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# UMass Carbon Farming Initiative Design Overview

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# UMass Carbon Farming Initiative

## Design Overview

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STOCKBRIDGE SCHOOL of AGRICULTURE | UMASS AMHERST

# Contents:




*Special thanks to contributors including:*

*Lisa DePiano, Nicole Burton, Sofia Cincotta, Trevor Brown, Russell Wallack, Amanda Brown, Marco Keiluweit, Samantha Anderson, Sustainability Education and Innovation Fund, Northeast Organic Farming Association, TK labs, and Terra Genesis*


# Overview:

- The UMass Carbon Farming Initiative (CFI) is an endeavor of Stockbridge School of Agriculture students and faculty to research and practice regenerative food production at the Agricultural Learning Center (ALC). Beginning in the Spring of 2018, students designed and installed a chestnut-sheep silvopasture with the support of Professors Lisa DePiano and Nicole Burton. Russell Wallack completed the final digital design maps. The project was initiated on the site of  a two acre food forest which was begun in 2016 and left unmaintained.

- In its first season, a nursery was started for seeding chestnuts, year old chestnuts were planted in alleys on contour, and six sheep were rotationally grazed between the rows of chestnuts. Students plan to welcome eight sheep to the land as the project's second season approaches. Priorities include feeding the sheep with onsite resources, improving soil health for chestnut growth, bringing meat to market and cultivating awareness of carbon farming while contributing to the vitality of the ecosystem at the ALC.

# Goals and Objectives

The project's primary goal is to provide hands on learning opportunities for UMass students, achieved through:

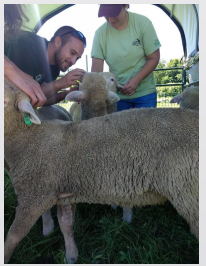
- Hiring 3-5 student research assistants per season who will learn to design, implement and manage the site.
- Building a site which can be utilized as an outdoor classroom to provide experiential learning opportunities.

The project will also establish a demonstration, production, and research site for UMass students and the wider community by;

- Modeling carbon farming practices with first farm-scale permaculture design implemented on campus.
- Producing up to 6,000 lbs. of chestnuts over 10 year period.
- Researching soil carbon levels, field testing hybrid chestnut varietals, and silvopasture livestock management.

And the project will help mitigate climate change through:

- Sequestration of up to 200 tons of atmospheric carbon per acre.
- Researching and advocating for alternative food systems development.



# History and Context

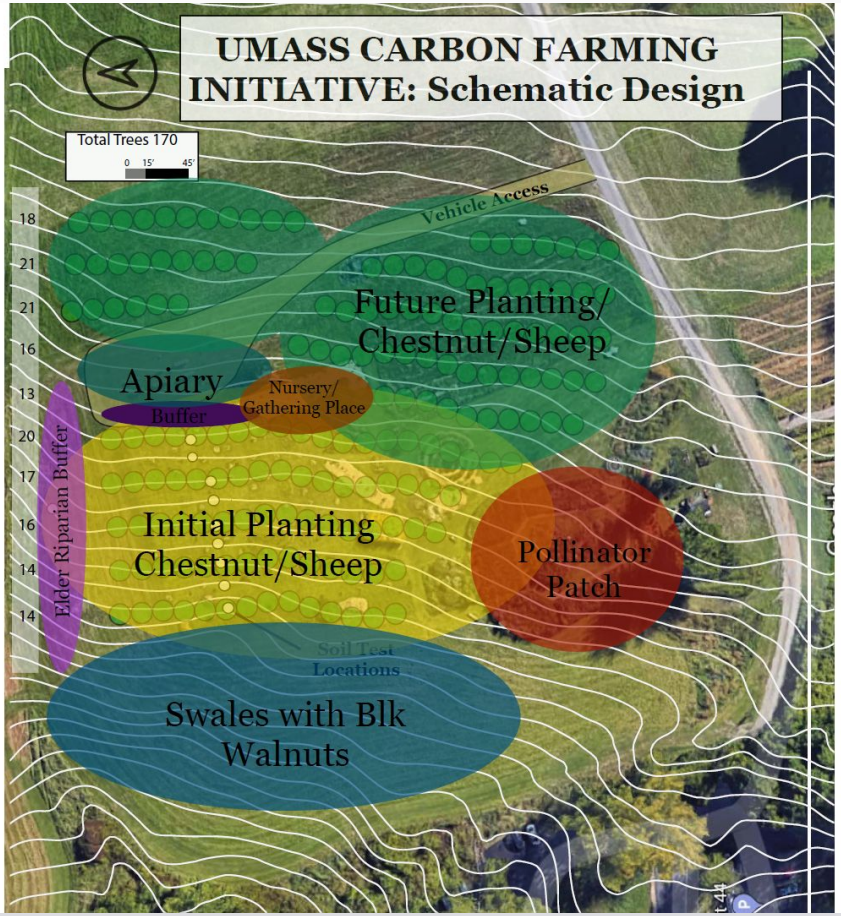
The Agricultural Learning Center is home to various projects. The current CFI site was previously a young food forest which was left unmanaged after the students who initiated the project graduated. The CFI revitalized this land after the recent publication of Project Drawdown, which listed silvopasture as the third most effective global food system solution to climate change. As many farmers can't afford to take the financial risk to implement experimental agricultural practices, more research and demonstration sites are needed to provide replicable models before wider application. Professor DePiano and Professor Burton began collaborating to create this site utilizing the university's resources to model the best sustainable agricultural practices.

UMass Amherst has a long history as an agricultural school, beginning in 1862 when the signing of the Morril Land-Grant Colleges Act displaced the original inhabitants of the land. While many farmers see these as experimental approaches, the practices have origins in traditional ecological knowledge held by indigenous cultures who have significant history in this land and around the world. Contributors to this project acknowledge the Pocumtuc, Norwottuc, Nipmuc, Elnu Abenaki, Pennacook, and Mahican peoples and nations for i) our occupation of their land and ii) their generation and maintenance of this knowledge. Contributors also name these practices with no claim to ownership or authority, but to highlight alternatives to destructive agricultural methods. We make this acknowledgement in solidarity, understanding that it does not rectify the injustice upon which our land tenure is based.

# Design Concept

The final digital design of the CFI site was done by Lisa DePiano and Russell Wallack from Appleseed Permaculture after an initial site design was created by students in the 2018 Permaculture Design practicum course. The design was initially conceptualized by Lisa DePiano with the intention to establish the first temperate-climate silvopasture research plot.

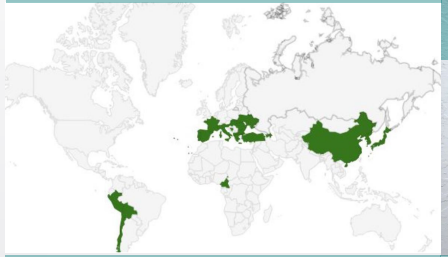
This co-created design concept had several focal points including: rows of chestnuts planted on contour to positively affect water movement on site, incorporation of existing vegetation into the CFI designs, fodder for rotationally grazed sheep pasture, and creating a research site to investigate carbon sequestration rates. Also considered in the design concept was the wetland zone immediately to the north of the site, which could be enhanced as a productive edible riparian buffer zone.



# Why Chestnuts?

Chestnuts, as a global staple, are underrepresented in US agriculture. Currently only ~4,000 acres of U.S. farmland are used for chestnuts, compared to 50,000 acres of farmland in Hampshire County alone.

## Global Context



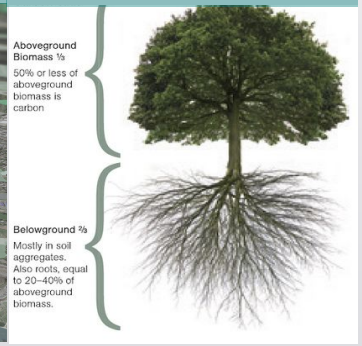
## Culinary Interest

A versatile, nutritionally dense food; chestnuts provide carbohydrates, vitamin C, Magnesium, and Potassium and can be eaten whole or ground as a flour.

The 2018 BioRegional Agroforestry Suitability Analysis reported approximately 104,000 acres in the Connecticut River watershed are potentially suitable for chestnut production.

## Agroecosystem Health


## Carbon Farming




Project Drawdown, a recent scientific analysis of climate change mitigation strategies, listed silvopasture, tree intercropping, and multistrata agroforestry as major opportunities to impact carbon levels through the food system.

# Existing Conditions

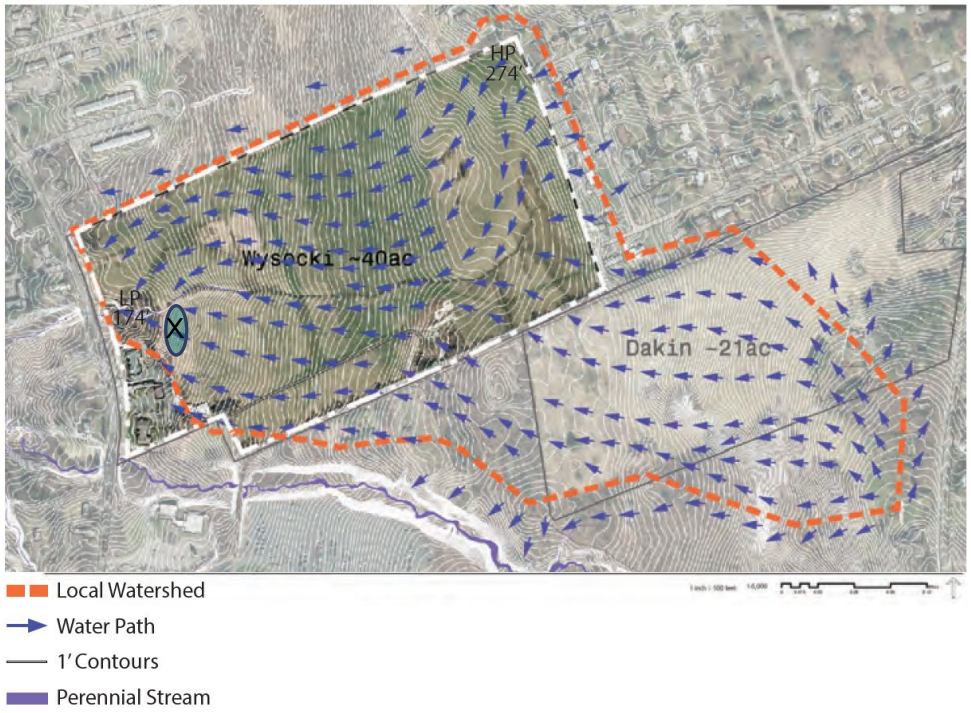
The CFI site is located on the Wysocki field at the Stockbridge School's Agricultural Learning Center. Previously existing on the site of the Carbon Farming Initiative was a student Food Forest project established in 2016. Water conditions have been a focal point at the ALC; Samantha Anderson completed a masters project presenting the water conditions on site at length. Included in the following slides are maps from her presentation of; a) perennial stream features and regional hydrologic context, b) soil types, c) wetlands delineation and d) a slope analysis map.

The site features a nursery, herb spiral, sunchokes, seaberries, raspberries, and other perennial vegetables between alleys of chestnut trees. Contiguous on the north-eastern edge is the Massachusetts Department of Agriculture State Apiary. To the south are pollinator gardens and demonstrational plots run by Stockbridge faculty. To the north is the perennial stream and to the northwest are forested wetlands, both part of the delineated federal wetland zone.

# Water

The hydrologic patterns on the Wysocki Field have significant impact on the CFI site, marked (X) on adjacent map. We accounted for water conditions by incorporating contour planting in our design, and plan to have a greater positive effect on quality of water through planting a riparian buffer zone. Noteworthy features of these maps include: the movement of water from the Dakin Field towards the CFI site, residential areas surrounding fields, and location of the perennial stream to the south.

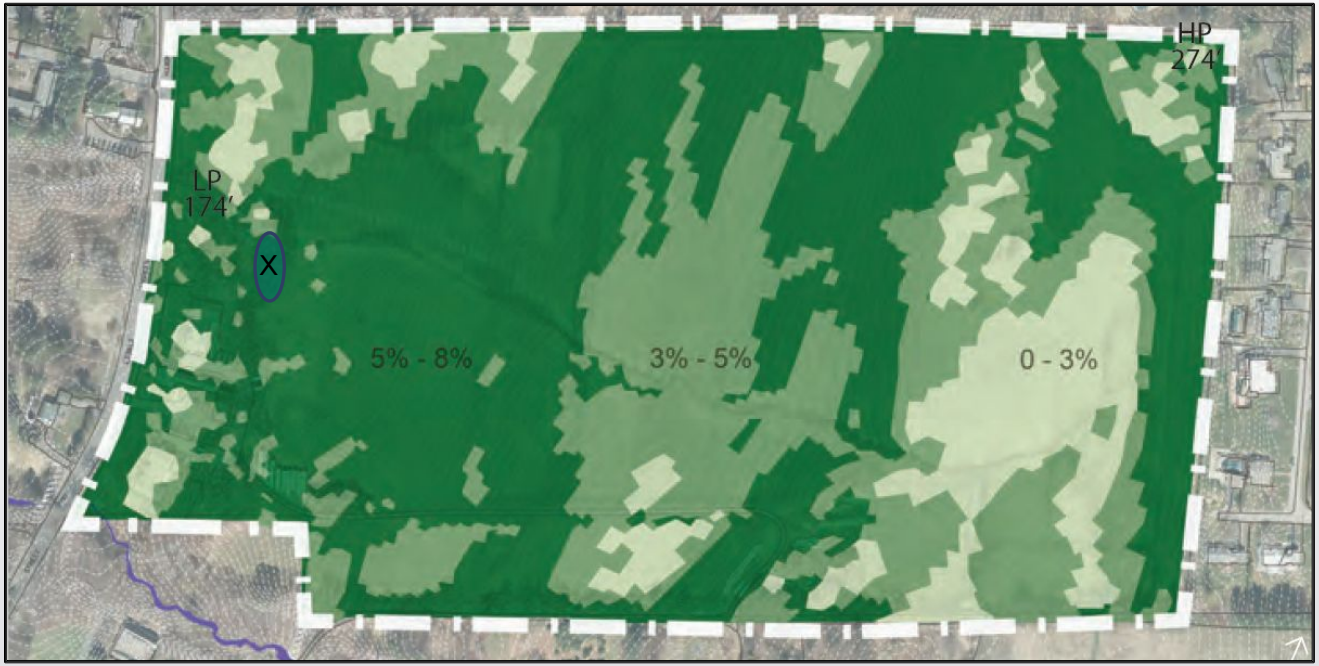

Perennial stream features and regional hydrologic context of Wysocki Field




Existing Hydrologic Patterns
Graphic: Interpreted from the original by Zhuoya Deng

# Slope

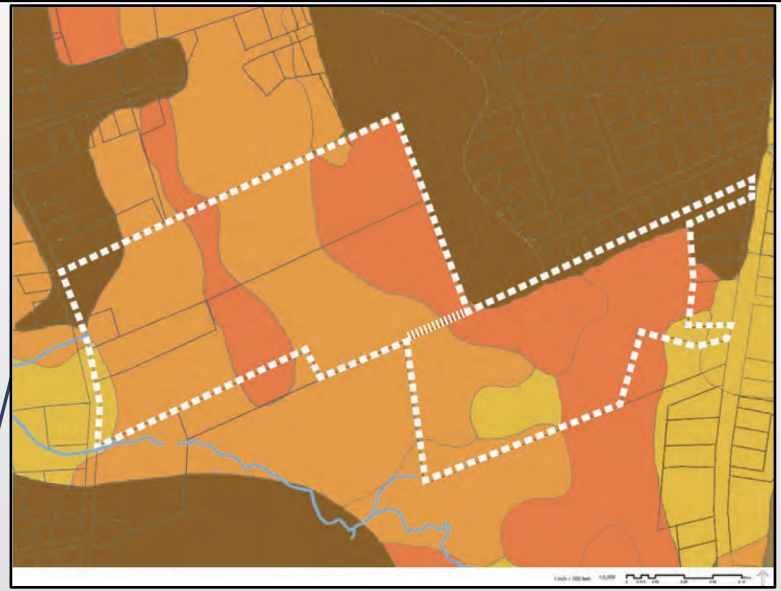
This map shows the slope of the land around the CFI site, marked (x). The site has slopes from 5-8%, and is close to the low point of the field which lies to the northwest at 174'. On account of the water conditions and slope on the site there is very high potential for effective riparian buffer plantings in the near future.

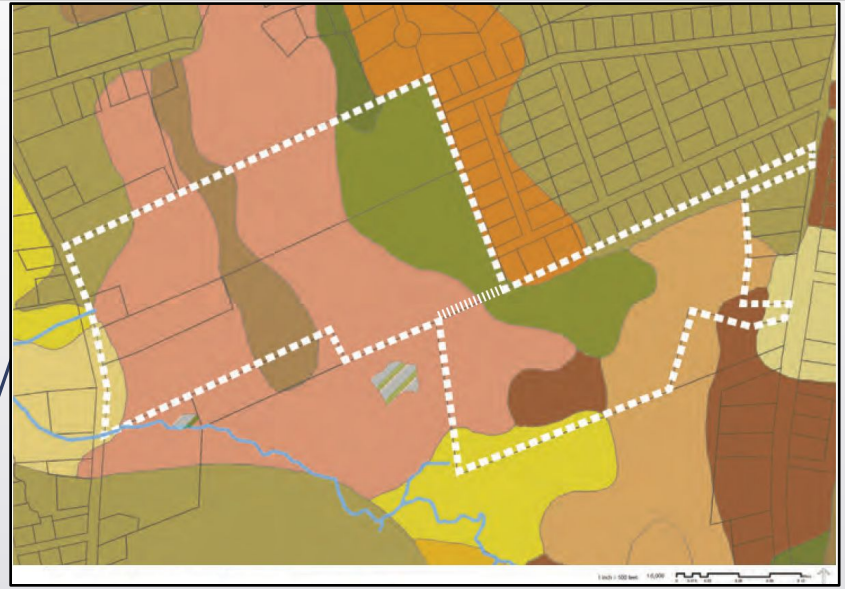



Slope Analysis
Graphic: Zhuoya Deng

# Soil

The ALC is composed of several soil types, with the CFI site consisting mainly of sudbury fine sandy loam. The map on the left groups soils from Group A with low runoff potential to Group D with high runoff potential. The map on the right shows specific soil types.





Group A
Group B
Group C
Group D

**Deerfield Fine Loamy Sand**
Ninigret Fine Sandy Loam
**Hinckley Merrimac Urban Land Complex, Hydric**
**Sudbury Fine Sandy Loam, Hydric**
**Charlton Fine Sandy Loam**
**Scituate Fine Sandy Loam, Very Stony, Hydric**
Merrimack Fine Sandy Loam
**Walpole Fine Sandy Loam, Hydric**
Paxton-Charlton Urban Land Complex
Montauk Fine Sandy Loam
Raynham Silt Loam

*(Orange Highlight indicates presence on Wysocki Field)*
*(Red Lettering indicates Prime Farmland)*
*(Blue Lettering indicates Hydric Soils)*


# Wetland Zones

- The adjacent map shows the federally recognized wetland delineation, with 25' and 50' buffer zones. At the bottom are images of critical points in the site's hydrology patterns. The forested wetlands and culvert inlet are directly adjacent the CFI site.

# Soil Carbon Testing

- For research purposes, it is critical that soil carbon levels are measured throughout project implementation in order to establish best practices for carbon sequestration in temperate climate silvopasture. Initial soil samples were taken in the summer of 2018, and are currently being processed using NOFA's Soil Carbon Proxy Testing Program and by UMass soil scientist Dr. Marco Keiluweit. Working with both Dr. Marco Keiluweit, Assistant Professor of Soils and the Environment at UMass, and NOFA Mass' Soil Carbon Proxy Testing Program diversifies our analysis methodology.

- This two-pronged approach is important, as they utilize unique methodologies to gather different data. The synchrotron-based tests conducted by Dr. Keiluweit measure soil carbon levels directly, while the NOFA tests measure soil biodiversity as an indicator of carbon sequestration. The relationship between carbon sequestration and soil biodiversity is complex, and more research is needed to understand the connection between soil carbon levels and biodiversity.

# Design Implementation

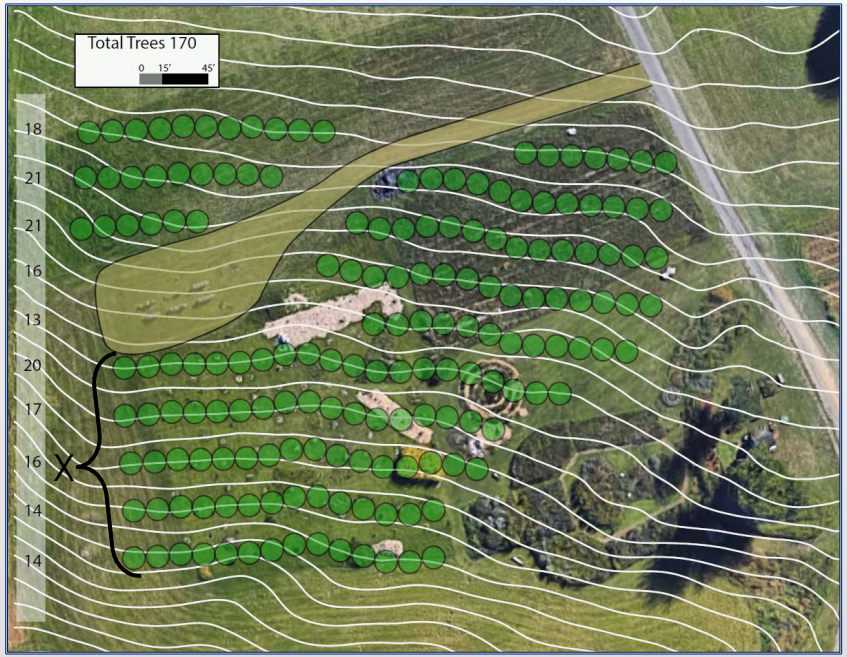
Implementation of the CFI project was initiated in the summer of 2018 by Lisa DePiano with the help of Russell Wallack and a crew of 3 undergraduate research assistants; Trevor Brown, Sofia Cincotta, and Jack Stambaugh.

Initial work included planting out a nursery with hundreds of stratified chestnut seeds and dozens of year old chestnuts saplings, measuring and marking contour lines for planting, digging and replanting existing vegetation on contour, then planting the first 100 of our year-old saplings on the contour lines.

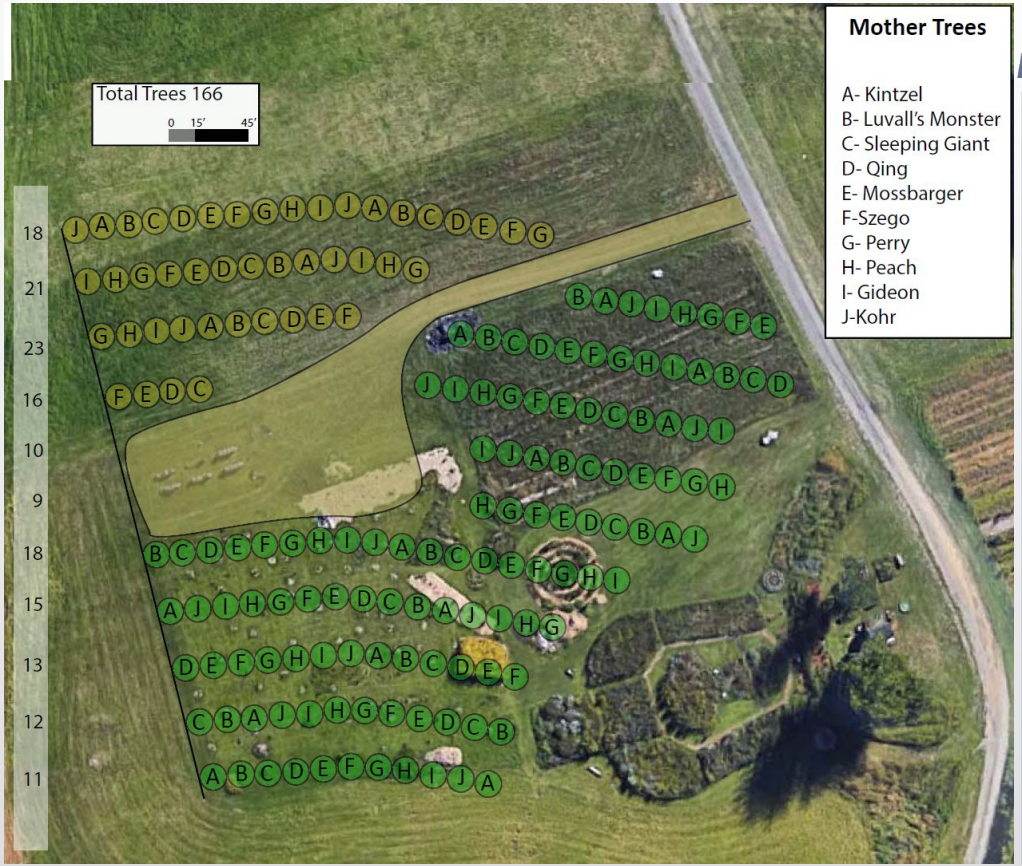
# Design Implementation (Cont'd)

After planting, research assistants mulched each row of trees with wood chips to reduce weed competition with newly planted trees, then helped Nicole Burton to manage the rotationally grazed sheep through the alleys between rows of chestnuts for the rest of the season.

# Design Detail: Contour Planting




Planting on contour is central to our land management strategy, having taken water into account when deciding where to place chestnut alleys. So far, 5 rows have been planted, marked (x). Integrating plants with landform in this way prevents erosion by slowing water as it runs downslope. Instead of quickly moving past the trees as runoff, water collects at the rows and is absorbed into the ground. This reduces irrigation needs as well as erosion, and can impact large-scale hydrologic patterns on site.



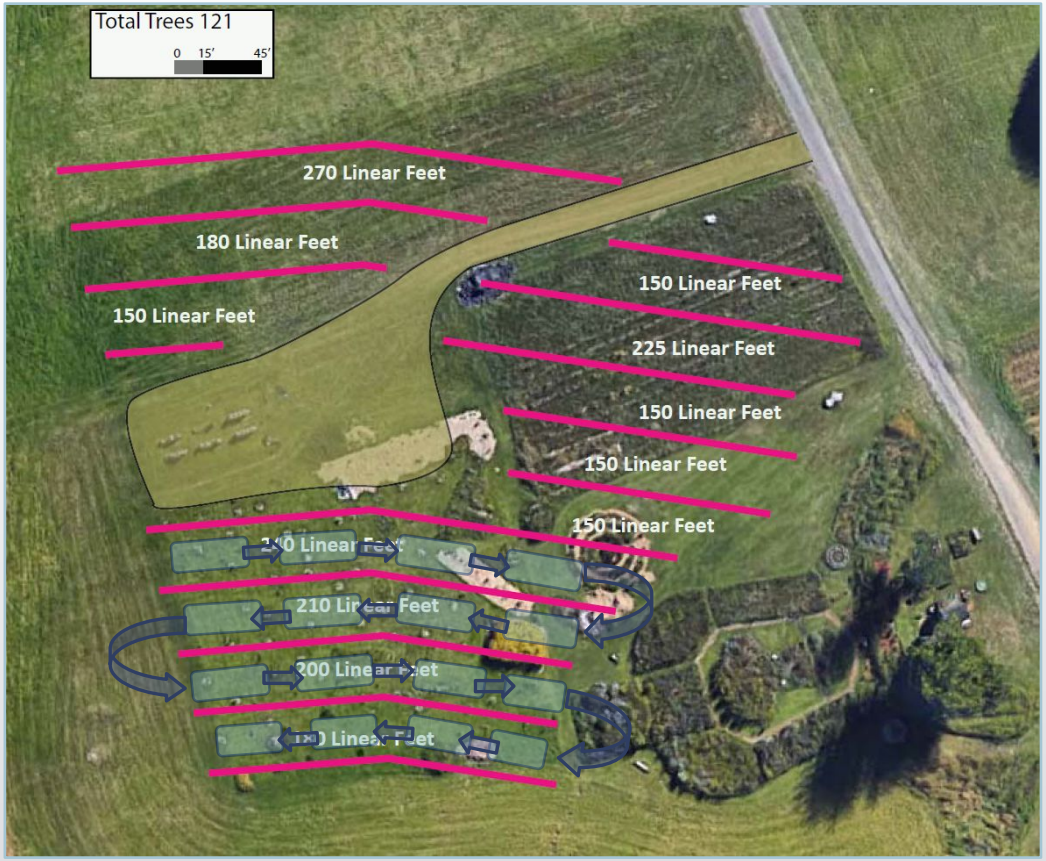

# Design Detail: Hybrid Chestnut Planting

10 varieties of Hybrid Chestnuts, labeled A-J, were collected from a nursery in Ohio to test on site. Our team will assess factors including cold hardiness, water tolerance, productivity, nut flavor and size, and other observable differences between varieties.

# Design Detail: Rotational Grazing Paddocks

The CFI employs rotational grazing to ensures that sheep get a balanced diet, that the pasture isn't overgrazed, and assists a beneficial relationship with soil microbes and root growth to heighten carbon sequestration potential.

During the summer of 2018 6 sheep were grazed in a paddock protected by electric fences with a mobile shelter. The shelter was moved across the alleys, approximately highlighted in teal on adjacent map. They were rotated to a new piece of land every few weeks, depending on size of paddock and density of available forage.



# Plant Palette:

The following two slides contain tables of all the plants which have been planted at the CFI site. Their niche location refers to their placement in the seven layers of a forest garden. Following is a map marking approximate locations of these plants in the field. Special thanks to Serena Hooper for initially compiling this list.

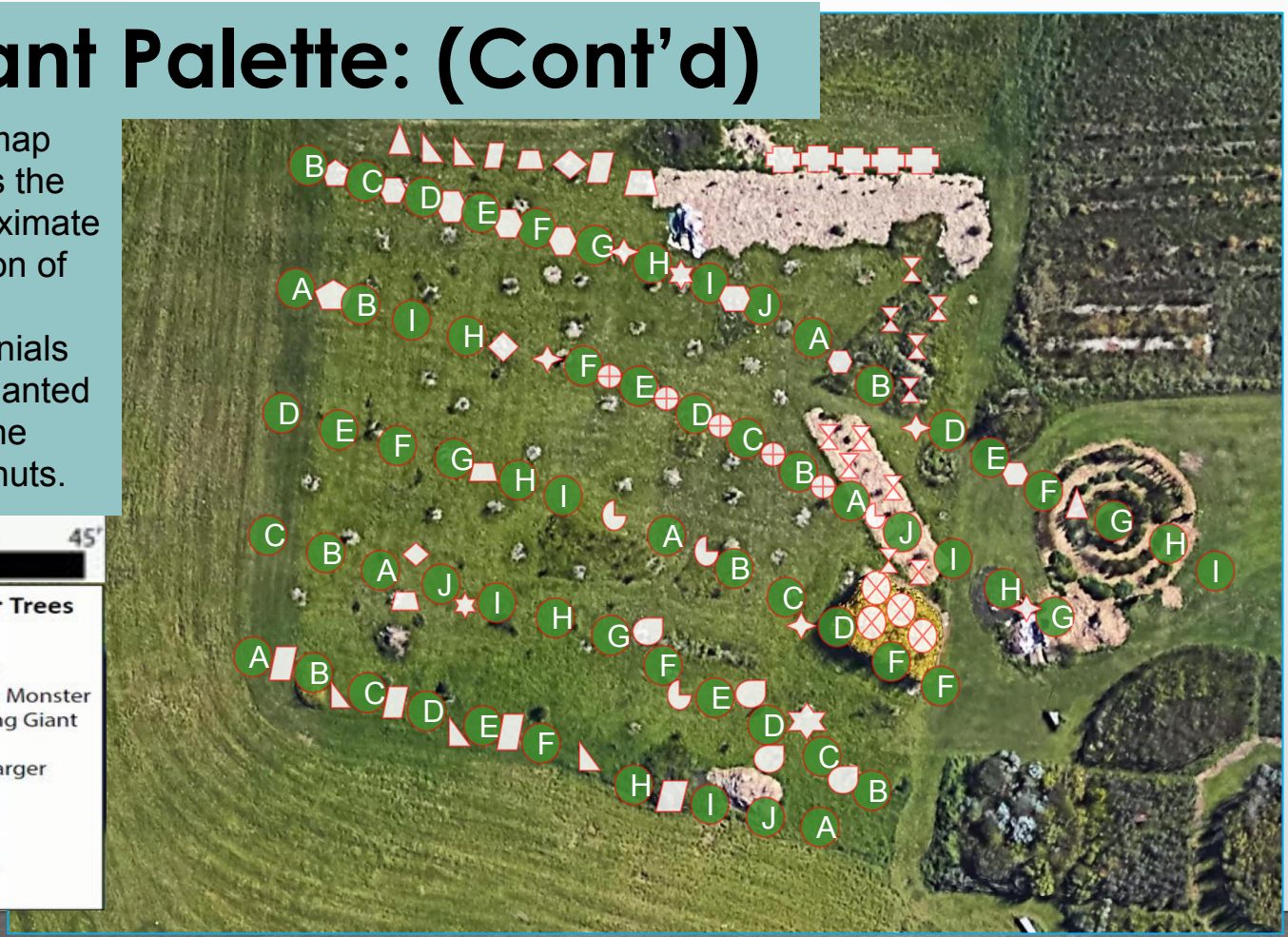
| Plant Name | Niche Location | Habitat and Conditions | Uses and Design Notes | Plant Name | Niche Location | Habitat and Conditions | Uses and Design Notes |
|---|---|---|---|---|---|---|---|
| Alder | 1,3 | Tolerate dry but prefer wet soils. Found near rivers, streams, wetlands. | Nitrogen Fixer, erosion control, medicinal, good coppice, pioneer species | Bayberry | 2 | Prefers dry to moist well-drained soils, acid to neutral soils, tolerates high salinity | Nitrogen fixer, edible fruit, produce wax for soap or candle making. |
| Cornelian Cherry | 2 | Full sun, medium moisture | Early season nectary, edible fruit | Rugosa Rose | 3 | Full sun to partial shade. Prefer slight acidity. Rich, well-drained soil. | Edible, medicinal, good hedgerow. |
| Hybrid Chestnut | 1 | Full sun, prefers well drained soils | Many varieties planted. Edible nut, shade for sheep, habitat, pollinator plant. | Pink Currant | 3 | Damp soils, prefer low acidity, grows from full sun to partial shade. | Edible fruits, dyes, medicinal. |
| Witch Hazel | 2 | Full sun to partial shade, prefers acidic soils, tolerates variety of moisture conditions | Medicinal | Sunchoke | 5, 6 | Alkaline soil preferred, grow in wide range of soils and light conditions | Edible tuber, biomass accumulator, high yielding food crop. |

# Plant Palette: (Cont'd)

| Plant Name | Niche Location | Habitat and Conditions | Uses and Design Notes | Plant Name | Niche Location | Habitat and Conditions | Uses and Design Notes |
|---|---|---|---|---|---|---|---|
| Seaberry | 3 | Full sun preferred, well-drained soils. Prefers balanced, slightly acidic conditions | Nitrogen fixer, wildlife habitat, pioneer species, medicinal, edible fruit | Serviceberry | 2 | Wide range of soil types and pH, tolerates full sun to part shade | Wetland plant, wind-hardy, good understory plant, beneficial insectary |
| Raspberry | 3 | Full sun, rich, well-drained soil. | Edible fruit, medicinal | Chokeberry | 3 | Prefers full sun, tolerates moist to dry soils. | Medicinal, habitat plant, wetlands plant |
| Spicebush | 3 | Wet woods and streams. Sandy or peaty soil. | Useful as condiment/tea, medicinal, insect repellant | Winterberry | 3 | Full sun, tolerates wet soils. | Bird habitat, fruit poisonous to humans |
| Buffalo Berry | 3 | Full sun to partial shade | Nitrogen Fixer | Siberian Pea Shrub | 3 | Dry or moist soil, well drained soil. Full sun. Drought resistant. | Nitrogen Fixer, edible fruit, seed, flower. Potential fodder crop. |
| Silky Dogwood | 2 | Partial shade to full sun. Tolerates moderate acidity. | Windbreak, erosion control, wildlife habitat, riparian improvement. | Elderberry | 3 | Moist or well-drained soil. Full sun preferred. | Biomass accumulator, erosion control, edible berries, medicinal. |

# Plant Palette: (Cont'd)

This map shows the approximate location of the perennials interplanted with the chestnuts.




| Plant Palette | Symbol |
|---|---|
| Chestnut (Lettered by variety) | |
| Siberian Pea | |
| Hazlenut | |
| Alder | |
| Comfrey | |
| Bayberry | |
| Dogwood | |
| Krimsk Cherry | |
| Buffalo Berry | |
| Chokeberry | |
| Cornelian Cherry | |
| Raspberry | |
| Seaberry | |
| Sunchoke | |
| Pink Currants | |
| Rugosa Rose | |

# Future Vision

The Carbon Farming Initiative is an example of what humans can do to contribute to the regeneration of this planet while meeting their needs. It is a productive, biodiverse ecosystem which is used by humans to trial chestnut varieties, empower students as land stewards, research financial viability and carbon drawdown potentials of temperate climate silvopasture, provide genetic material and research results to local farmers, and improve awareness of and access to regenerative agriculture in several communities. It annually engages hundreds of students, farmers, researchers, and community members, and produces bountiful harvests of several chestnut varietals, specialty meats, & medicinal herbs, all while providing a pollinator's haven, preventing erosion, building soil, and sequestering at least 200 tons of carbon per acre.