CornellCALS College of Agriculture and Life Sciences

NEW YORK SOIL HEALTH

Research

Use: Questions and Answers for Presenters

Use: Chat for sharing information with all participants

Microbial ecology of urban agricultural soils in New York City

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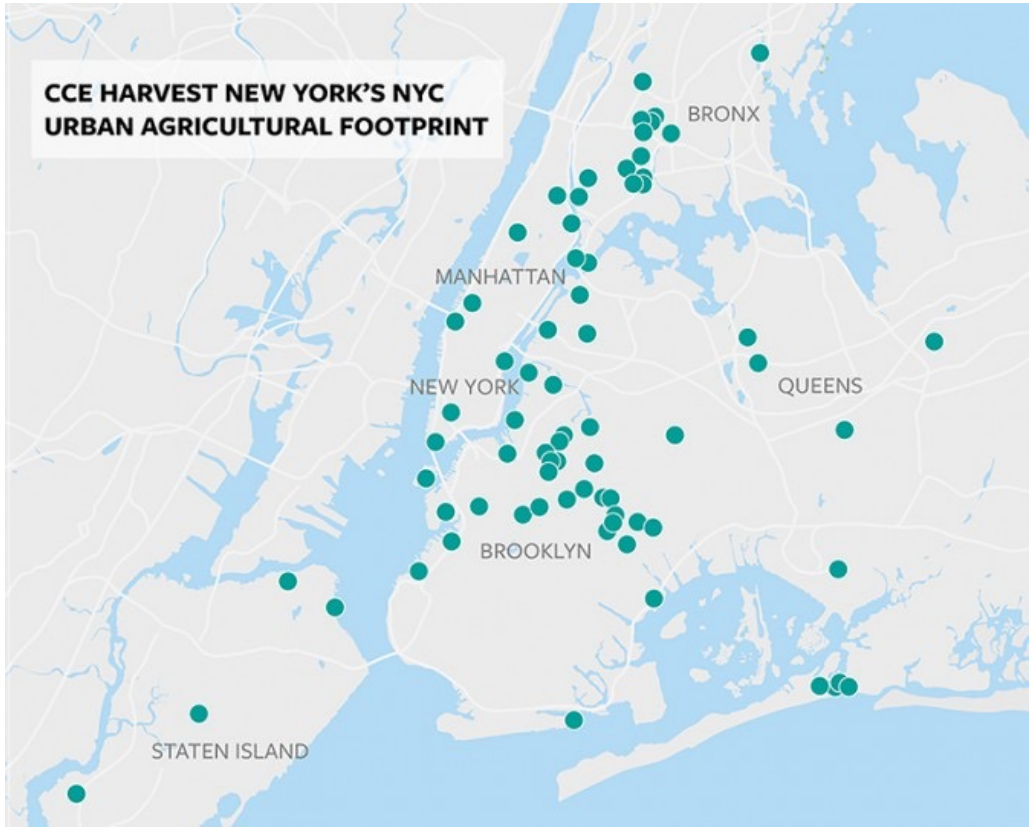
Cornell University
Cooperative Extension

Cornell CALS

Microbial composition differences in NYC agriculture soils across a 25+ year gradient

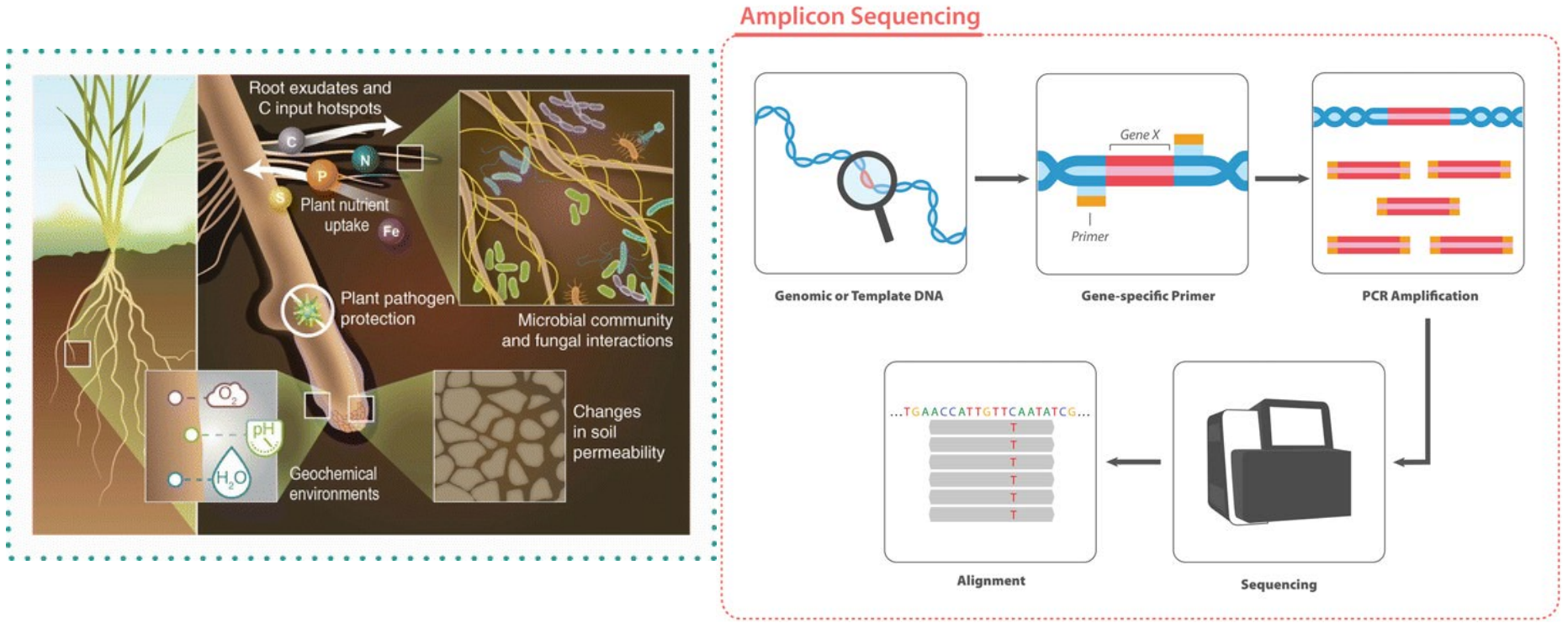


Do microbial communities converge over time to resemble similar taxa and functions?

Site locations

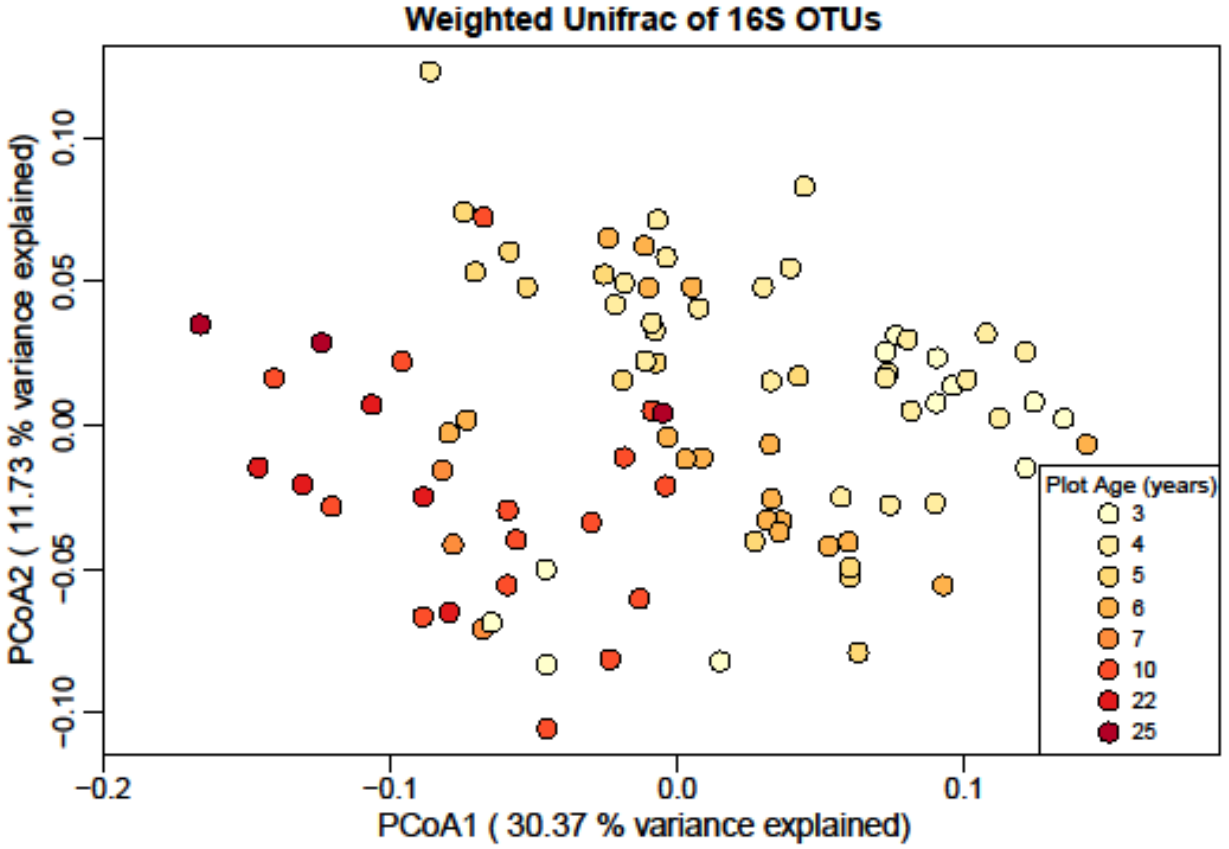
We sampled nine locations in four boroughs in 2020 ranging from 1 to 25+ years old, including 8 ground level and 1 rooftop soil system.

Approach



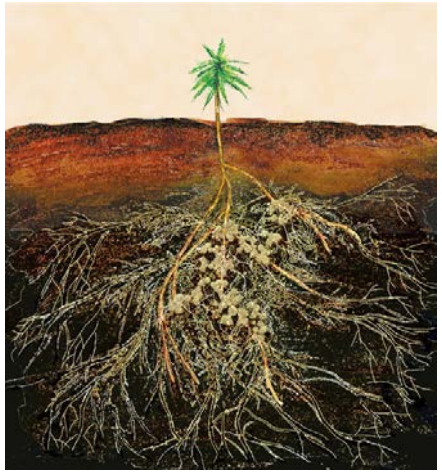
Bacteria and fungi were examined using amplicon sequencing methods of extracted soil DNA

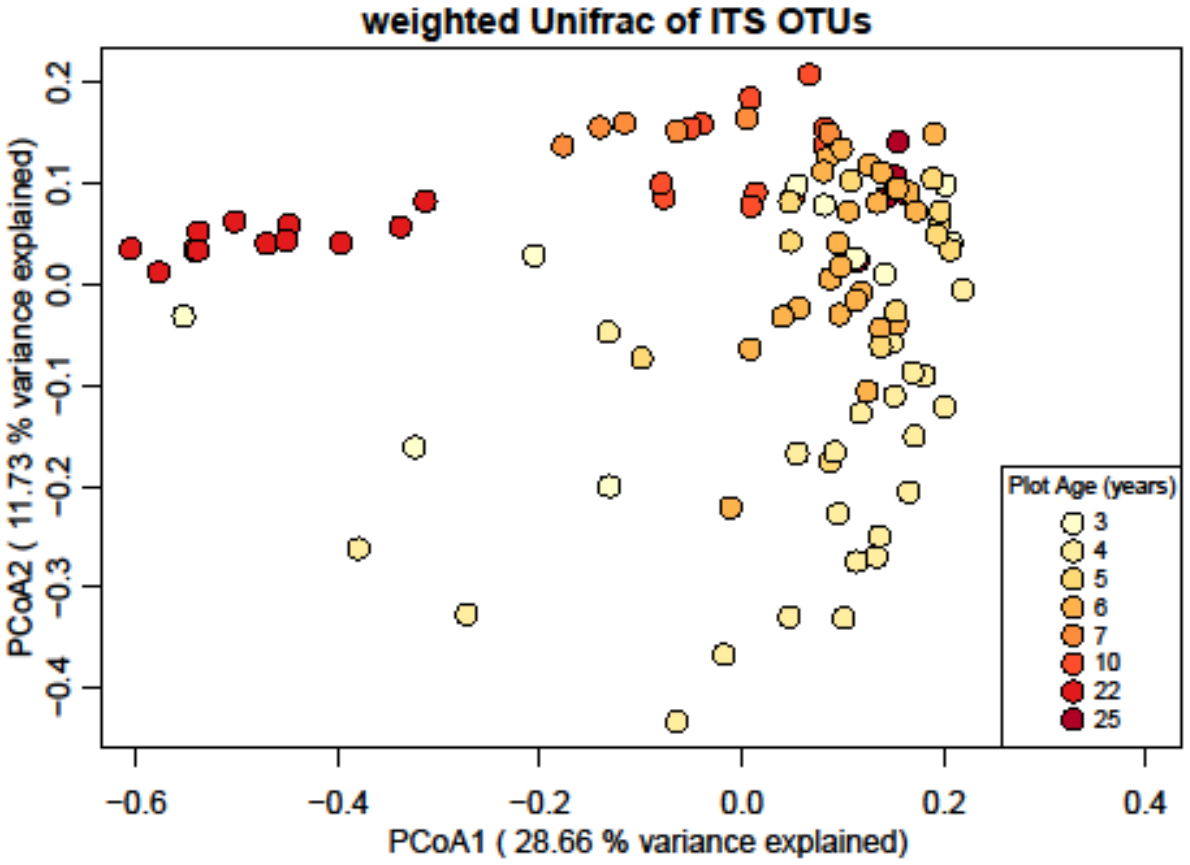
Results: Bacteria



Bacterial composition differs more with contrasting farm site age

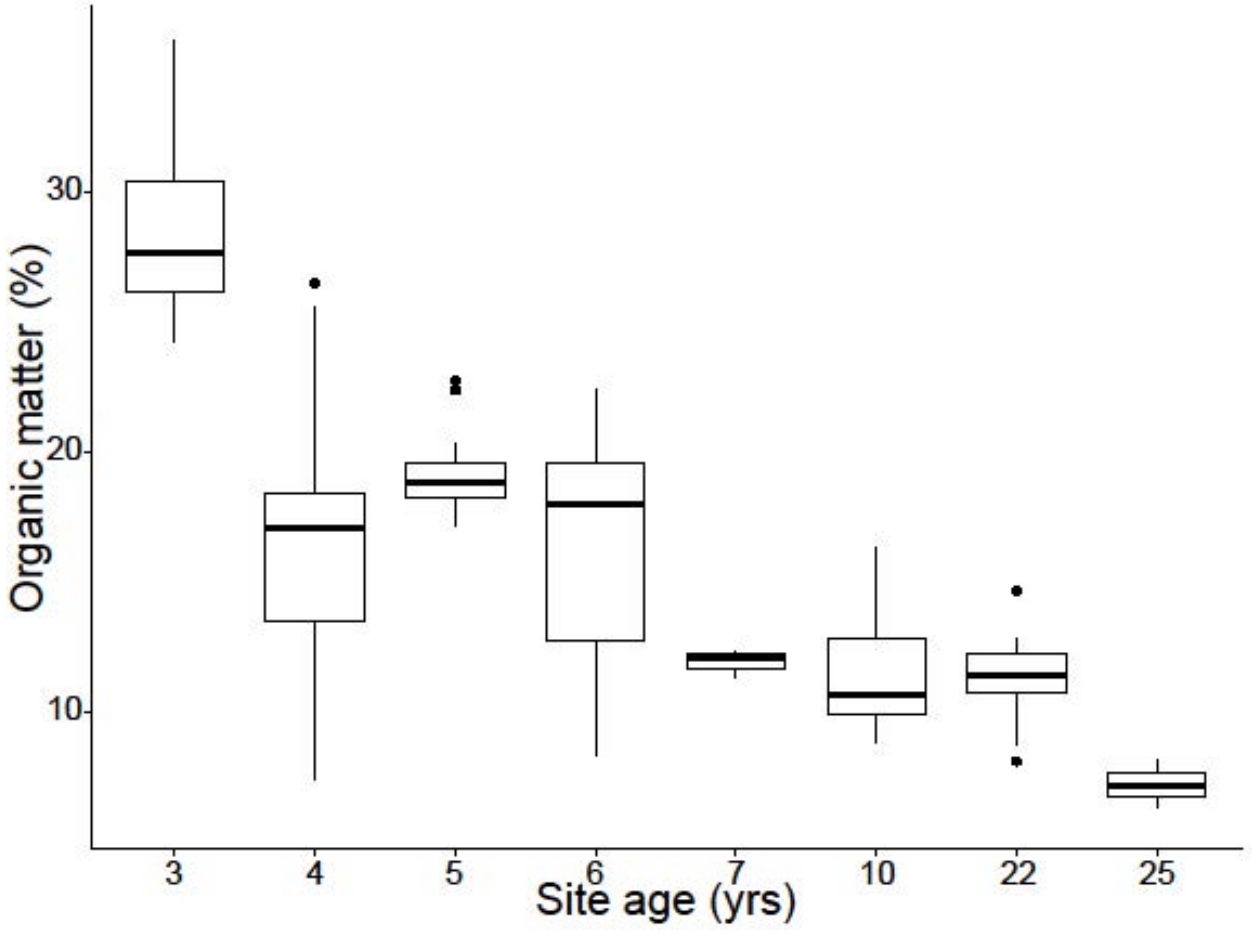
Results: Fungi





Fungal composition shows even greater contrasts by farm site age

Results: OM declines over time



Despite routine applications of new composts and soil mixtures, older farms show lower soil organic matter levels

Takeaways:

Do microbial communities converge on functions over time?

Acknowledgments

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Farm participants:
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New Roots Community Farm
Forest Houses
Randall's Island Park Alliance
East NY Farms
Hellgate Farms Rooftop
Queens Botanical Garden
Kingsborough Community College

Soil health for apple orchard systems

Gregory Peck, PhD
Associate Professor
Sustainable Fruit Production Systems

Orchards have different soil requirements than annual crops

Fewer opportunities to add organic matter

High-density orchard systems with shallow root systems

Increasing desire among producers to minimize fertilizer input

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Apple Orchard Soil Health

"***Our soil health policy, research, and outreach efforts need to be expanded to*** *reach these and other underserved audiences and regions, such as* ***apple*** *and grape* ***growers****, organic farmers, and managers of grasslands, pastures, forests, and urban landscapes."*

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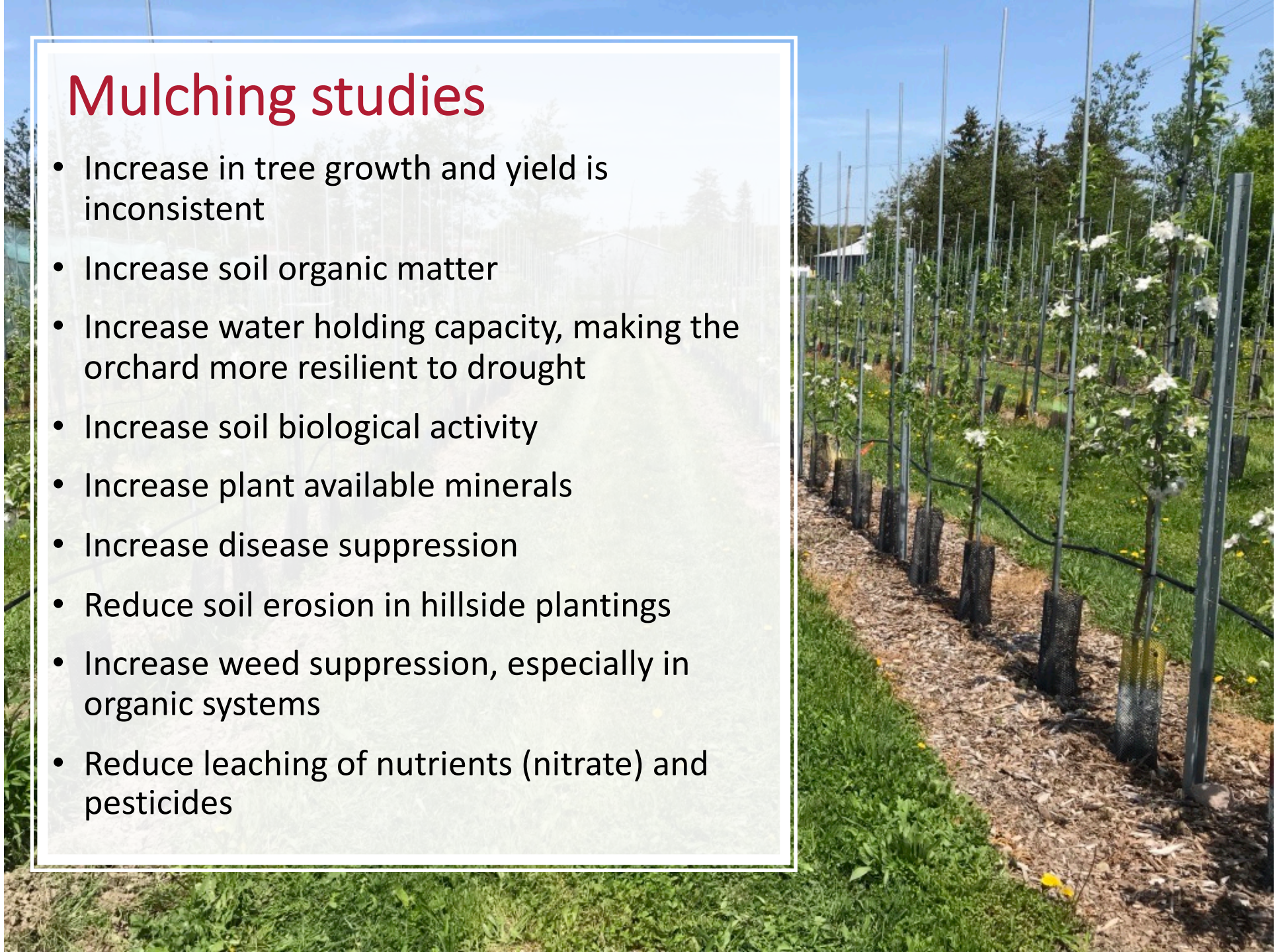
ROADMAP

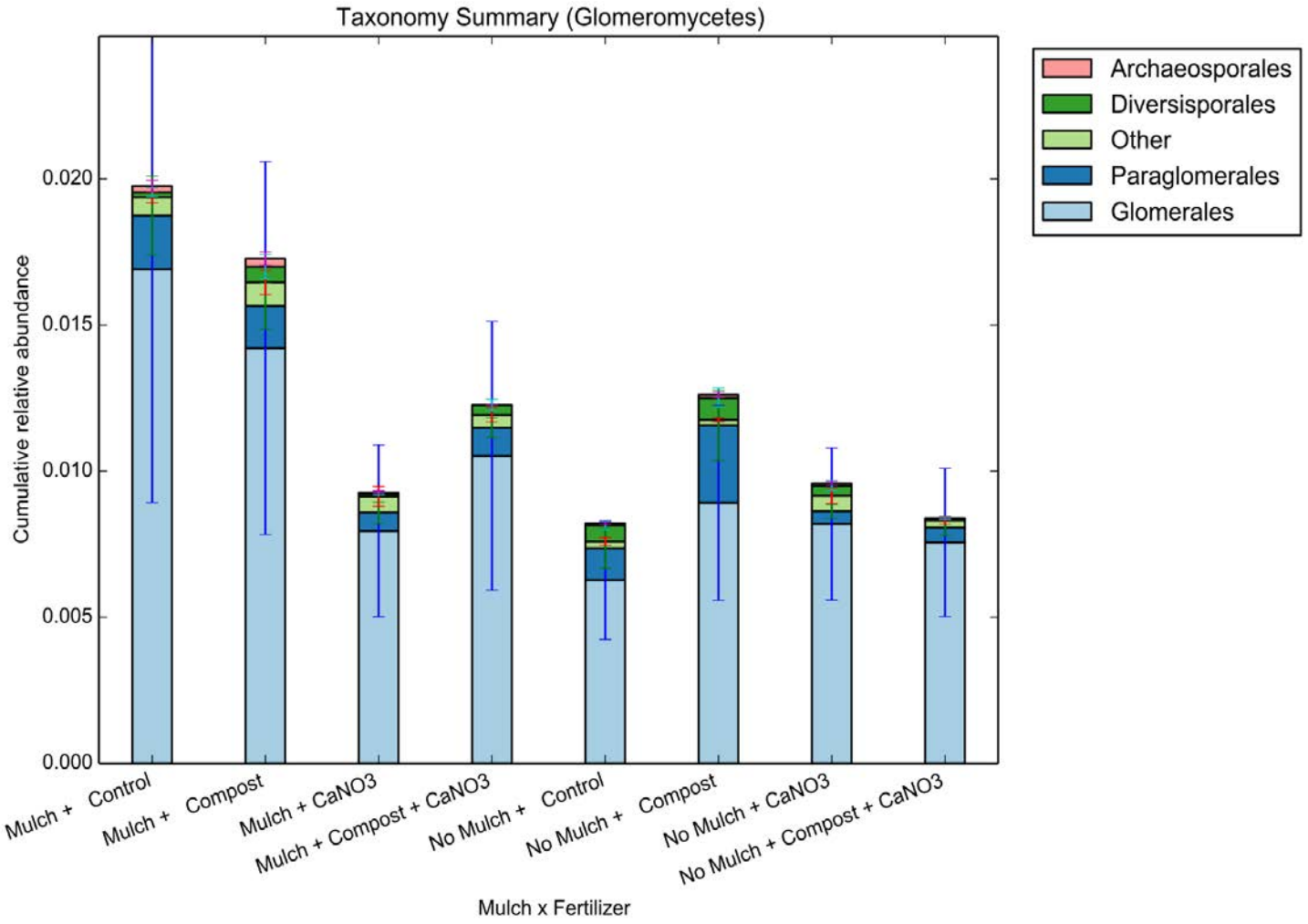
2019

New York Soil Health for Healthy Food, Profitable Farms, and Protection of Natural Resources

Mulching studies

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





Mulches foster beneficial microbial communities

Thompson AA, Williams MA, Peck GM. 2019. **Compost and Geneva® series rootstocks increase young 'Gala' apple tree growth and change root-zone microbial communities**. Scientia Horticulturae. 256:108573.

Weed Management in Organic Apple Orchards

Cultivation or Mulch used alone were not sufficient to control weeds, but when stacked with an herbicide performed adequately

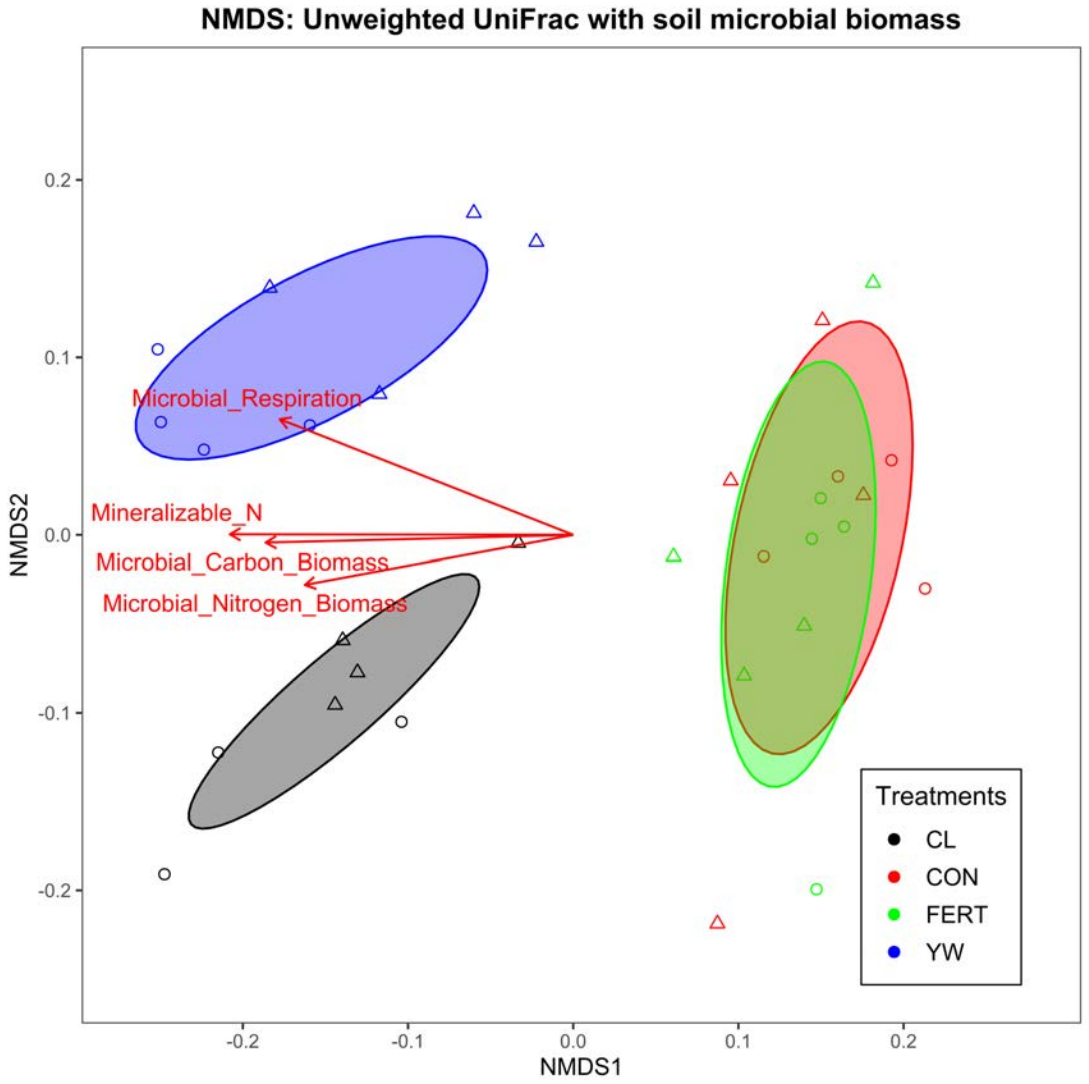
Wood chip mulch **improved soil quality** and limited weed pressure for three years after application

May have not allowed soil to dry in a wet year (2018)	Performed best in a dry year (2019)

Cultivation resulted in the largest trees by the 5th leaf

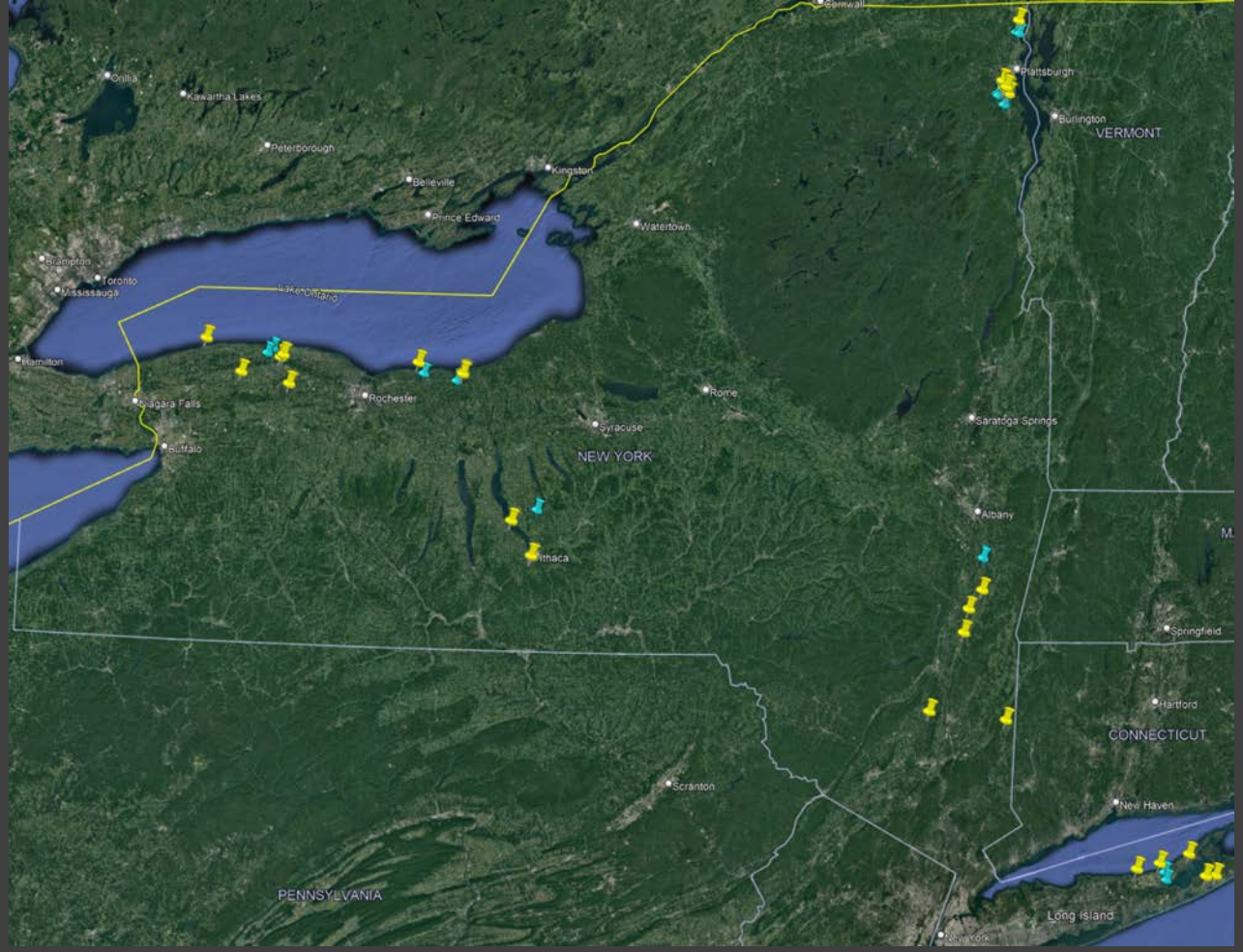
Kate Brown. 2022. Master's Thesis.

Fertilizer applications alter orchard soil microbiomes



- Carbon-based versus synthetic fertilizer
- Compost composition can alter bacterial communities
  - Chicken litter (CL)
  - Control (CON)
  - Calcium nitrate (FERT)
  - Yardwaste (YW)

Sharaf, H., A.A. Thompson, M. Williams, and G.M. Peck. 2021. **Compost applications increase bacterial community diversity in the apple rhizosphere**. Soil Science Society of America Journal. 85:1105–1121.



Statewide Sampling to Develop Orchard Specific Recommendations from the Comprehensive Assessment of Soil Health

2017, 2021, 2022 Soil Health Testing for Orchards

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- Debbie Aller & Joseph Amsili (Soil Health Initiative)
- Mike Basedow (CCE Eastern NY Commercial Hort)
- Janet Van Zoeren & Mario Miranda Sazo (CCE Lake Ontario Fruit Team)

Apple Orchard Soil Health is Being Studied From Multiple Perspectives

- **Composts and Mulches**
  - Greg Peck, Debbie Aller
- **Soil Health and Herbicide Applications**
  - Mike Basedow, Janet Van Zoeren
- **Mycorrhizal Products and Associations**
  - Mike Basedow
- **Rootstock - Soil Interactions**
  - Greg Peck, Gennaro Fazio, Terence Robinson

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Next Steps

Develop orchard-specific recommendations based on soil health indices

Explore microbial contributions to soil health, orchard productivity, and ecosystem services

Incentivize growers to improve soil health

Expand into other perennial fruit crops

Acknowledgments

- NY Soil Health Initiative
- Southern SARE
- Toward Sustainability Foundation
- USDA-Hatch
- Virginia Tech-CALS
- Cornell: CALS, CUAES, CCE
- Drs. Hazem Sharaf, Ashley Thompson and Mark William
- Kate Brown, David Zakalik, and Mike Brown
- Many other colleagues at Virginia Tech and Cornell
- Apple growers in NY, VA, and MD

Opportunities in **Plant Breeding for Soil Health**

NY Soil Health Summit

December 13, 2022

Soil health & plant breeding

1. Maximizing **living cover**
   - Breeding improved cover crop varieties
   - Breeding perennial cash crops
2. Maximizing **crop diversity**
   - Breeding for intercropping systems
   - Breeding new cash crops
3. Minimizing **tillage**
   - Breeding cash & cover crops for no-till systems

Maximizing living cover: **cover crop breeding**

-------- ***all* cover crops:** *high biomass, early vigor, winter hardiness, flowering time* ----------

Crimson Clover

soft & hard seed

Hairy Vetch

soft seed, reduced shatter

Winter Pea

disease resistance

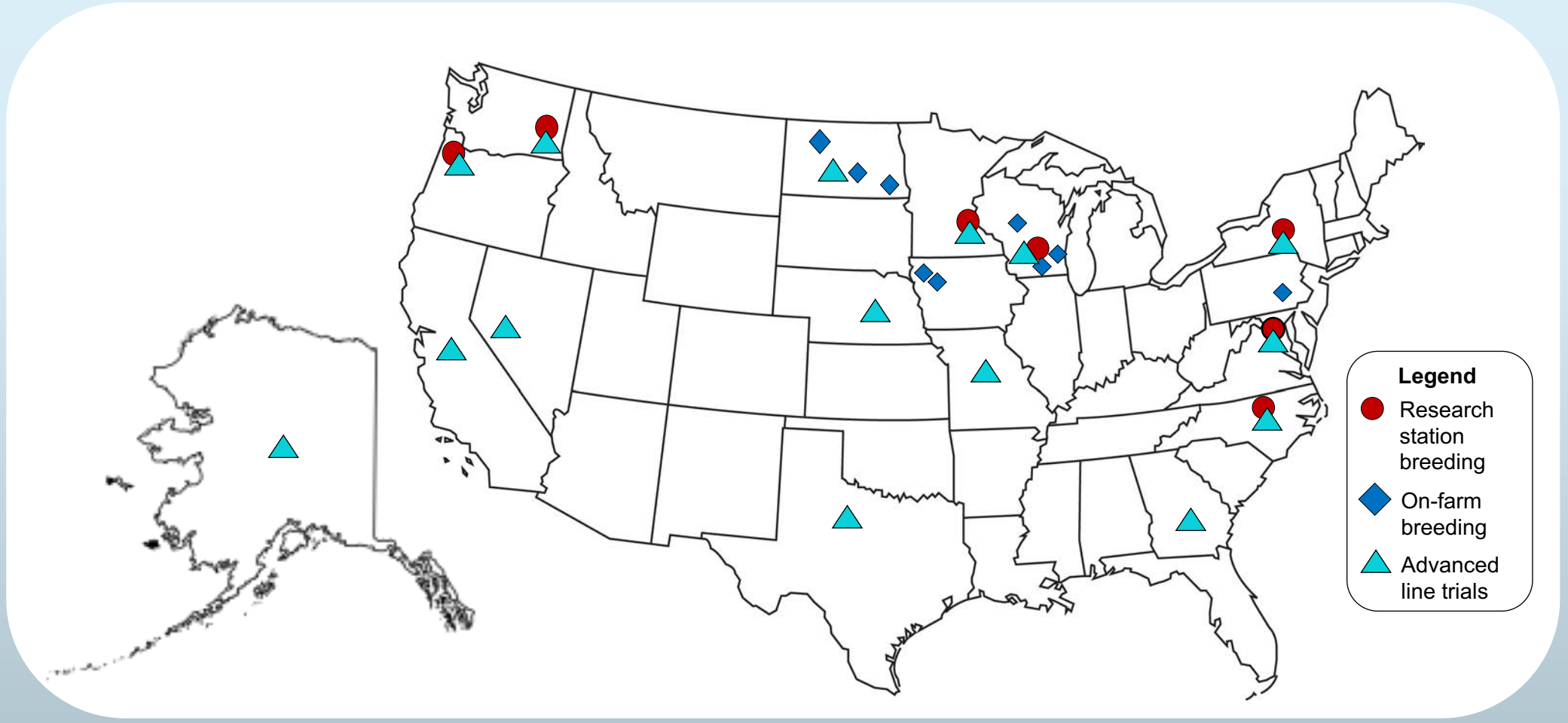
Cereal Rye

allelopathy

Brassicas

---------- ***all* legumes:** *nitrogen fixation* ----------

Cover Crop Breeding Network



Identifying optimal **varieties** & **planting dates** for winter survival

- **Sites** located in Zones 3-5:
  - Freeville, NY
  - St. Paul, MN
  - Carrington, ND
- 4 **winter pea** cultivars:
  - Blaze
  - Icicle
  - Windham
  - WyoWinter
- 4 fall **plant dates**

Planting dates at **2021-2022** study locations

Location	Date 1	Date 2	Date 3	Date 4
Freeville, NY	9/1	9/15	9/30	10/14
St. Paul, MN	9/2	9/13	9/27	10/8
Carrington, ND	8/26	9/9	9/23	10/7

Cereal rye variety evaluation for NYS

- **Study locations** include:
  - 3 research stations:
    - Canton
    - Chazy
    - Freeville
  - 3 on-farm locations
- **6 varieties:**
  - AC Hazlet
  - Aroostook
  - Danko
  - Elbon
  - Guardian
  - ND Gardner
- Up to **4 planting dates:** late September to early November

Cereal rye breeding for northern US

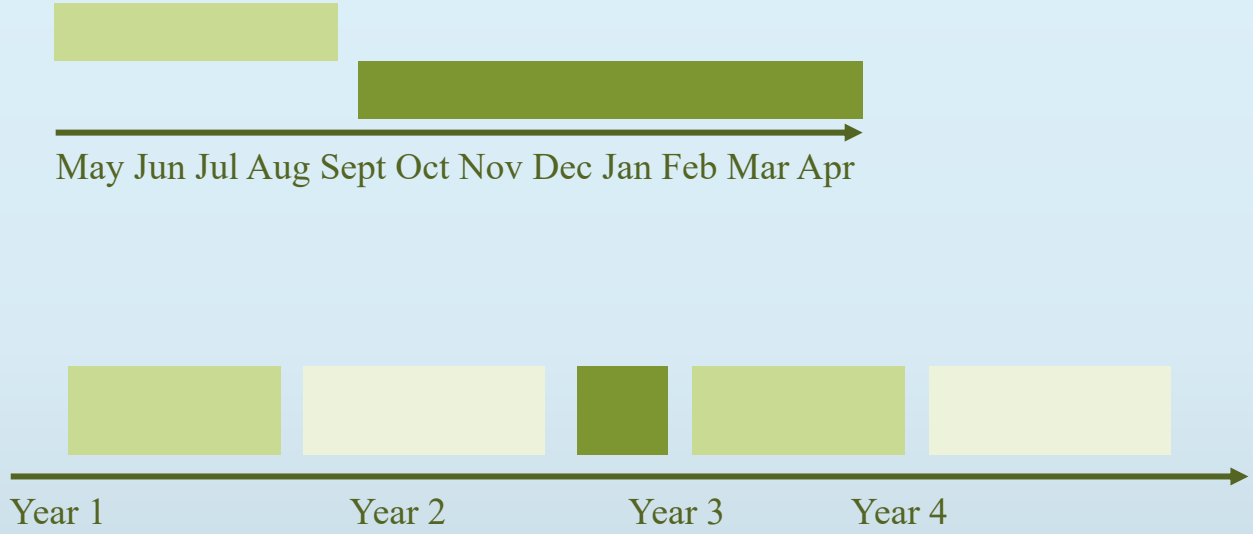
- Breeding nurseries in Freeville, NY and St. Paul, MN
  - NY location evaluating multiple planting dates for **tolerance of late planting**

- **Key traits:**
  - Early vigor
  - Winter survival
  - Biomass
  - Early maturity
  - Allelopathy

Maximizing living cover: **perennial forage breeding & variety testing**

Maximizing crop diversity: **breeding for diversity** in time

- Diversity in **time**
  - Within growing season
  - Multi-year rotation



Diversity in time:
hemp breeding & variety testing

Assessing breeding & research needs for **organic hemp production**

Interested in organic hemp production?

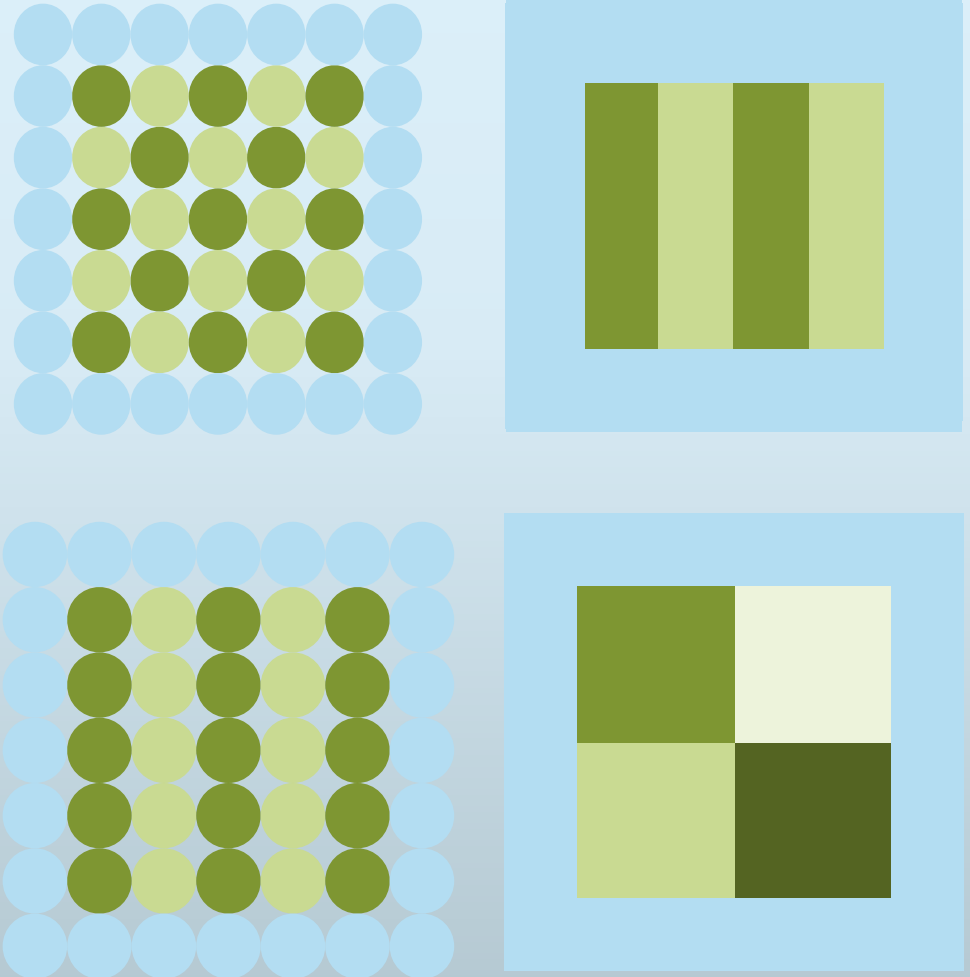
We are seeking feedback from farmers, industry, extension, educators, and others.

Keep your eyes out for a survey & focus groups starting in January!

To learn more, contact: Emily Fratz (ef389@cornell.edu) or me (vm377@cornell.edu)

Maximizing crop diversity: **breeding for diversity** in space

- Diversity in **time**
  - Within growing season
  - Multi-year rotation
- Diversity in **space**
  - Field-scale diversity:
    - Mixtures
    - Row intercropping
    - Strip intercropping
  - Landscape-scale diversity



Diversity in space: **intercropping alfalfa & perennial grains**

Evaluating & selecting optimal alfalfa varieties for intercropping

Maximizing crop diversity: **breeding for diversity** in time & space

- Diversity in **time**
  - Within growing season
  - Multi-year rotation
- Diversity in **space**
  - Field-scale diversity:
    - Mixtures
    - Row intercropping
    - Strip intercropping
  - Landscape-scale diversity
- Diversity in **time** & **space**
  - Relay intercropping
  - Perennial groundcover systems

Diversity in time & space: **red clover-corn interseeding**

- 2 seasons of data in Aurora, NY
  - Year 1: 2021-2022 (wet)
  - Year 2: 2022-2023 (dry)
- Evaluation of **11 varieties** of red clover
- Interseeding between corn rows at ~V6 growth stage

Minimizing tillage: **dry beans for organic no-till systems**

Photo: Kristen Loria

Organic dry bean variety trials (ME, NY, VT, WI)

- Starting in 2023: evaluation in organic **tilled** production systems
- Starting in 2024: evaluation in **no-till** (rolled rye) systems

Acknowledgments

- **Collaborators**
  - Cover Crop Breeding Network, especially Lisa Kissing Kucek, Nancy Ehlke, Steve Zwinger, Steve Mulkey, Bob Stupar
  - NNY collaborators: Mike Davis, Kitty O'Neil, Peter Hagar, Mike Durant, farmer-collaborators
  - Intercropping collaborators: Heathcliffe Riday, Valentin Picasso, Brandon Schlautman, Jake Jungers
  - Bean collaborators: Sarah Pethybridge, Matt Ryan, Kristen Loria, others in ME/VT/WI
  - Students: Raksha Thapa, Megan Williams
  - Moore Lab Staff: Julie Hansen, Jamie Crawford, Ryan Crawford, Jesse Chavez, Gabe Sanchez, Emily Fratz
  - Farm Staff: Steve McKay, Betsy Leonard, Paul Stachowski, Chris Pelzer
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  - USDA Organic Research and Education Initiative (OREI)
  - USDA AFRI Education and Workforce Development (EWD)
  - USDA Alfalfa Forage Research Program (AFRP)
  - Northern New York Agricultural Development Program (NNYADP)

Supporting NY State farmers in their experimentation towards soil health

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