Project Report presented to the TSF Foundation

Developing Agroforestry Options for Agriculture and Research: Alley Cropping on Marginal Lands for Farm Diversification

Submitted by:

Kenneth W. Mudge
Associate Professor of Horticulture
Department of Horticulture
13 Plant Science Building
Cornell University
Ithaca, NY
607-339-6950, kwm2@cornell.edu

Melissa Madden
Organic Farm Coordinator
CU Agricultural Experiment Station
147D Plant Science Building
Cornell University
Ithaca, NY
607-351-3313, mam233@cornell.edu

In our 2008 application for TSF funds, we intended to address marginal space Dilmun Hill Student Farm, based on our understanding that many farms in New York experience similar challenges ranging from poor soils, legacy concerns from previous management, and the need for farm diversification. Based on the combined interests of the Student Farm in producing high-quality seasonal produce and the adjacent MacDaniels Nut Grove in furthering research and extension in agroforestry, Horticulture Professor Ken Mudge and Organic Farm Coordinator Melissa Madden decided to pursue a new agroforestry collaboration. Previous agroforestry plantings at Dilmun Hill have had varied success due to lack of management continuity as students active in the Dilmun farm change from year to year. By incorporating the new agroforestry system into both the management of the Nut Grove and Dilmun Hill, we have created a continuous management pattern to stabilize both knowledge and site use. As of this writing, students have taken responsibility both for the management of the alley ways between trees and the design of the in-row spaces (between both hazels and maples).

An important goal of the project was to give students and other volunteers an opportunity for experiential learning by contributing to the development of an alley cropping agroforestry system at Dilmun Hill. Alley cropping involves rows of trees and/or shrubs interplanted with non woody crops like vegetables, medicinals and small fruits (berries, etc.). The two initial, or "keystone", woody components of the alley cropping system are hybrid hazelnuts and red and sugar maple trees. While integrated into a single alley cropping system, these three species were used to investigate two different sets of questions involving management of alley cropping systems. In the hazelnut planting we addressed two specific problems including 1) rodent damage to the seedlings due to stem girdling, and 2) weed competition and management of soil organic matter within and between tree rows. The maple planting was intended to evaluate an innovative approach to sustainable agroforestry production of logs in the alley cropping system, to be used subsequently as substrates for the cultivation of gourmet mushrooms (shiitake) at the adjacent MacDaniels Nut Grove forest farming site.

Figure 1. Location and physical layout of the Alley Cropping system established at the Dilmun Hill Farm, 2008.

Following are summaries of the project outcomes for each of the 3 main objectives described in the original proposal.

Objective 1: Determine the most effective hazelnut management strategies to ensure post-planting survival, seedling growth and rodent control.

We employed two different strategies for managing rodents in the hazelnut plantings- 1) a cover crop of buckwheat and 2) mulching within tree rows with hardwood bark mulch to a depth of 6 inches. Within each of these two main plots 12” long plastic guards (rodent barriers) were placed around stems of half of the seedlings while the other half remained “unguarded”. Guard (G) and non guard (NG) seedlings were planted randomly as shown on the map in Figure 1. At three times over the course of the summer (at planting 6.05.08, midsummer 7.20.08 and mid-fall 10.16.08), data was collected for each seedling to determine seedling survival, height and stem diameter (1" above soil line).

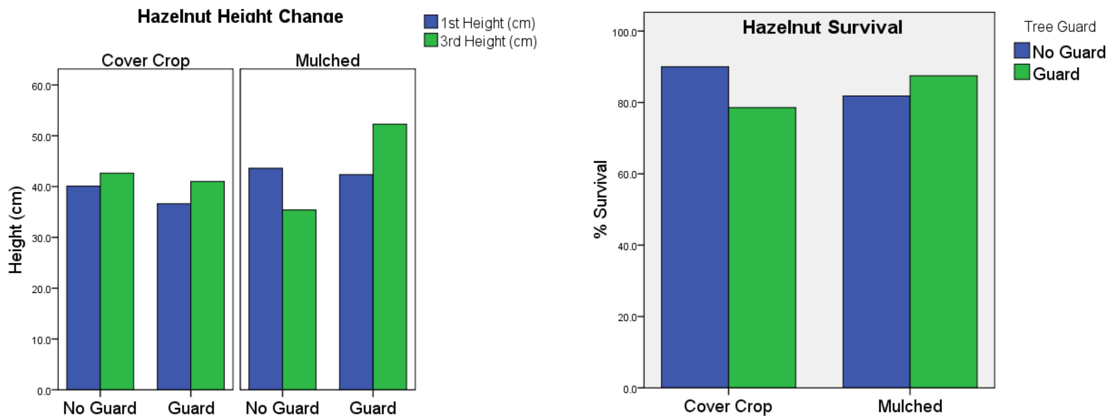

Figure 2. Effect of soil cover (cover cropping vs. mulching) and rodent barriers (guards vs. no guard) on hazelnut seedling height (left), and seedling survival (right). Height measurement were taken at the beginning of the experiment and again in mid October.

We observed only minor differences in seedling height (Figure 2, left) between the two soil cover management options (cover crop vs. mulch) and in the rodent barrier trials (guard vs. no guard). This result is not surprising during the seedling establishment phase (1st growing season) when seedling growth (height) is minimal. With respect to seedling survival, Figure 2 (right) shows only minimal differences between the cover crop vs. mulch treatments and between the guard vs. no guard treatments. Overall seedling survival was between 80 and 90%, and is encouraging for the first growing season. The effect of tree guards on survival after the first winter (2009) will be help demonstrate the feasibility of establishing alley cropping in the Northeast, since rodent damage by stem girdling is much more likely to occur during the winter, especially when snow is on the ground.

In addition to rodent control, a secondary objective of the comparison between cover cropping vs. mulching was to evaluate the effect of these ground cover strategies on weed control. During the first growing season the extent of weed suppression from the bark mulch was less than anticipated, so it was necessary to add a secondary barrier in the form of "sheet" mulch. This involved placing a layer of cardboard beneath the original mulch layer. Because of this "mid course correction" it was not possible meaningfully compare weed populations between the mulched and the cover crop plots. During the following growing season (2009), we will monitor the effectiveness of the two ground cover strategies and the rodent barrier (guards) on rodent control as well as on weed suppression.

Objective 2: Determine the most effective nursery production systems and tree species for coppice management systems to produce substrate logs for forest mushroom production

The proximate goal of this project was to achieve the direct benefits associated with the use of an alley cropping as an agroforestry practice for the low input production of organically managed, perennial crops. Another agroforestry practice known as forest farming has been underway since 2002 at the MacDaniels Nut Grove. This woodlot is on the eastern side of the Dilmun farm. The close proximity of these two different agroforestry practices gives us a unique opportunity to take advantage of possible synergies. At the MacDaniels Nut Grove (MNG), one of the most important non timber forest crops is gourmet mushrooms, especially shiitake. Shiitake mushroom are grown on logs from recently cut trees. For farmers and other land owners with limited forest acreage (such as the 7 acre MNG), harvesting a sufficient number of live trees for mushroom production of appropriate species (hardwoods) and diameter (4-6" diameter) is unsustainable, given that 100 to 200 trees per year would be required for a modest sized mushroom operation. In Japan where shiitake mushrooms have been grown for centuries, a sustainable production system is practiced that involves coppice management of oak trees for continuous production of mushroom logs. Coppicing is a pole production system that involves cutting back the main stem of a young tree, which stimulates growth of multiple new stems at the base of the original trunk. When these poles are harvested several years later, new stems arise, and this cycle can be continued indefinitely. In addition to hybrid hazelnut production for nut production in the TSF-funded alley cropping site we also planted two species of maple trees suitable as substrates mushroom production (sugar maple and red maple), that we intend to coppice for mushroom log production. Normally coppice production of 4" diameter poles might require 8-10 years or more, which is a challenging time horizon for most forest mushroom growers. The emergence of a new and patented tree seedling accelerated production technology called the Root Production Method (RPM) may allow us to reduce the time necessary for production of mushroom logs. Hence the objective of the maple component of the alley cropping system at Dilmun is to compare the performance of RPM trees vs. traditionally field grown seedlings (non RPM) for mushroom log production. This is one way in which alley cropping and forest farming complement each other in the sustainable production of organically managed woody and non woody crops.

Trees produced by the patented RPM method are considerably larger than conventionally field grown after the first year of growth, which is generally when they are marketed. An important caveat is that RPM trees are several times the cost of conventionally grown trees. The RPM Ecosystems company claims that the acceleration in seedling growth persists for many years beyond the nursery stage, perhaps throughout the life of the tree. While intriguing, this claim has not be convincingly demonstrated based on controlled experimental trials. The trial we are performing is important not only for the sake of sustainable mushroom production but also for many farmers and others who are cautions about spending more for RPM trees for whatever purpose (RPM trees are also widely marketed for habitat and restoration projects). We seek to determine whether RPM trees maintain their growth rate advantage for at least 5 years after planting, which is the maximum acceptable time necessary for for mushroom log production. The experimental design of this portion of the project is to compare RPM vs. conventionally grown seedlings from the same seed source (i.e. comparable genetics). At the time of planting the height and crown diameter of the 80 maple trees (40 sugar maples and 40 red maples) involved in this experiment were measured. Height, diameter and seedling survival were measured at the beginning, middle and end of the growing season. As can be seen in Figure 3, at planting time (1st height) the +RPM seedling of both species were considerably larger than the field grown seedlings. This “verifies” the “RPM effect” at the nursery stage, which is not unexpected. However, over the course of the growing season there was very little new growth for either the +RPM or –RPM seedlings of either species. Based on our expectations of the “RPM effect” it is somewhat surprising that +RPM seedlings put on so little new growth. Survival was 100 percent for both sugar and red maple over the course of the first growing season.

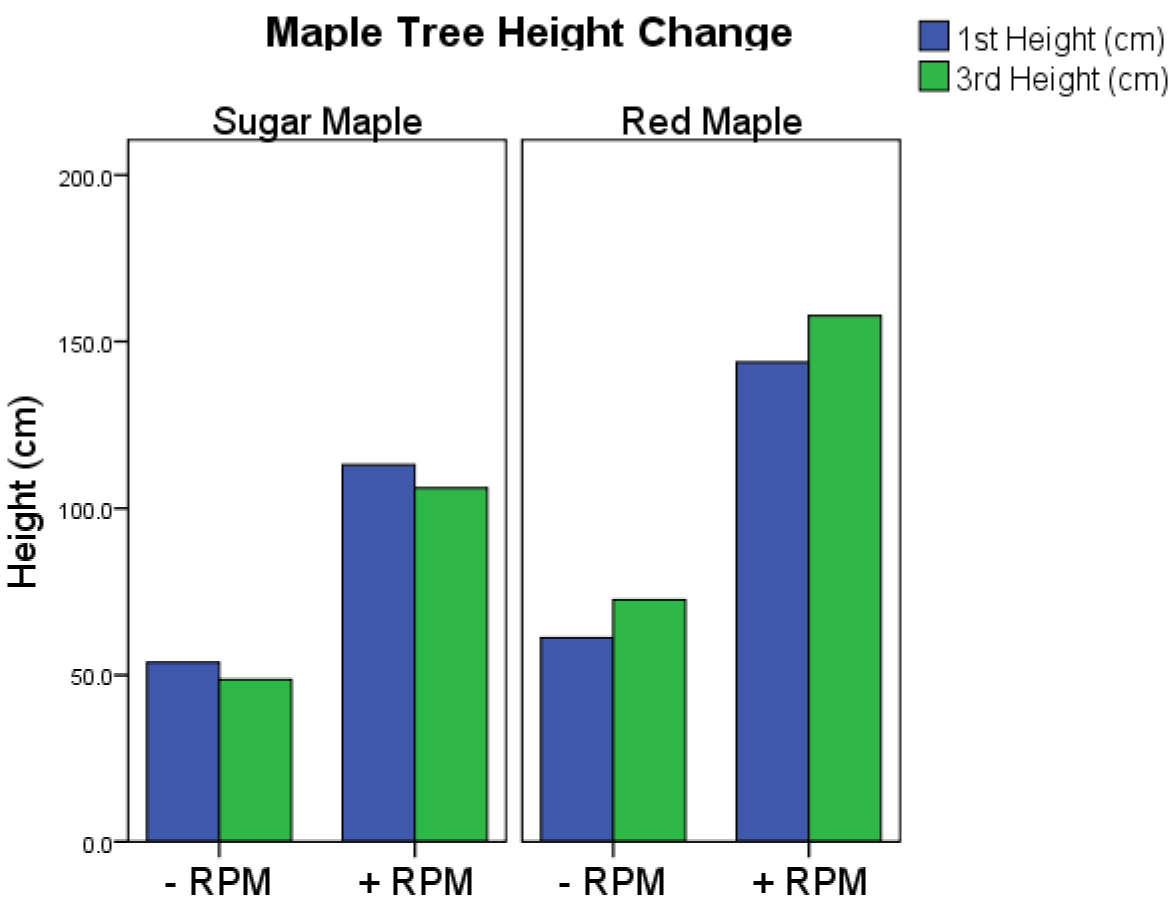

Figure 3. Effect of nursery production methods (patented, +RPM vs. field grown, -RPM) on height growth of red and sugar maple seedlings at the Dilmun Hill Farm alley cropping site.

Objective 3: Establish alley cropping as a complement to the existing forest farming system (MNG) to be used for agroforestry research, education and outreach.

2008 TSF funding of this alley cropping project and the Dilmun Hill Student Farm helped us to demonstrate sustainable agroforestry practices by integrating trees with non-timber crops to produce food, medicine, fiber, fodder and ornamental products. We successfully established rows of hazelnuts and maples to form the basic structure of our alleycropping system. During the 2008 fall semester undergraduate (junior) Wren Albertson-Rogers created a polyculture design described in detail in our student-guided 2009 TSF application (*Developing a student-run community site for Permaculture and Agroforestry*). This design details potential polycultures to meet the needs of the students, as envisioned by Wren in this statement:

> Our beautiful perennial forest garden is a self-sustaining, colorful sanctuary of seasonal and cyclical plant guilds complementary with the farm's established infrastructure and crops. The holistic permaculture design offers a diversity of saleable edible, medicinal, and ornamental plants to demonstrate multiple sustainable agriculture models. With increased access, informational signage, and equal opportunities for peer involvement, the low maintenance, vibrant garden provides year-round educational opportunities for students and community members from multiple interest groups.

Additionally, 2008 Dilmun student summer managers began building permanent raised beds in the alleyways of the westernmost mulched block for production of both annuals for the market garden and for perennials. This construction is proving to have more benefits than originally intended, primarily by making available the alleyways for production that would otherwise be considered unusable due to legacy effects from old orchard practices.

An important focus of this project is on biologically driven systems for fertility and maintenance. Both the mulch and cover crop management strategies are intended to provide insight into the permaculture-driven concept that polycultures provide multiple yields, one being system-wide self-renewing fertility. In the cover-cropping scheme, we are mimicking broad-acre applications by addressing the management options needed by mechanized farmers for establishing both ground covers and perennials with minimal tillage. In the mulch scheme, we are trialing this “best management practice” for establishing trees against growth parameters in the cover cropping scheme to determine if the high labor input of the mulch trial is outweighed by survival rates between the two systems. In both systems, fertility-enhancing elements are in place (cover cropping- legume ground cover; mulch- planned polyculture installations including nitrogen fixers and dynamic accumulators).

To take full advantage of the proximity between the between the Dilmun Farm and the adjacent MacDaniels Nut Grove in terms of our educational, research and outreach goals we continue to emphasize the sustainable agricultural continuum between the forest farming activities at the MacDaniels Nut Grove (MNG) and Dilmun Hill Student Farm.

This agroecological succession across the landscape is evident in the gradual transition from traditional annual agriculture in the market garden at the Dilmun Farm, across the hilltop to the new alley cropping system, and finally down the hill to the mature forest garden at the MacDaniels Nut Grove. The hazelnut and maple trees established during the first year will serve as keystone species for future development of a perennial polyculture system. They provide a spatial and species template for developing further plant "guilds", or groups of plants complementing one another in space and function.

An important educational and outreach component of this project is to collaborate with both the Cornell and regional agricultural community to further develop the site and strengthen the student-run aspects of DH. Three outreach events were held this summer and fall including tree planting on June 5, an Openhouse on August 26 and a public talk by Dave Jacke, the originator of the permaculture system known as Forest Gardening on October 1, 2008. After the October Forest Gardening event, a group of students expressed interest in collaborating to further the Agroforestry site and implement Wren Albertson-Rogers'design , culminating in the 2009 TSF application *Developing a student-run community site for Permaculture and Agroforestry*. In terms of Cornell undergraduate student education, multiple courses used the DH alley cropping and MNG forest farming sites as a teaching "laboratory" this past fall semester. Some of the classes include an introductory soil science course, Horticulture's Organic Food and Agriculture course and the MNG-based *Practicum in Forest* Farming.

At the end of the first growing season we were privileged to have the opportunity to share our progress with TSF Director and board member Susan Syversen and John Dunnell. We are grateful for their support.

Student Involvement in the Alley Cropping Project

Figure 4. Anne Piombino planting a RPM red maple tree on June 5, 2008 (Photo: Ben Scott-Killian)

Figure 5. Matt Ball, Taking seedling height measurements at the time of planting. A tree guard for rodent to prevent rodent girdling is shown. (Photo: Ben Scott-Killian)

Figure 6. Doug Lockwood and Ben Girtain planting bare root non RPM maple seedlings. (Photo: Ben Scott-Killian)

Figure 7. Rachel Brinkman in the buckwheat cover crop plot where the buckwheat has overgrown and hidden the hazelnut seedlings that have also been planted there. (Photo: Melissa Madden)

Figure 8. Red maple seedlings at the time of planting. One year old RPM seedling (left) compared to a one year old field grown (-RPM) seedling (right). The diameter of the larger container (left) is about 10 inches. (Photo: Rachel Brinkman)