106ème Promotion

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NUTRIENT MANAGEMENT AT UNADILLA COMMUNITY FARM

Internship synthesis note

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UNADILLA COMMUNITY FARM
United States of America

I. INTRODUCTION OF THE FARM

Unadilla Community Farm (UCF) is a non-profit fruit and vegetable farm (*Rachel ARMSTRONG, Erin HANNUM, Laura FISHER, Lisa SCHLESSINGER 2017*), cultivating 1 acre (*cf Appendix 1)* while employing no-till and organic practices. They have created a “Food Forest” with over 160 varieties of crops, most of which are perennial. The farm was started in 2014 by eight friends who met while working and volunteering on organic farms. Their wish was to create an educational farm to teach sustainable farming practices while helping those in need by donating their produce. Today, most of the farm's founders serve on the board of directors, Ben Tyler is the only founder still living on the farm as project manager and farm manager. The farm operates thanks to government and foundation grants available to non-profit farms and donations from companies and individuals. Their produce is donated to non-profit food pantries and herbalists. This corresponds to over $100,000 in 2024 alone.

II. PRESENTATION OF THE FARM

A. GEOGRAPHICAL PRESENTATION

UCF is in the United States, in the Central region of New York State. It is in Otsego County, in the hamlet of West Edmenston. The main cities are Utica (28 miles away) and Norwich (25 miles away). New York City is 206 miles away (4 hours by car). The hamlet where the farm is located has 250 inhabitants and at least as many Amish who are not counted in the national census. The region is predominantly agricultural, with mostly dairy farms, hay, and monocultures of corn and soybeans to feed the cattle. There are also many pine and fir plantations. The United States Department of Agriculture (USDA) describes the region as a “low-income, low access, food desert.” This designation indicates that the region is economically disadvantaged (low income), the nearest supermarket is more than 10 miles away (rural food desert), and a significant portion of the population does not have access to a vehicle (low access). This has a major impact on the farm, which has seen the number of people in need in the region increase considerably since it was set up 10 years ago.

B. GEOLOGICAL AND CLIMATIC PRESENTATION

Regarding geological and geographical context, UCF straddles 2 soils: Riverhead (balanced loam) and Herkimer (sandy loam) (*cf Appendix 2*). These soil types can be prone to excessive drainage and crusting *(cf Appendix 3*), but the farm, with different soil amendments, manages to counter the negative effects of these soil types. Secondly, the farm is in a mountainous area, at the bottom of a valley, at an altitude of 426m. In addition, the farm has a USDA Zone 4 climate (*cf Appendix 4*), meaning an extreme continental climate. Temperatures can reach 90 degrees Celsius in summer and drop to -20 degrees Celsius in winter. The first frosts begin in early September and end in early June. The climate and altitude are not ideal for market gardening, so the farm had to come up with some strategies to extend the growing season and protect themselves from the elements. Finally, the region's rainfall is 106 cm per year. This covers half of the crop's water needs; the rest is managed by drip irrigation, which is powered by a pump that recovers water from a spring-fed creek, which runs through the farm. This pump, like all the farm's power tools, is powered by solar panels.

25 percent of the land area in production is in annual vegetables. These include garlic, turnips, radishes, cucumbers, tomatoes, lettuce, etc. The remaining 75 percent of the farm is in perennial crops, in the form of a food forest. A food forest is a form of agriculture that replicates a young forest. It is made up of 7 vertical layers in symbiosis with each other, ranging from low-growing herbaceous ground covers to a forest canopy of fruit and nut trees (*cf Appendix 5*). The plants are perennial and therefore, the maintenance can be very different from the annual vegetable production. Moreover, the farm follows the precepts of permaculture and organic farming. This means that it aims to produce food and have an economically stable

farm while respecting the farm's biodiversity. The idea is to work with nature rather than against it, and so minimize the harmful effects of modern agriculture. However, with the many parameters set out above, we can see the challenges that this type of agriculture can bring, particularly in the management of the nutrients needed by the plants. Indeed, we can ask ourselves how a permaculture farm like UCF manages its soil fertility. We will thus review the different practices implemented by UCF to support the nutrient needs of its annual and perennial beds, and how the farm adapts its strategies for different types of plants while adhering to sustainable, no-till, and organic farming principles.

III. NUTRIENT MANAGEMENT OF UCF

A. CROP ROTATION and COVER CROP:

Crop rotation consists of the succession of crops on a bed. Rotations can be of varying lengths, based on crop family, and their role is to manage pests and nutrients in the field. At UCF rotations are only on the annual beds. They are 2 to 3 years rotations, depending on the plant family. Regarding nutrient management, crop rotation is beneficial because “crop rotation that integrates deep-rooting crops with less-nutrient efficient crops and help cycle nutrients in the soil profile” (*Charles L. MOHLER, Sue Ellen JOHNSON, editors, 2009*). Rotation therefore helps to avoid creating deficiencies in the soil. It homogenizes all beds and simplifies soil amendment. UCF also includes cover crops in its crop rotation. These are plants seeded in between crops to improve the soil and reduce weed pressure. The farm has chosen Poaceae-Fabaceae mixes. It's a classic type of mix that's interesting because, on one hand, Fabaceae plants are nitrogen fixers that help to fertilize the soil and, on the other hand, Poaceae plants will absorb the nitrogen fixed by the Fabaceae plants and keep it until the cover crop is terminated. When they die, they give the nitrogen back to the soil as they decompose. The Poaceae encourages the Fabaceae to fix more nitrogen and store it for the next crop. The farm interplants oats and winter peas, which they seed in early autumn. These plants are not resistant to temperatures below -8 °C, so they will die over winter. This allows this no-till operation to transplant directly into the mulch formed by cover crop residues when spring arrives. Moreover, you should “consider mixing oats with an overwinter legume if your objective is to maximize N contribution to the next crop” (*CLARK Andy, 2007*). They also interplant winter rye and hairy vetch, cover crops that survive temperatures down to -30 °C. It makes them hardy to survive the winter in Central New York and allows them to keep beds in cover crop longer if they're not planting new crops in early spring. It is a typical pair to seed because the legume will help with “rye’s tendencies to tie up soil nitrogen in spring” (*CLARK Andy, 2007*).

B. AMENDMENTS:

UCF follows organic practices. For this reason, it uses only OMRI-listed amendments or raw minerals from the earth. Thus, they use OMRI-listed organic corn gluten meal for N, potassium sulfate for K, and rock phosphate for P. They also apply compost, which is a good way to raise your pH (compost is alkaline) and increase your organic matter and soil nutrients in your field - but you must be careful of excess. They use municipal compost because it’s cheap, but it is not the best quality of compost. Applied in too much quantity, it could cause ‘soil obesity’, when the soil has excesses of nutrients, especially phosphorus which their municipal compost is high in. The quantity of soil amendments applied is determined by soil tests made each year, which are used to determine the amendment plan for the following year.

For the annual beds, the amendments are usually applied after harvesting one crop, when the soil is prepared for the next crop. Because UCF follows no-till practices, amendments are spread evenly by hand and then incorporated into the soil with a wheel hoe, a tool that allows cultivation at 1-3 inches deep, which is the maximum depth for cultivation on no-till farms. As for the perennial beds of the food forest, the amendments are usually applied as a “top dress” in the spring before plants emerge.

C. MULCHING:

UCF has chosen to mulch with locally sourced fresh woodchips. There are several reasons for this choice. Firstly, the region is forested, so they were able to establish good relationships with tree services, permitting them to obtain mulch at a very low cost. Secondly, using fresh woodchips creates a shell on the beds, helping to suppress weeds. Thirdly, woodchips are a good source of organic matter and nutrients for soil composition and the microbes and fungi living in it. "Mulching is a variation on nature's way of building soil by accumulating and breaking down organic debris from the top down" (*Toby HEMENWAY, 2009*).

In annual beds, mulching is done after seedling emergence or transplantation to not mix the woodchips with the soil. That would trap the nitrogen for 3 years, which is the time of decomposition of the woodchip mulch. In the perennial beds of the food forest, the woodchip mulch is spread following the "lasagna gardening" style: every year, they add additional layers of woodchips on top of last year's woodchips. This helps elevate the level of the raised beds and creates new organic matter as lower layers of woodchips decompose.

D. NUTRIENTS CYCLING IN THE FOOD FOREST:

One of the main ways food forests manage plant nutrients is by preserving the nutrients already in the soil. To achieve this, UCF practices nutrient cycling with the help of several types of plants. The farm uses a technique called "chop and drop" to cycle their nutrients. This technique involves cutting down the foliage of certain plants and giving them back to the soil so that it can recover the plant's nutrients. It allows farmers to give back to the soil nutrients that would normally be lost through off-gassing, leaching or runoff, and thus removed from the nutrient cycle.

Some plants are essentially grown for this reason. They support cash crops such as apple, cherry, and plum trees, which need more nutrients to be more productive. Those particular "chop and drop" plants are interesting because they can accumulate high concentrations of specific nutrients. They are called dynamic accumulators. These plants can recover nutrients from the deeper horizons of the soil and accumulate them in their tissues. So, when the top of the plant is cut, it allows the accumulated nutrients to be assimilated in the first soil horizons as the plant tissue decomposes. This makes certain nutrients more available to the plants in the row where the process is done. For this reason, UCF cultivates comfrey, a dynamic accumulator of nitrogen and potassium, and nettle, which accumulates calcium.

UCF has also planted the food forest with a lot of plants from the Elaeagnus family such as sea buckthorn, autumn olive, silverberry, and buffaloberry. In addition to being cash crops, these plants are also nitrogen fixers. These plants, through symbiosis with the fungi Frankia, can make atmospheric nitrogen bioavailable. This is a very interesting skill, as nitrogen is a highly mobile nutrient, and commonly lost through off-gassing, leaching, and runoff, but it is also one of the main nutrients required for plant growth, due to its role in photosynthesis. Therefore, plants from this family are placed in the same rows as other cash crops to enable them to continuously have nitrogen. Moreover, to increase nitrogen production on a plot, UCF grows a nitrogen fixer (sea buckthorn), a nitrogen dynamic accumulator (comfrey), and a cash crop (apple) on the same bed. The nitrogen fixer coupled with the dynamic accumulator will optimize the quantity of nitrogen available for the apple tree. They calculate the number of square meters of nitrogen fixator plants they need to supply their soil following Martin Crawford's method (*cf Appendix 6*) (*Martin Crawford, 2010*).

As described earlier, this same process is used by UCF in annual beds with Poaceae-fabaceae cover crop pairings, where a heavy feeder will encourage the nitrogen fixer to produce even more nitrogen. The difference is that for annual beds, the nutrient is returned to the soil by killing the cover crop, whereas for perennial beds, it's only through chop and drop and the cyclical dieback of roots during winter that nitrogen is returned to the soil.

E. TAKING CARE OF THE SOIL:

Before amending the soil and integrating nutrient-cycling plants, one of the main ways of having a productive farm and the quantity of nutrients required by each plant is to take care of the quality of the soil. Soil structure and texture have an impact on nutrient retention and availability. Clay-humus complexes, for example, help retain nutrients in the soil. We can also think about the micro-organisms living in the soil helping to create humus and to stabilize the soil. At Unadilla Community Farm, soil quality is managed using no-till practices. This involves growing in permanent raised beds and never cultivating deeper than 3 inches. Soil life such as earthworms and fungi mycorrhizae, roots, and beneficial soil bacteria are this way spared. The soil then creates a balance that is beneficial to its structure and texture. If working the soil is still necessary, it can be carried out using a shallow cultivator to prepare for seeding beds, or with a broad fork to aerate and decompact the soil without turning it over or destroying the balance of soil life.

In addition to no-till agriculture, Unadilla Community Farm’s food forest contains creeping ground cover and living mulch plants. These plants have a beneficial effect on soil microorganisms and structure, by keeping the topsoil moist, cool, and shaded. The creeping ground covers used by the farm are mainly from the Lamiaceae family and are propagated by rhizomes. Living mulch, often rosette plants such as comfrey or horseradish, have the advantage of creating mulch without human help: the lower leaves, shaded by the upper leaves, die and fall to the ground, creating mulch. These plants also have other numerous advantages for the food forest, such as being pollinator attractors, aromatic pest confusers, and soil biofumigants (*Toby HEMENWAY, 2009*). Many of these plants are valuable cash crops on their own as well.

IV. CONCLUSION

To sum up, the farm's principle is to practice sustainable agriculture, respecting its soil and the biodiversity present on the farm. UCF has developed some techniques to manage the nutrient requirements of its food forest and annual bed, in keeping with the farm's philosophy. First, this involves managing soil quality with no-till farming, accompanied by regular checks on soil properties through numerous soil tests, which are then used to amend the soil accordingly. It also involves frequent mulching of all types of beds to increase the amount of organic matter in the soil. Finally, the farm takes great care not to create deficiencies with these crops, so the farm has set up multi-year family rotations in the annual beds and has introduced many nutrient-cycling plants into the perennial beds of the food forest, whose main role is to maintain stable soil fertility (*cf Appendix 7*). Thanks to all these nutrient management strategies, UCF can run a healthy, productive farm while respecting its values.

About the Author: Louise Fourcade is a master’s student at the University of Purpan in France. She completed an internship at Unadilla Community Farm in the summer of 2024.

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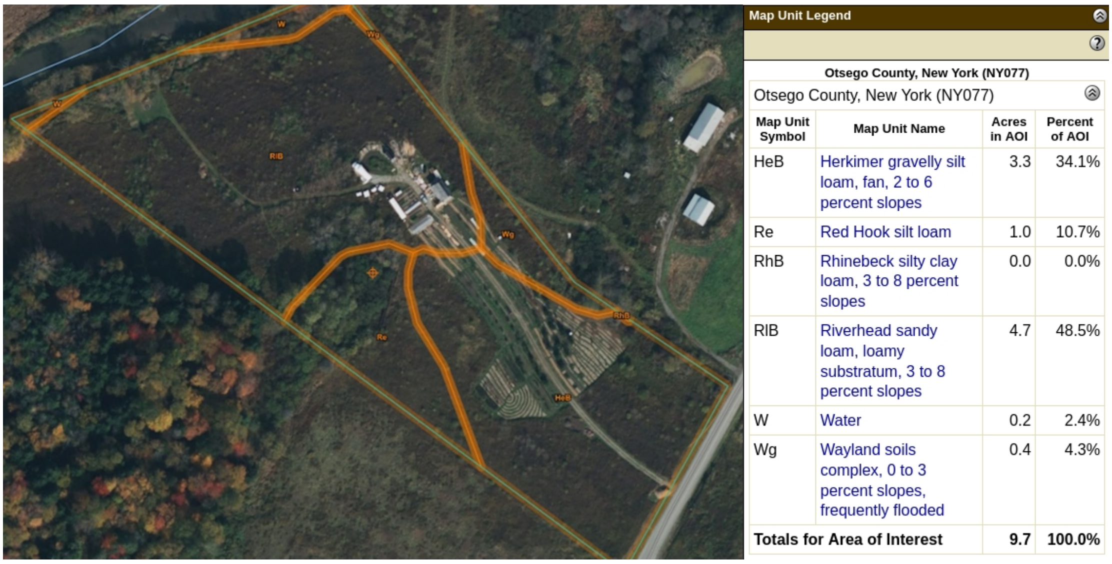
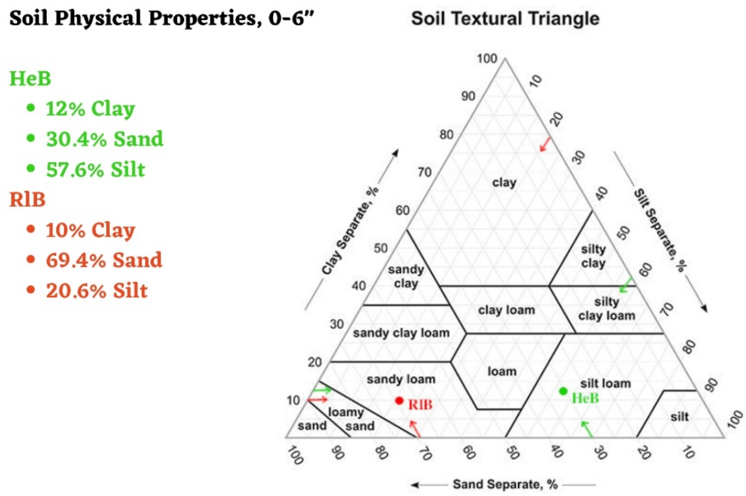
VI. APPENDICES

Appendix 1 : GIS imagery of the farm (USDA.gov, 2019)

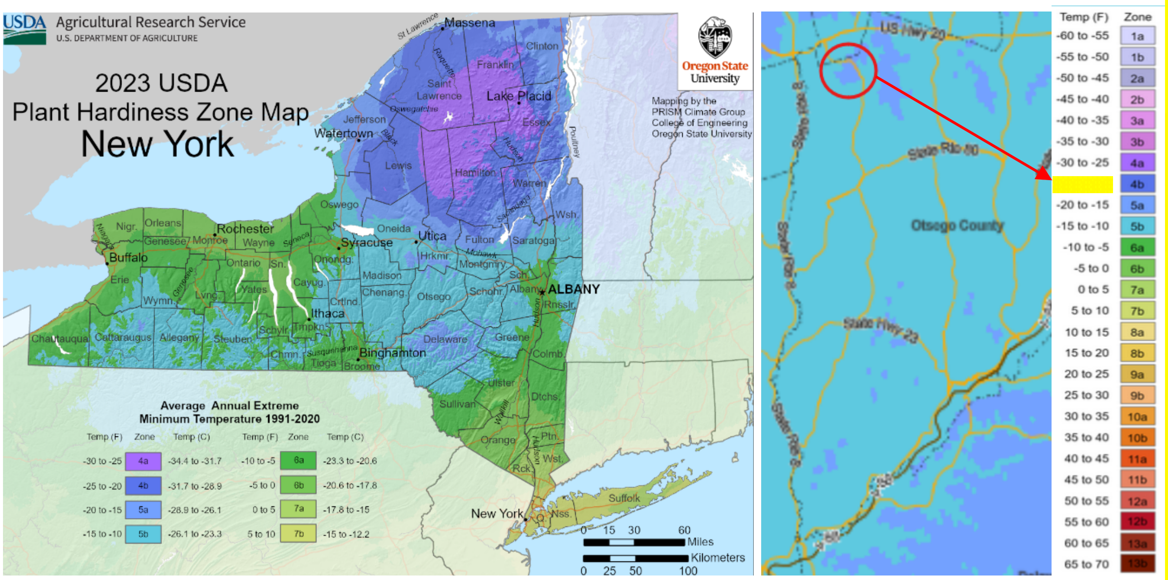


Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
HeB	Herkimer gravelly silt loam, fan, 2 to 6 percent slopes	3.3	34.1%
Re	Red Hook silt loam	1.0	10.7%
RhB	Rhinebeck silty clay loam, 3 to 8 percent slopes	0.0	0.0%
RlB	Riverhead sandy loam, loamy substratum, 3 to 8 percent slopes	4.7	48.5%
W	Water	0.2	2.4%
Wg	Wayland soils complex, 0 to 3 percent slopes, frequently flooded	0.4	4.3%
Totals for Area of Interest		9.7	100.0%

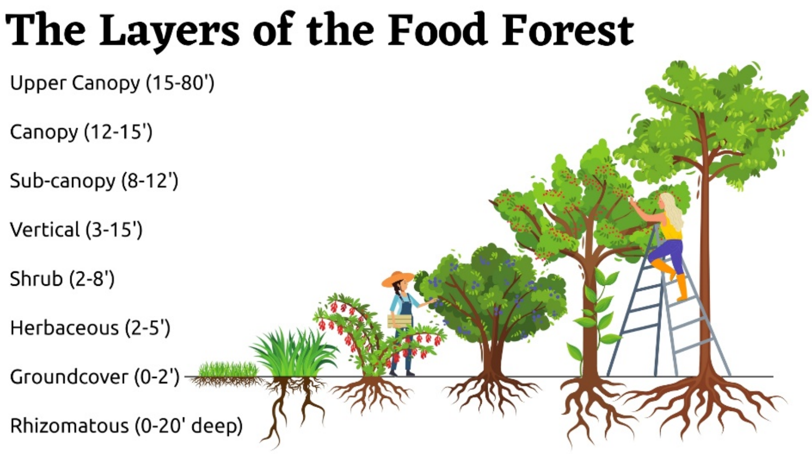
Appendix 2: Soil texture of the farm and its legend (USDA.gov, 2019)



Appendix 3: Soil textural triangle of UCF (Ben Tyler, 2022)



Appendix 4: 2023 USDA Plant hardiness zone map focusing on UCF region (USDA, 2024)



Appendix 5: The layer of the food forest in UCF (Ben TYLER, 2022)

Nitrogen Requirement & Supply

Source: Martin Crawford's "Creating a Forest Garden" (pages 51-66)

NITROGEN SUPPLY TO SUSTAIN CROPPING				
		Annual requirement		
Supply of nitrogen	Nitrogen (N) content	Moderate croppers: $2g/m^2$. Amount of N supply per m^2 =	Heavy croppers: $8g/m^2$. Amount of N supply per m^2 =	Annual vegetables: $28g/m^2$. Amount of N supply per m^2 =
Nitrogen fixer in full light	$10g/m^2$	$0.2m^2$	$0.8m^2$	$3m^2$
Nitrogen fixer in part shade	$5g/m^2$	$0.4m^2$	$1.6m^2$	$6m^2$
Human urine	5.6g/pee	½ pee	1½ pees	5 pees
Manure	6g/kg	0.3kg	1.3kg	4.5kg
Compost	5g/kg	0.4kg	1.6kg	5.5kg
Comfrey mulch (single cut)	0.5g per cut	4 cut plants	16 cut plants	60 cut plants
Fresh seaweed	2g/kg	1kg	4kg	14kg

Appendix 6: Martin Crawford's method to calculate the nitrogen requirement on a row (Martin Crawford, 2010)

Appendix 7: Photo collage with Carine Lemire's photographs of the farm and its legend

1: Cultivation no till with a wheel hoe to prepare the bed for garlic plantation

2: Soil testing of a bed of annual vegetables for Kansey Agriculture Services

3: Mulching with woodchips a bed of oats and peas

4: Harvest of the sea buckthorn, a plant from the Eliagnus family

5: Comfrey flower, a dynamic accumulator with apple trees, the cash crop it helps in the back

6: Direct seeding of oats and peas after the harvest of the garlic on an annual vegetable bed