A Test of Reed Canary Grass as a Pellet Fuel Stock in Michigan's Eastern Upper Peninsula

By Gregory Zimmerman, Dept of Biology, Lake Superior State University

http://www.michigan.gov/documents/dleg/LSSU_Technical_299139_7.pdf

Based on the increasing interest in alternative energy sources, we have recently looked at the potential for using reed canary grass as a source of heating fuel. Reed canary grass is an abundant, non-native species in Michigan's Eastern Upper Peninsula (EUP). Widely considered a nuisance species, it is not preferred forage for livestock nor is it preferred by wildlife. It is, however, being used as a heating fuel in Scandinavia and tests of this grass species are ongoing at Cornell University as well as in Canada.

In a recent previous project, we examined the energetics of using reed canary grass for use as a pellet fuel in Michigan's Eastern Upper Peninsula (EUP). The analysis was favorable. Specifically, given the energy content of reed canary grass (about 8000 BTU/lb – the same as wood or other plant material), the productivity (more than 1 ton/acre) and the fact that reed canary grass is a perennial naturalized to this area, we estimated that pelletized reed canary grass contains 32x the energy required to harvest and pelletize it. The latter point that it is a naturalized perennial simply means it requires no inputs of energy to grow it. It does not have to be planted, it requires no insecticides nor herbicides.

We then followed up that project with the present investigation in which we examined, at a small scale, the practicality of producing reed canary grass-based pellets and the burning of those pellets in a multi-fuel pellet stove. This project (# PLA-09-36) and the previous project (# PLA-07-48) were funded by grants from the Michigan's Department of Energy, Labor and Economic Growth's Biomass Energy Office. Funds for these grants were made available to Michigan via US Department of Energy's State Energy Program

In this project, we harvested about 1⁄2 acre of reed canary grass from a field on Taylor Side Road, just south of Sault Sainte Marie, Michigan. This field appeared typical of the many fields of reed canary grass throughout the clay lake plain of eastern Chippewa County, Michigan. We harvested the material with a haybine in early November 2008 after the grass had gone dormant for the winter. We gathered the cut material by hand and stored it under a loafing shed roof (i.e., exposed to ambient temperatures but out of snow/rain) until the following March when we had procured the processing equipment. We did not dry it other than the natural air drying.

We ground the material to pass a 1⁄4" screen, using a hammer mill obtained from PelletPros, Inc., a machinery dealer in Kewaunee, IL. The hammer mill (Model PP1000D, manufactured in China) included 15HP diesel motor. We did not meter fuel use, but it seemed minor (we processed the material we harvested in a few hours with less than a few gallons of fuel). For experimenting with binders, we also ground in the hammer mill corrugated cardboard we collected from used boxes, greyboard from food packages (e.g., cereal boxes), maple leaves and conifer needles collected from a yard in town. The cardboard and greyboard came out as fluff. We ground the few hundred pounds of grass in about 1-1/2 hours. The grinder emitted some fine material into the air. Nuisance dust masks (and of course eye and hearing protection) were needed for the operators. Besides the safety of the operators, the emission of fine particulates could represent an air pollution source and thus precautions should be taken to prevent their escape.

We then began to experiment with producing pellets, using a small pellet press, also obtained from PelletPros (Model PP-PTO, also manufactured in China). The press features a flat die with material driven through by rollers. The pellet press attached to the 3-pt hitch of a tractor and ran off of the PTO. We used a small Holder brand tractor, provided by LSSU's Physical Plant.

After trying various amounts of moisture and the binders, we came upon the two successful recipes listed below. With too much moisture, the material clogs up the press, with too little moisture, pellets do not stick together. Too much oil makes pellets that exude oil into the bag they are stored in. We were unable to create pellets using ground maple leaves and pine needles. We made some pellets from 100% cardboard and some from 100% brewer's grain, but the idea is to use the resource of reed canary grass.

The two successful recipes were:
1). 5 gallon bucket of uncompressed ground reed canary grass (about 2.3 kg), 1.5 L of ground corrugated cardboard, 200 mL of used frier oil, 400 mL of water
2). 5 gallon bucket of uncompressed, ground reed canary grass (about 2.3 kg), 800 mL of wet, spent brewer's grain.

We stirred the ingredients in a larger tub by using a paint stirrer inserted in the chuck of an electric hand drill. We stirred the ingredients until they were evenly distributed (two to three minutes). A grinding method for the cardboard that didn't leave it so fluffy would improve the mixing process but we have not experimented with any other grinding method.

The material was then run through the pellet press. We experimented with various PTO speeds and found that the rated 540RPM provided the heat needed to form the pellets. Pellets formed at lower speeds were not as firm and the pellets were produced slowly. After about 15 min of running at 540RPM, the material warmed to a point of emitting water vapor and firm pellets were formed. We let the pellets cool to ambient temperature (about 20 minutes) in a shallow layer of pellets in the bottom of a bucket that we used to catch them from the press. We then placed the pellets in plastic bags for later test combustion in the stove.

The tractor was not especially loud, but hearing protection (and of course eye protection) is still recommended. The process did not eject fines into the air, so a nuisance dust mask was not necessary.

Pelletizing compacted the material to about 1/5th its original volume to a density of approximately 0.60 g/mL for recipe 1 and 0.55g/mL for recipe 2. Our pellets are slightly lighter than the standard of 0.64 g/mL (40 lbs per cubic foot) for hardwood pellets as set by the Pellet Fuel Institute. Thus our pellets would require slightly more storage space and more frequent filling of a user's stove.

Once we got the recipes established, we were able to make a recipe's worth of pellets in 10 minutes (after the pellet press ran for 15 minutes to reach optimal temperature). This time frame reflects production of test runs – a full production run of several pounds of material would likely go faster but we have not yet tried to make a production run of, say, 50 lbs of material.

We then tested the pellets in a multi-fuel stove (Quadrafire Mt Vernon) we purchased from a local dealer. We mounted the stove on a small utility trailer to make it portable for demonstration purposes. We bolted the stove to the trailer bed and installed a short (ca. 4') wall behind the stove and mounted the computerized thermostat on the wall. We passed a stove pipe from the stove, through the wall and up past the wall.

Both types of pellets fed well and burned well. In running the stove continuously for up to 2 hours at a time, we encountered no clinkers in the ash. The two hour time simply reflects an amount of time that the demo ran at the farmer's market. The stove seemed to produce what seemed like a good heat output within about 45 minutes. In an actual home installation, it would cycle off and on under control of the thermostat. We set the thermostat to a 10 degrees above the outside temperature so that observers would see the pellets burning.

We tested both pellets with the automated ignition feature of the stove which requires that the stove be plugged into an 100v AC power outlet. We also tested them with the stove running on a 12v battery, which required manual ignition (we used a blow-torch). The pellets lit readily with both methods of ignition.

We will be starting another project in which we will test other proportions of the above binders and to compare reed canary grass to switchgrass as a base stock for pelletizing and to test heat output of the stove, ash production and ash composition of reed canary grass pellets, switchgrass pellets and wood pellets. Characterizing emissions of particulates from the stove (as well as prevention of emissions of fine particulate matter during grinding) would be another area that should be investigated.

The production process described here is for lab-benchtop scale experimentation. The information would also be useful for an individual making pellets for his/her own use. According to our previous project, 3 tons of reed canary grass pellets would yield a BTU content equivalent to 800 gal of propane. <u>For someone who already has hay harvest equipment and with reed canary grass on his/her property, we would expect a substantial savings in heating fuel.</u>

This technology also has broader commercial potential for local industrial development. Based on the results of this project we are encouraged about the commercial potential. Commercialization will, however, require investigating larger capacity mixing and pelletizing.

We are presently looking into various business models and opportunities for commercialization. Broad scale adoption of pellet fuels, wood and/or reed canary grass, could be beneficial in terms of reduced carbon emission compared to use of fossil fuels and reduces reliance on foreign energy sources.