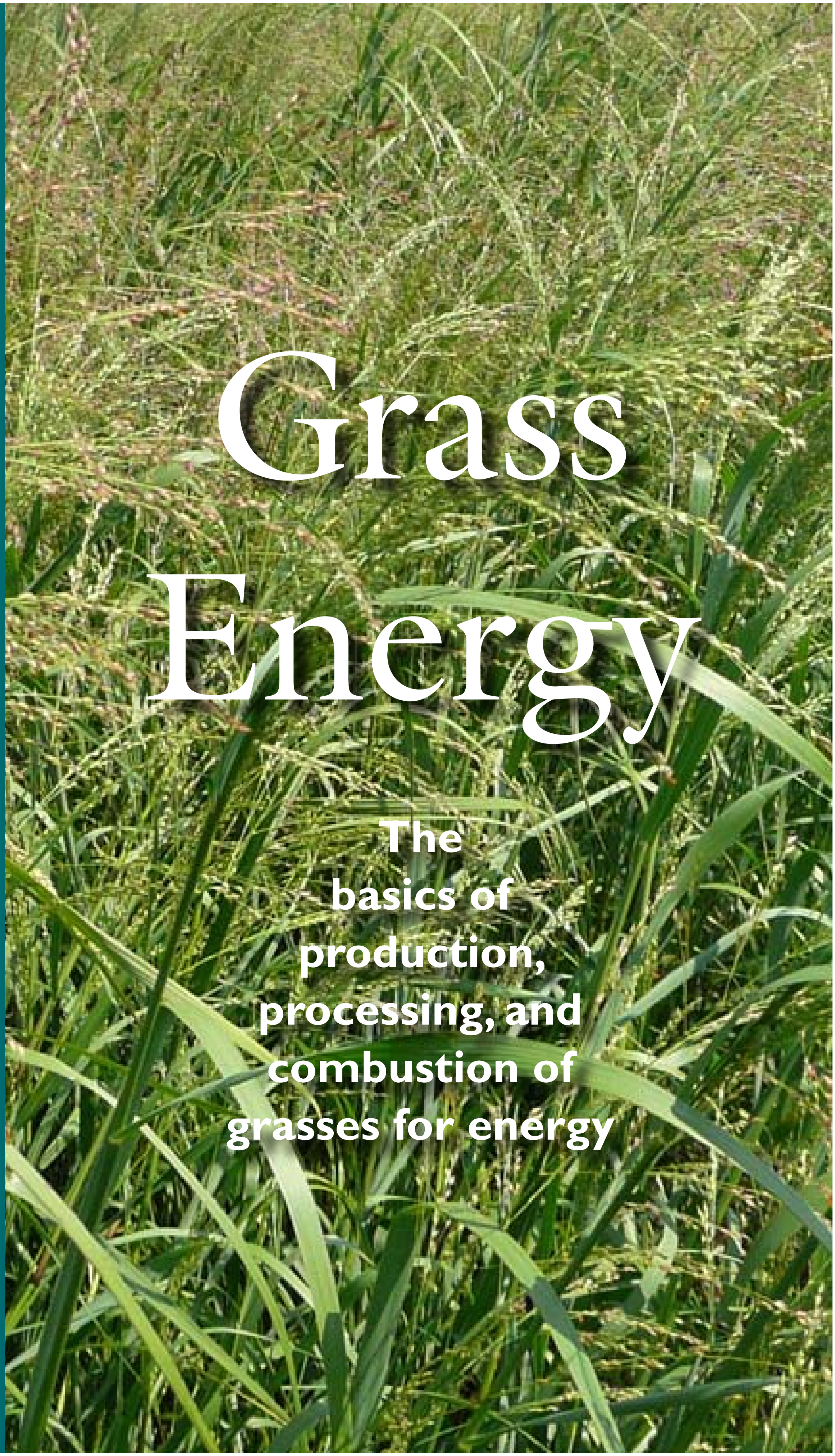

Grass Energy

The basics of production, processing, and combustion of grasses for energy

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A BASIC DISCUSSION ON

Grass Energy

Conventionally, most solid biomass heating fuels—woodchips, wood pellets, and cordwood—came from forests and the forest products industry. Over the past 15 years, however, growing crops (both herbaceous and woody) specifically for energy has gained widespread appeal, and perennial grasses such as Switchgrass, Miscanthus, and Reed Canarygrass present exciting new renewable energy options.

Perennial grasses are now being used as a solid fuel in co-fired coal power plants as well as targeted as a choice feedstock for such advanced biofuels as cellulosic ethanol. Despite this focus on generating electricity and producing liquid fuels, perennial grasses can also be pressed into pellets, briquettes, and cubes and used as a heating fuel to replace or complement fuels made from wood fibers. Including a thermal component in the use of solid biomass for energy increases a combustion system's efficiency more than threefold.

Benefits of Using Grass for Energy

Perennial grasses have many benefits as a bioenergy crop. The simplest way to think of grass is as an efficient and fast growing solar energy collector that is relatively easy to grow, harvest, and process. Grasses not only sequester and store vast amounts of carbon in the root systems and soil, but conveniently occur globally in a wide range of geographies, climates, and soil types.

Grasses can be grown on marginal lands ill suited for continuous row crop production and/or in open rural land currently not in agricultural production. They yield more biomass per acre, and, once established, require far fewer inputs in comparison to annual crops that require more diesel, fertilizer, and pesticides.

Additionally, perennial grasses grown for energy can provide a new revenue stream and profit center to farmers and other landowners, and afford important water quality and wildlife benefits. Grasses and other agriculturally produced crops can be grown easily (with conventional equipment), quickly, and in large acreages and volumes. This can help increase the production of biomass fuels by utilizing local resources. Soil erosion, water quality, and wildlife benefits can also be enhanced depending on what type of land and current crop cover is converted to energy crops.

Energy studies indicate that significant gains in energy return and reducing carbon emissions can be achieved with using Switchgrass as a biomass fuel. Switchgrass used for heating has an energy output to input ratio of at least 10 to 1, compared to other bioenergy sources with output to input ratios around 1 to 1. A recent study determined that one acre of farmland is capable of producing an average annual yield of herbaceous biomass sufficient to meet the annual space- and water-heating needs of an average home. An existing energy prospect, with planning and conservation, is the ability for communities to produce their own heating fuel through local farmers growing grasses and farm supply cooperatives (or other aggregating businesses) densifying and delivering fuel.

EVOLUTION OF GRASS ENERGY

In the late 1800s, grasses were widely used as a heating fuel in the prairie regions of the United States, an area with little forested land. Farmers in these areas relied on harvested straw and prairie grasses, or "prairie coal," which were often twisted into bundles and burned in simple stoves.

Today, modern solid biomass heating systems are highly engineered, automated, and clean-burning. Like the existing wood pellet market in Europe and the developing market in the United States, grasses may soon be pelleted and delivered in bulk by a special tanker truck, pneumatically blown into storage systems, and automatically fed into the combustion system with no manual labor required.

The most promising areas for development of a grass-based energy industry are the north central and northeastern regions of the United States, where there is sufficient agricultural land base and heating costs are high due to long winters. As an alternative fuel for heating, grasses have Btu levels approximately 95 percent of wood. Densified grass fuel is competitive in price with fuel oil, natural gas, propane, and electricity.

Choice Grasses for Fuel

No one grass species can be grown effectively in all regions and climates, however, the most broadly considered grasses for energy production are Switchgrass (and other native prairie grasses such as Big Bluestem and Prairie Cordgrass). Miscanthus, a super high-yielding crop, has garnered much interest and is now being studied. Reed Canarygrass is often naturally present and high yielding in wet, marginal areas, however, it is also recognized as invasive—choking out other native wetland species—so its use as an energy crop is more contentious. Each has its own benefits and disadvantages as a biomass fuel source (see panel at right).

When considering which is the best choice, the first consideration is generally the yield per acre in any given microclimate/soil type, as this greatly influences the economics of conversion of the crop to a useful form for energy extraction. Another consideration is the mineral/ash content of a given grass on a given plot, which may affect the value of the crop as a densified fuel for thermal applications. Another consideration may be harvest windows as influenced by local climates. What will the moisture content of the harvested grass be? Will this limit uses? Are there other users, birds, for example, of the grass as it is growing and how do they shape options for harvesting?

Managing Grass for Energy

In general, grasses grown for energy are managed for biomass yield rather than forage or nutritive quality. In fact, lower nutrient levels (nitrogen, sulfur, chlorine, etc.) may improve fuel quality and reduce emissions.

As expected, the growth and yield of the grass crop is highly dependent on soil conditions, moisture, fertility, weed control, and timing of harvest. During the growing season, modest use of fertilizers may be needed to maintain soil fertility and improve crop yields. Careful attention must be paid to ensure that crops are not overfertilized for risk of leaching surplus nutrients into ground and surface waterways.

Native, warm-season grasses like Switchgrass are widely adaptive once established, however, require attentive weed control in the first year of establishment so cool season grasses do not overwhelm it. Nitrogen fertilizer is not recommended in the first year to reduce competition from grassy weeds. Switchgrass should be harvested once per year, generally after frost, using standard haying equipment. Grasses cut in the fall and left to over-winter are far lower in yield but have been shown to leach out potassium and chlorine, two minerals that may create issues during combustion.

Miscanthus can be tricky to establish and should be harvested late in the fall, after senescence, using standard farm equipment (i.e,. corn silage choppers, balers).

Each species has its own management protocol, and state university extension offices can provide information on specific seeding, harvesting, fertilizing, and weed-management practices.

MAJOR FUEL GRASSES

SWITCHGRASS

(Panicum virgatum) is native to the United States and one of the best herbaceous (not woody) energy crops because of its perennial growth habit, high yield potential on a wide variety of soil conditions and types, compatibility with conventional farming practices, and value in improving soil and water conservation and quality.

MISCANTHUS

(Miscanthus x giganteus, a natural hybrid of Miscanthus sinensis and M. sacchariflorus) is a giant, perennial warm-season grass native to Asia that is generating much enthusiasm for extremely high yields and very high cold tolerance. Miscanthus, however, does not produce viable seed (a sterile hybrid) so must be propagated by planting underground stems, called rhizomes.

REED CANARYGRASS

(Phylaris arundinacea) is a perennial wetland grass, native to parts of the US, Europe, and Asia. It is a cool-season grass that is less productive than warm-season grasses. It is winter hardy so can be grown in colder climates and under shorter growing seasons; however, many ecologists and conservation departments consider it an invasive species because it frequently out competes and threatens natural wetland species.

Densifying Grasses

To utilize the energy stored in grass, the crop must be harvested and processed into a 'user-friendly' format, either on farm or transported to an off-farm facility.

Like wood, grasses can be densified into a durable, high-quality pellet fuel, sized to a standard ¼ -inch diameter. There are also prototypes of 'portable' pelletizers that could support a distributed production model, although, to date, these units are not commercially available and the fuel does not match the quality of those from centralized pellet plants.

A less-expensive densification method (higher throughput per hour) is by forming the grass into larger briquettes, also called tablets or pucks (see image at top right of page) or cubes, allowing the material to be handled and stored easily, transported economically, and burned efficiently. One advantage to this method is that grasses dry in the field, reducing drying costs at a pellet mill. While this process is easier than making ¼-inch pellets, so far there are very few systems that can successfully burn these larger forms of grass-based fuels, and they may not be as durable or flowable through augers and upon conveyers.

Grass Combustion

Grasses have 95 percent of the Btu value of wood and several pioneering companies are beginning to produce high-quality grass pellets for heating. Historically, since biomass combustion systems were designed around wood, simply substituting grass for wood in the same combustion system will generally not produce satisfactory results.

Grasses have a higher ash content and a different chemical composition, therefore distinct combustion systems are needed to handle these differences. During combustion, higher chlorine and potassium levels in grasses vaporize and form salts on boiler walls. These salts can cause 'clinkers' (incombustible residues) in systems not specifically designed to handle grasses, reducing performance markedly.

At both the commercial and residential scale, there is a growing number of equipment manufacturers producing multi-fuel combustion systems that show promise, e.g., 80-90 percent efficient "close-coupled" gasifier pellet stoves and multi-fuel stoves and furnaces capable of burning moderately high ash pelleted fuels.

Resources

Switchgrass [http://plants.usda.gov/factsheet/pdf/fs_pavi2.pdf]
Prairie Cordgrass [http://plants.usda.gov/factsheet/pdf/fs_sppe.pdf]
Reed Canarygrass [http://plants.usda.gov/plantguide/pdf/pg_phar3.pdf]
GrassBioenergy.org [Cornell University College of Agriculture and Life Sciences website]
reap-canada.com [Resource Efficient Agricultural Production Canada website]

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Switchgrass images courtesy Agrecol® Corporation.

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