Executive Summary
Biomass Feedstock Partnership Workshops

BIOMASS ENERGY FEEDSTOCK PARTNERSHIP WORKSHOPS

The five regions of Sun Grant Initiative universities, together with the U.S. Departments of Energy and Agriculture, the National Biomass State and Regional Partnership, and private and industry stakeholders, formed the Regional Biomass Energy Feedstock Partnership with an ultimate goal of annually producing cost-competitive ethanol from 1.3 billion tons of biomass (non-grain) feedstocks in an economically feasible and environmentally sustainable manner. This amount of ethanol is predicted to displace 30% of current gasoline consumption by 2030.

Regions of the United States vary in kinds and availabilities of biomass feedstocks due to species composition, soil types, rainfall, and existing land use. Regional workshops independently determined the biomass feedstocks available and identified research gaps and other barriers to development of those feedstocks. These workshops are a preliminary step toward establishing biorefineries that will process a variety of materials into fuels, power, and products.

This summary is a compilation of all five workshop reports, including key portions from the different regions. Complete summaries of each region's workshops:

- North Central Region
- Northeastern Region
- South Central Region
- Southeast Region
- Western Region

The Billion Ton Study was the impetus for the workshops.

All regions of the Sun Grant Initiative held Biomass Feedstock Workshops in 2006 and 2007 in which participants sought to identify and quantify potential biofuel feedstocks that could meet the 1.3 billion ton feedstock target identified in the Billion Ton Study. Although feedstocks in the various parts of the U.S. vary greatly, the emphasis was on those that could be produced in an environmentally sustainable manner and be economically delivered to a biorefinery.

Water availability is a concern across all regions. Given the high value of crops grown on available arable lands and limited water availability, particularly in the South Central and Western regions, the focus must be on crops that can be grown under deficit irrigation and on marginal irrigated and dryland ground.

Crop/Animal Residues

The majority of the 17 residues identified from existing or potential crops in the North Central Region are expected to come from small grain (wheat) straw, corn stover, manure, and dried distillers grains. The projected estimates for crop residues in the Billion Ton Study (428 million tons/year) are thought to be excessive in more than one region.

Agricultural crop residues play an important role in maintaining and improving soil tilth. The amount of residue sustainably removed for biomass is a function of crop rotation, field management practices, timing of those operations, physical characteristics of the soil type, localized climate, and amount of residue left on the field until the next planting. Residue production can be enhanced by breeding, agronomics, management, equipment modification, and education and outreach.

Because the mid-South is already starch deficient for animal feeds (which must be shipped in) corn and grain sorghum were not considered as possible biofuel sources. Cottonseed meal is a valuable animal feed component, but if converted to biofuel the potential energy available is almost 19 trillion Btu per year. There are no competing uses for cotton gin trash, which is currently land applied to fields near gins. If converted to heat energy, the potential value of gin trash is nearly 14 trillion Btu per year. Broken rice grains can be fermented to produce fuel ethanol; if the entire regional supply were converted to energy the potential would be nearly 14 trillion Btu per year. The heat energy value of rice hulls and trash is 32 trillion Btu per year. Broiler litter and manure from feedlots and dairies were also identified as possible sources of bioenergy.

Information about the volume, distribution, quality, and characteristics of municipal solid waste, sewage sludge, animal waste and manure, and organic materials is spotty. Most are underutilized, but barriers to their use are numerous.

Starch and Oilseed Crops
Participants in the North Central Region projected that the region's existing annual row crops under sustainable, innovative cropping systems can produce 65 billion gallons of transportation fuels by 2030 while still meeting food, feed, and export markets. Ethanol from the crop residues would provide 24 billion gallons and 41 billion gallons of fuel will come directly from the starch and oilseed crops.

The wild card in assessing energy crop production in the mid-South is the large number of crops produced in the region, the more limited potential acreages for biomass crops compared to other regions, and variable weather conditions. The estimate of the mid-South workgroup is that the region has approximately a 20 billion gallon ethanol limit based on the acreage of starch crops planted and their current yields.

Increasing existing feedstocks requires increasing grain yield per acre and fuel production per bushel of grain. Advances in technology and a solid partnership between public and private entities are required to meet these goals. Increasing ethanol production from starch crops might be possible if starch concentrations were increased. However, most cereal grains are already more than 70% starch.

The mid-South group recommends investigation of a summer annual such as sunflower and a group of related crops in the Brassica complex (winter canola, camolina, mustards) as potential biomass crops.

Lignocellulosic and Perennial Feedstocks
The North Central Region can exceed the biomass production predictions as outlined in the Billion Ton Study if the economic return for lignocellulosic feedstock exceeds existing agricultural production systems. None of the rangeland and very little (<10%) pastureland will be converted to bioenergy crop production in this region. The land base will come from marginal lands capable of supporting perennial crops (switchgrass, prairie cordgrass, etc.) and from existing cropland. There are many areas in the North Central Region that can supply a 50 million gallon per year biorefinery with lignocellulosic feedstock from within a 25 mile radius.

The three most significant gaps to be addressed before making a reasonable assessment of perennial feedstock potential in the Northeast are 1) the extent of the land base (NASS, forest, CRP, urban) and its appropriateness for feedstocks; 2) who manages this land and what is currently grown on it; and 3) the availability of agronomic adaptation inventories for numerous species on a range of land types and ecological zones.

Other constraints, not limited to the Northeast, include lack of organized feedstock associations; the risk of fluctuating biomass supply from year to year depending on weather conditions; low energy density feedstock, affecting transport, storage, and siting; lack of public knowledge of benefits of bioenergy; and a realistic perception by growers of feedstock prices.

At $25 a ton, say South Central participants, you are not going to get much acreage devoted to biomass production.

Woody and Forest Resources
Potential woody crops in the North Central Region include hybrid poplar, cottonwood (native), and willow. Woody crops have the advantage of year-round harvest. A conceptual model of a mixed cropping system could produce 400,000 dry tons of biomass per year in the region where 8 to 10 thousand acres of woody crops are planted each year into agricultural and urban landscapes.

Forest resources are available for both liquid fuels and wood energy. The estimates in the Billion Ton Study are reasonable but anticipate that the North Central Region contribute 5 to 10 million dry tons per year. A barrier to delivery may be policies that restrict supply from public lands.

In the Northeast Region where this resource is more dominant, data on forest biomass and yield are very good at the regional and state scale. However, data on actual removal of biomass from forests are not as strong. Data on wood byproducts are even weaker. This leads to a knowledge gap that a GIS layer of wood-consuming facilities could go far to solving.

Another and more serious knowledge gap is a lack of understanding of landowner attitudes and management choices. The trend in forest ownership is to smaller parcels, and harvesting is not the main reason most people buy forest land.

Rail infrastructure for distributed forest resources, bridges, and storage capacity need to be improved in the Northeast Region. Regional legislators must consider whether the scale assumptions of national policies are applicable to the Northeast. Feedstocks, which will be mixed, should be considered in moderate scales appropriate to the region.

Workshop participants in the Northeast estimated that 50

miles is the most economical hauling distance for forest residues but that this radius might not capture enough resource even for mid-sized ethanol projects.

Major categories of woody biomass are forest restoration thinnings, logging slash, hazardous fuel reduction, rangeland restoration, urban wood waste, orchard, vineyard, nursery, Christmas tree residues, and energy crops (poplar and eucalyptus, mill residues, and low grade lumber).

Woody feedstocks that can be captured most successfully are logging slash and urban wood waste. Ideal "new" woody feedstocks would have rapid growth, low nutrient and water requirements, drought tolerance, appropriate stem/branch/bark/foliage ratios, low lignin content, single main stems, low costs for establishment, rapid regeneration and easy maintenance, wildlife value, and ability to provide co-production of other wood products.

Preprocessing of logging slash on site will be necessary due to material handling and transportation costs, and at the present time the logging industry doesn't have the equipment. For a biorefinery processing 2 million tons of woody feedstock, the South Central regional logging infrastructure would need a $40 to $50 million dollar investment to purchase equipment enabling it to supply the biorefinery's demand for logging residues.

Making fuel out of cellulose is not yet economical and there are a number of technological hurdles, and policy incentives likely will be needed to encourage woody biomass use. Another barrier, particularly in the Western region, is that much of the forest resources are in public rather than private ownership and far removed from processing facilities.

Relative to other regions, the Western Region has a large variety of potential woody feedstocks for which pretreatments cannot be individually optimized due to cost. The diversity of feedstocks means that sugar platforms are likely to be unique with respect to non-sugar, inhibitory components. There will be a need to develop useful ways of disposing of the lignin-rich residue; this will require more research on lignin chemistry.

Gasification and pyrolysis can accommodate a wide range and quality of feedstocks and afford many more product options, including alcohols and hydrocarbon fuels. Although barriers or challenges remain, these technologies could be more readily adapted to the biomass resources available in the Western region than could biological conversion options. These technologies would fit well with the existing refining and fuel distribution infrastructure.

Economics and Engineering

The question is not "What feedstocks are available?" Rather, it is "What feedstocks are available at what price?"

A large-scale biorefinery does not make sense for all areas, Northeast workshop participants reiterate. What is the economically viable distance for biorefinery location? What is the end use of the feedstock? How will diversion to bioenergy affect the price of other products from the same resource?

Overcoming the problems and challenges of barriers in woody crop development will require funding—funding for people much more than for trees, plantations, and fields of grass. Inventories and surveys must be conducted, along with public outreach and landowner education, even K-12 education, and geneticists, silviculturists, process engineers must be hired.

Then, if the first few enterprises are not successful, how will this affect public confidence? Long-range and thorough planning for every contingency is necessary.

Cross-Cutting Concerns

Are the assumptions used in the Billion Ton Study accurate? They should be reexamined and refined. The 50% yield increase assumption is of greatest concern.

What are the long-term impacts of consistently removing the majority, if not all, of the biomass from a parcel of land on soil carbon, soil quality, water quality and quantity, nutrient cycling, and erosion? What is the livestock grazing, carbon sequestering, and nutrient building value of residues left in place vs. market price?

What impacts will changing current land uses for bioenergy feedstock production have on wildlife populations and on biodiversity? Will new feedstocks eventually become "weeds"? Will new monocultures encourage the emergence of new pests and diseases?

Will additional biorefineries contribute to air pollution and excessively draw down groundwater?

Will the general public accept proposed changes in land use and biorefineries in their communities?

If they do, a false sense of improved economy and additional jobs may exist. After processing facilities are built, there will not be that many jobs associated with the plant. Are dollars going to stay locally in rural areas? Will this enhance/decrease property val-

ues?

Will issues arise over the impact of biofuel production on global food production, food security, and food prices?

What if land and resources that can be used for biofuel feedstocks are pulled from current uses determined by producers to be more economical. How will subsidies, tax incentives, and policy changes play out? Introduction of government backed incentives may have unintended consequences.

There should be no slacking off on attention to audience targeting, message content, and information delivery to multiple audiences. Participants emphasize the naming of key communicator contact persons at land-grant universities, the use of BIOWEB and eXtension (an educational partnership of more than 70 universities designed to provide access to objective, research-based information and educational opportunities), and continued development of industry and professional organization partners.

Key to the success of biomass feedstocks is the emergence of a biofuel market. The challenges are numerous: technology uncertainty with a long time to maturity, siting complexity, high capital requirements, a fuels commodity market where margins are low, difficult resource sourcing and pricing, and geographic distances, as listed by participants in the Western region.

Research Needs

A repository of existing literature.

An accurate assessment of feedstock resources: What is the true cost of production, harvesting, storing and transporting various biomass feedstocks?

Crop breeding and genetics research to increase yields and improve persistence of biomass crops: This effort must be at a level comparable to current efforts in corn, soybeans, and other major crops.

Investigations into long-term management systems for perennial and woody crops that allow for significant biomass production and removal without degrading the environment or soil resource: Future research programs in woody biomass must permit long-term (5-6 years) project life spans. Normal funding cycles are often inadequate for projects involving growing trees.

Integrated systems research incorporating several biomass feedstock sources into a diverse agriculture-forestry-urban landscape.

A GIS framework to assess potential supply curves for various feedstocks on a sub-regional level; models that examine supply curves and warn of impacts of climatic or land use change and extreme weather events.

Best management practices for biomass and residue harvest to determine how much must to be left to maintain the resource.

A new investment (not re-direction of existing resources) into sustainable bioenergy feedstock development: It would take a minimum of $25 million per year in the North Central Region alone to achieve the 30x30 bioenergy goal.

An economic impact analysis of various biomass production and processing systems at state and regional levels: Additional research is needed to determine if valuable co-products can be produced along with the biofuels, thus reducing the net cost of energy production.

Partnerships with industry and producer groups and with tribal governments to scale up laboratory successes to pilot plants.

Graduate and undergraduate programs in bioenergy to develop the future scientists who will continue forward progress and populate the professional positions necessary to manage a biorefinery.

Complementary state and federal policies affecting biomass bioenergy and streamlining of the permitting process.


Western Governor's Association

The Council of Great Lakes Governors


United States Department of Energy

United States Department of Agriculture