USDA/NRCS CIG Grant Narrative Meach Cove Farms Grass Pellet Combustion Evaluation

Project Title: Fuel from the Field to the Flue:
Grass pellet heating equipment combustion optimization project.

Meach Cove Farms, Shelburne, Vermont.

3. Abstract

Previous research by BERC, Cornell College of Agriculture, the EPA and others has shown that grass fuel is a true renewable fuel source with 80-90% of the energy content of wood and 70% less greenhouse gas emissions than fossil fuels. There have also been a number of recent studies and combustion trials of heating equipment burning grass. Previous studies have documented some of the issues and challenges when burning grass fuels in commercially available wood or biomass heating equipment. This project will start by selecting from the most promising grass species for combustion fuel and heating units that are best suited for burning pelletized grass fuels. Meach Cove will install two different types of heating equipment in the 100,000 – 500,000 BTU output range. We will monitor the operation of this equipment and make improvements to them to optimize their combustion, emissions and ash handling for several species of pelletized grass. We will modify the heating equipment with control systems that will monitor and instantaneously adjust key settings to optimize the combustion of the pelletized grass fuel. This will make it possible to burn a wider variety of grasses as fuel sources and improve the emissions and quality of the ash produced. When the project objectives are met the result will be two types of heating equipment that can be marketed with the validation that they will perform well for agricultural, commercial or small industrial users with a greater range of pelletized grass fuel. Our final report will provide the detailed information necessary for Vermont farmers to select and grow the most promising species of grass and burn them in commercially available heating equipment that have been modified to insure that they are efficient and clean burning. Following the submission of the final report and completion of this project Meach Cove Farms will run this heating equipment beyond the project timeline to provide information on their long term performance. In this way we will determine and report any corrosive or mechanical issues that should be addressed by the manufacturers, which will benefit any consumer using this equipment.

4. Project Description

a. Project Background

We intend to draw from and add to the grass fuel combustion research done recently by a number of highly qualified individuals, groups and institutions in this region, such as Dr. Jerry Cherney at Cornell University, the Biomass Energy Resource Center in Vermont, the Hudson Valley Grass Energy Group, Enviro Energy in Unadilla, N.Y., LEI Products in Kentucky, Gus Swanson of LST Energy in Nova Scotia, and the Resource Efficient Agricultural Program in Ontario, Canada. Projects such as these exist around the region but until last year's Vermont Sustainable Jobs Fund sponsored

research on grass fuel combustion, very little work has been done in Vermont. There are still some major unanswered questions, such as the optimum species of grass fuel, the behavior of grass in some heating equipment, and issues with the production of grass pellets to be resolved. There are a small number of wood pellet or grass heating equipment that are supposed to be able to burn pelletized grass, but there are issues such as high ash content, clinker formation and high particulate emissions to overcome. We have located several companies that have developed heating equipment that have been optimized to burn grass with minimal complications. This project will review the information available, select two of the most promising heating equipment models, and monitor their performance over fourteen months. We will also modify these units to automatically adjust some key settings for optimum performance as the grass is being burned. One of the objectives of this project will be to have two different heating unit types (a hot water boiler and a hot air furnace) that are commercially available for installation that will cleanly and reliably burn pelletized grass fuels that can be grown in Vermont.

The owners of Meach Cove Farms have always been interested in exploring ways to make better use of the natural resources available locally to offset petroleum that is being used for space heating. Being able to efficiently and dependably burn grass fuel that is raised on this or other Vermont farms would represent a huge step towards another renewable alternative to fossil fuels. Recent studies have demonstrated that grass can be harvested and pelletized at a cost that is comparable to heating fuel oil at around $2.50 per gallon. We have contacted several groups and companies that have modified or built heating equipment that can burn pelletized grass fuel. We also know from previous studies that there are numerous issues to solve when burning some species of grass in heating equipment. Meach Cove Farms participated in a grass fuel blend study in 2010 using a 500K BTU rated solid fuel boiler located at the All Souls Interfaith Gathering, an interfaith church located on an adjacent property in Shelburne, VT. This study was a collaboration with the Vermont Sustainable Jobs Fund and the Biomass Energy Resource Corporation (BERC) of Montpelier, VT. That study yielded important data on how various pelletized grass species behaved when they were burned as a heating fuel. The study of this combustion testing was published in January, 2011. (See the Appendix section for the link to these studies)

The grass fuel combustion experience gained by doing the VSJF/BERC study prompted Meach Cove Farms to seek funding to install and monitor other grass pellet capable heating equipment. As previously noted, we will identify one hot water boiler and one hot air furnace known to be able to burn grass pellets, evaluate them in use, and modify them to optimize their combustion efficiency. This project will provide new data on the operational performance of this equipment, the types of grasses that are burned, and it will compliment the work being done to improve the quality of pelletized grass fuel in Vermont. One such example is the 2011 Vermont Sustainable Jobs Fund RFP offering funding for the construction of a mobile or stationary grass pelletizing plant to be built in Vermont. There is a need for expend the research into both the pelletizing of grass and identifying heating equipment that will burn grass pellets efficiently and cleanly. The Meach Cove Farms project will focus on grass capable heating equipment

in the 100,000-500,000 BTU output range so that the information reported is applicable to agricultural, small industrial or commercial applications for similarly sized heating equipment. This information is complimentary to any work on producing grass pellet fuel in Vermont.

b. Project Objectives

1. Identify and evaluate the most promising grass pellet capable heating equipment in the 100,000 – 500,000 BTU output range.

2. Select two grass pellet capable heating equipment (one hot water boiler and one hot air furnace) and install them in two buildings at Meach Cove Farms where they can be evaluated under typical operating conditions.

3. Collect and analyze the data obtained from the grass pellet combustion and make modifications to this heating equipment to optimize their efficiency, emissions and ash handling systems. A hand-held combustion analyzer (such as the Enerac M500 combustion and flue gas analyzer made in Westbury, N.Y.) will be used to gather this data. Pellet and ash sample testing will be done by outside laboratories as needed.

4. Determine which of the heating equipment operational parameters can be automated and controlled using an instantaneous reading microprocessor and modify and test the appliances accordingly.

5. Operate, monitor and modify the heating equipment to provide continuous adjustment to optimize the combustion process and ash handling for grass pellet fuel. Document the performance under typical operating conditions.

6. Publish the results of this project for the various media such as print, video, the internet, and open house tours and field days.

7. Work with the manufacturers of the heating equipment to adopt these improvements.

8. Continue to operate, evaluate and report on this heating equipment for years after the final report is submitted and objectives number 1 through 7 are completed.

Meach Cove Farms staff have previous experience with burning pelletized grass fuels; they have established connections with experts in biomass, heating equipment, engineering and academic institutions; they have the facilities to accommodate the project, and there is a variety of grass species known for their suitability as fuels already growing on the property. These facts give us the confidence that we can accomplish these objectives.

c. Project Methods

1. We will select one hot air furnace and one hot water boiler that research by others and ourselves have shown to be capable of running reliably on pelletized grass fuel and install them in separate buildings at Meach Cove Farms. Our experience in the Vermont Sustainable Jobs Fund grass pellet combustion study in 2010, along with research done by others, will be beneficial in our selection of the species of grass we will use as fuels in the combustion testing. We have included funding to do laboratory tests for the energy, chemical and ash content of up to four different species or blends of grass that will be used as fuel in this project.

2. We will purchase and use a digital combustion analyzer such as the Enerac M500 (details in the Appendix) to monitor the combustion and emissions of the heating equipment being tested.

3. We will run the combustion testing with up to four pelletized grass species that have been identified in earlier studies to have a high energy content, low ash, minimal issues with clinker formation and emissions and record their performance in these heating units. The type of data collected will include:

    - Combustion and stack output temperatures, Oxygen, Carbon Dioxide, Carbon Monoxide, Nitrogen Oxide, Sulphur Dioxide and particulate stack emissions

    - Clinker formation and any impact this might have on ash handling

    - Corrosive properties of the flue gas or ash

    - BTU output

4. Determine the best means of adjusting the critical combustion settings on the heating equipment.

5. We will modify the heating equipment to automatically adjust the critical combustion settings. This will allow continuous combustion adjustments which will improve the performance while burning different species of pelletized grass. This is an important feature in dealing with variations in the grass used in the fuel and the quality of the ash that is produced. We will use available off-the-shelf control processors and mechanical devices, whenever possible, to automate these adjustments.

6. Test the heating equipment with up to four of the most promising grass species to insure safe, efficient and low emission operation.

7. Identify and report which grass species or blends of grass are best suited for heating fuel based on the combustion performance data we will collect and report.

8. Tests of the pelletized fuels and the resulting ash using an independent lab. The data will be evaluated by some of the collaborators for this project.

9. Document the findings of this project in reports and video; disseminate the information via various media outlets.

10. Host field days, open houses and tours by appointment to allow others to see the heating equipment in operation.

11. After the final report is submitted and the project has ended we will continue to operate the heating equipment to gather long-term data on their operation and report that information. The heating equipment will be accessible to visitors by appointment, and we will submit updates on their performance.

d. Location and size of the project area

Meach Cove Farms, a privately owned one thousand acre certified organic farm is located in the southwest corner of Shelburne, Vermont between U.S. Route 7 and Lake Champlain (see the location map provided). The primary crops grown are 300-plus acres of organic and conventional soy beans, organic hay, wheat, rye, corn, three acres of wine grapes, and 350 acres of productive woodland. The two buildings, where the grass pellet capable heating units will be installed, are located at 308 and 310 Beach Road and they are indicated on the location map provided.

e. Producer participation

The Meach Cove Farms will be one of the EQIP-eligible producers that will supply the grass used for fuel in this project. If additional grass is needed, we know of several other EQIP-eligible producers in Vermont that we would be able to obtain the required amount of grass fuel from. The pellets will be produced in Vermont at a currently operating pellet plant.

f. Project action plan and timeline

We estimate that this project will take 14 months to deliver a final report on the two types of heating equipment that will be evaluated while burning up to four of the most promising species of pelletized grass fuel. This time period will permit us to operate the heating equipment through one heating season to accumulate performance data under actual heating loads, and to make the modifications identified in the project objectives.

We will provide quarterly updates on the progress of this work, prepare a final report, and disseminate the information within that timeframe. Once the report is submitted we will continue to operate this heating equipment to monitor, document and report on their long term performance. We see the specific action steps, the milestones and the estimated time to complete them as follows:

1. **Action:** Identify and evaluate a promising hot water boiler and a hot air furnace in the 100,000 – 500,000 BTU output range that have already been proven to be capable of burning grass pellets.
   Day 1-45

   Our initial research has identified promising grass capable heating equipment such as those made by the Harmon Corporation in Pennsylvania, the Bio-Burner made by LEI Products in Kentucky, and a grass pellet boiler developed and tested by LST Energy and Gus Swanson in Nova Scotia. Information on these units is in the Appendix.

2. **Milestone:** The selection of one hydronic boiler and one hot air furnace that are grass pellet capable and the install them in two buildings at Meach Cove Farms.
   Day 30-75

3. **Action:** Collect and analyze the data obtained from the grass pellet combustion and design monitoring equipment and automatic controls for this heating equipment to instantaneously adjust the basic combustion settings to optimize their efficiency, emissions and ash handling systems. Day 75-135

4. **Milestone:** Install the identified control and automation devices, operate the equipment and make any adjustments as needed. Day 135-240

5. **Action:** Operate, monitor and modify the heating equipment to optimize the combustion process and ash handling for grass pellet fuel. Document the performance under actual heating conditions. Day 240-375

6. **Milestone:** Publish the final report containing the results of this project and host open houses, field days and tours by appointment. Day 375-389

7. **Action:** Work with the manufacturers of the modified heating equipment to adopt the discovered improvements into production. Day 350-420

8. **Action:** Run this heating equipment after the project has concluded to determine how well they perform over the long term. Report the results and provide visitors access to the heating equipment by appointment.

g. Project Management

The Meach Cove Farms Project Director will assemble and manage a team to collaborate, monitor, evaluate and provide resource information to this project. I have indicated the role the individuals or institutions listed below will have in this project.

Disclaimers:

Meach Cove Farms is involved in an ongoing grass species trial in collaboration with Sid Bosworth of the University of Vermont Plant and Soil Science Department. This project began two years ago and we anticipate it will continue for several more years. We would use Sid Bosworth as a resource for this project but he will not be actively involved in the project.

Meach Cove Farms submitted a proposal to the Vermont Sustainable Jobs Fund in March, 2011 to set up a grass pelletizing production facility in Vermont. As a component of that proposal we indicated that if selected we would use pelletized grass capable heating equipment to provide the space and process heat for the grass pellet production. We did this because it made sense for us to heat the building with the same grass pellets we would be producing. The project we are describing under this CIG application would go beyond simply using a commercially available boiler because we would automate the combustion control functions of two different heating units to improve their operational performance when burning grass. The VSJF project focus was manufacturing grass pellet fuel and not on combustion of grass. Meach Cove Farms included using a grass pellet heating boiler in their proposal to the VSJF, but this was not required. Using grass capable heating equipment may not be a component of the VSJF project depending on who receives approval. As of this submission date we have not heard if we were successful in receiving funding under the VSJF program.

Project Director, Christopher W. Davis, Manager, Meach Cove Farms, Shelburne, VT, will be responsible for the project from approval, delivery of the final reports and satisfying all of the grant requirements. 29 years of experience managing agricultural and construction projects including the construction and operation of a fuel ethanol plant in 1982-85, which used wood pellet fuel to make process steam, and managing the boiler testing component of the VSJF sponsored pelletized grass fuel combustion study conducted in 2010.

Project Accounting: Barbara Mercure, Office Manager, Meach Cove Farms, Shelburne, VT, will be the assistant to the project director, she will track the project budget, project expenditures, and she will prepare the required grant accounting documentation. Ms. Mercure will also help prepare the project report, media materials and open houses. Ms. Mercure has 20 years of experience with grant administration, expenditure tracking and reporting.

Collaborators

Dr. John Warner, former Professor and Director of the University of Massachusetts Lowell Center for Green Chemistry. Dr. Warner may collaborate on analysis, problem solving and evaluating this project.

Averill Cook and Charlie Agnew, Biomass Commodities Corp., Williamstown, MA. They have 30-plus years of collective experience in biomass fuel combustion, boiler installation and adjustment. Biomass Commodities Corp. may collaborate on the grass pellet combustion, heating appliance operation and modification and evaluation of this project.

Nathan Palmer, Ferrisburgh, VT. 30-plus years of experience in agricultural, industrial and commercial businesses, several years of experience pelletizing and burning grass fuels in modified heating units. Mr. Palmer may collaborate on the grass pellet combustion and heating appliance operation and modification.

Harry Atkinson, Thunderbolt Research Corp, South Burlington, VT. 40-plus years of experience with oil and solid fuel boiler installation and operation. Thunderbolt Research Corporation and Mr. Atkinson may collaborate on the grass pellet combustion, heating appliance operation and modification.

University of Vermont College of Engineering and Mathematics, Burlington, VT. Faculty and/or students from UVM College of Engineering may collaborate in the heating unit modification and control systems work.

Massachusetts Institute of Technology, Cambridge, MA. Faculty and/or students from MIT may collaborate in the heating unit modification and control systems work.

Resources

Sid Bosworth, University of Vermont Plant and Soils Science Department, Agricultural Extension Service, South Burlington, VT. Dr. Bosworth may act in a resource capacity on the grass species component of this project and with the analysis of data gathered in this project.

Biomass Energy Resource Center, Montpelier, VT. Staff members of BERC may act as a resource in evaluating the data gathered in this project.

h. Project deliverables

When the objectives of this project are met we expect to have the following deliverable products…

1. A final report available in printed, electronic and video formats which will summarize the information collected as a result of this project containing:

    - Operational data for one hot water boiler and one hot air furnace both capable of burning pelletized grass fuel

    - The published results of the combustion testing of several promising species of pelletized grass fuel in this heating equipment.

    - A detailed summary and diagrams of any modifications or adjustments made to the two types of heating equipment to optimize the combustion of up to four types of pelletized grass fuel.

2. Hold open houses, field days and tours by appointment to showcase the work being done in this project.

3. The heating units evaluated as part of this project will be improved to optimize their operation when using more than one species of pelletized grass. The modifications will be detailed and included in the project report.

4. Collaborate with the manufacturers of the two heating units to incorporate modifications that resulted in improved performance into their production designs.

5. Evaluate, analyze and report on the composition, combustion and ash production of up to four species of grass fuels. This information will be useful to farmers who wish to grow grass for use as pelletized fuel for Vermont and the region. The information will also be useful to anyone wishing to make grass pellet fuel.

6. Long term evaluation and updates on the heating equipment after the completion of this project. Provide access to the equipment by appointment.

i. Benefits, results expected and transferability

1. Meach Cove Farms will identify two types of the available grass pellet capable heating equipment in the 100,000 – 500,000 BTU output range that have the greatest potential for dependable space heating. We will install and monitor

them in use, and modify them to provide automatic adjustments to optimize their operational efficiency and emissions.

2. Monitoring the operational performance of this heating equipment will allow us to learn which species of pelletized grass or grass blend is best suited for use as boiler or furnace fuel.

3. This project is an essential step to safely, efficiently, and cleanly using Vermont grown grass crops to provide a renewable biomass fuel source. A primary goal of this project is to improve the heating units' performance by increasing their combustion efficiency, reducing their emissions profile, and improve the quality of the ash produced.

4. There have been numerous attempts to solve the documented combustion issues such as high ash content, clinker formation, and high particulate stack emissions that are often associated with burning grass as a fuel. This project will solve the greatest of these challenges by modifying available heating equipment to automatically adjust their combustion and emission performance on a continuous basis.

5. Meeting these objectives will provide two different types of heating equipment that will be able to perform well for agricultural, commercial or small industrial users with a better defined range of pelletized grass fuels.

6. This project will provide new options for using renewable, locally grown grass as a source of heating fuel benefitting numerous grass producers and consumers in Vermont, and anywhere similar grass species can be grown and made into pellets.

Transferability

Meach Cove Farms sees this project as a way to offset the increasing costs of petroleum heating fuel by using a biomass crop that can be grown and harvested on the property. Meach Cove Farms has designed this project to accomplish this goal, and in doing so will benefit others who wish to grow grass species for fuel, or those who wish to install proven grass pellet heating equipment such as the ones evaluated and improved by this project. This project will add operational data to compliment the grass combustion work done by others to date. The problems addressed by this project also compliment other grass pellet producers by identifying several grass pellet capable heating equipment in the 100,000 – 500,000 BTU output range that can efficiently and cleanly burn grass.

j. Project evaluation

We will follow a methodical evaluation of the features and operation of two different types of grass pellet fuel capable heating equipment; one will be a hot water

boiler, the other a hot air furnace. We will use the same performance analysis methods and equipment typically used by biomass heating unit service technicians to monitor and evaluate the performance of this heating equipment. We will use an independent lab to test the samples of the grass fuels used in the testing and to provide data on the ash byproducts. The data collected during this project will be evaluated by the Project Director and reviewed by some of the listed project collaborators.

We will provide progress reports on any findings and data quarterly and in the final report. We will incorporate any feedback we receive from collaborators, resources, and visitors in the reports. We anticipate receiving additional evaluation and comments as the information we document and report is reviewed by others who examine it in the various media outlets such as the internet that we will use to disseminate it.

5. Assessment of Environmental and Social Impacts:

This project will use grass grown on the Meach Cove Farms property, or grown on other Vermont farms, as the fuel for the boiler and furnace tested. Previous research by BERC, Cornell College of Agriculture, the EPA and others has shown that grass fuel is a true renewable fuel source that contains 80-90% of the energy of wood and 70% less greenhouse gas emissions than fossil fuels. The ash produced by the pelletized grass fuel used in this study will be recycled as a grassland fertilizer on the Meach Cove Farms property following the Vermont Agency of Agriculture Best Management Practices regulations.

We do not anticipate any adverse impacts on the soil, water, air, plants, animals or wetlands as a result of this project. We do anticipate that the information and data obtained from this project will have a major benefit to these same environmental resources as more producers and consumers switch to growing and/or burning grass fuels.

6. Budget Information

Please see the attached SF-424A Budget information Non-Construction Program form.

7. Budget Narrative

This project budget spans a fourteen month period. We expect to complete the tasks requiring Federal Funding within twelve months. Meach Cove Farms expenses included in the total project budget would continue through fourteen months. In addition Meach Cove Farms would continue to operate the heating equipment beyond the fourteen month period to gather long-term test data on these units using pelletized grass fuel and report the results.

Percentage Match:

The project budget requires $73,400.00 in Federal funding representing 37% of the total, and a Meach Cove Farms contribution of $125,640.00 in cash, or 63% of the total funds required for the fourteen month duration of this project.