1. Project name and contact information

Greenhouse Heating System - Final report
SARE Farmer Grant FNE07-598
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2. Goals

This project involves creating a compost pile adjacent to a greenhouse to generate heat for the greenhouse. The compost features elements that produce heat for an extended period of time and those elements are replenished regularly.
Heat is absorbed into water, and then black plastic pipe and hoses transport the heated water into the greenhouse. The heat is released below the plants on the growing tables. The water flows in a continuous loop of hoses and plastic pipe back to the compost pile to be heated again. The heat generated is sufficient to heat the greenhouse to the mid-forty degree range.
I previously moved my plants between my living quarters and the greenhouse daily according to the temperature changes. My goal was to heat the greenhouse to a level that would allow my plants to remain in the greenhouse regardless of the outside temperature using an eco-friendly, inexpensive system.

3. Farm Profile

My business, Misty Morning Herbs and More, produces herbs, popular vegetables, cut flowers and gourds. An unheated greenhouse measuring 12 feet by 16 feet is used to grow herb and vegetable plants. The seeds are germinated in the living quarters and moved to the greenhouse as small seedlings.

4. Participants

I began my application process with a Technical Advisor. That did not work out so I proceeded with construction without one. A new Technical Advisor was obtained, and then he became ill. He later provided assistance with outreach, a handout and photocopying.

5. Project activities

Construction of the shell for the compost pile began in November 2007. Addition of compost materials began in December. The reservoir, pump and fill hose were added when the pile was at a depth of twelve inches and the plastic semi-rigid pipe continued to coil within the compost pile, with subsequent additions of three inch layers of wood chips, chipped ornamental grasses, crimson clover, hairy vetch, manure and soil. All materials were chipped to a small particle and moistened. The pile began to heat up at a depth of thirty inches and the width of five feet. The internal temperature of the pile reached one hundred fifty degrees on December 25, 2007 and remained at the high level for ten days. A plumbing leak was detected at a fitting and required removing a small amount of compost material, thus disturbing the pile and its microbial action. The temperature in the pile dropped about fifteen degrees, but this did not affect the temperature inside the greenhouse drastically. The lesson learned in this event was to locate the connection between the plastic pipe and the hoses within the compost pile where it would not have the stress of the settling of the compost material on it. The shell and top of the compost pile were lined with plastic. The hoses exiting the pile were well insulated and insulation was

used from the point where the hoses entered the greenhouse to the growing tables. Compost material settling was on-going and additional materials were added about twice a week until March 31, 2008. There were only three snowfalls of several inches with several light dustings. Snow and rain affect on the compost pile was minimal. The cost to operate the pump was $0.30 per day.
An estimate to install a propane heating system was obtained. Installation costs would be $1,483 with monthly fuel costs of $215.00. Lost greenhouse space would be approximately three feet by three feet. The effects of propane emissions could not be calculated.

I had agreed to calculate BTU's generated and made several attempts to do so. I first contacted the Delaware Department of Natural Resources Energy Office. They stated that they were unable to assist me, but referred me to another individual. That person did not respond to my contact. I also searched the Internet and found that BTU measurement is an outdated form and is no longer in use. I have enclosed the printed material.
My encyclopedia gives the simple formula of the energy required to raise the temperature of one pound of water from thirty nine degrees to forty degrees. Based on this formula, using the average nighttime temperature for a ten hour period of time, 5,600 BTU's were generated and released in the greenhouse. BTU's to heat the water in the reservoir were 28,350.

6. Results

There was a slight improvement in plant growth. The savings of time previously lost moving the plants between the living quarters and the greenhouse was a significant benefit.
Overall results were that the system did function as expected and that a compost pile will remain at a moderately high temperature for an extended period of time, provided that compost material is added on a regular basis. I will use the system again with some minor modifications. I will begin the compost pile one foot below soil grade to facilitate adding compost material. I will include a sturdy metal stand to hold the reservoir about fifteen to twenty inches from the bottom and a horizontally placed four inch mesh wire for the plastic pipes to rest on. These additions should keep the internal components from settling with the compost material. The changes should also minimize the possibility of a leak occurring. I will also line the compost pile with a thermal blanket available from farm supply outlets. I believe the system could produce even higher inside temperatures with more insulation.

7. Conditions

There were no unusual conditions at my farm during this timeframe.

8. Economics

Economic findings were positive in time saved that is usually spent moving plants. Winter vegetables were grown and harvested successfully. The outreach and media contacts brought a substantial increase in customers so far and I expect this to continue.

9. Assessment

This project generated the idea to possibly harvest the methane gas generated by the compost. Revisions as stated above will be minor. I learned that it is a greater challenge to get a compost pile to heat up during the winter than it is during the warmer months. Diligence and attention to detail has overcome this issue.

10. Adoption

I will continue to use this system with the aforementioned modifications because it is an inexpensive, earth-friendly and workable project.

11. Outreach

I gave presentations as follows: January 7, 2008, Vegetable Growers Association/Agriculture Week; January 9, 2008, Delaware Herb Growers and Marketers Association; January 12, 2008, Delaware Organic Food and Farming Association; January 15, 2008 On the Farm Radio; January 15, 2008, Delaware Master Gardeners; January 24, 2008, Women in Agriculture; February 12, 2008, Delaware Composter's Association; January 16, 2008 Regional Nurserymen Association (display only); January 16, 2008, New Jersey Vegetable Grower's Association (display only); Maryland Organic Food and Farming Association (display only). I was unable to get into the Pennsylvania Farm Show and Delaware State University has not held a Field Day. They usually do this during the summer months. Flyers were produced and distributed at the Open House held on April 5, 2008 and all of the above events except the radio broadcast.

Media coverage: The Delaware State News did two articles, The News Journal, Delmarva Farmer printed articles and WBOC TV did a clip that was aired a total of four times February 16 and 17, 2008. An article was written and submitted to Mother Earth News magazine, Back Home magazine and People Places and Plants magazine. Back Home will publish an article this summer and Mother Earth News plans to do one in the future. Many individuals have visited and viewed the system some from the local area and others from other states. Information about the system has been sent to individuals in Vermont, Rhode Island, Massachusetts, New Jersey, Pennsylvania, Virginia, Tennessee, Arizona, Colorado, Indiana and Delaware. Those in Indiana are associated with a Missionary group and hope to send the project idea to other countries.

12. Report summary

This system was designed to provide heat to an otherwise unheated greenhouse so plants could remain in the greenhouse regardless of the outdoor temperature. This was accomplished through the construction of a five foot high and five foot wide cylindrical compost pile adjacent to the greenhouse and ongoing additions of compost material. A reservoir in the center held water and a pump. A system of pipes and hoses transported the heated water to the greenhouse forming a complete loop. The average high temperature inside was 79.8 degrees and the average low temperature was 44.9 degrees. The average temperature within the compost pile was 124.6 degrees and the project lasted for three and one half months, from December through March. The project fulfilled my expectations to maintain an adequate temperature during the cold winter months at a very modest cost of $9.00 per month for electricity. Compost materials were expendable farm waste items.