UMass Extension Dual-Use Solar Research

Field Crop Updates

PAC Meeting
September 7, 2022

University of Massachusetts Amherst

Vegetable Crop Site

Lettuce and squash

- **Delayed plantings**
  - Lettuce seed failure; cause external to project
  - Squash planting delayed to July 4th
    - More time than anticipated was needed to rock pick and prepare the field
    - Various states of development as of 9/1/22
      - Not suitable for sampling
- **Focus on protocol optimization**
  - Challenges with crop establishment are not unusual in field research in new systems
  - Shift from full sensor deployment to focus on building and monitoring sensor mounting systems

Vegetable Crop Site

Lettuce and squash

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- **Visualization of shade over bed one**
- *Note: planting refinements needed for even bed spacing next season. Part of year one site optimization efforts.*

Sensor Mounts

Development

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- These sensors are primarily developed and used for stand alone weather stations
- **Step one**: visit the UMass Orchard to learn about their set up and get recommendations about installation, maintenance, & monitoring.

Sensor Mounts

Development

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- **Step two**: build the first prototype, test it in the field, and get feedback from on-campus colleagues

Sensor Mounts

Development

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- **Step three**: get feedback from fresh eyes. Build 5 test mounts with refinements and install in the field.
  - *Pictured: view of sensors facing the vegetable array.*

Sensor Mounts

Development

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- **Step three**: get feedback from fresh eyes. Build 5 test mounts with refinements and install in the field.
  - *Pictured: view of sensors facing the back fence of the vegetable array.*

Sensor Mounts

Hayfield

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- **Step four**: final refinements to mounts based on success/failures with first five installs and initial ~3 weeks of data
  - *Pictured: view of sensors in the hayfield array.*

Sensor Mounts

Hayfield

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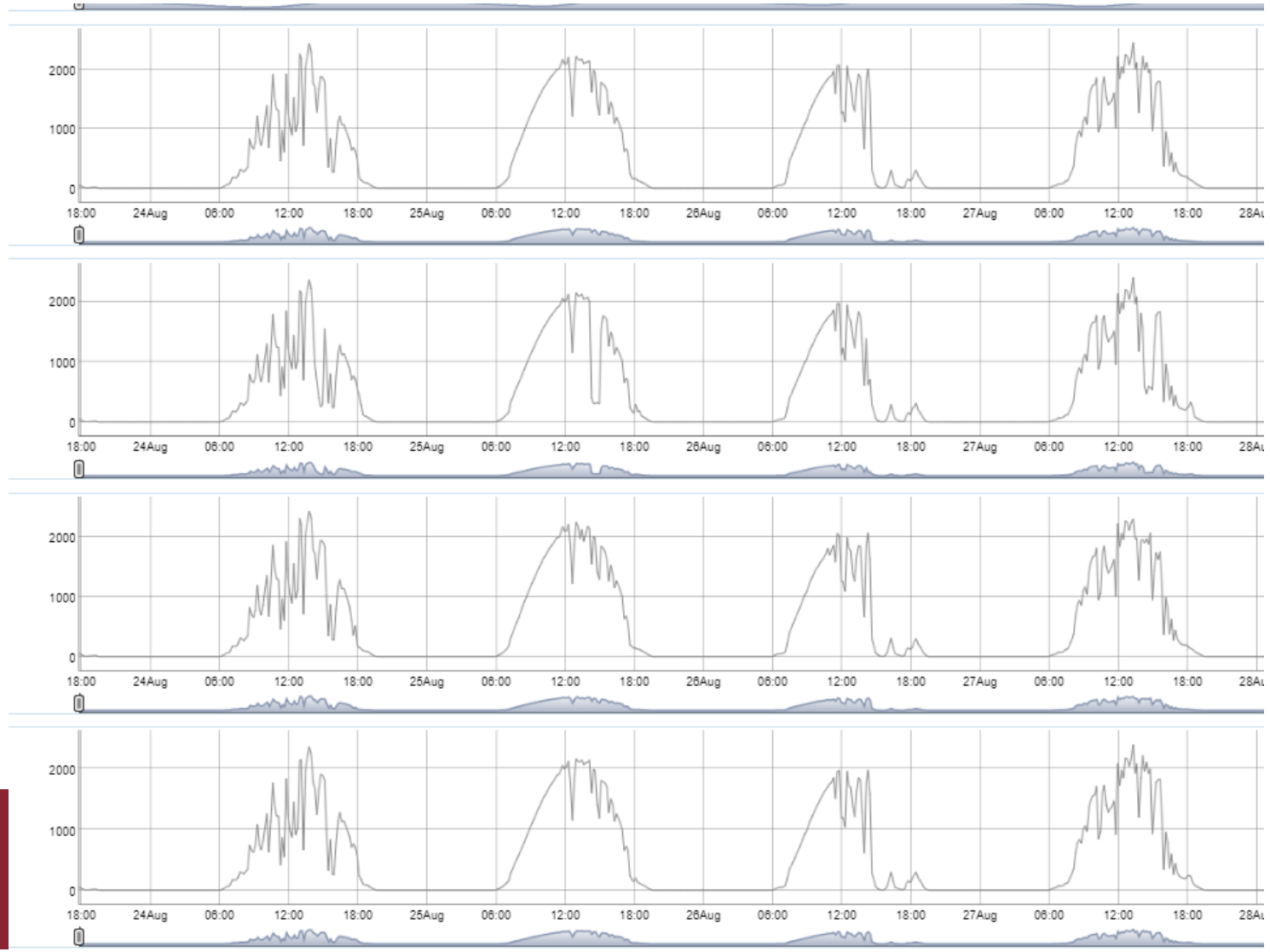
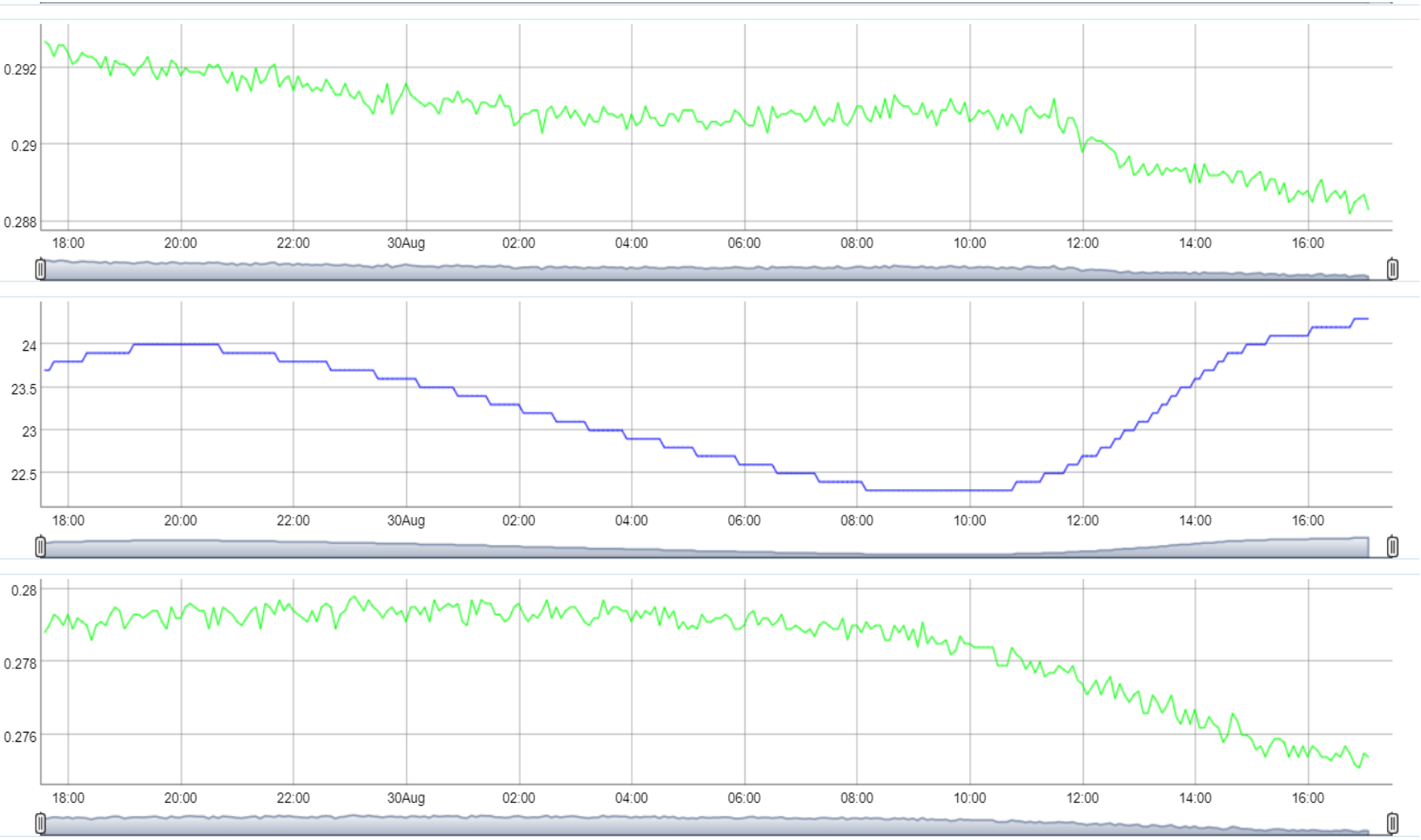
- **Step five**: in progress.
  - Continue to monitor data this fall to make sure the sensor mounting system is optimized for:
    - easy install/easy removal when needed
    - stability
    - accurate data collection
  - 48 mounts will be built this fall for spring installation

Sensor Data



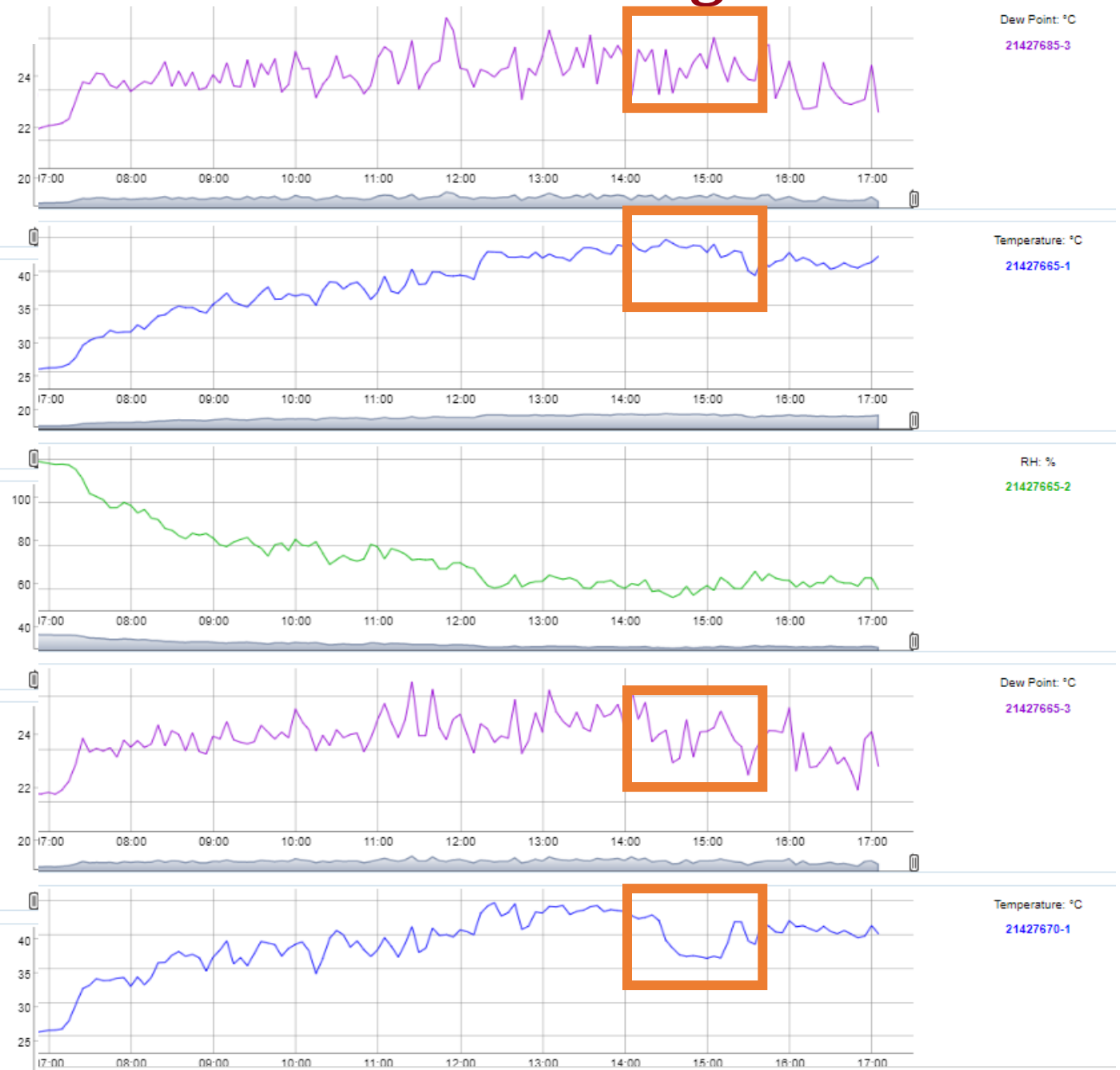
- Example of PAR (light) fluctuations across 4 days
- PAR Unit = µmol/^{2}/sec
  - µmol = micromoles, a measurement of photons (light particles)
  - PAR = the light that plants can use for photosynthesis

Sensor Data



- Example of natural soil moisture variation (green line)
  - Measured as volumetric water content (m^3/m^3),
- Lots of variation just a few feet apart.
- Data in the control area is used to determine the “normal” amount of variation

Sensor Troubleshooting/Verification



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- Small difference in temperature (blue line) observed between sensors 7 feet apart.
  - Cloud passing by? Bird sitting on the sensor?
  - Temperature and RH (green line) are used to calculate dew point.
  - Site visit to check the sensor mount and housing

Sensor Troubleshooting/Verification

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- Small difference in temperature (blue line) observed between sensors 7 feet apart.
  - Cloud passing by? Bird sitting on the sensor?
  - Temperature and RH (green line) are used to calculate dew point.
  - Site visit to check the sensor mount and housing
  - **Turns out – the PAR sensor AND the ambient temp & RH sensor were being shaded part of the day by a panel.**

Pasture & Grazing Site

- **6 cows brought on site in July**
  - 5 females and 1 male; spring calving expected
- **Perennial pasture establishment in process**
  - The pasture was seeded with annual grazing crops in the spring
  - Currently working with the farmer to determine plans for establishing perennial pasture
  - Sensors will be deployed after perennial pasture establishment
    - Sensors will be surrounded be electric fencing
    - Sensors will not be moved once installed
    - The area around sensors will be maintained with a weed whacker

Hayfield Site

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- Currently testing sensors.
- Took 1st cut samples in array only
- Awaiting 2nd cut

July 7: first cut in progress (late)

Sept 1: drought & heat has greatly hampered regrowth

Soil Health & Fertility Baseline Samples

Before construction

iain@solaragservices.com

Field ID: Know-VegE1
Date Sampled: 01/15/2021
Given Soil Type: 305C
Crops Grown: GRT/GRT/GRT
Tillage: no till
Coordinates: Latitude: 42.223566670000
Longitude: -71.661875000000

Measured Soil Textural Class: **sandy loam**

Sand: **47%** - Silt: **47%** - Clay: **4%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	0.33	99	
physical	Surface Hardness	300	5	Rooting, Water Transmission
physical	Subsurface Hardness	464	6	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	70.6	98	
biological	Organic Matter Total Carbon: 2.55 / Total Nitrogen: 0.23	4.0	85	
biological	ACE Soil Protein Index	10.4	88	
biological	Soil Respiration	0.6	47	
biological	Active Carbon	662	80	
chemical	Soil pH	6.4	100	
chemical	Extractable Phosphorus	6.2	100	
chemical	Extractable Potassium	75.7	100	
chemical	Minor Elements Mg: 113.6 / Fe: 20.0 / Mn: 1.4 / Zn: 0.7		100	

Overall Quality Score: **76** / High

After construction

Agricultural Service Provider:
Julie Fine
AFT Solar Farms
jfine@farmland.org

Crops Grown: GRE/GRE/SQW
Tillage: 7-9 inches
Coordinates: Latitude: 42.220403400000
Longitude: -71.663128700000

Measured Soil Textural Class: **silt loam**

Sand: **34%** - Silt: **52%** - Clay: **12%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	0.25	92	
physical	Surface Hardness	48	91	
physical	Subsurface Hardness	475	5	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	51.3	87	
biological	Organic Matter Soil Organic Carbon: 2.54 / Total Carbon: 2.54 / Total Nitrogen: 0.19	4.0	87	
biological	Predicted Soil Protein	8.90	76	
biological	Soil Respiration	0.4	22	
biological	Active Carbon	432	35	
chemical	Soil pH	5.5	7	Low pH: Toxicity, Nutrient Availability (note exception for acid loving crop species)
chemical	Extractable Phosphorus	5.3	100	
chemical	Extractable Potassium	58.5	83	
chemical	Additional Nutrients Ca: 392.7 / Mg: 51.0 / S: 12.0 Al: 195.4 / B: 0.05 / Cu: 0.26 Fe: 30.1 / Mn: 5.3 / Zn: 0.9		55	

Overall Quality Score: **62** / High

Soil Health & Fertility Baseline Samples

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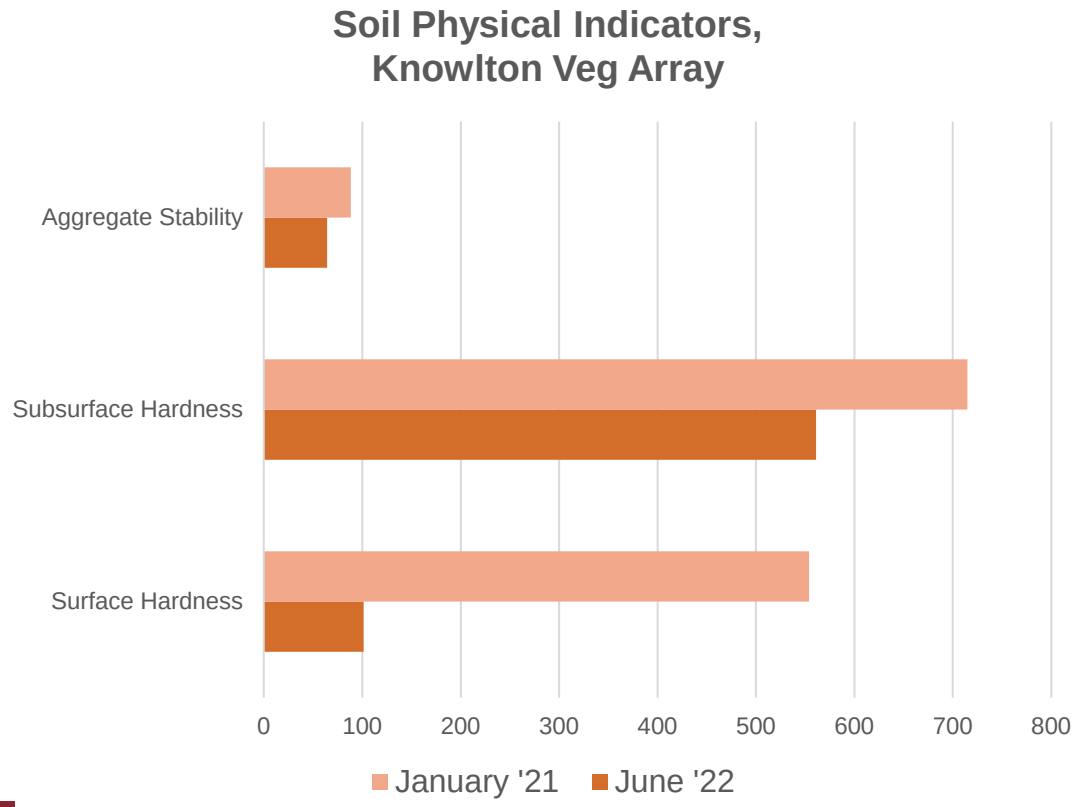

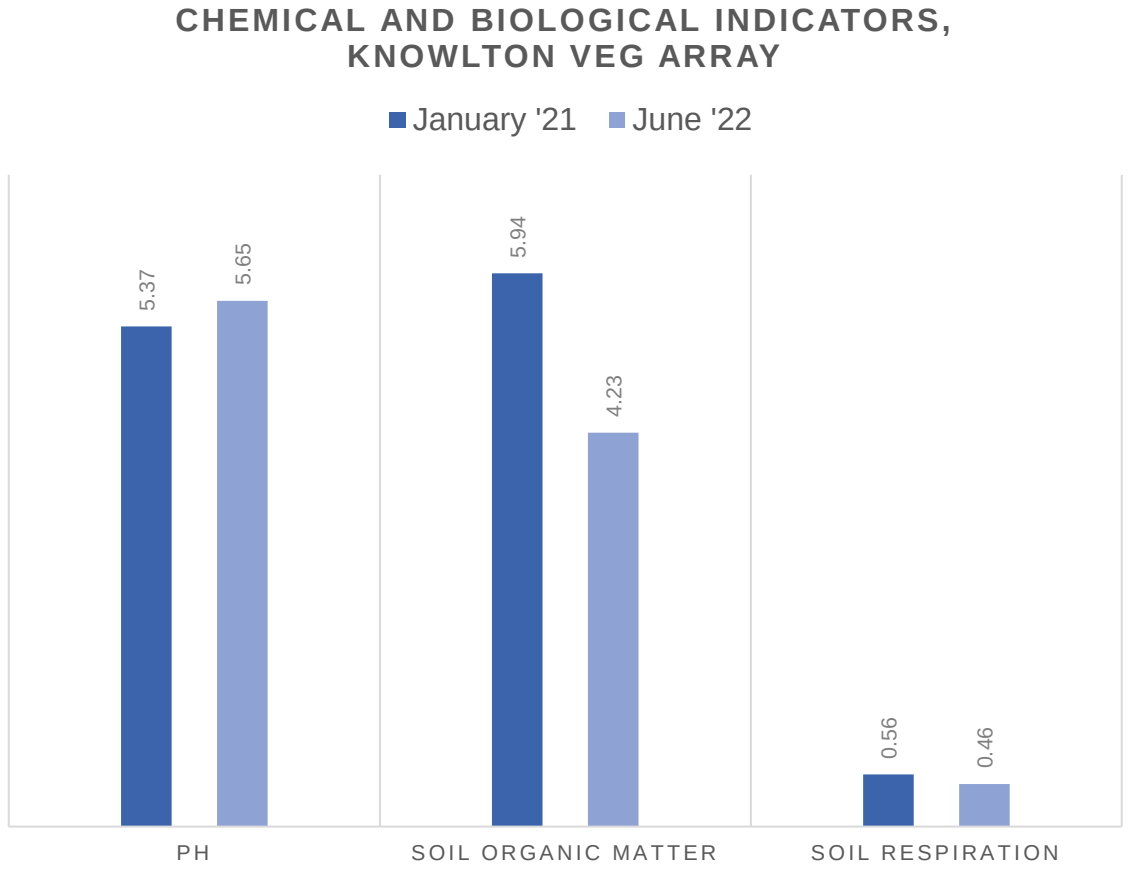

Ask of the PAC + Q&A

- **Consider the "nitty gritty" questions that you would like to be answered by our data set**
  - We measure light, air temp, relative humidity, dew point, rain fall, soil temperature, soil moisture, and leaf wetness in addition to plant yield & quality + soil health & fertility.
  - Basic example
    - How is each parameter different under solar panels versus not under solar panels?
    - Can crops grow successfully underneath solar panels?
  - More complex examples:
    - Is the shading effect of solar panels (light) offset by reduced heat stress to plants (air temperature and soil temperature)
    - Does the shading from panels improve water retention in some areas and exacerbate drought in others?
    - Are changes to rainfall associated with significant patterns of variation in soil nutrients that could affect soil sampling protocols and nutrient management recs?
    - If periods of leaf wetness are increased, are the observed periods of leaf wetness consistent with known periods of leaf wetness likely to result in the proliferation of common plant diseases?