Variable Rate Irrigation for Vegetable Production

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Background

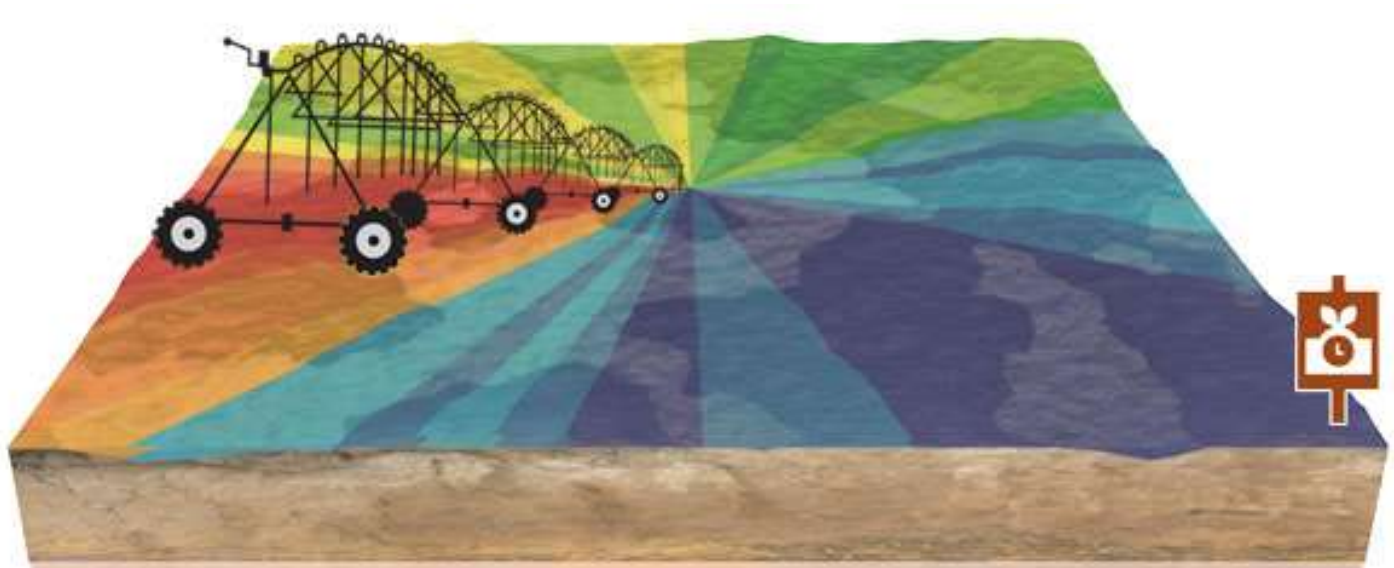
- Agricultural irrigation has been linked to reduced ground and surface water levels in the Central Sands region
- New technologies and strategies that can improve the irrigation efficiency of vegetable cropping systems has become a top priority
- About 99% of Wisconsin vegetable growers are using center pivot irrigation systems, and Variable Rate Irrigation (VRI) has been recently adopted by some pioneers
- Benefits of VRI that have been observed include:
  - up to 25% of water saving on the farm
  - improvement of crop yield and quality at harvest
  - extended storage season

What is Variable Rate Irrigation (VRI)?

- VRI applies water at variable rates rather than one uniform rate along the length of the center pivot
- Varying the moving speed of the pivot or turning on and off individual nozzles
  - Electrical conductivity (EC) mapping or elevation mapping
  - Divide the field into management zones
- VRI can apply water at differing rates to different crops or cultivars, varying soil types, high run-off areas or low areas prone to getting wet and saturated, and environmentally sensitive areas within the field

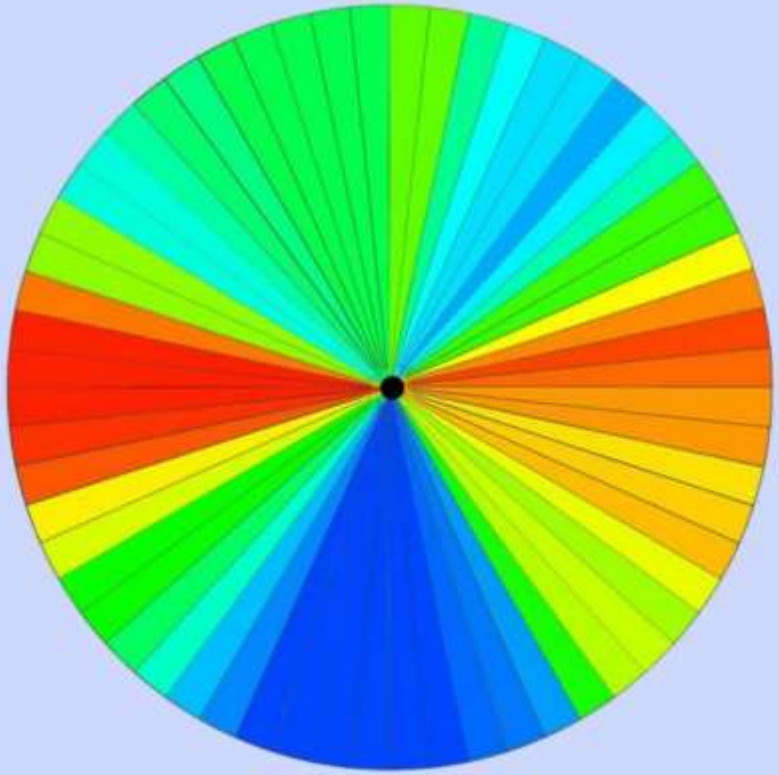
What is Variable Rate Irrigation (VRI)?

- The overarching goal of VRI is to avoid over- and under-irrigation so no water is wasted and no water stress occurs, while crop yield and quality are maintained or increased
- Currently the main hurdle of wide adoption of VRI is the upfront cost, ranging between $5,000 and $50,000 per pivot, and the potential of VRI to improve farm profitability



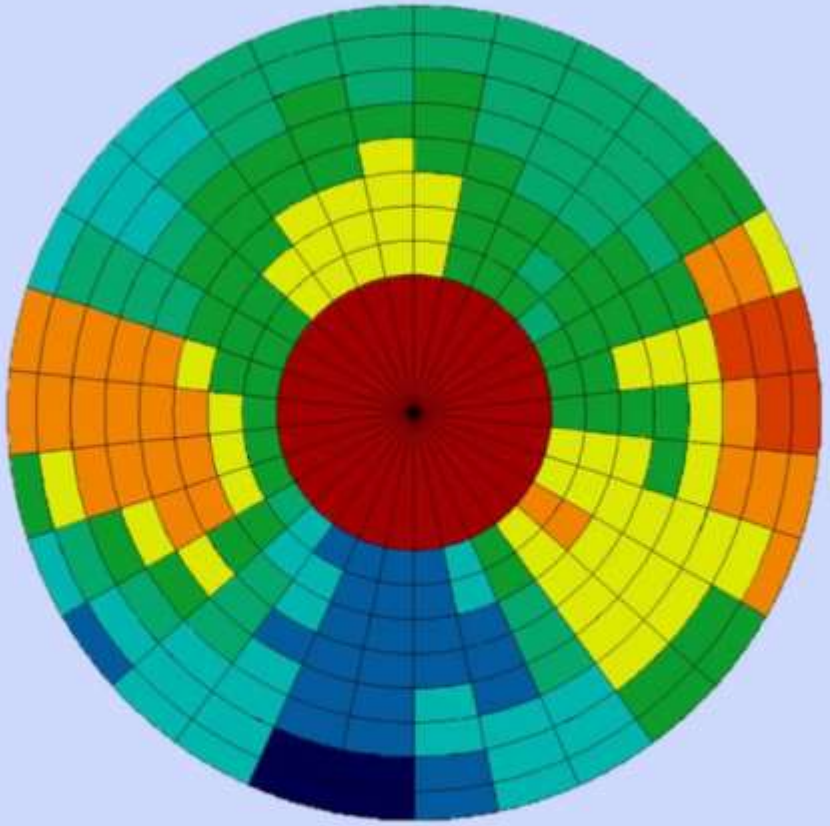
Two types of VRI systems

Speed control



Total Cost: ~$3,000
(free with some new panels)

Nozzle control



Total Cost: ~$16,000+

Summer of 2018

- Objective: evaluating on-farm vegetable production under VRI
- Three commercial fields:
  - Potato field with nozzle control VRI
    - per event, irrigation to driest – to wettest = 0.3’’
  - Potato field with speed control VRI
    - per event, irrigation to driest – to wettest = 0.3’’
  - Snap bean field with nozzle control VRI but didn’t use it
    - every irrigation event was flat rate
- Soil moisture sensors installed within and below rooting zone at the driest (highest) and wettest (lowest) spots on each field

Farm 1 – potato

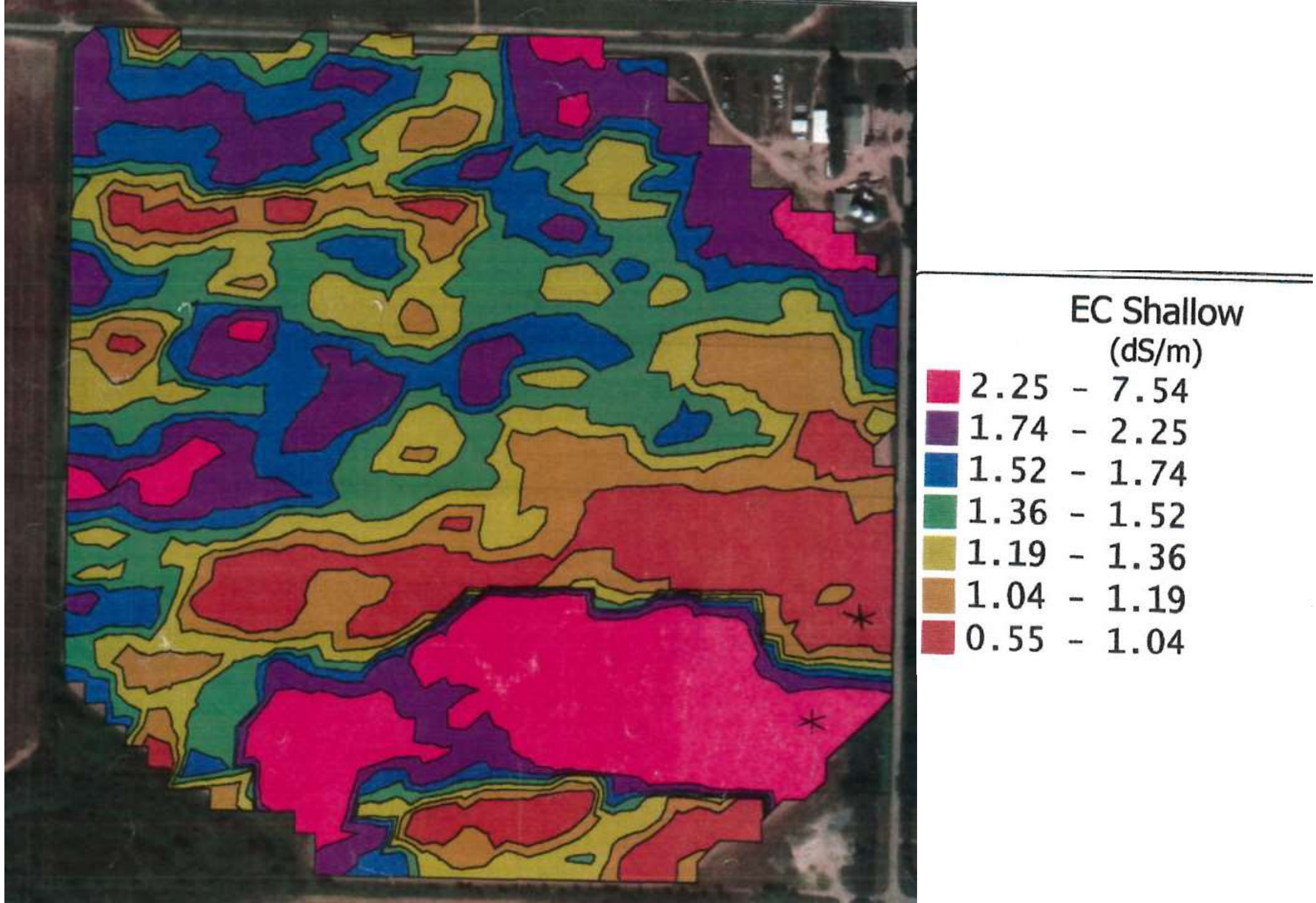
Wettest (lowest) spot right after precipitation

Driest (highest) spot right after precipitation

Farm 2 - potato

Wettest (lowest) spot right after irrigation

Driest (highest) spot right after irrigation

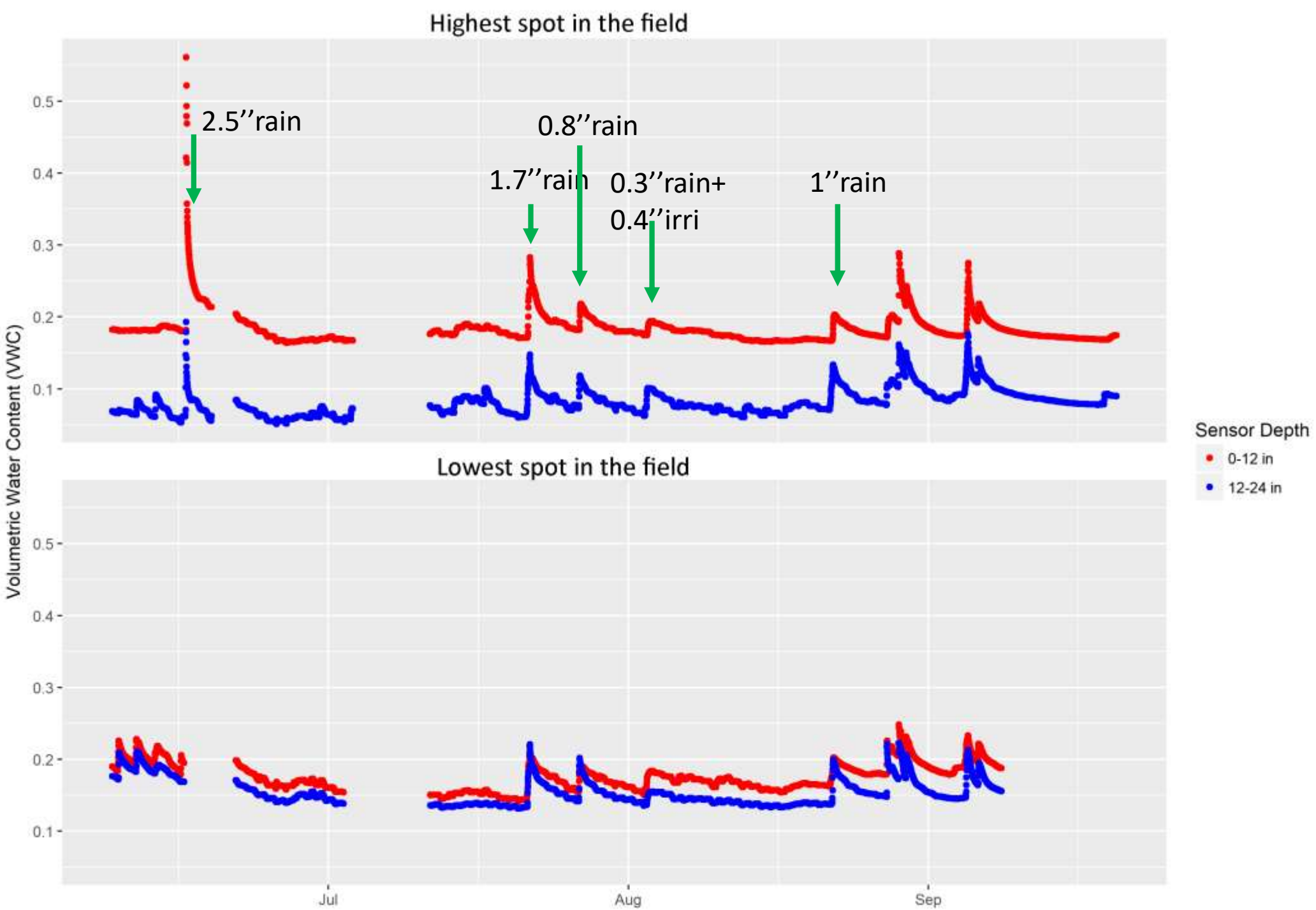

EC Shallow
(dS/m)
2.25 - 7.54
1.74 - 2.25
1.52 - 1.74
1.36 - 1.52
1.19 - 1.36
1.04 - 1.19
0.55 - 1.04

Farm 3 – snap bean

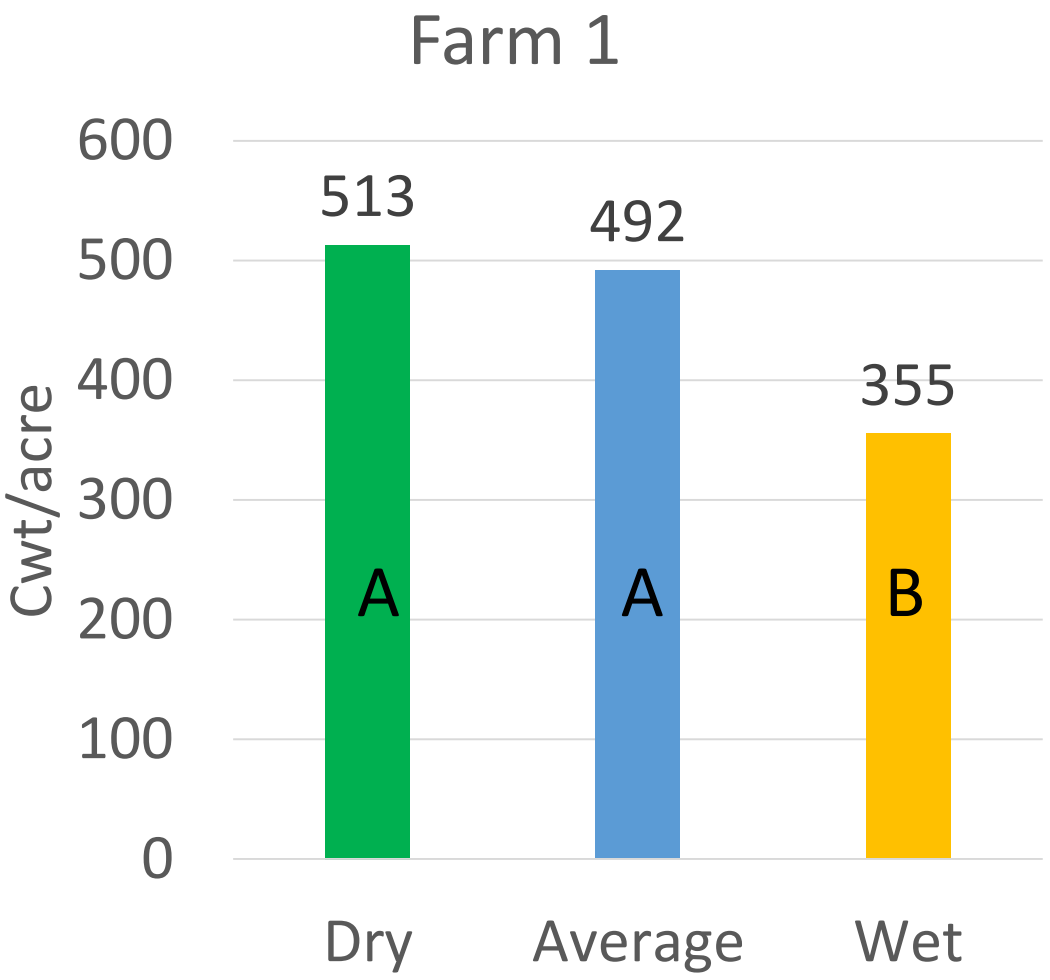
Wettest (lowest) spot

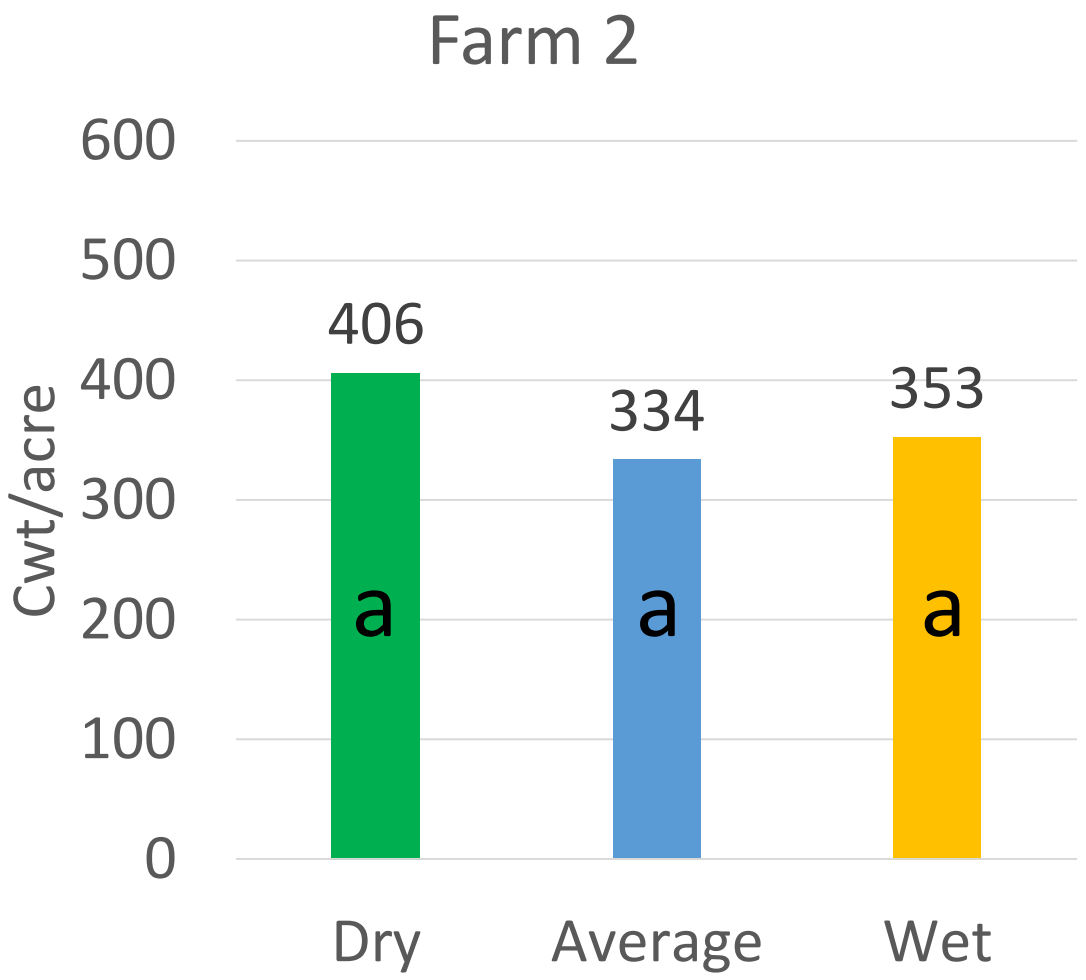
Driest (highest) spot

Farm 1 – potato – nozzle control VRI



Potato yield





Irrigation efficiency and water use efficiency of VRI on Farm 2

- Total irrigation water applied to wet spot 10.6’’
- Total irrigation water applied to average spot and dry spot 16.1’’
- Total rainfall 23.4’’
- About 0.15 million gallons of irrigation water per acre was saved

Spot	IE (cwt/inch irri. water)	
WET	0.123	A
DRY	0.093	AB
AVG	0.076	B

Spot	WUE (cwt/inch irri. + rain water)	
WET	0.038	A
DRY	0.037	A
AVG	0.031	A

Potato quality – specific gravity

Farm 1

Spot	SG
Dry	1.077 A
Average	1.081 A
Wet	1.069 B

Farm 2

Spot	SG
Dry	1.073 a
Average	1.068 a
Wet	1.068 a

Potato quality – length to width ratio (tuber shape)

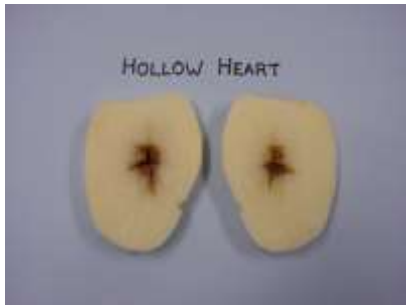
Farm 1

Spot	L/W
Dry	2.14 AB
Average	1.94 B
Wet	2.26 A

Farm 2

Spot	L/W
Dry	1.99 b
Average	1.99 b
Wet	2.34 a

Potato quality – hollow heart



Farm 1

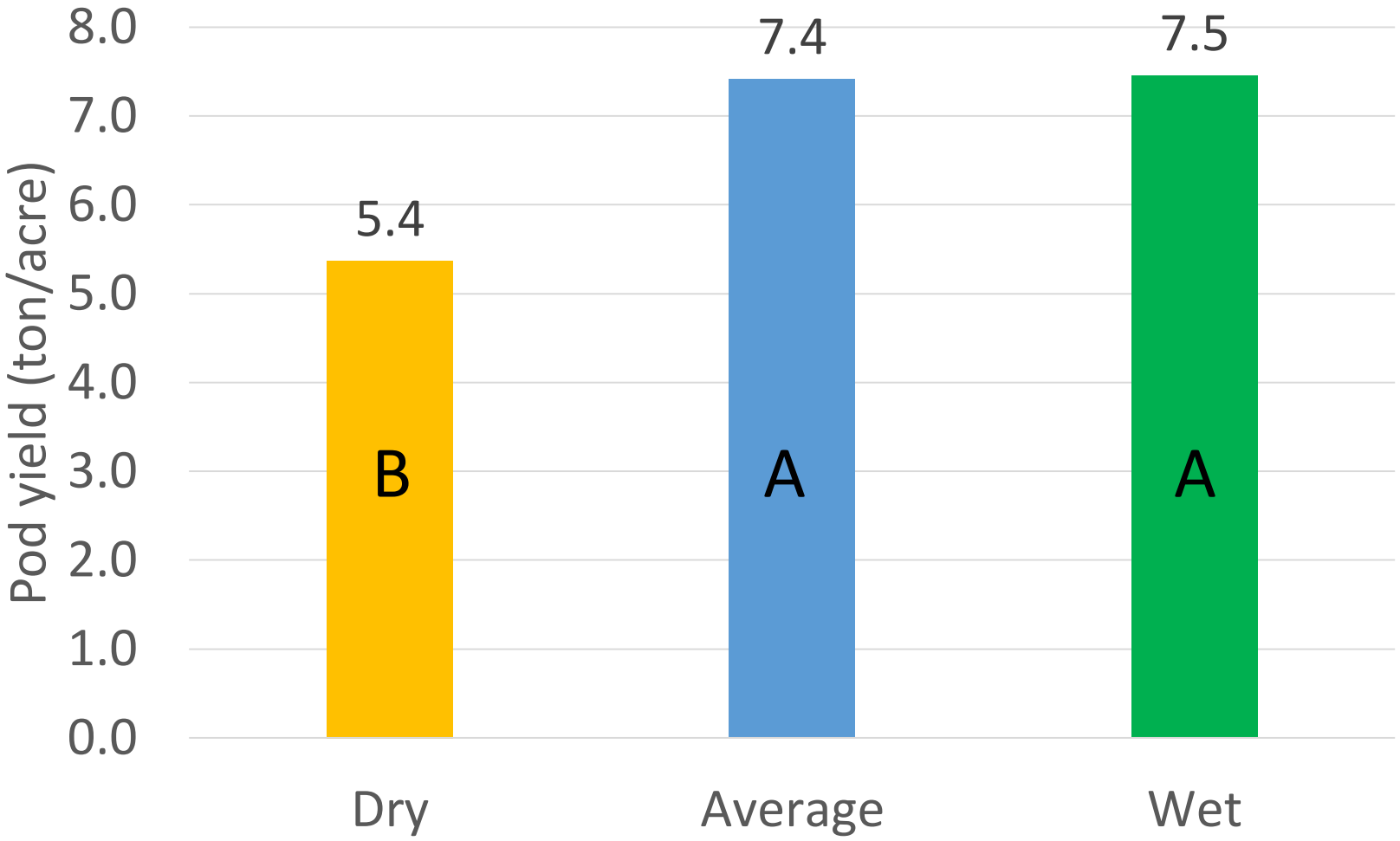
Spot	Hollow heart %
Dry	8% A
Average	13% A
Wet	15% A

Farm 2

Spot	Hollow heart %
Dry	3% b
Average	5% ab
Wet	13% a

Rotting tubers from wet spot

Snap bean yield



Summary so far

- The biggest benefit of VRI is at the driest (highest elevated) spot of the field
  - it can keep soil moisture within the crop rooting zone, and thus avoid yield penalty and quality reduction
- VRI can save water pumping on the wettest (lowest elevated) spot of the field, and thus significantly improve irrigation efficiency
- However the wettest spot of the field is still hard to manage, even with VRI, soils always saturated, tubers always have higher rate of rotting and defect issues
- Future tweaking is needed


THANK YOU