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Introduction to Session 10: The New Biofuels Industry: Biomass Environmental Feasibility and Sustainability

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Session 10 looked at a variety of topics regarding sustainability of bioenergy production ranging from environmental resources, life cycle analysis, energy balance, and environmental impact of renewable products, as well as the sustainability of biomass production. This session was dedicated to the successful career and life of the pioneering scientist, Alex Farrell, who had passed away just a few weeks prior the 30th Symposium and it was chaired by Robert Anex, of Iowa State University, and Wallace Wilhelm, of the USDA Agricultural Research Service. Wally could not make it to the conference due to illness and later past away. Our thoughts are with his family.

Thomas R. Sinclair examined the limitations of water and nitrogen resources for bioenergy production. Water is needed to allow plants to open stomata in the leaf surfaces so that carbon dioxide can diffuse into leaves for photosynthesis. There is no genetic solution to the physical laws of gas diffusion. Interestingly, sufficient carbon matter in the soil is critical to promote properly balance water accessibility, i.e., too little make water less available. Similarly, nitrogen is required for virtually all growth processes, including photosynthesis. The impact of proper and insufficient availability of these two critical resources was discussed during this presentation.

May Wu presented the results of their analysis of the life cycle of water use during fuel production. The purpose of this work is to address the water use for energy generation in US by providing a baseline of current consumptive water use in the fuel industries including ethanol, petroleum oil, etc. and examining two major steps of the fuel life cycle—feedstock production and fuel processing/production. This work is an attempt to analyze regional variation, historic trend of consumptive water use in the selected fuel production life cycle, and identify opportunities to reduce water use for fuel production. Results from this study could be used to address water resource sustainability, guide R&DD directions in renewable fuel development, and to provide a basis for decision-making in order to meet the overarching goal of energy independence for the nation.

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Johannes Lehmann described how biochar is produced during pyrolysis of biomass for bioenergy and offers a means of energy production with a net carbon removal from the atmosphere. When incorporated into soil it provides a stable long-term carbon sink, while improving the soils that are at risk of becoming degraded by maximizing biomass off-take. Since biochar is able to retain nutrients better than other types of organic matter in soil, it can potentially improve soil productivity and additionally reduce emissions of greenhouse gases other than carbon dioxide from agricultural soils. This presentation introduced biochar, covering the ancient carbon-rich soils of the Amazon as well as its potential future application within the context of modern bioenergy production.

Bruce E. Dale described the results of a life cycle assessment for the production of polyhydroxyalkanoates (PHA) used for biodegradable products. They estimated the environmental performance of PHA derived from corn grain regarding renewable energy consumption and greenhouse gas emissions. The system boundary includes processes from agricultural production to the PHA fermentation and recovery processes based upon corn wet milling. The environmental burdens associated with products in multi-output processes were estimated which included alternative product systems for co-products. Scenario and sensitivity analyses are done to determine the environmental effects of the following aspects on the overall renewable energy consumption and greenhouse gas emissions: tillage practice, winter cover crop practices, and allocation procedures.

Elizabeth D. Sendich presented an environmental and economic analysis of the fully integrated biorefinery which used ammonia fiber expansion pretreatment. The process was modeled for the production of fuel ethanol from cellulosic biomass. They used the Integrated Farm System Model (IFSM) that permitted the biorefinery to be concurrently simulated with the animal and crop production units in various locations within the United States, under various farm production scenarios. This combined approach allows analysis of economic profitability and directs the development of pathways that also enhance the environment.

Andrew D. Jones, from Alexander E Farrell's lab wrapped up the session as they examined the market-mediated land use change consequences of crop-based biofuel production. Specifically, growing biofuel feedstocks on prime cropland creates pressure to both intensify and expand agriculture elsewhere via changes in the prices of commodities and land. While preliminary results suggest land conversion can contribute to GHG, a better understanding of land use change associated with biofuels production will greatly inform the development of biofuel technologies and policies that will be compatible with climate change mitigation. Current economic and bio-physical models used to estimate market-mediated land use change are incomplete and employ uncertain data. This talk reviewed existing models of land use change and current estimates of indirect GHG emissions with the aim to clarify the land use situation as it impacts biofuels. They also presented a research strategy for reducing the uncertainties in these estimates and developing more usable modeling tools.