PART II–BREAKOUT SESSIONS

Workshops Summary

Allan Eaglesham & Ralph W.F. Hardy
National Agricultural Biotechnology Council
Ithaca, NY

Three breakout workshops were held, under the following general topics:

- *Optimizing the Value of Co-Products/Byproducts*
- *Enhancing Productivity of Biofeedstocks*
- *Policy Issues Impacting Agriculture and Bioenergy*

Four groups, each with a facilitator and recorder[1], met for 1-hour sessions to discuss predetermined questions. This is a synthesis of key points[2] that emerged from those discussions.

Workshop I – *Optimizing the Value of Co-Products/Byproducts*

Question 1: What economic and social issues need to be considered as industrial products are made from bioresources instead of from petroleum?

- Good market analysis of costs, demands, *etc*. of co-products.
- Positive aspects of biotechnology—resulting from solid science—should be emphasized in published articles.
- Effective communication and management of risk are important. Perceived risk and real risk should be differentiated.
- There is the possibility of a wealth-shift in the US economy as it transitions to being biobased rather than petro-based.

[1]These duties were shared as follows:
Facilitators—David Benfield, Colin Kaltenbach, Bryan Kinnamon, John Kirby and Bruce McPheron.
Recorders—Karunanithy Chinnaduari, Sarah Kiger, Srilakshmi Makkena, Lisa Meihls, Sachin Teotia and Thu Van Vuong.

[2]Comments more relevant to workshops other than those in which they were raised have been reassigned accordingly, and comments not related to the theme of the conference are not included.

Question 2: What elements are necessary to develop a systems approach (value chain) to predict best end-uses of biobased industrial products (*e.g.* biofuels and co-products)?

- New systems infrastructure will be needed as we transition to second-generation biofuels.
- Distillers dry grains (DDGs) are a by-product of corn-starch conversion to ethanol. It is not widely understood by the public that DDGs are a valuable component of animal feed.

Question 3: How can life-cycle greenhouse-gas impacts (footprint) be minimized for the biobased economy

- Accurate life-cycle analyses are needed to understand energy gains/losses and waste generation associated with biofuel production.
  - A sound scientific basis is needed on which to make lifecycle analyses of biofuels and fossil fuels.
- Lifecycle analyses can be used by technology developers to improve sustainability and minimize waste.
- Renewable fuels should not be held to stricter standards than non-renewables.
  - The risks inherent in the biobased economy should be compared to risks inherent in a petro-based economy.
- Broader studies of carbon sequestration by plants are needed; such plants should be chosen on a regional/climate basis.
  - Land use for maximum carbon sequestration should be encouraged.
- New technologies should be developed to capture carbon and re-use it.
  - CO_2 produced during yeast fermentation can be captured by microalgae, for use, in turn, as a feedstock for biofuel production.
  - The regulatory framework should encourage introduction and adoption of new technologies.
- A comprehensive approach to reducing the carbon footprint and the focus should not be wholly based on energy consumption. There should be economic incentives, laws and policies, moral imperatives, education, introduction of new social norms, and technological/mechanistic changes aimed at reducing the carbon footprint.
- A carbon tax would raise revenue to make people realize how much carbon they use and increase their desire for efficiency.
  - The effect of rising fuel prices on driving habits shows that consumer behavior can change.

Workshop II – *Enhancing Productivity of Biofeedstocks*

Question 1: What are the economic, environmental and social issues that should be considered in the selection of biofeedstocks?

- Government should provide a financial safety net for farmers growing new crops.
- Increasing productivity per unit area will be necessary as arable land is limited. Availability of new, productive crops will be key, *e.g.* switchgrass.
- Profit and risk factors—including disease, insect predation and drought—should be considered.
- Maintenance of ecosystem services is vital by using production systems that support natural and managed ecosystems.
  - Consideration of ecosystem services should be built into the feedstock-decision-making process.
- Regional and local factors will influence choice of biomass feedstocks. In the Northeast, for example, there is emphasis on woody biomass. Pennsylvania about 750,000 private forest landowners with an average woodlot area of <19 acres. Whether these will be available becomes a sociological issue.
- There is concern over cultivating land that hasn't been intensively farmed before.
  - Land conversion can have long-term effects on the ecological footprint.
  - Perennial systems should not be converted to annual systems.
  - Systems that store large amounts of carbon should not be converted to those that store minimal amounts of carbon.
- The ultimate measure for a biofeedstock might be that the production system has to be carbon neutral.
  - Biofeedstock standardization is problematic.
  - Not all feedstock/bioproducts solutions are equal.
- We need to help people understand that we already affect ecosystems—it is just a matter of degree and intensity.
- A likely consequence of increasing biofuel production is the cultivation of more land with implications for wildlife habitats and environmental quality.
- Land on which corn is productive should not be planted to switchgrass. Illinois, for example, should stay in corn, whereas switchgrass might be usefully grown in parts of Tennessee. It might be most useful to grow cellulosic feedstocks on land no longer used for agriculture. Also, pasture land may be well suited for switchgrass production.
- The emphasis on switchgrass as a perennial feedstock for cellulosic ethanol may not be feasible on an industrial scale due to costs of transportation from the field to the biorefinery.
- Feedstock-resource owners will need education on economic and sociological issues.
- The advancing average age of farmers is a factor in receptiveness to new ideas. Young farmers are more attuned to emerging opportunities.

- Inappropriate infrastructure can be a hindrance to switching to new crops and new technologies.
- It is necessary to understand the market.
  - Industry won't build an ethanol facility without having buyers for ethanol and DDGs.
  - The Farm Bill emphasizes cellulosic ethanol rather than alternative fuels, responding to public perception that rising corn prices result from diversion to biofuel.
- A bridge will be needed between industrial and agrarian considerations as they relate to advanced biofuels.

Question 2: Where are the greatest opportunities for genetic and agronomic productivity enhancement of biofeedstocks to provide sufficient supply to meet demand?

- Emphasis on plant breeding is needed, with incorporation of biotechnological innovations.
  - Because the germplasm base of biofeedstocks like switchgrass is narrow, genetic engineering will play a key role in achieving genetic improvements.
  - Hybrid technologies may play an important role.
  - Genome sequencing should be a component of the appraisal of new crops to maximize understanding of their biology.
- Crop rotations should be encouraged; in recent years, corn and soybean have been increasingly sole-cropped.
  - Although not initially affected by pests, biomass crops may be affected in the future. Vigilance is required.
  - Growing feedstocks in polyculture will help minimize pest problems.
  - Companies and farmers will make feedstock choices.
- Over-seeding biomass crops with nitrogen-fixing cover crops should explored.
- Multiplication of seed material will be needed in anticipation of cellulosic ethanol becoming economically viable.
- Water is an important resource for crop production and access to irrigation will be an increasing challenge.
  - Breeding for increased drought resistance will be important.
- At this stage, we should embrace the complexity that solutions are not equivalent.
- It has been suggested that marginal lands may be recultivated to produce biofeedstocks. However, if productivity is relatively poor, increasing transportation costs may make this strategy unfeasible.
- Studies are ongoing on the genetics of algae.
  - The use of algae for production of biofuels and for carbon dioxide sequestration faces scale-up problems.

Question 3. What are the primary systems obstacles/opportunities for utilization of new biofeedstocks?

- The biofeedstocks discussed include the current production crops of corn, soybean and sugar beet. In the short term, we should focus on these traditional crops—for which production systems are in place—and then in a few/several years overlap with cellulosic feedstocks, which will assume the increasingly greater role.
  - There is need to educate people that woodland resources are renewable. Somewhere in the ethical debate there needs to be understanding of plant lifecycle.
  - A niche will exist for academia to educate on ecosystems and plant processes.
  - As we move into cellulosic solutions the definition of "agrarian" becomes different from what it is now.
- There is need to capitalize on previously unused components. Before considering new biofeedstocks, we should examine the possibility of using corn and soybean more efficiently, including straw, stover and cobs as sources of carbon.
  - More research is needed on how much straw and stover can be removed from the field without compromising soil organic matter replenishment.
- It doesn't make sense to convert the corn belt into the energy belt because infrastructure for the former industry is already in place.
- Financial investments in corn ethanol are large, will take years to pay off and may delay the transition to cellulosic ethanol.
- More than feedstock development, vertical integration is needed, involving harvesting, in-field processing, transportation, storage, in-factory processing, co-product catchment and utilization, *etc.*
- Vertical integration is likely; as with food producers, fuel producers will buy the land they will need.
  - On the other hand, forest-product companies also bought woodland but later sold it and now buying their wood.
- Papermill waste and wood chips may be good candidates as feedstocks for ethanol production.
- If bio-oil can be produced economically it would solve many problems.
- Important scale issues underpin production of significant quantities of biomass feedstocks to support a cellulosic ethanol industry.
- The type and cost of feedstock, its transportation, storage and processing all affect the value chain.
- In-field feedstock preparation may be necessary; in the future, farming may involve more than production.

- The area available for planting biofeedstock crops will depend on the processing-plant location; "capture zone" size will depend on many factors including the energy content of feedstock on a per unit weight basis.
- Through research, we may be able to guide farmers on their land use.
- Aesthetic value: increasingly, the appearance of "pretty" farmland has implications for decisions that non-farmers make about land use with the growing interface between rural and urban communities.
  - Couched in appropriate terms, animal-waste conversion to energy could be an important factor in improving acceptance of the livestock industry by exurbanites.
- To a large extent, the petroleum industry controls development in biofuels. If oil companies decrease the price of petro-fuels, interest and investment in biofuels could suffer.
- New construction is likely to be more robust with built-in capability to adjust to new technologies.
- Farmers have the potential to steer the momentum towards cellulosic biofuels.
- The support of environmental groups is needed. Industries are investing profits in ecological restoration.
- Opportunities for revitalizing rural economies are important.
  - Use of marginal, or underutilized, land for production of biofeedstocks represents potential new income for farmers.
- Cellulosic ethanol will also be transitional. The future lies with a combination of fuel cells and batteries.
  - The transition time will be influenced by the marketplace.

Workshop III – *Policy Issues Impacting Agriculture and Bioenergy*

Question 1: What primary economic, environmental and social perspectives should be considered in making effective public policy to encourage adoption of bioproducts?

- Much of the public policy on biofuels needs to be re-examined.
- "Biobased" certification would give bioproducts a preferred status for government purchase. This would assist achievement of production at the scale necessary for companies to provide bioproducts commercially.
- Risk-management incentives should be available to farmers growing new biofeedstock crops.
- Incentives should be available to encourage farmers to form cooperatively owned processing plants.
- Introduce incentives for dairy farmers to install manure digestors to capture the energy content of biogas and minimize methane release as a greenhouse gas.

- Change state policies so that people with solar power are rewarded for adding electricity to the grid.
- Regulatory aspects require reconsideration, with emphasis on deregulation coupled with selective incentives.
- Policies are needed to ensure energy security.
  - The main market driver always ends the value chain. Everyone in the process has to profit.
  - One of the drivers of the USDA strategic plan is contribution to energy security.
  - Policy decisions need not be complex, largely because we don't have many working technologies.
- "Green" collar jobs will be created and, over time, policies will be shaped by endeavors that grow jobs.
- There is a disconnect between policies at the city, state and national levels. City and state policymakers are, in general, more aware of opportunities.
- States are putting renewable fuel standards in place, although they are not necessarily well located geographically for feedstock availability and ethanol production. This may lead to variation in implementation of national-scale policies.
- The government should implement a land-use policy that dictates return of organic matter to the soil to maintain its organic matter content.
- Public education is as important as introducing new ideas. The public has the right to know about new products and technologies.
- The public isn't aware of much of the policy that affects them, nor are they aware of the effects of public policy on them.
- Institute a system for paying for ecosystem services.
- Maximize efficiency of biofuel-powered vehicles.
- The negative public perception of private companies holding ownership of varieties and genes should be addressed. It is important that the public understands that, without the profit motive, much of the expensive research that will be needed to improve food production will not be done.
- There is need for funding that encourages skill integrations, such as plant breeding and molecular biology.
- US energy consumption is 25% of the amount consumed globally. If the United States were to reduce consumption, developing countries might use that energy to become developed. The United States should use all possible resources (including corn) to become energy-sufficient.
  - The United States needs a national energy policy.
  - There is pressing need for energy conservation in the United States.

- The petroleum industry is centralized at ports for shipping. In contrast, food comes from a variety of places. Production of biofuels is likely to benefit people in rural areas.
  - More than 50% of the population is in cities; if subsidies keep people in rural communities, it may be worth the cost.
- Wealth generated from ethanol production will accrue mainly to landowners.
- Eventually a tipping point will be reached at which the cost of waste disposal will become more than the cost of recycling.
- The new Farm Bill $1.01 subsidy on blending ethanol could be a disincentive to developing new technologies beyond cellulosic ethanol.
- As developing nations become more affluent, there is increased demand for meat in the diet making agricultural sustainability more difficult to achieve.
- In creating fuel to replace foreign oil, co-products can bring benefits in creating new sources of income for local communities.
  - It's important to support the agricultural strengths of a given region.
- This issue is often viewed from a national perspective, whereas the focus should be regional.
- There is a perception that the bioeconomy will be "green," which is not necessarily so.
- Durable products can be economic disincentives; in that case we will have to change the view of what constitutes a successful economy.

Question 2: What key issues must be resolved for the discussion to move beyond the "food versus fuel" debate to encourage consumer acceptance of "food and fuel"?

- There is much media coverage of direct adverse effects on food prices of using corn as a feedstock for biofuels and bioproducts. This subject needs more study and the degree to which it is perception rather than reality needs to be conveyed to the public.
  - Public forums should be initiated to address key issues.
- There is need to develop and publish concise white papers on food-versus-fuel and fuel-versus-nature. These should include all cost elements.
- Food security concerns should be addressed. Bioenergy policy should take food security into account such as to secure our food first.
  - Bioproducts can contribute to food security.
- Public understanding of the food-versus-bioproducts issues is needed; Outreach programs could be aimed at high-school students and consumers in general.
- Land-management issues need to be resolved.
- A white paper on food versus fuel and food versus nature should be produced and circulated.

- The debate over food versus fuel may never go away. Good science doesn't always carry the day in the public perspective.
- We must seek economic fuel solutions that are not in direct competition with food production.
- Will we have a sufficient natural-resource base to produce the food needed to support an increasing global population and demands for higher living standards?
- As alternative fuel scenarios are developed and tested, we must not compromise the natural resource base necessary for increased food production.
- Soybean and corn may not provide the best feedstocks for biofuels. The new Farm Bill will encourage farmers to switch to new crops such as native species like switchgrass.
  - Why make corn-starch ethanol at all, if it's only a temporary fix? It's immoral to use food to make fuel, when people are hungry.
- Technologies are being developed for growing microalgae as a source of biomass feedstock for fuel and polymer production. Relatively little land mass need be involved. The liquid fuel needs of Ohio could be met with an area equivalent to one and a half counties. There is room for optimism that we can solve our energy needs without affecting food production.
  - Algal ponds could be placed adjacent to coal-burning power plants, to utilize CO_2 and provide biofeedstock, on otherwise unproductive land.
- The increasing global population dictates the need for long-term alternatives to cellulosic biofuels.
  - In the long term, agriculture will be unable to keep pace with growing demands for food, fiber and fuel without impingement on the ecosystem services—clean air and water, fertile soil and biodiversity—that human survival depends upon.
- Woody crops can provide feedstock without impinging on food production.
  - In terms of woodchips as feedstock, use of fruit-crop trees would help sustainability.
- Countries like China don't want food *or* fuel; they want one crop that can serve as both in case of food shortage.
- High food prices are an incentive to farmers to produce, but will the consumers buy?
  - US food prices were relatively higher in the 1960s and 1970s.
- Farmland continues to be used for building. If we are to achieve a biobased/renewable economy, policies should be instituted to keep land in agricultural production. One approach would be to subsidize land rather than crops.

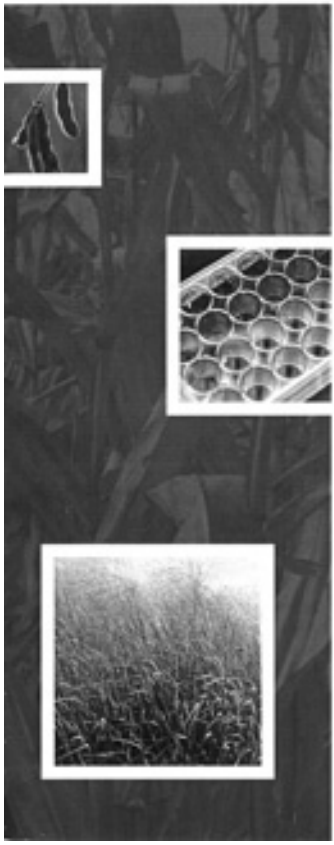
Question 3: What unresolved technical issues are impeding progress toward sound biofuel policies?

- The major issue is technology availability.
  - Familiarity with the current technologies may constrain adoption of new technologies. The corn-starch process is so well known, that there will be inertia to change to more complex processes.
- Several technical issues remain unresolved. Conversion of cellulosic biomass to ethanol is not yet economically viable. Furthermore, biomass transportation and storage systems are not ready to deal with large-scale production of cellulosic biofuels.
- Missing technologies may constrain policy.
  - Cellulosic ethanol production has its attendant technologies, but breakthroughs are needed.
  - Policy lags behind technology.
  - Many technical issues are unresolved, but not all have policy implications.
  - Lack of profitability of the current technologies is driving incentives for new technologies.
- Regulations should facilitate the implementation of novel developments. Unfortunately, the current federal regulatory framework is inhibitory to the adoption of new policies.
  - Improved technologies are sitting on the shelf because implementation is encumbered by regulations and cost of negotiating the regulatory process.
  - These technologies are disruptive and may be difficult to regulate.
- Facilitation is needed of technology transfer from the university (discovery) to companies (marketing).
  - Collaboration among industry, university, and government is needed.
  - With adoption of the Canadian model—*i.e.* with federal funding to encourage the uniting of efforts from academia, industry, and government—more rapid progress would be possible in terms of advancing agriculture and its contributions to energy security, the biobased economy, and human health.
- Modification of educational systems is needed at the high-school and undergraduate levels to put greater emphasis on cellulose-based chemistry as well as petro-based chemistry. Greater emphasis should be placed on plant biology across the educational system. For example, chemical engineers should have at least a grounding in plant biology.
- Graduate students need to learn how to implement their molecular and cellular studies at the economic and ecological levels.
- A key component of ethanol-production technology should be capture and recycling of water.

- Corn-grain production is dependent on water and inputs; it has required subsidization.
- The public is more open to rational discussion on biotechnology than it was 5 years ago.
- We need to establish collaborative worldwide efforts scientists in India, China, *etc*. to share research and technological information.
- A policy group should evaluate and define what bioproducts are, to facilitate uniform legislation among states.

NATIONAL AGRICULTURAL BIOTECHNOLOGY COUNCIL

NABC 20



Reshaping American Agriculture to Meet its Biofuel and Biopolymer Roles

HOSTED BY THE OHIO STATE UNIVERSITY

HYATT REGENCY HOTEL • COLUMBUS, OHIO

JUNE 3-5, 2008