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A Burning Rationale for Grass Biomass

By Jerry H. Cherney
Cornell University, Department of CSS

*It takes 70 days to grow a crop of grass for pellets.
It takes 70 million years to make the fossilized grass in fossil fuels.*

Rural America has a tremendous capacity for energy production. While the ongoing energy crisis is the primary driving force for alternative energy development, environmental issues will sooner or later overshadow energy supply issues. An ideal alternative solid biomass feedstock should be nearly carbon neutral, without significant net increase in atmospheric carbon dioxide.

Due to the lower fossil fuel inputs and the high energy conversion ratio of grass combustion, grass fertilized with manure provides at least 8 times the greenhouse gas reduction benefit of corn ethanol. Using grass for heat, replacing liquid fossil fuels, results in about 4 times more useable energy for transportation than converting corn to ethanol, using Ohio State data. REAP-Canada estimates that the net energy gain per acre from switchgrass fuel pellets is 3 times greater than that for switchgrass cellulosic ethanol. A recent article in Science magazine claims that low-input native grasses as biofuel can actually result in a net removal of carbon from the atmosphere. This would greatly increase the greenhouse gas reduction benefits

of grass compared to the estimates above, which assume 85-90% carbon efficiency for grass.



Reed canarygrass baled in September at less than 3% ash content on marginal land.

Hay as fuel. John Davie Butler in Nebraska in the late 19th century noted that "Straw and old prairie grass have been thought as useless as grave stones after the resurrection." Then he observed firsthand how grass heating had saved the lives of many Great Plains settlers. Large stone and brick fireplaces fueled with grass, straw or dried manure provided enough heat for cooking and extended radiant heating in the late 19th century. Metal stoves were invented that were fueled with grass twisted into stovewood lengths, the first attempt at

grass densification. Once transportation infrastructure was established on the Great Plains to allow delivery of cheap fossil fuels, grass heating quickly disappeared.

Management issues. It is possible to significantly change both the composition and quantity of grass biomass through management. Existing mixed stands can be used for grass biomass production, although sowing a single species is likely to maximize yield. In our region the most likely species chosen would be switchgrass or reed canarygrass. Switchgrass is much less tolerant of imperfect soil drainage, compared to reed canarygrass. Some fertilization of grass is essential for reasonable yields. In our region dairy manure can be used for this purpose, alleviating nutrient management problems on dairy farms. No weed, insect or disease control is anticipated with cool-season grasses, maintaining a pure stand of switchgrass will probably require some weed control. Cool-season grasses can be cut sometime between late July and late August. Cut grass left in the field for a week or more will permit leaching of the two most problematic minerals, potassium and chlorine. Care must be taken to avoid soil contamination, which would offset leaching gains. Chlorine content can be reduced to as low as 0.01% and potassium content to less than 0.5% with this management. The BTU content of grass can be higher than premium wood pellets, but averages about 5% lower than wood.

Switchgrass will require a different management scheme, compared to cool-season grasses. Switchgrass cut in late summer may damage plant persistence, even if cut at a higher stubble height. Late fall harvest of switchgrass also is risky, because a wet fall season could prevent baling of dry hay. Overwintering standing switchgrass for early spring harvest has the advantage of maximizing chlorine and potassium losses through leaching, but a large yield reduction is possible. As with all forages, crop quality is important for grass biomass, but a significant yield reduction will severely impact the economics of the system. Currently the best harvest system for switchgrass biomass in the northern USA may be to mow and swath the grass in the late fall, allow it to overwinter in the field, and bale the following spring (REAP-Canada system). Grass biomass can either be densified for ease of transport into pellets or briquettes, or coarsely chopped biomass can be burned without densification.



Russian oven in Krause House, photo courtesy of the Mennonite Heritage Museum, Goessel, KS. The metal "zweibach" pans were designed to fit into the long narrow baking chamber.

Burning issues. Ash is more than an issue of convenience for the user. The composition and quantity of combustion residue are the primary factors determining whether or not a feedstock can be burned effectively in a particular appliance. The range in total ash content of grasses can be very large, from less than 1% to greater than 20%. Ash values significantly higher than 10% are most likely the result of excessive

surface soil contamination. Mineral composition determines the melting point of ash, and also the potential for corrosion. These are the issues of primary concern when

burning grass. Melting of ash into solid clinkers makes ash management problematic. Silica is the largest component of ash and is found in much higher concentrations in the leaf and inflorescence, compared to the grass stem. Silica can combine with alkali metals to form silicates that melt at lower temperatures. Of the alkali metals, potassium is by far the most abundant in grasses. It will reduce the melting temperature and also contribute significantly to corrosion potential. Chlorine is a particularly damaging component of grasses, as it catalyzes corrosion reactions. Sulfur reacts with alkali metals to form deposits on heat transfer surfaces. Reduced concentration of all the above mentioned minerals in grass is highly desirable.

Do we fit the grass to the combustion appliance or vice versa? The primary technical stumbling block to for a grass combustion industry in the USA is the lack of residential-scale appliances specifically designed to burn high ash pellet fuels. Through management and breeding, grass biomass composition can be modified to minimize corrosion and clinkering. Although grass compositional improvements are worthwhile, a more robust solution is to modify appliances to be able to burn a diversity of feedstocks. Industrial sized ceramic-lined boilers (1 million BTU or more) are currently capable of burning grasses. Some light industrial sized boilers (500,000 BTU range) may be able to burn 100% grass, but almost certainly are able to burn fuel mixtures up to 75% grass or higher. Residential scale boilers from Europe with ceramic-lined combustion chambers, electronically controlled shaker grates, and auto de-ashing are capable of burning a least up to 75% grass in a fuel mixture, and may be able to burn 100% grass depending on composition. Mixing grass with corn, wood or other biomass fuels will expand the number of suitable appliances for grass combustion.

The grass litany. There is a long list of positive traits associated with grass bioenergy that are beneficial to society in general and/or beneficial to farm operations. In order of relative importance these are:

- 1) Greenhouse gas emissions impact our future as a species on planet earth, reduction of emissions is the most significant contribution of grass combustion.
- 2) Economic assessments of grass biomass to-date indicate that grass can be competitive with fossil fuels without government subsidies.
- 3) Local energy security means local production, local processing, and local consumption; few solid biomass energy crops can make this claim.
- 4) Energy conversion efficiency is very high, with an energy-out:energy-in ratio of about 14:1 for grass combustion.
- 5) This system is ideal for helping to solve nutrient management problems on livestock farms.
- 6) Perennial sod crops also are ideal for minimizing soil erosion and leaching.
- 7) Grass energy farming is a low-technology, small-scale energy system that will result in rural jobs and economic diversification, absorbing excess production capacity.
- 8) Necessary equipment is available on most farms and harvest time is flexible, resulting in high grower acceptance.



Grasses do not require any binders to form good pellets, but the pellet die and pelleting conditions need to be adjusted to grass.

- 9) This energy crop can be produced on any agricultural land resource, particularly those not suited to row crops.
- 10) Pure stands are not essential; no need to apply pesticides to grass biomass stands meant for combustion.
- 11) Wildlife nesting in grasslands has become a sensitive topic; the late harvest of grass biomass solves this problem.
- 12) It is not necessary to maintain a pure stand for grass combustion purposes; this system can encourage species diversity.

How do we light a fire under politicians? Grass combustion would not directly compete with corn ethanol, and it can be viewed as a near-term alternative energy source that can bridge the gap until the promise of cellulosic ethanol is realized. The overall primary stumbling block for a grass combustion industry in the USA is the lack of political support. Grass combustion has great potential, but highly successful ethanol and biodiesel lobbies have forced grass combustion to stay on the back burner. Some effort needs to be invested in modifying appliances for grass. Some government support is essential for start up of an industry that requires both production and a simultaneous market for the product. Although fighting politics with facts can often be frustrating, the many positive benefits of grass for bioenergy should eventually overcome the lack of an organized political lobby.

For more information on grass biomass, visit www.grassbioenergy.org.

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