Testimony Before the Senate Committee on Agriculture, Nutrition, and Forestry

Hearing on Farm Bill Policy Proposals Relating to Farm and Rural Energy Issues and Rural Development

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Focus of my remarks. Thank you Mr. Chairman and distinguished committee members for the opportunity to testify at this hearing.

Among various forms of plant biomass, cellulosic biomass – including perennial grasses, woody crops, winter cover crops, and various residues from the agricultural and forest industries – have the greatest potential for energy production and will be the focus of my remarks. I will address two topics today: the potential of cellulosic biofuels, and strategic observations and recommendations with respect to policies impacting biofuels. I note at the outset that plant biomass is the only foreseeable sustainable source of organic fuels, chemicals, and materials.

My perspective.

I am an expert on the science and technology of producing energy from of plants. My perspective is shaped by:

- Over 25 years experience as an academic doing laboratory research on advanced cellulosic biomass conversion technology as well as analysis of big picture issues related to biomass production and utilization;

- Co-leading, with Nathanael Greene of the Natural Resources Defense Council, of a project entitled "The Role of Biomass in America's Energy Future", the most comprehensive analysis of mature biomass conversion technology and biomass-intensive energy futures to date;

- Co-founding, and serving as Chief Scientific Officer for, Mascoma Corporation, a prominent start-up company in the cellulosic biofuels field.

I. The Potential of Cellulosic Biofuels.

a. Conversion technology. At the representative price of $50 per metric ton, cellulosic biomass costs $3/GJ, which is equal to oil at $17/barrel. The immediate factor impeding the emergence of an industry converting cellulosic biomass into liquid fuels on a large scale is the high cost of processing rather than the cost or availability of feedstock. Large reductions in processing costs are clearly possible and indeed likely given a sufficiently large and well-targeted effort. Analysis carried out as part of the Role of Biomass in America's Energy Future project indicates that production of ethanol and other fuels from cellulosic biomass can reasonably be expected to be cost-competitive with fuels oil at $30/barrel once cellulose conversion technology is mature. The central issue to be addressed is improving technologies to overcome the recalcitrance of

cellulosic biomass - that is, converting cellulosic biomass into reactive intermediates such as sugars. This is true not only for ethanol but also for other biofuels produced by fermentation, since the cost of converting cellulosic biomass to sugars must be lowered in order to have a cost advantage relative to sugar production from more easily-processed raw materials such as corn.

I know of no informed difference of opinion with respect to the proposition that the fossil fuel displacement ratio is decidedly favorable for production of ethanol from cellulosic biomass in a well-designed process representative of anticipated industrial practice.

All indications are that construction will begin within the coming year on multiple industrial facilities producing cellulosic ethanol on an unprecedented scale. These include, but are by no means limited to, the 6 projects recently funded by the DOE. Thus, the nascent cellulosic biofuels industry is being launched and will soon be informed by experience.

b. Biomass feedstocks. Looking beyond industry emergence to large scale application, the second central challenge implicit in developing a large-scale biofuels industry is sustainable production of cellulosic biomass using a feasible amount of land. Attention thus far has focused largely on crops and cropping systems that were chosen and developed for production of production food, feed, or fiber rather than energy. This likely will change as processing challenges are overcome. Achieving high land fuel yield is a key objective in order to both improve feedstock economics and minimize the ecological footprint of biofuel production. Projected future increases in biomass production per unit land and fuel production per unit biomass could together result in a roughly 10-fold increase in land fuel yield compared to today, enabling scenarios in which biofuels play a large energy service supply role. New crops and cropping systems will likely be developed that are conducive to coproduction of feedstock and feed in response to new demand for non-nutritive cellulosic biomass. In short, we have a historic opportunity to reimagine agriculture to accommodate large scale energy production.

c. Addressing national needs. *How much land would be required to meaningfully impact energy security and sustainability using biofuels? In light of competing land uses, is it appropriate to look to biomass energy as a major contributor as we seek paths to a sustainable and secure energy future?* One can find widely disparate answers to these important questions among knowledgeable analysts. Recently, my colleagues and I have published an analysis that documents this disparity and attempts to understand it. We conclude:

> Ultimately, questions related to the availability of land for biomass energy production and the feasibility of large-scale provision of energy services are determined as much by world view as by hard physical constraints. If the question is: "In a world motivated to solve sustainability and security challenges, assuming that innovation and change responsive to this objective are possible, could biomass make a large contribution to provision of energy services?" We think that the answer is unequivocally "Yes". On the other hand, biomass can make a much more limited contribution to energy supply in a world based on current or extrapolated realities with respect to important technical and behavioral variables determining biomass requirements and availability. To a substantial degree, the starkly different conclusions reached by different analysts on the biomass supply issue reflect different expectations with respect to the world's willingness or

capacity to innovate and change. However, change is our only option if we are to achieve a sustainable and secure future, whether we are talking about biomass or all renewable energy sources.

Rejecting energy service supply options because they require innovation and change decreases the set of alternatives that can make a meaningful contribution markedly, and perhaps to zero. Such rejection also denies the essence of our current situation: that we cannot extrapolate the current unsustainable and insecure present and get to a sustainable and future. The scenarios most conducive to biomass playing a significant energy service supply role involve complimentary combinations of several changes, with the largest contributions made possible by a combination of technical advances and behavioral changes. We suspect that this is not limited to biomass and indeed is true of most if not all paths to a sustainable future. Studies that project a small role for biomass generally change only the source of fuel and leave other variables constant. This, however, amounts to projecting that technologies and behaviors that arose in a world largely unconstrained by energy availability will continue in the future. This is unlikely if one believes that energy sustainability and security challenges will become yet more pressing as we move forward – a proposition for which more support is accumulating daily.

I offer the following examples of what could be achieved based on expected results of ongoing analyses I am involved in with others:

1. Cellulosic biofuels could conceivably provide for the entire current U.S. vehicular mobility requirement using little or no land beyond that already devoted to agriculture, with little or no decrease in food and feed production, and with substantially increased farm income and profitability, decreased crop payments, net removal of greenhouse gases from the atmosphere, and improved soil fertility and other environmental metrics compared to the status quo. Available information indicates that these results could be realized by:

- High but achievable efficiencies with respect to feedstock production, conversion of feedstocks to fuels, and utilization of fuels in vehicles;

- Integration of energy feedstock production into agriculture. There are many strategies by which this could be accomplished, including feed protein and feedstock coproduction from grasses, crops and cropping systems designed to maximize feedstock coproduction (e.g. large biomass soy), and expanded use of winter cover crops. Many of these strategies would be market-driven if there were a demand for non-nutritive cellulosic biomass to feed cost-competitive conversion processes.

2. Biofuels could be a substantial part of broader strategies leading to approximately zero net greenhouse gas emissions from the U.S. transport and utility sectors. Available information indicates that this could be realized by:

- Production of 1/3 of transportation fuel from cellulosic biomass;

• Production of 40% of electrical power demand from sources that do not emit greenhouse gases;

• Tripling the efficiency, that is miles per gallon, of the transportation sector;

• Taking advantage of opportunities to capture and sequester carbon arising from the production and processing of cellulosic biomass.

Although the changes implicit in these two examples are large, this is equally true of the benefits.

II. Observations and Recommendations on Policies Relevant to Biofuels.

Today there is an unprecedented opportunity to align the farm, energy, and environmental agendas in a way that vastly broadens support for biofuels. However, biofuel and farm advocates will have to earn this support by meaningfully incorporating energy and environmental objectives into policies aimed at fostering the development of a biofuels industry. If we do this right, we can dramatically improve the outlook for rural America while also addressing pressing energy security and climate issues. If we do not, the current wave of enthusiasm will pass us by and will likely be difficult to rekindle.

Advocates for biomass energy and farm interests need to focus our attention, as well as that of the media and our skeptics, on farm-based options that have potential to make a contribution on a scale large enough to have a meaningful impact on energy security and sustainability. Indiscriminate support of feedstock and fuel combinations that are inherently limited to a small energy contribution will invite impeachment of all biofuels as being a provincial indulgence of the farm lobby rather than an appropriate response to national energy challenges.

Congress should avoid over incentivizing corn ethanol production to the point that the costs are perceived as outweighing the benefits and we risk a backlash that will, again, likely negatively impact all biofuels.

While it is reasonable to expect that environmentally advantageous biofuel production from cellulosic feedstocks can be achieved, this outcome should not be taken for granted. Realizing the clear potential for environmental benefits will be fostered by rigorous evaluation and exploration of alternative production and management practices, crops and cropping systems responsive to local circumstances, and policies that reward environmentally desirable outcomes.

Policies aimed at increasing fuel production from sources other than petroleum must not increase greenhouse gas emissions and should recognize the value of emission reductions. If we do not consider greenhouse gas emissions as incentives and standards aimed at alternative fuels are formulated, we will likely have to reverse course as the climate imperative becomes ever more urgent. Such consideration is not picking winners, but rather avoiding losers.

There is a strong public interest in increasing energy efficiency, and correspondingly large public costs for failing to do so. Recent proposals by the President and others to increase CAFÉ standards and/or adopt a market-driven "feebate" mechanism, are encouraging signs that these

realities are at last being recognized. Following through on these proposals by enacting aggressive measures to increase energy utilization efficiency in transportation as well as other energy sectors should be a very high priority. Increasing energy efficiency is our most effective near-term option to respond to the twin challenges of energy security and sustainability, and is an indispensable element of any comprehensive strategy to address these challenges. In addition, increased energy efficiency leverages the fractional impact of new supply technologies.

Congress and agencies need to adjust policy formulation in response to the new reality of a private sector that is newly active in investing in biofuels and other alternative energy technologies. In particular, public funds should be used to accelerate the emergence of a biofuels industry – for example by cost sharing commercial deployment of first-of-a-kind technology, indexing economic incentives against the price of oil). In addition, we should keep a close eye on things that need to be done but the market may not adequately motivate – for example research on new crops and cropping practices that integrate biofuel feedstock production into agriculture, including but not limited to better understanding and documentation with respect to possibilities for soil carbon sequestration, and research on fundamentals and high-risk innovation related to biomass conversion and production.

The collective genius of the United States research community has in the past been engaged in the biomass energy field to a very limited extent, particularly in America's universities. The three large bioenergy centers solicited by the DOE Office of Science will be significant steps toward rectifying this situation and should be fully funded. Providing broadly accessible opportunities for investigators and institutions not part of the Office of Science Centers would further increase the engagement of the research community and should also be a priority.

References.

Greene, N., F.E. Celik, B. Dale, M. Jackson, K. Jayawardhana, H. Jin, E.D. Larson, M. Laser, L. Lynd, D. MacKenzie, J. Mark, J. McBride, S. McLaughlin, D. Saccardi. 2004. Growing energy. How biofuels can help end America's oil dependence. (http://www.bioproducts-bioenergy.gov/pdfs/NRDC-Growing-Energy-Final.3.pdf).

Lynd, L.R., M.S. Laser, J. McBride, K. Podkaminer, J. Hannon. Energy myth three – high land requirements and an unfavorable energy balance preclude biomass ethanol from playing a large role in providing energy services. p 75-101 In: B.K. Sovacol and M.A. Brown (eds.), Energy and American Society – Thirteen Myths. Springer (2007).

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