Use of invasive local grasses for pellet fuel stock: Progress Report, Spring 2014

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Over the past few years, I have been working with LSSU students to investigate the potential use of local invasive grasses as feed stock for pellets to be used in pellet stoves.

Reed canary grass, *Phalaris arundinacea*, is a cool season perennial grass not native to the EUP. It was planted widely for erosion control and as a possibility for livestock use. It is not a high quality forage for livestock or for wildlife. In fact, some reed canary grass harbors an endophytic fungus (i.e., a fungus that lives within the shoots of the plant) that makes the grass unpalatable for livestock. Reed canary grass spreads aggressively and can overtake entire fields. Many old hay fields in the EUP have been overtaken by reed canary grass. It is considered an invasive nuisance species.

Our first project, in partnership with MSU's Chatham Experiment Station and funded by Michigan Biomass Energy Program, looked at the economic feasibility of reed canary grass as a pellet fuel. We looked at typical end-of-season yields of reed canary grass and caloric content of the material. We examined pellet making processes, estimated yields of the pellets and energy input required to harvest the grasses and to make the pellets. We also examined types of pellet stoves that could handle grass pellets. Our analysis indicated that three (3) acres of reed canary grass could produce pellets with the energy equivalent of 800 gallons of propane and that the energy output was 32 times the energy required to harvest the material and make the pellets.

Our second project, also funded by Michigan Biomass Energy Program, followed up on this initial project. We obtained a hammer mill and a pellet mill and a multiuse pellet stove. The pellet mill was driven by the PTO of a tractor. We used a tractor made available by LSSU Physical Plant for the pellet production. We harvested late season reed canary grass and experimented with various recipes for making pellets. We were able to identify a recipe that made consistent pellets. The pellets had BTU content similar to wood pellets and burned well in the pellet stove, but as expected had greater ash content. One LSSU student research technician was hired on this project, and the project became the subject of his senior research project.

Following these projects, we partnered again with the Chatham Station and with Bay Mills Community College to examine the potential of switchgrass (*Panicum virgatum*) as feedstock for pellets. We obtained switchgrass bales from the Chatham station and we were able to make pellets from them. The pellets were quite similar in energy content, the switchgrass pellets had slightly less ash content. We planted switchgrass in two fields. The clay soils and cold, wet climate of the EUP was not amenable to the growth of this warm season grass.

As part of the project with Bay Mills Community College, we attempted to scale production up from benchtop (i.e., pounds at a time for experimental purposes) to production level (i.e., several hundred pounds at a time) and with various feedstocks including reed canary grass, switchgrass, reed (*Phragmites australis* – a genotype of which is an invasive nuisance species of wetlands) and giant miscanthus (*Miscanthus sinensis* – a nonnative grass planted ornamentally and for biomass production). Part of this phase of the work was completed during my sabbatical in the Spring of 2014.

Five different LSSU students worked as student technicians on this project (two at any one time). Due to a variety of circumstances, pellet production was moved from LSSU to our farm using our tractor.

Miscanthus was obtained from ornamental plantings in Sault Sainte Marie, Michigan, phragmites from a stand on private property south of Sault Sainte Marie. The student technicians developed harvest techniques to increase efficiency of the hand harvesting and bundling. They also developed a method for screening the extra-fines and fluff from the ground material (both the fluff and extra-fines interfered with the pelletizing process).

The student technicians experimented with various recipes, systematically varying the moisture and binder content and fired the stove with the resulting pellets to determine heat output.

The student technicians ran into several problems in attempting to scale production up. At the benchtop scale, we mixed the grasses, water and binder using an electric drill with a paint stirring paddle. For larger quantities, the students used a vinyl-barreled cement mixer. The static electricity on the vinyl proved to be a problem since the ground grass material clung to the side. We could not achieve uniform moisture dispersal and a thick layer of moist ground grass formed inside the mixer. We tried various anti-static and hydrophobic compounds (e.g., RainEx). None worked as well as we would have liked.

Another problem was that the pellet mill main shaft became stressed and bent. That resulted in undue wear on the bearings. After replacing the bearings a few times, the shaft finally gave way and left the pellet mill inoperable. Replacement parts are not available from the manufacturer in China. We are presently investigating whether another shaft could be machined locally at a reasonable price.

With the loss of our pellet mill, Bay Mills Community College (BMCC) acquired an electrically operated pellet mill. Once a 220 volt circuit was installed, production moved to the BMCC farm on M221 just south of Brimley. The student technicians have had to discover the best techniques for pellet production with this new equipment.

We are slowly making progress but we have not yet been able to scale up to production level. The pellet production process is finicky. The recipe that works one day with one kind of material on one machine does not work as well the next day and especially with different material and on a different machine.

This past summer, I was contacted by researchers at DePaul University and Loyola University Chicago about their proposed work on invasives-to-energy. As a result of these discussions, I was invited to be a part of the proposal to the EPA Great Lakes Restoration Initiative. Other collaborators are out of the University of Michigan Biological Field Station at Pelleston. We recently received word that the project was funded. With this additional funding, we will be further developing the production process and we will be converting phragmites and reed canary grass to fuel pellets in the Sault Sainte Marie, Michigan and Cheyboygan, Michigan areas. Funding is available to continue one of our current student technicians (the other one is graduating in May).

Regarding the work completed while I was on sabbatical, the objectives listed in the sabbatical proposal were to investigate:

- how the pellet making process can be scaled up from benchtop to several-ton production level,
- how well excess hay and other grasses such as Phragmites work as pellet stock and whether they can be harvested in an appropriate way.

The first objective remains a work in progress but because of the time I was able to devote to the project that one semester, it is continuing thanks to an EPA grant in collaboration with researchers at DePaul, Loyola University Chicago and University of Michigan Biological Field Station.

The first objective was completed. Phragmites works well as a pellet stock. We developed a small-scale technique for hand harvesting (viz., tie into bundles and cut the stalks near the ground with an electric hedge trimmer). Part of the EPA grant will be to develop large-scale, machine harvesting techniques. Miscanthus does not work well in our pellet process due to the elasticity of the pith material.

The deliverables for my sabbatical project were to be a report and presentation on how to scale production up. Since that portion remains in progress, I do not have a such a report available at this time. When we develop the larger scale production process for the EPA grant, I will develop that report and presentation.

This project continues to provide opportunities for LSSU students and strengthens LSSU's reputation off campus as shown by the researchers on the EPA grant contacting me. I have also been in contact with a graduate student at George Mason University who is developing a pellet production system. I also receive enquiries from farmers around the state who are looking at potential for energy grass crops. I am encouraged by the new program to be coming out of our Engineering Department that will help position LSSU as a leader in undergrad education and research in alternative energy.