

Sustainable soil management strategies for improved soil health in vineyards

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THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION



healthy soils program

- Administered by the CDFA
- Supports farmers and ranchers that adopt sustainable soil management practices to:

Enhance soil health

Increasing soil organic matter



Reduce environmental impacts

- Lower GHG emissions (N₂O, CO₂, CH₄)
- Increase C sequestration

Healthy soils program in numbers



IMPACT OF THE HEALTHY SOILS PROGRAM

- Farms awarded incentive grants: **84**
- Farms awarded demonstration projects: **28**
- Number of counties with Healthy Soils grants: **33**
- GHG reductions: More than **18,500** metric tons CO₂ emissions reductions annually, equivalent to removing almost **4,000** cars from the road for one year*



FINANCES

- Awarded to date: **\$6.1 million**
- Budget for FY 2018-19: **\$15 million**

What is soil health?

Soil health is **the continued capacity of soil to function as a vital living ecosystem** that sustains plants, animals, and humans (NRCS)-

A healthy soil is a soil that functions and provides services

What is soil health?

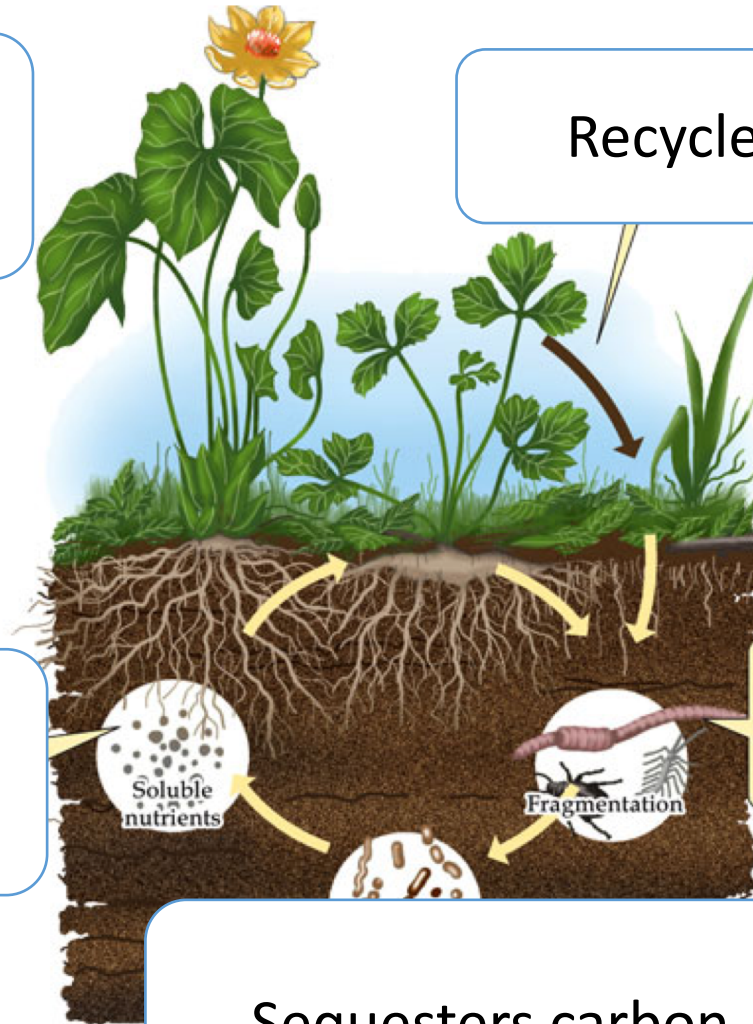
Supports plant growth

Recycles nutrients

Holds water

Provides habitat for soil organisms

Sequesters carbon



Management strategies to support soil health

Increase soil organic matter

- Use of organic fertilizers (compost, manure, sewage sludge)
- Cover crops
- Incorporation of crop residues

Reduce disturbance

- No-till or low till management
- Management of vegetation cover through grazing or mowing

Increase diversity

- Crop rotations
- Cover crops

Management strategies to support soil health in vineyards

**Increase soil
organic
matter**

Compost application



**Reduce
disturbance**

No till/ reduced till



**Increase
diversity**

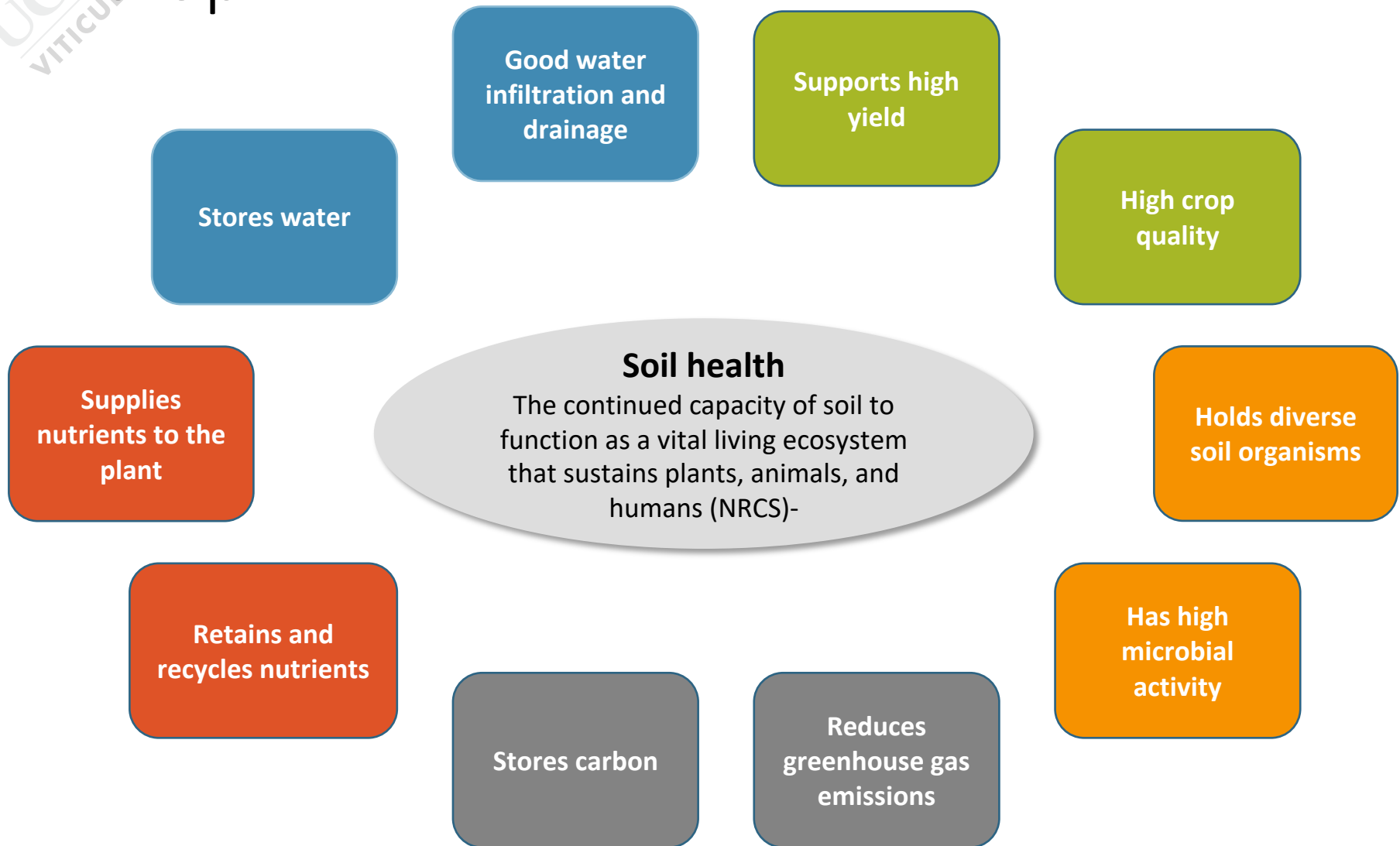
Cover cropping



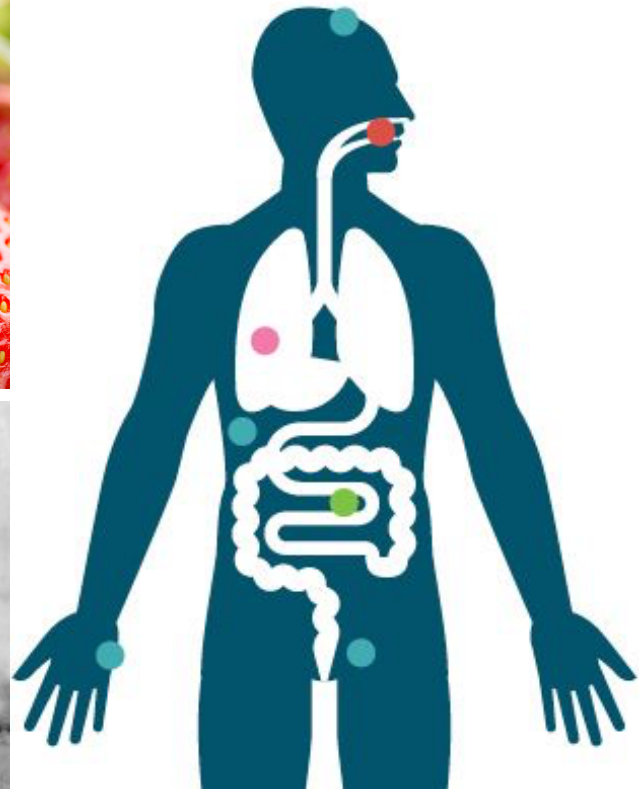
Ok but, what are the benefits for my crop?



Ok but, what are the benefits for my crop?



Soil health is key for environmental and human health



Supporting soil health in vineyards

Vineyards are **perennial systems** that have a great potential to build up soil organic matter and sequester C – due to the relatively low intensity management and soil inputs



Supporting soil health in vineyards

Vineyards are key components of the landscape in several regions of California- by promoting soil health and C sequestration **vineyard managers are stewards of the environment**



Supporting soil health in vineyards: what are the best management practices?

- Fertilizer inputs (compost, inorganic)
- Weed management (herbicide, tillage)
- Cover crops
- No till
- Grazing of cover crops

A R I



J. LOHR
VINEYARDS & WINES



MONTEREY

- CHARDONNAY
- PINOT NOIR
- MERLOT
- CABERNET SAUVIGNON
- RIESLING

WINE MAP OF CENTRAL COAST CALIFORNIA

LEGEND

GRAPE / BLEND

- White
- Red

AREA UNDER VINE

100,000 acres
40,500 hectares (2013)

© 2016 Wine Folly
Made in Seattle, WA, USA

Cover crop management

PASO ROBLES

- CABERNET SAUVIGNON
- MERLOT
- SYRAH
- ZINFANDEL
- GRENACHE-SYRAH-MOURVÈDRE

Fertilizer management

SAN LUIS OBISPO

- CHARDONNAY
- PINOT NOIR
- SYRAH
- VIOGNIER

SANTA BARBARA

- CHARDONNAY
- PINOT NOIR

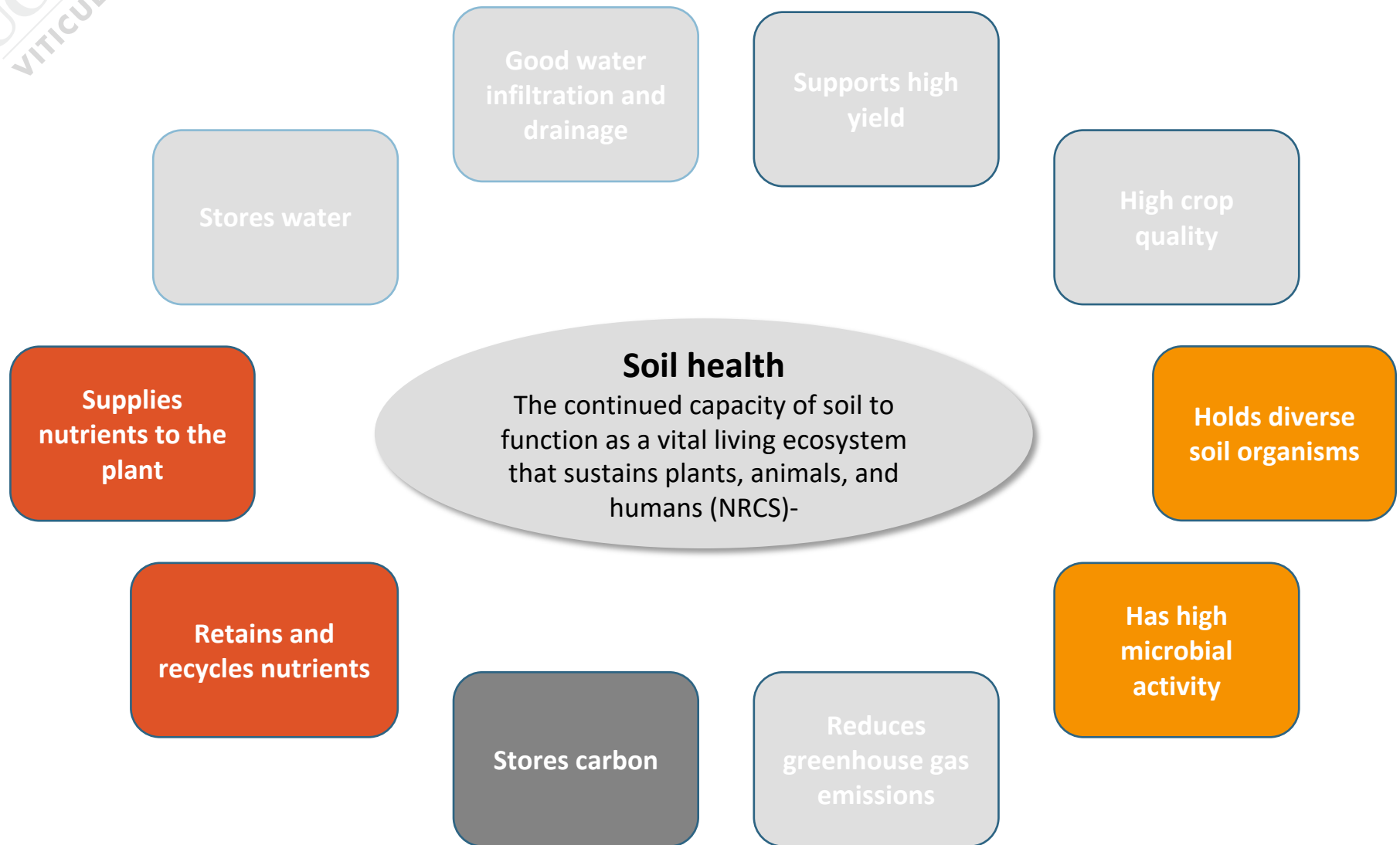
Effects of fertilizer management strategies on soil nematode foodwebs

Holly M Deniston-Sheets, James J. Smith, Amanda K Hodson, Katherine Watts, Jean C. Dodson Peterson, Cristina Lazcano

*California Polytechnic State University, San Luis Obispo
University of California, Davis*

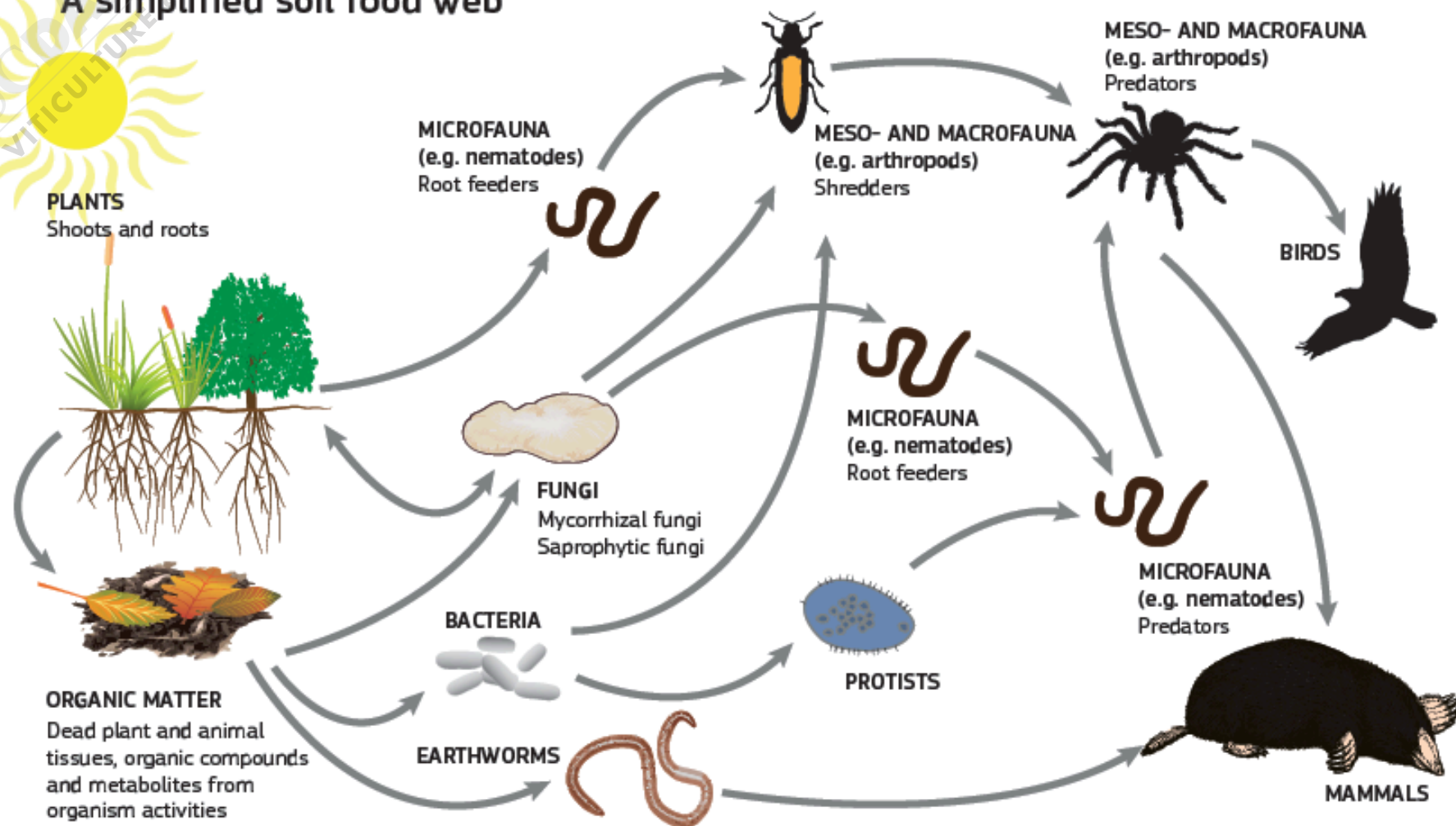


Ecosystem services provided by healthy soils



The soil foodweb

A simplified soil food web



1st TROPHIC LEVEL:
Primary producers

2nd TROPHIC LEVEL:
Decomposers, litter and soil organic matter feeders
Mutualists
Pathogens and parasites
Root feeders

3rd TROPHIC LEVEL:
Shredders
Predators
Grazers

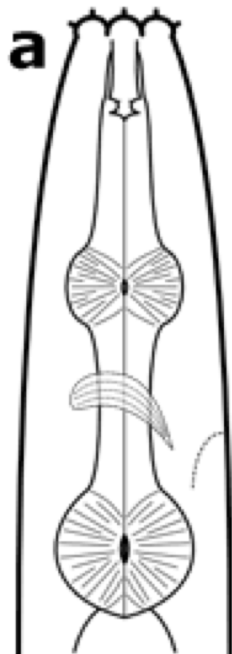
4th TROPHIC LEVEL:
Higher-level predators

5th and higher TROPHIC LEVEL:
Higher-level predators

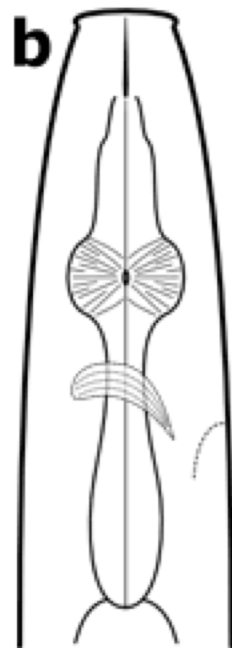
Nematodes

Can be classified into different trophic groups depending on the morphology of their mouthpieces

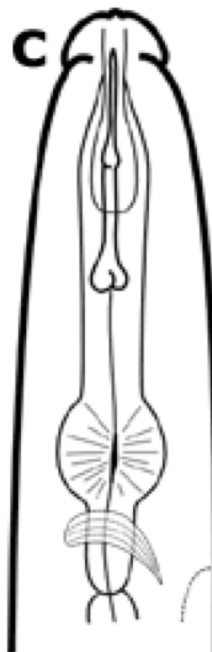
Bacterivores
Bacterial feeders



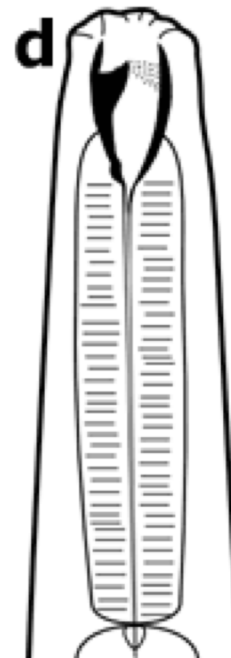
Fungivores
Fungal feeders



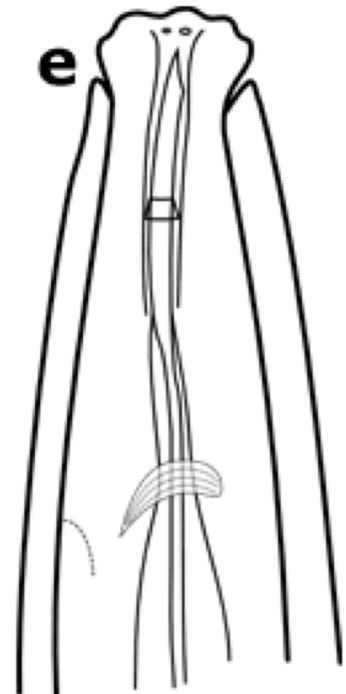
Herbivore
Plant parasites



Predator



Saprophytes
Omnivores





Nematodes are good bioindicators of soil health

- Sensitive to disturbance
- Well-correlated with beneficial functions
- Useful for elucidating ecosystem processes

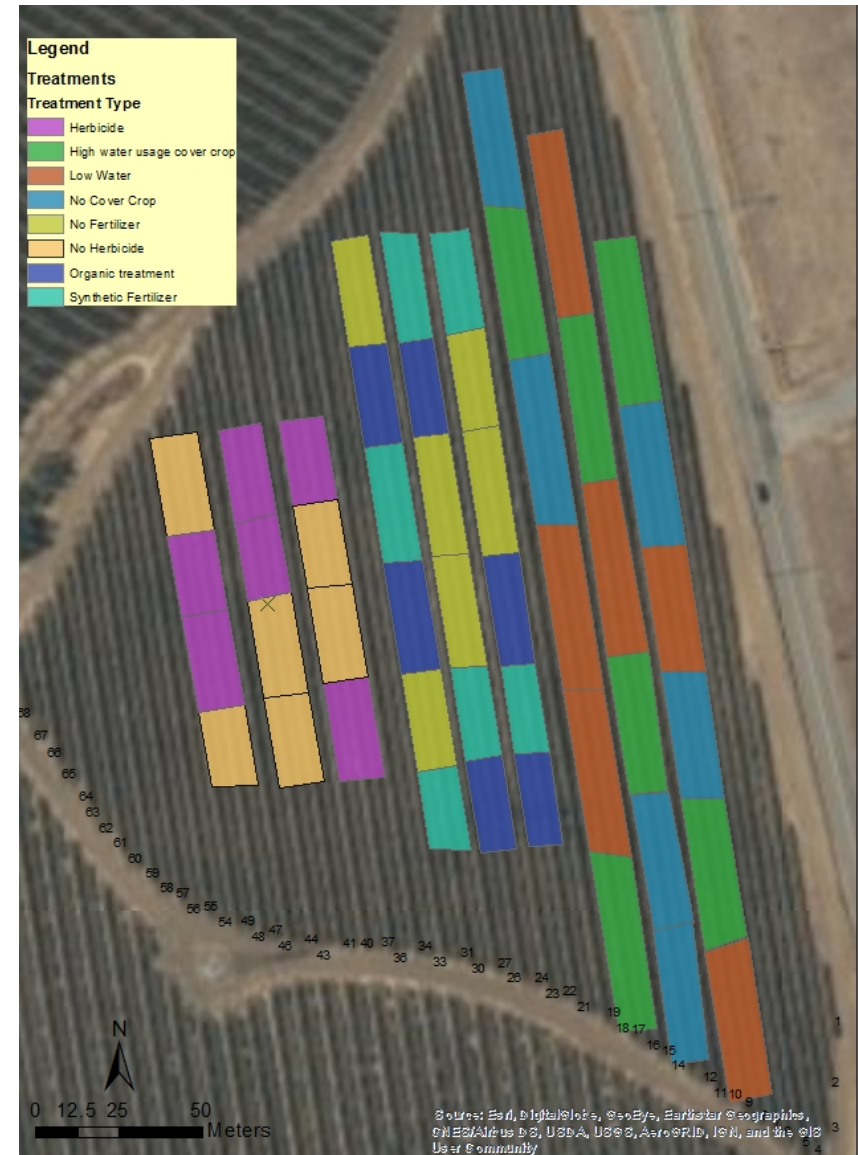
Sustainable vineyard management and soil health

Field trial in a commercial Pinot Noir vineyard (Edna Valley)

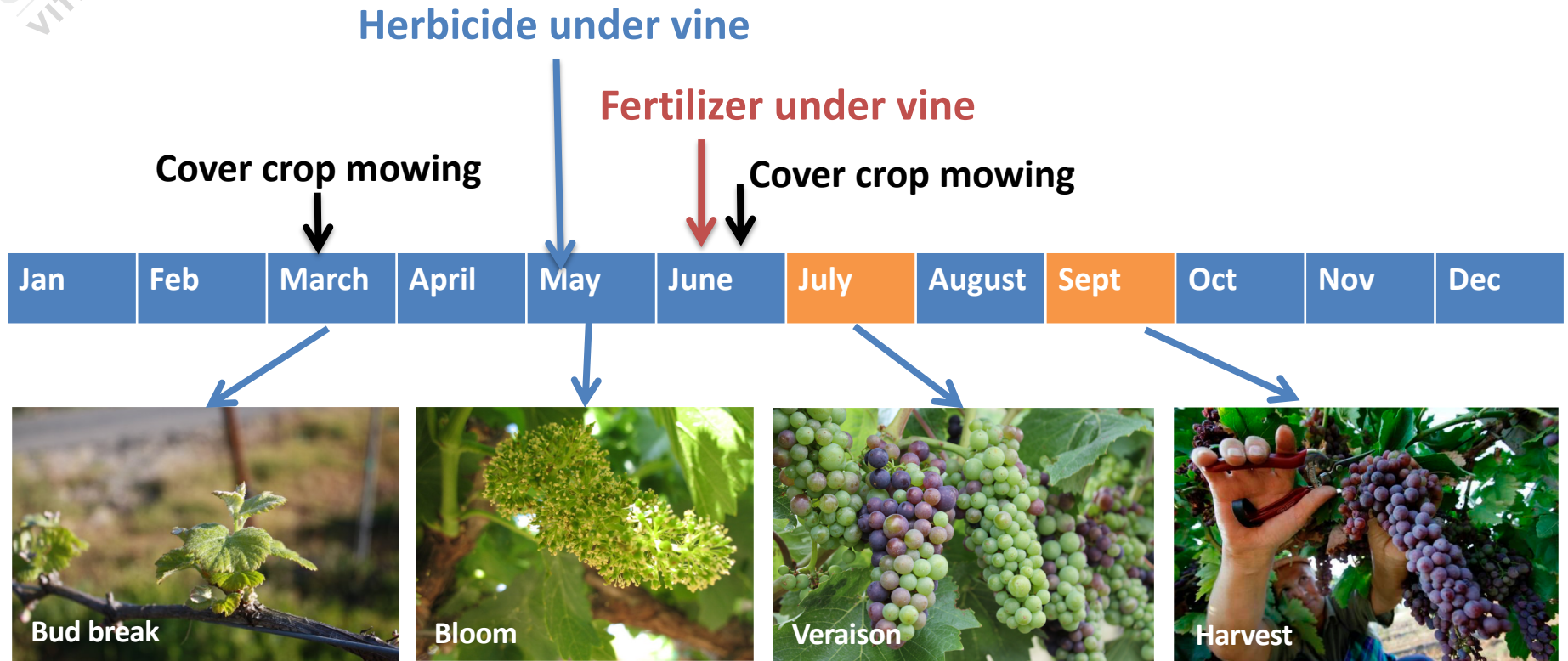
Three sub trials:

- *Cover crop* (no cover crop, high water use, low water use)
- *Fertilizer* (no fertilizer, synthetic fertilizer, organic fertilizer)
- *Weed management* under the vine (herbicide, tillage)

Treatments applied for two years
6 replicates per treatment, plots arranged following a complete randomized design within each trial



Practice implementation and sampling



Fertilizers applied to the soil

| | No fertilizer | Synthetic | Organic | |
|---|---------------|-----------|------------|--------------|
| CAN-17 | | 6/24/2016 | | 5 gal/ac |
| Cerys 5-2-15 | | 6/24/2016 | | 1000 lb/ac |
| CTI Dairy Compost/95% Gypsum (50/50 Blend) | | | 11/28/2016 | 1.25 ton/ac |
| Agropell 15-15-15 | | 6/17/17 | | 400 lb/ac |
| True 413 | | | 4/20/216 | 26.52 gal/ac |
| Soil Maximizer | | | 4/20/2016 | 8.84 gal/ac |
| Italpollina 4-4-4 | | | 6/24/2016 | 1000 lb/ac |
| Organic Farms 4-4-2 (poultry manure, feather meal, rock phosphate) | | | 6/17/2017 | 1000 lb/ac |

Practice implementation and sampling

Vine

- Fertilizers
- Irrigation
- Weed management

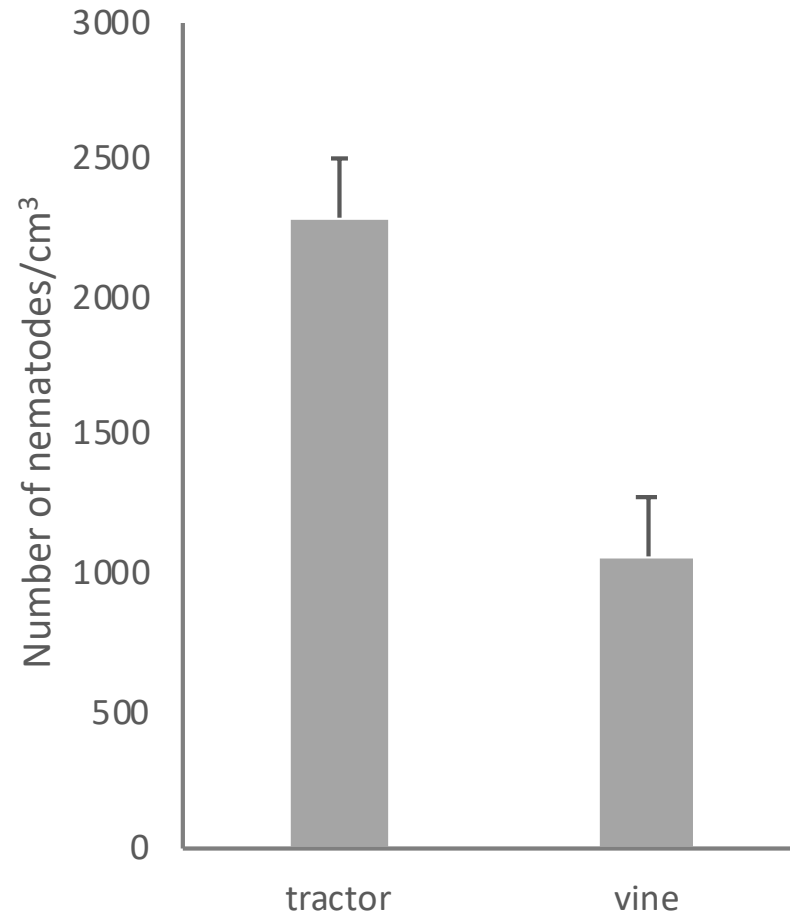
Tractor row

- Cover crops
- Tillage

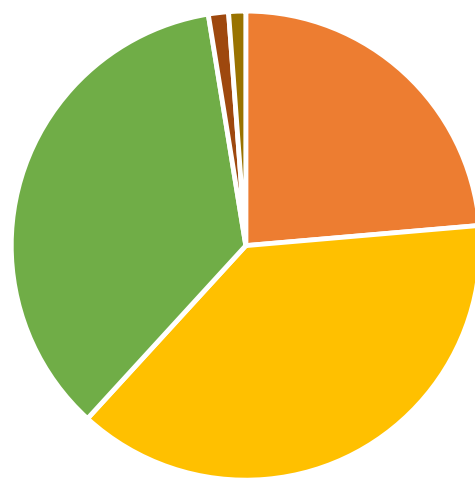


Nematode abundance within the vineyard

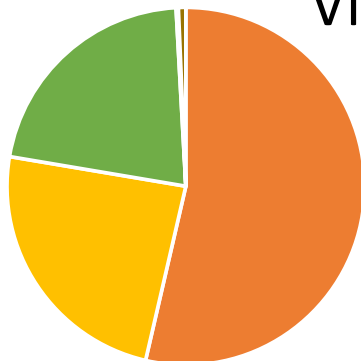
Nematode abundance was significantly higher in the tractor row than under the vine



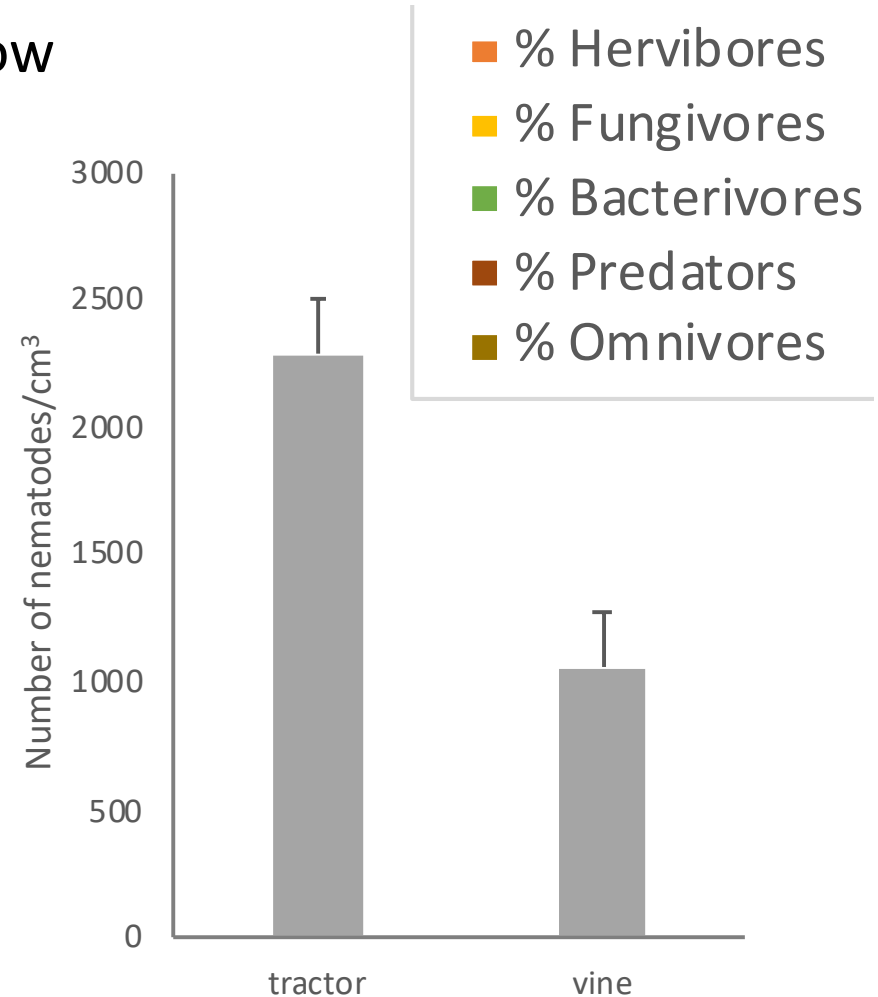
Nematode abundance within the vineyard



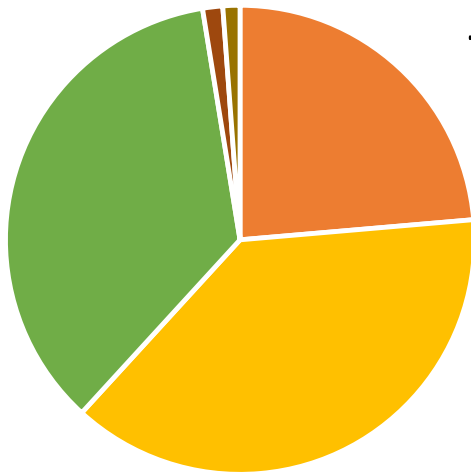
Tractor row



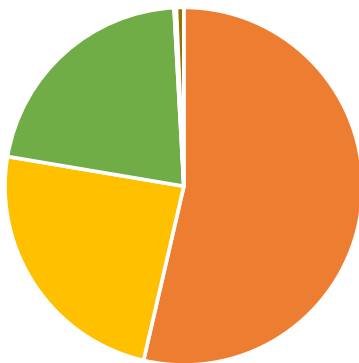
Vine row



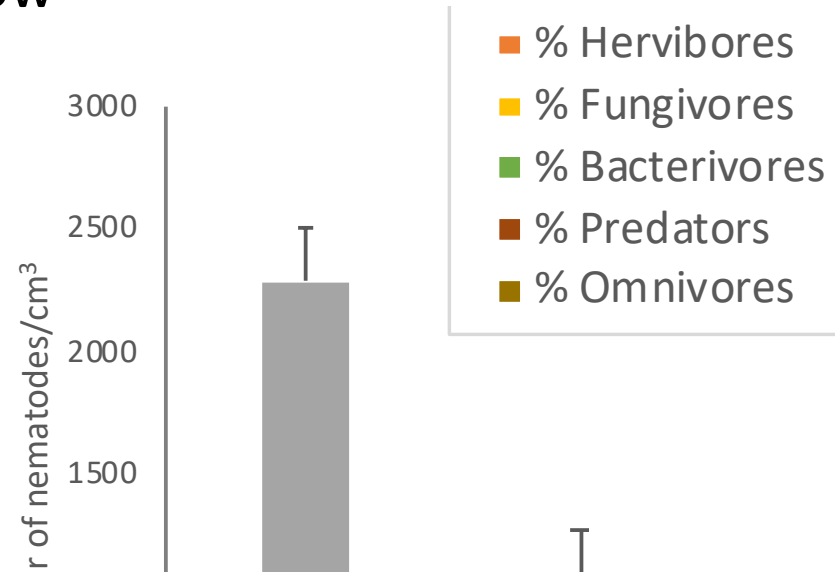
Nematode abundance within the vineyard



Tractor row



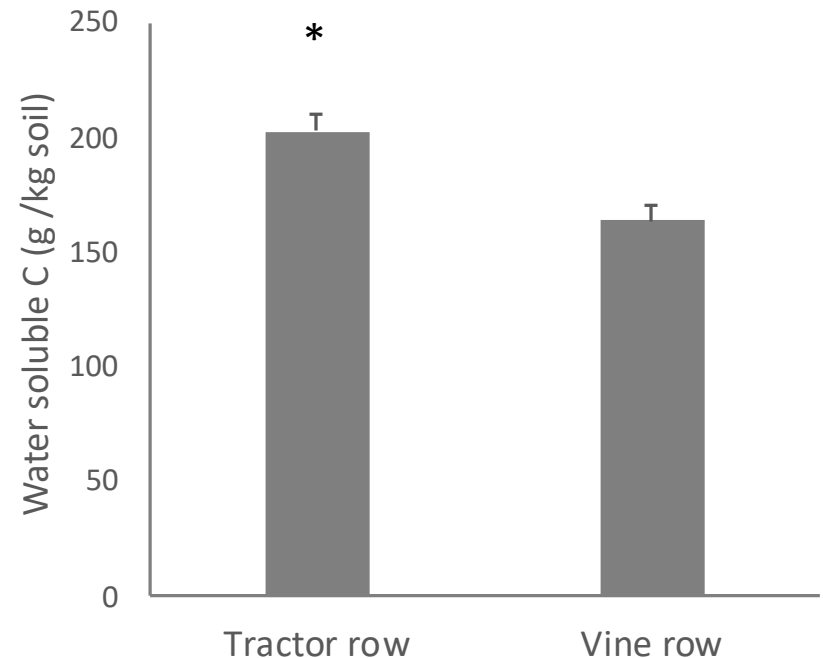
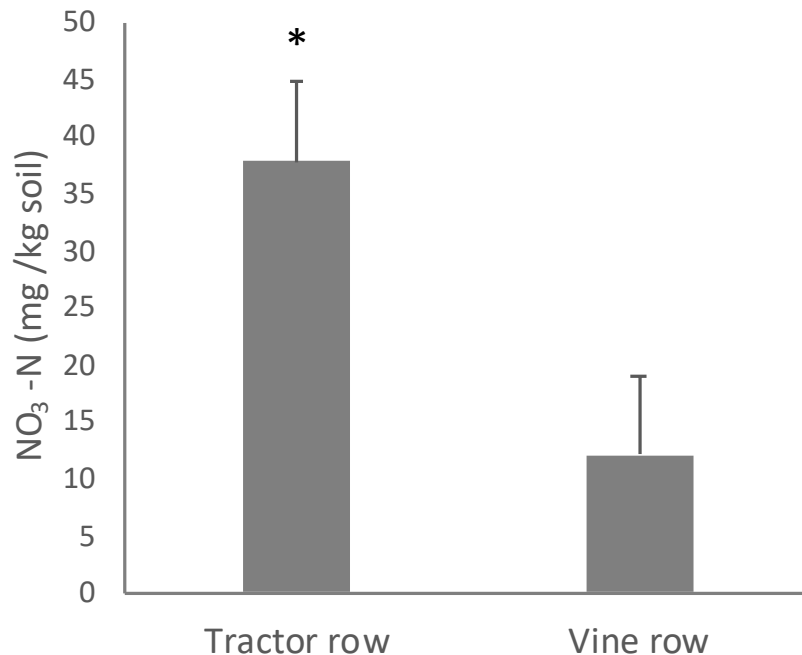
Vine row



The soil in the tractor row had a more balanced and diverse foodweb, with presence of higher trophic groups and lower abundances of plant parasitic nematodes

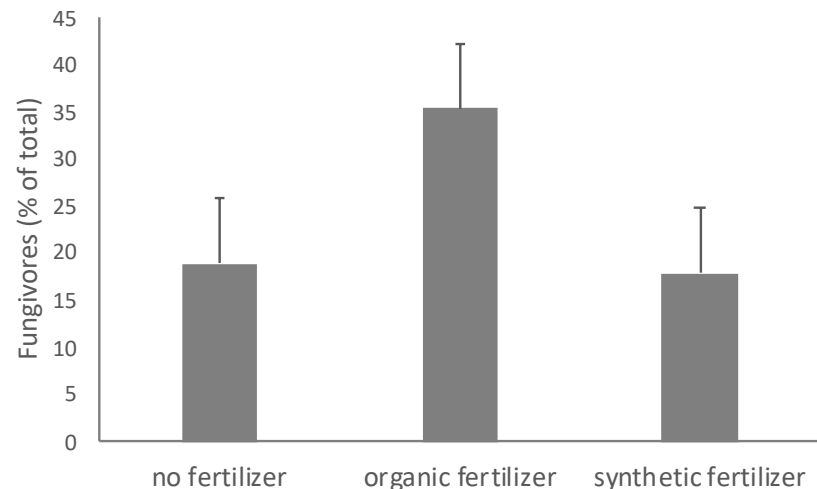
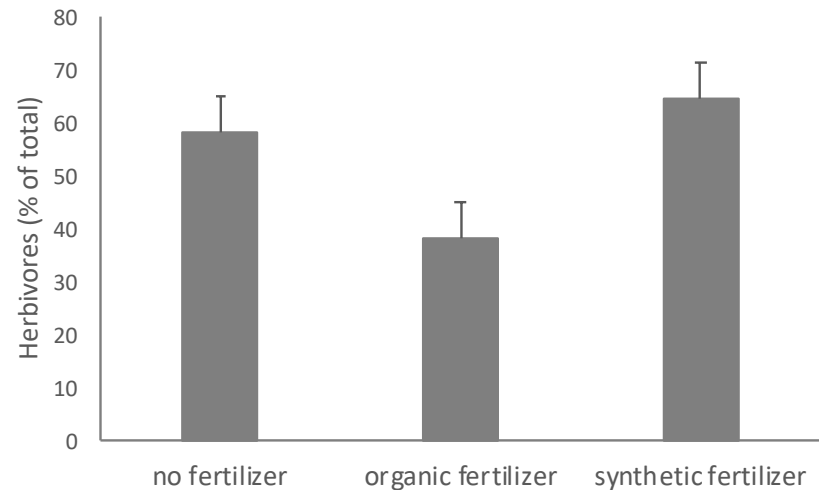
Soil C and N

Higher concentrations of available N and C in the rows could be related to the effects observed in the soil nematodes



Effects of fertilizer treatments on nematode foodwebs under the vine

The use of organic nutrient sources decreased the abundance of plant parasitic nematodes under the vine and increased the proportion of fungal feeders



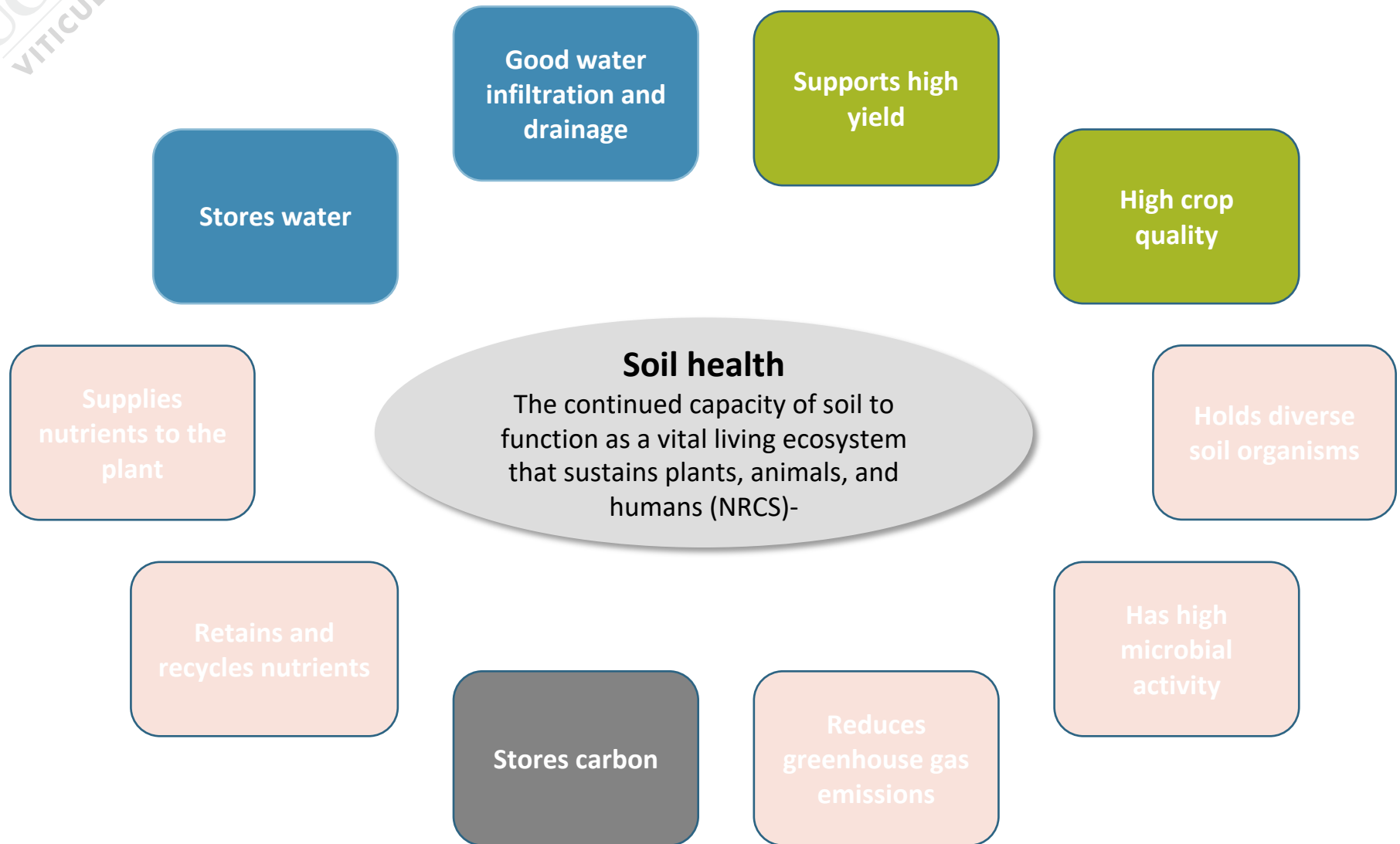
Effects of fertilizer management strategies on soil nematode foodwebs

Fertilizer management under the vine (organic fertilizers) can decrease plant parasitic nematodes and increase the abundance of beneficial nematodes

The soil under the vine has a lower abundance of nematodes and higher proportion of plant parasitic nematodes

Within a vineyard, tractor rows have a great potential as reservoirs of soil diversity C and N accumulation

Ecosystem services provided by healthy soils



Assessment of cover crop management through no-till and grazing on soil health

Jenna J. Merrilees, Tsz Fai Wong, Charlotte Decock, Geovan Rich, Bwalya Malama, Jean Dodson-Peterson, Cristina Lazcano
California Polytechnic State University, San Luis Obispo
University of California, Davis



TABLAS CREEK VINEYARD



Biodynamic operation

- Minimal external inputs: compost used as fertilizer
- No vegetation removal under the vine
- Cover crops to increase soil organic matter, C and N
- Cover crop is grazed and tilled into the soil
- Soil is a Linne Calodo complex with 30% clay



TABLAS CREEK VINEYARD



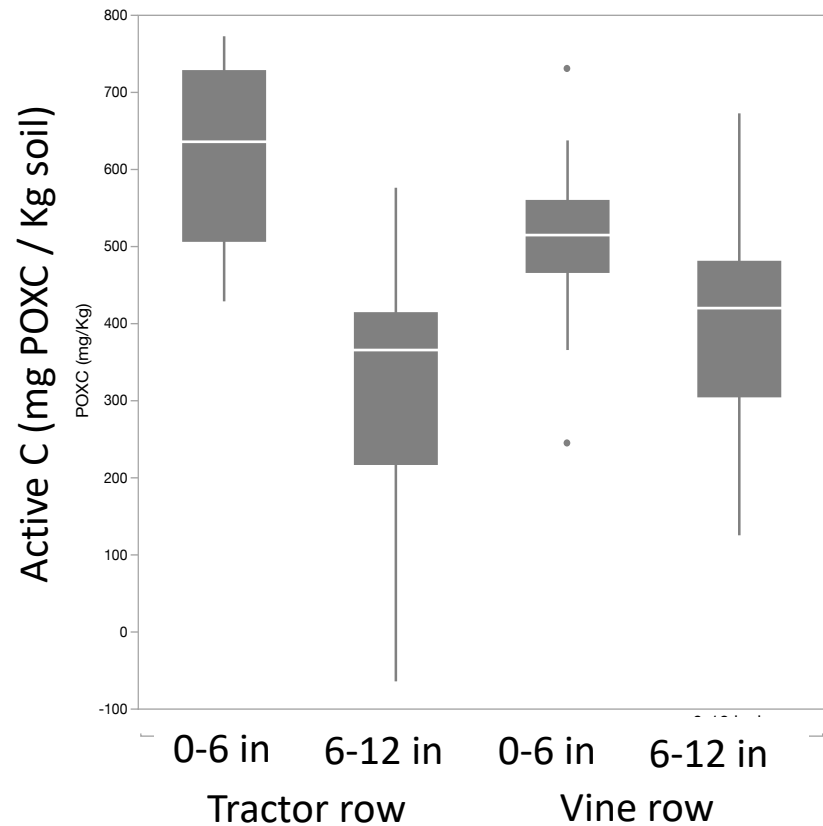
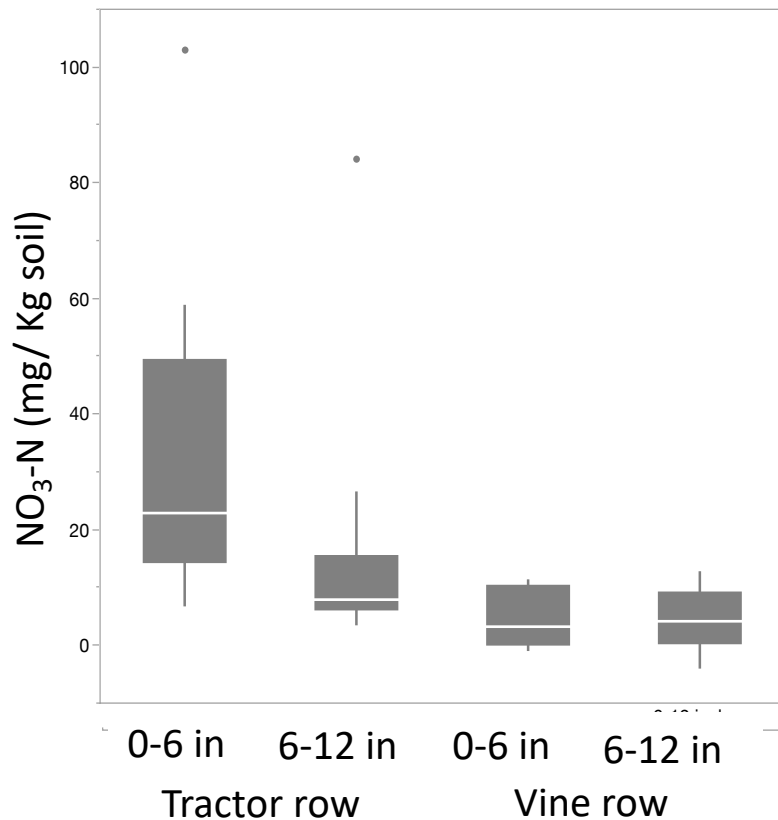
What are the effects of tillage and grazing on soil health?

- Soil total and active C (POXC)
- Soil N
- Soil physical properties and water holding capacity

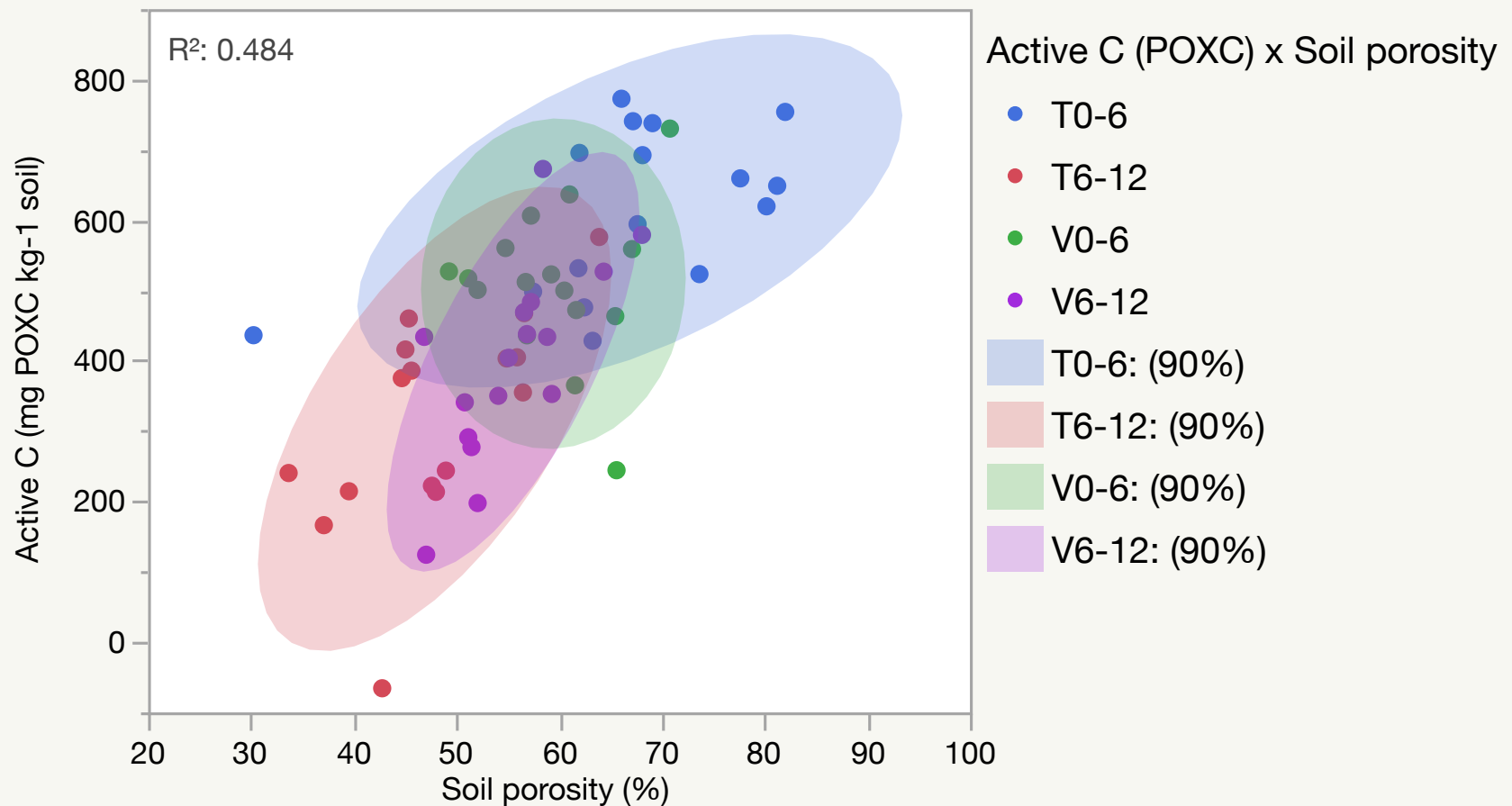


Tractor rows showed higher available N and active C

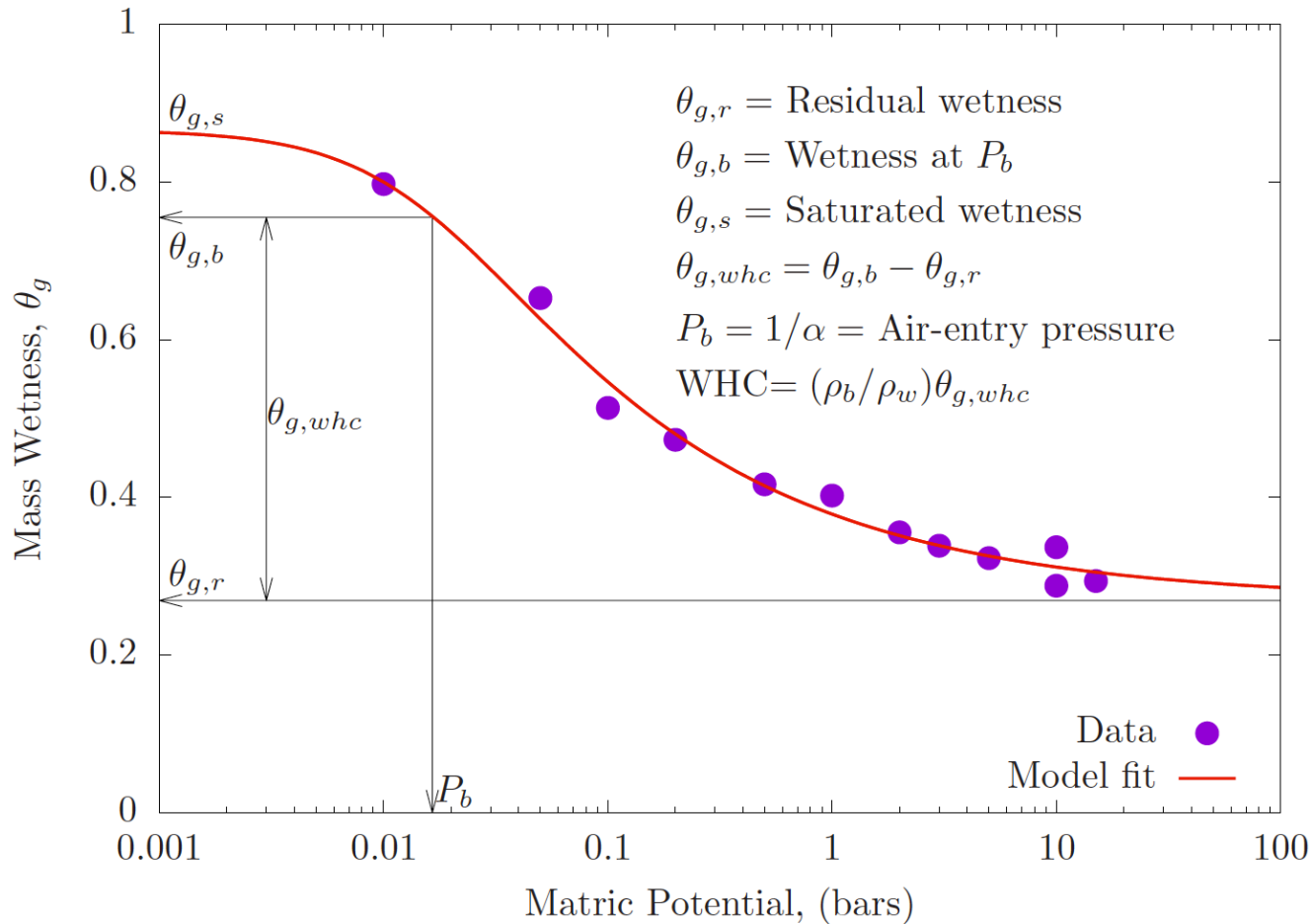
C and N availability was higher in the shallow layer of soil (0-6 in)



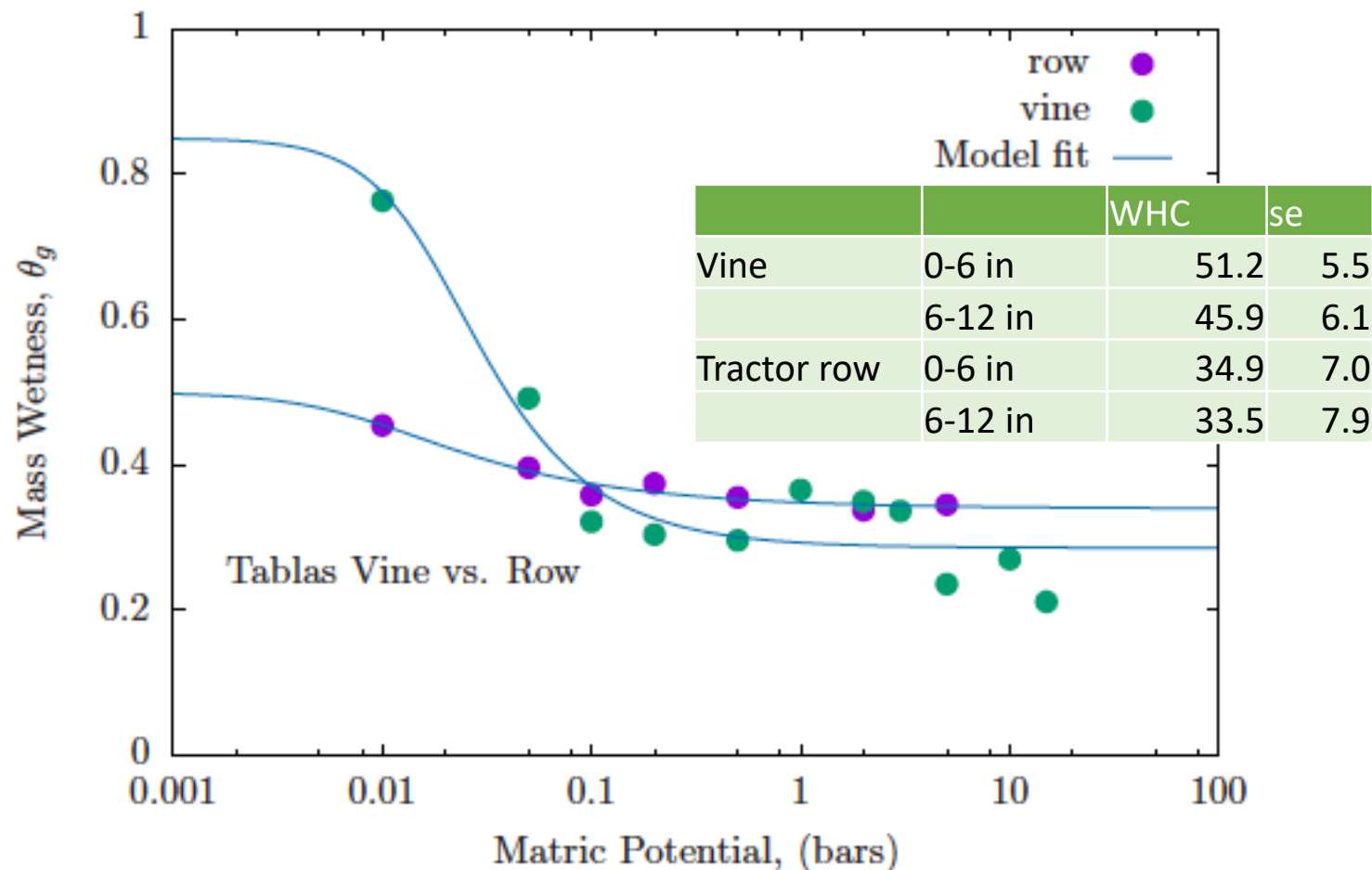
Higher active C was correlated with higher soil porosity



Did higher soil C result in higher water holding capacity?

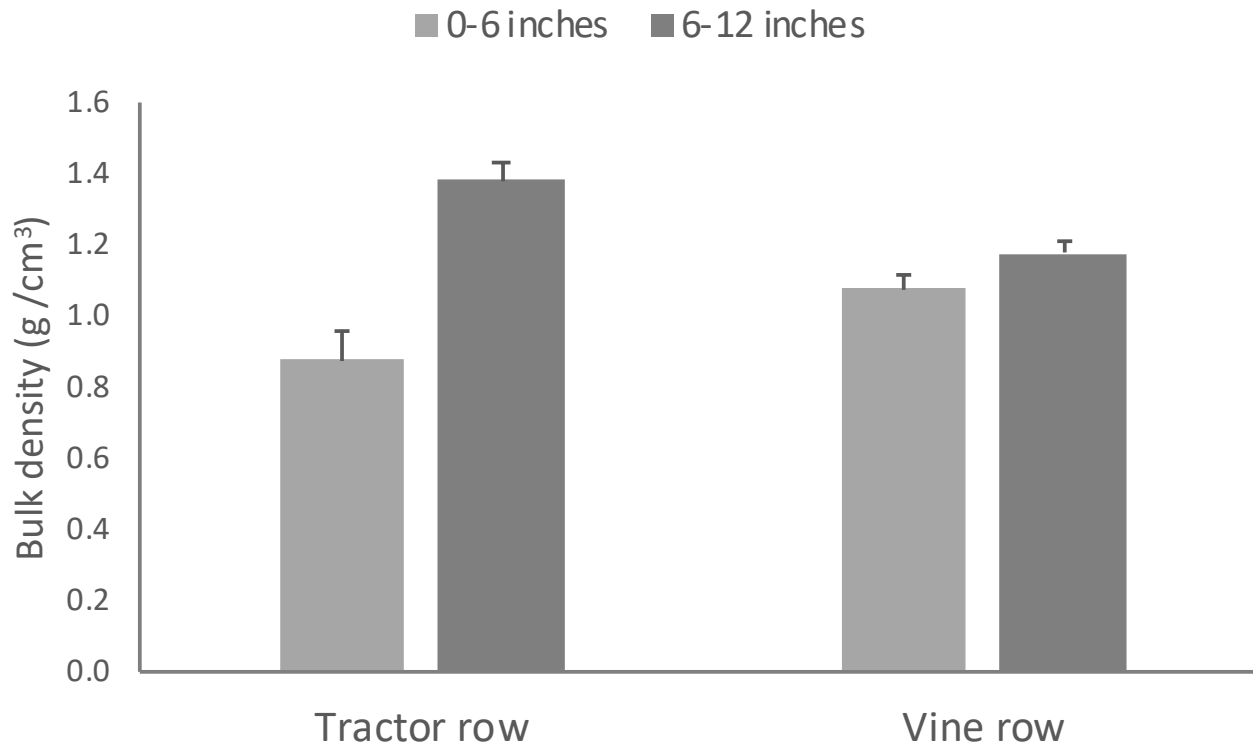


Did higher soil C result in higher water holding capacity?



Bulk density increased in the 6-12 inch interval of the tractor row

Aggregate stability?



Improving soil management practices to increase soil water holding capacity



Tillage

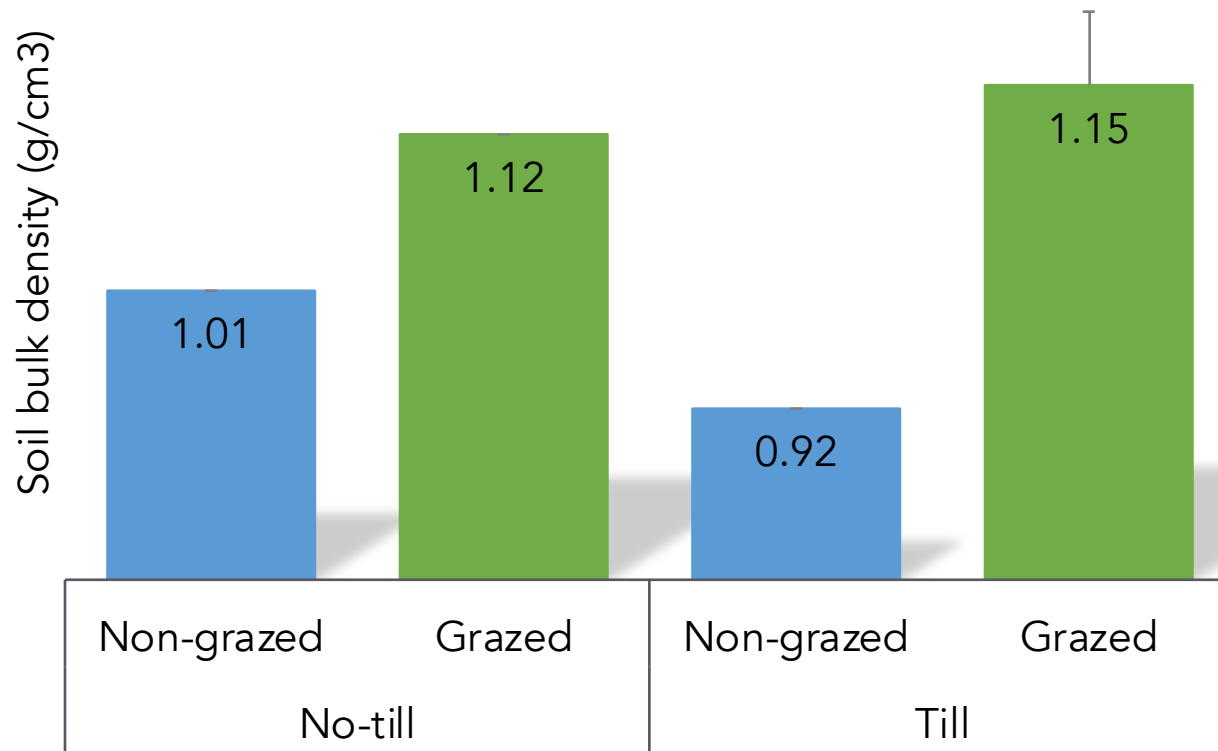
- Till
- No-till

Grazing

- Grazed
- Non grazed (mowed)

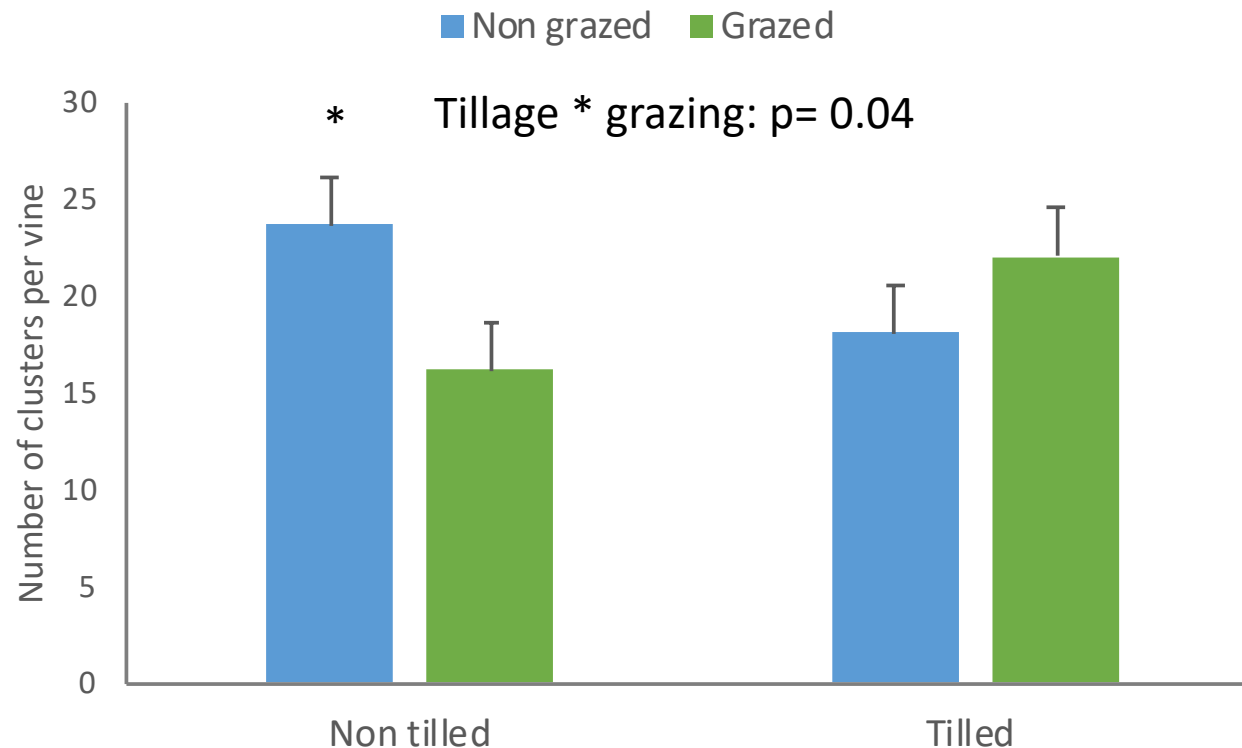


Tractor row management and soil bulk density



Yield and grape quality

- No significant differences in total yields or berry chemistry (brix, anthocyanins, phenolics, malic acid or TA)
- Slight increase in clusters per vine was observed in non tilled and non grazed plots



Sustainable soil management strategies for improved soil health in vineyards

The background image shows a vineyard with rows of grapevines. In the foreground, a flock of sheep is grazing on green grass. The background features rolling hills under a cloudy sky. A faint watermark 'UCD VITICULTURE' is visible in the top left corner.

Tractor rows store larger amounts of C and N- larger potential for C sequestration

Tillage seems to increase soil porosity in the top layer of soil but creates a plough pan at depth

Increased soil bulk density and poor soil structure are most likely related to low water holding capacity
Change to no-till may improve soil physical properties and water holding capacity

Vineyards in the landscape: Looking for collaborations

- Vineyard soil management has large potential to improve soil health affecting overall environmental health
- **What is the role of vineyards in the landscape?**





Photo courtesy Brittany Anzel App

Sustainable Ag Lecture Series - Spring 2019:

Cal Poly Healthy Soils Project

No-till and Cover Crop Management with Grazing

Thursday, June 13, 2019

Tablas Creek Vineyard

9339 Adelaida Rd, Paso Robles

9 am - 12 pm , Free to attend