

Production of Grass Biomass in the Northeast

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A Department of Energy Biomass Program Manager recently delivered a presentation at Cornell University on biomass feedstock supply systems. A USDA/DOE study has identified more than 1.3 billion tons of biomass feedstock potential in the USA. A system for harvest, storage, preprocessing and fractionation, and transportation of feedstocks was described, leading to a standardized feedstock material for large scale lignocellulosic biorefining at centralized locations. This system requires the design of many new or highly modified pieces of machinery in order to get the biomass to the biorefinery, and the design of very sophisticated equipment that can successfully biorefine lignocellulose into ethanol and other bioproducts. It is not clear how many years (decades?) it will require to make this system operational. This system is based on the principal that cellulosic ethanol is our supreme goal. The deployment of an astoundingly simpler and more efficient bioenergy system, such as biomass combustion for heat, could be viewed as a direct threat to the established role of lignocellulosic biomass by USDA/DOE. This is one of the significant hurdles we will face in trying to establish a bioheat energy system in the Northeast.

There is a near-term alternative solution to the many issues faced by any mega-conversion facility that would be located in the Northeast. Biomass for combustion can be a closed energy loop, with relatively small-scale local production, processing and utilization of lignocellulosic biomass. Such a system is economically feasible, environmentally desirable, energetically very efficient, and fits in very well with livestock farming operations. Delayed harvest also provides for successful wildlife nesting. Below is the system we are considering in NYS for site-specific evaluation and management of grasslands for biomass production.

Site Selection

If you don't like your soil type in the Northeast, walk a few paces in any direction. Not only do we have a myriad of soil types, but we have considerable land with improper drainage. In New York a database of potential yields for forage crops on all soil types has been developed (at www.forages.org). Potential yields are used as a basis for selecting the appropriate forage species for a given site. Pennsylvania has also developed a similar database, using the same species selection program. A database for biomass crops, including corn and soybeans, on all soil types has been developed for NYS and will be available shortly at www.grassbioenergy.org. This information should help in determining if a species is appropriate for a specific site, and for assessing the potential yield of a mixed grass meadow on a specific site. Such a database could be developed for Vermont.

Pure Grass Species vs. Mixtures

Because of variation in climate and soil conditions throughout the northern USA, both warm and cool season grasses should be investigated for their ability to produce biomass at low cost and simultaneously address nutrient imbalances for dairy and livestock farms. Herbaceous biomass studies going back to the early 1980's have indicated that switchgrass and reed canarygrass have considerable potential for biomass production in the northern USA. Switchgrass, as a C₄ species,

has greater photosynthetic, water and N use efficiencies compared to C₃ species. However, switchgrass is not well suited to soil types with imperfect drainage, thus it is important to investigate alternatives such as reed canarygrass, which is well suited to all agricultural soil types in the Northeast.

Pure species will likely produce higher yields, an important consideration in any biomass scheme. Pure species will require a higher level of management. Maintaining a pure stand of switchgrass will require some herbicide intervention. As long as warm-season grasses are appropriate for the soil resource, they will produce good yields with the most desirable composition of any grasses. Cool-season grasses can produce yields similar to switchgrass, and possibly higher yields on more marginal soils, but will require higher fertility inputs and may require 2 harvests each season. Species mixtures, particularly those with a legume component, will require lower inputs, and will likely produce lower yields.

Establishment

If a new grass stand is being established, both conventional tillage or reduced tillage can result in good stands. Switchgrass can grow on soils with a relatively wide pH range; however, a pH of 6.5 is optimal. To reduce competition by weeds it is not recommended to apply manure or nitrogen (N) fertilizer in the year of establishment. Switchgrass seed is relatively small, accentuating the need for good seed to soil contact for optimum germination. A seeding rate of 7-9 lbs of pure live seed (PLS) per acre is recommended in northern climates but switchgrass seed is often highly dormant, especially immediately after harvest and for this reason close attention should be given to information such as % dormancy located on the label on the bag. Seeding rates should be based on PLS. Seeding should occur after the soil temperature reaches 60°F or within 2 weeks of the recommended corn planting dates in your area. Seed should be sown at a depth of ¼ to ½ inch for conventional and no-till planting with the shallower seed depth for heavier soils. One to three seedlings per square foot at the end of the establishment year is considered a successful establishment. Weeds must be controlled in the seedling year, typically by clipping at the height of switchgrass seedlings.

While warm-season grasses should be sown in mid to late May, cool-season grasses can be sown in the early spring or late summer. Seeding rates vary by species, typically 12-15 lbs for reed canarygrass, with seeding depth similar to that for switchgrass. Weed control the seeding year is less critical than for switchgrass, but is still a good idea.

Stand Management

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 will maximize yield. In our region the most likely species chosen would be switchgrass or 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.

Switchgrass will require a different management scheme, compared to cool-season grasses. Switchgrass cut in late summer is likely to 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. "Improvement" in crop quality is important for ease of combustion, but a significant yield reduction will impact the economics of the system. It is not clear if the system of mowing and swathing grass in the late fall, and allowing it to overwinter in the field, is practical for winters where snow cover is sporadic through the winter season, with occasional thawing.

Harvest of abandoned or under-utilized grass meadows

There is approximately 1.5 to 2 million acres of unused or underutilized grass meadows in NYS. If these fields are not too far along the path of woody succession, they can be mowed and baled. The economic feasibility of this depends on the yield per acre, and the size (efficiency) of the harvesting equipment. Abandoned fields tend to revert to a more rugged terrain over time, so harvest of some of these fields may be problematic. Rough terrain will mean increased soil contamination of biomass, increasing the ash content. Straw or stover can be harvested, pelleted and used for combustion, but typically is relatively high in ash content, also due to increased soil contamination. A number of abandoned fields have been mowed and baled in east-central NYS in 2008, now waiting on the completion of a grass pelleting facility in Delaware county.

Summary

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. This will happen when the USA is forced to seriously deal with greenhouse gases, carbon crediting, and energy efficiency, as Europe has already done.

