National Agricultural Research, Extension, Education, and Economics (NAREEE) Advisory Board

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A Summary of the Scope and Effectiveness of Research, Extension and Economics Programs in Renewable Energy

Report and Recommendations of the Renewable Energy Committee of the National Agricultural Research, Extension, Education and Economics (NAREEE) Advisory Board

Executive Summary. The Renewable Energy Committee (REC) of the NAREEE Advisory Board was established in 2008 and is charged to study the scope and effectiveness of research, extension and economics programs within the USDA Research, Education and Economics (REE) mission area. A preliminary review of renewable energy programs and initiatives was conducted by a Work Group from the NAREEE Advisory Board. Work Group findings were presented and discussed at the full NAREEE Advisory Board meeting held in November, 2008, in Washington, DC. The Work Group findings, interviews with subject matter experts and Board member participation in meetings addressing renewable energy were used to develop this REC Report.

The Committee makes five general recommendations for research and development investments by the USDA Research, Education and Economics (REE) mission area. More specific recommendations will be forthcoming as the Committee continues its work. These recommendations are consistent with the 2008 REE Strategic Energy Science Plan.

REE should take a leadership role in the following areas:

- Research on feedstock sources and the sustainability of a bioeconomy.
- Acquisition and analysis of data on land use, economics and energy balances.
- Determine the sources of variation for specific aspects of analytical models, especially those involving feedstock yields and bio-based co-products.
- Disseminate information on current renewable energy technologies that will be economically beneficial to rural communities.
- Research and development of bio-based co-products associated with the production of biofuels.

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Background

Title IX of the 2008 Farm Bill includes a range of authorities for renewable energy research and development. The Renewable Energy Committee (REC) of the NAREEE Advisory Board was established in 2008 and is charged to study the scope and effectiveness of research, extension and economics programs within the USDA Research, Education and Economics (REE) mission area. A preliminary review of renewable energy programs and initiatives was conducted by a Work Group from the NAREEE Advisory Board. Work Group findings were subsequently presented and discussed at the full NAREEE Advisory Board meeting held in November, 2008, in Washington, DC. The Work Group findings, interviews with subject matter experts and Board member participation in meetings addressing renewable energy were used to develop this REC Report.

The USDA Research, Education, and Economics (REE) mission area is well positioned to contribute to the coordination and leadership of a national strategy for renewable energy. REE should continue to make strategic investments across a broad range of topics in renewable energy. REE's investments should be coordinated and leveraged with its interagency partners especially with the Department of Energy through the Biomass Research and Development Board to ensure that REE's unique capabilities and strengths are brought to bear on important challenges and opportunities in renewable energy that best contribute to our national needs in the development and use of renewable energy. In 2008, REE developed a Strategic Energy Science Plan "to establish a focus and to facilitate collaboration by providing a unifying vision and goals for energy activities." The Plan is focused around four goals:

- Sustainable agriculture and natural resource-based energy production
- Sustainable bioeconomies for rural communities
- Efficient use of energy and energy conservation

- Workforce development for the bioeconomy

REE has identified team leaders, a series of specific actions, and team members responsible for the implementation of each goal. Overall, the Strategic Energy Science Plan and the developing action plans are highly appropriate and make the best use of REE's strengths and national leadership roles. The Renewable Energy Committee of the NAREEE Advisory Board is highly supportive of this Strategic Plan and the developing action plans.

Recommendation 1 - REE should take a leadership role in research on feedstock sources and the sustainability of a bioeconomy

Biofuels research is needed and is being supported across the federal government on critical topics in bioenergy production, including; feedstock production and logistics, and biofuels production, distribution and end use. REE has a long history of agronomic research focused on fundamental plant biology and crop improvement that contributes to the first two areas, feedstock production and logistics. We recommend that this research be continued at an enhanced level. Substantial investments focused on bioenergy feedstocks are also being made by the Department of Energy with a particular emphasis on feedstock production and biofuels production. REE and the Department of Energy should continue to coordinate their efforts on feedstock production and biofuels production to ensure appropriate levels of overlap and complimentarity.

The emergence of a cellulosic biofuels industry offers the potential for a level of sustainability beyond the current grain and petroleum-based systems. However, sustainability will require the use of science-based strategies that minimize ecological damage, enhance economic viability, and build societal acceptance. Agricultural and forested landscapes growing feedstocks for cellulosic biofuels could accumulate carbon, conserve soil and nutrients, reduce greenhouse gas emissions, and contribute to the economic development of rural communities, while also providing a significant domestic source of fuel. Cellulosic crops could, if greater biodiversity were established at the field or landscape level, provide ecosystem services such as pest protection and disease suppression as well as wildlife benefits.

However, the potential benefits of cellulosic biofuels are not guaranteed. Therefore research must continue on plants currently used and other potential plants that produce or concentrate sugars and starches for the manufacturing of biofuels. Uninformed or short-sighted decisions about how, when, and where cellulosic and other feedstocks are produced could lead to costly mistakes. Success will depend on understanding the true nature of sustainability and a willingness to use this knowledge to guide the biofuels sector in ways that are not only driven by production costs, but also by other local, regional, national, and global needs.

The Departments of Energy and Agriculture co-sponsored a workshop entitled, "Sustainability of Biofuels: State of the Science and Future Directions," on October 28-29, 2008. A report from this workshop is anticipated in early 2009. This workshop

identified sustainability as the "economic production of biofuels in ways that are consistent with a consideration of future needs." Sustainability can be categorized by economic, environmental, and social drivers. Economic sustainability requires assessing demand for biofuels and ensuring that they are cost-competitive with other fuel sources and profitable for both feedstock producers and biorefineries. Environmental sustainability requires that we consider biogeochemical and biodiversity responses at multiple levels. Social sustainability requires that we consider food security, energy security, and rural community health among others. All renewable energy systems need to be analyzed and compared comprehensively in regards to their carbon footprint and water usage.

Sustainable biofuels production requires a Life Cycle Assessment (LCA). Life Cycle Assessment is a process for analyzing the environmental impacts generated over the entire life cycle of a product – from provision of raw materials to final disposal of the product. Research is needed to integrate biophysical, social, and economic information at many different levels and from a variety of geographical settings from sites of feedstock production to biofuel use. Sustainability research requires a multidisciplinary approach that engages experts in science, technology, markets, environment, population growth, economic development and human decision-making. REE is well suited to take a leadership role in the conduct of this research.

Viability of Bioenergy Production from Agricultural Waste

Waste materials from animals and other agricultural products can be used to produce bioenergy. Animal manure used to make bioenergy is referred to as feedlot biomass. The process can be accomplished by: (a) burning feedlot biomass directly for fuel, (b) gasifying the biomass, or (c) converting it into biogas by biological decomposition. However, the efficiency of converting feedlot biomass to bioenergy depends on the moisture and ash content of the manure at the start of the process. The higher the moisture and ash contents, the lower the efficiency. Numerous experiments using manure in coal-fired power plants have been conducted. Sami et al. (2001) [1] concluded that "biomass and coal combustion is a promising combustion technology; however, significant development work is required before large-scale implementation can be realized."

Anaerobic digesters are another promising technology that can help livestock producers manage their waste stream, reduce odors, control nutrient loading and produce clean biogas that can be used directly or for electricity generation. We recommend that USDA (1) sponsor additional research focused on lowering anaerobic digester costs and reducing operating complexity, (2) support focused research on the use of anaerobic digester technology for swine waste, and (3) identify and develop conversion technologies using feedlot biomass that is appropriate for the various feedstocks. As experimental results are scaled up to pilot plants and eventually to full-fledged plants, an

[1] Sami, M., K. Annamalai, and M. Wooldridge. 2001. Co-firing of coal and biomass fuel blends. Progress in Energy and Combustion Science 27:171-214.

analysis needs to be conducted at each step to determine the economic feasibility and environmental viability of the processes.

Recommendation 2 - REE should take a leadership role in the acquisition and analysis of data on land use, economics and energy balances.

Data for Energy Models

The Energy Independence and Security Act (EISA) of 2007 is an omnibus energy policy law that consists mainly of provisions designed to increase energy efficiency and the availability of renewable energy. The law sets a modified renewable fuels standard that starts at 9 billion gallons of renewable fuel in 2008 and rises to 36 billion gallons by 2022. Of the latter, 21 billion gallons are required to be obtained from cellulosic ethanol and other advanced biofuels. The increase in the volume requirements for renewable fuels means there will be increasing pressure on the use of land, water, and other resources. Can increasing biofuel production levels be maintained without adversely affecting the environment and the economic and social well being of rural communities? Research is needed to quantify the environmental, economic, and social dimensions resulting from the manufacture of biofuels.

Another issue that will require constant monitoring is the use of biomass to produce renewable fuels since technology is rapidly evolving. While corn is the largest current source, efforts are underway to use alternatives such as switchgrass, animal and other agricultural waste, corn stover, straw and wood chips. It will be necessary to compare the relative efficiencies of each; that is the amount of energy created versus the use of water, fertilizer, and other inputs. In addition, the effect of different feedstocks on the economics of biofuel production, on the environment, and on climate change will also require analysis.

Statistical needs

Soil, water and plant growth form the foundation of agriculture and are at the center of many current biofuel issues. Suitable land is required for biomass production. Land use strategies affect the environment, water and soil quality, and greenhouse emissions. Therefore, tools like geospatial mapping and satellite imagery should be used to create a digitized data layer of land usage, production and use of inputs such as water.

A baseline assessment of land use by categories including cultivated, once cultivated but now idle, irrigated, non-irrigated, forests and woodlands, pasture and grasslands could be provided using current remote sensing technology and the combined databases from USDA's National Agricultural Statistics Service (NASS), Natural Resources Conservation Service (NRCS), and the U.S. Forest Service (FS). The Natural Resource Inventory could be geo-referenced to the remotely sensed products produced by NASS. Likewise, lands administered by the FS could also be geo-referenced. Once this baseline, digitized framework is established, land use changes over time can be monitored and used to calculate possible biomass production affects on greenhouse emissions.

A second data requirement involves energy balances by commodity or biomass product. For example, in addition to sunlight, it takes energy in several other forms such as fertilizer, pesticides, gasoline and oil to produce biomass. The amounts of energy required to produce biomass differ by product and crop as well as geographically. Information on these energy uses is required by specific ecological site. The energy used to produce biomass should be compared with the energy that is derived from the end product. Possible affects on greenhouse gases also need to be measured considering the land used to produce the biomass.

A third data requirement is to assess the economic data from farms as the demand for biofuel feedstocks increases. Again, there is a need for baseline information. The 2007 Census of Agriculture contains farm level data that form the benchmark. If not already in place, the Census records should be geo-referenced. This can only be done broadly by the farm headquarters as a reference, but it still establishes reference points for analysis. The Agricultural and Resource Management Survey (ARMS) conducted by USDA's Economic Research Service (ERS) provides a rich data source on the economic situation of farms. We recommend that these records be geo-referenced with the digitized land use frame as well. This action also will allow more detailed analysis of the ARMS and census results.

Recommendation 3 - REE should take the lead in determining the sources of variation for specific aspects of analytical models, especially those involving feedstock yields and bio-based co-products.

Given the dynamic nature of agriculture and the uncertainty in analytical models used to predict feedstock yields and biobased co-products, more emphasis should be placed on sensitivity analysis for long term planning and integration of new technologies for biofuels production. Sensitivity analysis is used to determine how "sensitive" a model is to changes in the value of the parameters of the model and to changes in the structure of the model. Sensitivity analysis also helps build confidence in models by studying the uncertainties often associated with parameters in models. New technologies have an associated probability of technical and commercial success. In addition, the implementation of new technologies typically displaces current practices as they develop. With multiple government and private research programs underway for new energy crops, yield improvements for existing crops, and co-product utilization, consistent sensitivity analysis would aid in scenario planning that assume varying levels of success.

Understanding synergies between new technologies will be a key step in adopting developing strategies and new practices for US agriculture while minimizing risks. For example, corn-based technologies are often referred to as a bridge to a cellulosic platform. However, if publicly disclosed private industry yield improvements are realized by 2030[2], there will be a need for additional infrastructure and co-product

[2] Crosbie, T. "Why Corn?" presentation at Growing the Bioeconomy Conference, September 8, 2008, Ames Iowa

collection and utilization around corn as a central platform instead of viewing it as a bridge. If these improvements are realized and energy crop and cellulosic technologies meet their milestones as well, a better understanding of success will be required for appropriate resource and risk management since these technologies are not mutually exclusive. Assuming varying levels of success, this sensitivity analysis should be performed at the beginning of research programs and constantly updated during the course of the projects.

Recommendation 4 - REE should take the lead in disseminating information on current renewable energy technologies that will be economically beneficial to rural communities

Renewable Energy for Rural Communities

Historically, USDA has done little research or outreach related to distributed renewable energy technologies, specifically small wind, solar thermal, solar photovoltaic, geothermal, or anaerobic digesters. Although these technologies are a natural fit for rural and ag-based applications, the Agency has provided limited support in advancing their use. The one major exception is the Rural Energy for America Program (REAP, Section 9007 of the 2008 Farm Bill and formerly Section 9006 of the 2002 Farm Bill). The REAP program provides matching grants and loan guarantees for a wide array of renewable energy systems and energy efficiency investments for farms and rural small businesses. USDA Rural Development offices in the states have done some outreach on these technologies in the context of promoting this program.

USDA does have existing and well-established capabilities with conventional agriculture that should allow it to lead agriculture producers and rural communities to more efficient energy use and more effective energy conservation. USDA has the information gathering assets of NASS, the economic research assets of ERS, the established research programs of both ARS and the Land-grant system through the programs of CSREES, and the unique capabilities of the Cooperative Extension Service to quickly and efficiently take the latest research and technology advances to producers and rural communities.

There may be an opportunity to cooperate with other agencies in research to improve other renewable energy technologies such as solar, wind, and geothermal. This research is best supported primarily by other agencies. However, there is a lack of knowledge regarding the application and cost for using these technologies on farms and in rural areas. USDA should continue funding the Cooperative Extension system to better educate farmers and ranchers on the economics of and opportunities to adopt diverse forms of renewable energy.

Recommendation 5 - REE should take a leadership role in research and development of bio-based co-products associated with the production of biofuels.

One goal of the USDA/REE Energy Science Strategic Plan is to evaluate non-food biobased products that could replace products currently made from petroleum, as well as

food or non-food co-products from biorefineries. Co-products can be intermediate or final end-use products. The USDA Small Business Innovation Research Program (SBIR) 2009 Phase 1 Request for Applications (RFA) encouraged proposals addressing the development of biobased products from new industrial crops that will replace petroleum-based products. As bioproducts are evaluated to replace products currently made from petroleum, it is important to explore and develop sustainability principles, standards, and certifications for these products. An assessment of the economic, environmental, and social impacts of biobased crops and byproducts, wood and wood waste, and animal and municipal waste is critical for the sustainability of the bioproduct industry.

The Departments of Energy and Agriculture's Biomass Research and Development Technical Advisory Committee addresses feedstock systems, processing and conversion, transportation, storage, distribution, and end use markets; however, it does not address bioproducts. REE has the opportunity to take a leadership role in bio-based renewable sources of energy and coproducts research.

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