Lessons Learned from a Full Year of Measured Soil Health, Economic, and Social Indicators from 13 Conservation Innovation Grant On-Farm Demo Trials in California, Kentucky, New York, Massachusetts, & Connecticut

Co-Authors

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- **Dr. Bianca Moebius-Clune –** Co-PI & Climate Initiative Director
- **Dr. Rachel Seman-Varner –** Soils Team Lead & Sr Soil Health & Biochar Scientist
- **Dr. Gabrielle Roesch-McNally –** Social Team Lead & Women for the Land Director
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- **Ellen Yeatman –** Economics Team Manager & Water Scientist & Ag Economist
- **June Grabemeyer –** Consulting Economist
- **Aaron Ristow –** NY State Lead & NY Ag Stewardship Program Manager
- **Scott Franklin –** KY State Lead & Southeast Regenerative Ag Program Manager
- **Caro Roszell –** New England State Lead & Soil Health Specialist
- **Paul Lum** – California State Lead & CA Ag Specialist

Symposium by
American Farmland Trust
SWCS Denver, CO
August 2, 2022
10:30 am to 12 pm MST

AFT's soil health demo trial team

CALIFORNIA	KENTUCKY	NEW YORK	MA & CT








Former team members :

- Jennifer Moore –Co-PI / Climate Director
- Shelby McClelland –Soils Manager / SH Specialist
- Emily Cole –MA & CT State Lead / Deputy Director
- Alli Fish – Soils Manager / SH Specialist
- Krista Marshall – CA Conservation Technician

Contractors:

- CA – Project Apis M.
- KY – Craig Givens, District Conservationist, NRCS (retired)
- NY – Jodi Letham, Cornell Cooperative Extension
  & David DeGolyer, Western NY Crop Mgt Association
- MA –Arthur Siller & Masoud Hashemi, UMASS

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Session agenda

1. Welcome, Introductions, Agenda, About the Project (Michelle, 10 min)
2. Social results (Gabrielle via video, 10 min)
3. Soils results (Aysha, 20 min)
4. Economics results (Ellen & June, 10 min)
5. Coming up: Field Day (Aaron, 3 min)
6. Farmer Experiences & Lessons Learned (Aaron, Scott, & Ellen, 15 min)
7. Q&A + Discussion (20 min)

A cover crop mix flourishing between almond tree instead of bare soil

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ABOUT THE PROJECT

Agricultural-environmental-economic challenges we're addressing

- Soil health degradation is a major global concern threating soil biological function, crop productivity, food security, water quality, biodiversity, & climate
- Agriculture is a leading cause of water quality impairment in 70% of US waterbodies[1]
- Agriculture contributes 11%[2] of U.S. GHG emissions
- Only 5% of fields grow cover crops[3]; only 20% of commodity crop acres use no-till consistently[4]; only 6% of corn acres use 4R nutrient management consistently[5]
- Major barriers: short-term management challenges & unknown economic effects

Very platy soil structure, a sign of compaction & an indicator for soil degradation found on a New England dairy farm by Caro Roszell during IFSHA

(1) EPA, Year (2) EPA US GHG Annual Report, 2020, (3) Census of Ag, 2017, (4) Claussen et al., 2018, (5) Claussen et al., 2018

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Seeking solutions thru AFT's OFDT project

- Well managed cover crops reverse soil degradation; build soil health, resilience, nutrient cycling and availability; reduce nutrient loss, input requirements; but are not planted on most crop acres
- AFT estimated that increasing cover crop adoption to 44.4 M acres could reduce CO_2 emissions by 14.5 million MT CO_2e annually

  (Developing a USDA Cover Crop Initiative)
- Conservation Innovation Grant - SHDT sub-priorities (2020)
  - Aid transition to full SHMS, adapted to regional systems
  - Focus on cover crop management in challenging systems
- SHDT Evaluations and Study
  - Current and historic management
  - Minimum dataset
  - Economic and social evaluation
  - Historically underserved producers

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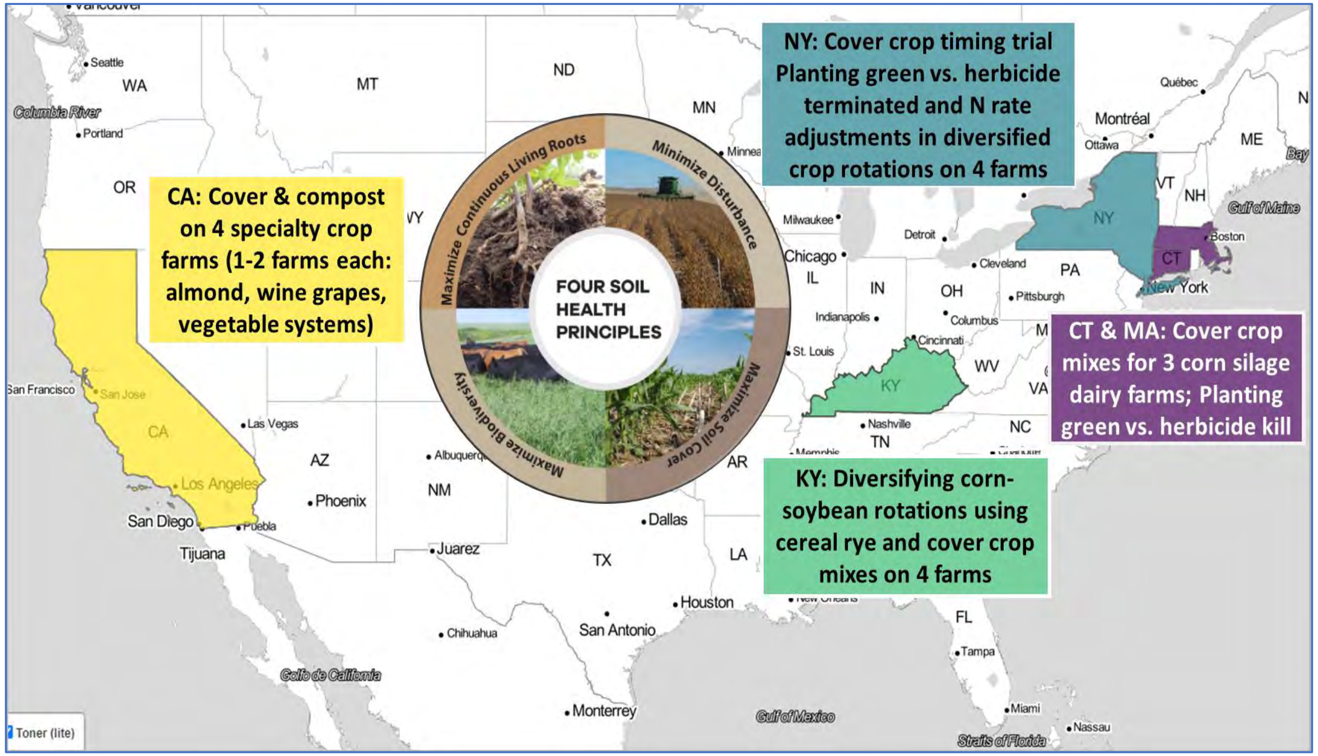
About AFT’s OFDT project: “Conquering Cover Crop Challenges from Coast to Coast”

- We are identifying, documenting, evaluating, supporting & showcasing **farmer-driven transitions** to improving soil health thru adoption of cover crops & other soil health practices
- Our project includes 15 farms in 3 geographic regions & 5 states (CA, KY, NY, MA, & CT), representing 6 crop systems:

Almonds	Corn-soybeans-wheat
Wine grapes	Corn silage diversified crops
Vegetables	Corn silage



***Regional issues & cropping system challenges**: soil moisture management, planting & termination timing in crop rotations, termination methods, & cover crop mixes*

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About our CA growers & their soil health practices

Farm Name (farm code)	Production	Design	Control, acres	Treatment A, acres
Bullseye Farms (CA1)	Tomatoes- sunflower-barley	1 Split Field, No Replicates	No cover crop, 54	Cover crop (bean, vetch mix), 52
Gemperle Family Farms (CA2)	Almonds	2 Fields, No Replicates	No cover crop, 12	Cover crop (bean, vetch mix), 9.3
Glendale Ranch Vineyard (CA3)	Wine grapes	2 Fields, No Replicates	No cover crop, 6.7	Cover crop (triticale, beans, peas and brassicas) and reduced tillage, 8.6
Hwang Farm (CA5)	Mixed Vegetables	1 Field, 2 Replicates	Rotational planting, 0.8	Rotational planting with compost application, 0.8

***Regional cover crop issues**: water availability, pest management, field hygiene, field access, frost damage, residue management, opportunity costs*

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About our KY growers & their soil health practices

Farm Name (farm code)	Production	Design	Control, acres	Treatment A, acres	Treatment B, acres
Mount Folly Farm, (KY1)	Corn-soybean-rye-sunflower-hay	1 Field, 3 Replicates	Cover crop cereal rye, conventional tillage, 14 total	Cover crop mix, conventional tillage, 14 total	Cover crop mix, no-till, roller-crimping, 14 total
Walnut Grove, (KY2)	Corn-soybean-wheat	1 Split Field, No Replicates	Corn-soybean-wheat rotation, 25	Cover crop mix after soybeans, 25	N/A
Pleasure View Farm, (KY3)	Corn-soybean-wheat	2 Fields, No Replicates	Winter wheat, cover crop after soybean, fallow after corn, 9	Cover crop mix after soybeans and corn, 18	N/A
Chris Pierce Farms (KY4)	Corn-soybean-wheat	1 Field, 2 Replicates	Soybean, Cover crop mix, 11 total	4-yr rotation with high biomass summer cover crop, 11 total	N/A

***Regional cover crop issues**: Termination timing, soil moisture conditions, nitrogen needs for cash crop, increased labor and management costs*

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About our NY growers & their soil health practices

Farm Name (farm code)	Production	Design	Control, acres per block	Treatment A, acres	Treatment B, acres
Swede Farm (NY1)	Soybean-wheat-corn silage-grain corn-sweet corn	1 Field, 3 Randomized Replicates	No cover crop, 6	6- and 3-way Cover Crop mixes, 6	6- and 3-way Cover Crop mixes, planting green w late termination, 6
Macauley Farms (NY2)	Corn-soybean-wheat	1 Field, 3 Randomized Replicates	No cover crop, 2.25	6- and 3-way Cover Crop mixes, 2.25	6- and 3-way Cover Crop mixes, planting green w late termination, 2.25
Mulligan Farm (NY3)	Alfalfa-corn silage-wheat	1 Field, 3 Randomized Replicates	Cover crop, herbicide termination timing and cash crop planting, 3.7	Cover crop, planting green w/ herbicide termination at post-cash crop planting, 3.7	Cover crop, planting green using mechanical termination at cash crop planting, 3.7
HarGo (NY4)	Triticale-corn silage-soybean-sorghum	1 Field, 3 Randomized Replicates	No cover crop, 0.75	6- and 3-way Cover Crop mixes, 0.75	6- and 3-way Cover Crop mixes, planting green w late termination, 0.75

***Regional cover crop issues**: planting cash crops through cover crop residues, planting too early, or yield declines due to heavy spring rains*

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About our NE growers & their soil health practices

Farm Name (farm code)	Production	Design	Control, acres per block	Treatment A, acres	Treatment B, acres
Bar-Way Farm (MA1)	Corn silage	1 Split Field, No Replicates	Corn Silage 105-days, Cover Crop Rye, Disc Harrow & Spray Termination, 7	Corn Silage 95-day, Cover Crop Mix, No-Till, Roller Crimp Termination, 3.5	Corn Silage 95-day, Cover Crop Mix, No-Till, Herbicide Termination, 3.5
Freund Family Farm (CT2)	Corn silage	1 Split Field, No Replicates	Corn Silage 105-days, Cover Crop Rye/Wheat, Disc Harrow & Spray Termination, 7	Corn Silage 95-day, Cover Crop Triticale, No-Till, Roller Crimp Termination, 8.9	Corn Silage 95-day, Cover Crop Triticale, No-Till, Green Chop Harvest, 9.6
Cushman Farm (CT3)	Corn silage	1 Split Field, No Replicates	Corn Silage 90-day, Cover Crop Triticale, Disc Harrow & Spray Termination, 5	Corn Silage 90-day, Cover Crop Triticale, No-Till, Green Chop Harvest, 7.5	Corn Silage 90-day, Cover Crop Triticale, No-Till, Roller Crimp Termination, 7.5

***Regional cover crop issues**: cover crop establishment before winter, generating additional income from cover crop as livestock feed, achieving sufficient cover crop maturity to crimp*

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SOCIAL RESULTS

Social Indicators

The social indicator effort is primarily targeted towards project farmers (as well as technical advisors and field day participants), which is aimed at answering two overarching questions:

- *How has participation in this program (or program field days) affected responses across six key social indicators (<u>from farmer characteristics to awareness, attitudes, constraints, capacity, and knowledge</u>) related to the adoption of cover crops?*
- *How has participation in this project influenced willingness to continue (or begin) practice implementation after the project and practice payments end?*

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Methods for Social Indicators

- Assessment survey of soil health participating farmers conducted in Year 1, Year 3, Year 5 to assess changes over time.
- Exit survey at dissemination events
- Focus group discussions with our TA partners and AFT staff

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Past and Current Practices
Working with Innovators

Practice	Before_On Some Acres/Crops	Before_On All Acres/Crops	After_On Some Acres/Crops	After_ On All Acres/Crops
Single species cover crops	10	2	9	2
Multi-species cover crops	9	1	11	3
Adaptive nutrient management	3	9	5	6
Applying organic amendments (e.g., compost, manure)	7	5	6	4
Reduced or Strip Tillage	8	4	8	2
No-Till	8	3	8	2
Short season cash crop (e.g., early maturing corn)	4	1	3	1
Experimenting with cover crop termination from timing to method	9	1	9	2
Experimenting with cover crop seeding rates	4	3	8	2
Diversifying crop rotation/varietal selection	6	4	6	2
Integrating livestock into cropping systems	1	3	2	2

Motivations for Experimentation with Practices

Big Picture Motivations	Precent of responses
Improve crop yields/increase productivity on my farm.	71%
Increase my resilience to drought.	43%
Sequester carbon in my soils.	43%
Reduce erosion on my farm.	29%
Save money by reducing input costs (e.g., fertilizer, fuel, livestock feed).	29%
Increase my resilience to excess precipitation events (e.g., flooding).	21%
Boost the profitability of my farm.	21%
Improve pollinator and beneficial insect habitat.	14%
Reduce labor costs.	7%
Reduce greenhouse gas emissions from my farm.	7%
Reduce the time I spend in the field.	7%
Other (please specify)	7%
Improve biodiversity on my farm.	0%
Reduce negative water quality impacts from my farm.	0%

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Desired Soil Health Outcomes

Answer Choices	Responses
Boost my soil organic matter.	64%
Increase plant available soil nutrients	64%
Improve habitat for soil organisms and beneficial microbes.	50%
Reduce compaction and improve soil structure.	50%
Improve my soil water holding capacity.	36%
Reduce ponding and improve water infiltration rates.	14%
Reduce sediment loss due to soil erosion	7%
Reduce nutrient loss due to soil erosion	7%

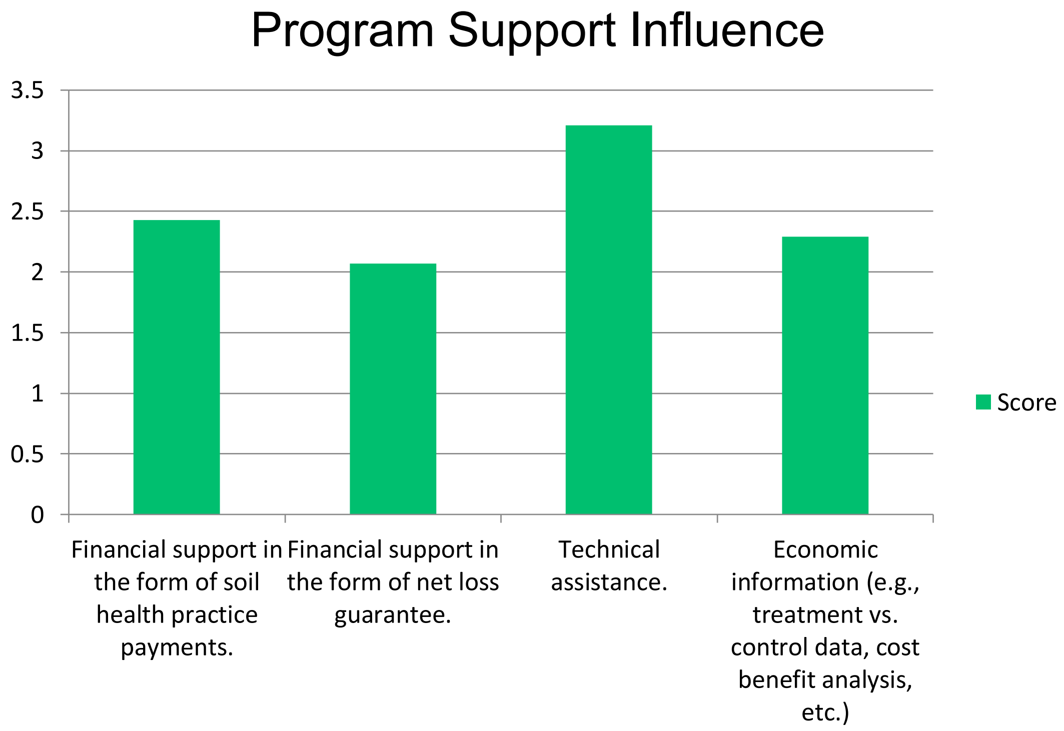
Environmental Impacts from Farming

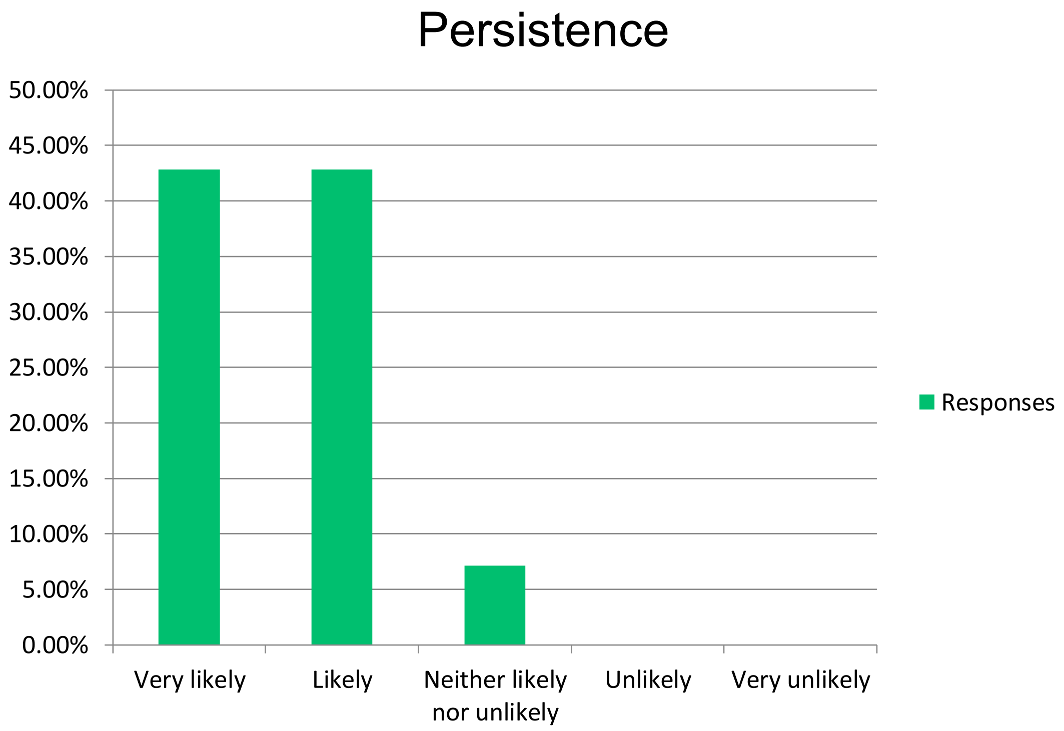
AWARENESS OF IMPACTS	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
There is a link between water quality and farming practices.	0%	0%	0%	43%	57%
There is a link between farming practices and biodiversity.	0%	0%	0%	43%	57%
There is a link between farming practices and wildlife habitat.	0%	0%	14%	36%	50%
There is a link between farming practices and a farm's resilience to extreme weather events (e.g., flooding and droughts).	0%	0%	0%	50%	50%
There is a link between farming practices and worker satisfaction.	0%	7%	29%	14%	50%
There is a link between soil management and soil carbon sequestration.	0%	0%	0%	57%	43%
There is a link between the health of my local watershed and farming practices in my region.	0%	0%	0%	64%	36%
There is a link between farming practices and pollinator habitat.	0%	0%	14%	50%	36%
There is a link between crop diversity and pesticide use.	0%	0%	21%	50%	29%
There is a link between farming practices and climate change (e.g., GHG emissions).	0%	7%	29%	36%	29%
There is a link between farming practices and human health.	0%	0%	29%	43%	29%

Challenges with Adoption/Persistence

Answer Choices (Choose all that apply)	Responses
I don’t know which cover crop(s) are best for my needs.	29%
I am worried about cover crops hurting my cash crop yields through yield drag.	29%
I don’t know how to adjust my N fertilizer application after use of cover crops.	29%
I am worried about the added costs associated with cover crops/soil amendments/reduced tillage affecting my operating expenses and my return on investment.	29%
I don’t know what herbicide management practices fit best with cover crops.	21%
I am worried about pest or pathogen problems associated with cover crops/soil compost.	21%
I don’t have the needed equipment for integrating cover crops/reduced tillage.	21%
I experimented with no-till/cover crops and I had trouble getting my cash crop planted due to field being too wet/cold in the spring.	21%
I don’t have the time to manage cover crop establishment/termination and cash crop planting/harvest.	14%
I am worried about cover crops’ adverse effects to the cash crops due to soil nutrient and water usage.	7%
I experimented with cover crops and had poor establishment/poor production due to weather (e.g., frost) or other management challenges (e.g., timing).	7%
I am worried about the costs and accessibility of compost materials/organic amendments.	7%
I am worried that my neighbors won't like the look of cover crops/no-till/compost.	0%
I experimented with stacking cover crops with no-till and I had trouble managing my cash crop as a result.	0%
I am worried that my landlord will not support the use of my conservation practices.	0%

Persistence





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SOIL RESULTS
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Soil health was assessed in the field & the lab

- Used two measures of soil health: NRCS In-Field Soil Health Assessment (IFSHA) and Cornell Comprehensive Assessment of Soil Health (CASH) reports
- For KY & CA, we also sent soil samples to local labs to provide more regionally specific nutrient recommendations

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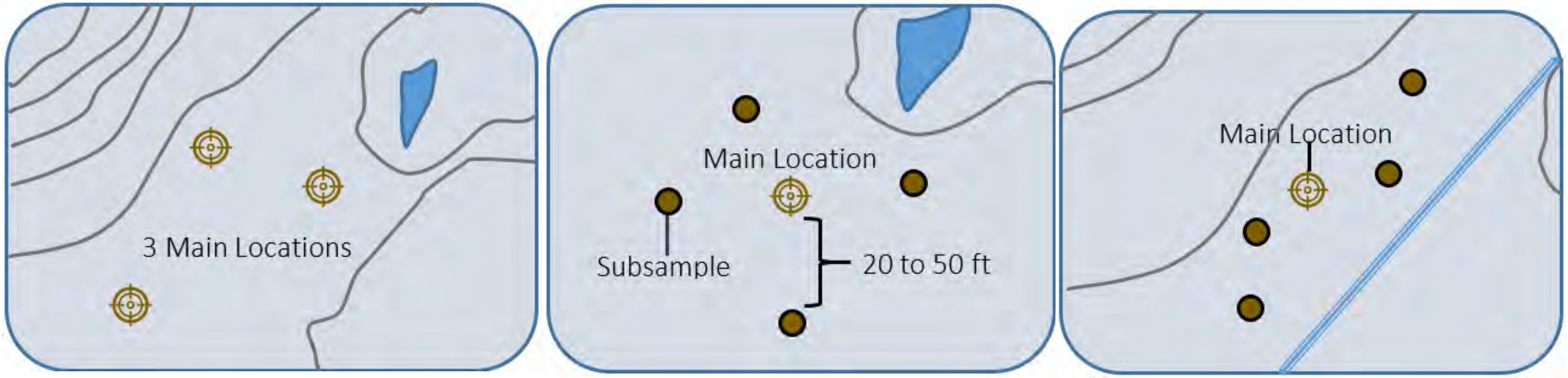
Soil sampling protocols

- Sampling protocols reflected USDA-NRCS Collection & processing Instructions for Soil Health Tests
- 3 Main locations per treatment/control
- 5 subsamples per main location



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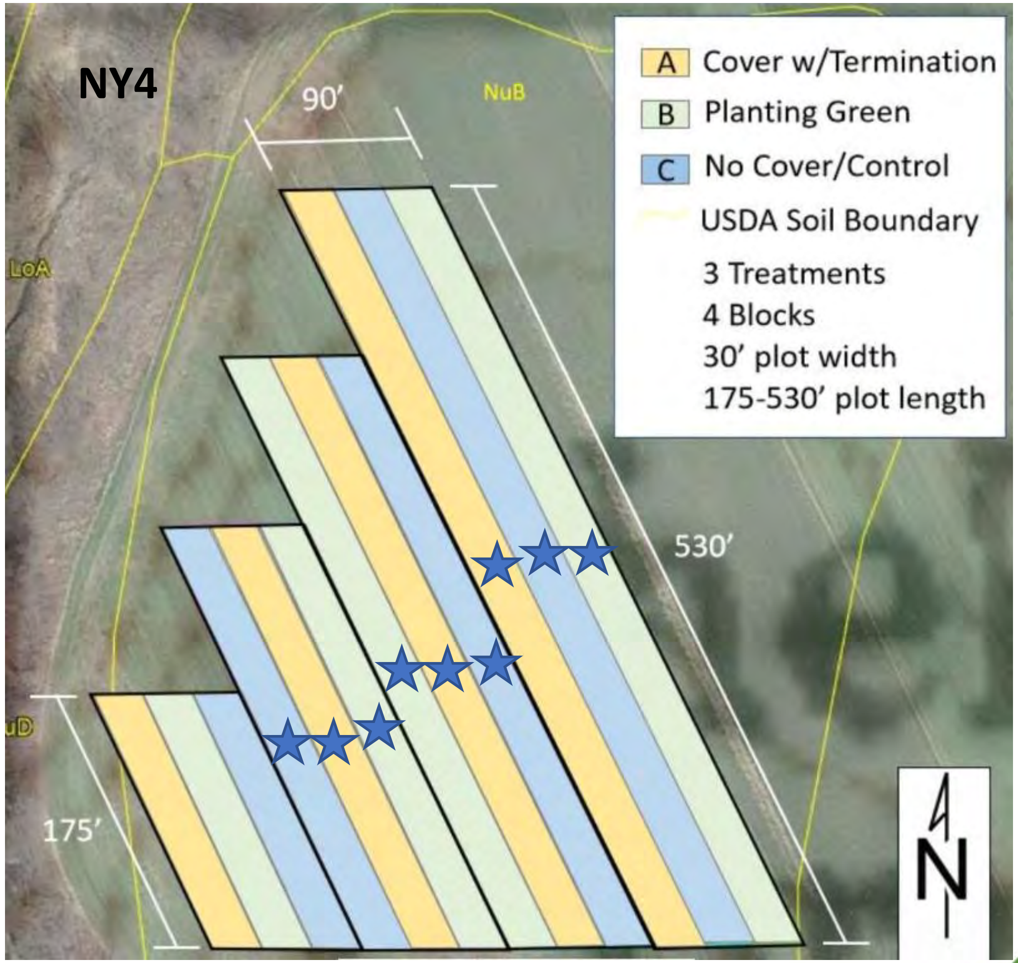
Demo trial design examples



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In Field Soil Health Assessment- IFSHA

- Followed NRCS Cropland IFSHA Guide (Technical note 450-06) to evaluate whether 11 different indicators meet threshold criteria
- Using the IFSHA decision tree & the results from the 11 indicators assessed the soil for four NRCS-defined soil health resource concerns:
  - Compaction
  - Soil organism habitat loss
  - Organic matter depletion
  - Aggregate instability

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Field/plot IFSHA soil health indicators

Soil Health Indicators	IFSHAs indicating SH resource concerns (n= 31*)	Percentage
Penetration resistance	24	77%
Soil structure	20	65%
Soil color	19	61%
Biological diversity	17	55%
Ponding / Infiltration**	6	32%
Soil Cover	8	26%
Biopores	7	23%
Plant roots	4	13%
Water stable aggregates	3	10%
Surface crusts	1	3%
Residue Breakdown	0	0

*2 farms with 1 IFSHA, 4 farms with 2 IFSHAs, 7 farms with 3 IFSHAs

** Ponding was not assessed in the 4 NY farms. Ponding/Infiltration n=19

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- Penetration resistance was the most frequently observed resource concern (77% of our farms/plots)

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** Ponding was not assessed in the 4 NY farms. Ponding/Infiltration n=19

- Penetration resistance was the most frequently observed indicator that did not meet assessment criteria (77% of our farms/plots)
- Every indicator showed at least one instance of not meeting assessment criteria except residue breakdown

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Field/plot IFSHA resource concerns

Resource Concerns	IFSHAs indicating SH resource concerns (n= 31*)	Percentage
Aggregate instability	23	74%
Soil organic matter depletion	15	48%
Compaction	14	45%
Soil organism habitat loss	10	32%

*2 farms with 1 IFSHA, 4 farms with 2 IFSHAs, 7 farms with 3 IFSHAs

- Aggregate instability is the primary resource concern, with 74% of the IFSHAs indicating a concern

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- Aggregate instability is the primary resource concern. with 74%, of the IFSHAs indicating a concern
- Aggregate instability could indicate other issues:
  - Destabilization in soil carbon
  - Reduced water infiltration
  - Decreased resilience to extreme weather
  - Increased soil erosion
  - Increased plant stress
  - Reduced habitat & soil biological activity

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Laboratory soil health assessment: Sample CASH report

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Results by Cornell Comprehensive Assessment of Soil Health

Sample ID:
Field ID: CT2_C_Average
Date Sampled: 04/26/2021
Crops Grown: COS/COS/COS

Measured Soil Textural Class:
Sand: **59%** - Silt: **30%** - Clay: **10%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	0.19	80	
physical	Surface Hardness	433	0	Rooting, Water Transmission
physical	Subsurface Hardness	564	1	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	34.0	57	
biological	Organic Matter Total Carbon: 2.1 / Total Nitrogen: 0.2	3.1	91	
biological	ACE Soil Protein Index	6.4	39	
biological	Soil Respiration	0.7	59	
biological	Active Carbon	688	88	
chemical	Soil pH	7.0	100	
chemical	Extractable Phosphorus	44.2	10	High Phosphorus, Environmental Impact Risk
chemical	Extractable Potassium	288.3	100	
chemical	Minor Elements Mg: 265.8 / Fe: 2.2 / Mn: 5.8 / Zn: 9.1		100	

Overall Quality Score: **60** / High

- CASH result interpretations are made relative to other farms of similar soil textures
- CASH report quantitatively analyzes physical, biological, and chemical soil properties, known as soil health indicators
- Raw values are translated to scores based on soil texture and ranked from very low to very high
- The rank is color coded
- Each farm is also given an overall score

CASH Scoring Legend

Score	Rank	Color Code
80 – 100	Very High	Dark Green
60 – 80	High	Light Green
40 – 60	Medium	Yellow
20 – 40	Low	Orange
0 – 20	Very Low	Red

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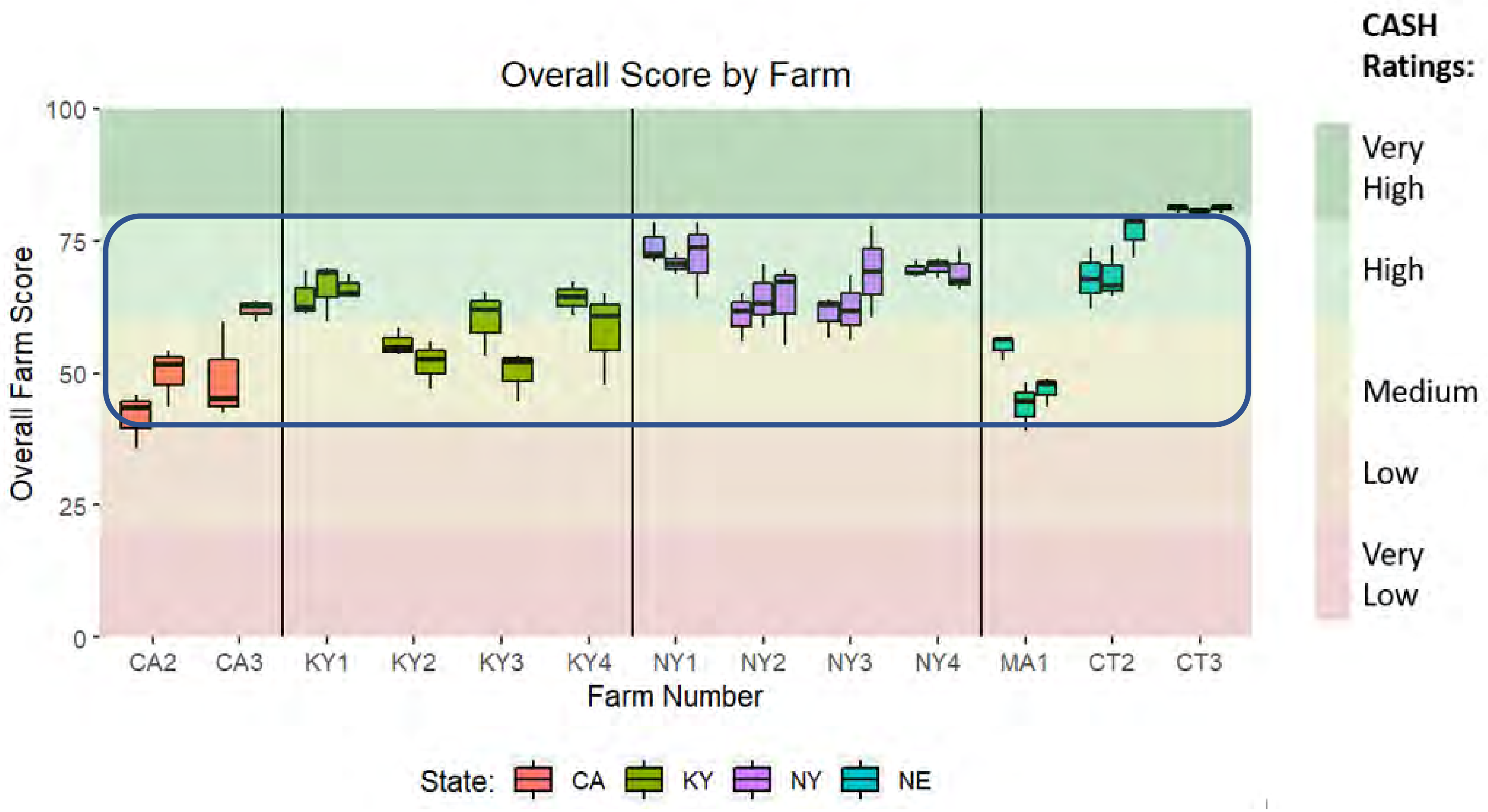
Overall Score:
Do they mean what we think they mean?



- Due to high baseline scores we may not see a significant change in soil health scores

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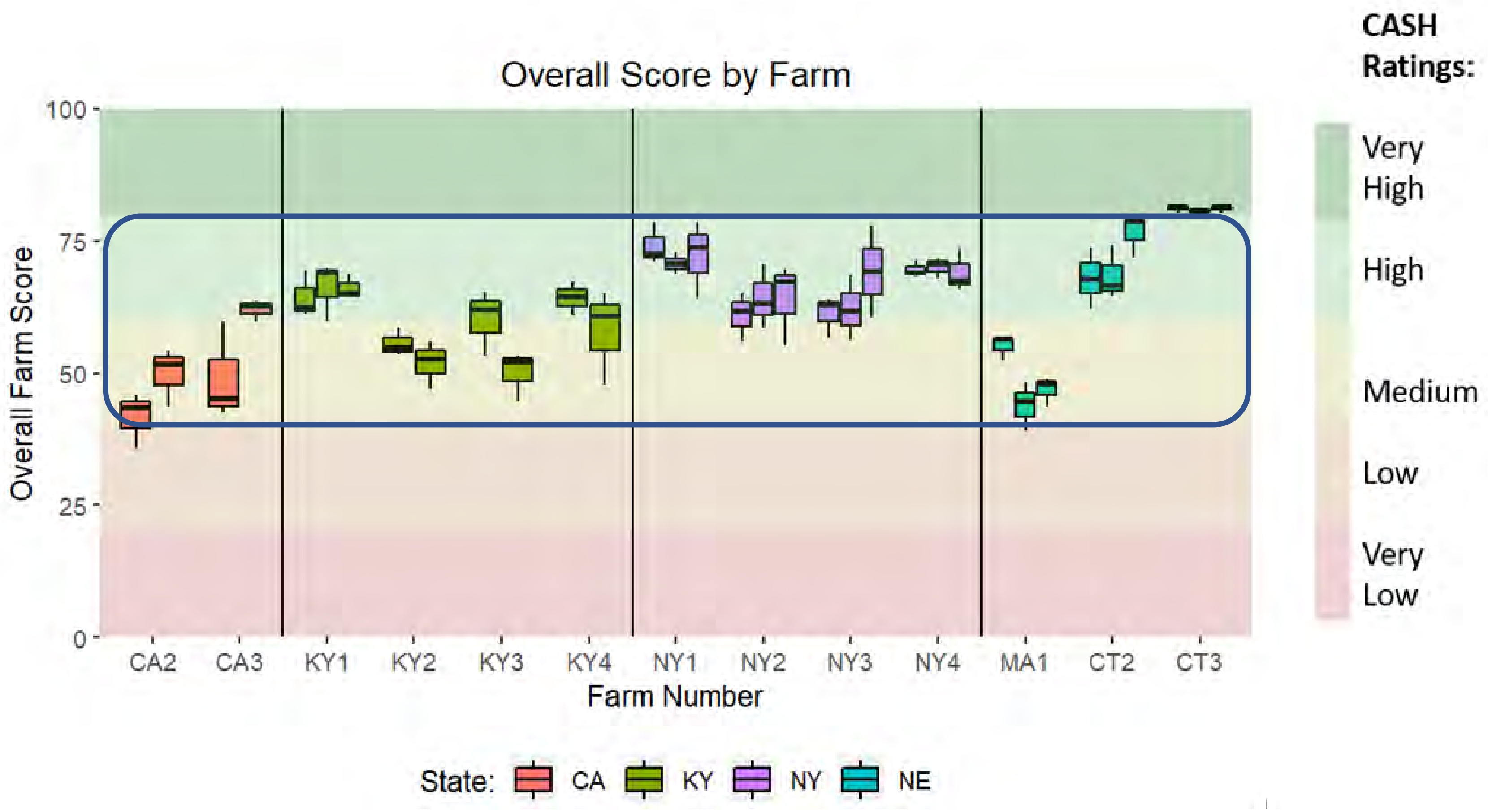

- Due to high baseline scores we may not see a significant change in soil health scores
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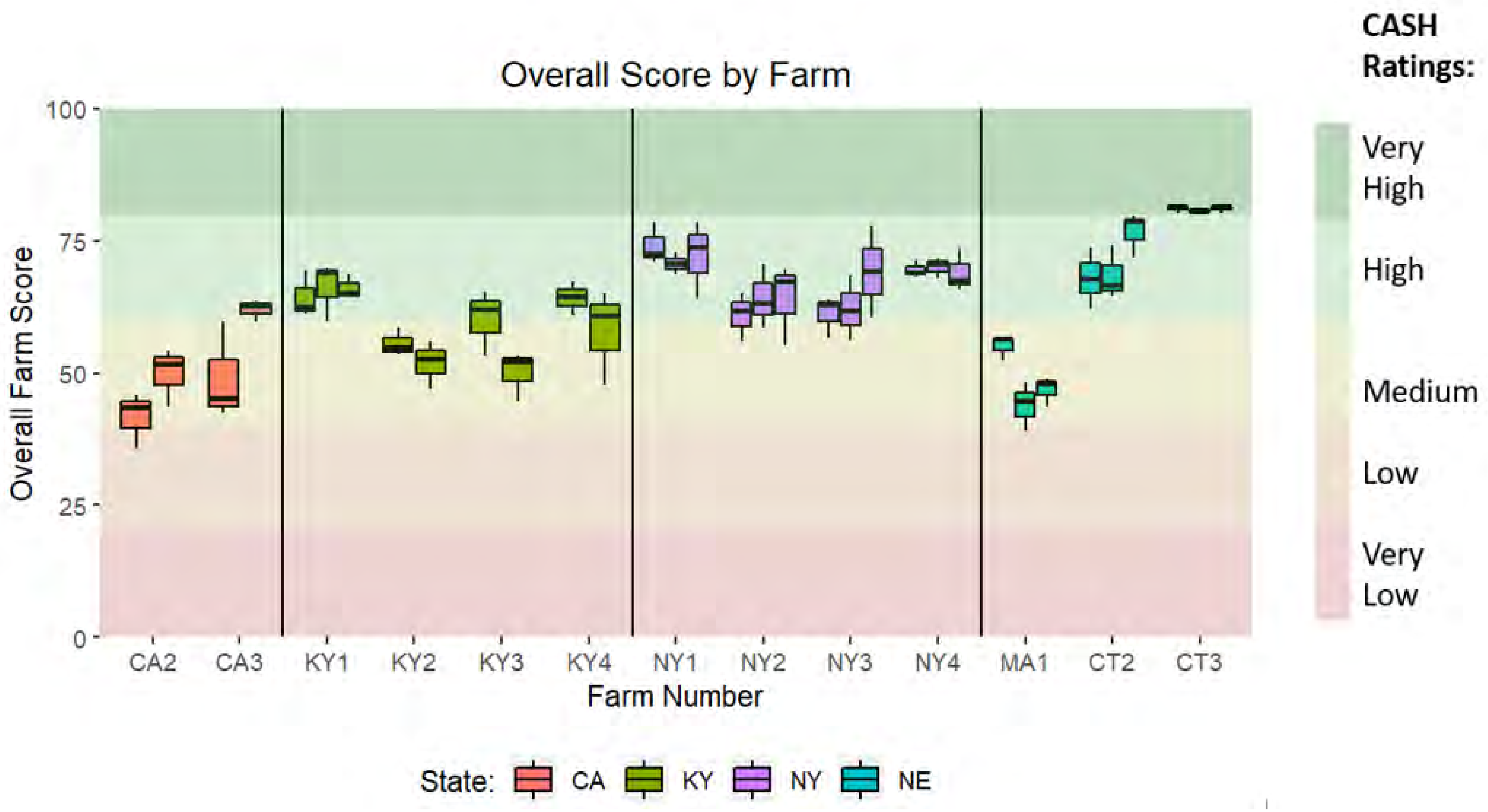

- Due to high baseline scores we may not see a significant change in soil health scores
- Overall score doesn't give us actionable information on the condition of the soil
- Soil physical, biological, and chemical properties show specific constraints

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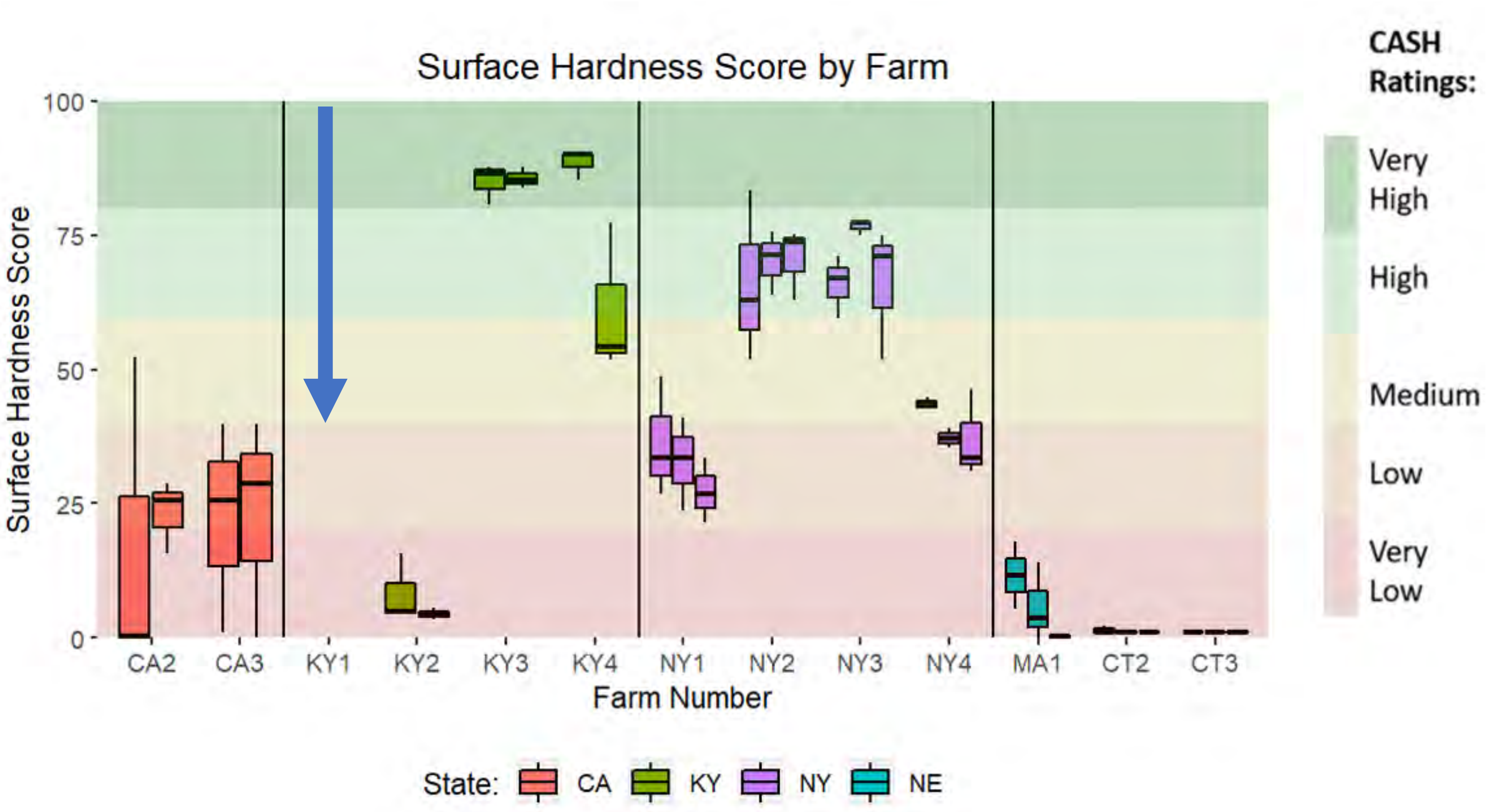
Physical Indicators:
Surface hardness shows compaction in 7 farms



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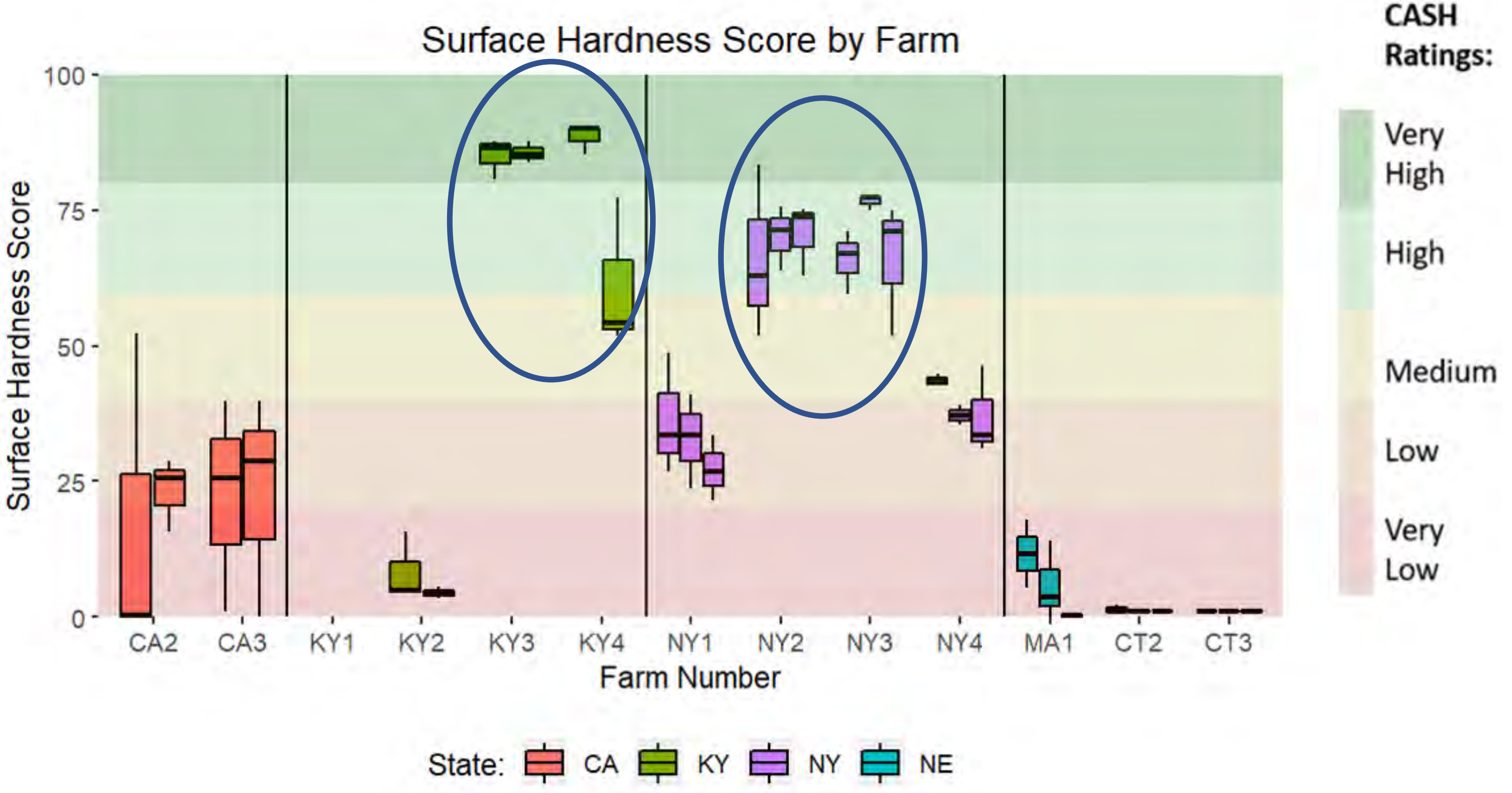

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- KY3, KY4, NY2, and NY3 farms show no compaction constraint, so we are unlikely to see change here by year 5.

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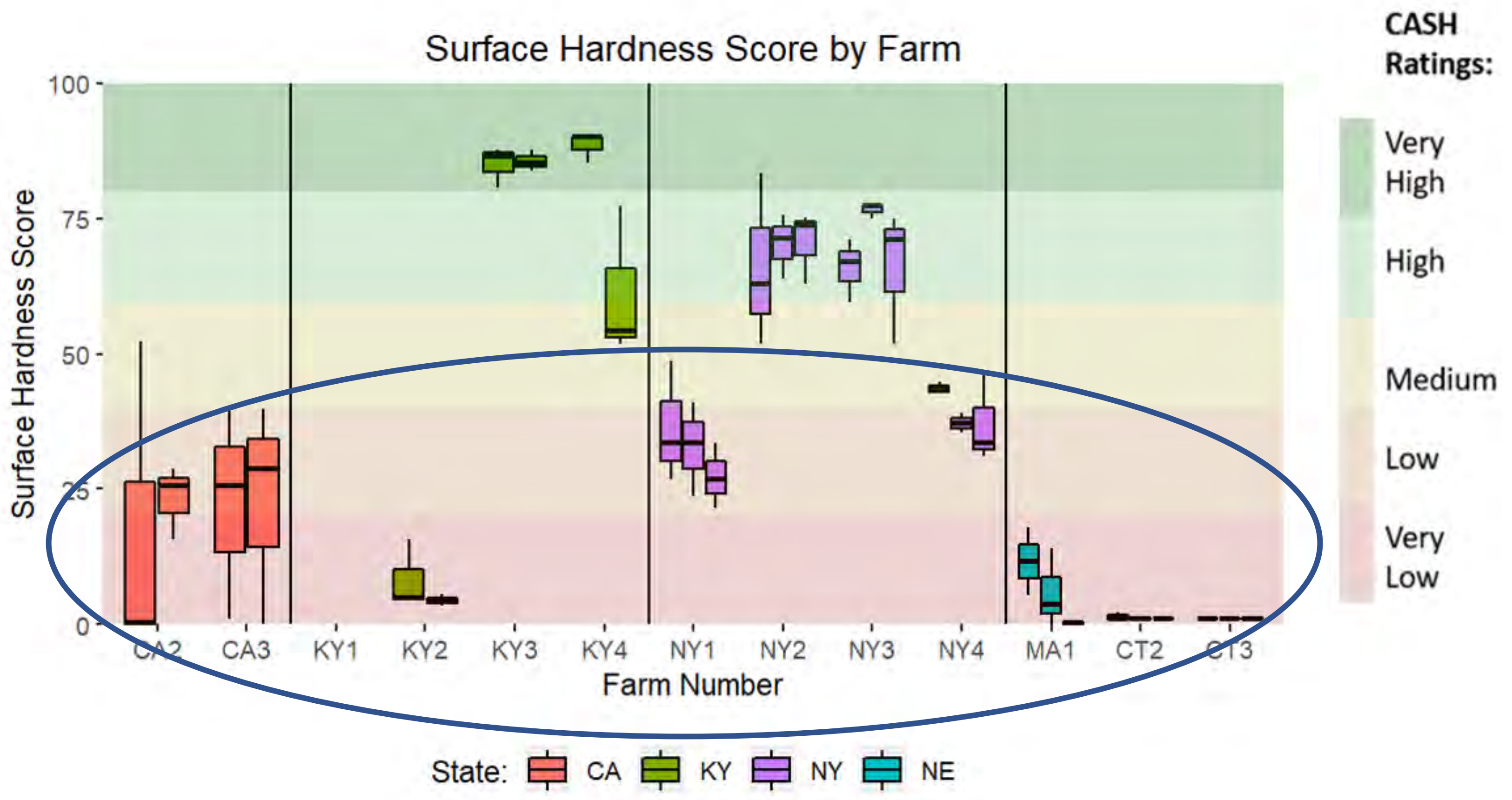

- KY1 is missing scores due to a broken penetrometer
- KY3, KY4, NY2, and NY3 farms show no compaction constraint, so we are unlikely to see change here by year 5.
- Most farms scored in the low to very low range indicating compaction as a major concern
- Most likely due to tillage & heavy equipment usage, especially after rain events

Physical Indicators:
Aggregate stability indicates impaired soil functioning

More recently available in soil testing laboratories.

Cornell uses sprinkle infiltrometer

https://soilhealthlab.cals.cornell.edu/resources/cornell-sprinkle-infiltrometer/

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Physical Indicators:
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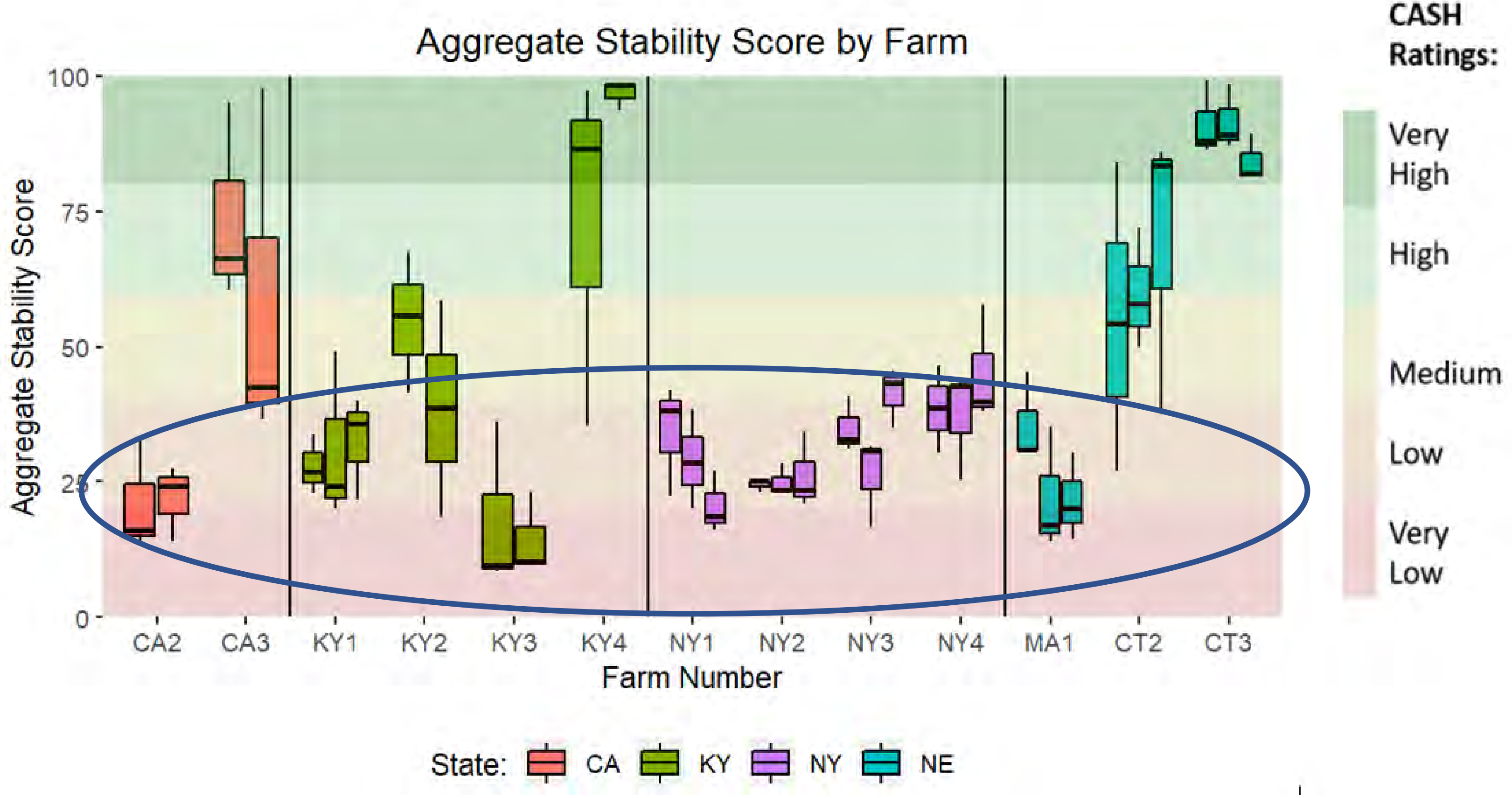

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- 2/3 of the farms scored low to very low on soil aggregate stability indicating impaired soil functioning with decreased aeration, water infiltration, rooting

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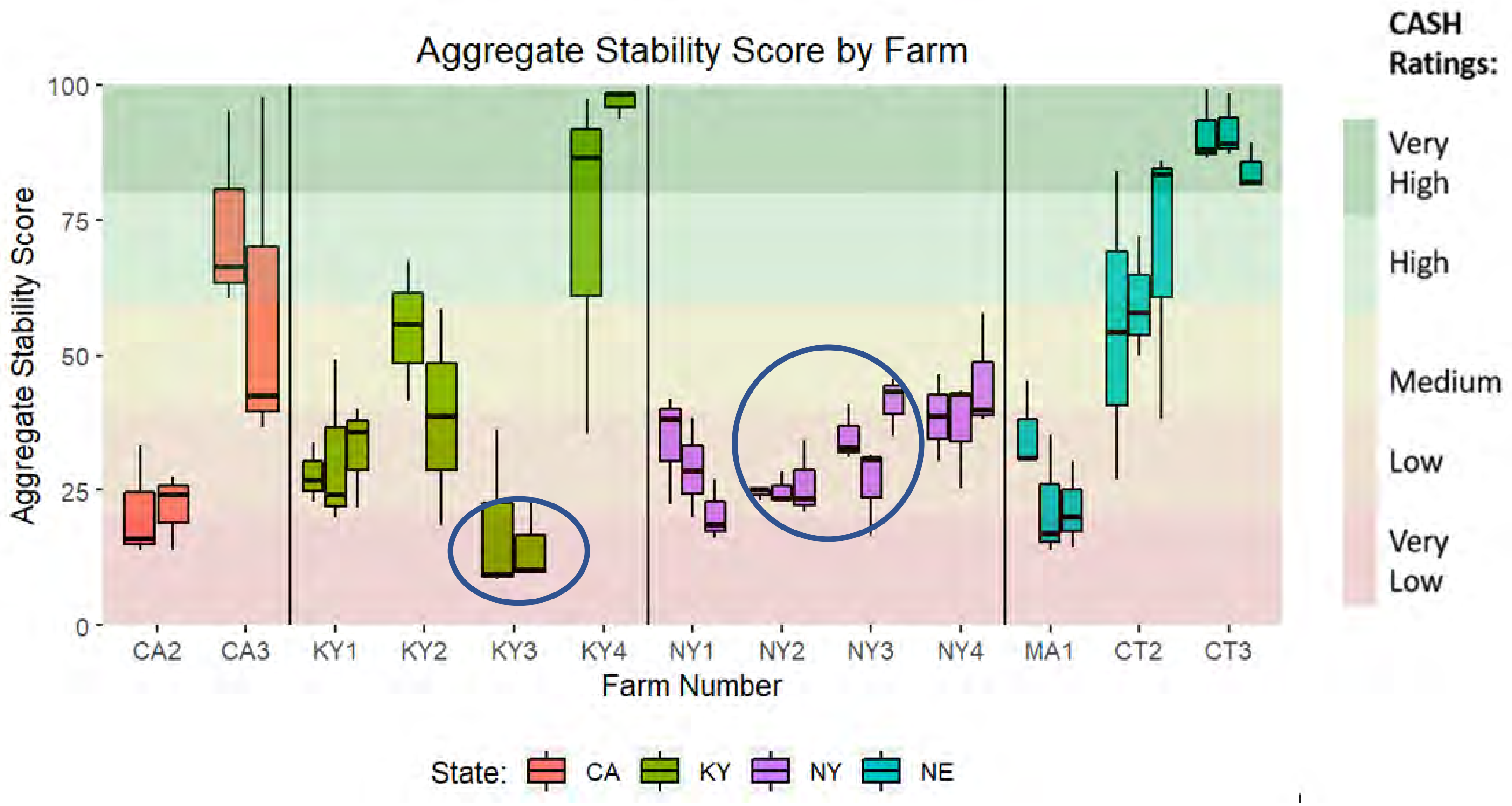

- More recently available in soil testing laboratories. Cornell uses rainfall simulator technique.
- 2/3 of the farms scored low to very low on soil aggregate stability indicating impaired soil functioning with decreased aeration, water infiltration, rooting
- KY3, NY2, NY3 that scored high on surface hardness score low on aggregate stability
- Focusing on cover cropping, no or reduced tillage, and planting green

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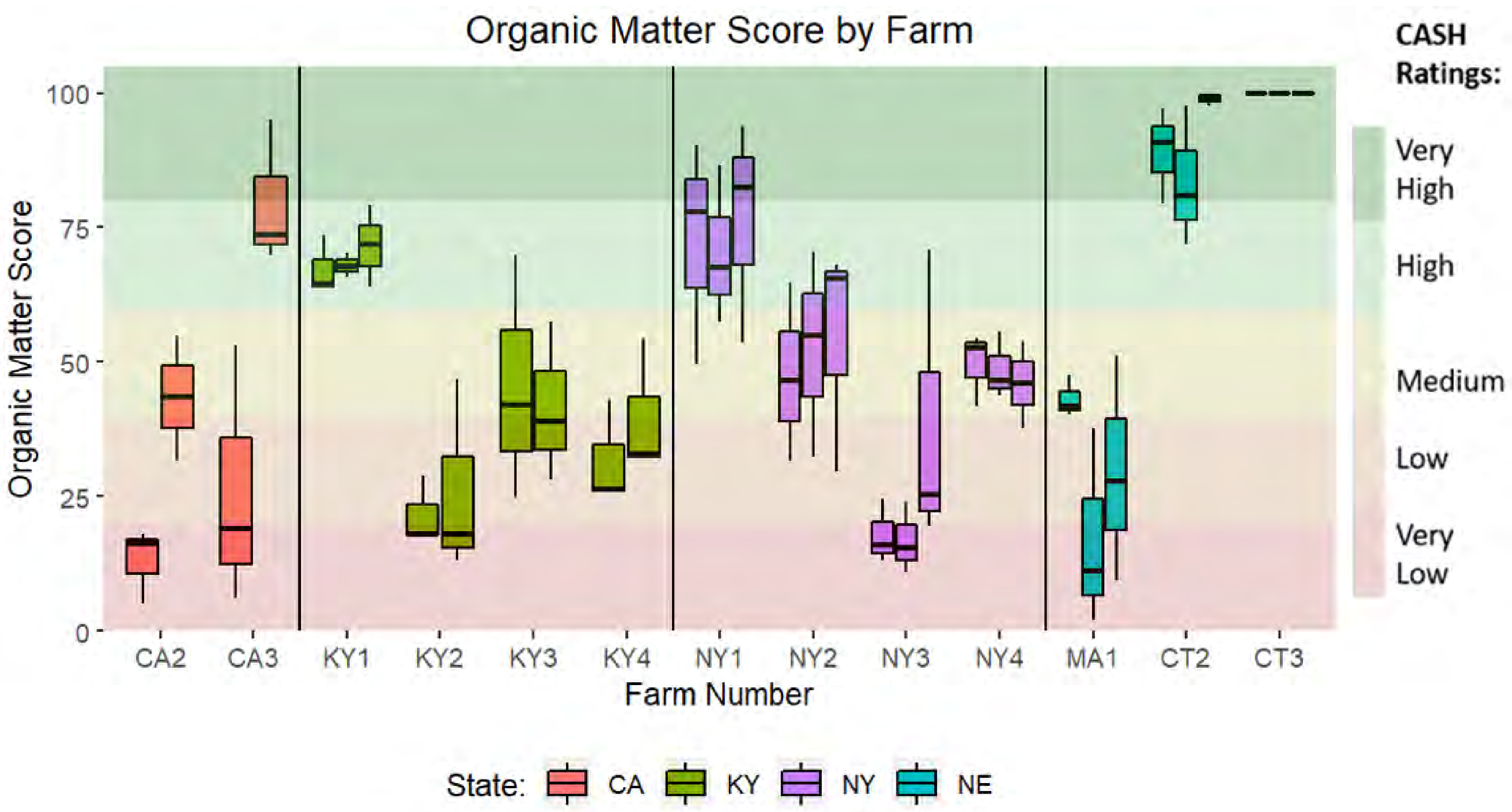
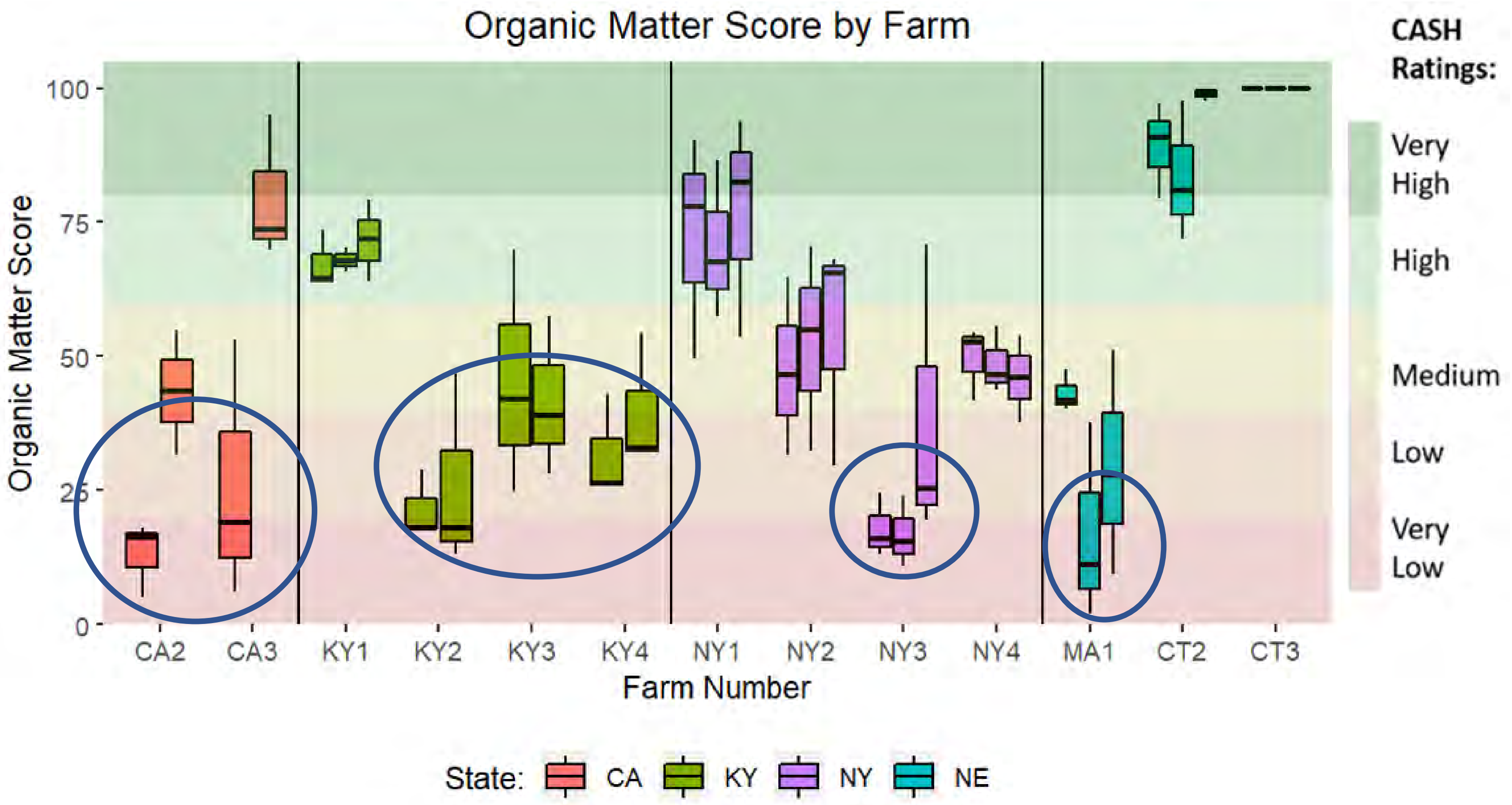
Biological Indicators:
Most farms are focused on increasing organic matter & biological activity



- Organic matter scores represent large variability across farms

Biological Indicators:

Most farms are focused on increasing organic matter & biological activity



- Organic matter scores represent large variability across farms
- 7 farms scored low to very low
- Increasing SOM is a priority in this project
  - Cover cropping
  - Planting green
  - Roller crimping

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Biological Indicators:
Most farms are focused on increasing organic matter & biological activity

Fungal hyphae fill spaces left by tillage radish on a Kentucky farm

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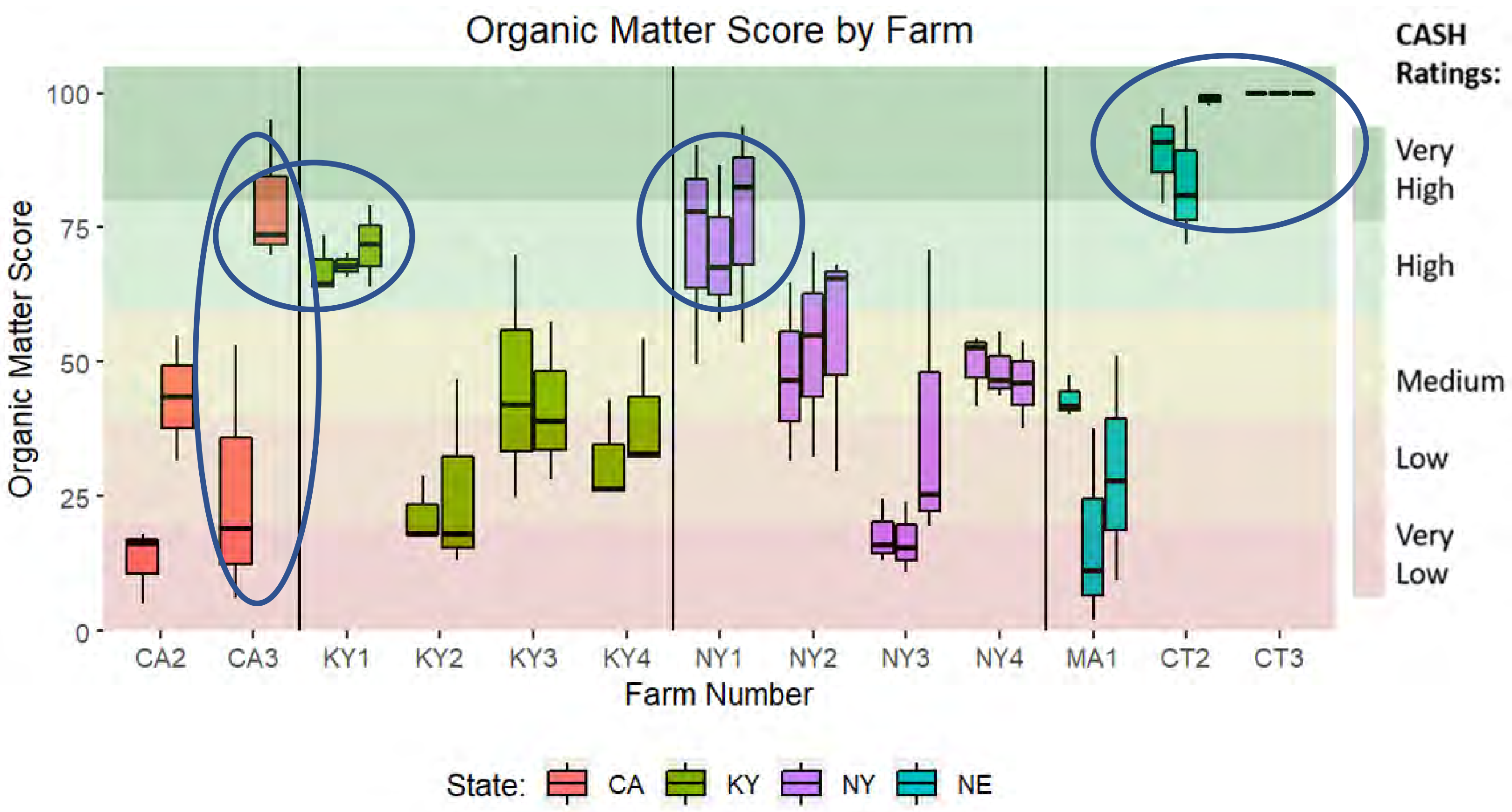
Biological Indicators:
Most farms are focused on increasing organic matter & biological activity

Roller crimping and planting green on a NY farm

Photos by: Kevin Keenan

Biological Indicators:

Most farms are focused on increasing organic matter & biological activity



- Organic matter scores represent large variability across farms
- 7 farms scored low to very low
- Increasing SOM is a priority in this project
- 5 farms scored in the high to very high range
- CA3 was counted twice due to the variability between fields

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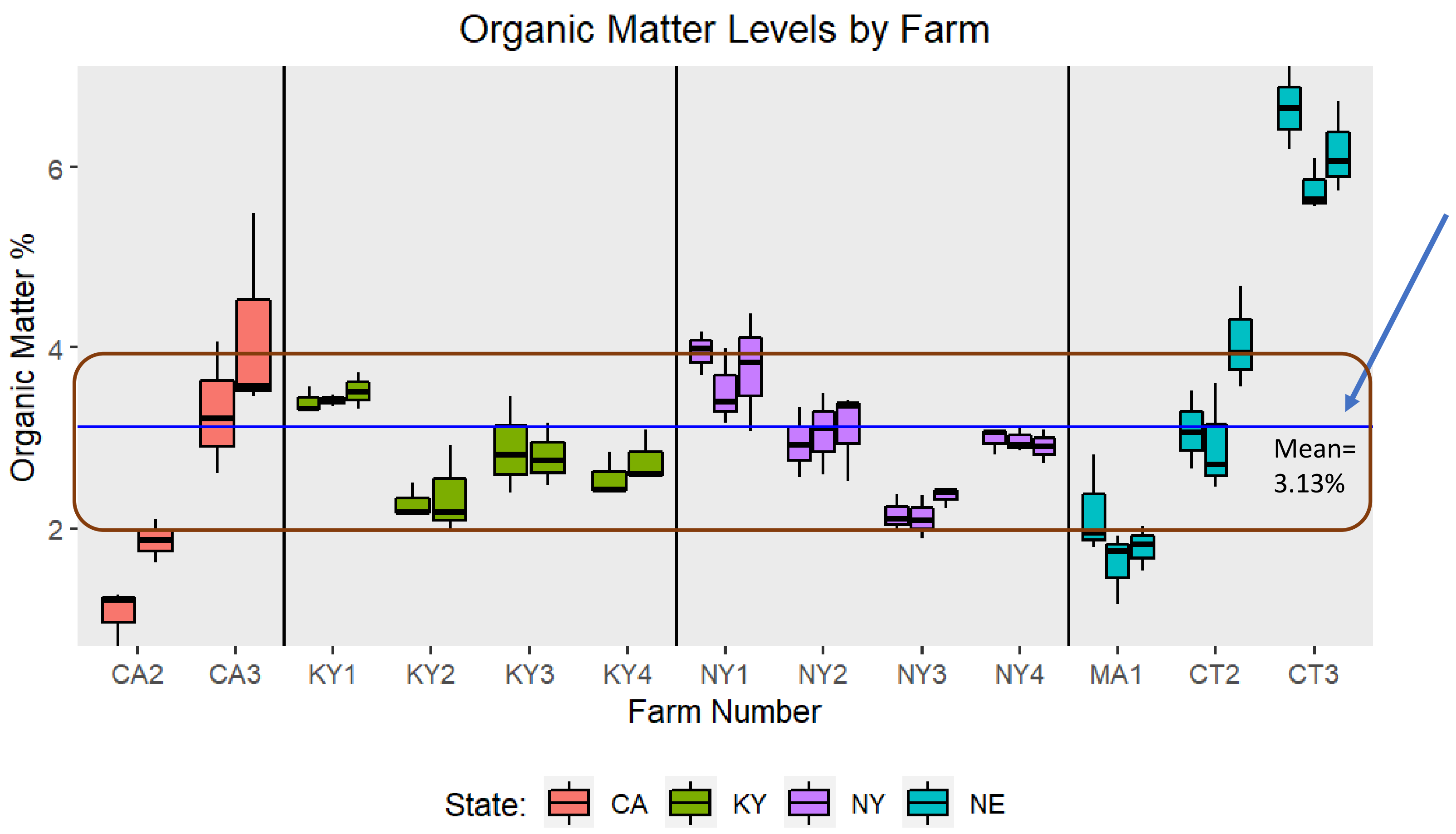
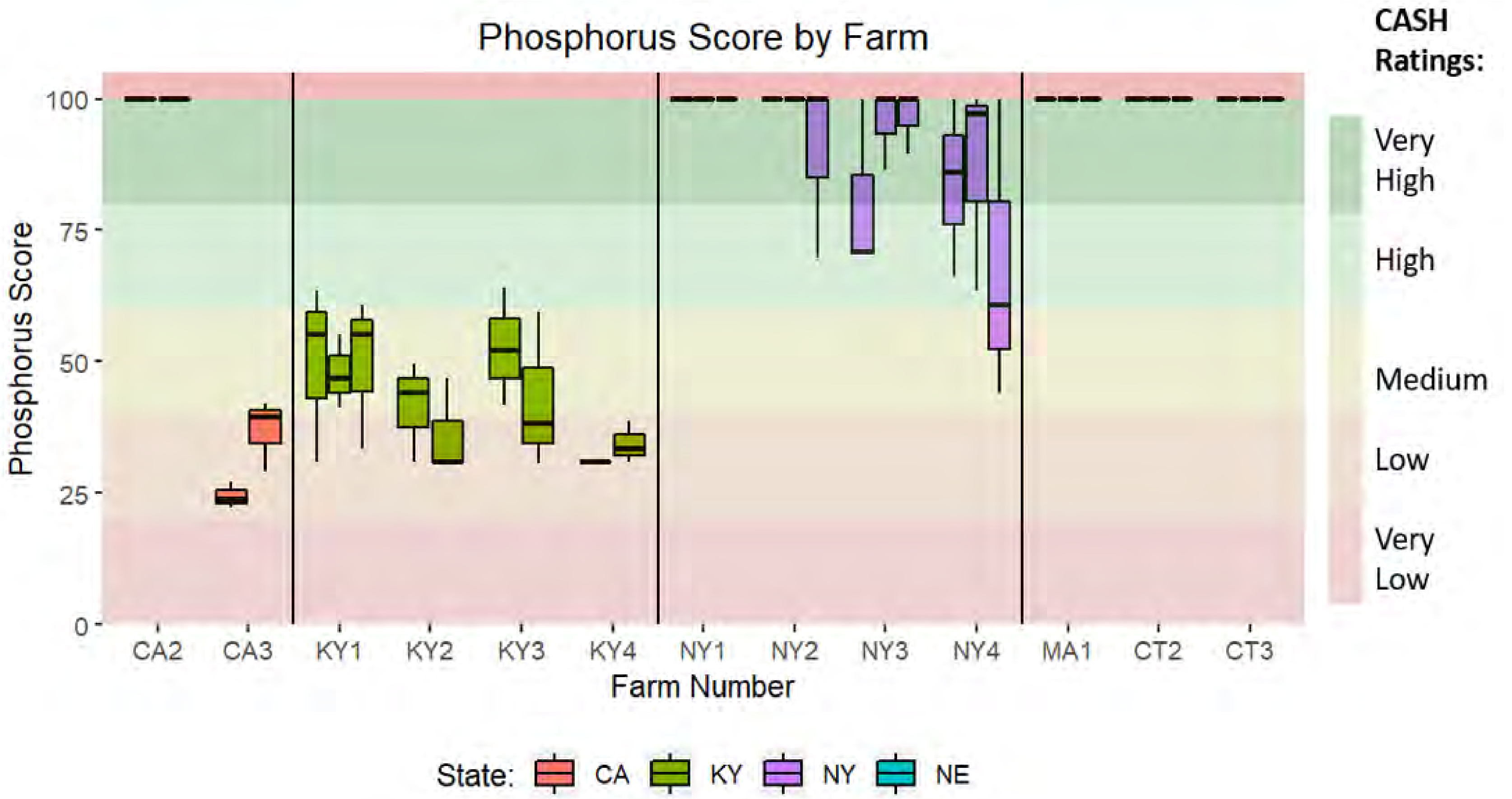
Biological Indicators:
Actual organic matter values show less variability



- 10 of the 13 trial farms fall within 2%-4% range
- Mean SOM of 3.13%
- In general, for the CASH report, 2% SOM falls in the lower range, while 4% falls in the higher range
- These generalities can change based on soil texture

Chemical Indicators:
Phosphorus scores & scoring systems are confounding



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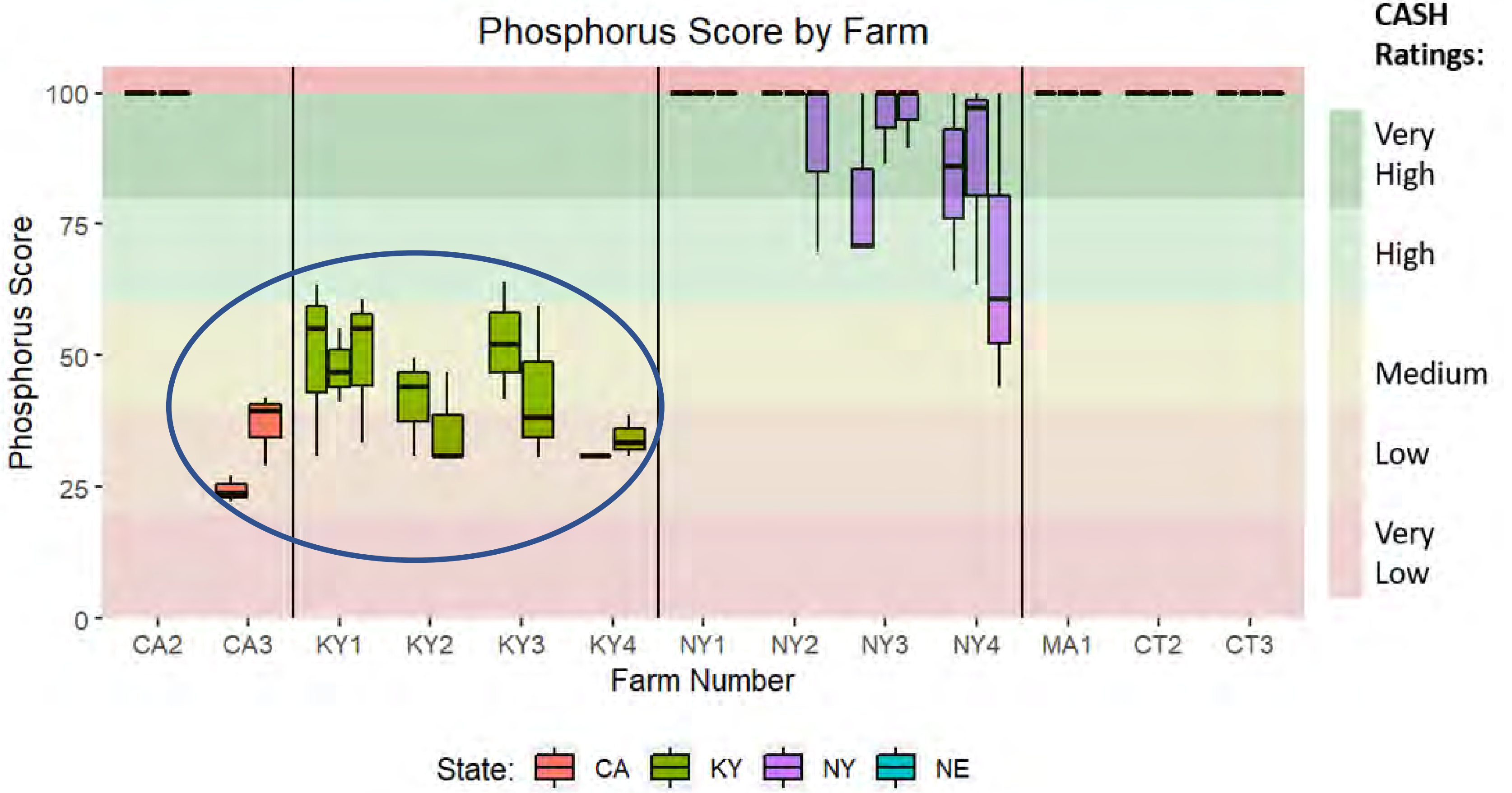
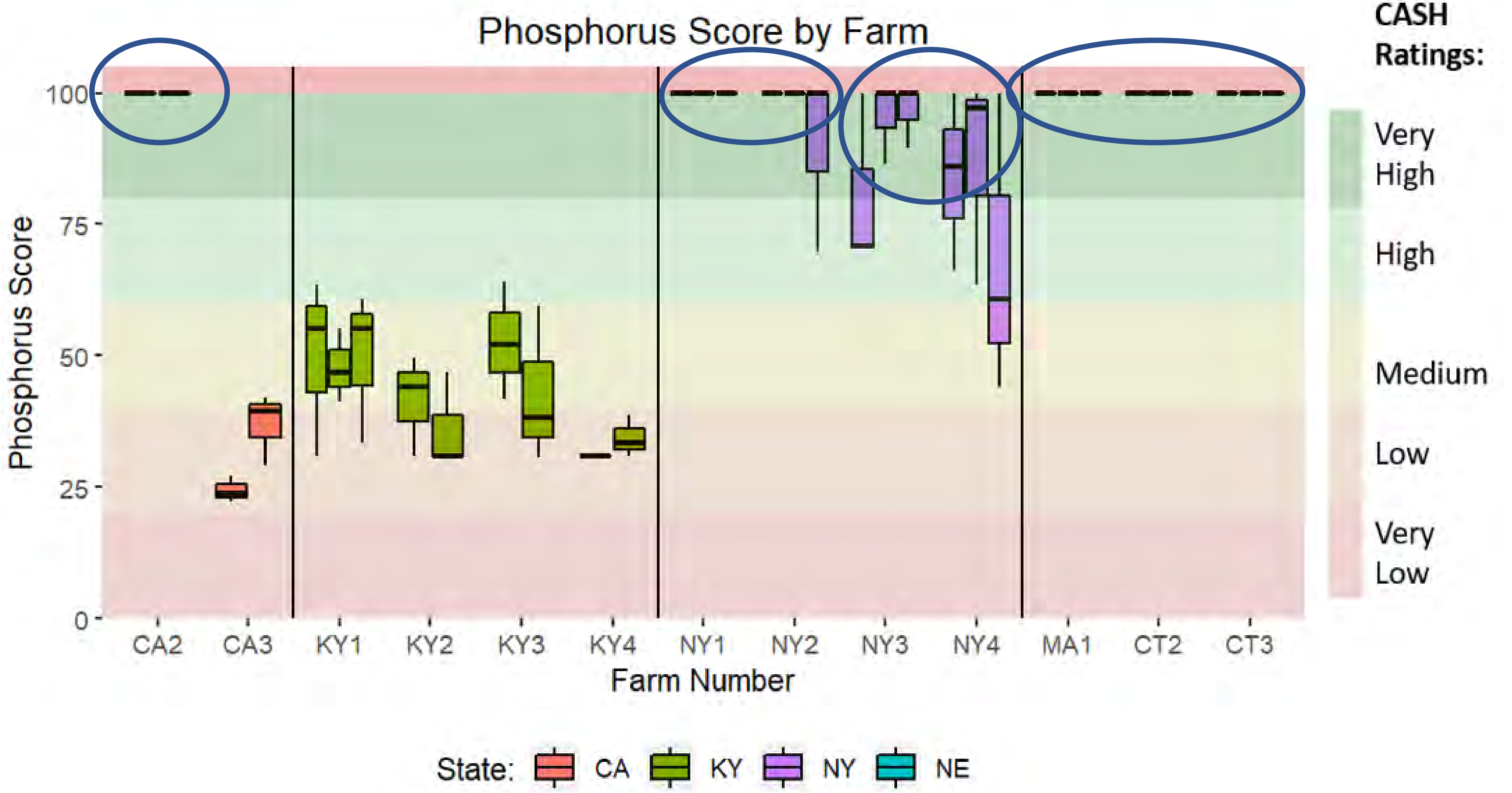
Chemical Indicators:
Phosphorus scores & scoring systems are confounding



- CA and KY farms score in the low to medium range

Chemical Indicators:
Phosphorus scores & scoring systems are confounding



- CA and KY farms score in the low to medium range
- 8 farms score in the very high range
- With 6 scoring 100.

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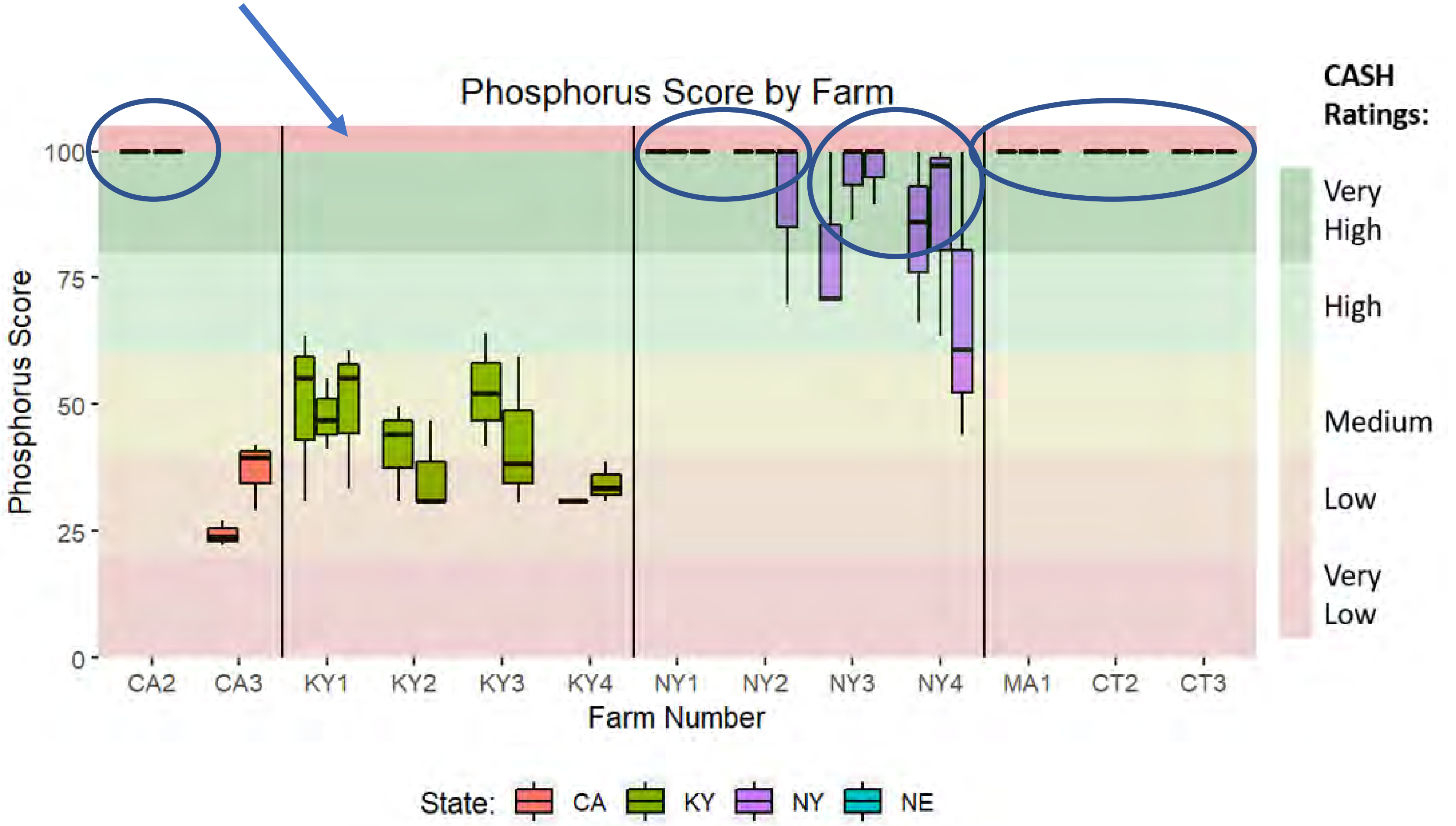
Chemical Indicators:
Phosphorus scores & scoring systems are confounding



- CA and KY farms score in the low to medium range
- 8 farms score in the very high range
- With 6 scoring 100.
- The very high scores of 100 could indicate excessive P levels
- CASH report indicates a possible environmental concern at ≥20ppm

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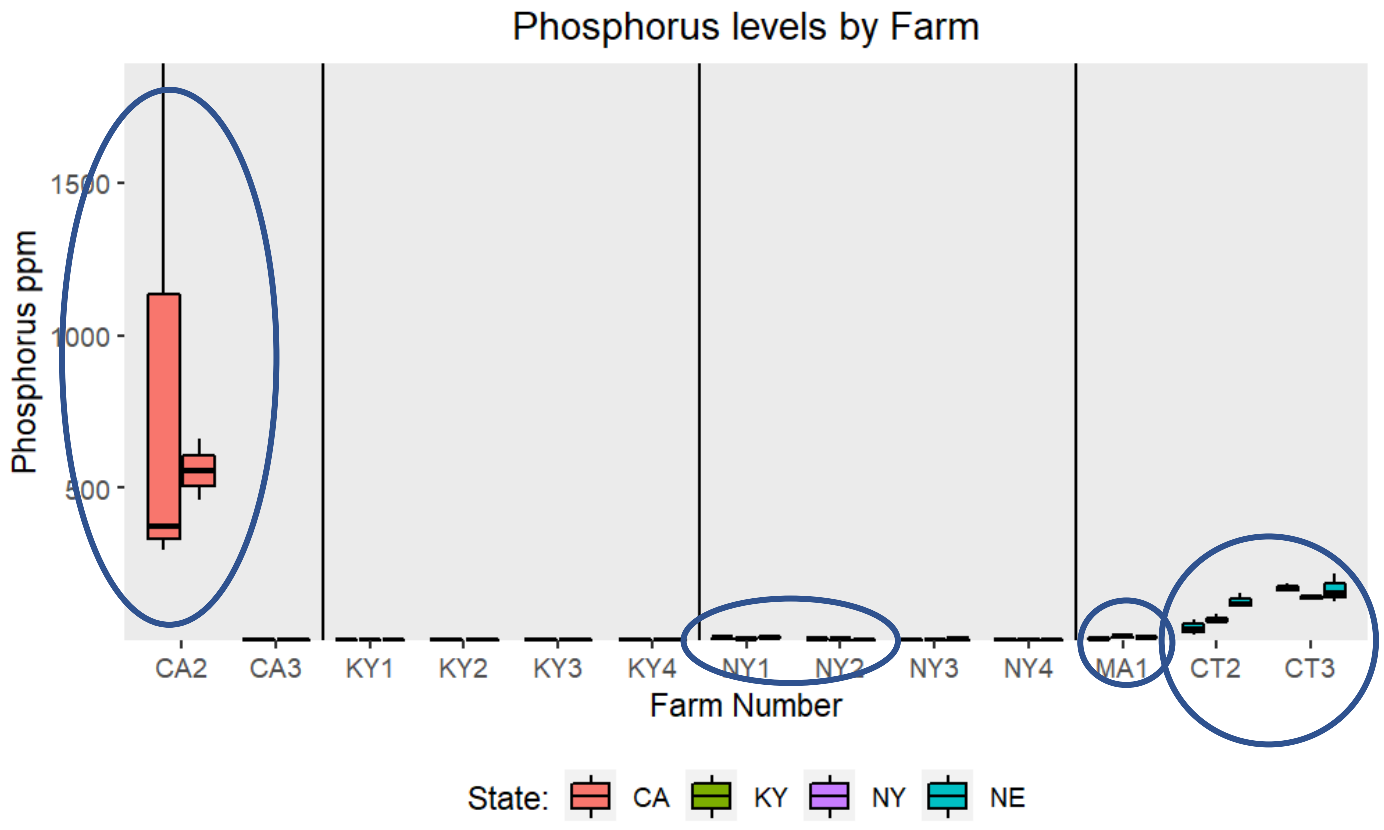
Chemical Indicators:
Phosphorus concentrations give a better picture for ↑ scores



- P concentrations of all 6 farms that scored 100

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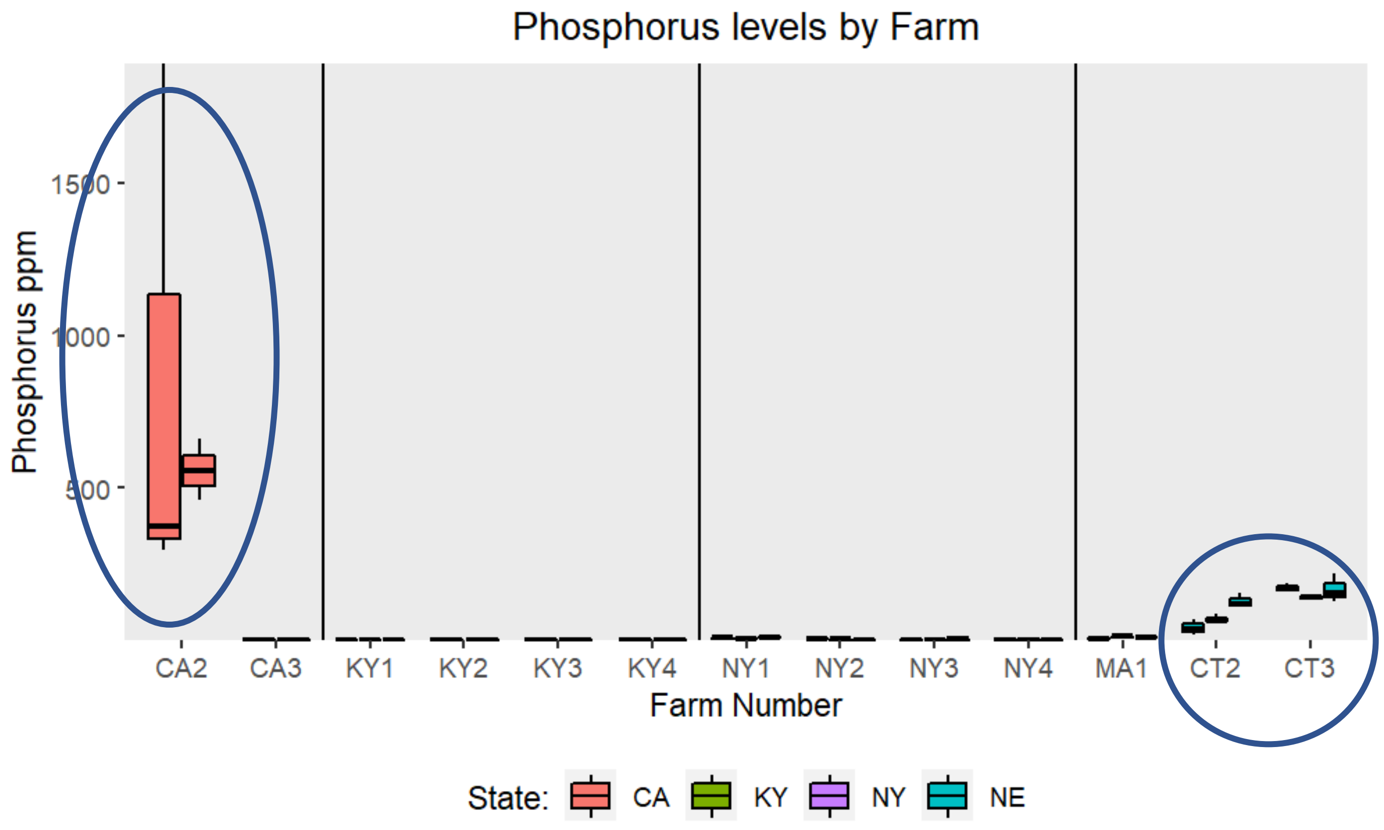
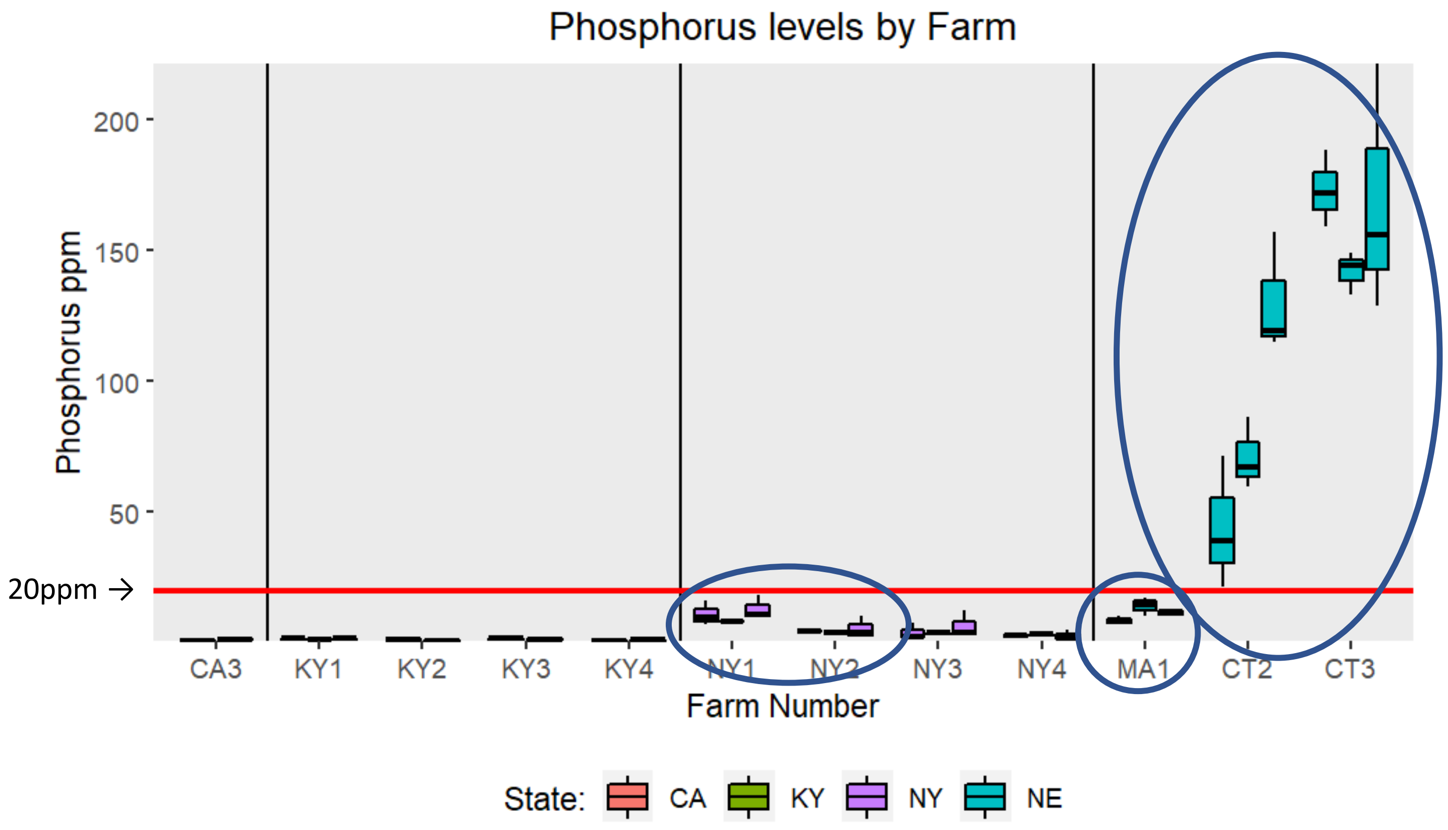
Chemical Indicators:
Phosphorus concentrations give a better picture for ↑ scores



- P concentrations of all 6 farms that scored 100
- CA2 and the two CT farms show problematic P levels: all due to manure use
- Met with CA NRCS agent to discuss CA2, determined P levels were not an environmental concern based on their lack of watershed impairments for P

Chemical Indicators:
Phosphorus concentrations give a better picture for ↑ scores



- P concentrations of all 6 farms that scored 100
- CA2 and the two CT farms show problematic P levels: all due to excess manure use
- Met with CA NRCS agent to discuss CA2, determined P levels were not an environmental concern based on their watershed
- When CA2 is removed:
  - NY1, NY2, MA1 farms are not a concern
  - the two CT farms are above 20ppm threshold

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What did we learn?!?!

- Overall scores do not show the whole picture
- Aggregate instability, compaction, and organic matter depletion are major constraints on many farms
- Baseline values, while difficult to compare initially, establish a starting point to compare changes over time
- Phosphorus concerns can vary widely between states

Photo by: Kevin Keenan

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ECONOMIC RESULTS

AFT edited the NRCS SHDT Data Collection Form

Field Operations Worksheet

- AFT added to the template for better data collection

Analysis:

- Compared control and treatment field/plots
- Calculated costs and economic effects on net income
- Attained Year 1 cost to establish cover crops

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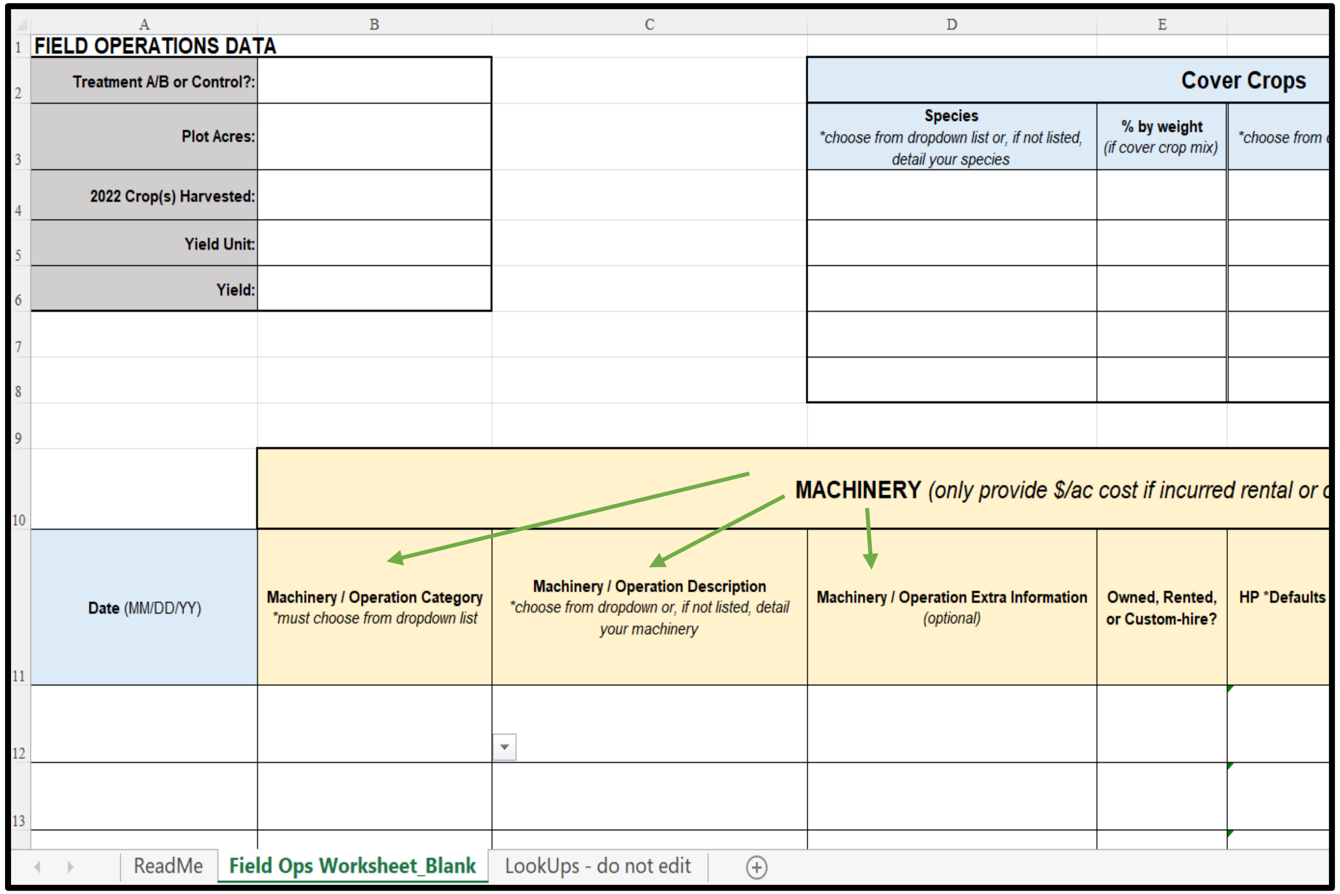
Economic Methods

- **Updated the NRCS Field operations worksheet to:**
    - *Make it more user-friendly*
    - *Insert machinery dropdowns*
    - *Pull from associated budgets*

- **3 ways collected data from farmers**
    - *Online SharePoint doc*
    - *Emailed hard copy*
    - *In-person or phone conversations*

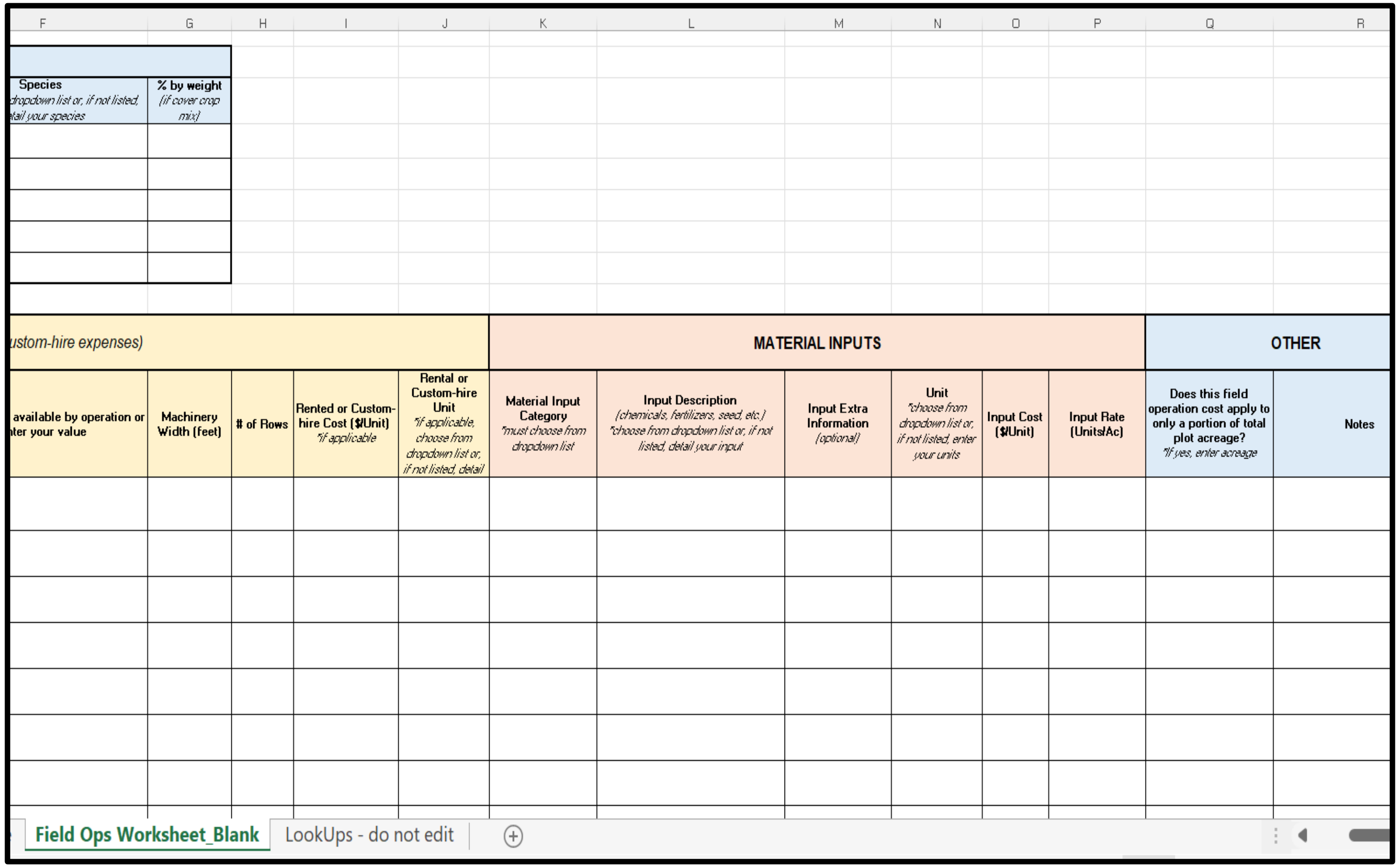


Economic Methods

Data collected in our field operations worksheet

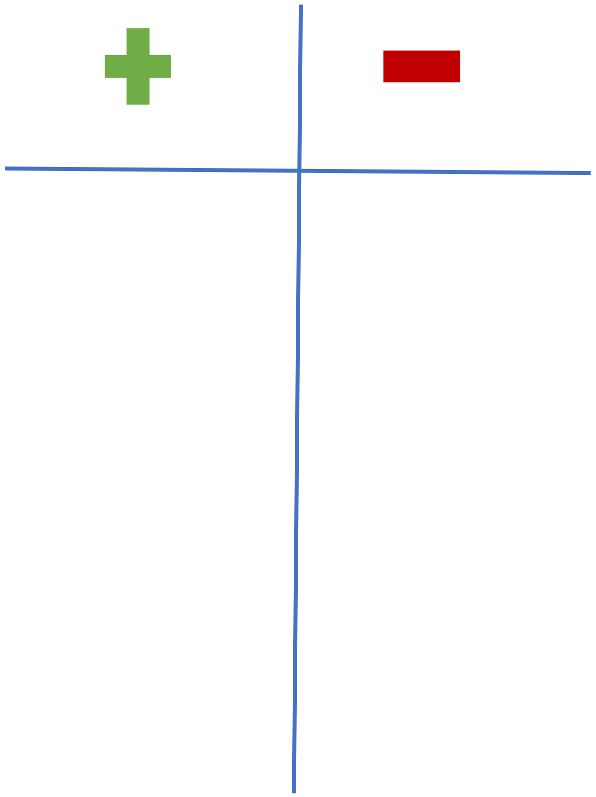
Data collected:

- **Crop & yield & acreage**
- **Operation date & category**
- **Machinery type**
  - Owned/Rented/Custom-hired
  - Horsepower (HP)
  - Row width
  - $/unit of rented or custom-hired operations
- **Material Type**
  - $/unit
  - Rate (units/ac)
- **Other operations not applied on a per acre basis**
  - $/unit



Economic Analysis

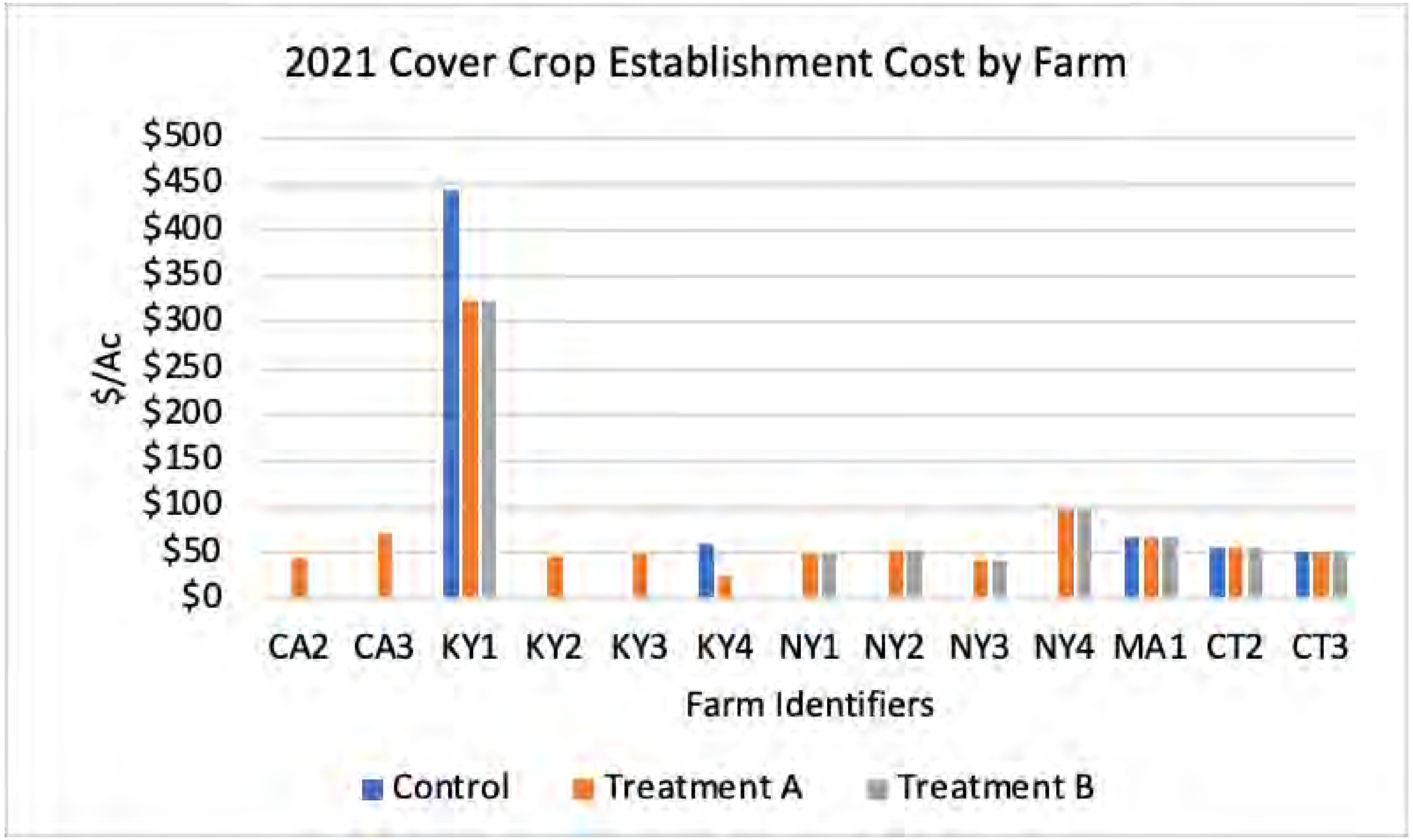
Three outputs from our cost and benefit analysis



- T-charts included in farmer reports – year 1 qualitative
- Calculated net income with partial budget of yield x published price minus machinery /operations cost & materials in dollars/acre for both control and treatment plots
- Compared net income & treatment costs between treatment and control

Economic Results for Year 1 (2021)

$24 to $98/Ac total cost to establish cover crops (excluding K1)

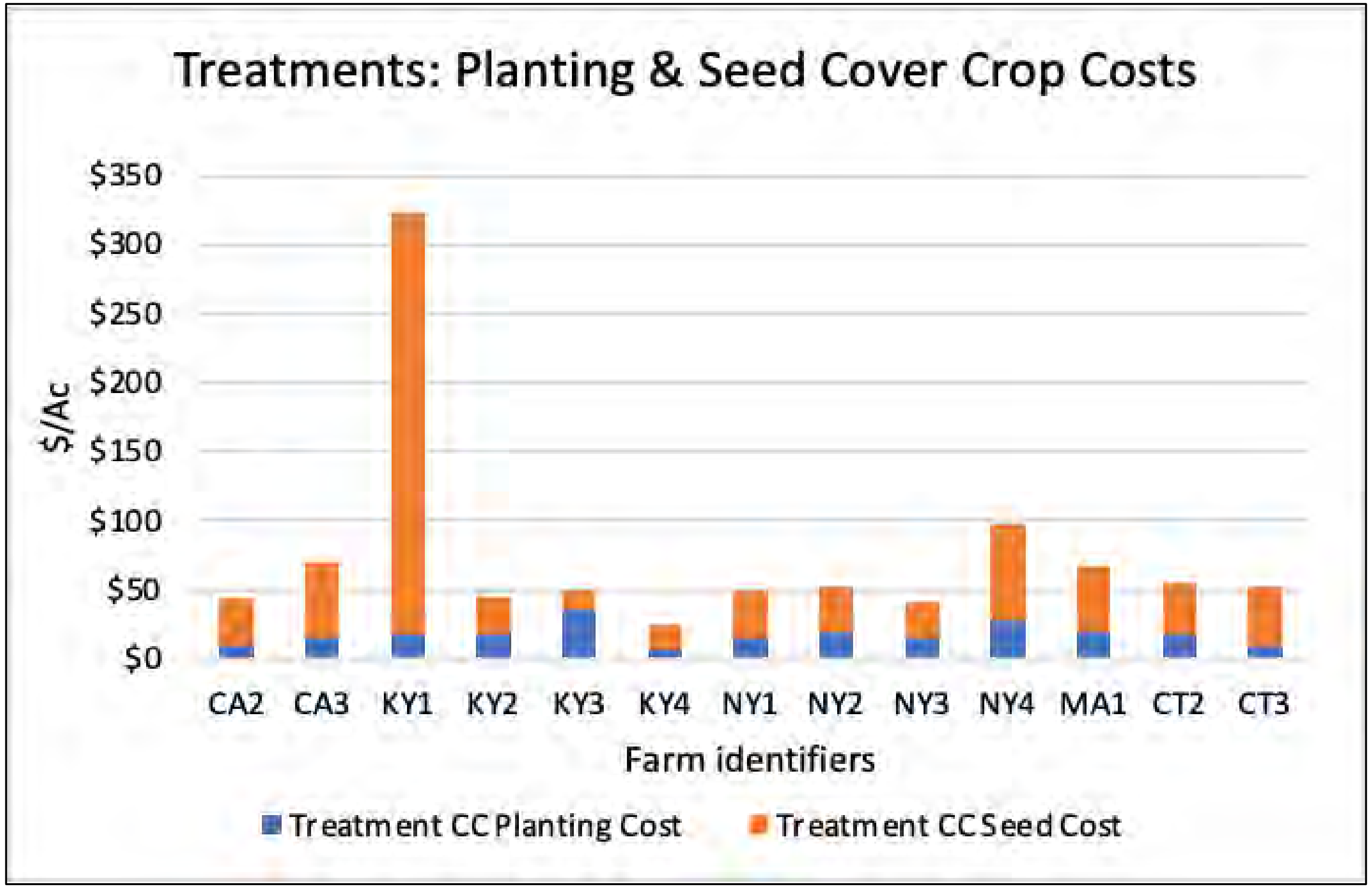


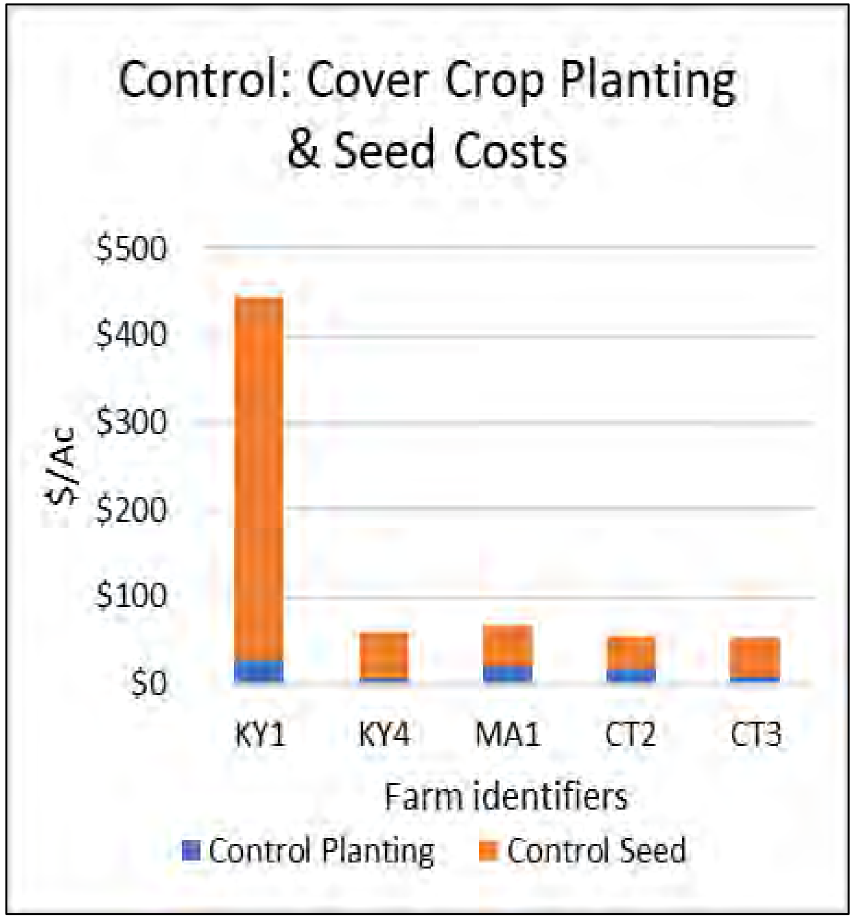
- Establishment costs including seed & planting range from $24 to $323 per acre (excluding KY1 control)
- KY1 control $444/acre includes the cost to terminate and replant the control cover crop with field design change
  - First Planting $323/Ac. Terminate and 2nd planting $121/Ac for a total of $444/Ac
- KY4 treatment missed summer cover crop in 2021, so was only the fall planting

Economic Results for Year 1 (2021)

**Cover Crop (CC) planting costs range from $7-$36/Ac*

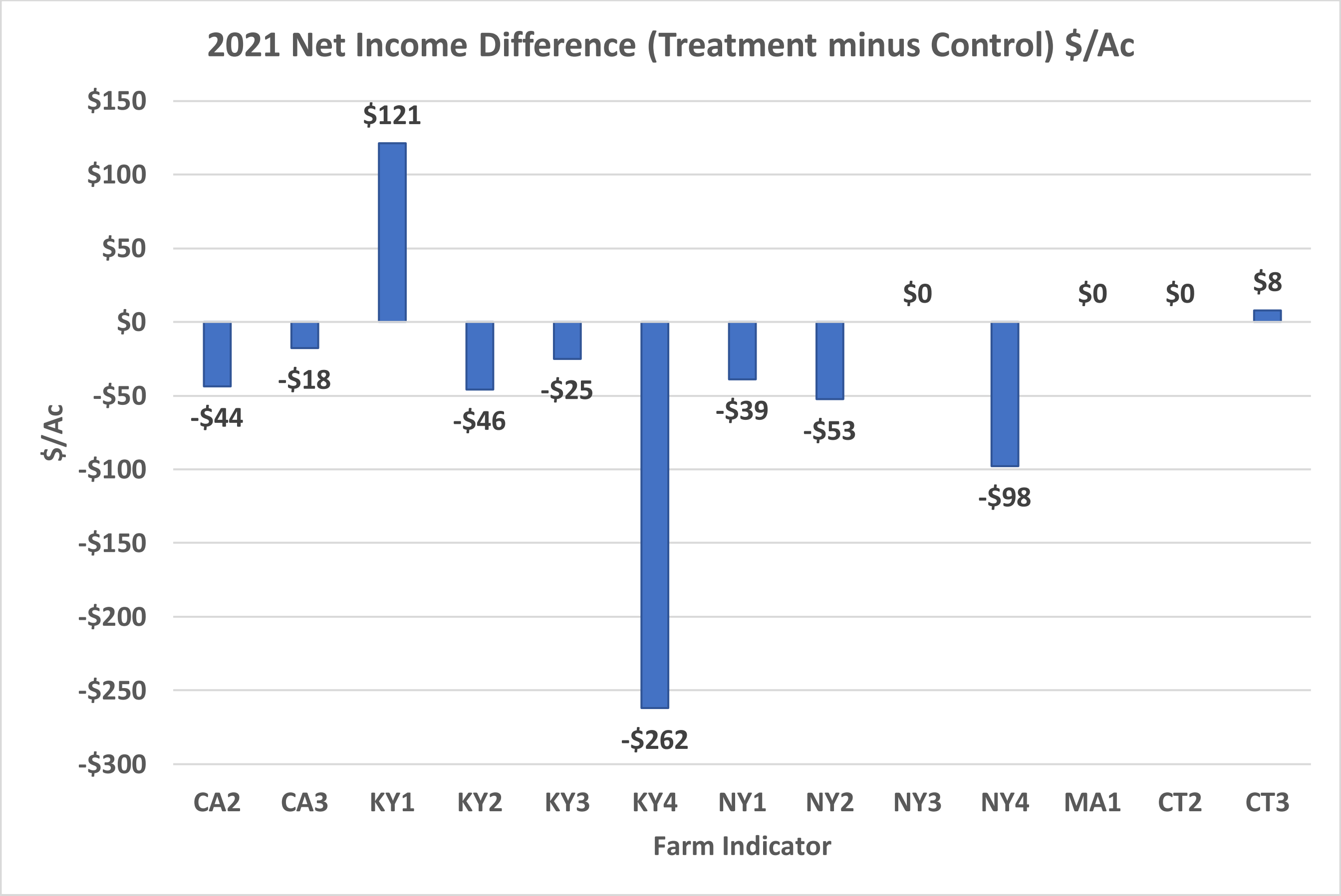
**CC seed costs range from $13-$417/Ac (KY1 is higher rate & organic mix)*





Economic Results for Year 1 (2021)

** Cost to implement treatment occur before benefits are observed & thus, had negative effect on net income per acre*



- Net income reduced from $18 to $98/Ac on 7 farms
- Net income unchanged on 3 farms; Expected change in 2022
- Net income increased $8/Ac on CT3 because of implementing No-Till
- KY1 Control cost $121/Ac more than Treatment
- KY4 Control had cover crop in 2020 termination in 2021 costs plus more costly 2021 cover crop planting cost than the treatment field


COMING UP: FIELD DAYS

Field Days – Scaling up via information transfer

- Determine key topic to share that meets audience needs
- Keep it light and informal; Handouts not presentations
- Include farmer panel
- Use an audio system such as a portable speaker
- Provide food; Allow time for social interactions
- Include an in-field demonstration
- Provide Continuing Education Credits
- Promote the event early, regularly and broadly
- Include pre and post participation surveys
- May use a QR code to facilitate survey completion

FARMER EXPERIENCES

Kentucky Reflections at Mt. Folly Farm

- **Laura Freeman and Bill Kingsbury**
- **Diversified Organic Farm in Winchester, KY**
- **Founded Laura's Lean Beef in 1980's**
- **Corn, soybeans, hemp, sunflowers, small grains, cattle on 1,150-acres**
- **Circular farm economy:**
  - **Wildcat Willy's farm-to-table bar and distillery**
  - **Laura's Mercantile: Value added hemp products**

Farmer Goals:

- Varying cover crop seeding rates impact weed populations
- Reduce compaction and improve soil structure
- Assess economic, soil health, social effects of cover cropping strategies, crop termination, no-till cash crop planting

Soil Constraints:

- Immense weed population
- Johnsongrass & cocklebur
- Soil compaction and hardpan in top 6”
- Lack of soil structure

Soil and Farm Constraint Photos from L-R: Johnsongrass; lower grain yield/quality; water infiltration; plating and horizontal rooting

Replicated Plot Design

- Control: Cereal rye cover crop at UK recommended rate, tillage prior to cash crop planting
- Treatment A: Diverse cover crop mix at high per/acre rate, tillage prior to cash crop planting
- Treatment B: Diverse cover crop mix at high per/acre rate, cover crop terminated with roller-crimper, no till cash crop planting after cc termination

Lessons Learned:

- Weed control is primary concern
- Change design to combat weeds first, address soil constraints second
- Last photo shows what a weed-free soybean crop looks like on Mt. Folly Farm
  - Achieved with regular mechanical cultivation
  - Paradox: Well-timed cultivation works very well often at detriment to overall soil health and function

Adaptive Management:

- Equipment availability and timing
- More diverse cover crop/seeding rate to address constraints

Jay Swede, NY
Farmer Report & Reflections

- Planting rye since the 80's but adopted strip till in 2005 to address compaction, erosion, and reduce inputs
- Evolved to planting oats with radishes in strips between wheat and then corn planted in strips
- Degrading soils for a long time. He picked up this field. Making improvements over time. Manure added in 2010, but only CC in 2014, 2015, 2018 and 2021
- Field was soft to walk on and looked good but subsoil issues
- Approached farmer with quantification
- Farmer can specifically address subsoil issues
- Confounding issues make addressing constraints challenging

LESSONS LEARNED

Reflections from Ellen Yeatman

AFT OFDT’s longest serving bus driver

#1 (a): Project kick-off challenges

- Delayed paperwork & funding for 2 months & no clear guidance on methods, data requirements, or data submission
- AFT staff transitions (2 project leads left 1 month into project)
- **AFT underestimated the time it would take to secure farmers participation and determine experimental designs at each of the 17 farms**
  - 2 farms dropped out and several treatments not implemented correctly
- Super demanding for NGOs to take on this kind of project as staff are not full-time researchers, but doing many, many other things

#1 (b): Project kick-off solutions

- AFT uniquely staged as a non-profit organization to implement an academic-level on-farm demonstration trial with side-by-side, replicated plots
- With AFT’s scientists on staff, we were able to face the many challenges kicking off this project, especially in terms of solidifying soil sampling methods & analysis, economic data collection, and choosing demonstration plot designs that answered the farmers’ resources concerns & worked within the complexity of their commercial farm operation

Farmer Recruitment Challenges

- Hard to find & recruit late- to middle-adopters, AND historically underserved farmers
- Need 1-year really, especially for co-production strategy

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Reflections from Ellen Yeatman

AFT OFDT's longest serving bus driver

On-Farm Demo Trial

- Very difficult to find farmers
- Very difficult to implement within complexities of a commercial farm, especially replicated plots
- Limited options for experimental design (depends on farmer, crop rotation, current practices, etc.)
- Time intensive
    - No control of field operations
    - Extra time spent choosing treatments that are possible & interesting for farmer
    - Extra time spent scheduling soil sampling & gathering field operations data
    - More effective to visit in-person (driving multiple hours to make these visits)
- More reflective of reality (large-scale, no control over variables, risk to personal income)
- More likely to convince farmers to adopt soil health practices

Research Station

- Location chosen
- Any experimental design is possible
- Less time intensive
    - Full control of field operations
    - Easy scheduling for soil sampling
    - Controlled data collection
    - Multiple experiments in one place, so less driving time
- Not reflective of reality
    - Researchers NOT farmers
    - Small-scale
    - Controlled variables
    - No risk to personal income, so can let things go awry
- Less likely to convince farmers to adopt soil health practices

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Reflections from Ellen Yeatman

AFT OFDT's longest serving bus driver

AFT uniquely qualified to take on this kind of project as an NGO!

- **Adapted to farm challenges, pandemic challenges, physical distance challenges, working mostly in a virtual setting on a very physical, on-the-ground project, etc.**

- **Co-production strategy -** very unique and huge strength for this project
  - AFT staff prioritized letting the farmer drive the experimental design to answer their questions and/or address regional barriers, &
  - Making project fit the farm operation, not forcing an experimental design upon them
  - And that takes A LOT of extra time, so it would have served us well to have a full year of just recruiting farmers and determining the experimental design that would for sure work for them
  - Working with farmers on working farms requires adaptability and farmer investment and engagement from the beginning, along with on-the-ground partners

Aaron Ristow discussing field ops with participating farmer

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Reflections from Ellen Yeatman

AFT OFDT's longest serving bus driver

Advice for those wanting to implement on-farm demo trials…

Isaac Freund, CT participating farmer, roller crimping

- **Budget enough time, resources, and number of staff to provide active, on-the-ground technical assistance**
  - **Ideally, 1-year for recruiting your farmers and solidifying demonstration trial plan that works for your farmer**
- **In-person visits are the best for securing farmer participation, determining treatments, gathering data, and ensuring implementation**
- **Partnerships are key for achieving the first two bullets**

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Q&A + DISCUSSION
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Questions we have for you

1. Are there other OFDT project leaders in the room that can share reflections on what they’ve heard from us and how it is similar or different to their projects?

2. Are there suggestions audience members have for us or making our project more efficient? Stronger?

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Thank you!

Please get in touch with Aysha Tapp Ross, our Soils Team Manager with questions or suggestions for us:

ATappRoss@farmland.org