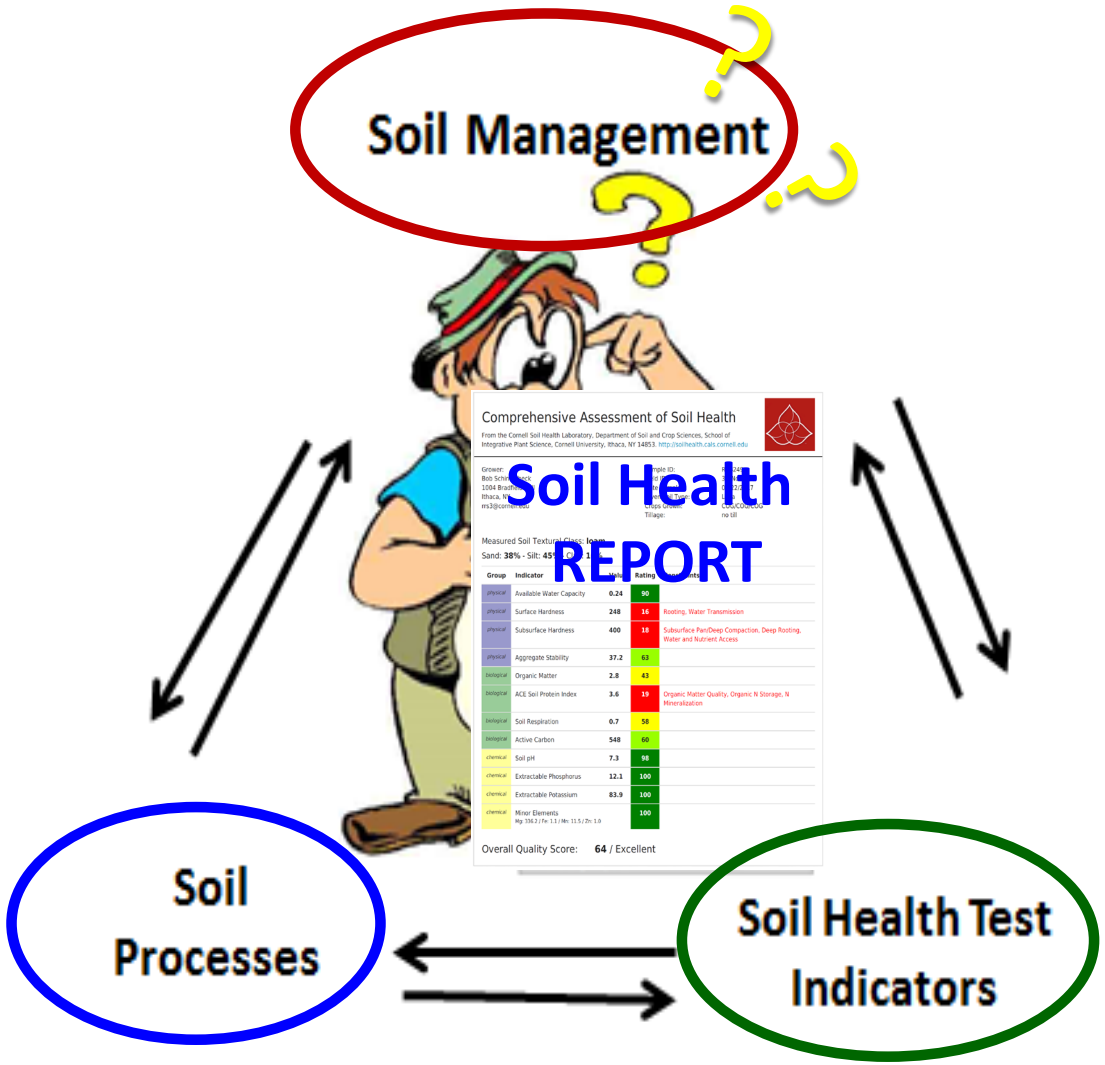
Creating a Soil Health Management Plan



How do I use the information?

- Understand soil processes & management impacts
- Identify constraints through soil health assessment
- Select & implement appropriate management strategies
- Monitor change and adjust management

Bob Schindelbeck, rrs3@cornell.edu

Director, Cornell Soil Health Lab

http://soilhealth.cals.cornell.edu

School of Integrative Plant Science

Soil and Crop Sciences Section

Principles of Soil Health Management

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

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	0.24	90	
physical	Surface Hardness	248	16	Rooting, Water Transmission
physical	Subsurface Hardness	400	18	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	37.2	63	
biological	Organic Matter	2.8	43	
biological	ACE Soil Protein Index	3.6	19	Organic Matter Quality, Organic N Storage, N Mineralization
biological	Soil Respiration	0.7	58	
biological	Active Carbon	548	60	
chemical	Soil pH	7.3	98	
chemical	Extractable Phosphorus	12.1	100	
chemical	Extractable Potassium	83.9	100	
chemical	Minor Elements Mg: 336.2 / Fe: 1.1 / Mn: 11.5 / Zn: 1.0		100	

Overall Quality Score: **64** / Excellent

Page 1

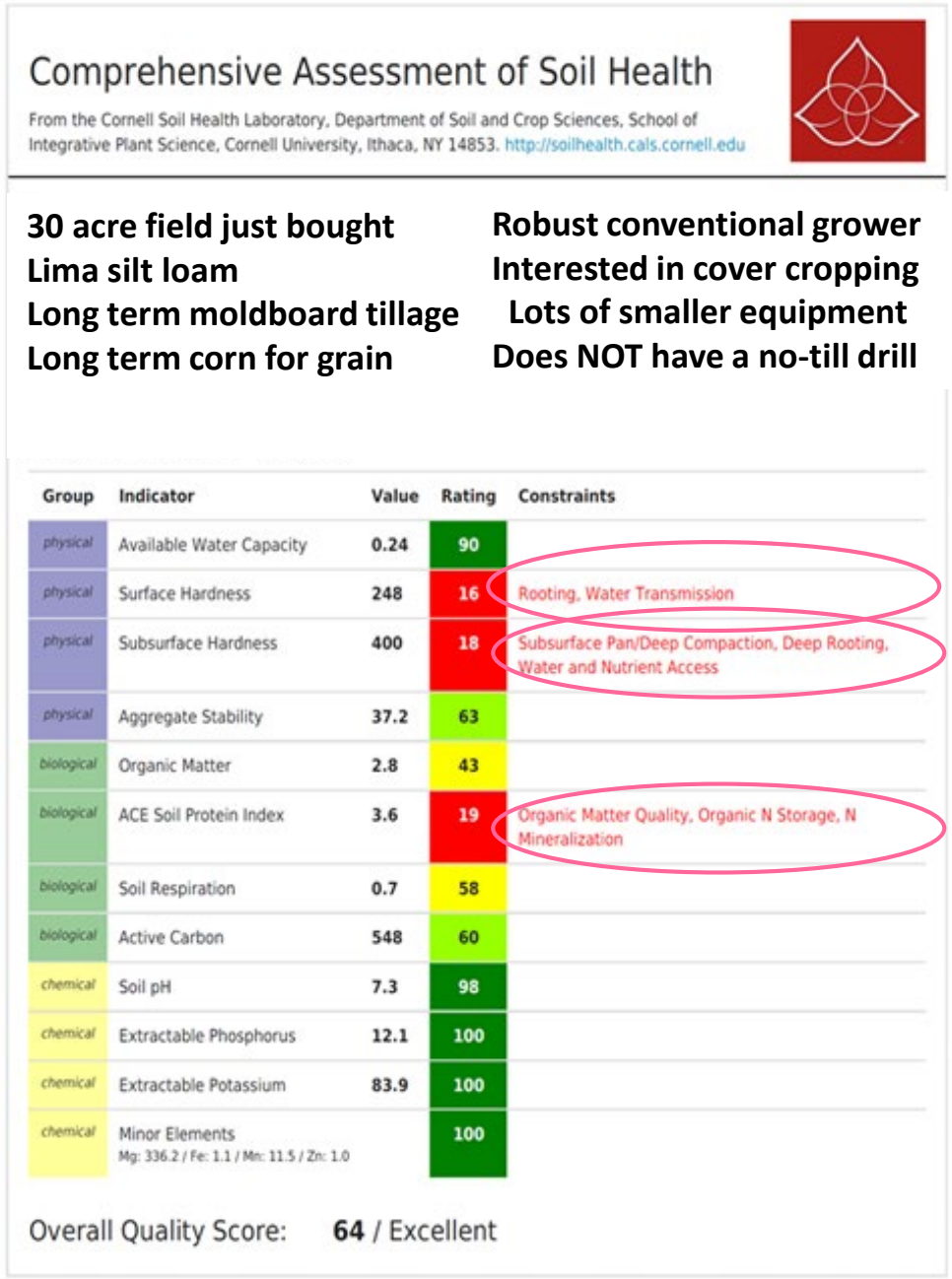
Field details
Grower background

+

Soil performance
targets to address

Soil Health Management Plan

Principles of Soil Health Management



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Overall Quality Score: **64** / Excellent

Page 1

1. Report is a Management Guide, not a prescription
2. Different management approaches can mitigate same problem
3. One management practice can affect multiple indicators
4. Information from varied sources: workshops, field days, local experience
5. **Adapt Report information to a strategy to fit your field/farm**
6. **Soil health changes slowly over time**

Management Suggestions for Physical and Biological Constraints

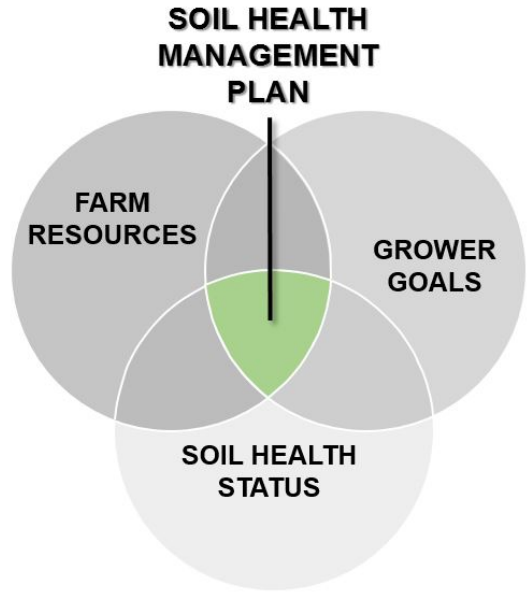
Constraint	Short Term Management Suggestions	Long Term Management Suggestions
Available Water Capacity Low	• Add stable organic materials, mulch • Add compost or biochar • Incorporate high biomass cover crop	• Reduce tillage • Rotate with sod crops • Incorporate high biomass cover crop
Surface Hardness High	• 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
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
ACE Soil Protein Index Low	• Add N-rich organic matter (low C:N source like manure, high N well-finished compost) • Incorporate young, green, cover crop biomass • Plant legumes and grass-legume mixtures • Inoculate legume seed with Rhizobia & check for nodulation	• Reduce tillage • Rotate with forage legume sod crop • Cover crop and add fresh manure • Keep pH at 6.2-6.5 (helps N fixation) • Monitor C:N ratio of inputs
Soil Respiration Low	• Maintain plant cover throughout season • Add fresh organic materials • Add manure, green manure • Consider reducing biocide usage	• Reduce tillage/mechanical cultivation • Increase rotational diversity • Maintain plant cover throughout season • Cover crop with symbiotic host plants
Active Carbon Low	• 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

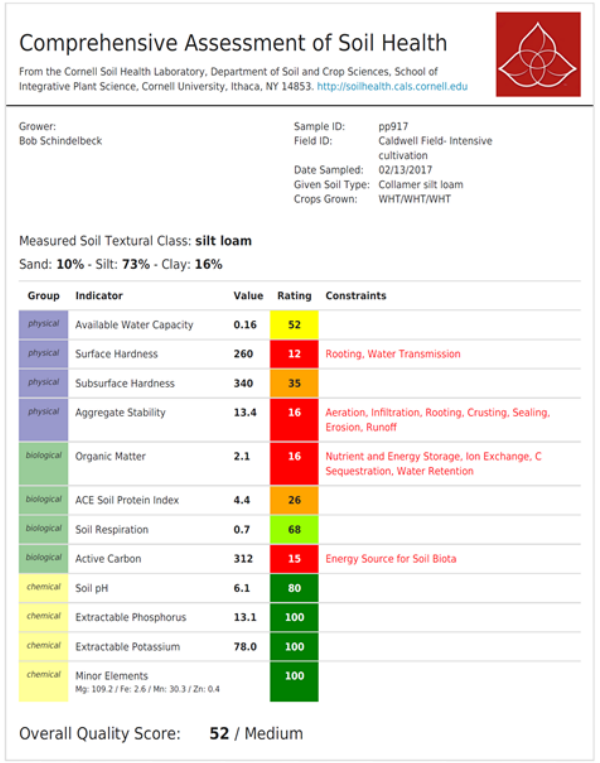
Pages 9-10

Constrained and Suboptimal indicators are flagged in Report management table

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.	**Grower strengths**
2. Set goals and sample for soil health Determine number and distribution of soil health samples needed according to operation background and goals.	**Grower goals** **Soil sampling**
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.	**Evaluate results**
4. Identify feasible management options Management suggestions table available as part of Soil Health Report, or online with NRCS practice linkages	**Define options**
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	**Refine options**
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.	**Implement** **Evaluate**





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: pp917
Field ID: Caldwell Field- Intensive cultivation
Date Sampled: 02/13/2017
Given Soil Type: Collamer silt loam
Crops Grown: WHT/WHT/WHT

Measured Soil Textural Class: **silt loam**
Sand: **10%** - Silt: **73%** - Clay: **16%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	0.16	52	
physical	Surface Hardness	260	12	Rooting, Water Transmission
physical	Subsurface Hardness	340	35	
physical	Aggregate Stability	13.4	16	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
biological	Organic Matter	2.1	16	Nutrient and Energy Storage, Ion Exchange, C Sequestration, Water Retention
biological	ACE Soil Protein Index	4.4	26	
biological	Soil Respiration	0.7	68	
biological	Active Carbon	312	15	Energy Source for Soil Biota
chemical	Soil pH	6.1	80	
chemical	Extractable Phosphorus	13.1	100	
chemical	Extractable Potassium	78.0	100	
chemical	Minor Elements Mg: 109.2 / Fe: 2.6 / Mn: 30.3 / Zn: 0.4		100	

Overall Quality Score: **52** / Medium

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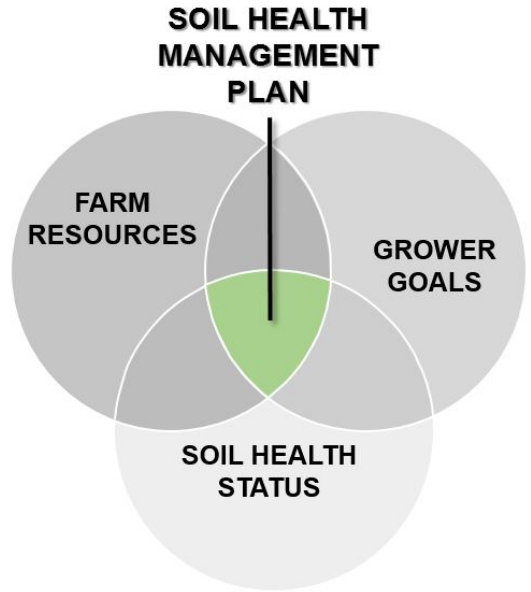
Phase I

Phase II

Phase III



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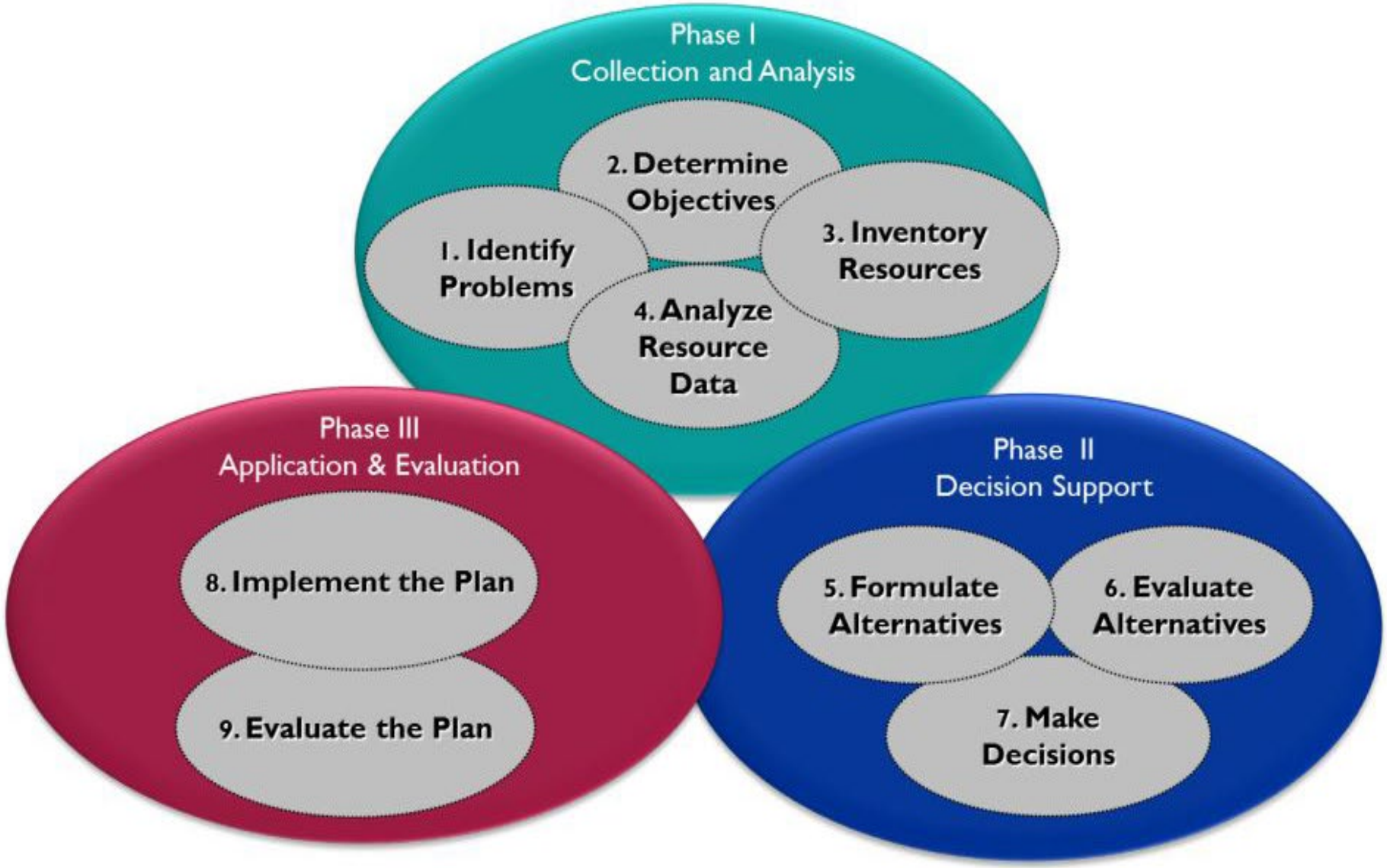
Overall Quality Score: **52** / Medium

SH Management Planning Process Overview

NRCS 9 step conservation planning process

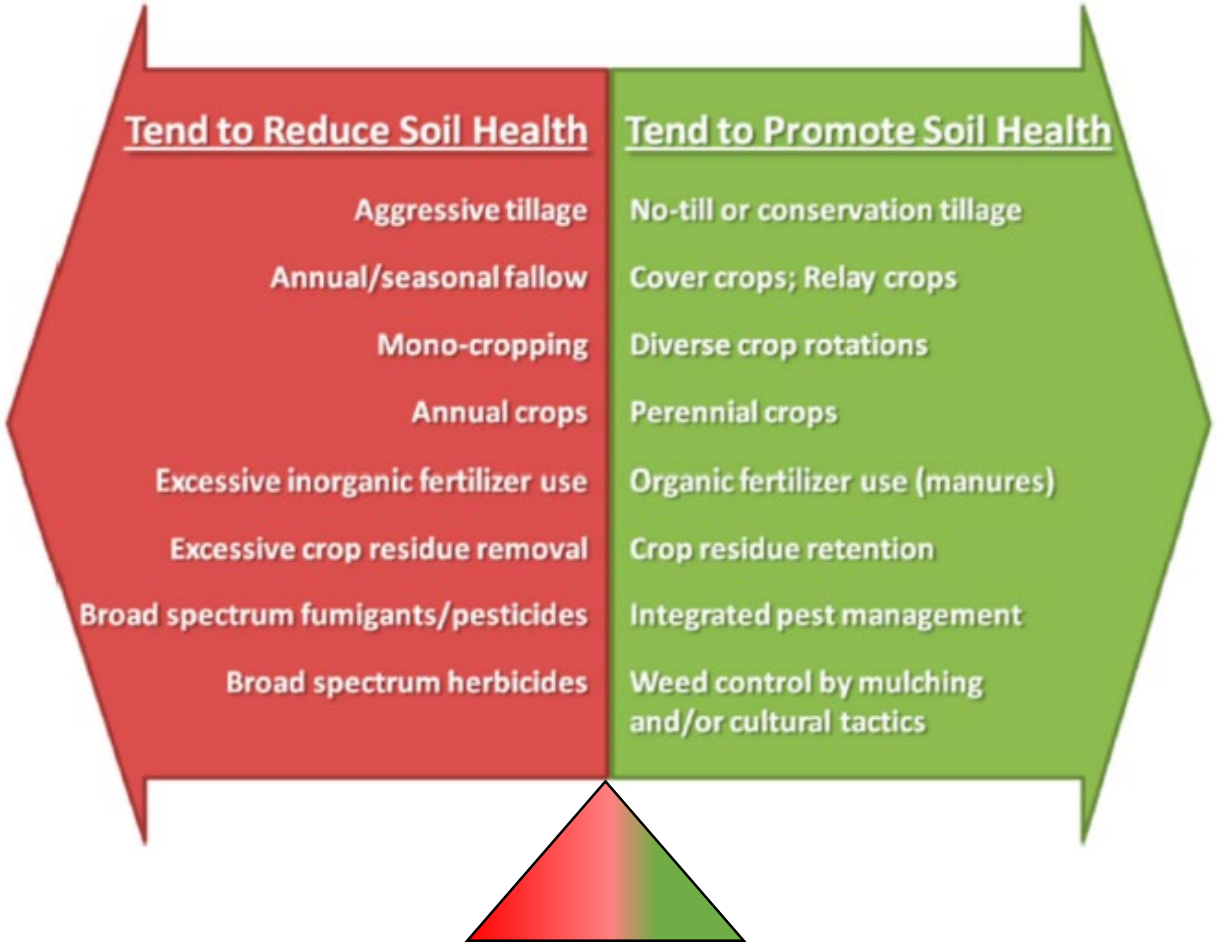


Source: NRCS.USDA.GOV

Step 4– Feasible Management Options

We know what works……

From: Lehman et al., 2015



NRCS Planning Process – Analyze Resource Data, Formulate and Evaluate Alternatives

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

Breakout Rooms

- You will be assigned a farm scenario and an associated soil health report to brainstorm a management plan to address the soil constraints that the farmer faces.
- The suggested management plan needs to fit within the farmer's context, resources, and interests

Conventional Grain 1	Conventional Grain 2	Conventional Dairy	Pasture/Hayfield	Organic Vegetable
Room 1	Room 2	Room 3	Room 4	Room 5
Kirsten Kurtz	*Joseph Amsili*	*Aaron Ristow*	*Bob Schindelbeck*	*Stephanie Castle*
Dave Magos	John Hill	Jacob Fox	Jevonnah Foster	Amanda Barber
Zachary Warning	Jillian Zajac	Bob Stryker	Leah Retherford	Wilfred Nieves
Paul Gier	Garet Livermore	Liz Camps	Miranda Ciardulli	Matthew Rayo
Samuel Joseph	Jessica Sargis	Jennifer Phillips Russo	Matthew Lamb	Briana Alfaro
Patricia Ehlers	Angelo Lampousis	Marci Muller	Tim Lewis	Megan Myers
Blank	Nick Rowell	Blank	Mila Fournier	Blank

Conventional Cash Grain 1

Location/Site History:

Five years ago Bob bought a piece of the Aurora research farm ~32 ac of mostly Lima silt loam. Field has been in **continuous corn** for 25 years. Tried NT and some interseeded cover cropping now for 5 years. Wet springs mean late planting and low areas had generally **poor stands of** corn. Soil is crusted but a few earthworms are present. Grower feels that this could be good land but it is "tired".

Opportunities, Challenges, Grower Info:

There are a number of **dairy farms** and an **equipment dealer** in close vicinity. Grower wants to try to incorporate some of the features of the "new" cover crops into the rotation to 1) loosen the profile, 2) add N to the soil, 3) produce forage for his brothers beef operation that has been brought in.

Bob has a moldboard plow, disc set, and an old grain drill. He has a modern Deere corn planter which can handle high residue. Brother brought TWO 65HP Deere tractors, a haybine and round baler with him. The brothers want to split the land and grow grain corn for the animals and graze the stover. The rotated land would be used for pasture and haylage.

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:
Sandy Rockland
Vernon Center, NY

Sample ID:	RR4424
Field ID:	Conventional field
Date Sampled:	08/22/2017
Given Soil Type:	Lima
Crops Grown:	COG/COG/COG
Tillage:	no till

Measured Soil Textural Class: **loam**

Sand: **38%** - Silt: **45%** - Clay: **16%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	0.24	90	
physical	Surface Hardness	248	16	Rooting, Water Transmission
physical	Subsurface Hardness	400	18	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	37.2	63	
biological	Organic Matter	2.8	43	
biological	ACE Soil Protein Index	3.6	19	Organic Matter Quality, Organic N Storage, N Mineralization
biological	Soil Respiration	0.7	58	
biological	Active Carbon	548	60	
chemical	Soil pH	7.3	98	
chemical	Extractable Phosphorus	12.1	100	
chemical	Extractable Potassium	83.9	100	
chemical	Minor Elements Mg: 336.2 / Fe: 1.1 / Mn: 11.5 / Zn: 1.0		100	

Overall Quality Score: **64** / Excellent

Conventional Cash Grain 2

Location/Site History:

Productive soil near the Aurora research farm –50 ac of mostly Lima silt loam. Long history of **moldboard plowing at 7-9”** depth. Field has been in **continuous corn/ soybean** for well over 20 years, and soil was eroded when taken on by this grower back then. Sidedressing usually done at V6 at 200lb/ac since 200 bu/ac is the usual yield. Extreme rainfall caused late planting and **poor stands** resulted. Corn was yellow. Much of field was **soggy, some ponded areas. Crusts formed** in higher areas.

Opportunities, Challenges, Grower Info:

There are a number of **dairy farms** and an **equipment dealer** in close vicinity. Farmer is concerned with weather variability, especially with all the talk of climate change. He is fairly social, willing to talk to growers in the area about options, but is also cautious/ risk-averse. Participated in a research trial for which he was given this soil health test and was told **his soil looks ‘tillage addicted**’ –all news to him. He isn’t up for spending a ton of money on equipment. He does have a smartphone, and is somewhat computer-inclined. He’s ideally looking for **one tried-and-true, simple solution** that can apply to the rest of his farm, since he manages 2000 acres and does not have a lot of extra time for special management of one field.

Comprehensive Assessment of Soil Health

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Grower:
Charlie Cashgrain
3333 Longacre
Poplar Ridge, NY 13026

Agricultural Service Provider:
Mr. Bob Consulting
rrs3@cornell.edu

Sample ID:	RR4249
Field ID:	Field E
Date Sampled:	10/22/2017
Given Soil Type:	Lima
Crops Grown:	COG/COG/COG
Tillage:	7-9 inches

Measured Soil Textural Class: **loam**

Sand: **39%** - Silt: **43%** - Clay: **17%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	**0.21**	**76**	
physical	Surface Hardness	**240**	**18**	Rooting, Water Transmission
physical	Subsurface Hardness	**290**	**53**	
physical	Aggregate Stability	**8.0**	**10**	Aeration, Infiltration, Rooting, Crusting, Sealing, Erosion, Runoff
biological	Organic Matter	**2.5**	**28**	
biological	ACE Soil Protein Index	**3.5**	**18**	Organic Matter Quality, Organic N Storage, N Mineralization
biological	Soil Respiration	**0.6**	**55**	
biological	Active Carbon	**326**	**17**	Energy Source for Soil Biota
chemical	Soil pH	**8.0**	**24**	
chemical	Extractable Phosphorus	**5.2**	**100**	
chemical	Extractable Potassium	**66.4**	**91**	
chemical	Minor Elements Mg: 301.1 / Fe: 1.4 / Mn: 10.7 / Zn: 0.7		**100**	

Overall Quality Score: **49** / Medium

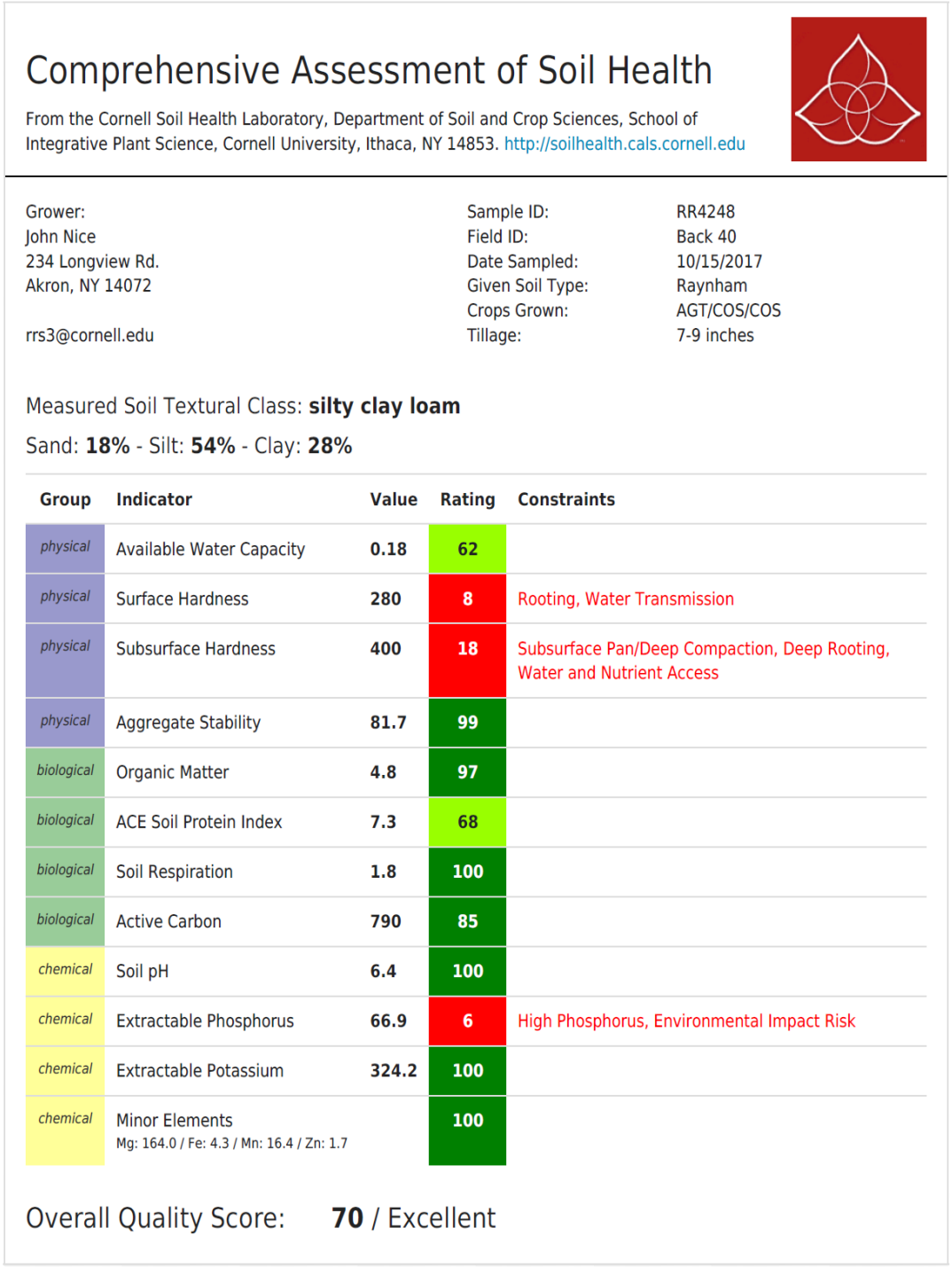
Conventional Dairy

Location/Site History:

This 40 ac field is part of a 60 cow dairy near Niagara Falls, NY. This field has been in **corn silage for 5 years**, receiving bedded pack manure frequently since there is not much storage. The dairy buys wood shavings from a local carpenter and wood chips from the city of Niagara Falls. Before this the field was hay field for a long time. Corn grew well early on but then just seemed to shut down in August and the soil surface got VERY dry.

Opportunities, Challenges, Grower Info:

Growers are older, but **their nephew is taking an interest in their operation.** They have never used a tillage system other than moldboard plowing and don't really want to branch out. **They incorporate manure with their Aerway** on occasion. The dairy has received requests to compost food waste from the college cafeteria since the nephew started to windrow some of their bedded pack to sell compost to a local nursery. He is **considering other options for diversification** and value addition now that he's done with college. He wants to move to more rotational grazing. He has also found some neighbors with an **Unverferth Zone Builder** that he could rent.



Comprehensive Assessment of Soil Health

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Grower:
John Nice
234 Longview Rd.
Akron, NY 14072

rrs3@cornell.edu

Sample ID: RR4248
Field ID: Back 40
Date Sampled: 10/15/2017
Given Soil Type: Raynham
Crops Grown: AGT/COS/COS
Tillage: 7-9 inches

Measured Soil Textural Class: **silty clay loam**

Sand: **18%** - Silt: **54%** - Clay: **28%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	0.18	62	
physical	Surface Hardness	280	8	Rooting, Water Transmission
physical	Subsurface Hardness	400	18	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	81.7	99	
biological	Organic Matter	4.8	97	
biological	ACE Soil Protein Index	7.3	68	
biological	Soil Respiration	1.8	100	
biological	Active Carbon	790	85	
chemical	Soil pH	6.4	100	
chemical	Extractable Phosphorus	66.9	6	High Phosphorus, Environmental Impact Risk
chemical	Extractable Potassium	324.2	100	
chemical	Minor Elements Mg: 164.0 / Fe: 4.3 / Mn: 16.4 / Zn: 1.7		100	

Overall Quality Score: **70** / Excellent

Pasture/ hay field

Location/Site History:

250 total acres of diversified organic hay and dairy production **(increasing)** on this farm. This 25 ac field has been in long term hay production with the alfalfa component decreasing. The naturally well-draining field is easily eroded and there is a pond located at the bottom of the 6% slope. There is a CNMP-required buffer strip around the pond but the family can no longer swim due to excessive algae blooms.

Opportunities, Challenges, Grower Info:

The farm uses most of the land to grow organic hay for sale off-farm. Limited inputs include wood ash and horse manure. The farm now offers eggs, meat, and **more milk** (sold to a local cheesemaker) all with organic certification. Farm goals are to improve soil health and farm productivity, long-term sustainability and the regained use of the pond for recreational uses. The CNMP showed that net nutrient exports off the farm were causing nutrient deficiencies on some of the fields.

Diverse equipment is available to the younger generation of farmers who want to use cover crops to improve pastures and enhance the function of the land resource.

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:
Ben Fayson
344 Eastview
Groton, NY 12294

Agricultural Service Provider:
Mr. Bob Consulting
rrs3@cornell.edu

Sample ID:	RR5249
Field ID:	Rolling Acres
Date Sampled:	10/22/2017
Given Soil Type:	Palmyra
Crops Grown:	pasture/pasture/pasture
Tillage:	no till

Measured Soil Textural Class: **fine sandy loam**

Sand: **56%** - Silt: **32%** - Clay: **11%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	**0.17**	**56**	
physical	Surface Hardness	**283**	**8**	Rooting, Water Transmission
physical	Subsurface Hardness	**404**	**17**	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	**84.0**	**99**	
biological	Organic Matter	**5.3**	**99**	
biological	ACE Soil Protein Index	**12.9**	**94**	
biological	Soil Respiration	**0.8**	**75**	
biological	Active Carbon	**566**	**63**	
chemical	Soil pH	**6.1**	**91**	
chemical	Extractable Phosphorus	**46.4**	**9**	High Phosphorus, Environmental Impact Risk
chemical	Extractable Potassium	**37.8**	**54**	
chemical	Minor Elements Mg: 256.9 / Fe: 0.9 / Mn: 6.7 / Zn: 2.1		**100**	

Overall Quality Score: **64** / Excellent

Organic Vegetables

Location/Site History:

Western PA, within 10 miles of population centers. 50 acres total of very intensive production on this farm. **Good vegetable land** is getting to be hard to come by –this 5 ac field is partly covered by **two high tunnels** (they happen to be movable, but haven't been moved). Long history of moldboard tillage and **intensive secondary tillage. Regular cultivation using Allis-Chalmers G tractors**. Multiple crops grown per year. Recently crops in high tunnel are looking a little odd (curled and brown leaf edges). **White crust was noticed on the surface a few times** –grower didn't know what it was. **Growing a lot of greens, tomatoes and brassicas for wholesale**. Sweet corn looked awful after all that rain last year. Some veggies sold at one larger farmer's market.

Opportunities, Challenges, Grower Info:

Grower uses **seasonal laborers**. Farm has access to an **organic matter source** – a nursery for wood chips, sawdust. **Daughter just finished college** and wants to **increase vegetable quality**. She is interested in taking over the business. Grower has no experience with cover crops. Varied equipment for veg production is available.

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Grower:
Charissa Carrot
556 Loamy Haven
Birdy, PA 12231

rrs3@cornell.edu

Sample ID:	RR4247
Field ID:	Deep six
Date Sampled:	11/01/2017
Given Soil Type:	Adams sandy loam
Crops Grown:	SWC/MIX
Tillage:	7-9 inches

Measured Soil Textural Class: **sandy loam**

Sand: **59%** - Silt: **36%** - Clay: **5%**

Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	**0.09**	**28**	
physical	Surface Hardness	**255**	**14**	Rooting, Water Transmission
physical	Subsurface Hardness	**400**	**18**	Subsurface Pan/Deep Compaction, Deep Rooting, Water and Nutrient Access
physical	Aggregate Stability	**26.2**	**27**	
biological	Organic Matter	**2.1**	**55**	
biological	ACE Soil Protein Index	**6.9**	**44**	
biological	Soil Respiration	**0.6**	**55**	
biological	Active Carbon	**359**	**32**	
chemical	Soil pH	**5.9**	**67**	
chemical	Extractable Phosphorus	**2.3**	**66**	
chemical	Extractable Potassium	**175.3**	**100**	
chemical	Minor Elements Mg: 134.0 / Fe: 3.4 / Mn: 2.7 / Zn: 1.3		**100**	

Overall Quality Score: **51** / Medium

SH Management Planning Process

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.

SH Management Planning Process

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3. For each management unit: identify and explain constraints, prioritize
4. Identify feasible management options
5. Create short and long term Soil Health Management Plan
6. Implement, monitor, and adapt