Permaculture and Landscape Design for Wilhelm Farm: A Case Study

Wilhelm Farm is dominated by perennial vegetation in forest, grasses, and brush. Very little of the land is in annual crop production. As we planned this NRCS Grant Project, we asked the questions: How can we work better with nature on this property to ensure both ecological and economic sustainability in the future? What can be improved?

Our starting point included the following conditions:

- Soils pH, nutrients, and other traits
- Hydrology – water flows on the surface and immediate subsurface
- History of forest management, stewardship, and timber harvests
- 22 years of fruit and vegetable production and sales at a roadside farm stand
- Complex climate, social, economic and political forces that are in flux

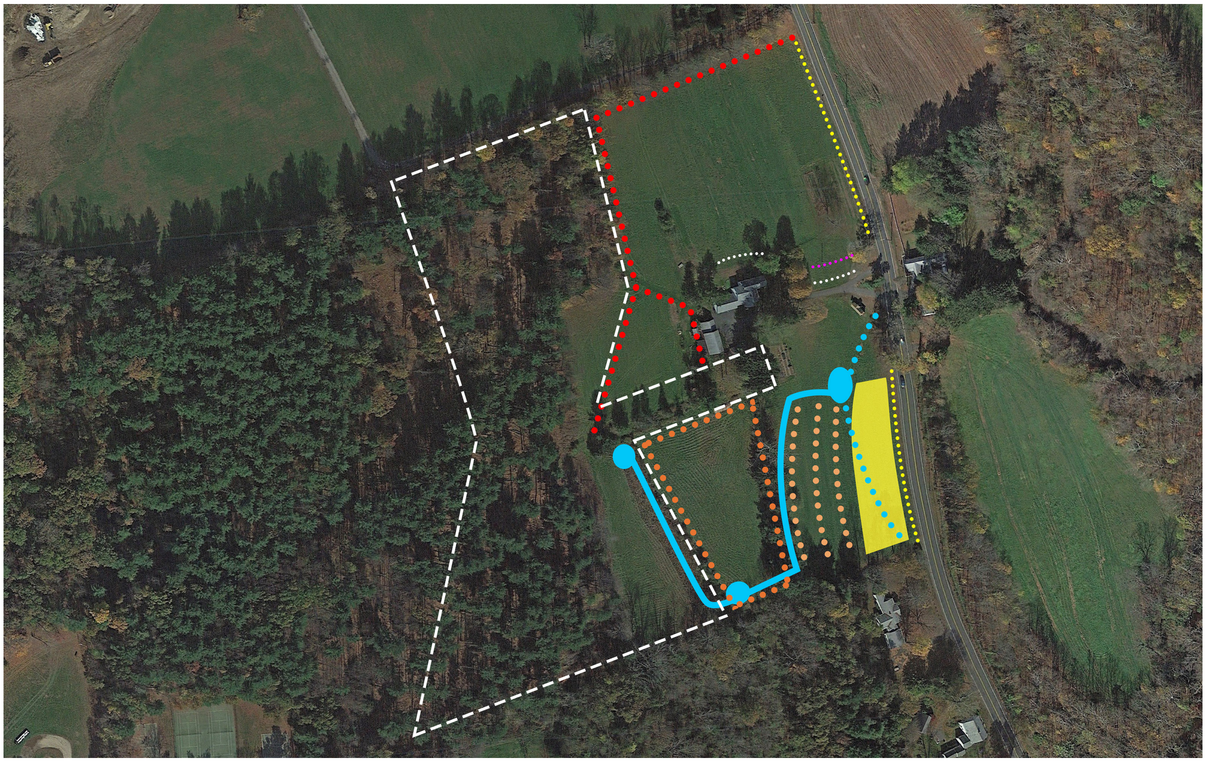
Also relevant is our current land use allocation (totaling 45.6 acres):

- House, barns, & garden areas (2.20 acres)
- Hayfields and pastures (8.00 acres)
- Silvopasture unit (4.90 acres)
- White pine/mixed hardwoods (15.50 acres)
- Red oak, other hardwoods (15.00 acres)

Permaculture design is not an end, but a process of observation, on-going learning, and adjustments to accommodate changes in climate, vegetation, markets, and household goals. We worked with Connor Stedman, a Principle and Lead Designer of AppleSeed Permaculture, to identify specific steps to move Wilhelm Farm towards our vision of a more integrated and resilient farming system. Our vision is one of dynamic change, guided by observation and learning from our current management plan.

We began by learning more about our soils, which led to learning more about water flows on the soil surface and immediate subsurface. Detailed soil maps for the property are in Appendices (xx-xx). The soils information confirms the land suitability of the forested portions; 15 steeply sloped acres on the west side of Mountain Brook for hardwood production and 15.5 acres on the east side for white pine and oak production. Some of the alluvial plain and steep south-facing esker slope on the west side will be used for forest farming crops like ramps and fiddlehead ferns. The focus of our permaculture design work is on the ~15.5 acres that has most recently been in hay, pasture, garden, and marginal forest. We are rethinking land use allocation on this part of the property.

Our farm vision includes mixed livestock and silvopasture. Keeping livestock in this climate requires storing feed for use during the winter months, so we plan to keep the north field in hay production. Hay yield can be improved by reseeding using a seed drill, application of manure, and application of soil amendments.



The current silvopasture plan: the dashed white line is silvopasture area; yellow dots are pollinator strips; blue designates proposed water works; orange dots are alley cropping trees (both around edge of pasture, and in contour lines); the new market garden is shown in yellow; windbreaks are shown in small white dots, and flowers in magenta dots; Livestock paths/access is indicated in red.

Over time, the south hayfield will be converted to other land uses. A new market garden area will be located on the flat-bottomed east edge. This area is also one of the few level areas on the farm and is perhaps the best potential location for hoop houses or greenhouses. The existing garden beds will be extended downhill, in a series of terraced beds. The sloped portion of this field will be planted to tree crops (fruit or nut orchard), with alley cropping of berries or animal grazing in the strips between the rows of trees. We are exploring chestnuts as a potential nut tree for this area as we learn more about the emergence of a commercial market for chestnuts.

We are expanding the silvopasture unit to include the center pasture, using alleys of trees on the edges to help hold the excess water that flows through this area in wet seasons. In addition, the small hayfield to the west of the barn will be converted to a mix of strawberries, winter barnyard, and silvopasture.

The most critical change we are planning, however, is a set of water management structures to help us capture excess water higher in the landscape, slow its flow downhill, and maximize its use while we have it on the property. In conversation with Connor Stedman and Kip Kolesinskas, a plan is forming that would channel water from wet areas in the silvopasture to a series of small, storage ponds and swales. The ponds can be used as water sources for animals as well as for fruit, tree, and vegetable crops.

We do not have a set schedule for these land use changes, but the timing is less critical than the order of implementation. The following seems the most logical sequence at this point in our farm planning:

Step	Task	Progress
1.	Set boundaries of silvopasture unit • Low quality woods, brush & brambles • Wet pasture with sedge and Carex	Done in 2017; adjusted in 2018 and 2019 in line with developing permaculture plan
2.	Plant hybrid poplar in wettest pasture areas to store water in trees and reduce waterlogged soils; protect natural black birch seedlings for same purpose.	Done 2017 with follow up in 2018 & 19. A cutting nursery will be implemented in 2020 to produce additional planting stock
3.	Follow-up mowing to clear stems that reduce movement through silvopasture unit that has been heavily browsed	Done late in 2018; being done in 2019 as goats are moved to new paddocks; a thorough mowing/trimming will be done in November to prepare for spring 2020
4.	Develop goat herd and expand with experience	Started in 2017 with 2 dairy goats in barnyard; expanded seasonally in 2018 and repeated in 2019 with 9-10 goats.
5.	Plant red cedar windbreak/snow fence	Done in 2019; will fill in as needed in fall; follow-up in 2020 to insure coverage at end of driveway
6.	Dedicate north field to hay production	Timing is not set, but steps include: 1. Remove old fruit trees in fall 2. Drill hay seed in following spring 3. Lime and fertilize with NKP as needed
7.	Rehabilitate chicken & other out buildings	Planned for 2020 or later
8.	Design of terraces below current raised beds	Planning in 2020 or later; design will include an implementation schedule.
9.	Selection for nut trees on south field's slope; design of alley widths; selection of forage or berry crops for alleys between tree rows Consideration/research into tree leases. How to bring in other parties to use the land? We can't do it all ourselves	Currently favoring chestnuts; will discuss with CT Agriculture Experiment Station, which is doing research on topic. Favor forage in between tree alleys if suitable small haying equipment can be identified.
10.	Design of water harvesting and storage system to move water off silvopasture unit to pond near proposed market garden area.	Will begin more detailed design work in fall 2019; will not complete until 2020 or later; design will inform a detailed implementation plan.

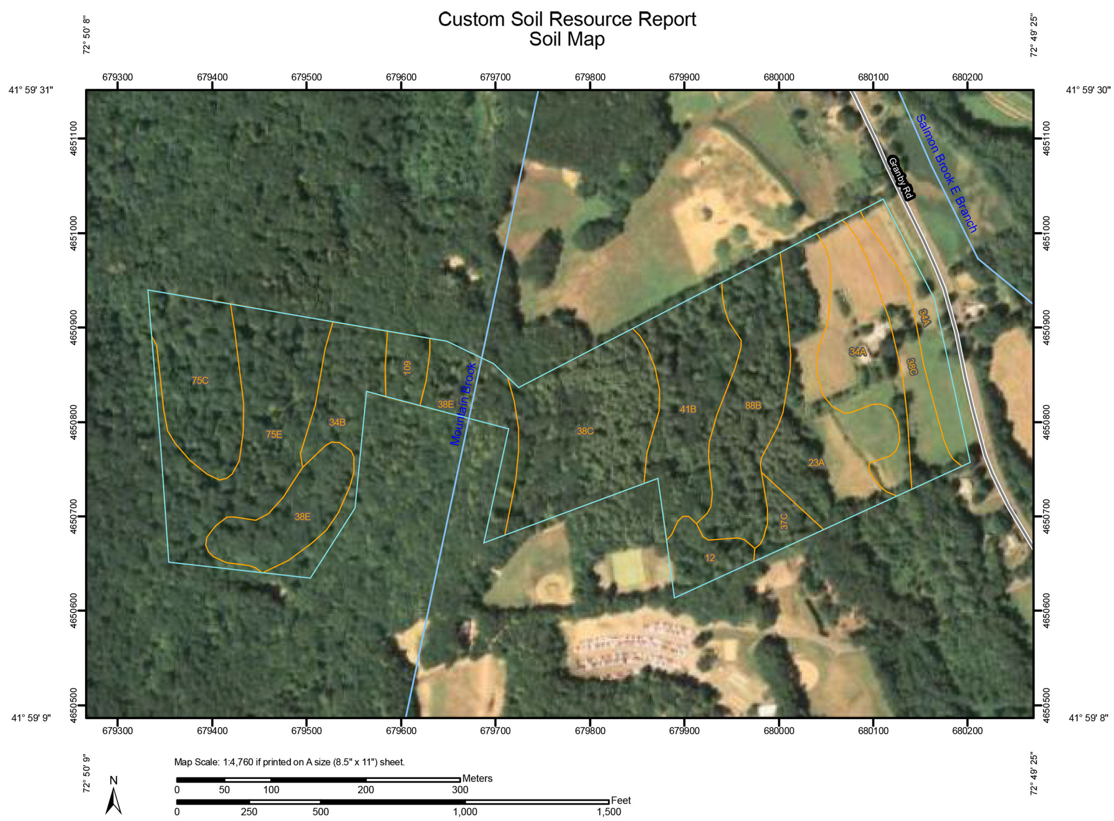
A study of permaculture refocused attention on understanding our soil resources. We are integrating a July 2013 NRCS custom soils report for Wilhelm Farm with a May 2018 analysis by Logan Labs in Ohio. The results reinforce that we must lime, apply add NPK fertilizer, and consider application of micronutrients. We will consult with Conner Stegman, Kip Kolesinskas and a NRCS soil scientist as part of our inquiry,

This is a case study of decisions and actions in flux, with the pace of action depending on the speed of learning, and the availability of capital and human resources. We will report progress on our webpage – www.wilhelmfarm.com – and update this factsheet every year or so.

Appendix

Wilhelm Farm Soils and Vegetation Maps

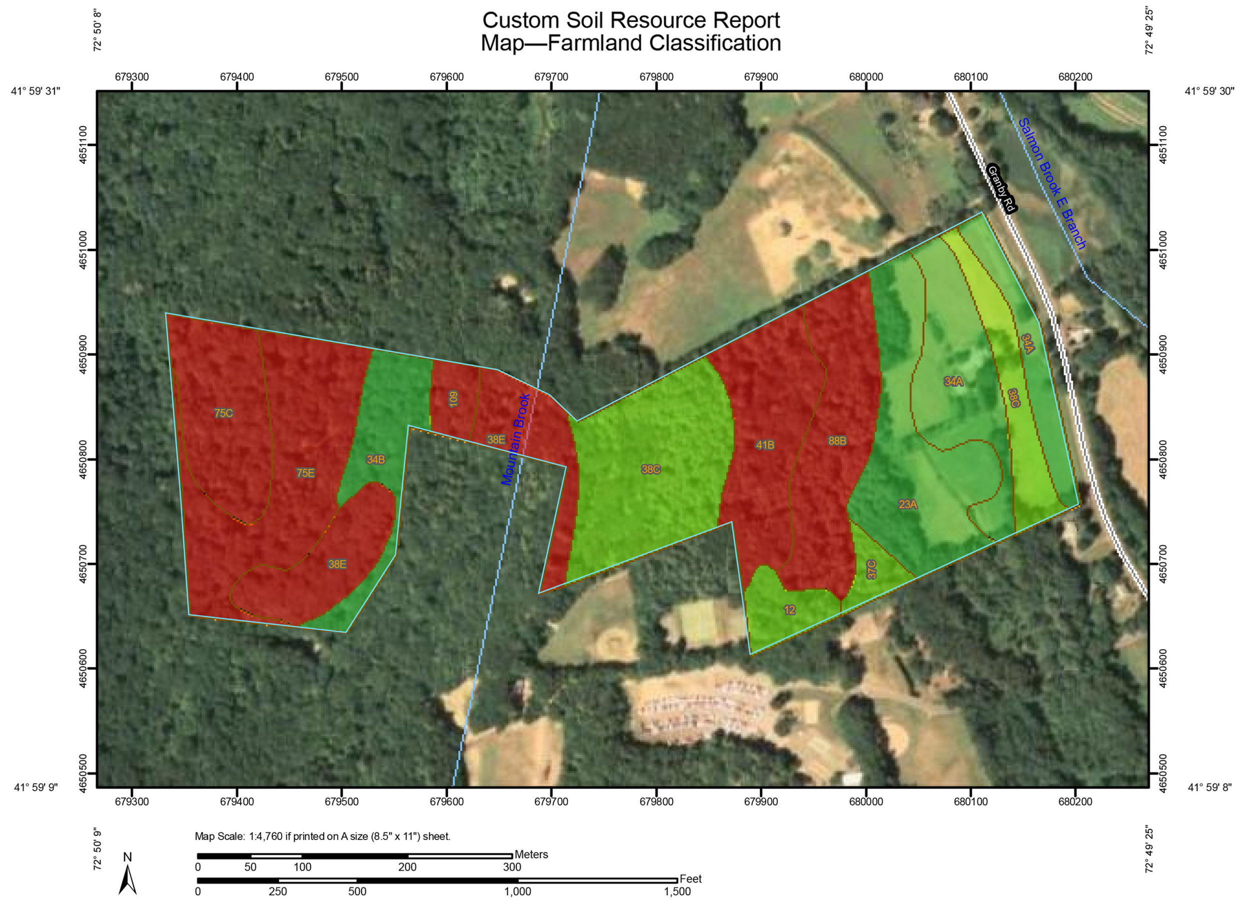
A custom soils report was done in 2013 done with support from NRCS. 2017 we had Logan Labs (Ohio) do a soil nutrient analysis of our pasture, crop and silvopastural soils. We have 12 soil types on the farm that include some reasonably good crop and pasture soil, and some excellent pine and hardwood sites. The following legend names the soils mapped on the page following. The second page following describes these soils in broad productivity terms.



Map Unit Legend

State of Connecticut (CT600)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
12	Raypol silt loam	1.1	2.4%
23A	Sudbury sandy loam, 0 to 5 percent slopes	5.1	11.1%
34A	Merrimac sandy loam, 0 to 3 percent slopes	5.2	11.4%
34B	Merrimac sandy loam, 3 to 8 percent slopes	2.6	5.6%
37C	Manchester gravelly sandy loam, 3 to 15 percent slopes	0.7	1.5%
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	7.8	17.0%
38E	Hinckley gravelly sandy loam, 15 to 45 percent slopes	4.5	9.7%
41B	Ludlow silt loam, 2 to 8 percent slopes, very stony	4.2	9.1%
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	3.7	8.0%
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	5.9	12.8%
88B	Wethersfield loam, 3 to 8 percent slopes, very stony	4.4	9.6%
109	Fluvaquents-Udifluvents complex, frequently flooded	0.8	1.6%
Totals for Area of Interest		**46.1**	**100.0%**

Custom Soil Resource Report
Map—Farmland Classification



Table—Farmland Classification

Farmland Classification— Summary by Map Unit — State of Connecticut (CT600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
12	Raypol silt loam	Farmland of statewide importance	1.1	2.4%
23A	Sudbury sandy loam, 0 to 5 percent slopes	All areas are prime farmland	5.1	11.1%
34A	Merrimac sandy loam, 0 to 3 percent slopes	All areas are prime farmland	5.2	11.4%
34B	Merrimac sandy loam, 3 to 8 percent slopes	All areas are prime farmland	2.6	5.6%
37C	Manchester gravelly sandy loam, 3 to 15 percent slopes	Farmland of statewide importance	0.7	1.5%
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	Farmland of statewide importance	7.8	17.0%
38E	Hinckley gravelly sandy loam, 15 to 45 percent slopes	Not prime farmland	4.5	9.7%
41B	Ludlow silt loam, 2 to 8 percent slopes, very stony	Not prime farmland	4.2	9.1%
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	Not prime farmland	3.7	8.0%
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	Not prime farmland	5.9	12.8%
88B	Wethersfield loam, 3 to 8 percent slopes, very stony	Not prime farmland	4.4	9.6%
109	Fluvaquents-Udifluvents complex, frequently flooded	Not prime farmland	0.8	1.6%
Totals for Area of Interest			**46.1**	**100.0%**

12, 23A, 37C – wet soils suitable for silvopasture	
34A, 38C—productive soils: hay, veggies (where flat), fruit/nut trees (steeper)	
75C, 75E, 38E – granitic soils; red and white oak, some sugar maple	
41B, 88B – well drained deep sandy with site 80 to 85 white pine plus oak	
109 – bottomland: birch, poplar, hemlock and shade tolerant forest farm crops	
34B – bottomland: sugar maple, other nutrient demanding tree crops	

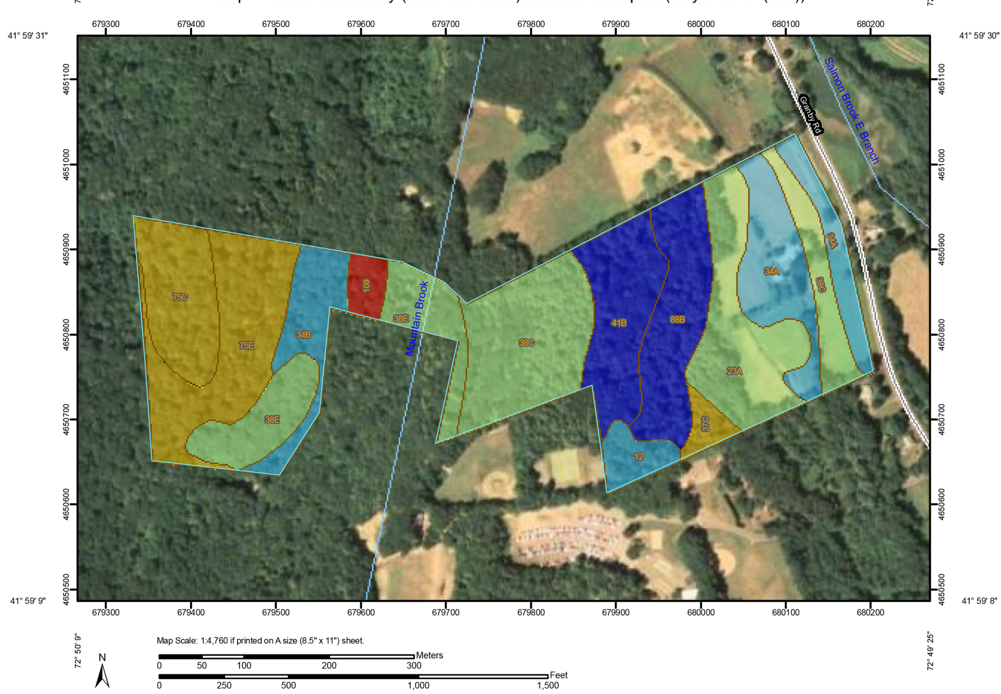
Vegetative Productivity

Vegetative productivity includes estimates of potential vegetative production for a variety of land uses, including cropland, forestland, hayland, pastureland, horticulture and rangeland. In the underlying database, some states maintain crop yield data by individual map unit component. Other states maintain the data at the map unit level. Attributes are included for both, although only one or the other is likely to contain data for any given geographic area. For other land uses, productivity data is shown only at the map unit component level. Examples include potential crop yields under irrigated and non-irrigated conditions, forest productivity, forest site index, and total rangeland production under normal, favorable and unfavorable conditions. (see facing map and key)

Forest Productivity (Tree Site Index)

The "site index" is the average height, in feet, that dominant and co-dominant trees of a given species attain in 50 years. The site index applies to fully stocked, even-aged, unmanaged stands, but it can be used more broadly as a measure of site productivity. We have tree site indexes for both eastern white pine (Lloyd 1970b) and northern red oak (Schnur 1937). The productivity ratings are virtually identical for the two valuable timber species, and they are closely associated on Ludlow silt loam (41B) and Wethersfield loam (88B). These soils are the areas that have tree growth indices of 70 to 75 feet, and we have measured trees that indicate tree heights at 50 years of 80 to 85 feet. We feel confident that white pine and red oak are the proper target vegetation for these 8.6 acres (18.7% of our productive acres)

Custom Soil Resource Report
Map—Forest Productivity (Tree Site Index): eastern white pine (Lloyd 1970b (660))



Table—Forest Productivity (Tree Site Index): northern red oak (Schnur 1937 (820))

Forest Productivity (Tree Site Index): northern red oak (Schnur 1937 (820))— Summary by Map Unit — State of Connecticut (CT600)				
Map unit symbol	**Map unit name**	**Rating (feet)**	**Acres in AOI**	**Percent of AOI**
12	Raypol silt loam		1.1	2.4%
23A	Sudbury sandy loam, 0 to 5 percent slopes	45	5.1	11.1%
34A	Merrimac sandy loam, 0 to 3 percent slopes	51	5.2	11.4%
34B	Merrimac sandy loam, 3 to 8 percent slopes	51	2.6	5.6%
37C	Manchester gravelly sandy loam, 3 to 15 percent slopes	50	0.7	1.5%
38C	Hinckley gravelly sandy loam, 3 to 15 percent slopes	49	7.8	17.0%
38E	Hinckley gravelly sandy loam, 15 to 45 percent slopes	49	4.5	9.7%
41B	Ludlow silt loam, 2 to 8 percent slopes, very stony	70	4.2	9.1%
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	47	3.7	8.0%
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	47	5.9	12.8%
88B	Wethersfield loam, 3 to 8 percent slopes, very stony	74	4.4	9.6%
109	Fluvaquents-Udifluvents complex, frequently flooded		0.8	1.6%
Totals for Area of Interest			**46.1**	**100.0%**

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We had Logan Labs, LLC (Lakeview, Ohio) analyze the nutrients and pH for the crop and silvopasture areas. 15 samples were systematically taken in each soil sample unit, partially dried, mixed and shipped to the lab. The results were as expected. The silvopasture soil has much lower pH, lower exchange capacity, low phosphorous, and bigger deficits of calcium, magnesium and potassium, than the adjacent cropping soils. The tree growth indices are 45 to 50. The general NRCS descriptions, however, suggest that these soil types on Wilhelm Farm are considerably wetter than the norm. Consequently, we believe the tree growth indices may be lower than the generally estimates. Forage productivity could be increased by liming and NPK fertilizer. Tree productivity also probably would increase with higher pH and exchange capacity.

Soil Report from Logan Lab

Job Name: **Wilhelm Farm** Date: 5/22/2018
Company: Wilhelm Farm Submitted By: Owners

Sample Location		34A - bottom	38C – mid-hill	34A - top	23A - silvopasture
Lab Number		86	87	88	89
Sample Depth in inches		6	6	6	6
Total Exchange Capacity (M. E.)		7.03	7.44	6.55	3.90
pH of Soil Sample		6.2	6.5	6.4	5.7
Organic Matter, Percent		5.32	4.76	4.66	4.72
SULFUR:	p.p.m.	13	14	13	13
Mehlich III Phosphorous:	as (P_2O_5) lbs / acre	1041	1461	1449	420
CALCIUM: lbs / acre	Desired Value	1912	2023	1780	1060
	Value Found	1755	1951	1689	827
	Deficit	-157	-72	-91	-233
MAGNESIUM: lbs / acre	Desired Value	202	214	200	200
	Value Found	238	300	276	90
	Deficit				-110
POTASSIUM: lbs / acre	Desired Value	219	232	204	200
	Value Found	196	164	85	99
	Deficit	-23	-68	-119	-101
SODIUM:	lbs / acre	87	82	68	72
Calcium (60 to 70%)		62.41	65.55	64.49	53.05
Magnesium (10 to 20%)		14.11	16.80	17.56	9.62
Potassium (2 to 5%)		3.57	2.83	1.66	3.26
Sodium (.5 to 3%)		2.70	2.40	2.25	4.02
Other Bases (Variable)		5.20	4.90	5.00	6.00
Exchangeable Hydrogen (10 to 15%)		12.00	7.50	9.00	24.00
Boron (p.p.m.)		0.34	0.34	0.33	0.31
Iron (p.p.m.)		211	174	187	228
Manganese (p.p.m.)		43	38	38	37
Copper (p.p.m.)		1.55	1.63	2.13	1.1
Zinc (p.p.m.)		4.61	6.78	7.26	3.97
Aluminum (p.p.m.)		1428	1442	1365	1315