STATEWIDE ORCHARD SOIL HEALTH PROJECT - UPDATES

Debbie Aller, PhD

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Cornell CALS
College of Agriculture and Life Sciences

NEW YORK SOIL HEALTH

NEW YORK ORCHARD SOIL HEALTH TEAM

DEBBIE ALLER
Extension Associate,
Cornell - NYSH Program

MICHAEL BASEDOW
Tree Fruit Specialist,
ENYCH Program

JANET VAN ZOEREN
IPM Specialist,
CCE - LOF program

MARIO MIRANDA SAZO
Fruit Extension Specialist,
CCE -LOF program

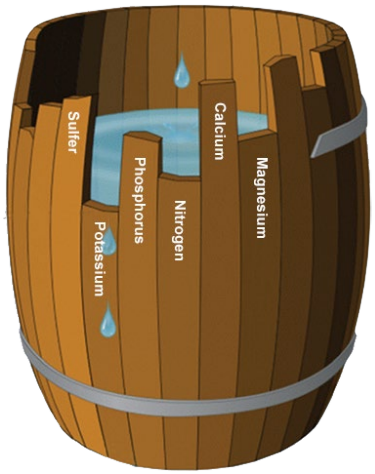
GREG PECK
Associate Professor,
Cornell University

DAN DONAHUE
Tree Fruit Specialist,
ENYCH Program

KYLE WICKINGS
Associate Professor,
Cornell AgriTech

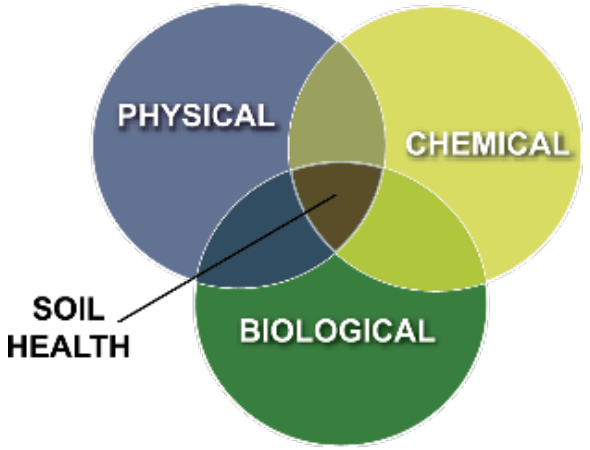
DIANA OBREGON
Postdoc, NYSIPM Program

SOIL NUTRITION

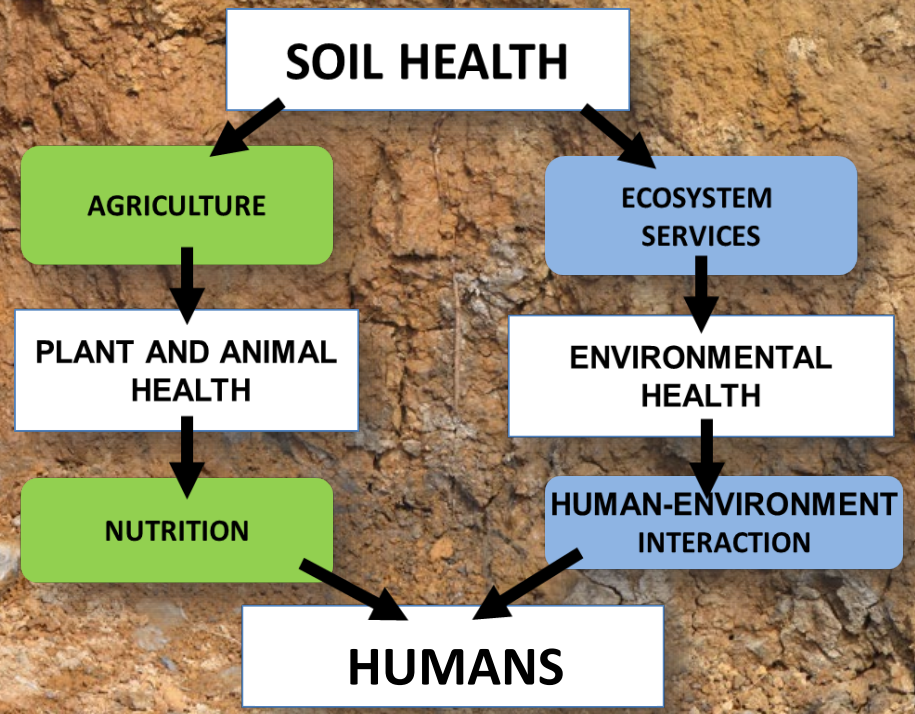


SOIL HEALTH

‘the capacity of the soil to function *or* the ability of the soil to perform key ecosystem functions that sustain plants, animals, and humans’



SOILS HAVE INHERENT AND DYNAMIC SOIL QUALITY



INHERENT SOIL QUALITY

The result of a location's unique combination of minerals, climate, biology, relief, and time

DYNAMIC SOIL QUALITY

Changes due to human use and management

SOIL HEALTH

Focuses on the dynamic and anthropogenic aspects of soil quality

SOIL HEALTH IN WASHINGTON STATE APPLE PRODUCTION

Important soil health indicators for Central WA orchards:

- AWC & % sand (water availability indicators)
- Bean bioassay & lesion nematode (root health indicators)
- Macro & micronutrients (nutrient availability)
- Penetration resistance or bulk density (compaction indicator)
- POXC & % OM (organic matter indicator)
- PMN (organic N availability)

RESEARCH ARTICLE

Soil health indicators for Central Washington orchards

Sara Tianna DuPont[1]*, Lee Kalcsits[1], Clark Kogan[2]

1 Tree Fruit Research and Extension Center, Washington State University, Wenatchee, Washington, United States of America, **2** Department of Mathematics and Statistics, Washington State University, Pullman, Washington, United States of America

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PREVIOUS RESEARCH IN NEW YORK

GROUNDCOVER MANAGEMENT - MULCHING

- Increase in tree growth and yield is inconsistent
- Increase SOM and biological activity
- Increase water holding capacity, making the orchard more resilient to drought
- Increase plant available minerals and disease suppression
- Reduce soil erosion in hillside plantings
- Increase weed suppression, especially in organic systems
- Reduce leaching of nutrients (nitrate) and pesticides

WHY CARE?

ENVIRONMENTAL PROTECTION

COST/ECONOMICS

PRODUCT RESTRICTIONS

TIME CONSTRAINTS

CONSUMER CONCERNS

PRODUCT EFFICACY

Economic Effects of Soil Health Practices on Gary Swede Farm, LLC (2018)

Increases in Net Income

Increase in Income

ITEM	PER ACRE	ACRES	TOTAL
Yield Impact Due to Soil Health Practices	$71.95	600	$43,168
Total Increased Income			**$43,168**

Decrease in Cost

ITEM	PER ACRE	ACRES	TOTAL
Reduced Machinery Cost due to Reduced Tillage	$23.43	1,500	$35,152
Nutrient Savings due to Nutrient Mngmnt.	$40.65	600	$24,390
Value of Decreased Erosion due to Soil Health Practices	$2.25	1,500	$3,369
Total Decreased Cost			**$62,911**
Total Increased Net Income			$106,079
Total Acres in the Study Area			1,500
Per Acre Increased Net Income			$71

Decreases in Net Income

Decrease in Income

ITEM	PER ACRE	ACRES	TOTAL
None Identified			$0
Total Decreased Income			**$0**

Increase in Cost

ITEM	PER ACRE	ACRES	TOTAL
Cost of Setting up Planter to Handle Residue	$0.72	600	$432
Cover Crop Costs	$51.00	450	$22,950
Residue and Tillage Mgmt. Learning Activities	$0.07	1,500	$98
Cover Crops Learning Activities	$0.22	450	$98
Nutrient Management Learning Activities	$0.16	1,500	$244
Total Increased Cost			**$23,822**
Annual Total Decreased Net Income			$23,822
Total Acres in this Study Area			1,500
Annual Per Acre Decreased Net Income			$16

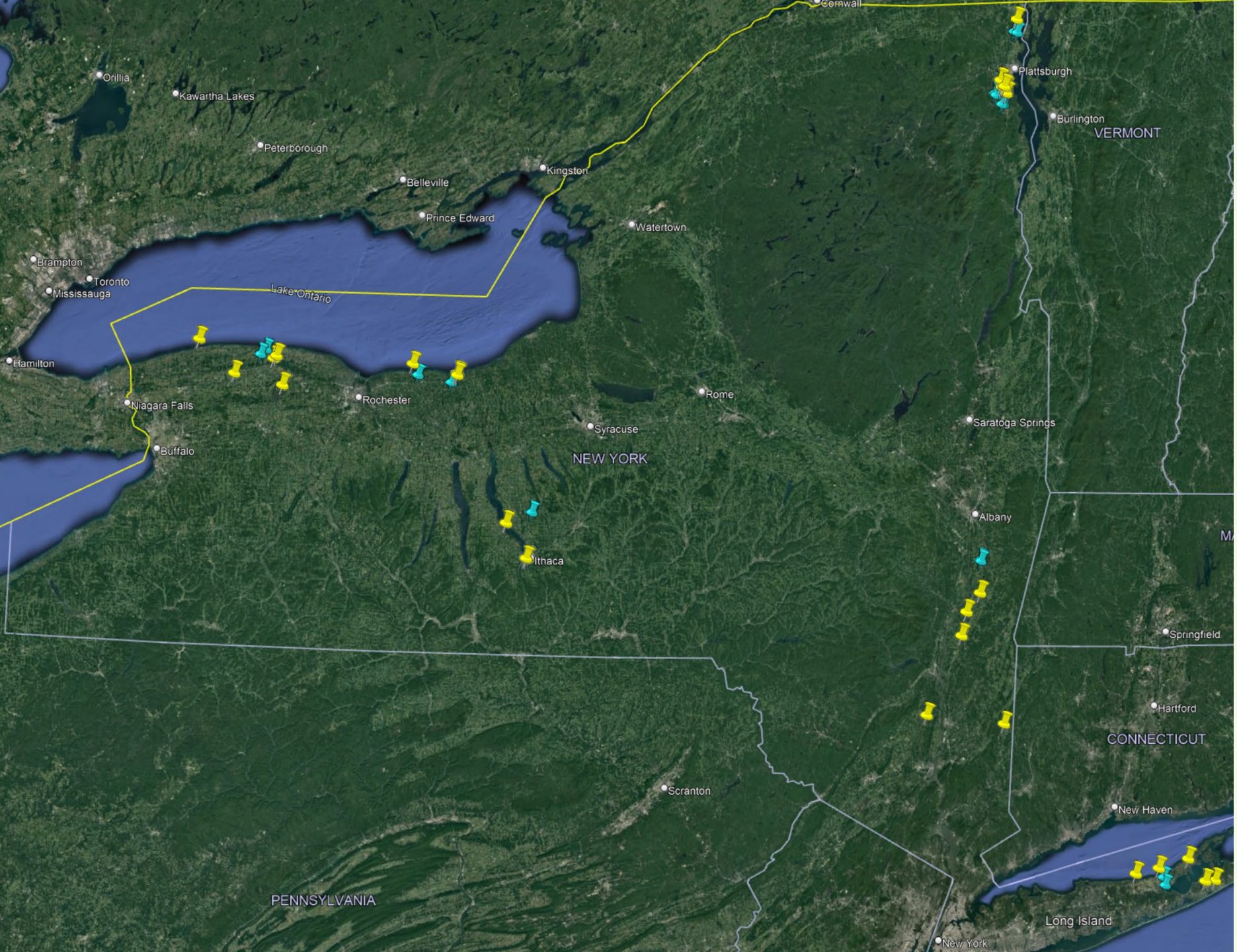
Annual Change in Total Net Income = $82,257

Annual Change in Per Acre Net Income = $55

American Farmland Trust - https://farmlandinfo.org/publications/soil-health-case-studies/

DRIVING QUESTIONS

1. What is the soil health status of orchards in NYS?
2. Is soil health the same in perennial vs. annual cropping systems?
3. What soil health indicators are the best predictors of yield/fruit quality in orchards?
4. What orchard management practices impact soil health indicators?
5. Are there opportunities to improve soil health in NYS orchards?



2021 - 2022 STATEWIDE ORCHARD SAMPLING LOCATIONS

PAIRED SAMPLES (2022)

SAMPLING

SOIL SAMPLING

Cornell Soil health (CASH) test
Nematodes (Clemson)
Root Health Bioassay

FOLIAR SAMPLING

Macro and micronutrients (Dairy One)

MANAGEMENT SURVEY

Fruit yield/quality
Grower management practices

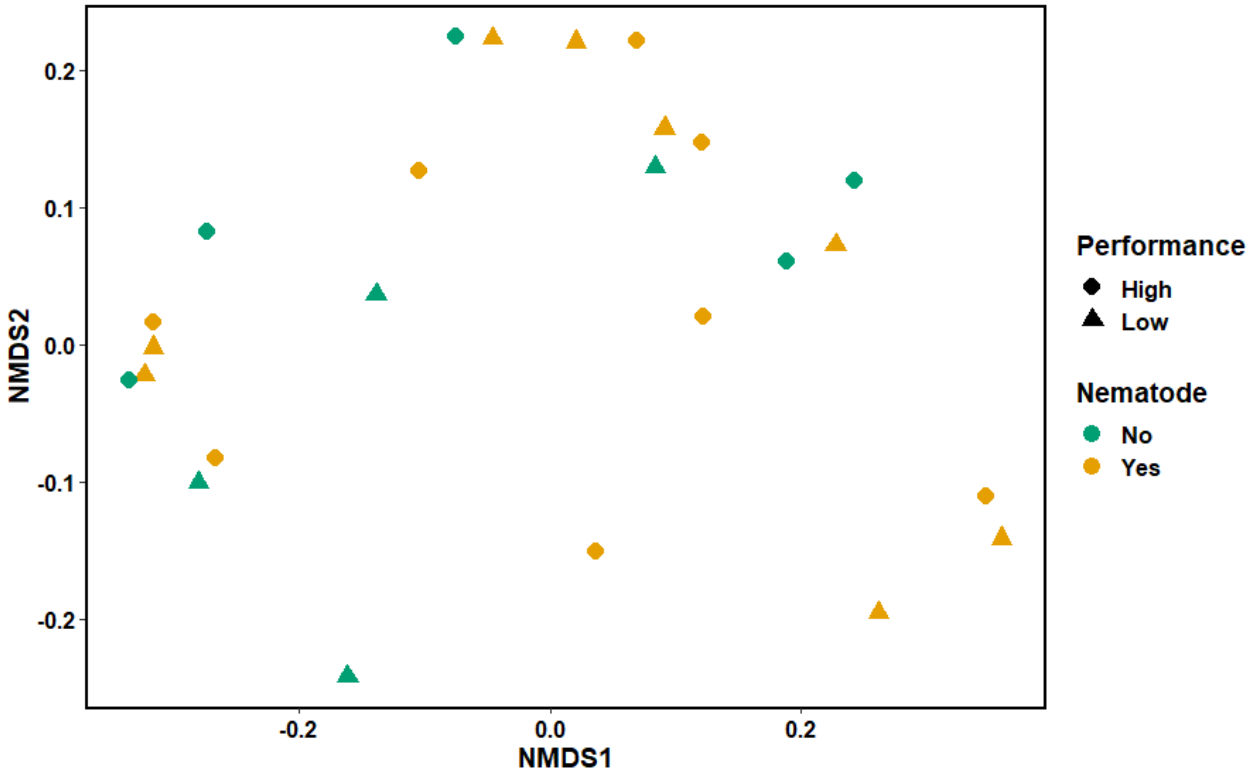
Measured Soil Textural Class: **silt loam**
Sand: **34%** - Silt: **56%** - Clay: **9%**

Group	Indicator	Value	Rating	Constraints
physical	Predicted Available Water Capacity	0.25	92	
physical	Surface Hardness			Not rated: No Field Penetrometer Readings Submitted
physical	Subsurface Hardness			Not rated: No Field Penetrometer Readings Submitted
physical	Aggregate Stability	9.4	11	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
biological	Organic Matter Total Carbon: 2.91 / Total Nitrogen: 0.18	2.9	43	
biological	Predicted Soil Protein	8.60	73	
biological	Soil Respiration	0.4	28	
biological	Active Carbon	718	88	
chemical	Soil pH	6.7	100	
chemical	Extractable Phosphorus	36.7	100	High Phosphorus, Environmental Impact Risk
chemical	Extractable Potassium	148.0	100	
chemical	Minor Elements Mg: 98.5 / Fe: 0.7 / Mn: 0.9 / Zn: 0.9		100	

Overall Quality Score: **74** / High

PRELIMINARY RESULTS - NEMATODES

NO CLEAR RELATIONSHIP BETWEEN NEMATODE PRESENCE AND PERFORMANCE

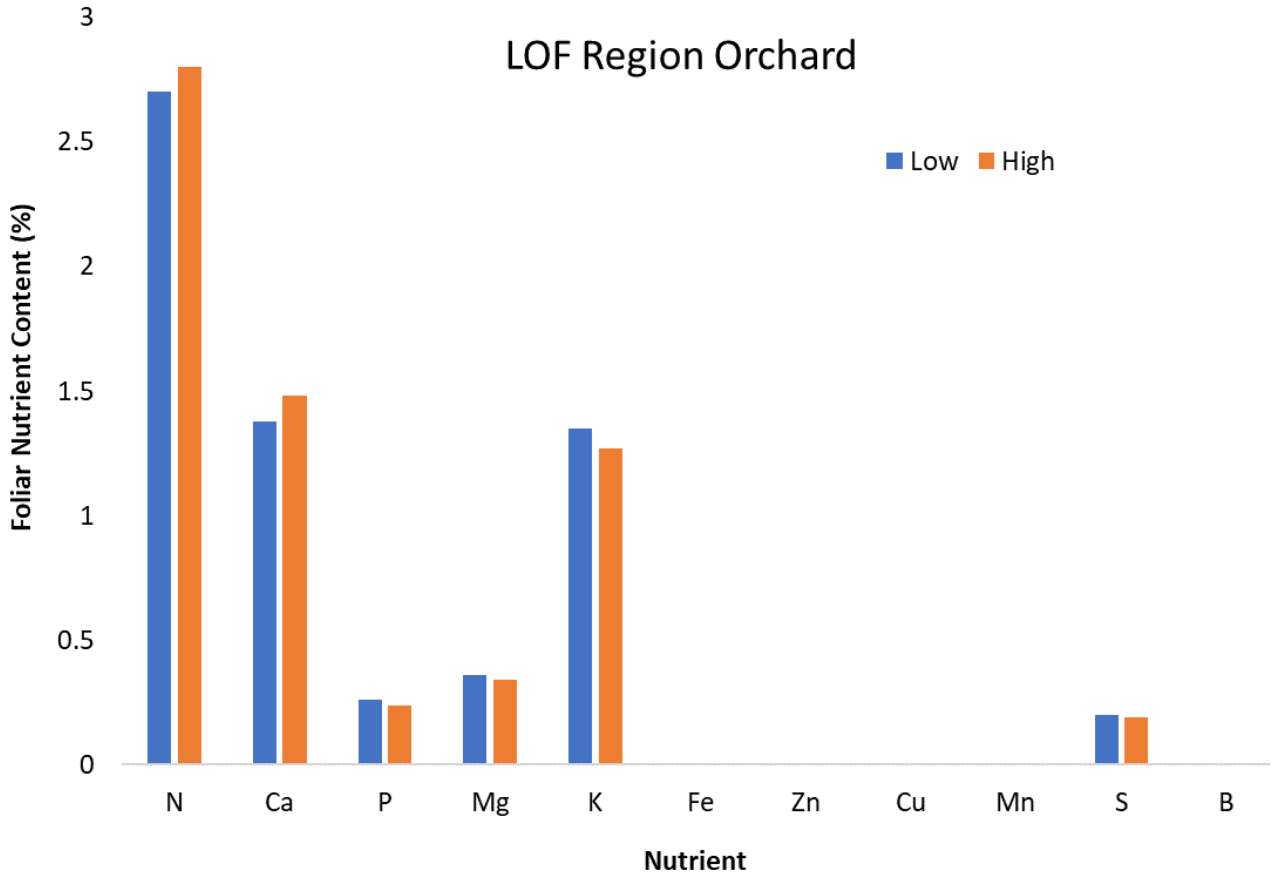


Nematodes present: lesion, dagger, pin, ring, root knot, spiral

92% of orchards (23 of 25) had nematodes present

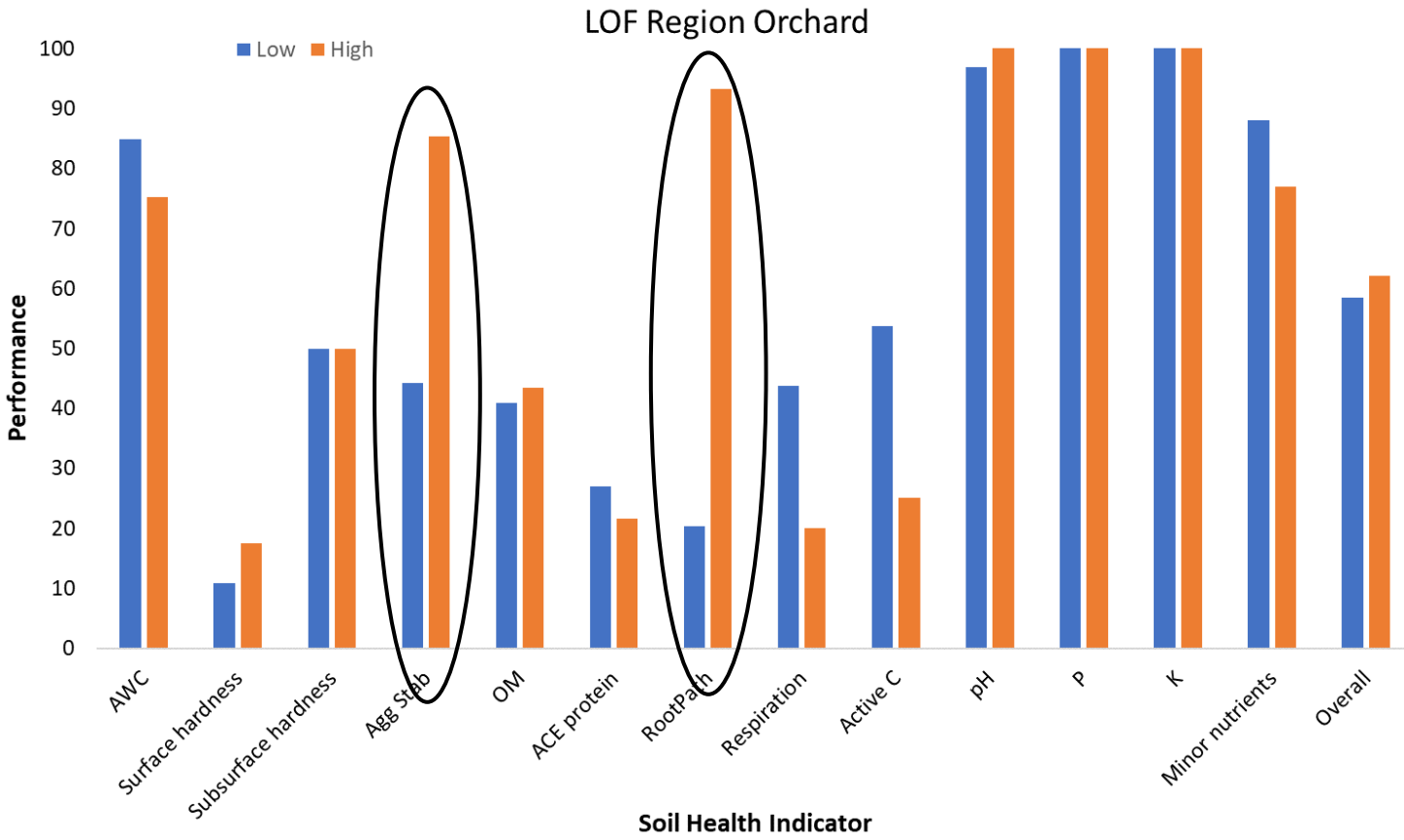
64% of orchards (16 of 25) had levels of concern to plant productivity

FARM EXAMPLE – LOF REGION
FOLIAR NUTRIENTS



FARM EXAMPLE – LOF REGION
SOIL HEALTH INDICATORS

Is the soil health test telling us something the foliar and soil nutrient tests are not?



PRELIMINARY RESULTS – VARIABLE CLUSTER ANALYSIS (YIELD)

2021

Number of Members	Most Representative Variable	Cluster Proportion of Variation Explained	Total Proportion of Variation Explained
10	Total Carbon	0.854	0.267[++]
5	% Silt	0.687	0.107[+]
3	Zn	0.759	0.071
3	Subsurface hardness	0.751	0.07
3	B	0.61	0.057
2	C/N ratio	0.854	0.053
2	Mg	0.804	0.05
2	p	0.69	0.043
1	Root pathogen pressure	1	0.031
1	Aggregate stability	1	0.031

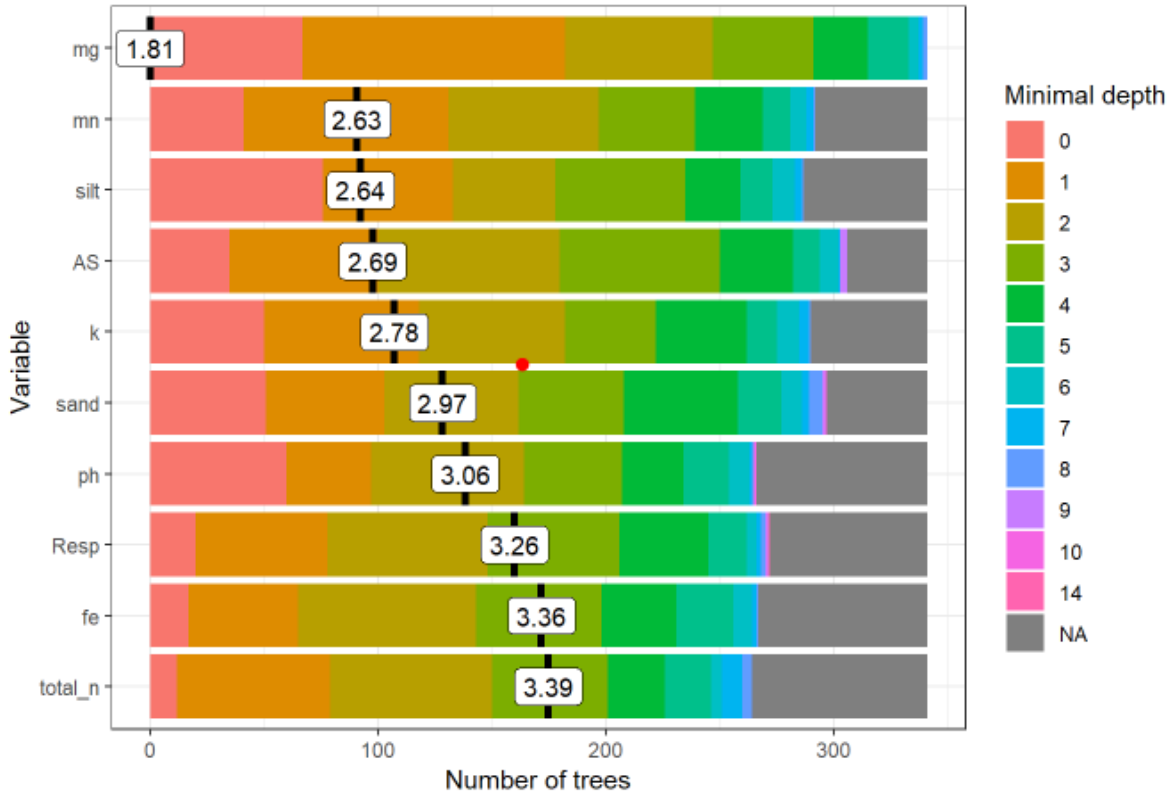
2022

Number of Members	Most Representative Variable	Cluster Proportion of Variation Explained	Total Proportion of Variation Explained
9	Soil Organic Carbon	0.698	0.233
7	Ca	0.683	0.177
4	% Sand	0.854	0.127
3	Subsurface hardness	0.709	0.079
3	Al	0.833	0.062
2	S	0.818	0.061

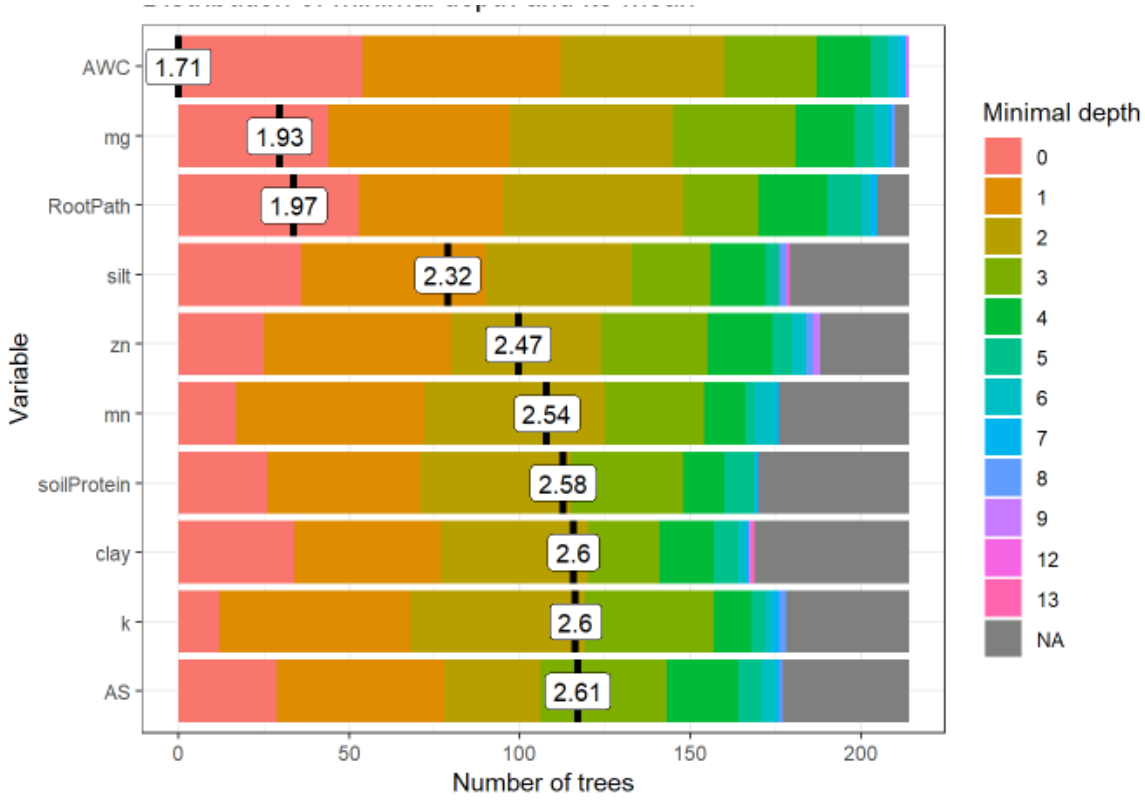
Consistent variables clustering : Soil Carbon, texture, compaction, nutrients

PRELIMINARY RESULTS – RANDOM FOREST MODEL (YIELD)

2021



2022



FUTURE WORK

- Continue to expand soil health sampling
  - 20 orchards in 2023
- Maintain paired sampling method
- Continue nematode & foliar nutrient analyses
- Collect data on soil arthropods (e.g., collembolas, earthworms) – NEW!
- Bulk density data – NEW!
- Create orchard soil health case studies – NEW!
- Develop minimum dataset of soil health indicators for NYS orchards
- Expand into other perennial fruit crops

SUMMARY

Orchard soil health is the capacity of soil to support productive trees over time without negatively affecting the surrounding environment. Soil health is influenced by interacting biological, physical, and chemical properties of soil.

It is important we increase our understanding of the biological and physical properties of soil in addition to the traditional chemical properties to increase the productivity and sustainability of our orchards.

THANK YOU AND QUESTIONS

Debbie Aller, PhD

da352@cornell.edu

www.newyorksoilhealth.org

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