Understanding the Soil Health Management System Planning Process

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Soil and Crop Sciences Section

soilhealth.cals.cornell.edu
Soil Health Philosophy:

A healthy soil is balanced and therefore provides for crop resiliency to stress. If we can

1) **measure** soil indicators to identify constraints, then we can

2) **optimize** our soil management.

Quality soil has value

Resiliency is the goal, not yield

Bundle management into efficient, cost-saving actions
How do I use soil health assessment information?

- Understand soil processes & management impacts
- Identify constraints through soil health assessment
- Select & implement appropriate management strategies
- Monitor change and adjust management
Considerations in interpreting Soil Health Assessments

1. The Report is a management guide, not a prescription
2. Different management approaches mitigate the same problem
3. One management practice can affect multiple indicators
4. Draw on information from varied sources—field days, workshops, local experience
5. Adapt the Report information to a management strategy to fit YOUR field/farm/goals
6. Certain indicators are related, but over-interpretation of relationship misleading
7. Soil health changes slowly over time
SH Management Planning Process Overview

1. Determine farm background and management history

Compile background info: history by management unit, farm operation type, equipment, access to resources, situational opportunities or limitations.

2. Set goals and sample for soil health

Determine number and distribution of soil health samples needed according to operation background and goals.

3. For each management unit: identify and explain constraints, prioritize

Soil Health Report identifies constraints, guides prioritization. Explain results based on background, and adjust priorities.

4. Identify feasible management options

Management suggestions table available as part of Soil Health Report, or online with NRCS practice linkages

5. Create short and long term Soil Health Management Plan

Integrate agronomic science of 2-4 with grower realities of 1 to create a specific short-term schedule of management practices for each management unit and an overall long-term strategy

6. Implement, monitor, and adapt

Implement and document management practices. Monitor progress, repeat testing, and evaluate outcomes. Adapt plan based on experience and data over time.

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SOIL HEALTH MANAGEMENT PLAN

- FARM RESOURCES
- GROWER GOALS
- SOIL HEALTH STATUS

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Comprehensive Assessment of Soil Health
From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853. http://soilhealth.cals.cornell.edu

Grower: Bob Schindelbeck
Sample ID: 0097
Field ID: Calciferous Field: intensive cultivation
Date Sampled: 06/15/2013
Grower Soil Type: Cinnamon silt loam

<table>
<thead>
<tr>
<th>Measured Soil Textural Class: silt loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand: 10% - Silt: 73% - Clay: 16%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Indicator</th>
<th>Value</th>
<th>Rating</th>
<th>Constraints</th>
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</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Available Water Capacity</td>
<td>0.16</td>
<td>52</td>
<td>Rooting, Water Transpiration</td>
</tr>
<tr>
<td>Physical</td>
<td>Surface Hardness</td>
<td>260</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>Subsurface Hardness</td>
<td>340</td>
<td>15</td>
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<tr>
<td>Physical</td>
<td>Aggregate Stability</td>
<td>13.4</td>
<td>16</td>
<td>Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff</td>
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<tr>
<td>Biological</td>
<td>ACE Soil Protein Index</td>
<td>4.4</td>
<td>26</td>
<td></td>
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<tr>
<td>Biological</td>
<td>Soil Respiration</td>
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<tr>
<td>Biological</td>
<td>Active Carbon</td>
<td>312</td>
<td>16</td>
<td>Energy Source for Soil Bacteria</td>
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<tr>
<td>Chemical</td>
<td>Soil pH</td>
<td>6.1</td>
<td>50</td>
<td></td>
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<tr>
<td>Chemical</td>
<td>Exchangeable Phosphorus</td>
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<td>100</td>
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<tr>
<td>Chemical</td>
<td>Exchangeable Potassium</td>
<td>10.8</td>
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<tr>
<td>Chemical</td>
<td>Major Elements</td>
<td>303.3</td>
<td>64</td>
<td></td>
</tr>
</tbody>
</table>

Overall Quality Score: 52 / Medium
SH Management Planning Process Overview

1. **Determine farm background and management history**
   - Grower strengths
   - Compile background info: history by management type, farm operation type, equipment, access to resources, situational opportunities or limitations.

2. **Set goals and sample for soil health**
   - Grower goals
   - Soil sampling
   - Determine number and distribution of soil health samples needed according to operation background and goals.

3. **For each management unit: identify and explain constraints, prioritize**
   - Soil Health Report identifies constraints, guides prioritization. Explain results based on background, and adjust priorities.

4. **Identify feasible management options**
   - Grower goals
   - Soil sampling
   - Define options
   - Management suggestions table available as part of Soil Health Report, or online with NRCS practice linkages

5. **Create short and long term**
   - Grower goals
   - Soil sampling
   - Refine options
   - Integrate agronomic science of 2-4 with grower realities of 1 to create a specific short-term schedule of management practices for each management unit and an overall long-term strategy.

6. **Implement, monitor, and adapt**
   - Grower goals
   - Soil sampling
   - Implement Evaluate
   - Implement and document management practices. Monitor strategies, repeat testing, and evaluate outcomes. Adapt plan based on experience and data over time.
Step 1 – Farm Background and Management History

Soil Health Management Planning begins with grower questions..

- Where is my soil strong or weak?
- What can I do to address these issues?
- How can I “put it all together” to make a sound soil management plan?
- Can someone help me with this?

AEM Tier I – Farm info
Step 2 – Set Goals and Sample for Soil Health

**Ask your best question** based on goals.

**What is your purpose?**

Use different approaches depending on question being asked

**GENERAL NEEDS**

- Ideal for uniform fields
- Get a baseline for monitoring
- Assess general needs? **Yield drag, rapid onset of crop stress**

AEM Tier II - Assess and prioritize areas of concern
Step 2 – Set Goals and Sample for Soil Health

Use different approaches depending on question being asked

TROUBLESHOOTING

• Ideal for comparing treatments or uneven crop performance? Tillage, crop variety, cover crop, zone B versus zone A?
• Identify constraints and manage them?
• Research? Baseline and long term effects of management
Step 3 – Identify and explain constraints, prioritize

Quantification

“You don’t know if you don’t measure....”

“What gets measured, gets done.....”
Comprehensive Assessment of Soil Health Summary Report

- Assesses soil chemical, physical and biological functioning
- Process oriented
- Measures indicators
- Uses scoring functions (see page 2)
- Overall score
- Targeted management suggestions (see pages 9-10)

AEM Tier II – Field Evaluation and Summary
Assess and prioritize concerns
### Step 3 – Constraints Identified, Explained, and Prioritized

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Short Term Management Suggestions</th>
<th>Long Term Management Suggestions</th>
</tr>
</thead>
</table>
| Available Water Capacity    | • Add stable organic materials, mulch  
• Add compost or biochar  
• Incorporate high biomass cover crop                                      | • Reduce tillage  
• Rotate with sod crops  
• Incorporate high biomass cover crop                                        |
| Low                         |                                                                                                    |                                                                             |
| Surface Hardness High       | • Perform some mechanical soil loosening (strip till, aerators, broadfork, spader)  
• Use shallow-rooted cover crops  
• Use a living mulch or interseeded cover crop                             | • Shallow-rooted cover/rotation crops  
• Avoid traffic on wet soils, monitor  
• Avoid excessive traffic/tillage/loads  
• Use controlled traffic patterns/lanes                                         |
| Subsurface Hardness High    | • Use targeted deep tillage (subsoiler, yeomans plow, chisel plow, spader.)  
• Plant deep rooted cover crops/radish                                      | • Avoid plows/disks that create pans  
• Avoid heavy loads  
• Reduce traffic when subsoil is wet                                           |
| Aggregate Stability Low     | • Incorporate fresh organic materials  
• Use shallow-rooted cover/rotation crops  
• Add manure, green manure, mulch                                             | • Reduce tillage  
• Use a surface mulch  
• Rotate with sod crops and mycorrhizal hosts                                  |
| Organic Matter Low          | • Add stable organic materials, mulch  
• Add compost and biochar  
• Incorporate high biomass cover crop                                         | • Reduce tillage/mechanical cultivation  
• Rotate with sod crop  
• Incorporate high biomass cover crop                                           |
Step 4—Feasible Management Options

We know what works......

AEM Tier III – Develop plans addressing concerns and opportunities

From: Lehman et al., 2015
### Step 4– Feasible Management Options

**Interpreting Soil Health Assessments in NH NH-590 Quick Reference**

<table>
<thead>
<tr>
<th>Physical Concerns</th>
<th>Suggested Management Practices</th>
<th>NH NRCS Practice</th>
</tr>
</thead>
</table>
| **Low Aggregate stability** | - Incorporate fresh organic materials  
- Use shallow-rooted cover/rotation crops  
- Add manure, green manure, mulch | - Reduce tillage  
- Use a surface mulch  
- Rotate with sod crops | (328) Conservation Crop Rotation;  
(340) Cover Crop;  
(329) Residue Mgmt No-Till/Strip-Till;  
(484) Mulching;  
(512) Forage & Biomass Planting;  
(528) Prescribed Grazing |
| **Low Available Water Capacity** | - Add stable organic materials, mulch  
- Add compost or biochar  
- Incorporate high-biomass cover crop | - Reduce tillage  
- Rotate with sod crops  
- Incorporate high-biomass cover crop | (328) Conservation Crop Rotation;  
(345) Residue Mgmt, Mulch Till;  
(340) Cover Crop;  
(484) Mulching;  
(528) Prescribed Grazing;  
(548) Grazing Land Mechanical Tr| |
| **High Surface Hardness** | - Perform some mechanical soil loosening (strip till, aerators, broadfork, spader)  
- Use shallow-rooted cover crops  
- Use a living mulch or interseed cover crop | - Shallow-rooted cover/rotation crops  
- Avoid traffic on wet soils, monitor  
- Avoid excessive traffic/tillage/loads  
- Use controlled traffic patterns/lanes | (328) Conservation Crop Rotation;  
(345) Residue Mgmt, Mulch Till;  
(340) Cover Crop;  
(484) Mulching;  
(528) Prescribed Grazing;  
(548) Grazing Land Mechanical Tr;  
(666) Subsurface Drain |
| **High Subsurface Hardness** | - Use targeted deep tillage (subsoiler, yeomans plow, chisel plow, spader.)  
- Plant deep rooted cover crops/radish | - Avoid plows/disks that create pans  
- Avoid heavy loads  
- Reduce traffic when subsoil is wet | (324) Deep Tillage;  
(329) Residue Mgmt, No-Strip-Till;  
(345) Residue Mgmt, Mulch Till |

<table>
<thead>
<tr>
<th>Biological Concerns</th>
<th>Suggested Management Practices</th>
<th>NH NRCS Practice</th>
</tr>
</thead>
</table>
| **Low Organic Matter** | - Add stable organic materials, mulch  
- Add compost and biochar  
- Incorporate high-biomass cover crop | - Reduce tillage/mechanical cultivation  
- Rotate with sod crop  
- Incorporate high-biomass cover crop | (328) Conservation Crop Rotation;  
(340) Cover Crop;  
(329) Residue Mgmt No-Till/Strip-Till;  
(317) Compost Facility;  
(484) Mulching;  
(512) Forage & Biomass Planting;  
(528) Prescribed Grazing |
| **Low Active Carbon** | - Add fresh organic materials  
- Use shallow-rooted cover/rotation crops  
- Add manure, green manure, mulch | - Reduce tillage/mechanical cultivation  
- Rotate with sod crop  
- Cover crop whenever possible | (328) Conservation Crop Rotation;  
(340) Cover Crop;  
(329) Residue Mgmt No-Till/Strip-Till;  
(317) Compost Facility;  
(484) Mulching;  
(512) Forage & Biomass Planting;  
(528) Prescribed Grazing |
| **Low Mineralizable Nitrogen** | - Add N-rich organic matter (low C:N source – like manure, high N well-finished compost)  
- Incorporate legume or young, green cover crop (inoculate legume seed)  
- Adjust pH to 6.2-6.5 (helps molybdenum) | - Reduce tillage  
- Rotate with forage legume sod crop  
- Cover crop and add fresh manure  
- Keep pH at 6.2-6.5 (helps molybdenum)  
- Monitor C:N ratio of inputs | (328) Conservation Crop Rotation;  
(329) Residue Mgmt No-Till/Strip-Till;  
(317) Compost Facility;  
(340) Cover Crop;  
(512) Forage & Biomass Planting;  
(528) Prescribed Grazing;  
(590) Nutrient Mgmt |
| **High Root Rot Rating** | - Use disease-suppressive cover crops  
- Biofumigate  
- Plant on ridges/raised beds  
- Monitor irrigation | - Use disease-suppressive cover crops  
- Increase diversity of crop rotation  
- Sterilize seed and equipment  
- Improve drainage/monitor irrigation | (328) Conservation Crop Rotation;  
(346) Residue Mgmt, Ridge Till;  
(340) Cover Crop;  
(449) Irrigation Water Mgmt;  
(595) Integrated Pest Mgmt;  
(666) Subsurface Drain |
Step 5—Short and Long Term Soil Health Management Plans

- Integrate agronomic science of Steps 3 and 4 with grower realities of steps 1 and 2
- Create a specific short-term schedule of management practices
- Specific to management unit
- Develop overall long-term strategy

AEM Tier III – Develop and adapt plans

Step 6—Implement, monitor, and adapt

- Implement and document management practices
- Monitor progress
- Repeat testing
- Evaluate outcomes
- Adapt plan based on experience and data over time

AEM Tier IV and V – Implement and evaluate

REMEMBER: SOIL HEALTH CHANGES SLOWLY OVER TIME
Principles for Interpreting and Using the Comprehensive Assessment of Soil Health Report

The Soil Health Management Toolbox

1. Reducing or modifying Tillage
2. Crop Rotation/ hybrid choice
3. Growing cover crops
4. Organic/ chemical amendments

4 management strategies in our toolbox to address constraints
Options are numerous and combinations endless
It is that simple but that complicated
TILLAGE ADDICTION

Tillage of plastic soil  

Increased tillage  

Crusting after rain  

Crusting  

Infiltration  

Erosion  

Loss of OM, nutrients  

Ponding but less storage  

Underconsolidation (cloddy)  

Declining OM  

Aggregate breakdown  

Unhealthy microbial communities  

Surface and subsurface compaction  

Increased erosion  

Packing to crush clods
Crop Rotation to:

• Suppress disease/ break cycles
• Insert cover crop/ cash crop into sequence to smother weeds
• Best utilize land/ equipment/ labor
• Sell in high return markets
• Rotation with sod: Builds up organic matter/soil health in general
• Use the principles on following slide to increase or maintain yields
• BUT can we insert a cover crop or full season crop that can affect the CHARACTER of the soil

Free on-line download or purchase ( $24) at http://www.sare.org/Learning-Center/Books/Crop-Rotation-on-Organic-Farms
Tool #3 – Cover Crop Considerations

Strategies to consider for reducing tillage intensity:

- Identify Your Problem or Use
- Identify the Best Place and Time
- Describe the Niche
- Select the Best Cover Crop
- Settle for the Best Available Cover
- Build a Rotation Around Cover Crops

Goal is to provide canopy, OM input, increase species diversity and living root activity

Soil protection and improvement
Tool #4 – Organic Amendments

GOAL to balance:

- Minimize organic matter losses through excessive decomposition and erosion
- Rotate crops
- Regularly add diverse kinds of organic matter (manures, composts, cover crops, crop residues, leaves, biochar? ...)

Need OM to decompose nutrients
“glue” for aggregates
food for microbes

Need OM to accumulate
Water storage
C-storage
Nutrient retention
Soil Health Management Planning Process

Comprehensive Assessment of Soil Health
From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853. http://soilhealth.cals.cornell.edu

30 acre field just bought
Lima silt loam
Long term moldboard tillage
Long term corn for grain

Robust conventional grower
Interested in cover cropping
Lots of smaller equipment
Does NOT have a no-till drill
Brother now has beef

Measured Soil Textural Class: loam
Sand: 38% - Silt: 45% - Clay: 16%

Continuous corn ground is addicted to tillage. Soil is hard, biologically sluggish, low in organic Nitrogen stores. Grower has learned of some new cover crops available and wants to know if he can “grow” needed nitrogen and not have to pay for it. And at the same time produce some needed feed for beef.

Given on your Group Report
*Provided in Scenario*

1. Determine farm background and management history

2. Set goals and sample for soil health
Determine likely goals from Scenario:
Grower needed baseline soil health info, wants to increase soil resiliency, likes green manures as feed for his new beef operation, access to equipment

3. For each management unit: identify and explain constraints, prioritize
Explain from Scenario, prioritize:
Continuous corn ground is addicted to tillage. Soil is hard, biologically sluggish, low in organic Nitrogen stores. Grower has learned of some new cover crops available and wants to know if he can “grow” needed nitrogen and not have to pay for it. And at the same time produce some needed feed for beef.

4. Identify feasible management options
Identify, using Scenario and Management Tables:
Hard soil could be decompacted with tillage. Crops need to be used that prevent reconsolidation of the surface. Deeper zones also need loosening. Root penetration to deeper zones desired to keep subsoil “open”. Legume cover crop for nitrogen and to provide some forage material. Need to research cover crop seed availability, rates, etc.
<table>
<thead>
<tr>
<th>Steps that are taken after the plan you create:</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Implement, monitor, and adapt</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use provided table on other side:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Create short and long term soil health management plan</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Formulate and evaluate alternatives</th>
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</table>

<table>
<thead>
<tr>
<th>Identify resource concerns</th>
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</table>

<table>
<thead>
<tr>
<th>Analyze resource data</th>
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</table>

<table>
<thead>
<tr>
<th>Determine objectives</th>
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<table>
<thead>
<tr>
<th>Soil Health Management Planning Process Worksheet</th>
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<table>
<thead>
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<tr>
<th>2. Set goals and sample for soil health</th>
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<tr>
<th>3. For each management unit: Identify and explain constraints, prioritize</th>
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<table>
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<tr>
<th>4. Identify feasible management options</th>
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<th>5. Identify scenarios, prioritize</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>6. Identify probable options from scenario</th>
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</thead>
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Thank You!

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