BF 104 Soil Health & Management
Kip Kolesinskas, Conservation Scientist
Listo Para Iniciar Farming Program, Stamford, CT
October 2016
INTRODUCTIONS
Advancing the Business of Farming in Connecticut in Partnership with Agricultural Learning Centers

Advancing the Business of Farming in Connecticut Project provides new farmers with core training and assistance to develop their farm plan, explore production options, and grow their farming enterprise. Visit www.newfarms.extension.uconn.edu for resources and events.

- Common Ground, New Haven
- Community Farm of Simsbury, Simsbury
- Green Village Initiative, Bridgeport
- Killingly Agricultural Education Center, Killingly
- Knox- Urban Farming Incubator Program, Hartford
- Grow Windham, Willimantic, Windham
- Listo Para Iniciar Program, Bethel, Stamford, New Milford
Advancing the Business of Farming in Connecticut in Partnership with Agricultural Learning Centers – Core Trainings

- BF 101 New Farmer Business Planning
- BF 102 Setting Up Financial Records for Farm Business
- BF 103 Finding, Evaluating Farm Sites, Leasing Farmland
- BF 104 Soil Health & Management
- BF 105 Fruit Production for Small Scale Farming
- BF 106 Vegetable Production for Small Scale Farming
- BF 110 Unheated hoop houses- installation, production systems
- BF 120 Irrigation & Water Management Systems
- BF 130 Hydroponics/Aeroponics/Aquaponic Systems
- BF 140 Post – Harvest Handling
- BF 150 How to Enter the Market, State regulations and support for CT Grown, EBT sales
Core Trainings continued....

• BF 201 Quickbooks for Farm operations
• BF 202 Record Keeping for Organic Certification
• BF 203 Balancing Farmland Capacity with Conservation & Financial Goals
• BF 210 Design Fundamentals for Greenhouses & Tunnels
• BF 220 Safety & Maintenance for Small Engines & Power Tools
• BF 221 Tractor Safety & Maintenance
• BF 230 Safe & Effective Use of Pesticides- For organic/non-organic producers
• BF 240 Climate change and Adaptation Strategies
• BF 250 Marketing for Success- developing relationships, branding
• BF 261 Selling to Institutional Buyers-schools, hospitals, colleges
Take an apple
Have it represent the Earth
Cut out and save ...
$\frac{1}{4}$ of the apple
This much represents land area.
Now cut that slice in half, and keep one piece.
This much represents where people live.
Cut that piece in quarters and keep one \( \frac{1}{4} \). This represents the amount of soil where food can be grown.
This is 3% (1/32) of the Earth’s surface.
It’s All About the Soil!!

Your soil is here, sir.
We Study Soil Because It’s A(n)

- Medium of crop production
- Producer and absorber of gases
- Medium for plant growth
- Home to organisms (plants, animals and others)
- Great integrator
- Essential natural resource

- Snapshot of geologic, climatic, biological, and human history
- Waste decomposer
- Source material for construction, medicine, art, etc.
- Filter of water and wastes

Essential natural resource
Five Soil Forming Factors

- Biota
- Parent Material
- Topography
- Climate

(The first four factors over) Time
Hydrologic Cycle

Water enters the soil, interacts with soil particles and leaves the soil (through evaporation, transpiration or leaching).
Hydrologic Cycle and the Soil

Soil Properties that are part of the hydrologic cycle.

- Moisture
- Color
- Temperature
- pH
- Horizon Depths
- Structure
- Texture
- Bulk Density
A Soil Profile
Soil Structure - With Structure

Granular

Platy

Blocky
(Subangular)

Wedge

Columnar

Prismatic

Granular

Platy

Blocky
(Angular)

Wedge

Columnar

Prismatic
Soil Structure – Without Structure

Single Grain

Massive
34% Sand
33% Silt
33% Clay

Texture = CLAY LOAM
### General Influence of Soil Separates on Properties and Behaviors of Soils

<table>
<thead>
<tr>
<th>Property/Behavior</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water holding</td>
<td>Low</td>
<td>Med-high</td>
<td>high</td>
</tr>
<tr>
<td>Aeration</td>
<td>Good</td>
<td>Med</td>
<td>Poor</td>
</tr>
<tr>
<td>OM decomposition</td>
<td>Fast</td>
<td>Med</td>
<td>Slow</td>
</tr>
<tr>
<td>Water erosion pot.</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Compact-ability</td>
<td>Low</td>
<td>Med</td>
<td>High</td>
</tr>
<tr>
<td>Sealing (ponds)</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Nutrient supplying</td>
<td>Poor</td>
<td>Med-high</td>
<td>High</td>
</tr>
<tr>
<td>Pollutant leaching</td>
<td>High</td>
<td>Med</td>
<td>Low</td>
</tr>
</tbody>
</table>
Soil Organic Matter

- Decomposing organic matter 
  active fraction: 33% - 50%
- Stabilized organic matter (humus): 33% - 50%
- Fresh residue: <10%
- Living organisms: <5%
- Living organisms: <5%
Landscape Factors

- Depth to bedrock
- Depth to water table
- Flooding vs. ponding vs. high water table
- Erosion & water quality concerns
- Human influence
Relative Landscape Position

- summit
- shoulder
- backslope
- drainageway or depression
- footslope
- toeslope
### Soil Catenas of Connecticut

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Lithology</th>
<th>Texture Group</th>
<th>Excessively Drained</th>
<th>Moderately Well</th>
<th>Somewhat Poorly</th>
<th>Poorly</th>
<th>Very Poorly</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNRAITE &amp; SCHIST</td>
<td>SANDY</td>
<td></td>
<td>WESTMINSTER #</td>
<td>MILLS $</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCHIST, GRANITE &amp; GNEISS</td>
<td></td>
<td></td>
<td>CHAFFIELD</td>
<td>CHATFIELD $</td>
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<td></td>
<td></td>
<td></td>
<td>FAYTON</td>
<td>MONTAUK $</td>
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<td></td>
<td></td>
<td></td>
<td>WOODBRIDGE</td>
<td>ASHFIELD $</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>FARMINGTON</td>
<td></td>
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</tr>
<tr>
<td>GLACIAL TILL, Unstratified Sand &amp; Gravel</td>
<td>LOAMY</td>
<td></td>
<td>HYDE $</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>YALEVILLE $</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>WETHERSFIELD</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>MACOMBER $</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>BRIMFIELD</td>
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<td></td>
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<td></td>
<td>BERNARDSON $</td>
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<td></td>
<td></td>
<td></td>
<td>BERNARDSON $</td>
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<td></td>
<td></td>
<td></td>
<td>HOLLIS</td>
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</tbody>
</table>

### Glacial Fluvial, Stratified Sand & Gravel

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Lithology</th>
<th>Texture Group</th>
<th>Excessively Drained</th>
<th>Moderately Well</th>
<th>Somewhat Poorly</th>
<th>Poorly</th>
<th>Very Poorly</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACIDIC CRYSTALLINE ROCKS</td>
<td>SANDY &amp; GRAVELY</td>
<td></td>
<td>HICKLEY</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ACIDIC CRYSTALLINE ROCKS</td>
<td>SANDY &amp; GRAVELY</td>
<td></td>
<td>WINDSOR $</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RED SANDSTONE, SHALE, CONGLOMERATE &amp; BASALT</td>
<td>LOAMY</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### Glacial Lauge, Stratified Sand & Gravel

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Lithology</th>
<th>Texture Group</th>
<th>Excessively Drained</th>
<th>Moderately Well</th>
<th>Somewhat Poorly</th>
<th>Poorly</th>
<th>Very Poorly</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIXED CARBONATE ROCKS &amp; CRYSTALLINE ROCKS</td>
<td>LOAMY</td>
<td></td>
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</tbody>
</table>

### Wetland Type

<table>
<thead>
<tr>
<th>Wetland Type</th>
<th>Fibers</th>
<th>Thickness</th>
<th>Substrate</th>
<th>Soil Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORGANIC</td>
<td>FEW</td>
<td>&gt;51 (130 cm)</td>
<td>VARIABLE</td>
<td>CATDEN $</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16-51 (40-130 cm)</td>
<td>LOAMY</td>
<td>FREETOWN $</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-5 (0-10 cm)</td>
<td>COMMON</td>
<td></td>
</tr>
</tbody>
</table>

### Parent Material

<table>
<thead>
<tr>
<th>Parent Material</th>
<th>Highly Fluid Surface</th>
<th>Sulfidic</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARINE-BERIES BANDS</td>
<td>0-4 (5-10 cm)</td>
<td>RHODESFOLLY</td>
</tr>
<tr>
<td>MARINE-BERIES SILTS</td>
<td>0-10 (10-50 cm)</td>
<td></td>
</tr>
<tr>
<td>SUBMERGED TERRIELAR</td>
<td>&gt;95 (100 cm)</td>
<td>NAPATREE</td>
</tr>
<tr>
<td>SUBMERGED TERRIELAR</td>
<td>&gt;95 (100 cm)</td>
<td>BILLINGTON</td>
</tr>
</tbody>
</table>

### Historical Soil Series

Since the publication of the soil surveys for all eight Connecticut counties, the classification of soils has continued to evolve. When using the historical published soil surveys, one will encounter a variety of soil series names not currently in use. These series, noted above, are referenced by number to the most current name available at the time of this publication. For example, the soil mapped as Acton, if classified by today's standards, may be named Sutton.

Charts on this page supplement all Connecticut soil surveys by referring to both current and previously used soil series names. However, since there are some major differences in map units and soil series interpretations from survey to survey, it is necessary to refer to the narrative descriptions within the appropriate archived survey to obtain complete information concerning a particular soil.

### Official Soil Series Descriptions

More detailed information about each soil series is located on the USDA-NRCS soils webpage under Official Soil Series Descriptions (OSDs). This site is updated and maintained online as the official source of tentative and established soil series.
Bedrock begins to disintegrate

Organic materials facilitate disintegration

Horizons form

Developed soil supports thick vegetation
Dinosaur Era
Today
350 years ago
4,000 years ago
6,000 years ago
8,000 years ago
10,000 years ago
13,000 years ago
17,000 years ago

Adapted from the Mashantucket Pequot Museum
Physiographic Regions of Connecticut
Glacial Till Parent Material

Sutton Series
Glaciofluvial Parent Material

Manchester Series
Alluvium Parent Material

Hadley Series
Glaciolacustrine Parent Material

Scitico Series
Organic Parent Material

Natchaug Series
Disturbed Parent Material
Criteria Used in Soil Taxonomy

• Chemical, physical, and biological properties (such as moisture, temperature, texture, structure, pH, soil depth)

• Presence or absence of certain diagnostic horizons (surface and subsurface horizons)
12 Soil Orders

- Entisol
- Inceptisol
- Andisols
- Spodosols
- Mollisols
- Alfisols
- Ultisols
- Oxisols
- Aridisols
- Vertisols
- Histosols
- Gelisols

http://soils.usda.gov/technical/classification/orders/
A polypedon or soil individual

Landscape

A pedon

Solum

Soil Profile

Ap
Bw
BC
C
Click on the green “start” button

http://websoilsurvey.nrcs.usda.gov
View the Soil Map
Click on map unit name for description

State of Connecticut

2—Ridgebury fine sandy loam

Map Unit Setting

Elevation: 0 to 1,200 feet
Mean annual precipitation: 37 to 56 inches
Mean annual air temperature: 45 to 55 degrees F
Frost-free period: 140 to 185 days

Map Unit Composition

Ridgebury and similar soils: 80 percent
Minor components: 20 percent

Description of Ridgebury

Setting

Landform: Depressions, drainageways
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: 20 to 30 inches to dense material
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.6 inches)
Networking Break & Soil Texture DEMO
Get to know other participants!
35 min
Texture by Feel

START

Place approximately 25g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.

Does soil remain in a ball when squeezed? NO NO NO

Add dry soil to soak up water

Is soil too dry? Is soil too wet? Is soil too wet?

SAND

Place a ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.

LOAMY SAND NO NO NO

Does soil form a ribbon?

Does soil make a weak ribbon less than 2.5 cm long before breaking?

NO NO NO

Excessively wet a small pinch of soil in palm and rub with forefinger.

SANDY LOAM YES NO NO

Does soil feel very gritty? Does soil feel very smooth?

SANDY CLAY LOAM YES NO NO

SILTY LOAM YES NO NO

Neither grittiness nor smoothness predominates

SILTY CLAY YES NO NO

Neither grittiness nor smoothness predominates

CLAY LOAM YES NO NO

Neither grittiness nor smoothness predominates

CLAY YES NO NO

Neither grittiness nor smoothness predominates
SOIL QUALITY/HEALTH:
The continued capacity of the soil to function as a vital living system that sustains plant, animal, and human health.
Properties of Soil Heath:

Inherent Properties:
—Physical properties that usually cannot be changed without much difficulty
  • Soil texture
  • Type of clay
  • Depth to bedrock
  • Drainage class

Dynamic Properties:
• Management dependant properties that we do have the ability to change relatively easily
  • Organic matter content
  • Biological activity
  • Aggregate stability
  • Infiltration
  • Soil fertility
  • Soil reaction (pH)
Benefits of Managing for Soil Health

- Improved Nutrient Cycling
- Maximizes fertilizer availability
- Fungi increase P and water supply to plants
- Improved soil aggregation
- Increased water movement and storage
- Better root growth into more soil
- Better habitat for the Soil Food Web
- Fewer weeds and diseases
- A balanced Food Web helps suppress pests
- Less soil disturbance plants fewer weed seeds
Indicators of Soil Health:

Physical indicators commonly used to assess agronomic soil quality include:

- Aggregate stability
- Available water holding capacity
- Bulk density
- Infiltration
- Root distribution
- Soil crusts
- Soil structure and macropores
- Visible soil fauna
Soil is a Living Factory

Macroscopic and microscopic organisms—Food
-Water
-Shelter
-Habitat
-Powered by sunlight

Management activities improve or degrade soil health—Tillage
-Fertilizer
-Pesticides
-Grazing
-Plant Diversity
What the Soil Food web Does:
Plant nutrient immobilization / mineralization
  Creates stable soil aggregates  Water infiltration / retention
Habitat for soil food web
Root movement
Nematode, microarthropod movement
Air movement

What is the most limiting element in the soil for agricultural production?
Where does the Carbon contained in the soil come from?
The Soil Food Web

Create Quality Microbial Habitat, Every Farmer has Livestock

- **Plants**: Shoots and roots
- **Organic Matter**: Waste, residue and metabolites from plants, animals and microbes
- **Nematodes**: Root-feeders
- **Fungi**: Mycorrhizal fungi, Saprophytic fungi
- **Bacteria**: Amoebae, flagellates, and ciliates
- **Arthropods**: Shredders, Predators
- **Protozoa**: Shredders, Predators, Grazers

**First trophic level**: Photosynthesizers

**Second trophic level**: Decomposers, Mutualists, Pathogens, parasites, Root-feeders

**Third trophic level**: Higher level predators

**Fourth trophic level**: Higher level predators

**Fifth and higher trophic levels**: Higher level predators
Rhizosphere...where roots meet soil

Zone of concentrated biological activity adjacent to the root...

Bacteria
Fungi
Protozoa
Nematodes
Microarthropods
Earthworms
Principles of Managing for Soil Health

• Minimize Disturbance of the soil
• Maximize Diversity of plants in rotation
• Keep Living Roots in the soil as much as possible
• Keep the soil covered with plants and plant residues
• Create the most favorable habitat possible for the soil food web
Soil Health Toolbox

• (No) or reduced Tillage
• Crop Rotation Diversity
• Cover Crops
• Degree of Fertilizer use
• Degree of Pesticide use
• Livestock

Which of these tools could positively affect soil health on your farm or garden?
Reduce/Eliminate Tillage of the Soil

• Tillage is physical soil disturbance
• Destroys aggregates
• Exposes organic matter to decomposition
• Facilitates compaction
• Damages soil fungi
• Reduces habitat for all members of SFW
• Disrupts soil pore continuity
• Promotes salinity at the soil surface
Advancing the Business of Farming in Connecticut in Partnership with Agriculture Learning Centers
Reduced Tillage and Infiltration

- No-, zone-, strip-, ridge-till, etc.
- Less macro-fauna disturbance (i.e., earthworms)

(Source: Herbek, AGR-101; www2.ca.uky.edu)
(Dan Brainard, msue.anr.msu.edu)
Field Assessment

Compaction

Decrease in pore spaces are where plants get air, water, and nutrients.

Adapted from Sulzman and Frey, 2003
Try this at home!

Test your compaction!

Use what you have:
• Fingers
• Shovel
• Pin flag
• Rod
Plant Diversity through crop rotation / cover crops:

- Crop diversity = Soil Food Web (SFW) diversity
- Diversity Balanced/Diverse diet to Soil Food Web
- Help Reduce pest pressure
- Help Increase soil nutrient cycling
- Reduces risk
- Increased influence of living roots Feeds Soil Food Web
- Increase soil aggregation and porosity to increase available water holding capacity, infiltration and percolation
- Increase OM holds more available water for plants
- Stimulate SFW into increased activity
- Integrate grazing
- Nitrogen fixation/recovery
Figure 2. Averaged over 10 years and three vegetable cropping systems, a winter rye cover crop reduced runoff throughout the year on a Freehold loamy sand with 3% slope in New Jersey (Brill and Neal 1950)
Organic Matter and Infiltration

Cumulative Infiltration (m$^3$/m$^2$) vs. Minutes

High O.M.

Low O.M.

(Colla et al., 2000)
Soil Organic Matter Fun Facts

• Soil organic matter (SOM) is <6% of soil by weight but controls >90% of the function
• Density of SOM: .6 g/cm³  Density of Soil: 1.45 g/cm³
• SOM has less density than soil so it has more space for air and water storage.
• SOM is negatively charged, but binds both cations and anions
• As soil organic matter increases from 1% to 3%, the available water holding capacity of the soil doubles (Hudson, 1994).
• Soils stockpile 1500 gigatons of carbon in SOM, more than Earth's atmosphere and all the plants combined (Dance, 2008).
• The majority of the SOM is present in the top 10 cm of soil

- 1.0% OM = 20,000 #10,000 # Carbon (5 ton) @ $4/ton = $20
- 1,000 # Nitrogen@ $.50/# = $500
- 100 # Phosphorous@ $.70/# = $70
- 100# Potassium@ $.40/# -= $40
- 100 lbs of Sulfur@ $.50/# = $50
- Total $680

Mineralization Rate = 2-3% from Organic N to Inorganic N. Resulting in 20 to 30 lbs of useable N per acre.
Drought Resilience

- Crops can’t use water that doesn’t infiltrate
- Organic matter
  - For every 1% increase in OM, another inch of water available (Emerson, 1995)
- Avoiding compaction
  - Deep moisture
  - Increased storage
  - Increased conductivity
- Role for moisture sensors
  - Drought and compaction prevention

(Courtesy USDA-NRCS)
Chemical Soil Disturbance from Fertilizer

• Excessive nitrogen or phosphorus fertilizer... Short-circuits the rhizosphere
• Depresses activity of natural N fixers
• Stimulates bacterial decomposition of Soil OM
• N at risk for leaching or denitrification
• Synthetic fertilizers are salts (salinity) and can lower pH
Chemical Soil Disturbance from Pesticide use:

• Impact of pesticides on non-target organisms not well understood.
• Pesticides simplify, not diversify SFW“cides”

• Produces Crop rotation restrictions
• Produces Cover crop diversity restrictions
Keep soil covered as much as possible

- Control Erosion
- Protect Soil Aggregates
- Suppresses Weeds
- Conserves Moisture
- Cools the Soil
- Provides Habitat for Soil Organisms

When soil temperature reaches.....

140 F  Soil bacteria die

130 F  100% moisture is lost through evaporation and transpiration

113 F  Some bacteria species start dying

100 F  15% moisture is used for growth

95 F  85% moisture lost through evaporation and transpiration

70 F  100% moisture is used for growth
Livestock as a practice for soil health

• Add and distribute biology to soil
• Cycle residues, reduce C:N ratios
• Puts plant residues in contact with soil
• Can help control weeds and disease
• Opportunity for increased income
• Increase intensity & reduce duration to improve soil health on pastures
How do we know if soil health is improving?

- Soil aggregate stability increases
- Water infiltration increases
- Organic matter increases
- Crop response
- Plants use less water, nutrients
- Less crusting, ponding, erosion
- Reduced input costs
- Soil Food Web analysis
### Site Indicator Scorecard for Connecticut Community Gardeners

#### NRCS
USDA, Natural Resources Conservation Service

<table>
<thead>
<tr>
<th>Site Indicator</th>
<th>Poor</th>
<th>Tolerable</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accessibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Walking distance to site.</td>
<td>10+ minutes.</td>
<td>5-10 minutes.</td>
<td>0-5 minutes.</td>
</tr>
<tr>
<td>3. Visibility from street.</td>
<td>Can't see site, or it is very visible.</td>
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<td></td>
</tr>
<tr>
<td><strong>Topography</strong></td>
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</tr>
<tr>
<td>6. Bedrock, ledge, or large boulders on site.</td>
<td>Too many to work around.</td>
<td>Some, but can work around them.</td>
<td>None.</td>
</tr>
<tr>
<td><strong>Location/Distance to Water</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Water access – city water, pond, or river for irrigation.</td>
<td>No water available on the site, and no access to bring it to site.</td>
<td>Have to connect to city water or bring water to site.</td>
<td>Water available easily.</td>
</tr>
<tr>
<td>9. Runoff.</td>
<td>After rainfall, a lot of soil washes from site.</td>
<td>After rainfall, a little soil washes from site.</td>
<td>After rainfall, no soil is seen to wash from site.</td>
</tr>
<tr>
<td>10. Water on site during the growing season (spring, summer, fall).</td>
<td>After a moderate rainfall, water stays on surface for a few days.</td>
<td>After heavy rainfall, water stays on surface for a short time.</td>
<td>After rainfall, no water is observed on the soil surface.</td>
</tr>
<tr>
<td>11. Sun exposure through the day.</td>
<td>Shady, very little exposure.</td>
<td>Sun is blocked some of the time.</td>
<td>Mostly sunny.</td>
</tr>
<tr>
<td>12. Amount of existing pavement on site.</td>
<td>Too much pavement, will interfere with plans for the site.</td>
<td>Some, but can work around.</td>
<td>None.</td>
</tr>
<tr>
<td>15. Neighborhood pets.</td>
<td>Site used heavily by animals.</td>
<td>Some use.</td>
<td>No pet evidence observed.</td>
</tr>
<tr>
<td>16. Human activity on site.</td>
<td>Lots of evidence of people on site.</td>
<td>Some people use site.</td>
<td>Very little or no evidence of people on site.</td>
</tr>
<tr>
<td>17. What’s growing on the site now?</td>
<td>Lots of unwanted trees and brush.</td>
<td>Some unwanted trees and brush.</td>
<td>Plants will not interfere with site plans.</td>
</tr>
<tr>
<td><strong>History of Site</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Soil Indicator Scorecard

**for Connecticut Community Gardeners**

<table>
<thead>
<tr>
<th>Soil Indicator</th>
<th>Poor</th>
<th>Tolerable</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Can you use the soil that is on the site? (Is there soil on this site?)</td>
<td>No. Need to bring soil to site.</td>
<td>Some.</td>
<td>Yes, all soil is workable.</td>
</tr>
</tbody>
</table>

### Surface of Soil

| 21. How do existing plants grow? Compare same kind of plant. | Plants are dead or scraggly. | Plant color and size are different. | Plants look healthy. |

### Soil Examination

| 22. Smell of soil. | Oily, chemically, gasoline, rotten eggs, or bad or strange. | No smell. | Fresh, earthy. |

---

**It is not possible to smell some contaminants, like lead, in the soil. Avoid the site if the soil smell is poor unless you can determine the soil history is safe and environmental testing for contaminants indicates the area is safe. Do not touch the soil if the smell is offensive.**

| 24. Try to insert a wire coat hanger into soil surface two days after rainfall during the growing season. | Coat hanger bends or cannot be inserted. | Coat hanger can be pushed in with pressure. | Coat hanger goes in easily with fingers. |
| 26. Depth of topsoil layer | 0-2 inches. | 2-5 inches. | 5+ inches. |
| 27. Color of topsoil layer | Yellow, gray, multicolored. | Light brown. | Black, dark brown, dark red, color is uniform. |
| 28. Moisture of soil two days after heavy rain. | Soil is very dry or very wet. | Soil is somewhat dry or muddy. | Soil is moist, but not muddy. |
| 29. How quickly water drains in one foot deep hole during the growing season. | Water stays in hole and doesn’t drain after 15 minutes. | Water drains, but less than one inch in 15 minutes. | Water enters soil quickly and moves down more than one inch in 15 min. |
| 31. How moist soil particles hold together. | Soil is hard and very difficult to break with fingers. | Soil breaks apart with some difficulty with fingers. | Soil crumbles easily with fingers. |
| 32. Roots in the top 12 inches of soil. | None. | Some, roots grow mostly across the soil, not down. | Many, roots grow mostly down into the soil, not across. |
| 34. Stones or rocks in the soil. | Too many. | Some. | None. |
| 35. Debris in the soil (bricks, construction materials, glass, concrete, etc.) | Too much to dig around. | A little bit, doesn’t interfere with digging. | None. |
| 36. Rotten stumps, old trees in the soil | Lots of stumps and trees. | A few small pieces. | None. |
MATTER CYCLING IN ECOSYSTEMS

• Nutrient Cycles: Global Recycling
  – Global Cycles recycle nutrients through the earth’s air, land, water, and living organisms.
  – Nutrients are the elements and compounds that organisms need to live, grow, and reproduce.
  – Biogeochemical cycles move these substances through air, water, soil, rock and living organisms.

To know if nutrients are available in the soil for plants, TEST the Soil!
Advancing the Business of Farming in Connecticut in Partnership with Agriculture Learning Centers

University of Connecticut
Department of Plant Science
Soil Nutrient Analysis Laboratory, 6 Sherman Place, Box U-102, Storrs, CT 06269-5102, Phone: 860-486-4274, Fax: 860-486-4562.

GROWER'S ADDRESS
IRONWOOD COMMUNITY PARTNE
52 DUNCASTER RD
BLOOMFIELD, CT 06002

SAMPLE ID
#2 ICP

LAB ID  RECEIVED    REPORTED
3043     05/06/15    05/19/15

SALES AGENT

NUTRIENTS EXTRACTED FROM YOUR SOIL (MODIFIED MORGAN EXTRACTABLE)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>ppm</th>
<th>Below Optimum</th>
<th>Optimum</th>
<th>Above Optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>5.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>1174</td>
<td>lbs/acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>254</td>
<td>lbs/acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>7</td>
<td>lbs/acre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>97</td>
<td>lbs/acre</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Element | ppm | Soil Range | Estimated Total Lead: Low, typical background levels
Boron (B) | 0.10 | 0.1-2.0      |
Copper (Cu) | 0.30 | 0.3-8.0      |
Iron (Fe) | 4.20 | 1.0-40.0     |
Manganese (Mn) | 4.00 | 3.0-20.0     |
Zinc (Zn) | 3.00 | 0.1-70.0     |
Aluminum (Al) | 119  | 10-300       |

LIME AND FERTILIZER RECOMMENDATIONS

CROP OR PLANT - VEGETABLE GARDEN

LIMESTONE (GROUND, GRANULAR, PULVERIZED OR PELLETED):
Apply 90 lbs. per 1000 sq. ft. to raise the pH level. Have your soil re-tested in 3-4 years. Apply half the lime in the spring and half in the fall.

FERTILIZER:
Soil test values for both phosphorus and potassium are below optimum. Before planting, incorporate 40 lbs of 5-10-10 per 1000 sq ft or the equivalent from other sources. If plants develop pale green to yellow color, side-dress with 3 lbs. of 10-6-4 or 10-10-10 per 100 ft. of row in late June or early July. Apply next to the row about six inches from plants avoiding contact with foliage to prevent burning.
See the enclosed information on natural fertilizers for alternatives to synthetic chemical fertilizers.

COMMENTS:
Soil texture classification: Sandy loam
Organic content classification: Medium
Nutrients in Soil

• Nutrients are chemical elements and compounds found in the environment that plants and animals need to grow and survive.
  – Nitrate (NO$_3^-$),
  – nitrite (NO$_2^-$),
  – ammonia (NH$_3$),
  – organic nitrogen (in the form of plant material or other organic compounds), and
  – phosphates (PO$_4^{3-}$)(orthophosphate and others)
The Big 13

• The 13 mineral nutrients, which come from the soil, are dissolved in water and absorbed through a plant's roots. There are not always enough of these nutrients in the soil for a plant to grow healthy. This is why many farmers and gardeners use fertilizers to add the nutrients to the soil.
Macronutrients: Primary Nutrients

- Macronutrients are those elements and compounds needed in large quantities for a plant to grow.
- The primary nutrients are nitrogen (N), phosphorus (P), and potassium (K).
- These major nutrients usually are lacking from the soil first because plants use large amounts for their growth and survival.
- A fertilizer of 5-10-10 contains 5% N, 10% P, 10% K
Macronutrients: Secondary Nutrients

• The secondary nutrients are calcium (Ca), magnesium (Mg), and sulfur (S). There are usually enough of these nutrients in the soil so fertilization is not always needed.
  – Large amounts of Ca and Mg are added when lime is applied to soils.
  – Sulfur is usually found in sufficient amounts from the decomposition of soil organic matter.
Micronutrients

- Micronutrients are those elements essential for plant growth which are needed in only very small (micro) quantities and are sometimes called minor elements or trace elements.

- Micronutrients include **boron** (B), **copper** (Cu), **iron** (Fe), **chloride** (Cl), **manganese** (Mn), **molybdenum** (Mo) and **zinc** (Zn).
Soil pH is a major factor

- Soil pH (a measure of the acidity or alkalinity of the soil)
- Soil pH is one of the most important soil properties that affects the availability of nutrients.
  - Macronutrients tend to be less available in soils with low pH.
  - Micronutrients tend to be less available in soils with high pH.
Most *nutrients* are highest and most *toxins* are lower at pH 5.5-7.
The pH can be changed

- Lime can be added to the soil to make it less acidic and also supplies calcium and magnesium for plants to use.
  - Lime also raises the pH to the desired range of 6.0 to 7.0. In this pH range, nutrients are more readily available to plants, and microbial populations in the soil increase.
Nitrogen

• Nitrogen is a part of all living cells and is a necessary part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.

• Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.

• Nitrogen is usable in the forms of $\text{NO}_3^-$, $\text{NO}_2^-$, and $\text{NH}_3$
Where does N come from?

• Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops.

• Nitrogen often comes from fertilizer application whether it is industrial fertilizer or animal waste.

• Bacteria can fix Nitrogen from the atmosphere \((\text{N}_2)\) into a more usable form.

• Decomposition of organic matter puts nitrogen back into the soil.
Phosphorus

• Like nitrogen, phosphorus (P) is an essential part of the process of photosynthesis.
• Involved in the formation of all oils, sugars, starches, etc.
• Helps with the transformation of solar energy into chemical energy; proper plant maturation; effects rapid growth; and, encourages blooming and root growth.
Sources of Phosphorus

• Phosphorus often comes from fertilizer, bone meal, and from rock.

• Phosphorus is found in rock and is therefore a function of the rock cycle.
  – P is in limited supply and is often a limiting factor because the rock cycle is so slow!

• Phosphorus also comes from bird guano.
Potassium

- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- **Helps in the building of protein, photosynthesis, fruit quality and reduction of diseases.**
- Potassium is supplied to plants by soil minerals, organic materials, and fertilizer.
Calcium

• Calcium, an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant.

• Sources of calcium are dolomitic lime and gypsum
Magnesium

• Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth.

• Soil minerals, organic material, fertilizers, and dolomitic limestone are sources of magnesium for plants.
Sulfur

• Sulfur is essential plant food for production of protein. It promotes activity and development of enzymes and vitamins; helps in chlorophyll formation; improves root growth and seed production; helps with vigorous plant growth and resistance to cold.

• Sulfur may be supplied to the soil from rainwater. It is also added in some fertilizers as an impurity, especially the lower grade fertilizers. The use of gypsum also increases soil sulfur levels.

• The decomposition of organisms can add sulfur to the soil.

• Sulfur is used by plants in the form of sulfates (SO$_4^{2-}$) and sulfites (SO$_3^{2-}$)
Micronutrients

**Boron (B)**
- Helps in the use of nutrients and regulates other nutrients.
- Aids production of sugar and carbohydrates.
- Essential for seed and fruit development.
- Sources of boron are organic matter and borax

**Copper (Cu)**
- Important for reproductive growth.
  - Aids in root metabolism and helps in the utilization of proteins.

**Chloride (Cl)**
- Aids plant metabolism.
- Chloride is found in the soil.

**Iron (Fe)**
- Essential for formation of chlorophyll.
- Sources of iron are the soil, iron sulfate, iron chelate.

**Manganese (Mn)**
- Functions with enzyme systems involved in breakdown of carbohydrates, and nitrogen metabolism.
- Soil is a source of manganese.
Sampling instructions for a Soil Test

1. Follow the instructions from the testing lab, there are variations
2. Fill out the form, include crop information
3. If manure or compost applied, estimate amount
4. Sampling in Fall is best, other times ok too
5. Areas of different soils, crops, or management should be tested/sampled separately
6. Avoid non typical areas for sampling
7. Take 6-20 (depends on size area) thin slices/cores of soil to depth of 4-8 inches, mix in clean container
8. No sample should be for an area larger than 10-15 acres
9. Pull out one cup of soil mix, this = 1 soil sample
10. Label samples, keep track of location and sample # on a map/sketch
Other Tests

• Percolation (permeability), infiltration
• Bulk density
• Organic matter
• Salinity
• Ion Exchange
• Heavy and Trace Metals
• Biological activity
• Aggregate stability
Soil pH Test Kit DEMO - 15min
Best Management Practices for Agriculture

Conservation practices and systems address:

• Water Quality
• Water Quantity
• Soil Quality
• Air Quality
Best Management Practices for Agriculture

Conservation practices and systems address:

- Energy Conservation
- Animal Health and Welfare
- Plant Health
- Fish and Wildlife Habitat
Well managed agriculture systems provide:

- Food, Fiber, and Wood Products
- Clean and Abundant Water
- Clean Air
- Fish and Wildlife Habitat
Best Management Practices for Agriculture

Well managed agriculture systems provide:

• Scenic Vistas

• Open Space
Best Management Practices for Agriculture

Well managed agriculture systems provide:

- Cultural Heritage
- Support to Local Economies
Best Management Practices for Agriculture

Well managed agriculture systems provide:

• Enhanced Quality of Life

Social Awareness
Best management practices, also called conservation practices, are implemented based on a conservation plan.
Best Management Practices for Agriculture

Conservation planning steps include:

• Taking an inventory of resource conditions
Best Management Practices for Agriculture

Conservation planning steps include:

• Identifying issues and opportunities with the farmer
Best Management Practices for Agriculture

Conservation planning steps include:

• Developing choices and solutions

• Scheduling implementation of practices

• Evaluating effectiveness of the plan
**Best Management Practices for Agriculture**

**Cropping Systems**

- Cross slope tillage
- Contour strip cropping

- Residue management
Best Management Practices for Agriculture

Cropping Systems

- Cover crops / green manure
Best Management Practices for Agriculture

Cropping Systems

- Crop rotation
- Grassed waterways
Best Management Practices for Agriculture

Cropping Systems

- Nutrient management
- Pest Management
Best Management Practices for Agriculture

Cropping Systems

- Irrigation water management
- Buffers and field borders
Best Management Practices for Agriculture

Grazing Systems

- Rotational grazing
- Fencing systems

- Animal trails and walkways
Best Management Practices for Agriculture

Grazing Systems

- Water systems
- Nutrient management
- Pathogen control
Best Management Practices for Agriculture

Manure / Waste Management

• Waste storage structures
Best Management Practices for Agriculture

Manure / Waste Management

- Heavy use/sacrifice areas
- Composting systems
Best Management Practices for Agriculture

Manure / Waste Management

• Transfer and application
• Nutrient management

• Septic systems
• Silage leachate collection
Best Management Practices for Agriculture

Farmstead Management

- Gutter systems
- Storm drains / subsurface drains
- Sediment basins
Best Management Practices for Agriculture

Farmstead Management

- Diversions / waterways
- Wellhead protection
- Covered heavy use areas
Best Management Practices for Agriculture

Habitat Management

- Riparian buffers
- Streambank protection
- Food plots
- Pollinator plantings
Best Management Practices for Agriculture

Habitat Management

- Woodland management
- Delayed mowing
- Wetland restoration
- Invasives control
Best Management Practices for Agriculture

Natural Resources Conservation Service

Helping People Help the Land Through …

- Conservation Planning and Technical Consultation
- Conservation Implementation
- Technical Standards and References
- Financial Assistance Programs
Best Management Practices for Agriculture

Natural Resources Conservation Service

• Technical Standards and References

Welcome to eFOTG

What is eFOTG?

Technical guides are the primary scientific references for NRCS. They contain technical information about the conservation of soil, water, air, and related plant and animal resources.

Technical guides used in each field office are localized so that they apply specifically to the geographic area for which they are prepared. These documents are referred to as Field Office Technical Guides (FOTGs).

Appropriate parts of the Field Office Technical Guides are automated as data bases, computer programs, and other electronic-based materials such as those included in these web based pages.

• Electronic Access to Field Office
• Conservation Standards and Symposium Proceedings
• Conservation Resources
Best Management Practices for Agriculture

Conservation Partners

• Natural Resources Conservation Service
• UConn Cooperative Extension
• CT Agriculture Experiment Station
• CT Department of Agriculture
• CT Department of Energy & Environmental Protection
• USDA Farm Services Agency
• USDA Rural Development
• Conservation Districts
• CT NOFA
Questions?

Charlotte Ross, Project Coordinator, 860-875-3331, charlotte@sweetacrefarm.com

Kip Kolesinskas, Conservation Scientist, 860-878-0393, kip.kolesinskas@gmail.com
Please Complete the Survey!
Thank You...

Advancing the Business of Farming in Connecticut Project provides new farmers with core training and assistance to develop their farm plan, explore production options, and grow their farming enterprise.

Visit www.newfarms.extension.uconn.edu for resources and events.