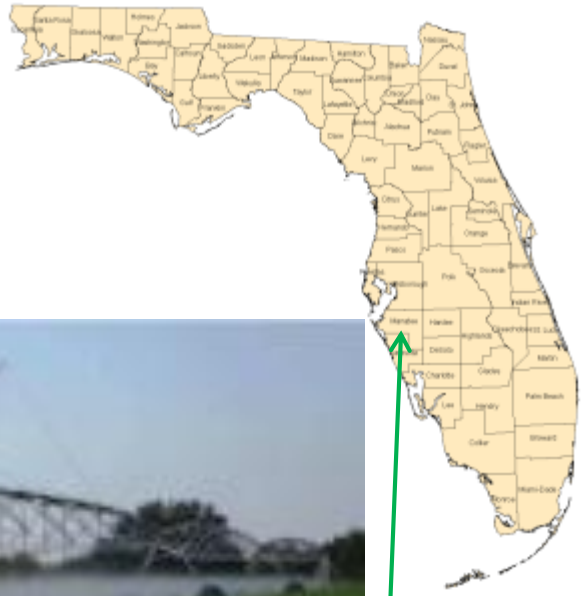
- Water usage of potato production: 32–38”
- Potato water requirement: 16–18”
- Water saving potential: 16–20”
- Potato acreage in FL: 35,000 acres
- Our goal is to save 350,000 acre inches of water in FL per potato growing season
- 350,000 acre inches are much enough for 220,000 people to use for one year

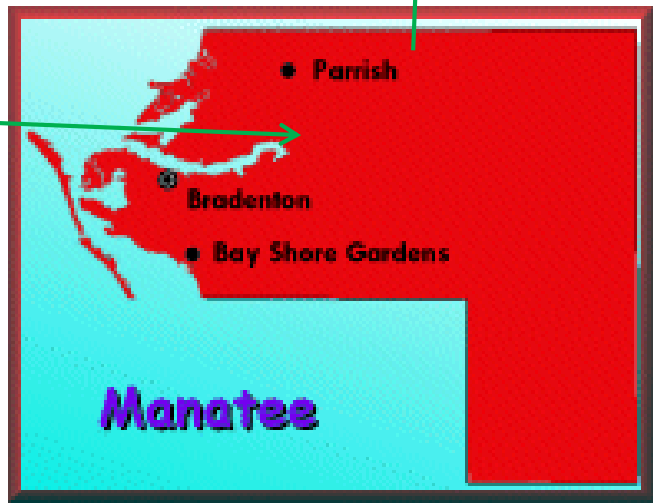
Trials on Private Farms

- Objective: to evaluate water savings by using center pivot irrigation
- Treatments: (1) Seepage (CK); (2) Center pivot irrigation
- Measurements: Water usage, Soil moisture, rainfall, tuber yield

Trial locations





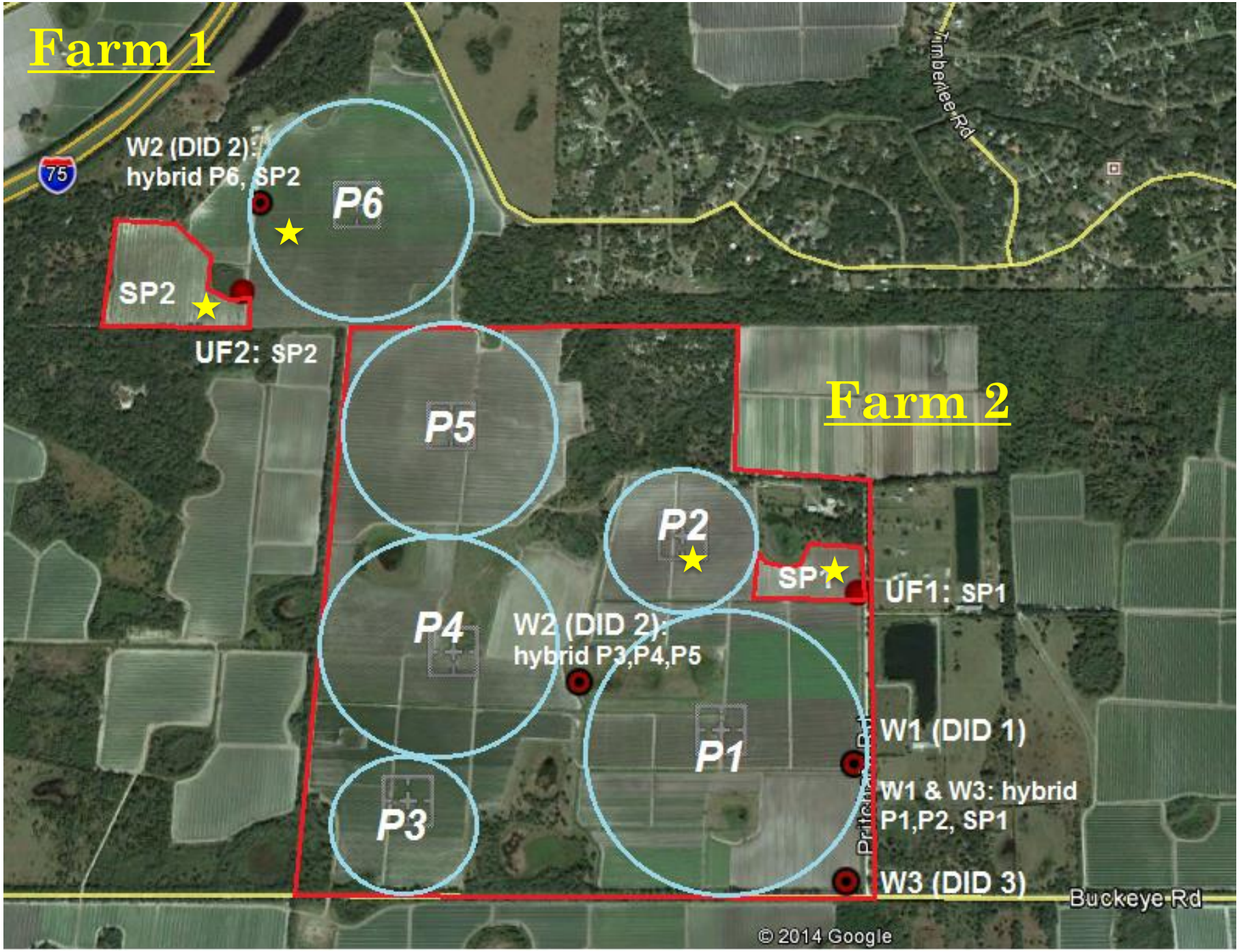


Seepage (SP) *vs.* center pivot (CP)

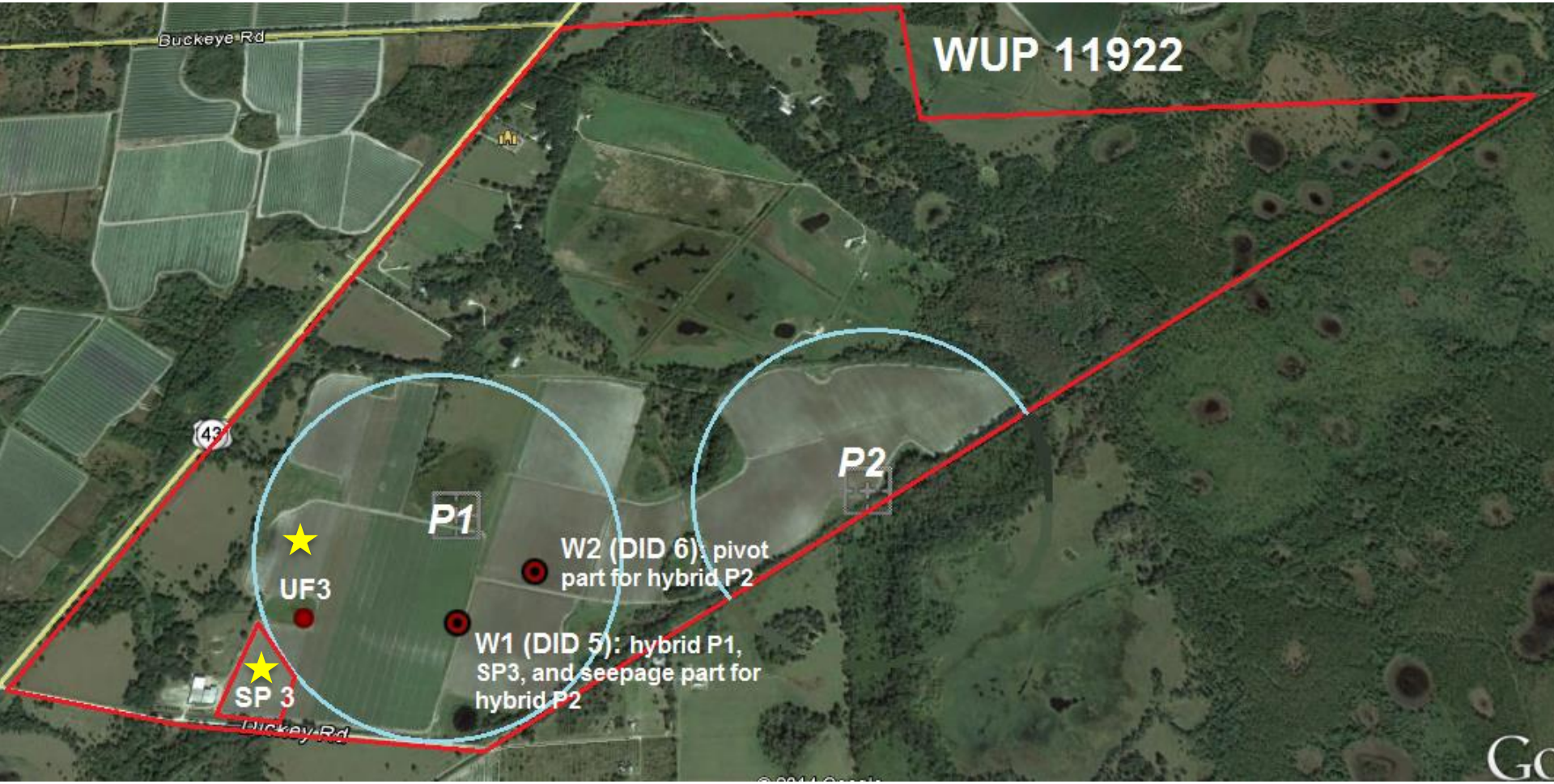
Water table indicator

Devices used on the farms

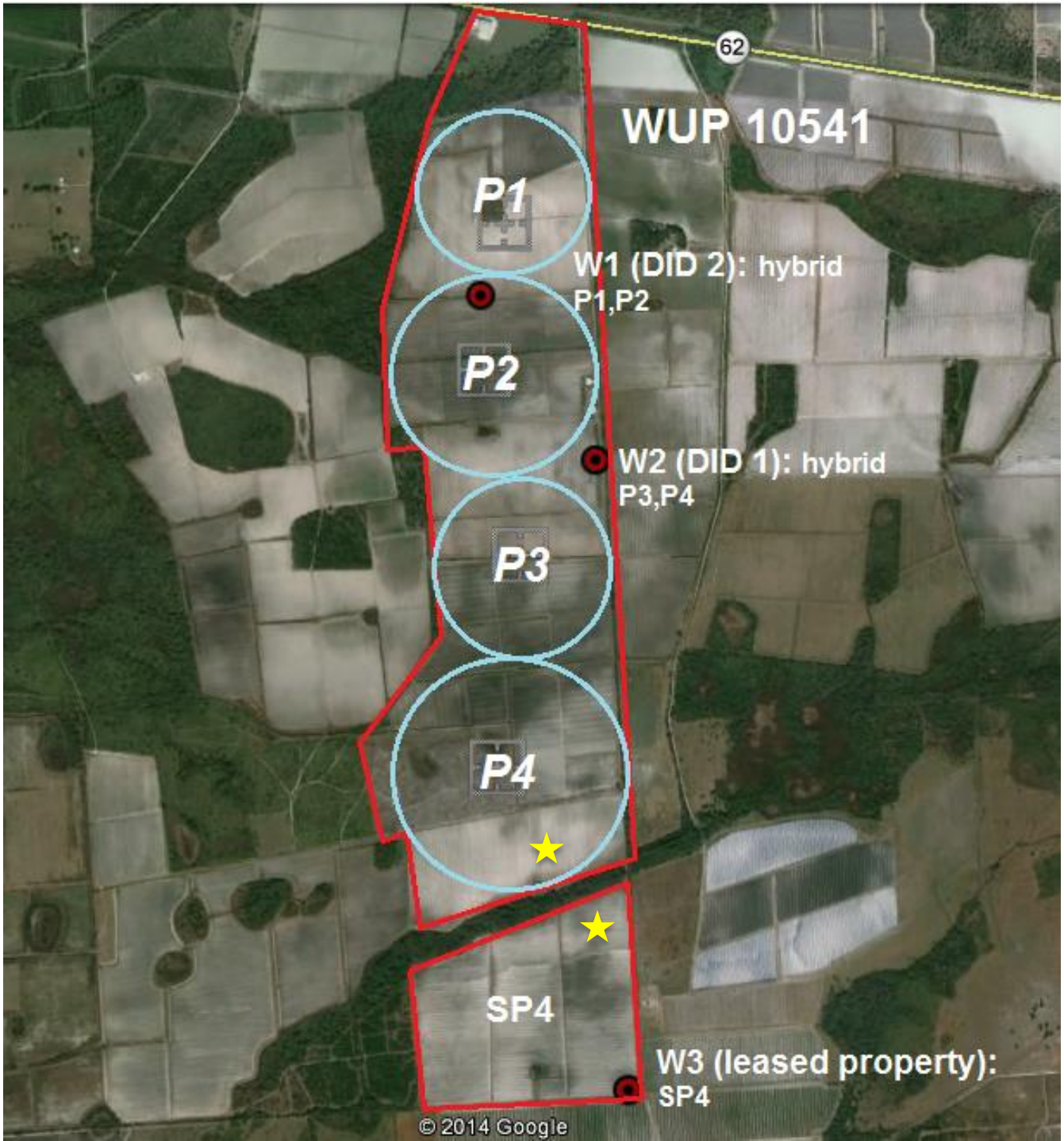
Flow meters


Farm 1
W2 (DID 2):
hybrid P6, SP2
P6
SP2
UF2: SP2
P5
Farm 2
P2
SP1
UF1: SP1
P4
W2 (DID 2):
hybrid P3,P4,P5
P1
W1 (DID 1)
W1 & W3: hybrid
P1,P2, SP1
P3
W3 (DID 3)
Buckeye Rd
Timberlee Rd
75
© 2014 Google

Farm 3


Buckeye Rd
WUP 11922
P1
P2
UF3
SP 3
W2 (DID 6): pivot part for hybrid P2
W1 (DID 5): hybrid P1, SP3, and seepage part for hybrid P2
Buckeye Rd

Farm 4


62
WUP 10541
P1
W1 (DID 2): hybrid
P1,P2
P2
W2 (DID 1): hybrid
P3,P4
P3
P4
SP4
W3 (leased property):
SP4
© 2014 Google

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**

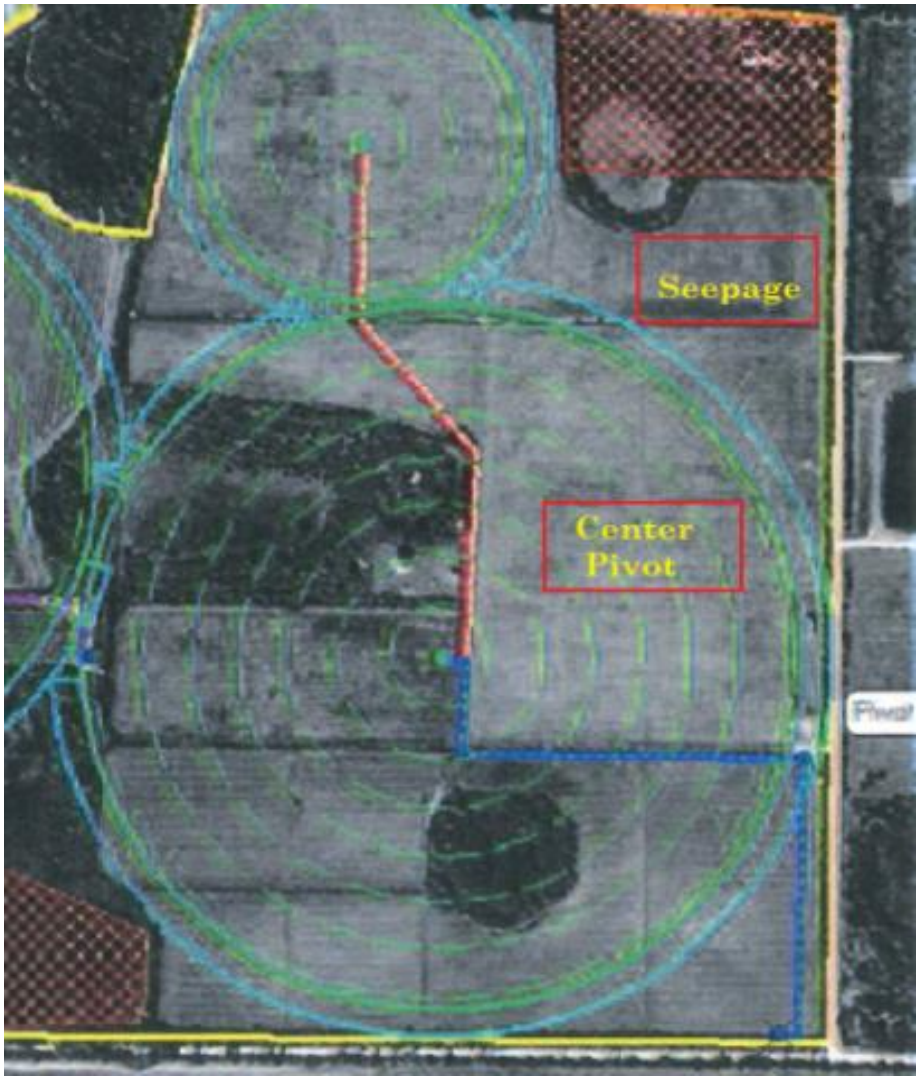
Varieties and acreage

- 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

Calculation of water savings

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

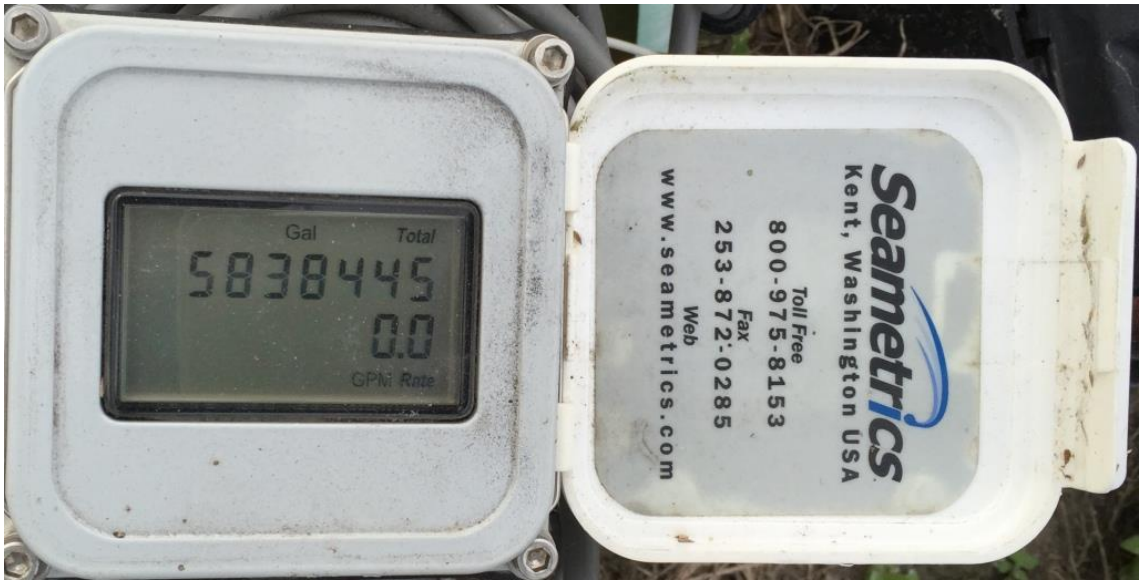
- WS = water savings (%)
- WU_{sp} = water usage of seepage irrigation (gallons/acre)
- WU_{cp} = water usage of center pivot irrigation (gallons/acre)

Results

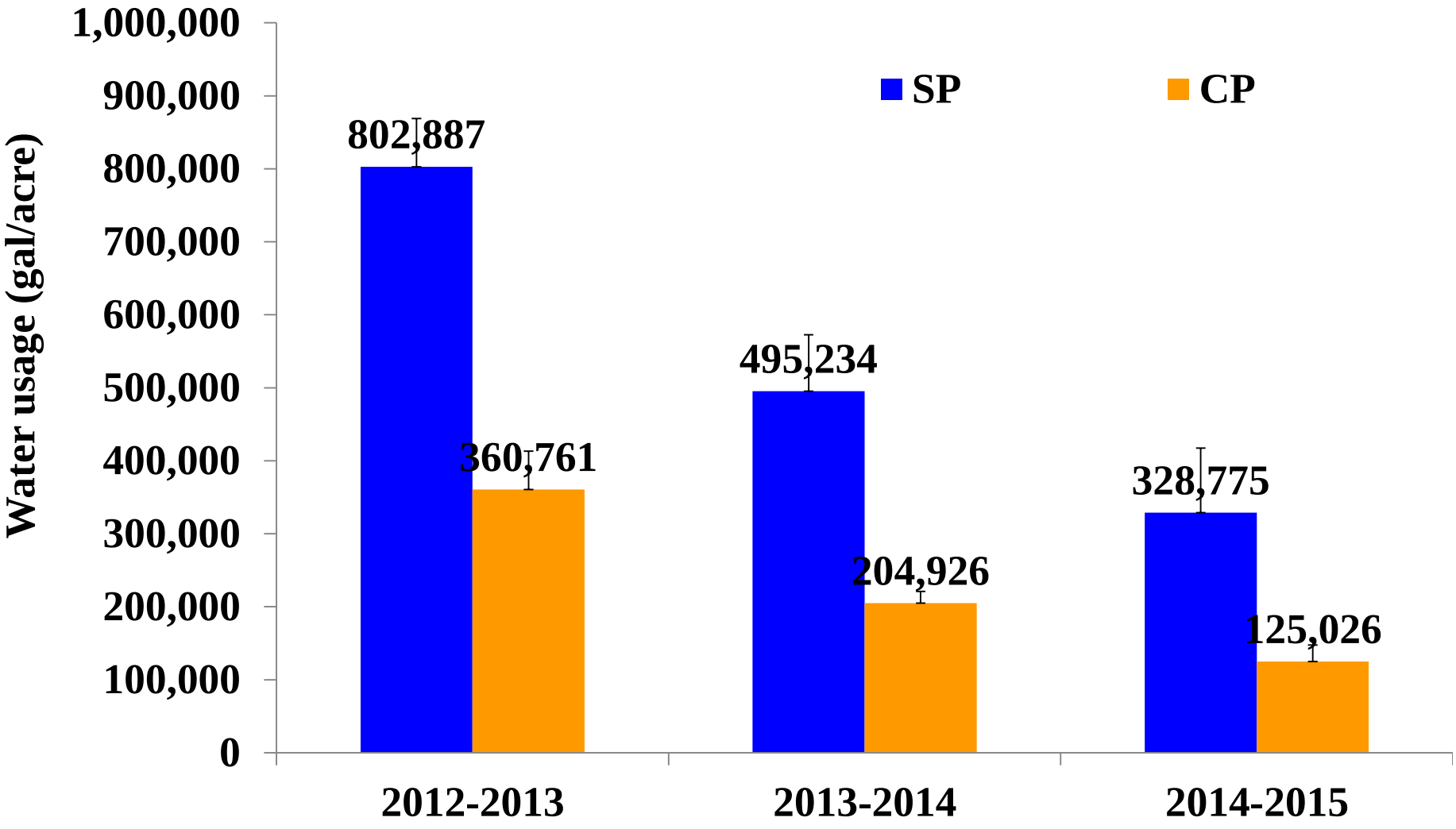
- Water usage
- Water use efficiency
- Water savings
- Potato tuber yields

Water usage

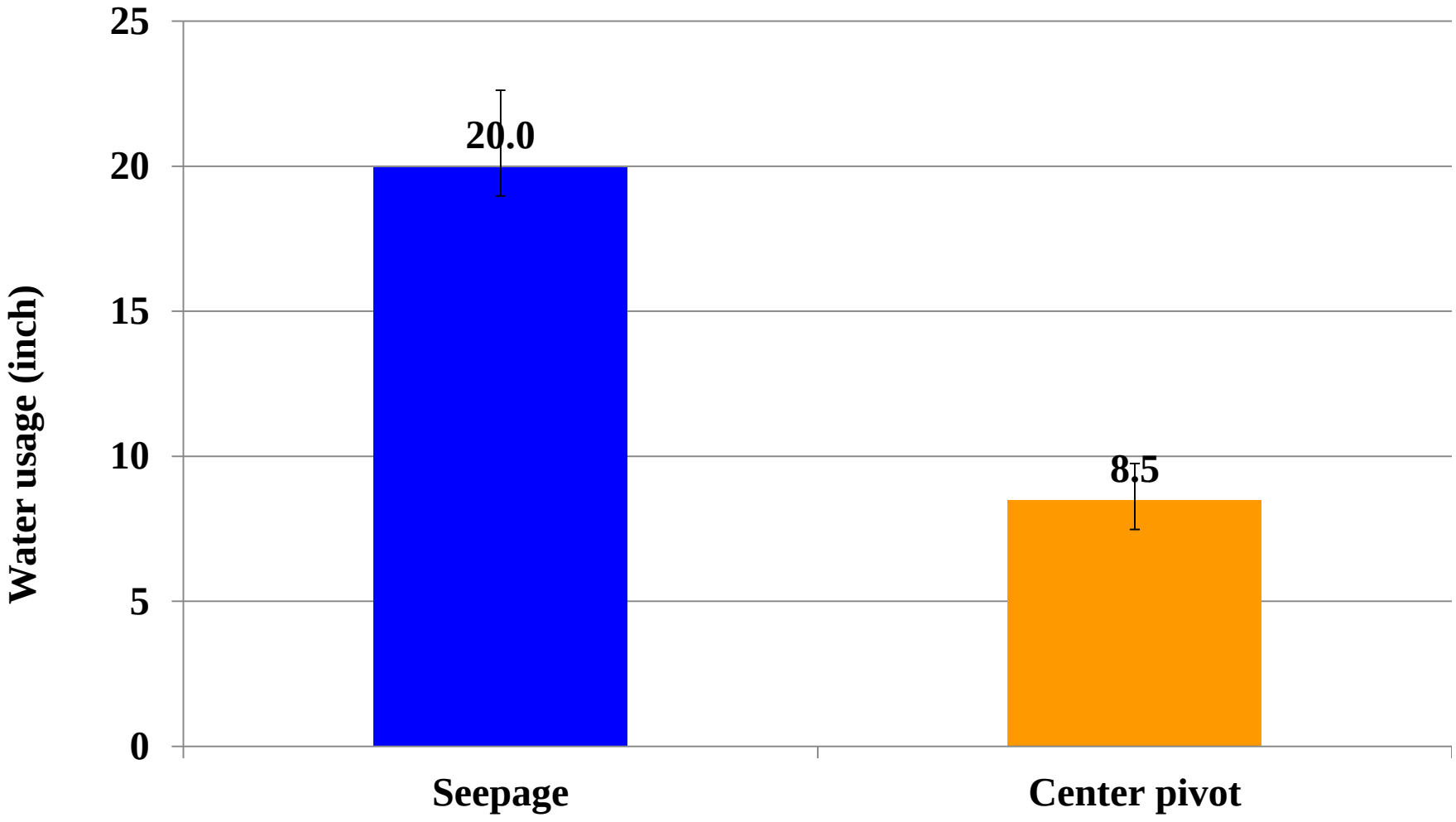
0
100
900
01219000
GALLONS
800
200
700
300
600
400
500
WATER SPECIALTIES
PROPELLER METER
McCROMETER, INC.
HEMET, CA
POLY-2


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

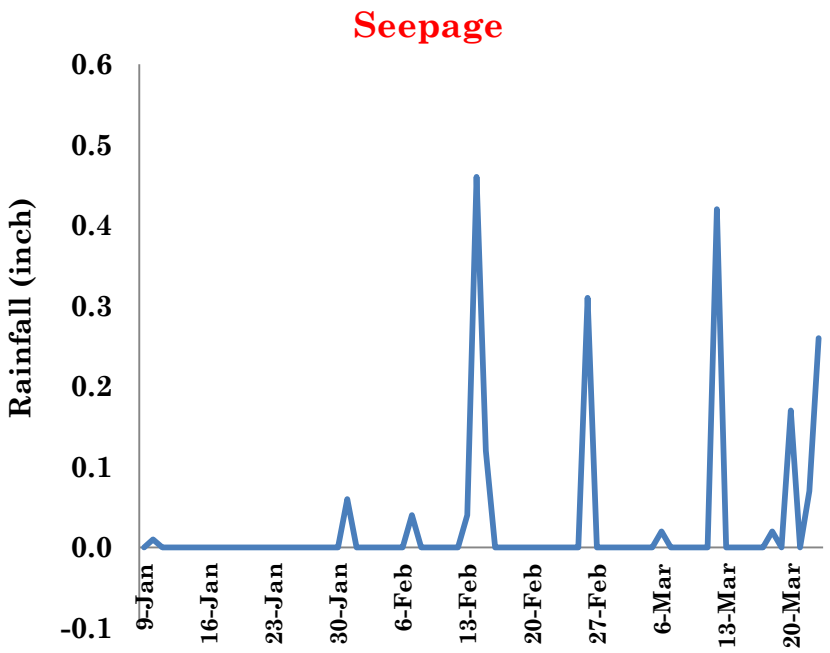
Irrigation water usage

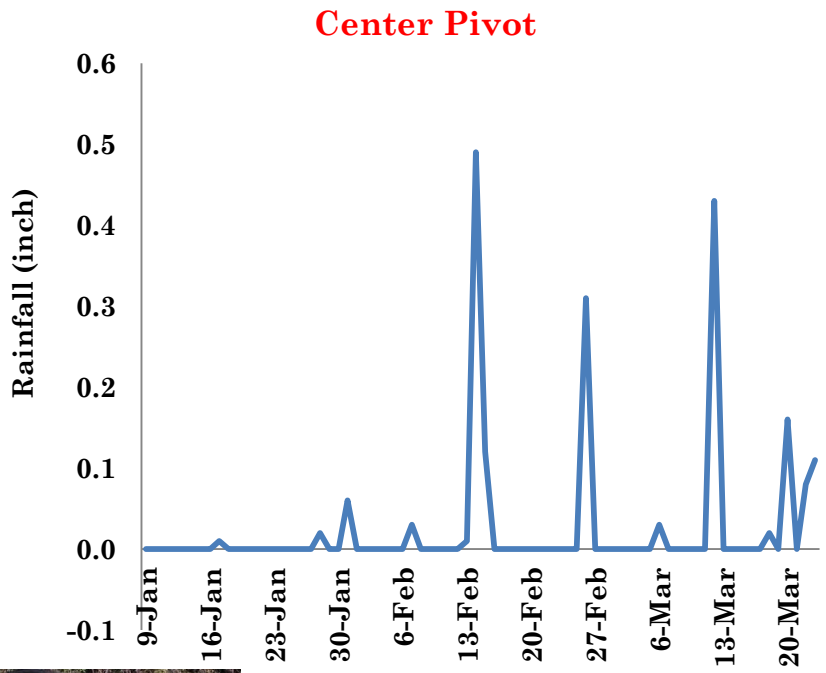


Average water usage, 2012-15

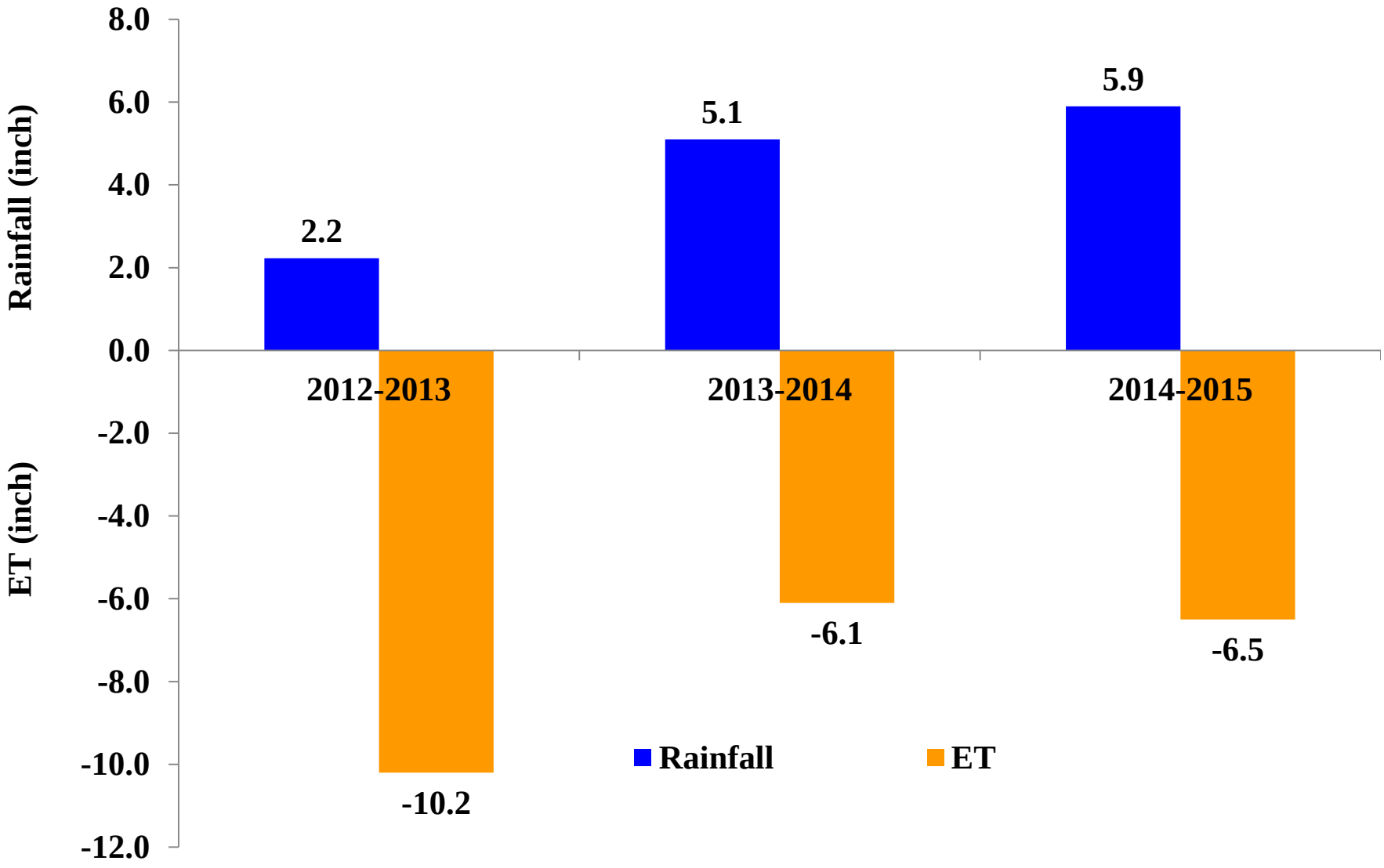


Rainfall

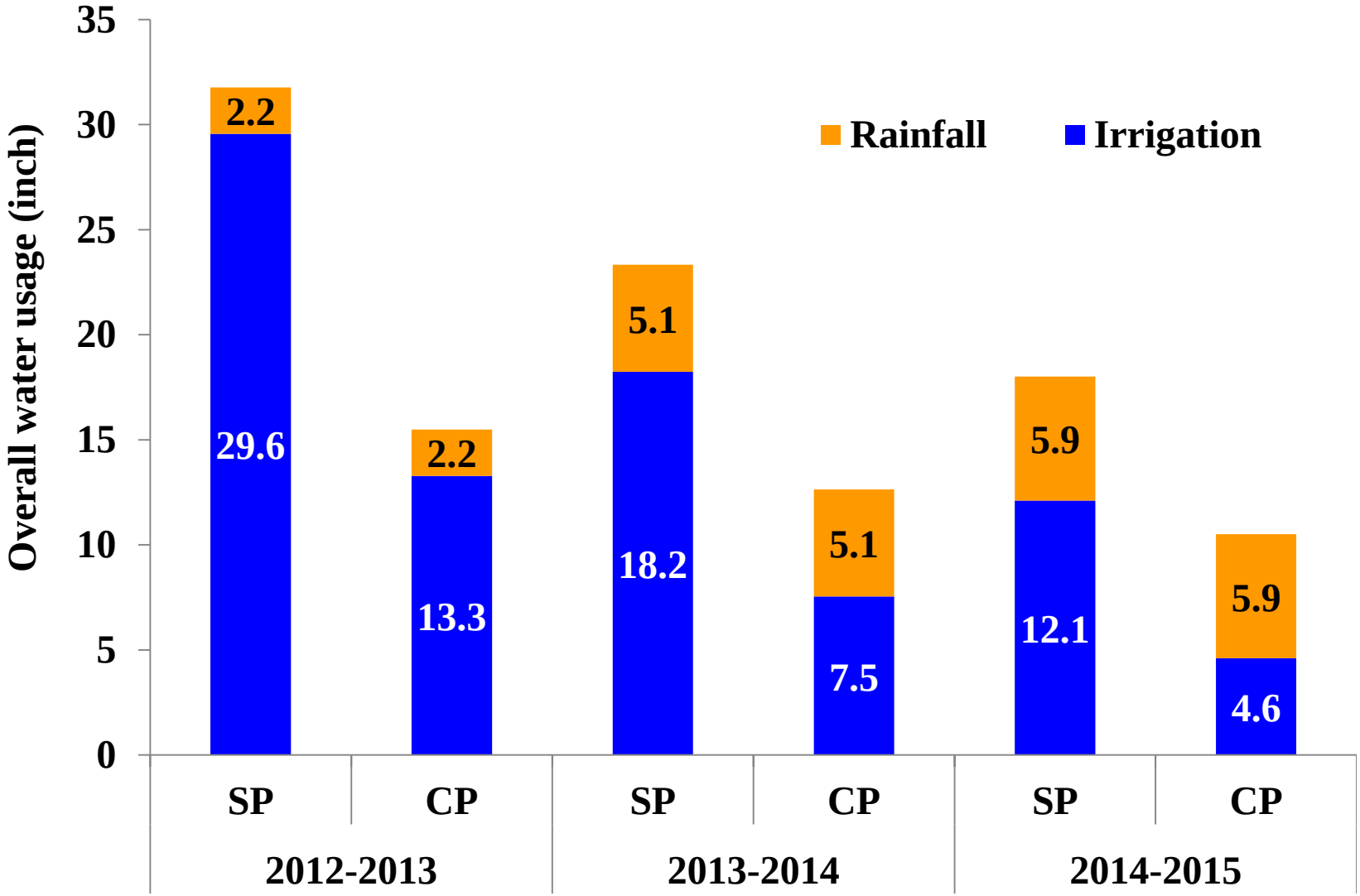

Seepage
Rainfall (inch)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
9-Jan
16-Jan
23-Jan
30-Jan
6-Feb
13-Feb
20-Feb
27-Feb
6-Mar
13-Mar
20-Mar


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

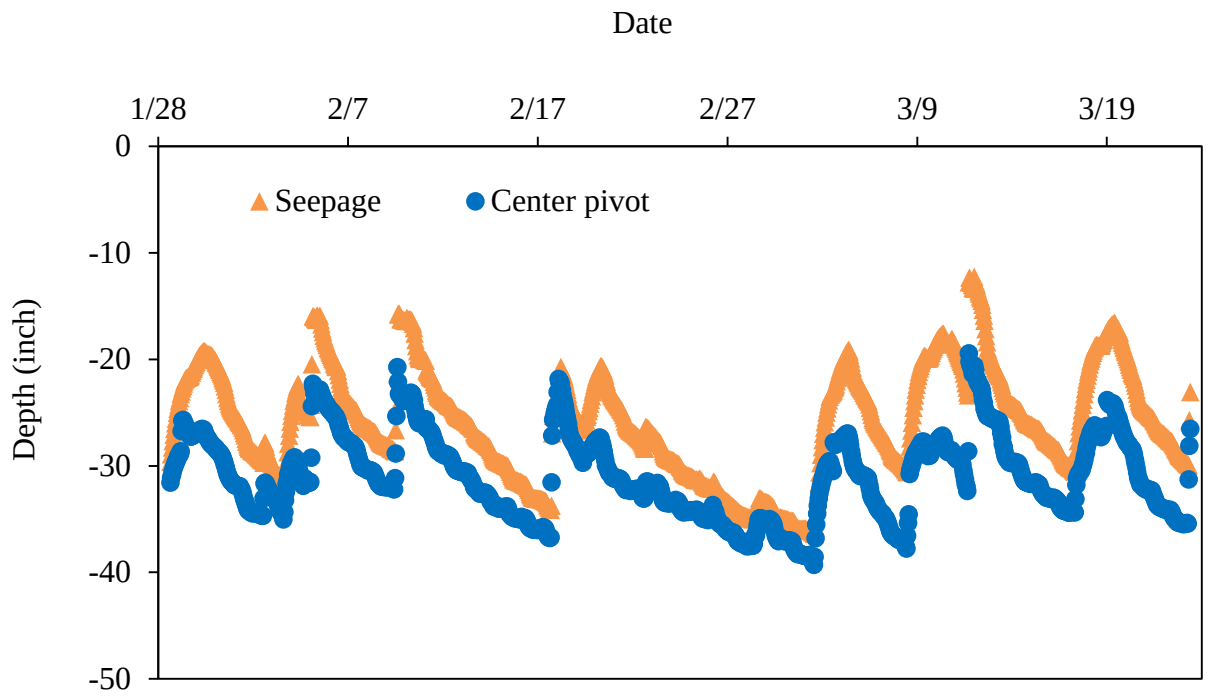
Rainfall and Evapotranspiration (ET)



Overall water usage



Water Table



Pressure transducers

❖ **Seepage plots had higher water tables than center pivot plots.**

Difference in soil moisture

Seepage

Center Pivot

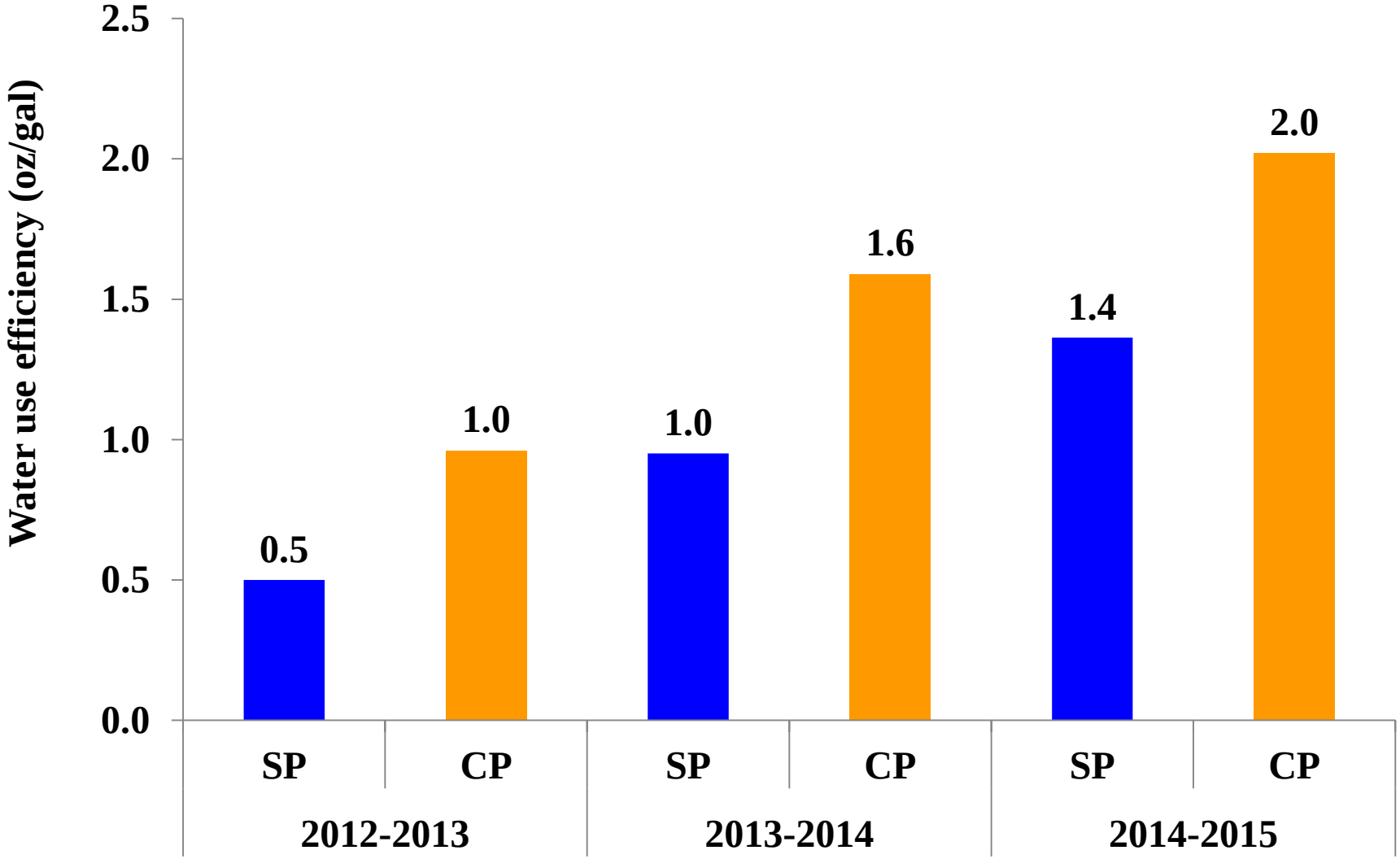
Summary: water usage

- **Seepage**: 543 (329~803) ×1000 gal/A
- **Center pivot** : 231 (125~361) ×1000 gal/A
- **Seepage**: higher water table, dry top soil
- **Center pivot**: lower water table, moisturized top soil

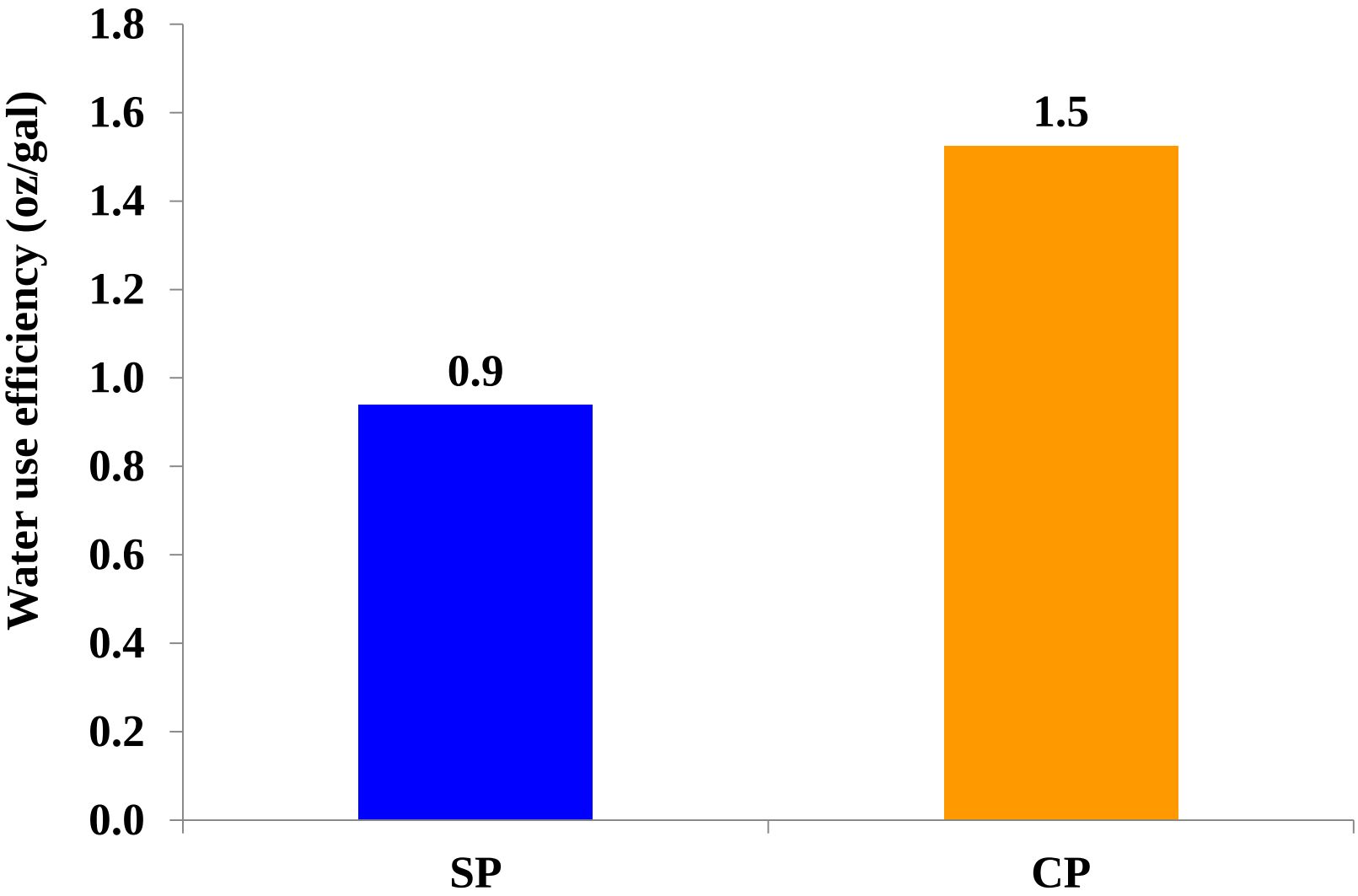
Water use efficiency

$$WUE(oz/gal) = \frac{Tuber(oz)}{Water(gal)}$$

Water use efficiency



Water use efficiency



Summary: water use efficiency

- **Seepage**: 0.9 (0.5~1.4) oz/gal
- **Center pivot**: 1.5 (1.0~2.0) oz/gal
- **Center pivot**: 60% greater than seepage

Water savings

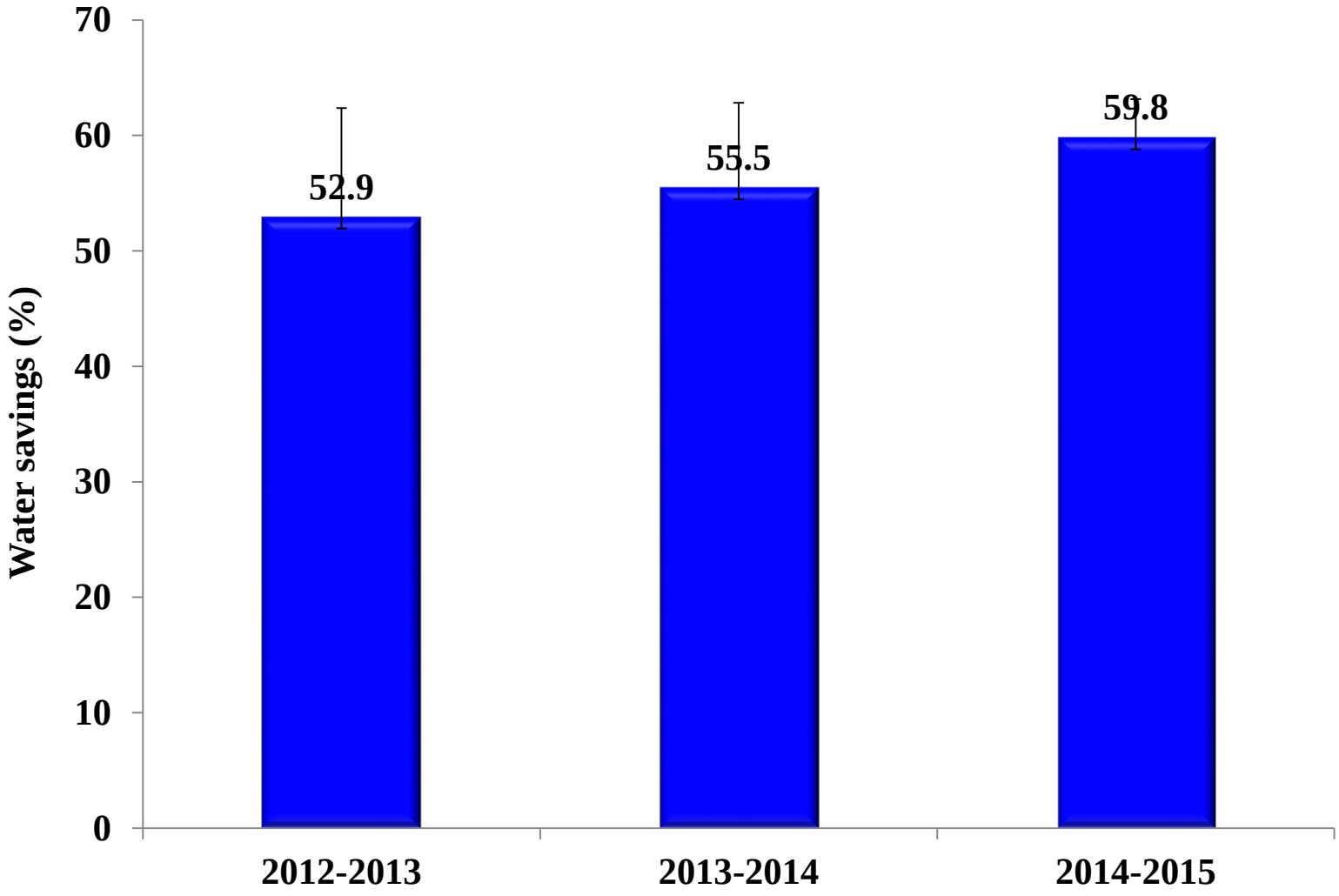
$$WS(\%) = \frac{WU_{SP} - WU_{CP}}{WU_{SP}} \times 100$$

Water savings:

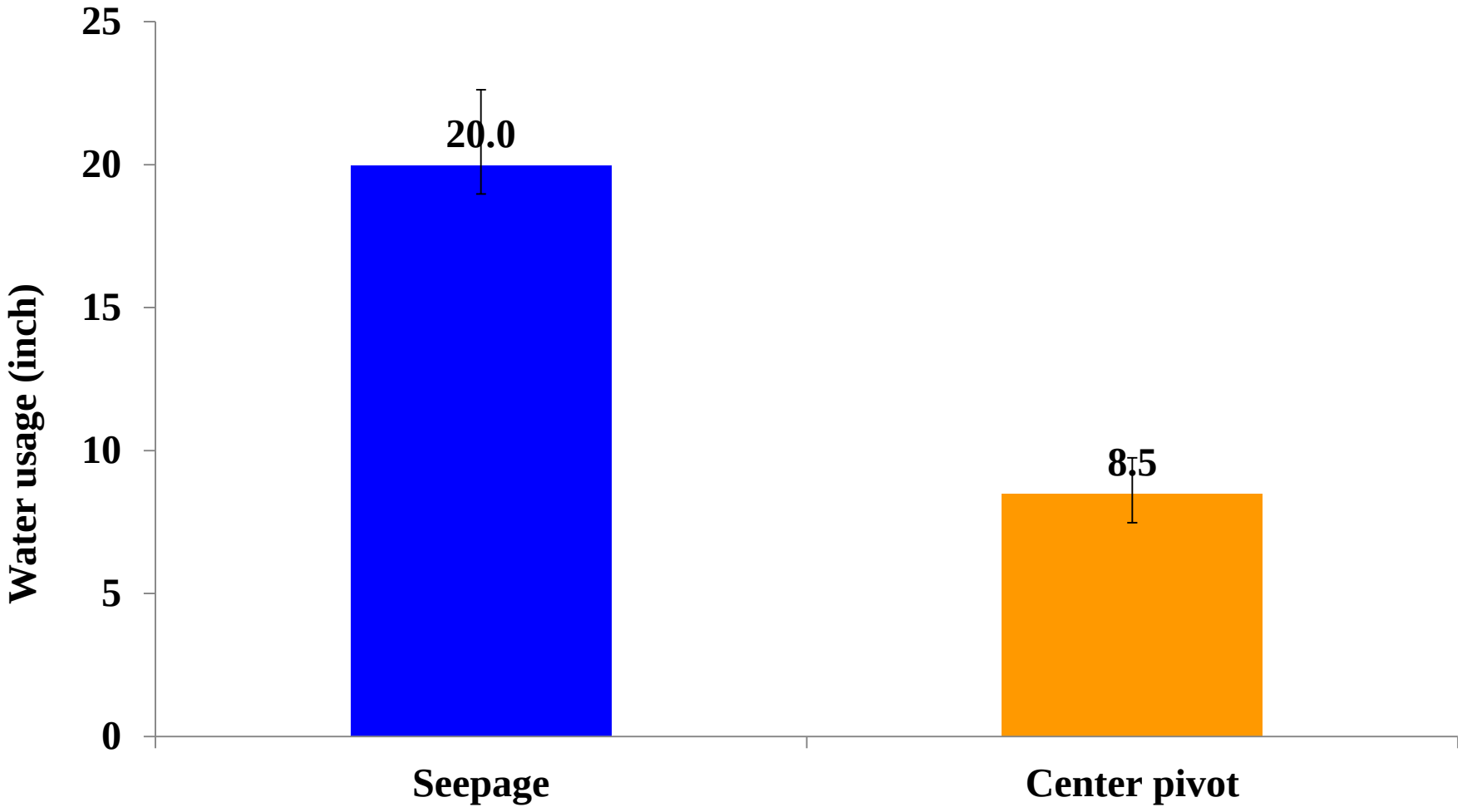
1.0 billion gallons saved!

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**

Water savings: 53-60%



Water savings: 57.5%

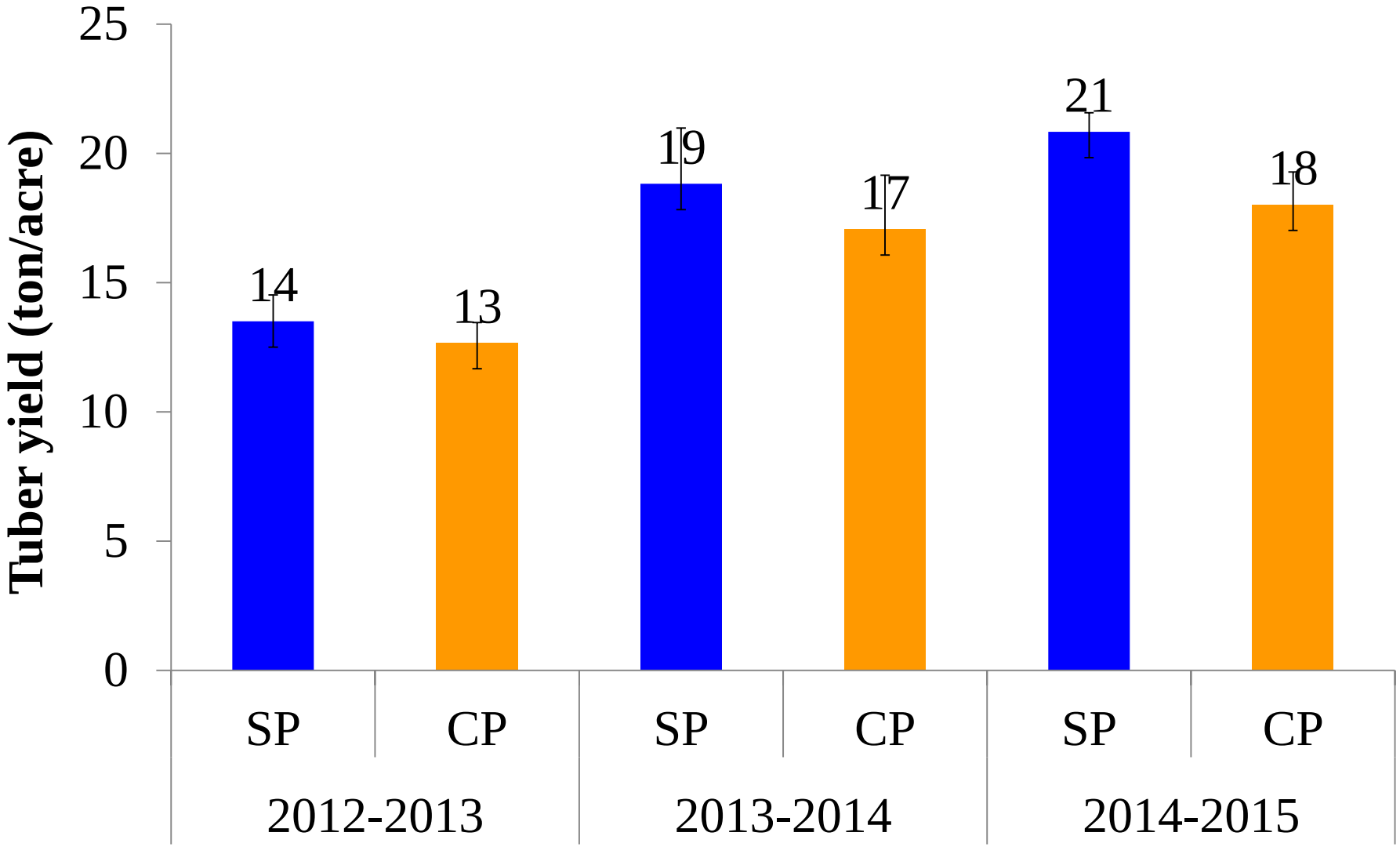


Summary: water savings

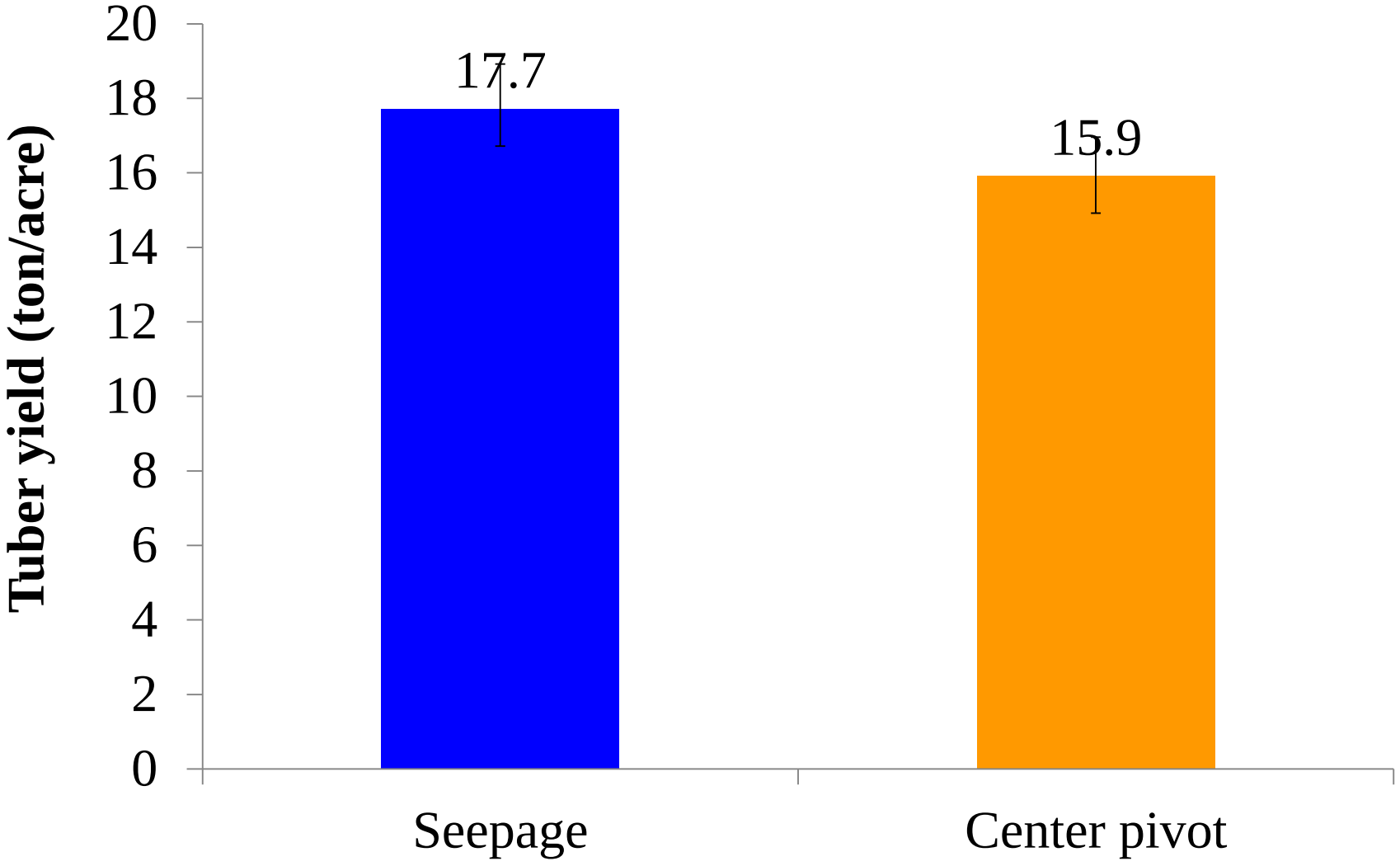
- **The farm**: ~1,000,000,000 gal
- **FL**: potentially~10 billion gal/season
- **Potential savings**: additional 30%

Potato tuber yields

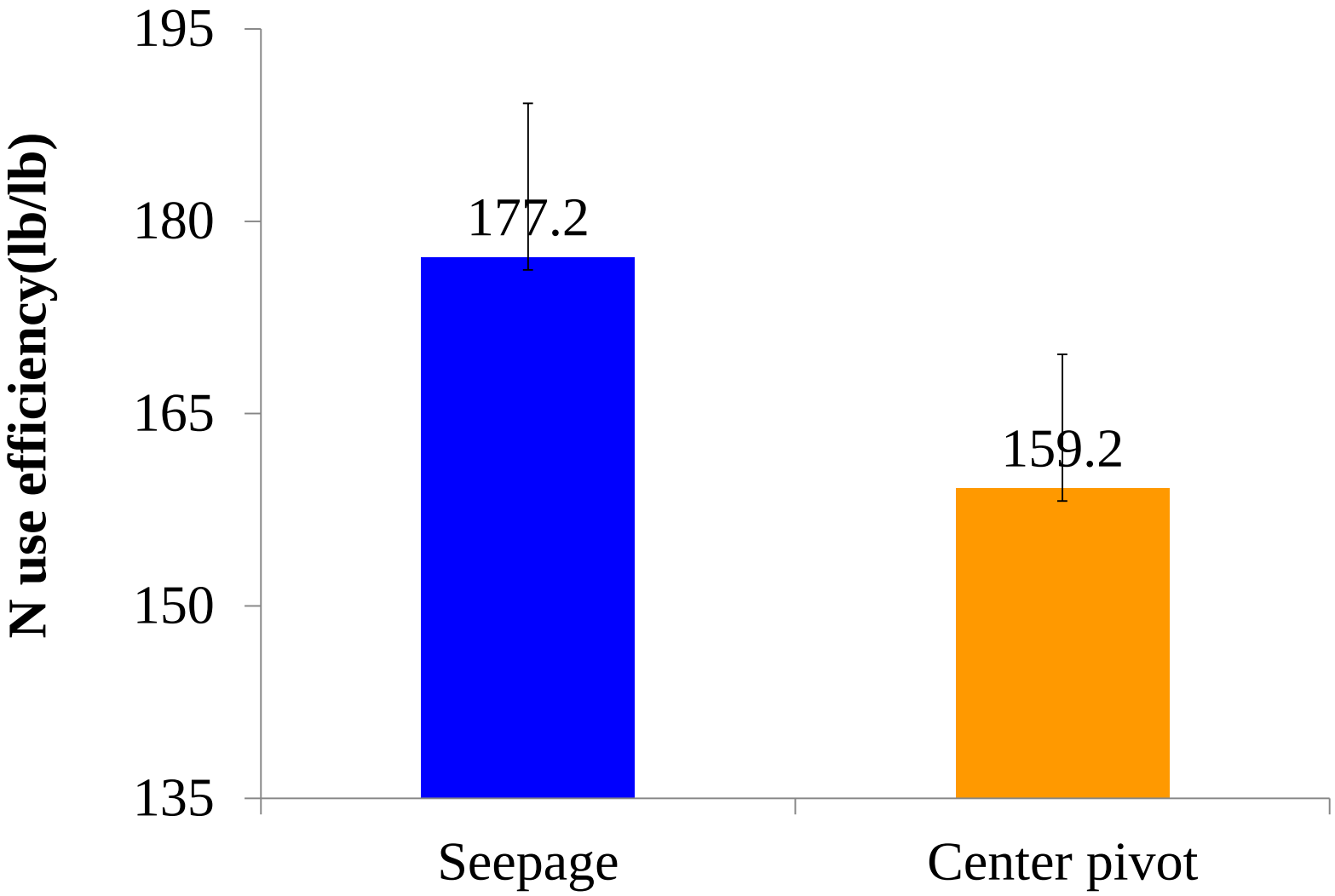
Average tuber yields



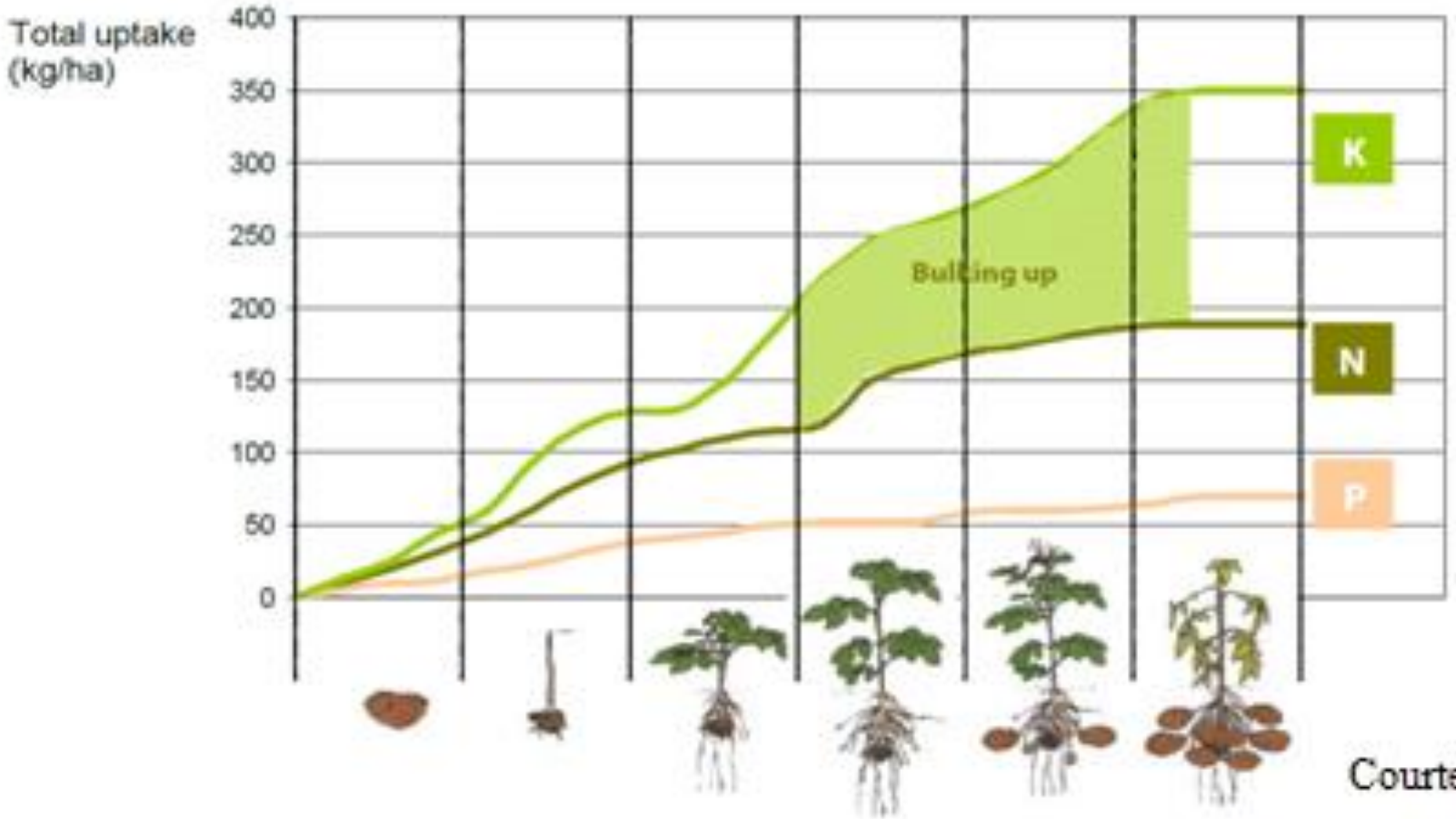
Average yields, 2012-15



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



Uptake of NPK by potato plants and current fertilization practices



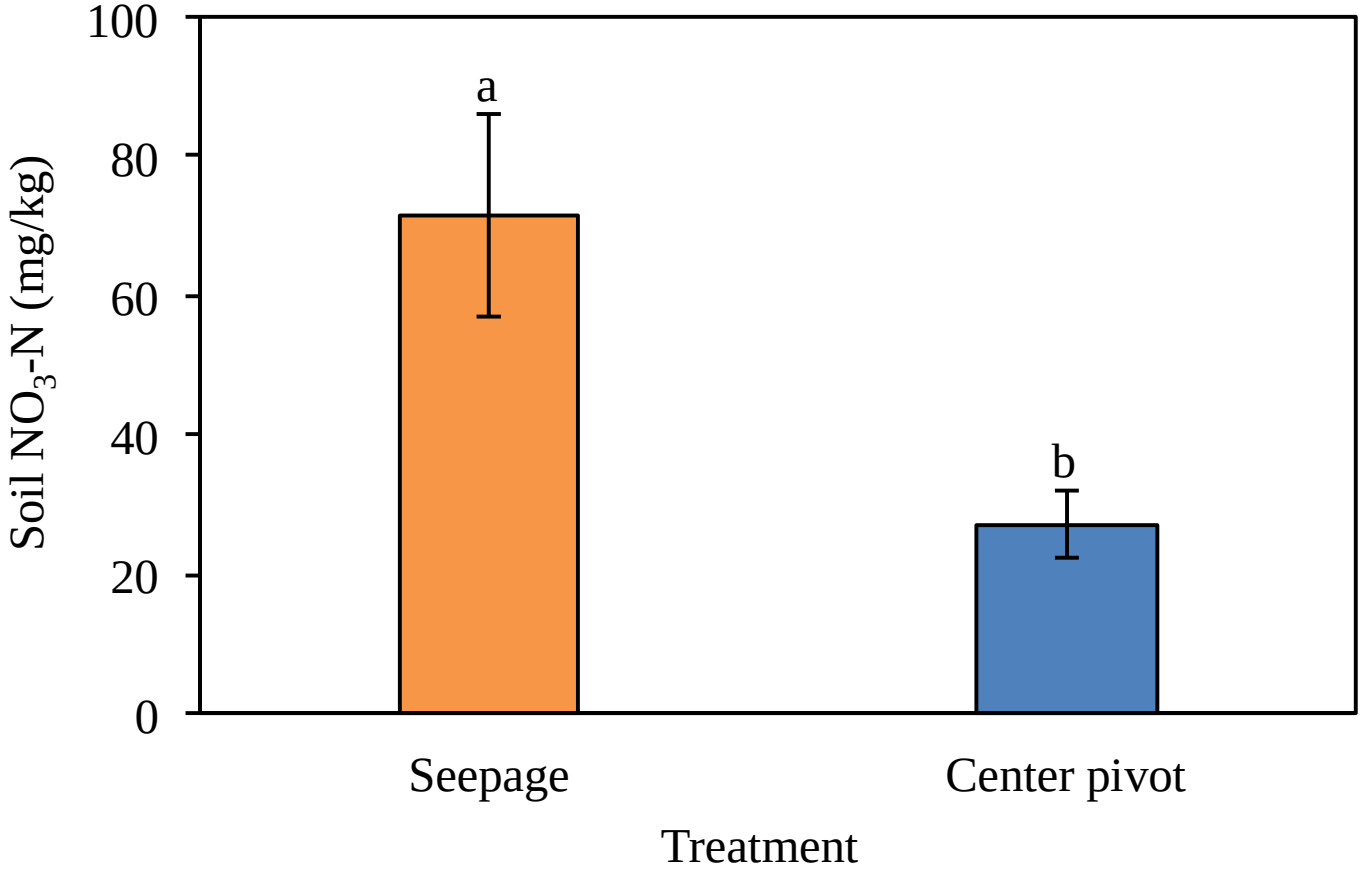
Courtesy of Haifa

Fertilizer program: 40% 60%

Matching plants' need: 1% 20% 41% 38%

planting | Vegetative growth | Tuber initiation & bulking | maturation

Soil NO_3-N level at harvest



Cover crop growth
July 8, 2014

Center Pivot

Seepage

Summary: tuber yields

- **Seepage**: 354 (280~420) cwt/acre
- **Center pivot**: 318 (260~360) cwt/acre
- **Tuber quality**: similar

Conclusions

- The center pivot irrigation saved 57% water.
- Water use efficiency increased by 60%
- N use efficiency reduced 10%
- Fertigation should be adopted to reduce nutrient leaching

Acknowledgements

- Southwest Florida Water Management District
- Mr. Alan Jones, Mr. David Fleming, and Mr. Jesse Cavillo
- Miss Crystal Snodgrass, graduates

Thank You!