1. Farm Information

Farm Owner/Manager Name: Amanda Lee-Milner

Farm Name: Highfield Hollow Farm

Address: 150 Hilltop Road Gardners, PA 17324

Email: amandaleemilner@gmail.com Phone: 717-919-4603

Total Acres: 90 Acres in Production: 80

Farm Production Type (check all that apply)

Livestock (please specify): Sheep, Goats
Silvoculture: We have roughly 25 acres of forest on our farm that we manage
Other: Honey/honeybees

2. Management System

What crops, livestock, or agricultural products are produced on your farm?

- Pastured lamb and goat meat
- Local, unpasteurized honey
- Eggs

Describe your current crop and/or livestock rotation pattern, including size of management units (field, plot, bed, paddock), duration of rotation, crops or species planted (incl. cover crops).
[Eg. 4 year rotation of Solanaceae-Cucurbits-Brassicae-Mixed Species Cover Crop. Some fields include other vegetable species, as well, and may be double or triple cropped. Each field gets a full year of cover crop every 4th]

The pastured lamb/goat flock is rotated weekly by dividing existing pastures into 2 acre paddocks. Paddock division is done through portable, polywire fence.

We have an herd of approximately 15 goat does. They are pastured in 15 acres of woods during the summer. They are housed on 3 acres of pasture during the winter. They receive hay and feed during the winter.

We have a flock of approximately 55 ewes. They are rotationally grazed during the summer on pastures that are 3 to 6 acres in size. They are also grazed simultaneously in our 15 acres of woods, with the goat does.

We have approximately 20 acres that we utilize for hay. These fields have a mix of orchardgrass and red clover in them. We make enough hay to feed our animals through the winter. We rotationally graze these fields in September, October, and early November.

List the tools and equipment most commonly used for field management activities (tillage, weed-management, harvest, etc.) and the frequency used per year. (e.g. Rototiller, 6” depth- 2 times per year).

- Cutditioner to mow 20 acres of hay twice a year.
- Hay rake and round hay baler to make hay on 20 acres of pasture twice a year.

- Brush hog to clip the pastures where we rotate livestock. These 14 acres of pasture are clipped approximately twice a year.
- String trimmers and lawnmowers to trim next to and under high tensil electric fence and woven wire fence, to keep weeds down.
- Manure spreader used once a year on some of the hay fields and pastures.

List soil amendments used (e.g. compost, manure, gypsum, lime, etc.) with amount, timing, method and frequency of application.

- Manure from our barns is applied 15 out of 20 acres of hay fields. Manure is applied as time permits either once a year or once every other year. The 5 acres that does not get manure is heavily rotationally grazed and gets manure inputs that way.

List fertilizer/nutrients used, and rate, timing, and method of applications. (Attach Nutrient Management Plan, if available)

- We apply lime and commercial fertilizer to our hay fields as, well. However, this is infrequent and not on any particular schedule. The amendments are based on soil test done through Penn State University.

List pesticide(s) used, with frequency and method of application.

- Pesticides are not used on our farm.
- We use herbicides once or twice a year. They are used to spray our fence lines to suppress weeds and to kill invasive species of trees (Tree of Heaven).
    - Glyphosate and 2-4-D are used to spray fence lines. This is done in April/early May as a pre-emergent technique.
    - Triclopyr (Gordon's Brush Killer for Hard to Kill Brush) is used for Tree of Heaven that is less than 6 inches in diameter. This application is done in late September/early October.
    - "Notch & spray" method is used for the larger Tree of Heaven. The spray used on the larger trees is glyphosate. This application is done in late September/early October.

Indicate cover crops used, including species, planting and termination dates, and methods used to establish and terminate.

- We do not use cover crops. We do not have any bare land. It is all covered in grass or woods.

****

Applying Soil Health Principles

Minimize physical, chemical and biological disturbance

Questions to consider:

- Is the equipment you are using the least disruptive available, in terms of weight, depth, and disturbance type (tilling, plowing, etc.) to achieve the same function?
- Are there practices that you could adopt that would minimize or eliminate soil disturbing activities?

- Do the amendments or products you rely on for fertility, nutrient management, pest, disease and/or weed control disturb or damage soil biology, and if so, are there alternatives, or methods to limit use of those substances?

Maximize living roots
Questions to consider:

- Are there opportunities to minimize the period of time between cash crops, where the soil is left bare, by promptly replanting the next cash crop or planting a cover crop?
- Are you getting your cover crop in as early as possible, and terminating as late as possible?
- Are there areas where it may be possible to keep a living cover in pathways (e.g. grass, clover)?
- Are there bare spots, or areas with sparse vegetation in your pasture or forage fields? If so, how might you fill these spots in?
- Are there perennial crops that would fit well into your production system, or provide other benefits, such as wildlife habitat, wind break, or erosion control?

Maintain soil armor
Questions to consider:

- What materials (leaves, woodchips, straw) are available in the vicinity of your farm that could be used as ground cover in pathways, or beneath crops?
- Is crop residue being left on the surface of your fields, after harvest, and if so, is the percentage of cover meeting target goals for that particular crop (30% minimum-- up to 40%for soy, 60% for corn)

Maximize diversity
Questions to consider:

- Are there additional crop species that you could add to your planned rotation, in order to increase above and/or below ground biodiversity?
- Are there additional benefits that could be achieved, or constraints that could be addressed, by using a cover crop mixture vs. a single species?
- Are there areas on your farm landscape that could provide habitat for pollinators and/or wildlife?

Integrate Livestock (where appropriate)
Questions to consider:

- If your farm raises both crops and livestock, separately, how might you integrate the systems, for mutual benefit (while employing GAP principles for food safety)?
- Are there neighboring farms raising livestock that may need additional forage opportunities that you could offer?

****

3. Soil Properties and Constraints

A. In-field Assessments and Observations:

List the in-field qualitative assessment(s) completed, and share results (e.g. Jar/texture test; worm count; MD Soil Health Card, Pasture Condition Score Card etc.).

Share any observations you have made that may be attributed to soil health/function. *E.g. After periods of heavy rain, I can see channels through field A where water is causing erosion; or, On field B, there are areas of poor pasture growth where plants appear stunted and slightly yellow.*

We have a 7 acre hayfield that routinely under produces and is full of junk (vines, poison ivy, some milkweed). We have completed many of the recommended soil management practices: no till drill new grass & legumes, fertilized with commercial fertilizer based on Penn State University soil tests, applied lime, applied manure, and grazed the pasture with sheep and goats. This field continues to be a challenge for our farm.

B. Soil Tests

Soil tests that include soil health indicators beyond nutrient levels, such as organic matter, active carbon and aggregate stability, are recommended.

We use soil tests on our main hay fields and occasionally on our grazing pastures. We always do soil tests on our hay fields before we apply commercial fertilizer.

We generally use the Penn State University soil lab for our testing. However, we recently used Cornell for one of the hay fields that remains a challenge to manage.

Based on your most recent soil tests, in-field assessments and/or observations, what soil health problems or constraints are you experiencing, or where is there room for improvement on your farm or property?

1. Nutrient deficiency
2. Pest/disease pressure
3. Soil Acidity
4. Soil Alkalinity
5. Low Organic Matter
6. Compaction (stunted root growth, poor infiltration/standing water)
7. Poor water holding capacity (soil dries out quickly)
8. Soil Crusting
9. Poor Aggregate Stability
10. Low Microbial Activity/Biomass
11. Other, please describe

To help figure out the problem with our 7 acre hay field, we had USDA NRCS come out to look at the pasture and use a pentrometer to measure compaction. The field registered at 100 and the NRCS office made some general recommendations on how to use a no-till drill to break up the compaction. The NRCS office is also going to seek additional colleague opinions before we implement any changes to the field. We are waiting for the NRCS's recommendation after the staff does some additional research.

4. Identify Goals

A. Short term (1 year)

- Purchase no-till drill with grant money from SARE and from farm income.
- Drill tillage radish, cereal rye, sorghum/sudan grass in 7 acre hay field to reduce compaction.
- Drill perennial rye grass or tillage radish into a small section of an 8 acre hay field to break up fescue and increase hay yield. Heavily apply manure to this same section. Apply phosphorus to the entire field, per PSU soil test recommendation.
- Drill a "wild card mix" of pasture grasses to a 2 acre pasture that requires re-seeding. "Wild card mix" will include chicory and lesperanza. NRCS will be making a recommendation of what to include in the "wild card mix" after consulting with a sheep farmer.
- Engage pasture management consultant through grant funding.
- Investigate matching funding available through Capital Resource Conservation and Development Area Council (www.capitalrcd.org).
- Investigate conservation tax credits available through the PA Department of Agriculture's REAP program.

B. Long term (3+ years)

- Apply recommendations from pasture management consultant and NRCS.
- Measure compaction in 7 acre hay field and continue to mitigate.
- Enroll in PASA's Soil Benchmark Study.
- Complete annual soil samples on the 15 acres of hay fields.
- Begin restoring two additional pastures that contain grasses that the sheep and goats do not like.
- Learn more about winter pasture stockpiling.
- Learn more about incorporating annual brassicas into rotational grazing pastures to extend grazing in fall and early
- Continue looking for grant funding and tax credits for conservation, sustainable agriculture, women owned businesses, and pastured livestock.

5. Assessing Options

Consult the *Principles:Practices:Problem Solving Table* (Appendix B) to view management practices through the lens of NRCS's five Soil Health Principles to determine what practices might make sense for your operation, and your particular soil health goals.

1. Address compaction issues through pentrometer testing and no-till practices.
2. Use soil tests to determine the health of the soil.
3. Amend soil with nutrients/manure, fertilizer, and lime as appropriate.

6. Plan of Action and Timeline

Describe how you will address soil health constraints and/or make improvements, to meet your short and long term goals, then use the calendar table (Appendix B) to outline

the soil health activities in your plan, by month. Add notes throughout the year to describe challenges, or changes to the plan.

7. **Investments and Returns**

Many factors can influence farm profitability on any given year, making it difficult to assess the economic impact of an individual practice on whole farm income. While difficult, it is very important to track investments made towards soil health and resulting benefits or losses in order to create a clear picture of what works and what doesn't; where additional technical support may be needed, and where outside incentives or funding sources might be utilized to ease the transition to a new practice.

Use this space to record observations and anecdotes related to the benefits and/or losses* associated with soil health management techniques, and when possible, estimate the economic impact.
E.g. After a 6" rain event that resulted in flooding and crop loss for other growers at my market, my fields drained well and I was able to continue bringing a consistent amount of produce to market. Drainage has greatly improved after planting a tillage radish cover crop last winter, and I'm pretty sure that I would have lost crops, as others did, resulting in at least 2 weeks of reduced income at market, equaling approx. $3500.
**If you are interested in doing a more detailed budget analysis, contact Lisa Garfield, lisa@futureharvest.org for additional resources.*

Appendix A: Principles, Practices and Problem Solving

Problem	**Practice**	**Principle(s)**
Nutrient Levels/Chemical	Test soil annually, in fall, to monitor nutrient levels and pH, and plan for appropriate soil amendments.	See how managing chemical attributes in the soil relate to the 5 principles of soil health.
Nitrogen	Nutrient Management • Apply precision and/or 4R principles so that N is applied when crop needs it (e.g. split application) Cover Crop/Crop Rotation • Plant legume, or mixture that includes legume, prior to cash crop. Mulch • Keep the soil covered with mulch or crop residue to protect soil	**Minimize chemical disturbance** and protect water quality by using non-synthetic fertilizers (whenever possible), and applying at optimal time for plant uptake **Keep living roots** in the ground between cash crops to scavenge excess nutrients and provide N for next crop **Soil Armor** to protect microorganisms that aid in nutrient cycling, and reduce volatilization

	microorganisms that mineralize N for crop uptake.	**Maximize diversity** by growing multi-species cover crops mix that will supply N to cash crop, and promote healthy microbial populations that aid in N mineralization **Integrate Livestock** for an N-rich source of organic matter
High Phosphorus	Nutrient Management • Stop adding manure or compost • Use fertilizers with low- or no- P, or limit to low starter P amendments • Apply P at or below crop removal rate Cover Crop/Crop Rotation • Grow cover crop with high P scavenging potential, and harvest from field for use elsewhere • Grow cash crop with high P scavenging potential, for removal through harvest Prescribed Grazing • If feeding additional rations, consider low P feed options • Use phytase for non-ruminant livestock	**Minimize chemical disturbance** and protect water quality by limiting phosphorus use on land that has sufficient or excessive levels **Keep Living Roots** in the soil to cycle nutrients more effectively, and reduce nutrient runoff **Maximize Diversity** by using cover crops and crop rotations that introduce crop species with high P scavenging potential
Low Phosphorus	Nutrient Management • Follow soil test recommendations for P amendments • Keep pH in optimal range (6.2-6.5) to access fixed P Cover Crop • Grow cover crop to scavenge and recycle soil P • Grow cover crops that host Mycorrhizal fungi Compost/Mulch • Apply high quality compost as a source of soil nutrients and to promote mycorrhizal population • Use mulch to protect and promote Mycorrhizal population	**Keep Living Roots** in the soil to cycle nutrients more effectively, and reduce nutrient runoff (and save $!) **Maximize Diversity** of crops in rotation, cover crops, and by adding organic amendments to add nutrients **Minimize Disturbance** to reduce soil erosion and nutrient loss **Soil Armor** helps protect soil microorganisms that aid in nutrient cycling **Integrate Livestock** to add organic matter, microbial diversity and nutrients
Low Potassium	Nutrient Management • Follow soil test recommendation for K amendments, using wood ash, manure, compost, or fertilizer • Apply 'maintenance' K each year, per soil test recommendations Cover crops • Grow cover crops to scavenge and recycle soil K	**Keep Living Roots** in the soil to cycle nutrients more effectively. **Maximize Diversity** of crops in rotation, with cover crops, and by adding organic amendments to add nutrients **Minimize Disturbance** to reduce soil erosion and nutrient loss

		Soil Armor helps protect soil microorganisms that aid in nutrient cycling **Integrate Livestock** for nutrient rich manure as an organic amendment
Low Minor Elements	Nutrient Management • Add chelated micros according to soil test recommendations • Maintain optimal soil pH (6.5 for most crops) Cover Crops • Use cover crops to scavenge and recycle minor elements, increase soil organic matter, and promote mycorrhizal populations Compost • Use compost to increase organic matter	**Keep Living Roots** in the soil with cover crops to cycle nutrients more effectively **Maximize Diversity** of crop rotation, cover crops, and compost to cycle nutrients more effectively and promote microbial diversity **Soil Armor** helps protect soil microorganisms that aid in nutrient cycling
High Minor Elements	Nutrient Management • Raise pH to 6.2-6.5 (for all high micros except Molybdenum) • Do not use fertilizers with micronutrients • Improve soil calcium levels • Monitor irrigation/Improve drainage	**Minimize Chemical Disturbance** by correcting nutrient and pH imbalances **Keep Living Roots** in the soil by using cover crops to cycle nutrients more effectively, reducing the need for nutrient amendments
Low pH- acidity	• Add lime or wood ash per soil test recommendations • Add calcium sulfate (gypsum) in addition to lime, if aluminum is high • Use less ammonium or urea • Increase organic matter to raise buffering capacity	**Minimize Chemical Disturbance** by maintaining optimal pH for crops to avoid hindering uptake of micronutrients that may cause toxicity **Keep Living Roots** in the soil between cash crops using cover crops that build soil organic matter
High pH- alkalinity	• Stop adding lime or wood ash • Add elemental sulfur per soil test recommendations	**Minimize Chemical Disturbance** by maintaining optimal pH for crops to avoid nutrient deficiencies, yield loss, and degradation of soil health. **Keep Living Roots** in the soil between cash crops using cover crops that build organic matter
Pest/Disease Pressure	Scout for evidence of pest or disease damage throughout the growing season, and consider the least harmful alternative when deciding on a course of action, including cultural practices and biological controls.	See how pest and disease management recommendations relate to the 5 soil health principles.

Fungal Pathogen	Crop Rotation • Diversify crop rotation by growing/adding different species in succession • Choose crop varieties with resistance to pathogen Cover Crops • Grow mustard or other species that provide biofumigant properties, solely or as part of a multi-species cover crop mix. • Grow multi-species cover crop mix to increase above and below ground biodiversity Conservation Tillage • Practice no-till or a reduced tillage strategy to protect soil structure and beneficial soil organism habitat Mulch • Use organic materials, or leave sufficient crop residue to cover the soil and reduce soil splash that can lead to spread of pathogens IPM • Use least harmful alternative, and appropriate timing and method when treating for soil pathogens	**Minimize Physical Disturbance** of beneficial soil microorganism habitat and soil structure by using reduced till or no-till. **Minimize Chemical Disturbance** by limiting, or eliminating the use of chemicals that harm beneficial soil organisms **Maximize Diversity** of crop rotation, and/or cover crops to break pathogen host cycle and promote beneficial soil microorganisms **Keep Living Roots** in the soil to maintain healthy soil microorganism habitat, and plant:bacteria feedback loops. **Soil Armor** such as mulch or crop residue protects the population of beneficial soil microorganisms, and reduces spread of soil borne disease to crop leaves.
Bacterial Pathogen	Crop Rotation • Diversify crop rotation by growing/adding different species in succession Cover Crops • Grow multi-species cover crops to increase above and below ground biodiversity • Grow cover crop species that act as host to beneficial soil organisms, and interrupt the host opportunity for pathogens Conservation Tillage • Practice no-till or a reduced tillage strategy to protect soil structure and beneficial soil organism habitat Mulch • Use organic materials, or leave sufficient crop residue to cover the soil and reduce soil splash that can lead to spread of pathogens IPM • Use least harmful alternative, and appropriate timing and method when treating for soil pathogens	**Minimize Physical Disturbance** of beneficial soil microorganism habitat and soil structure by using reduced till or no-till. **Minimize Chemical Disturbance** by limiting, or eliminating the use of chemicals that harm beneficial soil organisms **Maximize Diversity** of crop rotation, and/or cover crops to break pathogen host cycle and promote beneficial soil microorganisms **Keep Living Roots** in the soil to maintain healthy soil microorganism habitat, and plant:bacteria feedback loops. **Soil Armor** such as mulch or crop residue protects the population of beneficial soil microorganisms, and reduces spread of soil borne disease to crop leaves.

Pest Intensity/Population	Crop Rotation • Diversify crop rotation to break pest cycle Cover Crops • Grow mixed species cover crops to add above and below ground biodiversity, break pest cycle and attract beneficial predator species Conservation Tillage • Use reduced or no-till to protect habitat of beneficial organisms that help keep pests in check IPM • Use least harmful alternative, and appropriate timing and method when treating for soil pathogens Hedgerow • Establish perennial hedgerows to provide habitat for beneficial predator species	**Minimize Disturbance** of soil by using reduced or no-till to protect habitat of soil organisms that feed on ground-dwelling pests or larvae, and by minimizing reliance on broad spectrum pesticides that disturb predator:prey balance. **Maximize Diversity** of crop rotation, and/or cover crops to break pest host cycle and promote beneficial soil organisms. **Keep Living Roots** in the soil to maintain healthy soil organism habitat **Soil armor** helps protect organism habitat and reduces plant stress that can attract pests
Physical/structure	While soil texture cannot be changed, other attributes, like pore space and organic matter content can be optimized to provide a good physical environment for plant roots and soil organisms. Monitor water infiltration rates, soil crusting, root penetration throughout the season to determine where interventions are needed.	See how soil physical/structure management recommendations relate to the 5 soil health principles.
Organic Matter	Cover Crops/Mulch • Grow high biomass cover crops as green manure • Use organic materials (straw, wood chips, leaves) beneath crops and in pathways • Leave crop residue on the surface of the soil after harvest Conservation Tillage • Reduce tillage or use No-Till practices, to reduce soil disturbance Compost • Apply compost and biochar Prescribed Grazing • Integrate livestock into cropping systems • Use management intensive grazing system	**Minimize Disturbance** of the soil to protect soil organic matter from erosion and/or hastening of decomposition through aeration and microbial activity **Maximize Diversity** of crop rotation and with cover crops to **Keep Living Roots** to protect soil surface and add below ground biomass via root **Soil Armor** keeps organic matter in place and protected from loss via hastened decomposition **Integrate Livestock** to add nutrient rich source of organic matter
Compaction	Cover Crops/Mulch • plant shallow rooted cover crops for surface hardness	**Minimize Disturbance** to protect soil structure, avoid plowpan or compaction layers, and maintain healthy balance of pore size and space.

	• plant deep rooted cover crops, like tillage radish, for subsurface hardness • use living mulch, or interseed cover crops Conservation Tillage/Equipment Activity • avoid traffic and equipment activity on wet soils • use mechanical loosening (e.g broadfork, aerating, strip tillage) for surface, or deep tillage (e.g. chisel plow, subsoiler, yeoman's plow) for short term alleviation • avoid heavy equipment loads, or plows/disks that create pans • Adjust stocking density or duration of grazing events	**Maximize Diversity** of crop rotation and with cover crops to include root systems that occupy different strata in the soil profile **Keep Living Roots** to maintain belowground channels and pore space created by living and dead roots **Soil Armor** to protect the soil surface from overdrying that leads to reduced water infiltration and contributes to hardening **Integrate Livestock** to add organic matter and promote below ground root growth and decay
Water Holding Capacity	Cover Crop • Grow high biomass cover crop to increase organic matter Mulch • Use organic materials to keep ground covered under plants and in pathways to conserve moisture and regulate temperature • Leave crop residue on the surface of the soil to conserve moisture Conservation Tillage • Reduce tillage, or use No-Till to improve soil structure and pore space Compost • Add compost to increase organic matter and improve soil structure and pore space	**Minimize Disturbance** to protect organic matter and soil structure and to maintain healthy balance of pore size and space **Maximize Diversity** of crop rotation and with cover crops to include high biomass crops that help build organic matter **Keep Living Roots** in the soil to maintain healthy soil structure with channels and pore space created by living and dead roots **Soil Armor** to protect soil moisture and prevent surface drying that inhibits water infiltration I**ntegrate Livestock** using rotational grazing to build organic matter
Soil Crusting	Nutrient Management • Use soluble calcium, or Gypsum to correct high sodium levels in soil Crop Rotation/Cover Crop • Grow high biomass crops to build organic matter Mulch • Use organic materials to protect soil surface from impact of rain or irrigation on soil particles • Leave crop residue on the surface of the soil to protect and conserve moisture Conservation Tillage • Reduce tillage, or use No-Till to protect soil surface from impact of rain and irrigation, protect soil	**Minimize Disturbance** to protect organic matter and soil structure **Maximize Diversity** of crop rotations and use cover crops to build organic matter **Keep Living Roots** to protect soil surface and structure, and create pathways for water infiltration **Soil Armor** to protect soil surface from impact of rain, preserve soil moisture and prevent surface drying

	structure, and reduce surface drying	
Aggregate Stability	Cover Crop/Crop Rotation • plant shallow rooted cover crop or cash crop • Incorporate Mycorrhizal host crop into rotation (many crops, aside from Brassica, are good host to Arbuscular Mycorrhizal Fungi) Compost/Mulch • Add compost, manure and/or fresh organic materials Conservation Tillage • Reduce tillage, or use No-till methods to reduce soil disturbance	**Minimize Disturbance** to protect organic matter and microorganisms that help maintain healthy soil structure with variety of pore sizes and space **Maximize Diversity** of crop rotation and with cover crops to build organic matter and promote microbial communities **Keep Living Roots** to reduce erosion and provide food for soil microorganisms **Soil Armor** protects soil microorganisms that aid in aggregate formation, and reduce potential for erosion **Integrate Livestock** to increase organic matter and promote below ground biomass that feeds microorganisms and contributes to healthy soil structure
Biological Activity	Observe macroinvertebrates, such as earthworms, as an indicator of biological health, but consider adding Active Carbon, or other lab tests that monitor the amount, activity of soil organisms or the quality of food available to maintain a healthy population.	See how soil biology management recommendations relate to the 5 soil health principles.
Active Carbon	Cover Crop/Crop Rotation • Grow shallow-rooted cover crop and/or grow cover crops whenever possible • Add sod crop to rotation Conservation Tillage • Reduce tillage/mechanical cultivation, or use No-till methods Compost/Mulch • Add fresh organic materials, manure, mulch and/or compost	**Minimize Disturbance** to protect organic matter and microorganisms that help maintain healthy soil structure **Maximize Diversity** of crop rotations and with cover crops to promote diverse microbial communities **Keep Living Roots** to provide food source for soil microorganisms **Soil Armor** protects soil microorganisms that aid in aggregate formation **Integrate Livestock** to increase the amount and diversity of soil organisms that aid in organic matter formation
Soil Respiration	Cover Crop/Crop Rotation • Increase diversity of rotation • Maintain plant cover throughout the season/year	**Minimize Physical and Chemical Disturbance** to protect organic matter and microorganisms that help maintain healthy soil structure

	• Cover crop with symbiotic host plants Conservation Tillage • Reduce tillage/mechanical cultivation, or use No-till methods Compost/Mulch/Organic Inputs • Add manure/green manure • Add fresh organic materials • Keep soil surface covered with mulch and/or crop residue Pest/Disease Management • Reduce biocide use	**Maximize Diversity** of crop rotations and with cover crops to promote diverse microbial communities **Keep Living Roots** to provide food source for soil microorganisms **Soil Armor** regulates temperature and moisture to protect soil microorganisms that aid in aggregate formation **Integrate Livestock** to add nutrient rich manure that increases the amount and diversity of soil organisms
Soil Protein	Cover Crop/Crop Rotation • Incorporate young, green, cover crop biomass • Plant legume, or grass-legume mix • Inoculate legume seed with Rhizobia and check for nodulation • Rotate with forage legume sod crop Conservation Tillage • Reduce tillage/mechanical cultivation, or use No-till methods Compost/Organic Inputs • Use N-rich organic matter inputs, like manure or high-N well finished compost • Use low C:N ratio inputs • Monitor C:N ratio over time Chemical/Nutrient Management • Keep soil pH at 6.2-6.5 (helps N fixation) Pasture/Forage • Add legumes to forage species, and/or reseed if legume population is low • Check legumes in pasture for nodulation, and innoculate with Rhizobia if needed	**Minimize Disturbance** to reduce Nitrogen volatilization, protect organic matter and microorganisms that help maintain healthy soil structure **Maximize Diversity** of crop rotations, cover crops and fresh organic materials to promote microbial communities needed for N mineralization **Keep Living Roots** to provide food source for soil microorganisms and root hosts for Nitrogen fixing Rhizobia **Soil Armor** regulates temperature and moisture to protect soil organisms that aid in decomposition of organic materials and N mineralization **Integrate Livestock** to add nutrient rich manure that increases soil organic matter and food for soil organisms

1. *Adapted from* Cornell Comprehensive Assessment of Soil Health, The Cornell Framework Manual, Third Edition. B.N. Moebius-Clune, D. J. Moebius-Clune, B.K. Gugino, O.J. Idowu, R.R. Schindelbeck, A.J. Ristow, H.M. van Es, J.E. Thies, H. A. Shayler, M. B. McBride, D.W. Wolfe, and G.S. Abawi. Cornell University. 2016. Page 84-85.

Appendix B- Soil Health Planner

Month/Year	Activity	Notes
January	N/A	
February	N/A	
March	Frost seeding Fertilizer application	
April	No-till drill in pastures needing rehabilitation.	
May	Mow & make hay	
June	Mow & make hay	
July	N/A	
August	Mow & make hay	
September	N/A	
October	Graze with sheep/goats if possible	
November	Gather soil samples	
December	N/A	