Digging Into Soil Health:

How to build and maintain soil productivity for caneberries

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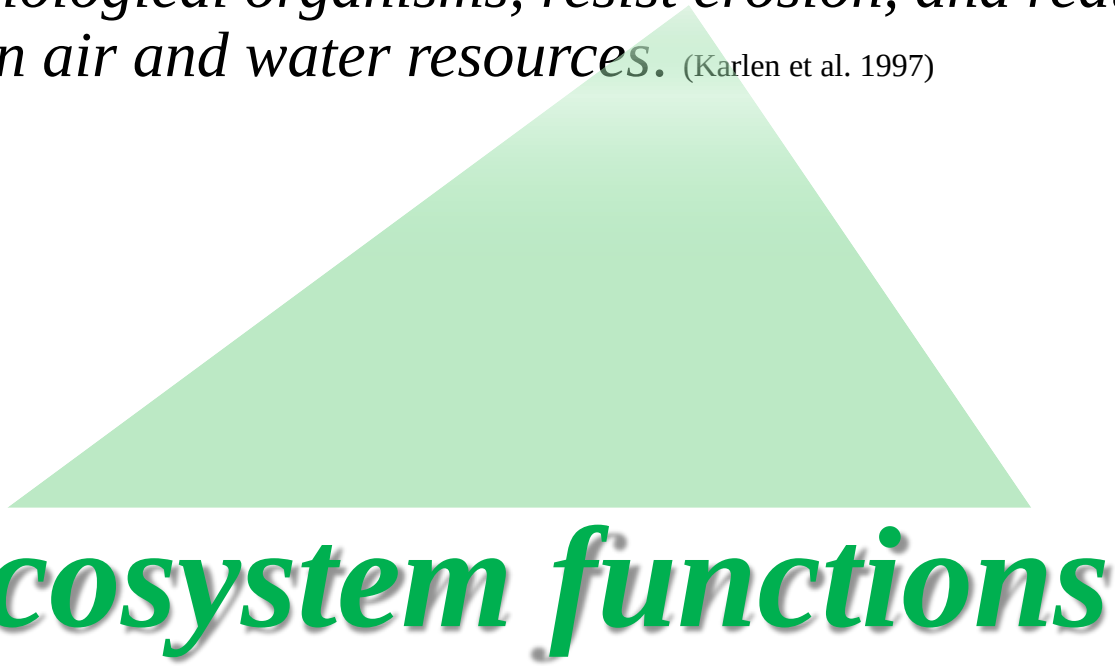
What is Soil Health or Soil Quality?

- *The capacity of the soil to perform ecosystem functions that support plant growth and biological organisms, resist erosion, and reduce negative impacts on air and water resources.* (Karlen et al. 1997)



Soil functions

Soils deliver ecosystem services that enable life on Earth

2015 International Year of Soils

faa.org/soils-2015

Food and Agriculture Organization of the United Nations

with the support of

Why is Soil Health Important to Ag?

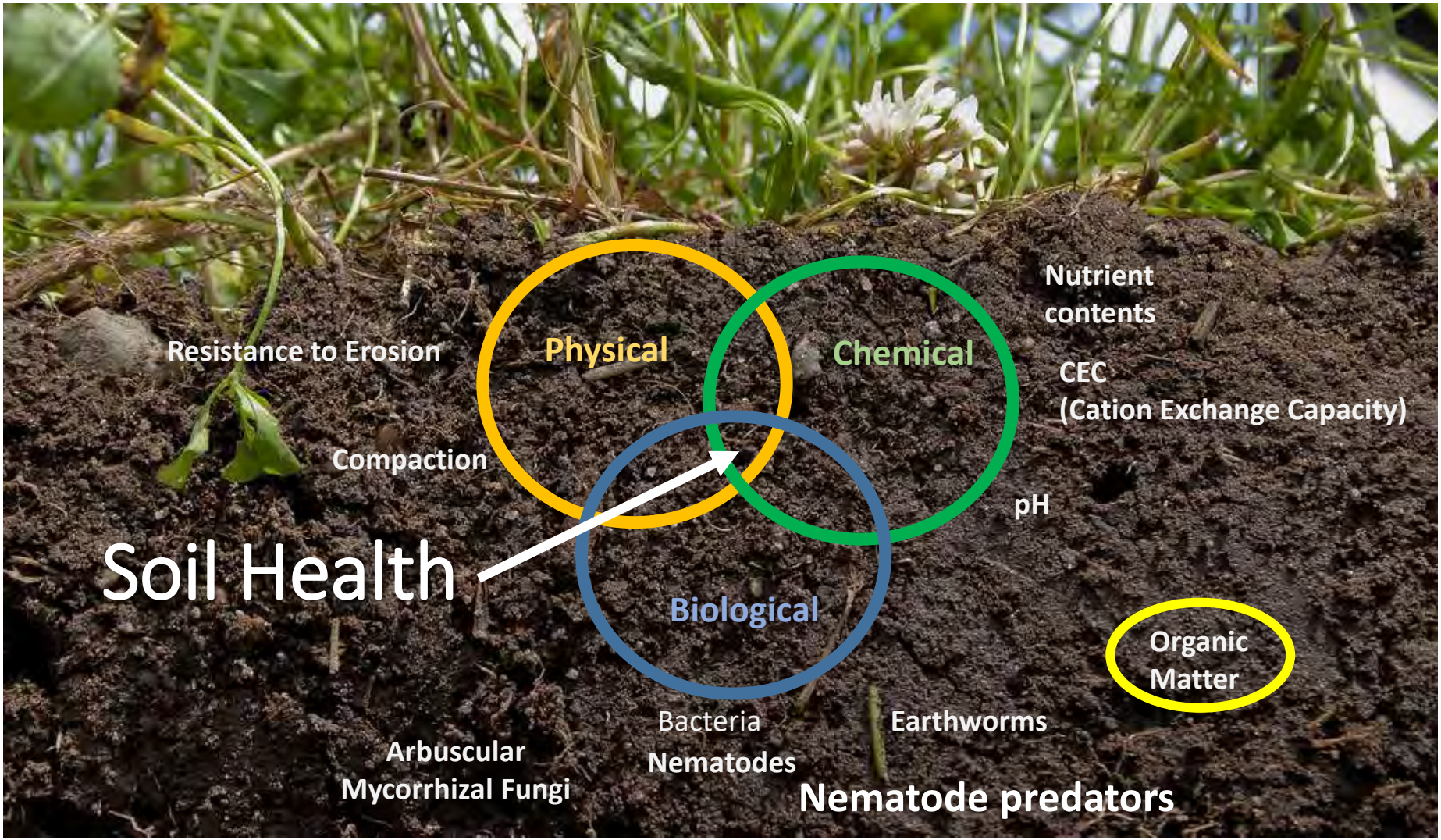
Soil is a Non-Renewable Resource

It takes 100 years to form 1 inch of topsoil

- *Not renewable in our lifetimes*

- *75 billion tons of soil is eroded worldwide each year, about two-thirds come from agricultural land*.

2015
International Year of Soils


Resistance to Erosion
Physical
Chemical
Nutrient contents
CEC (Cation Exchange Capacity)
Compaction
pH
Soil Health
Biological
Organic Matter
Bacteria
Earthworms
Arbuscular Mycorrhizal Fungi
Nematodes
Nematode predators

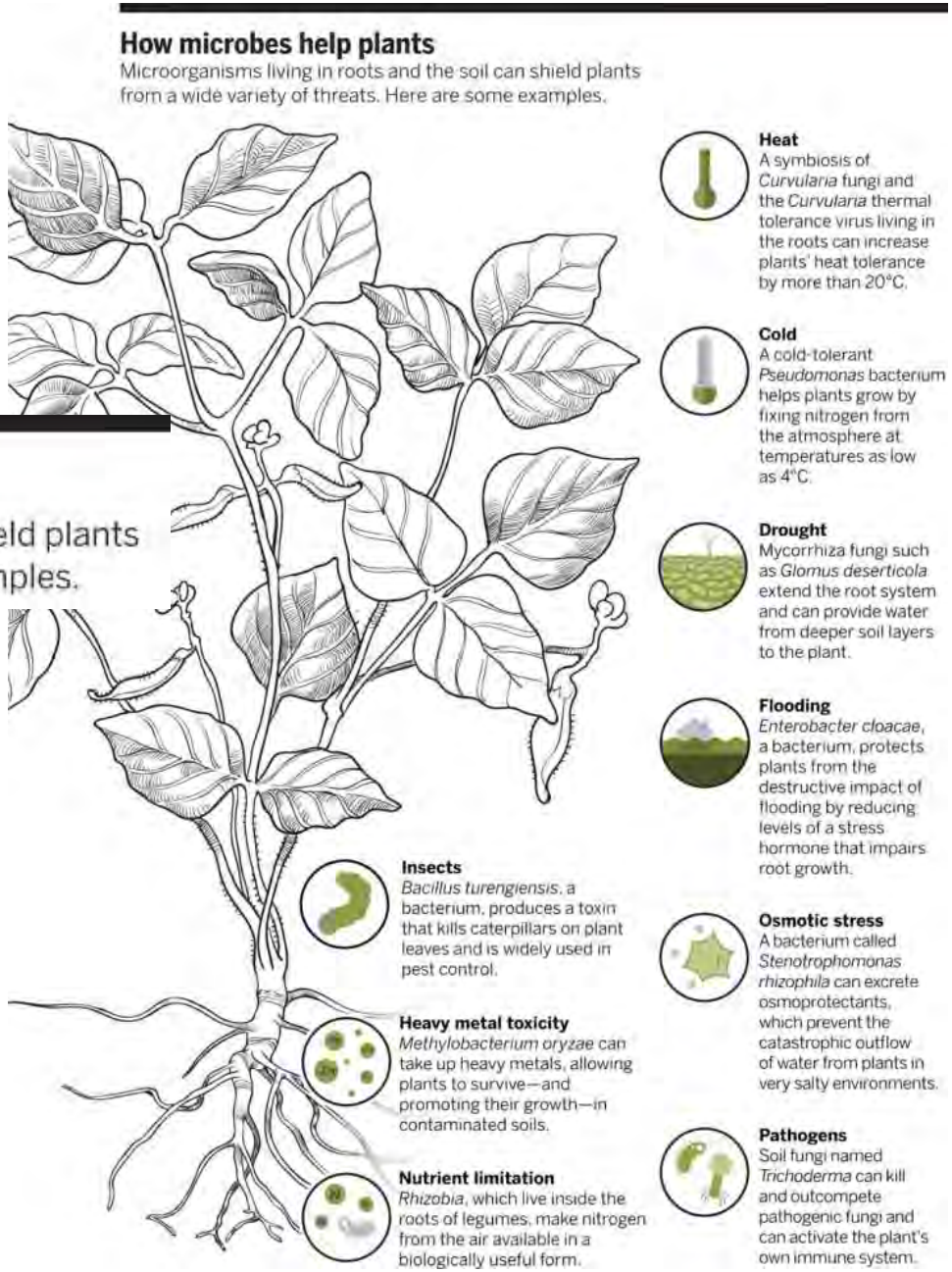
Science
AAAS

The Littlest Farmhands

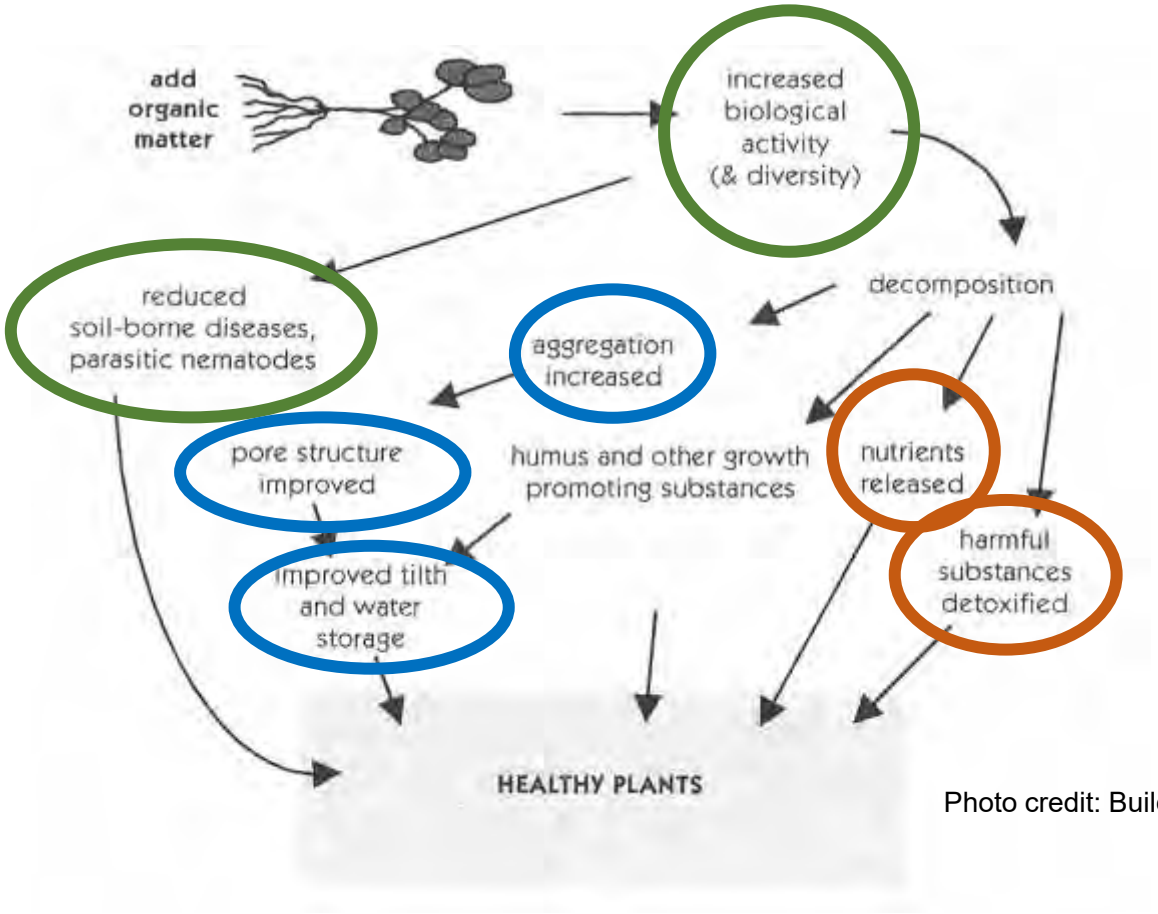
Jop de Vrieze Science 2015;349:680-683

How microbes help plants

Microorganisms living in roots and the soil can shield plants from a wide variety of threats. Here are some examples.



Organic Matter Drives Soil Health



Soil Properties:

- **Biological**
- **Physical**
- **Chemical**

All three must be in balance for soil health to be achieved.

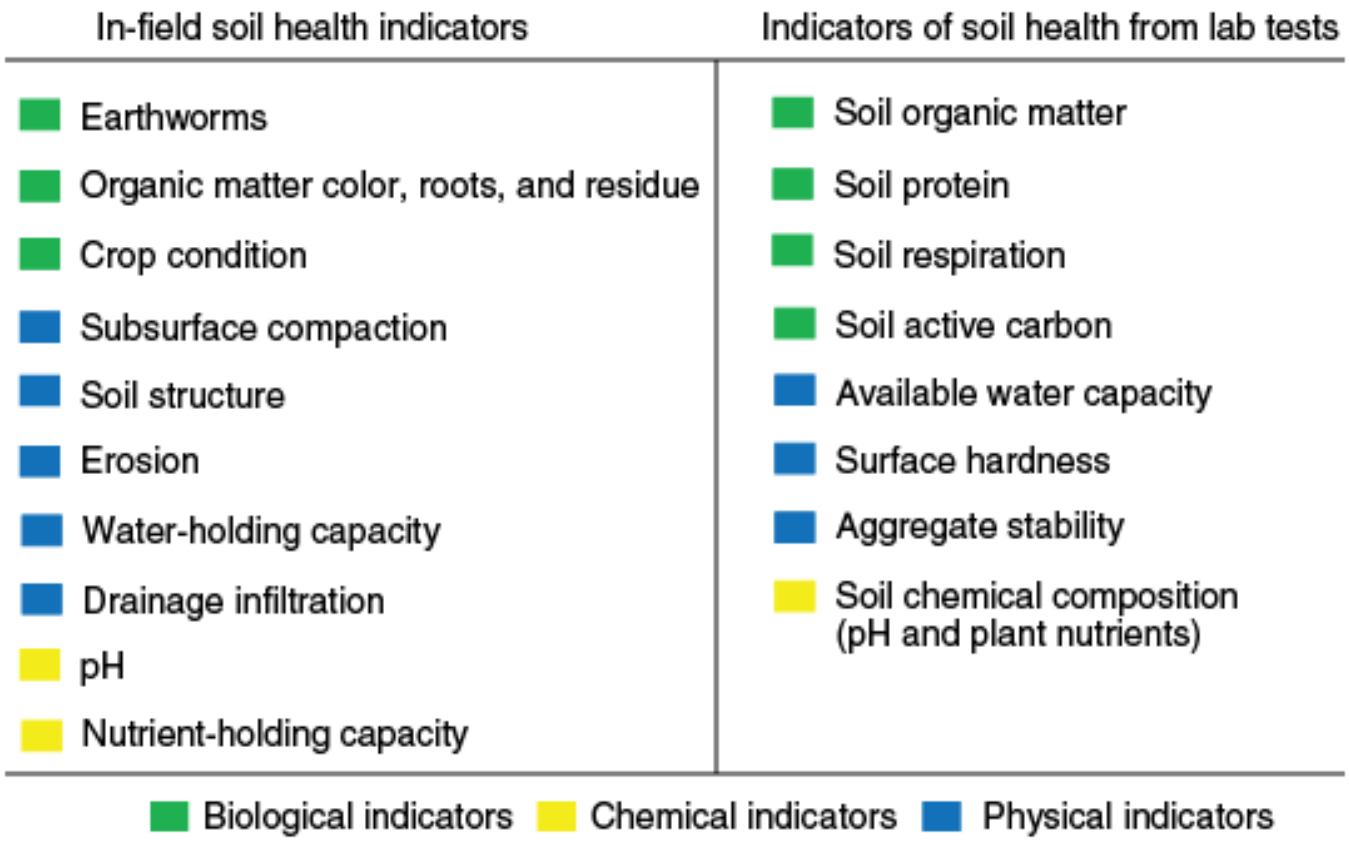
Photo credit: Building Soils for Better Crops, SARE [4]

Soil Sampling

- Easy way to monitor changes in or find out the baseline:
  - ✓*Soil nutrients*
  - ✓*Organic matter*
  - ✓*Soil pH*
  - ✓*Nematodes*

- *Pull Samples in August or late July*

Farmers and scientists can assess soil health in the field and in the laboratory using a variety of indicators



Note: Some of the in-field indicators in the left column are visual or can be evaluated by digging a small hole or feeling the soil. These include, for example: erosion, drainage infiltration, soil structure, organic matter, earthworms, and crop condition. For the specific indicators in the right column, farmers typically send their soil to a lab to be tested using more involved methods or equipment. Some indicators, such as pH, can be tested or evaluated in in the field or in the lab, though lab testing may be more accurate.
Source: USDA, Economic Research Service using Comprehensive Assessment of Soil Health—The Cornell Framework Manual, 3rd edition, 2016

Managing Soil Health

Planning for and maintaining soil health in caneberries

Soil Health in Caneberries

Managing Soil Health

- Prior to planting
  - Compost
  - Cover crops
  - Crop rotation
- In crop
  - Provide alleyway soil cover
  - Add mulch

Managing Soil Health

- Prior to planting
  - **Compost**

- In
  - Add mulch
  - way soil cover

✓ Why: Increase soil organic matter

✓ How:

Add compost and manure >3-6 months prior to bedding

- Food safety
- Salts (EC less than 4)
- Nutrients

Plant a cover crop with the compost/manure application to take up some of those nutrients

✓ Research:

Compost and manure applications suppressed lesion nematodes when applied prior to planting, nearly as well as fumigation. (Forge et al. 2015)

Gypsum amendments improved red raspberry survival on sites with phytopthera, compost application did not. (Maloney et al. 2005.)

Managing Soil Health

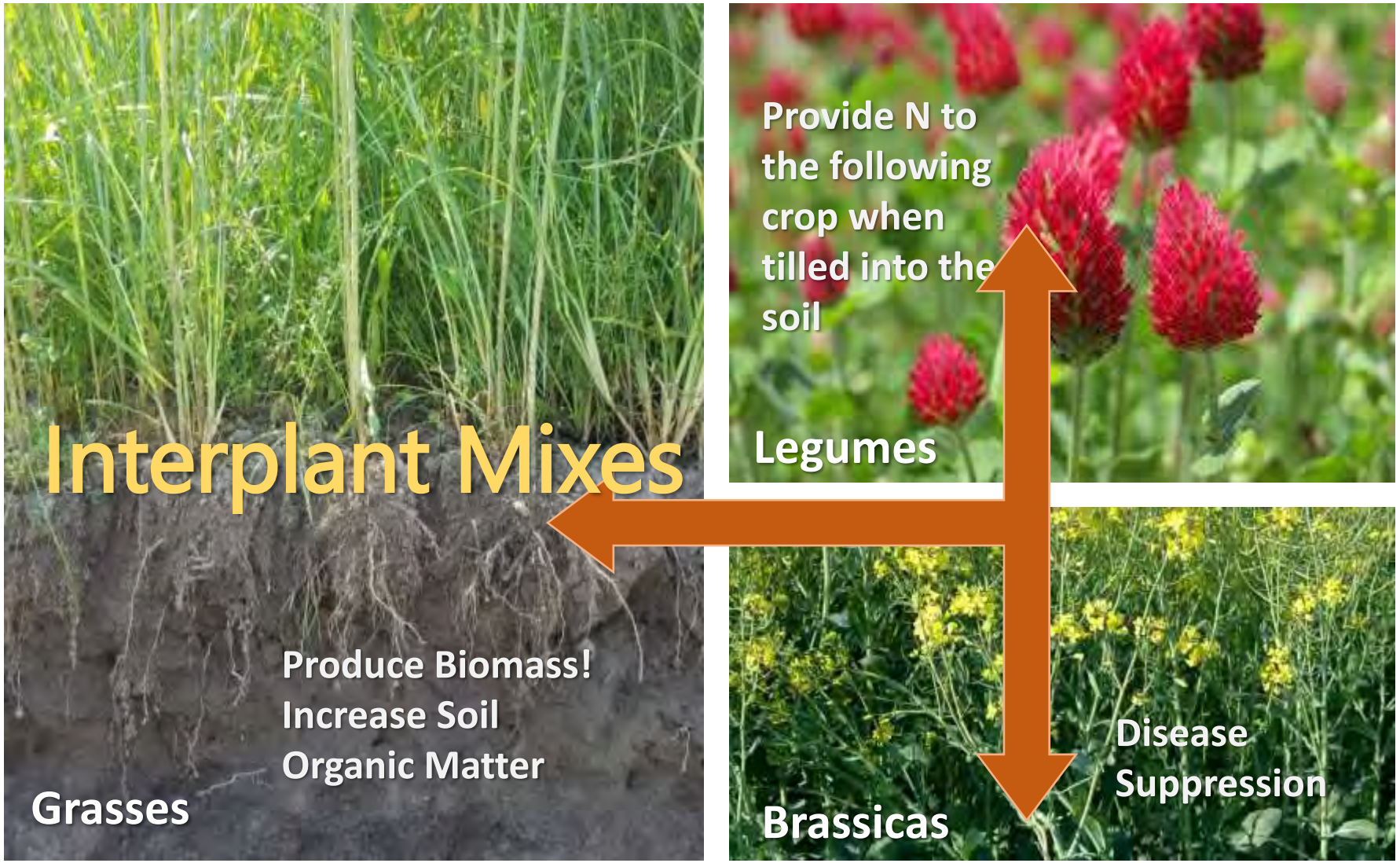
- Prior to planting
  - Compost
  - **Cover crops**
  - C
- In c
  - cover
  - A

✓ Why:
- Increase soil organic matter
- Suppress nematodes and disease
- Suppress perennial weeds

➢ Focus on their use pre-plant

Cover Crops

Instead of harvesting as a cash crop, cover crops are grown for the benefits they have on the soil or on subsequent crops



Cover Crops Can Suppress Weeds

Weed suppression can be accomplished:

- in the season the cover crop is planted
- in the following season if the cover crop residue is used as a weed mat or if the cover crop has *allelopathic* properties.

- **If cover crops are planted continuously for a year or more can reduce weed seed bank and suppress perennial weeds.**

Cover crops can reduce pest pressure

- Rotating to cover crops that are non-hosts can reduce nematode populations
  - **Mustards are non-host to dagger nematodes**
  - **Sorghum sudan is a non or poor host for lesion and root-knot**
  - **Cereal rye is a non or poor host to lesion, root-knot and dagger nematode**
- Brassica cover crops
  - biological fumigant crops

Managing Soil Health

- Prior to planting
  - Compost
  - Cover crops
  - **Crop rotation**
- In crop
  - Provide alleyway soil cover
  - Add mulch

✓ Why
- Break disease cycles
- Increase soil organic matter

✓ How
- Three to five year rotations are ideal
- Know your disease and nematode issues

Choose crops that:

1. Don’t share the same diseases
2. Root to different depths
3. Have different nutrient use requirements
4. Rotation of weed control options

Plant Families

Family	Crop Species	Weed Species
Solanaceae	peppers, tomatoes, potatoes, eggplant, tobacco, tomatillo	Nightshade, jimsonweed, ground cherry, horsenettle
Brassicaceae	horseradish, cabbage, cauliflower, broccoli, kohlrabi, kale, Brussels sprouts, turnips, Chinese cabbage, radish, rapeseed, mustard, collards, watercress, pak choi, bok choi, rutabaga	Shepherd's-purse, field pennycress
Cucurbitaceae	cucumber, melons, watermelon, summer squash, pumpkin, gourds, winter squash	White Bryony, etc.
Rosaceae	apples, peaches, apricots, nectarines, plums, strawberries, **blackberries**, raspberries, pears, cherries, quince, almond	Multiflora rose
Fabaceae	beans, peas, lentils, peanut, soybean, edamame, garbanzo bean, fava bean, hairy vetch, vetches, alfalfa, clovers, cowpea,	Various vetches, clovers, black medic
Poaceae	corn, wheat, barley, oats, sorghum, rice, millet, rye, ryegrass, sorghum-sudangrass, fescue, timothy	Crabgrass, orchardgrass, barnyardgrass, quackgrass, foxtail, Johnsongrass

COVER CROPS

Managing Soil Health

- Prior to planting
  - Compost
  - Cover crops
  - Crop rotation
- In crop
  - **Provide alleyway soil cover**
  - Add mulch

- ✓ Why
  - Reduce erosion
  - Reduce soil compaction
  - Increase soil organic matter
  - Suppress weeds that may set seed
- ✓ How
  - Choose species that won't compete with the crop (nutrients and moisture) and can compete with weeds.
  - Annual rye, fescue, etc. non-creeping/aggressive
- ✓ Research
  - No effect of alleyway cover crops on increasing lesion nematodes or suppressing plant growth through competition in red raspberry (Rudolph et al. 2017)

Managing Soil Health

- Prior to planting
  - Compost
  - Cover crops
  - Crop rotation
- In crop
  - Provide between row soil cover
  - **Add mulch**

✓ Why
- Increase OM
- Add nutrients to the soil

✓ How
- Apply mulch to the plant row, if no plastic is used

✓ Research
- Application of some organic mulches (compost and shredded paper+broiler manure) in a 1.5m strip to established red raspberry reduced lesion nematode populations. (Forage and Kempler, 2010).

Managing Soil Health

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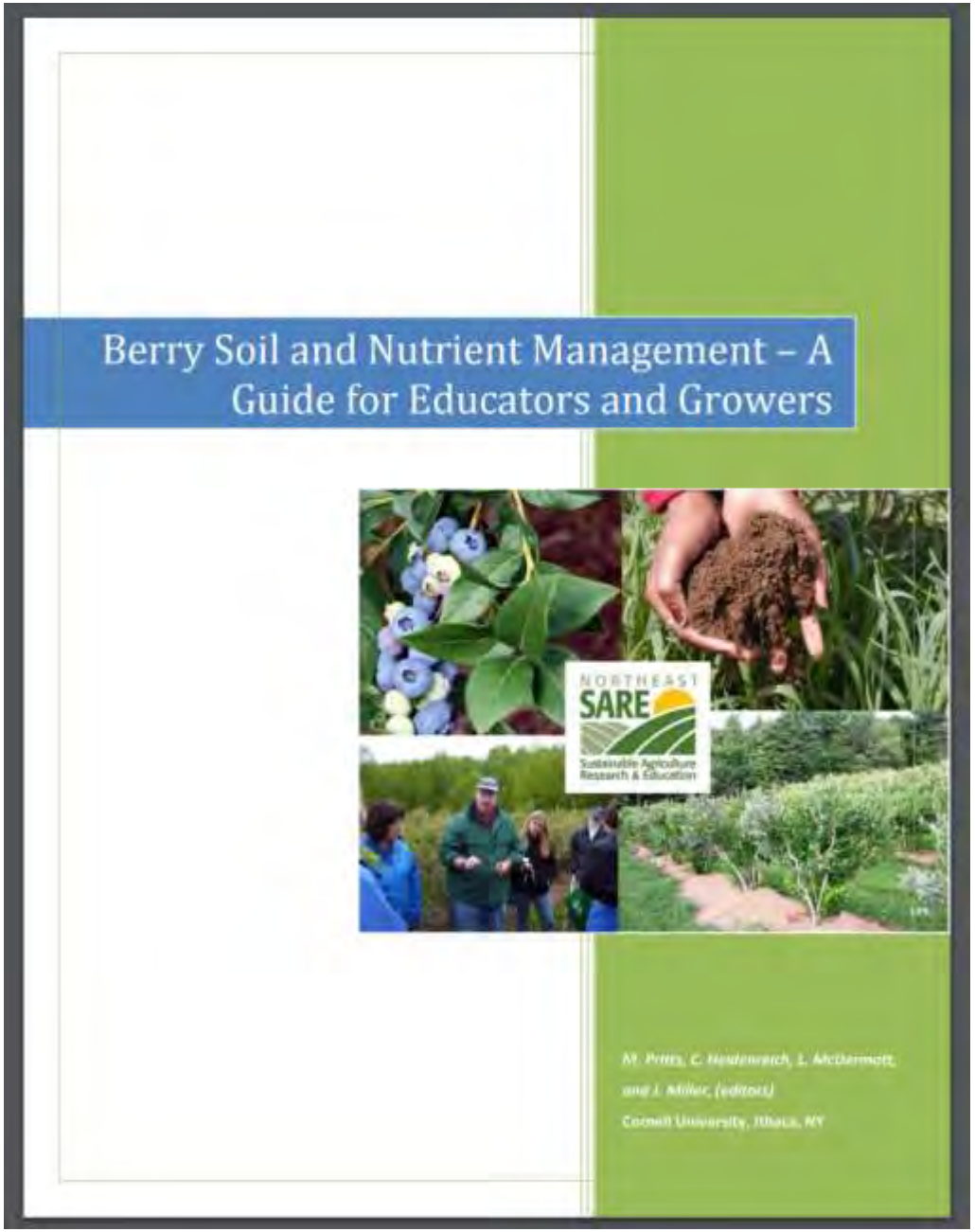
Effective management of soil health will require multiple tactics

Soil Health

A soil is not considered "healthy"
if it is *managed for short term productivity*
at the *expense of future degradation*
(Doran et al., 1994).

Resources

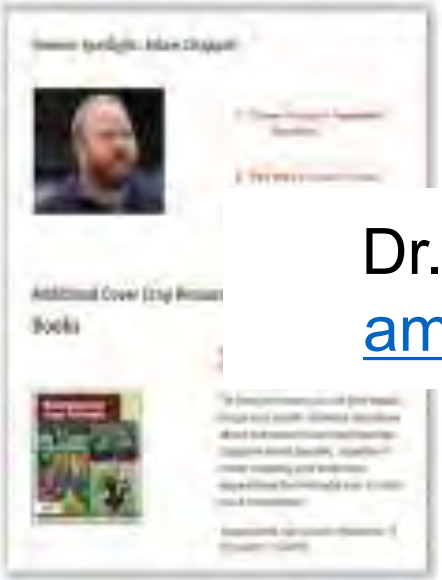


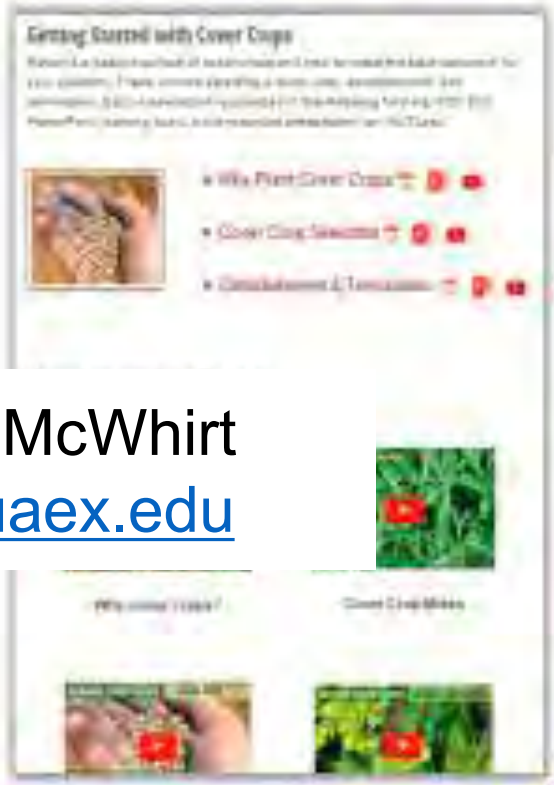
https://cpb-use1.wpmucdn.com/blogs.cornell.edu/dist/0/7265/files/2016/12/BerrySoilandNutrientManagementGuide-rx0i0k.pdf

COVERCROP
VEGETABLE PRODUCTION TRAINING

UofA DIVISION OF AGRICULTURE RESEARCH & EXTENSION | Cooperative Extension Service

www.uaex.edu/SAREcovercrop





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COVERCROP
VEGETABLE PRODUCTION TRAINING

Common Summer Cover Crops

Pearl Millet

Grows 4-6’ tall in 90-120 days.

Biomass

Sorghum Sudangrass

Biomass, may suppress root-knot nematodes

Buckwheat

Fast growth, pollinator habitat

Cowpea

Consistent producer of 100lbs of N per acre, Drought tolerant.

Nitrogen Fixer

Common Winter Cover Crops

Winter wheat

Fine root system, enhances nutrient cycling, good weed suppression

Cereal Rye

Can be planted late in fall, High Biomass, high C:N

Austrian Pea

Reliable establishment, good amount of N for seed costs

Mustard

Plant early to establish,
May winter kill