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## Workshop C

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# *Food and Environmental Issues Associated with the Biobased Economy of the Twenty-First Century*

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Workshop participants were asked to address the following issues regarding the influence of the expansion of agriculture for a biobased economy on food production and the environment:

- What will be the impact of an expanded biobased economy on food quantity and price?
- Is there enough agricultural land, including that now underutilized, for food and the production of biobased industrial products?
- What will be the local, regional, national, and global environmental impacts of the biobased economy, including those on global climate change, local and regional air pollution, and local pollution resulting from processing crop residues?

A remarkably diverse collection of professionals debated these issues, ranging from directors of university-based biotechnology centers, scientists, philosophers, sociologists, corporate managers, communications specialists and writers, reporters, and environmental planners. Given this diversity, it was relatively easy to identify major theme areas of consensus. That it was possible to reach a consensus speaks as a strong endorsement of the importance of the main theme areas identified by the participants.

### DEVELOPMENT OF FIVE THEME AREAS

During the first session, seventy-one issue statements or issue-related questions were identified (see Appendix). Individual statements or questions were grouped under one of five major theme areas that emerged: assessment, communication, global food security, process, and sustainability, of which, assessment, sustainability, and communication had the greatest concurrence.

## ASSESSMENT

The policy discussions and public debates now active would benefit significantly from the dissemination of substantive peer-reviewed quantitative analyses of the impact of biobased products on the environment, human health and safety, and the economy. For example, the report *Biobased Industrial Products* by the National Academies of Science (NRC 2000) concluded that production of plant biomass for biobased industries could pose a hazard to the environment. If possible, it would be best to know the disadvantages, risks, and potential economic costs of new biobased industrial production ahead of time instead of after the fact. Knowing the potential long-term consequences and costs can help guide the development of the most environmentally friendly and safe biobased economy possible.

Biobased products have the potential to significantly affect consumers and society. In order to evaluate these effects, the products should be subject to the same critical safety criteria as their conventional counterparts. Included among the risks that should be assessed are: food safety, allergenicity (introduction of non-human proteins to biobased products), gene flow and disease resistance to non-target plants. At the same time, the benefits of biobased products should be substantiated not only standing alone, but in comparison with displaced conventional agricultural and non-agricultural products. Expected benefits include: increased productivity; utilization of otherwise useless by-products and residues; lower costs; quality improvement of nutrition, flavor, and texture; reduced environmental footprint(s) or impact; renewable raw materials; economic security for farmers; and improved balance of trade.

In order to stimulate the comprehensive assessments of an emerging biobased-industry, the federal government should promulgate competitive solicitations and make grants on a peer-reviewed basis. Converting to a biobased production will also have significant impact on the economies of rural communities and of developing countries. In addition to the basic scientific research called for by the NRC report, the development of new industries, and the evaluation of environmental impacts and issues of social and economic justice should also be substantively analyzed.

## SUSTAINABILITY

The first step was to define sustainability. The group concluded that it is the ability to produce adequate food and materials for the human population in a manner that is continuously ecologically, socially, and economically sustainable, and in terms of the promise of a biobased economy. In addition, sustainability is also long-term survival with a high standard of living (good quality of life and environmental health), self-sufficiency in food/energy/materials in developing as well as developed counties, globalization of sustainable technology, and retention of wilderness.

Some of the problems and concerns about sustainability include what is the

carrying capacity of the earth (is it higher or lower than at present?) while providing a reasonable standard of living. Presently, there is an inadequate knowledge base, and sources of funding are lacking with which to develop the prerequisite information. In addition, a concern is how to provide incentives for adoption of practices that sustain land, water, and other limited resources.

Several policy statements regarding the development of a biobased agriculture were formulated to help guide decision-making:

- Large-scale conversion of agriculture to a biobased economy will require a thorough analysis of sustainability.
- Stable public-sector investments will be required to establish a knowledge base to develop appropriate technologies.
- All constituent groups must work toward the development of policies that incorporate consideration of ecological costs into products and goods destined for the marketplace.
- A global dialogue is necessary on these issues using partnership structures, with participation of federal, state, academic, industry, non-governmental organizations, and citizen groups.

One aspect of biobased production of biomass for fuels — such as alcohol — is that biomass is a renewable resource, that, unlike petroleum-based fuels, would not necessarily contribute additional carbon dioxide to the atmosphere (NRC 2000). Plant material used for biobased fuel fixes essentially the same amount of carbon dioxide as that released by combustion, and thus is more sustainable than petroleum-based fuels. It would be especially beneficial if biobased fuels could meet the growing energy needs of the developing world. Additionally, plants used for other biobased industrial purposes will act as a sink for additional carbon dioxide and help to mitigate the production of greenhouse gases that contribute to global warming. Another potential benefit of biobased industrial production includes the opportunity to use systems that require less input of agrochemicals and energy, improve soil structure, and increase water quality and soil organic matter.

## COMMUNICATION

Due to the complex nature of biotechnology/biobased industries, increased educational and communication efforts are needed for people to better understand the science and the products that originate therefrom. The NRC report on biobased industrial products states, “The public as well as policy-makers should be educated regarding the rationale and benefits of biobased production” (NRC 2000). In this process of communication, the risks and benefits of the science must be presented to the public. Sensational aspects of the topic have been reported by the media, thus communication efforts are now needed to show the complete picture. This must be accomplished in partnership with the media. In particular, examples of currently utilized products should be highlighted.

Based on studies showing that the public trusts universities as sources of information, these institutions can be charged with at least some of these communication efforts. Consumer focus groups should be actively pursued to identify major obstacles to acceptance for the public, and areas of concern. Out of this process, specific communication tools can be developed that reflect both the concerns and understanding of the public.

## PROCESS INVOLVEMENT

A biobased economy is inevitable, and is already being promoted by the federal government under Executive Order 13101 requiring federal agencies to implement cost-effective procurement preference programs for the purchase of recycled products and environmentally friendly products and services. However, the right process must be in place to ensure that biobased agriculture, as a source of fuel, materials, and chemicals is sustainable in terms of ecosystems, health, equity growth and economic viability. Further, the growth and transition to a biobased economy must be based on consensus among researchers, consumers, producers and processors, investors, and technology developers. For this to occur smoothly, good-quality science must focus on priorities set by the public as a result of widespread discussion. If there is public involvement from the beginning, general well-being can be protected. We need to continue with the systematic consideration of renewable non-petroleum alternative fuels, materials and chemicals. However, finding consensus is perhaps a most difficult task, especially when reasonable people disagree on basic premises. Concerns raised by the discussion regarding process and involvement include:

- What is the impact of current implementation of intellectual property rights on innovation and accessibility?
- Intellectual property rights hold up the transfer of technologies through licensing and non-exclusive licensing.
- Research priorities supported by public funds should be designed to serve the greatest public good.
- Risks and benefits must be shared so that farmers are dynamic partners in the value chains, rather than contractors or low-cost providers. Public involvement will help to build a political environment that will hasten a just and equitable transition.

*Recommendations* We recommend broad public involvement in discussions of the different ways a biobased economy could be achieved. There is opportunity for farmers and rural communities to benefit from new employment and businesses that develop from biobased industries. These opportunities can arise, in part, from the fact that biobased industries will likely be located near production areas. Therefore, it is critical that rural communities be equal participants in the development of new biobased production and industrial commodities.

## FOOD SECURITY

If world population continues to increase and at current production rates, we could face shortfalls in food production if large tracts of arable land are shifted to biobased non-food uses. Ideally, population growth would be restrained to limit pressure on the need for growth in the food-production system. Otherwise, there will clearly be impacts on food security, distribution of wealth, political stability and world peace. In 1998, the United States had about 2.2 million farms, with a total of more than 950 million acres and an average size of 435 acres (National Agricultural Statistics Service, <http://www.nass.usda.gov:81/ipedb/>). In 1990, 12 percent less land was devoted to crop production than in 1929 (USDA 1999). Coupled with continued losses of land under cultivation (which occurred at about one percent per year in the 1990s), large shifts of arable land to non-crop uses could result in food-price increases. Also possible are declines in global food stocks, price and supply fluctuations as producers shift back and forth between food-crop and non-food-crop production in response to changing government policies, the marketplace, corporate consolidation, spin-off and technological advancements. Global conflicts may be provoked by food shortages and inequitable distribution. On the other hand, productivity per acre has significantly increased over the past 60 years. For example barley yields remained constant between 19 and 25 bushels/acre from 1866 to 1949, then doubled over the subsequent fifty years (Table 1). Productivity gains for corn have been even more dramatic (Table 2). If biotechnology can lead to additional gains in yields similar to those of the past fifty years, then the shift of some arable land to non-food biobased industrial production may have little impact on food production or world food security.

	Yield (bu/acre)
1866–1940	19–25
1950–1959	27–32
1960–1969	30–45
1970–1979	40–50
1980–1989	49–57
1990–1998	55–62

Table 1. U.S. barley yields (USDA National Agricultural Statistics Service, 1999).

	Yield (bu/acre)
1920–1929	22–30
1930–1939	19–30
1940–1949	29–43
1950–1959	37–53
1960–1969	55–86
1970–1979	72–110
1980–1989	81–120
1990–1998	101–139

Table 2. U.S. corn yields (USDA National Agricultural Statistics Service, 1999).

## CONCLUSION

In the workshop's final session, additional important points about the five major theme areas were discussed.

## SUSTAINABILITY

When sustainability is discussed, there is a critical need to address specific terms, e.g. water, competition for resources, long-term vs. short-term considerations. Equally important is the need to consider the "true cost" of biobased industries and specifically how do we determine what elements contribute to it. It was again emphasized that there is a need for stable funding of research relative to the development and impacts of a biobased economy and that it is the obligation of federal/state/international partnerships to ensure that adequate information is available to capture the benefits and minimize the risks.

## ASSESSMENT

Assessment must include system impacts: what is grown and where. This must include all levels of human and environmental contact.

## GLOBAL FOOD SECURITY

In terms of global food security, there must be a balance between equitable food production and distribution and agricultural production of value-added specialty commodities.

## COMMUNICATION

Communication must go both ways. Information flow and dialog must occur in all directions among government, the public and industry. Communication must be sincere, thoughtful and substantive.

## Recommendations

- Comprehensive socio-economic assessments will be necessary of the influences of the biobased economy on food supply/prices particularly in importing countries of the developing world focusing on ability to pay, increased use of marginal or fragile land, and producers' desire to shift to higher-value biobased crops from food crops. Implicit to these issues is who will have access to technology and the distribution of its benefits?
- A national policy should be adopted that global food security shall not be compromised to meet the needs of a biobased economy. Food security is the underpinning of global political stability, which ultimately serves the national security and economic interests of the United States.

- Stakeholders (national and regional representatives, scientists, farmers' organizations) from the developing world should be included in policy formulations and decision-making regarding development and deployment of biobased non-food technologies. Opportunities for global forums on the subject should be encouraged and supported.

## REFERENCES

- National Research Council, *Biobased Industrial Products: Priorities for Research and Commercialization* (Washington, DC: National Academy Press, 2000).
- United States Department of Agriculture, National Agricultural Statistics Service, *Track Records, United States crop production* (<http://www.usda.gov/nass> May, 1999).
- United States Department of Agriculture, *Census Of Agriculture* (<http://www.nass.usda.gov/census/census97/cenfaqs.htm> 1997).

## APPENDIX

Important issues that were identified and issue-related questions that were raised.

### Global Food Security

1. Would there be a shift from food to biobased production?
2. What are the local versus global perspectives?
3. Would limited or diminished food resources increase chances of war?

### Assessment

1. A holistic examination of biobased agriculture is needed.
2. What will be impacts of raw-material transport to processing plants?
3. What will be the economic impact/price of products and farm income?
4. Life-cycle analysis is needed for individual products/crops, industry.
5. Environmental assessment of biobased conversion is needed.
6. What will be the long-term indirect effects (e.g., population growth rate) of biobased production?
7. We need to understand change on the large scale.
8. What will be the societal and consumer benefits and risks? Benefits: in health, productivity, quality. Risks: food safety, allergenicity, price, genetic pollution, disease resistance in non-target plants.
9. Will vertical integration of farmers and companies occur?
10. How can we integrate visions of a biobased agriculture with realities?
11. Where will funding come from to pay for assessment?
12. Will biobased agriculture advance consumption and/or conservation?

## Sustainability

1. Can biobased production be maintained with increased food production?
2. Can we maintain an adequate supply of biobased raw materials?
3. Land stewardship: how to improve it with biobased agriculture?
4. Will biobased agriculture stimulate an ecological economy? How to move forward?
5. Can we further intensify food and fiber production? Will there be conflict between new crops and old crops?
6. Will there be adequate resources e.g., water availability to support biobased agriculture?
7. Will limited resources increase likelihood for war?
8. If not sustainable, who pays? Who should?
9. Will water availability limit biobased agriculture?
10. A consumer-benefit list is needed.
11. A consumer-risk list is needed.
12. Will institutional innovation accompany technological innovation?
13. Substantive analyses of life-cycle assessment and equity assessment are needed.
14. What long-term indirect effects of biobased agriculture on population growth could arise?
15. Will a long-term stable funding source be available?
16. An open regulatory process/evaluation is needed to maintain community trust.
17. Risk/benefit assessment needs to involve the developing world in the debate.
18. Will high-risk GMOs arise from biobased applications?
19. There is a need for a holistic examination of biobased agriculture.
20. Can decentralized agricultural networks be maintained?
21. How will biobased agriculture affect raw-material transportation?
22. What will be the economic impact on food production?
23. Presently there are major acceptance obstacles.
24. How will a biobased economy impact land stewardship?
25. Clearly there will be a need to understand change on a large scale.
26. How can we effectively inform/communicate the risks/benefits of biobased agriculture to the public?
27. Further intensification in forestry is desirable.
28. How can a biobased agriculture help us to move to an ecological economy?



## Communication

1. How do we allay concerns about high-risk genetically modified organisms (GMOs)?
2. How can we effectively inform the public?
3. Public education must be a priority. Must improve public's knowledge of science.
4. Can there be a perception of DNA as a pollutant?
5. Can plant pharmaceuticals be as beneficial as pharmaceuticals derived from other sources?
6. Presently we have major acceptance obstacles.
7. Can there be sustainability with increased food production and increased biobased production?
8. Biomass cultivation could be useful to increase biodiversity of agriculture.
9. Can agriculture and input resources supply enough biobased raw materials?

## Process Involvement

1. Who will control and benefit from the intellectual property rights?
2. We need to make the public true participants in developing a biobased economy.
3. Who decides and who will decide what research priorities are necessary for sound assessment of benefits/risks
4. We need to ensure that farmers have an opportunity to participate as partners/contractors.
5. What is the current political/policy environment?
6. Communication/education of public is essential.
7. What are the health ramifications of a biobased agriculture?
8. Will the public embrace plant-based pharmaceuticals?
9. Some may see DNA may as a pollutant.
10. How do we go about creating a positive political space for biotech?
11. Should regulation be science based or politically based?
12. Intellectual property seems to exclude involvement of the public and farmers.
13. Can we increase the utilization of waste from existing crops to create new specialty crops without requiring more land or input resources?
14. It is important that farmers do not become contract providers to vertically integrated multinational corporations.

15. Will a biobased economy affect food safety?
16. Who decides what needs to be researched?
17. How can we make the public true participants in the debate on value-added applications of agriculture for the biobased economy?
18. Process involvement must include local and global perspectives.
19. How will the shift from food production to biobased products affect food security?