TO: Tania Howard, Michigan DELEG

FROM: Gregory Zimmerman, Lake Superior State University

RE: Final Report for PLA 09-36 "Production and Use of Reed Canary Grass as a Biomass Heating Fuel"

DATE: 28 August 2009

A. Summary of implementation plan

This project was designed to demonstrate the practicality of reed canary grass as a pellet fuel in the Eastern Upper Peninsula. A previous project showed the potential for reed canary grass as a pellet fuel from an energetics and cost standpoint. The present project was designed to actually produce pellets and burn them in a stove. The goal was to determine whether this fuel source is practical and cost-effective. An additional goal was to disseminate our findings in order to encourage the use of reed canary grass pellets in the EUP and possibly to lead to the development of a business in the EUP to produce pellets.

Specifically, the work plan called for project staff to

- Acquire and set up the necessary machinery (hammer mill and pellet press)
- Produce pellets from reed canary grass harvested the previous fall
- Develop standard operating procedures, record all aspects of the production for development of best practices.
- Record throughput of the process and any problems encountered and the solution to those problems
- Obtain a multi-fuel pellet stove
- Run the pellet stove, recording time required to fill and operate the appliance, any problems encountered and the solution to those problems, and the heat output of the stove.
- Hold public demonstrations of the processes and promote these demonstrations
- Produce a technical report and non-technical report of the results of the study.

B. Accomplishments and problems experienced while carrying out the project activities

A technical and non-technical detailed summary of the study is attached to this final report, but in summary….

In early November, 2008, we harvested a small part of a field of reed canary grass in Dafter Township. This field appears typical in extent and abundance and height of reed canary grass for this area.

We then ordered the production equipment which consists of a hammer mill and a pellet mill. We purchased the equipment from Pellet Pros, Kewanee IL. The hammer mill was a small mill with its own diesel motor (Pellet Pro's Model PP1000D) the pellet mill ran mounted on a tractor with a 3-point hitch and ran off the PTO (Pellet Pro's Model PP-PTO). The total cost for this equipment was just over $9,000.

The equipment was not difficult to assemble or operate. For the safety of operational staff, we developed standard operating procedures for use of the equipment (attached).

We ground the harvested material with no problems. Care should be taken to reduce the emission of fine particulates into the atmosphere during grinding. Workers must wear a nuisance dust mask and eye and hearing protection. The grinder has limited safety guards around rotating parts. Workers must use best safety practices.

We then began to experiment with pellet recipes to find a cost effective, readily available additive that would bind the material and enhance the release from the pelletizer dies. We experimented with corrugated cardboard run through the hammer mill, greyboard run thru the hammer mill, maple and conifer leaves raked up in the fall and then run through the hammer mill, used frier oil, and (later in the project) spent brewer's grain obtained from a local microbrewery. At first we added too much moisture and the pellets did not form and also the pellet mill dies became clogged. To clear the dies, we had to drill through the material with a hand drill, a procedure best avoided. At first we were also running the pellet mill too slowly. Pellets would form, but only very slowly.

After some experimentation, we found the correct speed and the right combination of ground reed canary grass, water, cardboard and oil or reed canary grass and spent brewer's grain to make pellets that came out of the die and held together well. Tech Support at Pellet Pros was helpful throughout the set up and use of the equipment. We established that the PTO needs to run at or close to 540 RPM (about ¾ throttle on the tractor we were using). Our recipe was a 5-gallon bucket of ground reed canary grass, 1 gal bucket of ground corrugated cardboard, 200 mL of used frier oil and 400 mL of water or a 5 gallon bucket of ground reed canary grass with 800 mL of wet spent brewer's grain. The pellets come out steaming (about 160F according to an IR thermometer). We allowed them to air dry until they were at ambient temperature (about 30 min).

We then acquired a multi-fuel stove from a local supplier. We purchased the Quadrafire Mt Vernon AE. The original work plan called for installing the stove in a LSSU building. We did not realize in writing the original work plan that, because LSSU is a state facility, such an installation would have required an inspection by the State Fire Marshall. We could not settle on a suitable location for such an installation and chose instead to mount the stove on a small trailer. We bolted the stove to the trailer and mounted a short wall behind it on which we installed the thermostat. This approach actually worked better because it facilitated taking the stove to various venues for demonstration purposes. Attached is a picture taken at the Sault Farmer's Market demo that shows the setup. When 110v power was not available, we ran the stove on a 12v battery (the stove is designed to run off of a 12v battery in the event of a power outage. The only difference in operation is that the electric igniter does not work on battery power. The pellets must be lit manually.)

The stove set up easily. It took some practice with the operator's manual (a few hours) to understand the start-up process but we quickly learned how to reliably start and run the stove. It takes very little time to program the thermostat. The time required to fill the stove or to empty the ash tray is minimal. No adjustments are necessary.

The stove operated well with the pellets. They fed well and produced heat well. Fine materials (i.e., unpelletized material) should not be introduced into the stove as one loads pellets. Fine materials may result in poor auger performance. Thus pellets should be run over a screen to separate any fine material that was not incorporated into the pellets.

We are still collecting data on the exact operating properties of the stove. We have planned to measure with an infrared thermometer how hot the stove will get after, say, 1 hour of operation using our two types of pellets compared to wood pellets. We will also record the amount of ash produced. But we are able to show that one can make reed canary grass pellets that burn well in a pellet stove. One other test we would like to do is to test the exhaust. Reed canary grass exhaust looks and smells cleaner than the wood pellet exhaust but we have no quantitative data to support that claim.

We have demonstrated the stove with our reed canary grass pellets at a few different venues as listed below. The demo consisted of firing the stove with the pellets we made, displaying the poster (2' by 3' format), handing out a small format (8 ½ by 11) copy of the poster and answering questions (a copy of the small format poster is attached to this report). The demos were held at: a monthly meeting of the Chippewa/East Mackinac County Conservation District (13 August 2009 at the Conservation District Office in Sault, Michigan, attended by approximately 8 people); the Sault Farmer's Market (29 July 2009 at the market pavilion in Sault, Michigan, approximately 20 people stopped by to discuss the demo), and at the Pickford Farmer's Market (30 July 2009 at the market site in downtown Pickford, Michigan, approximately 12 people stopped to discuss the demo). We have also arranged for a demo one afternoon at the Chippewa County Fair and have been invited to provide a demo at a Chippewa County Farm Bureau meeting. I discussed the project at the USDA's EUP Resource Conservation and Development Council as described below.

I mailed a copy of the poster to our local MSU-E office, the Conservation District Office, the EUP Regional Planning and Development Office, Pickford Feed Store, Rudyard Feed Store, our state representative (Rep Gary McDowell), the fireplace vendor from whom we purchased the stove, Tahquamenon Brewery which provided the grain, and a few other interested parties. LSSU's Public Relations department developed a press release and a local radio station, a local on-line news service, and a local newspaper ran stories based on the press release (and in the radio piece, an interview). The press release is also posted on the university website: http://www.lssu.edu/whats_new/articles.php?articleid=1816)
and picked up by the Associated Press from which it received good play in print and broadcast media across the upper Midwest and even in Florida (we do not have specific numbers but a Google search of reed canary grass LSSU will show the kind of coverage it received).

Deviations from project timeline:
Due simply to coordinating with the owner of the harvesting equipment (a local farmer), we harvested the reed canary grass a bit later in the fall than originally planned. We delayed purchase of the pelletizing equipment until we knew we would have material to work with. Then by the time we had the pelletizing equipment and got it set up, pelletizing occurred a bit later in the spring than the original work plan called for. We delayed purchasing the stove until we knew

we'd have pellets, and we changed the plan to the portable stove approach. Thus test firing and demonstrations of the stove was a bit later than the work plan had called for. Even with these delays, the work plan was completed within the project timeline.

C. Coordinated efforts with other organizations to complete the project

The project involved the collaboration of staff in LSSU's Departments of Biology, Chemistry/Environmental Science, Engineering and LSSU's Physical Plant. Local resource and agricultural agencies were helpful in allowing us to demonstrate the project at their events. Our partner on the first phase of the project, Dr Do Hong Min, Forage Specialist at MSU's Chatham Experiment Station, visited to see the progress we have made and wants to work on an Experiment Station Bulletin on our project.

D. Impacts, anticipated and unanticipated, experienced as a result of project implementation

In speaking to people at the demos, we have come to understand the growing market for pellet stoves and the interest in alternative fuels.

E. Financial expenditures of grant money and other contributions to the project, in-kind and/or direct funding.

Details are provided in section G, below, but in summary, we spent a total of $9,224.85 in direct expenses from state funds and $1,844.97 for indirect costs. The university provided funding for the purchase of the stove as well as in-kind match through donated personnel time, expenses for some incidental supplies, and equipment storage.

F. Any experience in applying the project procedures and anticipated "next steps"

Given the practical experience we now have in making pellets at the 'bench-top' scale the next step would be to work with interested farmers or others in the community to scale the process up to tons of production rather than pounds of production. The next step would thus include investigating either a student-run enterprise through LSSU, a cooperative business venture, or to discuss with a new local wood pellet producer the potential of manufacturing reed canary grass pellets for sale.

Along those lines, I recently met with the USDA's EUP Resource Conservation and Development Council and they are keen on moving forward with commercialization of this technology here in the EUP. We are looking into hosting a conference for potentially interested parties to discuss various business models and approaches.

Also, in the past week I've been contacted by Bay Mills Community College (BMCC) to help them continue some preliminary work they had started with MSU-E on looking at switchgrass as a feedstock for pellets. I have submitted a proposal to BMCC for funding of this continuing work. We will make switchgrass and reed canary grass and compare them with respect to the pelletizing process and then compare them to wood pellets in terms of heat output, ash production and chemical composition of the ash.

G. Actual budget expenditures compared to budget in project agreement and reasons for any discrepancies.

The table below summarizes actual vs. budgeted expenditures from state funding and local match. We underspent the state funds because the equipment was less expensive than we had budgeted. When we put the proposal together we were not sure which vendor we would choose so we stated a higher amount. Also the local vendor of the stove provided a discount to the University.

Actual vs. Budgeted Expenditures	Personnel	Fringe	Equipment	Other	Indirect	Total
Total Expenditures	13,482.00	2,516.46	13,200.54	1,700.00	1,844.97	32,743.97
Local Match	13,482.00	2,516.46	3,975.69	1,700.00	0.00	21,674.15
State Share of Expenditures	0.00	0.00	9,224.85	0.00	1,844.97	11,069.82
Total State Funds Authorized	0.00	0.00	13,000.00	0.00	2,600.00	15,600.00
Unexpended Balance of State Funds	0.00	0.00	3,775.15	0.00	755.03	4,530.18

Itemized equipment expenses:

State share

Hammer mill	$4,665.44
Pellet mill	$4,559.41

Local match

Stove	$3,400.00
Trailer	$ 399.99
Incidental supplies and small equipment	$ 175.70