NABC news

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Providing an open forum for exploring issues in agricultural biotechnology

NABC'S PRINCIPAL OBJECTIVES ARE TO:

- *provide an open forum for persons with different interests and concerns to come together to speak, to listen, to learn, and to participate in meaningful dialogue and evaluation of the potential impacts of agricultural biotechnology*
- *define issues and public policy options related to biotechnology in the food, agricultural, biobased industrial product, and environmental areas*
- *promote increased understanding of the scientific, economic, legislative, and social issues associated with agricultural biotechnology by compiling and disseminating information to interested people*
- *facilitate active communication among researchers,administrators, policymakers, practitioners, and other concerned people to insure that all viewpoints contribute to the safe efficacious and equitable development of biotechnology for the benefit of society*
- *sponsor meetings and workshops and publish and distribute reports that provide a foundation for addressing issues*

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Letter from the Chair . . .

Having just spent a week at the American Society of Plant Physiology meeting in San Diego, I now even more know why we need an organization like the NABC.

Like many of you, the meeting left me impressed and struck by the rapid advancement of molecular biology. This year, advances in the area of plant genomics particularly excited me. Two plant genomes (rice and *Arabidopsis*) are completed or nearly completed. Information on the genomes of several major crops is advancing rapidly including tomato, corn, sorghum, canola, soybean, and cotton. Potential agricultural and food applications for this technology abound. In my own area of plant winter hardiness, two papers by Jaglo-Ottosen *et al.*, at Michigan State University and Steponkus *et al.*, at Cornell demonstrated that the model plant — *Arabidopsis* — could be engineered to survive –20°C. This is a temperature attained by only the hardiest crop species like winter wheat and rye! It is impressive in part because *Arabidopsis* normally is not particularly winter hardy and the investigators only used one to three plant genes to get the result. Furthermore Jaglo-Ottosen reported this had already been accomplished in another crop species, canola. There were many such examples and there will be many more of relevance to agriculture at other scientific meetings this year and in the years ahead.

Scientist awareness about the public concern with biotechnology was high. The meeting started with a presentation by Gordon Conway of the Rockefeller Foundation who described opportunities, risks and

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public acceptance of biotechnology. There was a well attended mini-symposium on Societal Issues in GMO's with Steve Taylor of Nebraska addressing food safety, C. S. Prakash of Tuskegee describing challenges for developing countries, and Lesley Blancas presenting research on gene escape. Finally, in the very last presentation of the meeting, Robert Goldberg of UCLA predicted that all crops would be fully sequenced in 25 years and if one were missed it would be an easy job to do it. Goldberg speaking on plants of our future provided one of agriculture's challenges: "The next 50 years will require more food production than in all the collective history of humans on earth." He pointed out "It would have to be done on less agricultural land and with a smaller yield per person." But he posed a final question: "Will there be genetic engineering in the 21st century?"

Of course most scientists like myself think the answer to Goldberg's last question is yes there will be genetic engineering in the 21st century. However, as I left the meeting I was returned to reality when I picked up the San Diego Union Tribune to read the Reuters story "Campbell's biotech food targeted."

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NABC 12: An overview

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Introduction

With rapid world growth and changing consumer demands and attitudes, sustained economic and social growth will depend upon a secure supply of raw material inputs for manufacturing needs. Continued depletion of limited global natural resources supports the concept of supplying industrial production and energy needs through the use of renewable, or biobased, resources. The United States has a highly productive agricultural system, which in addition to providing basic food, feed, and fiber can produce significant plant and animal based resources for use as basic building blocks in industrial production. There is an opportunity for agriculture to become a major source for energy, chemicals and materials production in the 21st century.

Many believe that movement toward a biobased economy is the most significant opportunity for agriculture in more than 100 years. Various national activities in 1999 and 2000, such as the Presidential Executive Order for a biobased initiative, the National Research Council Report on Biobased Industrial Products, and the EPCOT Millennium Exhibit document the expanding enthusiasm for this opportunity. The use of biobased renewable resources as raw products for manufacturing holds the potential for use in many industries including liquid fuels, organic chemicals, polymers, fabrics, and health care products. Use of biobased resources for energy production may reduce our need for fossil fuels, impacting national and international security concerns. This will have major implications regarding our access to energy, and may influence balance of trade issues, jobs, and military expenses, which are used to ensure our access to oil. Current industrial chemicals and materials are mainly fossil-based, and a shift to producing these from biobased material shows promise. However, several economic, environmental and societal issues will develop from the use of plant and animal resources in a biobased economy. Issues such as removal of productive farming land, which could be used for food, feed and fiber production and replacing it with crop and animal production for use in biobased products must be addressed. Related bioethics questions of a global food supply and distribution system along with the use of genetically modified crops and animals in health, material, chemical and related fields will be debated. Potential loss of crop diversity through contract farming and the equitable treatment of farmers in their interaction with biobased companies are areas of concern for many groups.

The widespread use of plant and animal based inputs for fuel and industrial uses will require research and development efforts to address modifications in current processing systems, modifications to plant and animal production systems, and integration of fossil fuel/biobased approaches. Major plant and animal production areas are not geographically suited to traditional processing facilities. Transportation issues and location of processing facilities near plant and animal production areas must be addressed. Successful progress toward addressing these and other challenges facing biobased industrial production will be achieved by an integrated, multidisciplinary approach to research and development that combines talents from traditional agricultural disciplines with those from engineering, health, information technologies and many others.

To address the implications of this new invigorating technology, the National Agricultural Biotechnology Council's 12th annual meeting, held May 11-13, 2000 and hosted by the Institute of Food and Agricultural Sciences at the University of Florida, focused on "The Biobased Economy of the Twenty-First Century: Agriculture Expanding Into Health, Energy, Chemicals and Materials." Plenary presentations, along with participant-driven workshops, debated the research and development, regulatory, public policy, industrial and economic issues surrounding our society moving toward greater production and utilization of biobased products.

To follow are brief highlights of the meeting's presentations. A complete overview and full transcript of each talk will be available in the NABC Report 12, to be published shortly in the beginning of 2001.

Keynote presentations

Two opening keynote presentations set the stage for the plenary presentations and workshop sessions that followed over the next two days. Ralph W.F. Hardy, President of the NABC and moderator referenced the "Vision Statement for Agriculture in the Twenty-First Century," published by the NABC in 1998. The statement emphasizes that in addition to food, feed and fiber production, the "mission" for agriculture in the 21st century will include the production of

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energy, chemicals, and materials. He also noted the National Research Council's (NRC) recent report on Biobased Industrial Products suggesting the goal for 50 percent of our liquid fuel consumption from ethanol produced from biobased raw materials and 90 percent of our organic chemicals in the 21st century. This technology has far reaching social, environmental, and national/international security implications. Opportunities also exist for positive impacts on the environment, improved sustainability, and rural community development.

Additional recent activities are the Presidential Executive Order charging the US Department of Agriculture (USDA) and US Department of Energy (DOE) to jointly develop a plan for a biobased initiative and the "Village Green" exhibit at EPCOT, Walt Disney World, which focuses on the biobased, renewable resources theme and will be viewed by 10 to 15 million people.

James Woolsey, a partner in the law firm of Shea and Gardner in Washington, DC, and former director of the Central Intelligence Agency, gave his perspectives on "Hydrocarbons to Carbohydrates: The Strategic Dimension." We need alternatives to fossil fuels so as to decrease our susceptibility to disruption of supply. Our reliance on fossil fuels creates four difficulties: 1)CO_2 emissions and global warming, 2)air and water quality, 3)negative trade deficit and 4) national security.

Ralph Nader, founder of the Center For The Study Of Responsive Law, gave the second keynote address on "Changing the Nature of Nature: Corporate, Legal and Ethical Fundamentals." He pointed out that in the 1920's there was a similar attempt toward a carbohydrate-based economy. In Nader's view, that effort failed because the petrochemical, fuel, and paper industries did not "take up the cause," and petrochemical and associated products became dominant. This highlighted one of Nader's main points, which was the role of power (government and corporate) in making choices and setting direction. As an example, throughout the past 60 years the research budget of the US Department of Agriculture directed toward carbohydrate research has been minimal, whereas governmental subsidies to the oil, gas, coal, nuclear power, and forestry industries have been large.

He said that he hoped his comments were not taken as being negative about the promise of biomaterials, because he is quite positive about it. He likes what it does for small farmers, the environment, and for poor people abroad. His main concerns center around the process by which technologies are delivered and the potential misuse and redistribution of wealth and power that can occur.

Plenary Talks

The conference's second day focused on "Evolving Roles for Science, Technology, Business, Government and Education in a Biobased Economy." Greg Zeikus, CEO of MBI International and member of the NRC Committee on Biobased Industrial Products, gave an overview of the recently published NRC Report, *Biobased Industrial Products: Priorities for Research and Commercialization*. The NRC report states that "biological sciences will have the same impact on the formation of new industries in the 21st century as physical and chemical sciences had on industrial development in the 20th century." This statement is supported by four concepts. First, before the advent of the petrochemical industry, US agriculture was involved in making industrial products from agricultural feedstocks. Second, the new tools of genetic and bioprocess engineering now enable economic improvements in feedstock utility and manufacturing systems. Third, real environmental problems including air and water pollution and global warming are associated with industrial processing of fossil fuels. Finally, the realization that depletion of petroleum, a non-renewable chemical and energy feedstock needs to be replaced by renewable agricultural carbohydrates to drive the economy of the new millennium. The NRC report further states that "What is needed now is a national awareness far greater than that used to launch the space program and being the first country to get a man on the moon. Here both our future economic and planetary well-being are at stake in developing this biobased industrial products society."

Robert Dorsch, Director of Biotechnology Development for Dupont, gave a business perspective on biobased product development. He cited a specific example of the large-scale chemical industry's view of moving towards sustainable chemicals and materials. He suggested that this work is in its infancy and still hypothetical in some instances, but said that biotechnology is impacting the chemical industry, particularly the organic chemical industry, in a very major way. One of Dorsch's main points was that we should not polarize the issues of carbohydrate and petroleum based production. We will have to transition from where we are today to where we see ourselves in the future, and this will be driven by the combination of these two raw materials bases.

Dan Reicher, Assistant Secretary in the Department of Energy, gave an

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Workshop Reports

Workshop A: Roles of academia, industry, and government

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The expansion of agriculture into health, energy, chemicals and materials will require new skills and staffing, and additional investments into research, development and commercialization, along with specialized facilities. Participants in this workshop were asked to consider what role academia, industry and government should play in the development of a "biobased economy." Three broad issue areas were identified as important considerations in this development: 1) partnerships, 2) communication, and 3) maintenance of research credibility/objectivity.

Partnerships

Well-organized partnering between academia, industry, and government, as well as between and among various disciplines within academia will be critical to the future success of a bio-based economy. Academia should promote (and not hinder, as has sometimes been the case to date) multi-disciplinary team approaches to research. These teams should engage not only biological and agricultural scientists, but physicists, chemists, and social scientists. Industry should form alliances to fund basic research and become affiliated more closely with academia in terms of articulating research needs, or in jointly conducting research with academic scientists. Government should be involved at all levels (federal, state, local) to facilitate linkages, to aid in planning, prioritizing and conducting bio-based research with academia and industry, and in providing funding opportunities as well as other incentives that would foster the development of partnerships.

Specific recommendations

Assembly of multi-disciplinary teams within academia

1. When research administrators are hired, it should be made clear that one of their responsibilities is to enable multi-disciplinary research. Also, their performance as productive administrators would be evaluated accordingly.

2. An academic institution must value accomplishments made by multi-disciplinary teams by recognizing team members with full rewards and credits for their achievements.

3. Academia should look to hire faculty who have an interest in collaborative research and would plan on making such connections a high priority in their programs.

4. Seed monies need to be obtained from all sectors (public, private and government) and used to establish multi-disciplinary teams.

5. Stakeholders outside of academia should be active participants in the research when appropriate.

Development of a funding consortia

1. Funding consortia would consist of all 3 segments: academia, industry (including non-agricultural companies), and government (all levels and possibly being the largest contributor).

2. One main objective of any funding consortium would be to create biobased Centers. These centers may be real or virtual laboratories whose purpose would be to conduct core, basic, long-term biobased research, though they may also support more applied, short-term research. Scientists from academia, industry and government would be active researchers at these centers.

Communication

All sectors involved in funding, conducting and commercializing biobased research need to improve their efforts in communicating both the benefits and potential risks of biotechnology-based products and processes. Particular attention should be paid to communicating sound, science-based information to the general public, to particular clientele groups (farmers, processors, direct consumers), to the news media, and to members within their own businesses or institutions. To this end, scientists and administrators in academia, industry and government all need to be involved in developing communication strategies that promote scientific literacy — especially literacy about biotechnology — on a local, national and global scale. Further funding for communications research in this area will be necessary, since many strategies for communi-

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cating science and technology in the past have not been successful. For the biobased economy to become a reality, people who are well versed in the pertinent issues associated with the biobased economy must make informed decisions. This should result in responsible uses of biotechnology, and perhaps even eliminate the need for strong government scrutiny and regulations. Science can and should serve the public good, and effective communication of this fact is a key.

Specific recommendations

Communication workshops

1. Workshops focusing on effectively communicating about science and biotechnology in particular should be developed in order to best determine what techniques and methods of communicating science work best.

2. Workshops designed to highlight and educate participants in risk communication (or risk/benefit communication) would be valuable to all sectors.

3. Listening sessions should be conducted involving stakeholders, so that their ideas and concerns could be heard and discussed. The outcomes of these sessions would also serve as the basis for future development of appropriate messages that could effectively reach specific target audiences.

Improvement in scientific literacy

1. Development of science outreach programs for K-12, and science workshops for K-12 teachers that educate them about biotechnology and a biobased economy.

2. Design and implement biotechnology curricula at all educational levels.

3. Conduct extension activities to communicate to particular target audiences through printed media, web-based media, and workshops.

Facilitation of credible information between scientists and the news media

1. Train scientists in how to effectively communicate about science to non-scientists.

2. All sectors should make "expert" spokespersons available to the media.

3. Media should be invited to campuses, research centers, etc. for demonstrations, tours and seminars.

Maintenance of research credibility/objectivity

Although increased partnering between academia and industry would generally be desirable in bringing about a biobased economy, it does carry some risks. In particular, questions may be raised about the credibility and objectivity of academic research since funding would be provided by industry directly to academia. Any public perception that academic scientists lack credibility would seriously hamper efforts to increase the public's scientific literacy through effective science communication. Indeed, no one will believe the message if the messenger is not trustworthy. So, it is imperative that research objectivity be preserved in order for credibility to be maintained. Without this credibility / objectivity, a biobased economy may never reach its potential.

Specific recommendations

Maintenance and improvement of funding structure

1. Ensure that there is core funding (public universities, public centers) that provides monies for operating costs and to conduct essential research according to an agenda that should be set solely by scientists and administrators within academic institutions.

2. Some industry funds should be placed in a general or "escrow" account to finance research into safety or efficacy of industry products by academia. Decisions regarding the distribution of these funds to specific individuals/ projects should not be determined by the industry, but again, by those in the academic institution.

3. Academic freedom and independent peer-review of research results never should be compromised by the funding source.

Create a "disconnect" between industry and Extension

1. Those, whose positions include communicating about biotechnology and the biobased economy, such as extension faculty, should be independent of particular industry support and should not be in any position to benefit from research results.

2. A complete discussion encompassing all sides of a biotechnology issue — including the ethical, environmental, social, and legal aspects — should be brought out by those communicating the impact of this research.

In summary, there is little doubt that we are moving toward a biobased economy. However, in order for this transition to be efficient, sustainable, and ultimately, in the service of the larger public good, there must be new and creative ways in which public institutions and private enterprises can structure, fund, and monitor research and development of biobased processes and products. Moreover, there must be a spirit of openness on the part of individuals and institutions involved in the move to a biobased economy, in order to insure public trust in science, and ultimately guarantee as far as possible that real benefits associated with biobased processes and products are obtained. Participants in this workshop area articulated the need to move forward toward the biobased economy, though with a constant eye on potential risks as well as benefits.

Appendix

Individual ideas of workshop participants, which may not be directly addressed in the three areas

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Workshop Reports

Workshop B: Producer/industry relationships in a biobased economy

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Our group explored how the transition to a biobased economy will affect the relationships between producers and the food, fiber and fuel processing and marketing industries.

The issues identified

In our first session, we identified a number of issues concerning the development of new relationships between producers of agricultural products and the industries that process and market those products. Based on our discussion, participants assigned points to each of the 22 issues identified in the first session. The five key issues that emerged were:

1. How can farmers achieve alternative modes of organization so as to capture markets and control the end (final, processed) products in order to reduce the volatility of markets for agricultural products? How can these alternative modes of organization be financed?

2. The transition to a biobased economy will put farmers in an environment of continually changing technology and markets, and one where the rate accelerates. How can producers anticipate and embrace change in order to reap the benefits of change rather than suffer its negative consequences?

3. How can producers acquire the skills and attitudes needed to survive in a much changed business environment? Alliances will become more important and individual entrepreneurship will decrease. In an environment that is technologically sophisticated, the ability to take advantage of value-added opportunities will be critical.

4. How can farmers deal with the liability that results from their increased involvement in processing and marketing end products?

5. New processing facilities will need to be located near the resource base (products, infrastructure, labor, natural resources, energy, etc.) to reduce initial capital outlay and maintain product supply. What socio-economic impacts will these facilities have on rural communities?

Discussion

The number one issue that we identified dealt with the question of how producers can best organize themselves and acquire the capital needed to be effective players in this new economic environment. We noted that traditional commodity production would likely continue. Some noted that reliance on this traditional approach to moving the product to market might mean that producers would be able to retain the price premium for new crops for only a short time. Others pointed out that we could see a division within the producer community where those farmers who elect to use the traditional commodity markets will essentially be the economic losers in a biobased economy. The group noted that contracts reflect demand and supply and that there are both advantages and disadvantages to contracting, particularly long-term contracts. A five-year contract, for example, may protect the grower from downturns in market price, or it may prevent the grower from reaping the benefits of periodic upturns in demand and price. We concluded, among other things, that new, more flexible contract arrangements may be needed, but that these arrangements may well increase grower exposure to market volatility as well as offer opportunities to profit from new technologies and crops.

Much of our discussion dealt with new structural forms that could better position producers to capture economic benefits in a biobased economy. One example is the 21st Century Alliance, a group that shared their entrepreneurial strategy with us at this conference. The focus of this approach is to move farmers beyond producing raw materials into the processing and marketing of biobased products in order to capture more of the added value in the final product. We noted that this option ranges from full ownership and vertical integration by producers to developing more win-win synergistic relationships

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between industry and producers. One example of the latter would be that of a group of producers becoming essentially the sole suppliers of certain agricultural products, thereby ensuring a supply to the processor and protecting the intellectual property rights of the company that develops new knowledge. Other approaches involve restructuring agricultural businesses to capture niche markets or to use new technology to capture a greater share of the market value of transformed agricultural products.

We noted that implementing many of these approaches, especially those scenarios where producer ownership of processing and distribution increases significantly, requires large capital investments. We discussed the problems associated with raising capital and noted that raising capital may be difficult for producers at this juncture in history, where farmer resources — especially cash resources — are very limited. The dangers associated with offering land as the guarantee for venture capital were specifically identified. Our group also noted that moving upward in the processing and marketing hierarchy is probably not a panacea, because these sectors of the food, fiber and fuel industries are very competitive themselves. One specific example is that of large distributors who have gone to direct purchase or contract production of the final product, thereby eliminating several middlemen (wholesalers, etc.).

Another major issue can be summed up in one word: change. The transition to a biobased economy will entail change, rapid change. We characterized this future environment as one that is technology and market-driven and one where change is continual. Our group discussed how this environment of change would affect producers. We noted that the education and skills farmers will need will be different in the future. Embracing and taking advantage of change requires skills such as problem solving and analytical thinking. We noted that traditional attitudes and skills might not serve farmers well in this new environment. Furthermore, any given set of facts or production practices is apt to be outdated virtually before it reaches the farmer. We noted that the traditional approach of lengthy research to verify recommendations, passing these recommendations through a review process on to Extension, and finally reaching the farmer with these new practices will not be effective in a world of fast paced change. In short, this traditional approach to accumulating and sharing knowledge is too slow. By the time information reaches the user, the opportunities for taking advantage of the information are gone.

Although related to the previous issue, our third topic focused more specifically on the skills and attitudes that farmers will need to survive in a technologically sophisticated environment, where traditional individual entrepreneurship may not be the most appropriate way of making the most of economic opportunities. We noted that some of the attitudes traditionally held by farmers may not be well suited to this new environment. The strong tradition of individualism, for example, may need to give way to a tradition of building alliances and partnerships. Similarly, both farmers and the institutions that serve farmers may need to re-think the role of all professionals. Farmers need to be researchers and teachers, as well as businessmen. University faculty need a more entrepreneurial approach to their work and think about how farmers can reap economic and productionbenefits. In short, the attitudes, skills, and knowledge of farmers and other agricultural professionals will all need to change for farmers to be able to take full advantage of a biobased economy.

Our discussion regarding the fourth issue — increased liability as farmers move more into processed products and marketing — was limited. We did note that one advantage of the traditional approach to marketing is that the farmer's liability for product damage has been limited. In most cases, it is the processor and marketer of a product that is held liable for any damage to the consumer. Farmers have also not been liable for some of the environmental costs associated with producing food, fuel and fiber, because their liability limits have essentially ended at the farm gate. This, however, has changed in recent years. And as farmers move into new products, processing, and marketing, the potential liability—particularly consumer liability— increases.

Finally, our group focused on the question of how the processing facilities that are tied to new biobased products will affect the communities where they are located. We noted that these plants will need to be located near the raw material, an agricultural product, but will also have other requirements. Examples include power, infrastructure, transportation, labor, and human capital. Therefore, as these facilities are developed, it is clear that they will have some major socio-economic impacts on rural communities. In fact, their development implies very large changes for many communities. Labor is a good example. Getting enough labor is already a problem for many farmers. Processing industries will demand

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Workshop Reports

Workshop C: Food and environmental issues associated with the biobased economy of the 21st century

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Introduction

Workshop participants were asked to address the following issues regarding the influence of the expansion of biobased agricultural production 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 that on global climate change, local and regional air pollution, and local pollution by processing residues?

This workshop brought together a remarkably diverse collection of professionals 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. 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 issue theme areas

During the first session, a total of 71 issue statements or issue related questions were put forth by the participants (see appendix for complete listing). Individual statements or questions were grouped under one of five major theme areas that emerged from the list *in tota*. The five theme areas identified were: 1) assessment, 2) communication, 3) global food security, 4) process, and 5) sustainability. Of these five areas, assessment, sustainability, and communication had the greatest concurrence among participants.

Assessment

It is recommended that 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 report, 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 for significant societal and consumer impact. In order to evaluate that impact, biobased products should be subject to the same critical safety criteria as conventional products. 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 to the displaced conventional agricultural and non-agricultural products. Some of the expected benefits include: increased productivity; better utilization of otherwise useless by-products; help lower cost; quality improvement of nutrition, flavor, and texture; reduced environmental footprint(s) or impact; renewable raw materials; and economic security for farmers and overall improved balance of trade.

In order to stimulate the comprehensive assessments of an emerging biobased-industry, the US Government should promulgate competitive solicitations and make grants on a peer-reviewed basis. Converting to a

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biobased production will also have significant impact on rural economics and 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 of the group 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 (quality of life, 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 while providing a reasonable standard of living (is it higher or lower than at present?). Presently there is an inadequate knowledge base and sources of funding to develop the prerequisite knowledge. In addition, a concern is how to provide incentives for sustainability of land, water, and other limited resources.

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

1. Large-scale conversion of agriculture to a biobased economy requires a thorough analysis of sustainability.

2. Stable public-sector investments will be required to establish a knowledge base to develop appropriate technologies.

3. All constituent groups must work toward the development of policies that incorporate consideration of ecological costs into the products and goods destined for the marketplace.

4. Initiate a global dialogue on these issues using partnership structures involving federal, state, academic, industry, non-governmental organizations, and citizen groups as participants.

One aspect of biobased production of biomass for fuels— such as alcohol— is that the biomass is a renewable plant source, that unlike petroleum based fuels, would not necessarily contribute additional carbon dioxide to the atmosphere (NRC report, 2000). Plant material used for biobased fuel could fix essentially the same amount of carbon dioxide as given off by combustion and thus be more sustainable than the currently used petroleum based fuels. This could be especially beneficial if biobased fuels instead of petroleum-based fuels met the growing energy needs of the Third World. Additionally, plants used for other biobased industrial purposes could act as a sink for additional carbon dioxide fixation and help to mitigate the production of more greenhouse gases that contribute to global warming. Another potential benefit of biobased agricultural production includes the opportunity to use production 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, which originate from this science. The NRC report (NRC report, 2000) on biobased industrial products states "The public as well as policymakers should be educated regarding the rationale and benefits of biobased production." In this process of communication, the risks and benefits of the science need to be presented to the public. The sensational nature of the topic has been only partially captured by the media, thus communication efforts need to show the complete picture. This must be accomplished with the media as a partner in communication. In particular, examples of currently utilized products need to be highlighted.

Based on past studies showing that the public trusts universities as a source of reliable information, universities can be charged with at least some of these communication efforts. The use of consumer focus groups to identify major acceptance obstacles by the public and areas of concern should be actively pursued. 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, we need to have the right process in place to be sure that biobased agriculture, as a source of fuel, materials, and chemicals is sustainable in terms of ecosystems, health, equity growth and

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economic viability. Further, the growth and transition to a biobased economy needs to be based on consensus among researchers, consumers, produces and processors, investors, and technology developers. For this to occur smoothly, we will need to pursue good quality science focused around priorities set by the public from widespread public 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. Some concerns raised by the discussion regarding process and involvement include:

1. What is the impact of current implementation of intellectual property rights on innovation and accessibility?

2. Intellectual property rights hold up the transfer of technologies through licensing and non-exclusive licensing.

3. Research priorities supported by public dollars should be designed to serve the greatest public good.

4. There needs to be shared risks and benefits so 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.

Recommendation

Have wide public involvement in the different ways a biobased economy could be achieved. There is an 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 a biobased non-food use. Ideally, population growth could be further restrained to limit pressure on the need for growth in the food production system. If not, 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, there was 12 percent less land devoted to crop production than in 1929 (USDA, 1999). Coupled with the continued loss of about one percent of land under cultivation per year in the 1990s, the possible effects of large shifts of arable land to non-crop uses could include food price increases, decline 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, marketplace, corporate consolidation, spin-off and technological advancements, and global conflicts could be provoked by food shortages and inequitable distribution. In contrast, 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. But, over the past fifty years the yield has more than doubled. Productivity gains for corn are even more dramatic. If biotechnology can lead to additional gains in yield similar to the past fifty years, then the shift of some production arable land to non-food biobased industrial production may have little impact on food production or world food security.

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 like -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 the true cost. 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 of biobased industries.

Assessment

Assessment needs to 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 between

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government, the public and industry. Communication must be sincere, thoughtful and substantive.

Recommendations

1. Comprehensive socio-economic assessment 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 producer's 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?

2. A national policy should be adopted that global food security shall not be compromised to meet 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.

3. 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

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• US Department of Agriculture, National Agricultural Statistics Service, *Track Records, United States crop production*, (http://www.usda.gov/nass), May, 1999.

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described above, are listed below:

1. Congress should pass legislation to support industrial biobased research centers at the university level.

2. The federal government needs to aid in the development of a market for biobased products by providing the necessary incentives and minimizing investment barriers.

3. USDA must be more aggressive/successful in getting funds allocated to it for competitive grant programs. Agencies like NIH do a much better job at obtaining such funds.

4. The federal government needs to articulate the need for biobased research and fund it as it has done for NASA.

5. Peer review for safety and efficacy testing should be demanded of the industry and the findings should be in the public record.

6. Industry should provide graduate-level internships.

7. Intellectual property guidelines need to be in place to promote commercialization while protecting society.

8. Patents and intellectual property issues are having a paralyzing effect on developing commercial products from academia.

9. Ways must be found to redirect faculty to conduct research in an emerging technology such as biobased product development.

10. Universities need to provide a better context for entrepreneurship.

11. Biobased research occurring in universities often does not support the needs of the industry because there is no dialogue between the two when fundamental decisions about research first take place. This situation needs to be changed so that initial decisions are made together.

12. There needs to be a small group of leaders from all sectors that can champion the biobased vision.

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not only more labor, but also a different set of skills and knowledge. How will the supply of labor affect rural communities? The same issues arise for any of the major components needed to build and operate large scale processing facilities.

Recommendations

In our final session, we examined four of our five priority issues. We did not analyze the issue of increased liability. For the other four priority issues, we tried to analyze the challenges or problems and the opportunities or promises inherent to each issue and then looked for ways to overcome the challenges and take advantage of the opportunities. The result was a set of recommendations.

Structure and financing: We identified three opportunities associated with the need for new forms of organization and financing. 1. The potential for improving the economics of farming is high, since in a biobased economy, the opportunities for farmers to participate in all aspects of product development and sales will increase. 2. Similarly, a stronger role for biobased products in the economy offers the producer opportunities for longer term, more stable market relationships and for win-win relationships where both farmers and processors benefit. 3. Finally, the technological sophistication of the new biobased products offers opportunities for shared interests on the part of producers and processors, where proprietary ways of production extend from farm to market. On the other hand, these new structural and financial arrangements also offer challenges. One is the decreased independence of the producer. As farmers move into alliances either among farmers or with businesses in other sectors of the food, fuel, fiber, and chemicals industry the farmer's traditional independence is lessened. The other challenge is that the potential for losing the fundamental farm resource— the land— is high, if land is used as the capital to finance new organizational and production arrangements.

Our recommendations focused on new ways of financing the structural changes needed. These could include finding ways for farmers and industry to share risk, such as joint ventures and both formal and non-formal alliances among farmers and between producers and other segments of the food, fuel, fiber, and chemicals industry. We heard two presentations during this conference about new approaches to finding venture capital. Farmers have not traditionally been involved in raising venture capital; this will be one key to success in the future.

A rapidly changing environment: The promises relate to the enhanced opportunities for a stable farm economy. We noted that farmers can use biotechnologies of all types to increase the number of marketing mechanisms open to them, the kinds of products that they sell, and the portion of the consumer dollar that goes to the producer. All of these opportunities reduce the producer's current dependence on a highly volatile market with little elasticity. We also noted that the alliances discussed in our first recommendation could actually help farmers anticipate and take advantage of change. By working more closely with other segments of the business community — from suppliers of inputs to marketers — farmers will gain greater access to information of all types and will probably have a more robust set of tools for analyzing the information they receive. On the other hand, there are considerable risks associated with rapid change. One is that the public research and Extension system is simply too slow to respond effectively to a rapidly changing technological and economic environment. Another related concern is the quality of the data available for decision-making. Clearly all decisions are made based on imperfect or incomplete knowledge. However, as change accelerates, the need to make decisions even more rapidly may tend to force farmers into decision-making based on less — and potentially less accurate— information. Added to this is the fact that the technology and the economics of this technology are still largely unknown. Dealing with the unknown adds a very high risk factor to decision making. Finally, even the most skilled and knowledgeable decision-maker, who may or may not be backed by adequate capital, may not be able to meet the challenges of the highly volatile, rapidly evolving marketing environment.

Our recommendations focused on the need to enhance the flow of information to the producer. We specifically identified the weaknesses in the public research and Extension system as a point where significant improvement is needed. We felt that this could best be achieved by developing an institutional framework that is more entrepreneurial and product-focused than the current system. Starting with the research process, all professionals in the chain should focus on end product development. This requires an integrated approach to research and Extension where the goal is to develop a viable, marketable product. This will require changing institutional rewards to encourage entrepreneurial thinking, and training researchers and Extension personnel to think beyond simply developing knowledge to developing a

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salable product.

Attitudes, skills and knowledge: The promises offered by a biobased economy are that producers can use their skills and knowledge to secure a more stable, higher farm-based income. This can include both smaller producers who can develop skills and expertise in producing products with low volume but high value demand, , and larger producers who can take advantage of larger markets for new biobased products. The new structural mechanisms discussed above also offer producers who have the appropriate skills, attitudes, and knowledge opportunities to move out of the trap of solely producing a raw product for new business ventures, where the potential demand for and profitability of farm products are much higher. The challenges are that taking advantage of these opportunities simply requires new ways of thinking: in many cases less emphasis on production, but more on business skills, less emphasis on individualism but more on building partnerships and alliances.

We believe that the key to taking advantage of these opportunities is analytical and problem solving skills. We conclude, for example, that training programs for both producers and for agricultural professionals in the future will need to focus more on how to find information efficiently and how to evaluate the quality of available information. Similarly, problem solving and analytical skills will be critical and training programs should focus heavily on teaching these skills. In a rapidly changing technological and economic environment, knowing where to get information, how to evaluate it, and how to use it will be keys to success for all agricultural professionals, not just farmers.

Socio-economic impacts on communities*:* We discussed this issue at some length, but arrived at no clear recommendations for action. Many questions arose. Will the school systems in rural areas be able to prepare the quality work force demanded by these industries? Will the local labor supply be sufficient to meet the needs of processors? Will processing have negative impacts on the quality of life many people seek in rural areas? Will the infrastructure support the development of such facilities? In short, are we conscious of the profound effects that locating major processing facilities in rural areas would have on local communities? Given the current status of rural communities, it is not clear that they are capable of supporting robust processing industries or meeting the needs of these industries. This could be one factor that slows the development of a biobased economy.

Summary

Our group saw the development of a more biobased economy as offering great potential and great challenges. While the potential economic benefits of these changes to both producers and the communities where they live are great, reaping these benefits will require new ways of doing business, new forms of organization, new ways of getting knowledge to producers, and new attitudes, skills, and expertise on the part of all involved. We believe that one phrase describes the future of producers and rural communities: it will be different. Change and the ability to cope with change are clearly keys to success.

Save the Date

NABC 2001 Annual Meeting

May 22-24, 2001

NABC 2001: Consumer Concerns about Biotechnology in ou Food System: Past, Present, and Future

Hosted by the University of Illinois and Iowa State University

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overview of the DOE's contribution to President Bill Clinton's bioproduct and bioenergy Executive Order 13134. One of Reicher's key messages was that success with bioenergy and biobased products will require a more integrated approach, and that the nations colleges and universities will have a very large role to play and government, industry, and academic partnerships are ultimately the key to success in moving bioenergy forward.

As part of the President's Executive Order, an interagency council on biobased products and bioenergy jointly chaired by the DOE and USDA was established. A new advisory committee is being formed that will have university representation on it to advise the government on our approach to bioenergy and biobased products.

Roger Conway, Director of the USDA Office of Energy Policy, provided an overview of the USDA's contribution to the President's bioproduct and bioenergy Executive Order 13134. He indicated that the goal of the initiative is to triple the nation's use of biobased products and bioenergy by 2010. The USDA is interested in this initiative for its impact on rural, farm and forest economies. This past fiscal year $23 billion was made in direct payments to farmers, which was the highest payment ever. There is a need to develop a market-based solution for agriculture, which may provide an avenue for increasing agricultural income. Examples of markets in which biobased products could compete include lubricants ($5.1 billion in sales), composites ($14.6 billion), paints ($43 billion), and plastics ($77 billion).

Patricia Swan from Iowa State University gave her perspectives on the role of the land grant universities in developing a biobased economy. She said that when asking what land grant universities should do regarding the development of a biobased economy, it is important to review current societal expectations of them as well as the evolution of their responsibilities. It is also necessary to consider how they receive financial support for carrying out their responsibilities and to examine the nature of the present challenge and ways in which these universities might meet this challenge. Swan noted that over the past century, land grant universities have been given a federal mandate to work on new uses for agricultural commodities and this mandate continues into the present. The interest of the states, which fund a greater portion of the work of these universities than does the federal government, has been fragmented due to differing local interests within each state. Swan said there has been no attempt to address a comprehensive program toward the development of the biobased economy. Traditionally, the federal government has taken the lead in establishing programs aimed at developing new industries. It seems reasonable, therefore, that it should take leadership in programs for developing the biobased economy, which has the potential for spawning many new industries. Full participation of the land grant universities in fostering a biobased economy will require that they have both a clear and forceful mandate and adequate funding for the task.

Lynn Rundle, CEO of 21st Century Farming Alliance, provided a view of the producer's role in a biobased economy. Rundle said that the vision for a structure of the biobased economy of 21st century agriculture is still a fuzzy picture of how genetics, production, processing, distribution, and marketing to consumers will work together. Agricultural producers want to know if they will be serfs or partners in the new biobased economy. Production agriculture historically averages one to three percent return on investment; since 1980, the food processing industry has averaged a greater than 15 percent return on investment. These trends have driven farmers in his cooperative to look for ways to receive more dollars from the marketplace. The new biobased technology provides an opportunity for this, and the alliance structure allows farmers to be partners in this system.

The last day of the conference focused on "Issues Surrounding the Biobased Economy." Paul Thompson from Purdue University commented on bioethics in a biobased economy. There has been a 25-year debate over ethical issues regarding genetic engineering, although those associated with medicine have been treated separately and have received greater public acceptance than those associated with agriculture. Thompson believes that new biobased technologies that are not directly geared to food production may have wider consumer acceptance than those associated with food.

Cynthia Rosenzweig of the NASA/Goddard Institute for Space Studies gave an overview of global climate change and agriculture. The burning of fossil fuels and forest eradication have raised the atmospheric concentration of CO_2 by approximately 30 percent since the industrial revolution. Human-driven increases in atmospheric CO_2 concentration appear to be enhancing the natural greenhouse effect, and many scientists believe that these activities are leading to surface warming. Global surface temperatures have risen about 0.7°C over the last cen-

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tury. Extensive research capacity, such as in the US will enable farmers to adapt effectively to climate change, at least initially, while with less effective research infrastructure, such as in many developing countries, adaptation to climate change may be slower. The vulnerability of food-deficient regions in marginal climates is likely to worsen due to increased climatic extremes, including more severe and prolonged droughts alternating with floods. An overall increase in global food demand may benefit climatically favored regions, such as parts of the US, though that advantage may be offset by intensified competition from still more favored regions (possibly Canada and Russia).

Lois Levitan, Director of the Environmental Risk Analysis Program in the Center for the Environment at Cornell University, discussed the risks and restraints to realizing the vision of a biobased economy given the constraints to the quantity and quality of land, water, nutrients, and energy to propel the system. Her evaluations were based on a simulation model. A fossil energy-dependent economy is not sustainable over time from both supply and environmental perspectives. Levitan began her calculations by estimating world food needs relative to estimates of crop productivity, the supply of arable land, and thus the quantity of land available to drive a biobased economy. Based on four scenarios of varying crop yield estimates and quantity of arable land, Levitan predicts that sometime between the years 2000 and 2070 the world will exhaust its supply of land needed to grow enough food to provide a basic diet for the world population.

Such projections have been made throughout the last 100-plus years, but productivity increases have proven them false. Levitan then commented on other resources needed to drive not only these production levels but also a biobased economy including nitrogen fertilizer, water and energy. Renewable energy currently supplies approximately 21 percent of worldwide energy needs. Biofuels are considered as a means of increasing the quantity of renewable energy. Levitan noted that up until now, corn has been the primary biofuel feedstock. She also clearly pointed out that unless alternative biofuel feed stocks are successfully developed and marketed (*e.g.*, cellulosic biomass), the vision of biobased fuel production may be a mirage.

Mark your calendars

NABC2001: Consumer concerns about biotechnology in our food system: Lenses from the past, present, and future

by Steven Pueppke
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Planning for NABC2001 — Consumer concerns about biotechnology in our food system: Lenses from the past, present, and future — is well underway. Scheduled for May 22-24 at the Wyndham Chicago Hotel near Lake Michigan in the heart of downtown Chicago, the meeting is being organized by The University of Illinois and Iowa State University. The program committee includes Diane Birt, John Marinowski, and Colin Scanes from Iowa State and Steve Sonka, Pradeep Khanna, Mary Ann Smith, and Steve Pueppke from the University of Illinois.

As in previous meetings, NABC2001 will have a series of plenary sessions, plenty of time for discussion, and a series of workshops to share ideas and make recommendations on the issue of consumer acceptance. There will be time to network and to enjoy the culinary, cultural, and other amenities of Chicago.

We have just begun to contact special speakers, and are organizing the plenary sessions on the lenses theme. The first will be "Lenses from the Past" and will look at how technology is accepted, how language influences acceptance, and also consider one or two case studies. Plenary Session II, "How the lens of the consumer gets influenced," will focus on risk communication and perception, the impact of information technology, and consumer advocacy. The last session will let us peer through divergent lenses of the present and future—those of the farmer, the scientist, the public, the developing world, the bioethicist, and the food industry. We are looking forward to a thought provoking and relevant conference and hope that you will mark your calendars today.

When I returned to Corvallis the editorial in the *Capital Press* (the Pacific Northwest's agricultural weekly) was entitled "More science education needed before GMO's sell." The reality is that while opportunities of biotechnology are great, so are the concerns from some in the public. We scientists will not be able to ignore these concerns as they come from both customers of agriculture and constituents of universities.

In Purdue University's *Agriculture*, Paul Thompson (a frequent NABC contributor) says ". . . scientists, farmers, food processors, and input suppliers must take special pains to insure that the case for biotechnology is based on good science and good ethics, not just good public relations." A dimension missing from this ASPP meeting (and I predict most other scientific meetings) is how to use the best ethics in approaching biotechnology. That ethical dimension is out there and is being actively studied. The NABC recognized several years ago the importance of training in agricultural bioethics and organized an annual workshop for life science faculty. In 2000, the workshop was supported by the USDA. An excellent overview of agricultural bioethics can be obtained in Thompson's recent book *Food Biotechnology in Ethical Perspective*. I spent the last part of my ASPP week reading that book and I highly recommend it! So that was my week doing what I most like in science!

NABC has a laudable past and an important role to play in the future. Starting in 1989, NABC has provided a forum for discussions on agricultural biotechnology issues of public concern. Diversity of input and dialogue are high on the NABC agenda. Each of these forums has been published in an annual report. Topics include: food safety; nutritional quality; biological, social and instructional concerns; risk; public good; gene discovery, ownership and access; novel gene products; genes and challenged environments; gene escape and pest resistance; and biotechnology in a biobased economy. Next year in Chicago we will focus on *Consumer Concerns about Biotechnology in our Food System*. It is a timely topic. The opportunities and the challenges for agriculture and humanity are great. Our work in NABC is more important now than ever.

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