Grass Biofuel Pellets: An ecological response to North America's energy concerns

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Introduction

Unprecedented opportunities for biofuel development are occurring as a result of a combination of factors including: rising oil, natural gas and electricity costs, energy security concerns in the US, and the need to reduce greenhouse gas emissions. The 1.1 billion acres of farmland in North America could help mitigate these concerns if currently viable biofuel production systems were expanded. In most agricultural regions, warm season grasses such as switchgrass can be successfully grown at a cost of USD $2-$3/GJ. Much of this farmland can collect 100-250 GJ of energy per hectare with existing production technology and plant materials. Efforts have been made to produce power and liquid fuels from this material, but the development strategies demonstrated so far appear to be sustainable only with subsidies. Converting this feedstock into a viable energy option suitable for widespread application requires an energetically efficient, economical, and convenient energy transformation pathway to meet consumer energy needs.

Finding Energy Farming's Comparative Advantage

The recent development of "close coupled" gasifier pellet stoves and furnaces capable of burning moderately high ash pelleted agricultural fuels provides a completely new fuel cycle for energy farming development [1]. When burned in the gasifier stoves and furnaces, pelleted switchgrass provides fuel conversion efficiencies and particulate emissions in the same range as modern oil furnaces. Each GJ of grass pellet energy delivered to consumers thus directly substitutes for one GJ of delivered oil and can be utilized on a large scale without significant air pollution. The pelletized grass biofuel systems builds on, and is likely to overtake, the existing wood pellet heating industry, which is rapidly developing without any significant level of government intervention.

Pelletized grass biofuel is poised to become a major fuel source because this fuel pathway is capable of meeting some heating requirements at less cost than all available alternatives. The cost-effectiveness of pelletized grass as a fuel results from:

- efficient use of low cost marginal farmland for solar energy collection
- minimal fossil fuel input use in field production and energy conversion
- minimal biomass quality upgrading which limits energy loss from the feedstock
- efficient combustion in advanced yet modestly priced and simple to use devices
- replacement of expensive high-grade energy forms in space and water heating

Contrary to the prevailing wisdom that reducing greenhouse gas emissions will raise societal energy costs, pelletized biofuels can provide consumers with lower and more stable heating costs while dramatically cutting greenhouse gas emissions. Given that agricultural commodity prices are declining in real dollars, pellet fuels are likely to become cheaper over time. By contrast, wood-based pellets have been rising in cost due to ongoing improvement in industrial wood utilization which is reducing the waste fraction of delivered roundwood. Furthermore, the development of a grass pellet biofuel industry has great potential to revitalize the rural economy of North America by absorbing the surplus production capacity of the agricultural sector and cutting on-farm fuel costs in heating intensive sectors like green houses.

The Potential for Energy Farming with Grasses
Of the farmland in North America (932 million acres in the US and 168 million acres in Canada), we estimate that 150 million acres could be dedicated to energy farming without appreciably affecting North America's food production capacity. Assuming biomass energy crop yields are 50% higher than the current harvested hay yields, harvested perennial grass yields of 5.9 and 8.1 tonnes/ha in Canada and the US respectively can be expected. By energy farming 130 million acres in the US and 23.4 million acres in Canada, a total production capacity of 424 and 55 million tonnes could be achieved in the two respective countries. Assuming grass fuel pellets contain 18.5 GJ of energy/tonne, 8.9 billion GJ (an energy equivalent of 1.5 billion barrels of oil) could be produced each year from energy crop production on 14% of North American farmland. With U.S. crude oil imports of approximately 3.4 billion barrels per year, the U.S. could displace the equivalent of 39% of its oil imports by growing biofuels on 14% of its farmland.

The Economics of Pelleted Biofuels
The most promising regions to develop a grass pellet fuel industry are those where hay production costs are low (generally indicated by low land rent) and heating costs are high due to a long winter heating period and high fossil fuel costs. Based on hay prices, land costs and warm season grass performance data in North America, and the relative winter heat costs of the various regions of North America, the best regions are the states of North Dakota, South Dakota, Nebraska, Minnesota, Wisconsin, and the provinces of Manitoba, Ontario, and Quebec.

An ideal location for a biofuel pellet industry is the province of Manitoba. This largely agricultural region has amongst the lowest hay prices in North America and no indigenous fossil energy reserves. The spread between delivered heat costs of conventional energy sources and hay costs is rapidly growing. In real dollars, long-term hay prices remain flat at USD$2/GJ (USD35$/tonne) while delivered heat costs for natural gas, oil and electricity are rising and are now in the USD$10-$13/GJ range. With current pellet production costs estimated to be $2/GJ (USD$35/tonne) and a conversion efficiency of 80%, delivered heat costs for on-farm and residential grass pellet fuels are projected to be in the USD$5-$7.50/GJ range. There are major opportunities for Manitoba households to switch from electrical heating (used by 32% of households) to biofuel heating systems. Widespread implementation of this energy substitution strategy would enable hydro-rich regions such as Manitoba and Quebec to expand electricity exports into the US market.

Summary
This paper makes the case that the easiest way to move biomass energy ahead in North America in the future is to focus on the development of pelletized grass biofuels as an ecological substitute for high-grade energy forms such as oil, natural gas and electricity in heat related energy applications. North American energy markets could be profoundly transformed by the development of a large scale, pelletized grass biofuel industry. As prices continue to rise for high grade energy forms, low priced farm derived biofuel pellets will increasingly become the heating fuel of choice for many North American energy consumers.

References
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