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# Summary Presentation

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The twelfth annual meeting of the National Agricultural Biotechnology Council (NABC) brought together a collection of distinguished speakers on diverse subjects, with many different points of view espoused. The NABC strives to obtain a balance of opinions, and fosters communication on very challenging and often controversial topics. Its workshops are designed to serve as resources for broad-based discussion and policy-making.

The goal of this summary is not to give a chronological overview of the conference, but to search for common threads and possible disconnects among the ideas that were presented. To that end, I will seek answers to several simple questions — who, what, when, where, why, and how? — as they pertain to a biobased economy.

Speakers articulated many instructive and challenging ideas as they described their visions of the biobased economy. From examination of the definition of what the biobased economy is, several fundamental elements were outlined, including:

- raw materials from renewable resources
- highly productive agricultural systems both for food and industrial needs
- integrated, multidisciplinary approaches to R&D that combine agriculture, engineering, health, information technology, and other technologies and disciplines
- eventually 50 percent of fuels and more than 90 percent of organics and materials will be biobased
- beneficial effects on the environment, energy security, and rural economies.

Having defined the elements of a biobased economy, participants presented their views on its importance, anticipating the following benefits:

- sustainable production of needed materials, food, and energy
- revitalization of agriculture and better use of resources
- decreased dependence on foreign, and diminishing supplies of , oil-based raw materials
- political and economic self-sufficiency and security
- functionally superior, value-added products
- improved impact on global climate and the environment
- need to support and feed a growing world population.

Views were varied on when a biobased economy would take hold and become a reality. The question of time-scale generated the greatest discrepancy of viewpoints. Government representatives, largely from the USDA and DOE, cited goals and time frames established within President Clinton's Executive Order 13134, and the National Research Council report, "Biobased Industrial Products: Priorities for Research and Commercialization," issued in 1999. Thus, most major goals for a biobased economy are targeted for the years 2010, 2020, and 2090. There was little, if any, discussion of how these time-frames were derived and whether they are realistic.

Instead, most discussion focused on the current status of developments. While no one would claim that a biobased economy exists today, these discussions provided information on progress, and clues as to how fast we are advancing toward it. An apparent consensus existed that a technology-base is forming, that governmental forces are encouraging advances, and that some early developments are expected in terms of new commercialized products.

For many, these ideas were expressed by the frequently used phrase, "the stars are aligning." Government policy and agency efforts are promoting the development of a biobased economy. A clear response from academia is evident in the level of enthusiasm for creating new biobased technologies and the number of research projects undertaken. However, it is uncertain how much of the recent governmental push for a biobased economy hinged on the tripling of oil prices during 1999.

In contrast to the consensus, plenary speaker Ralph Nader offered a conflicting view. He described NABC's own position document on the biobased economy as "too optimistic, too self-assured, and too futuristically determined" that a biobased economy will become a reality. Nader suggested that a biobased economy will exist only as a promise as long as questions remain regarding the safety of some related technologies, particularly genetic engineering, and as long as power and decision-making lie within corporations.

Nader also stated that the biomaterial movement "depends on whether it is driven by a for-profit corporate structure or by arms-length government/university research, a free exchange of scientific information between scientists

and a different set of priorities.” Lois Levitan also raised serious and thought-provoking questions about whether a biobased economy is even possible, much less sustainable.

On a more optimistic note, Jerry Caulder stated his belief that success is already apparent. As an illustration of success in creating biobased materials and products, he noted that “we can and are doing it... in not just producing proteins, but in controlling metabolic pathways.”

With few industrial participants, the corporate/industrial view of a biobased economy was limited. DuPont, one of the most active and openly committed companies developing biomaterials, provided insight into its development and commercialization of 3GT, a new form of polyester. However, DuPont's commitment to the creation and development of biobased materials is a near exception among the dozens of chemical, oil and gas, and other companies with products based on petroleum feedstocks.

Nader suggested that the creation of a biobased economy could not take place under the current industrial and corporate structure. A contrasting view argued that corporations will be critical to the creation of biobased materials, as it is they who will make the investment to develop, commercialize, and market products. A greater industry presence at NABC meetings will be critical to expanding the discussion of the economic viability and industrial support needed to develop and further a biobased economy.

Obviously, there remain many issues, questions, and challenges to creating a biobased economy. This is a large part of the “how” question and involves not just the scientific and technological how, but the economic, political, and societal hows, along with questions of who (the roles various parties will play), where (what developments will occur first and in what markets), and when (how quickly technology will achieve the desired goals).

Some of the issues and challenges that still must be addressed are:

- moving technologies beyond their early stages of development
- ability and incentive to create new and desired products cost effectively
- modifications in processing and production systems including the creation of new supporting infrastructure
- integration with existing fossil-fuel approaches and infrastructure
- displacements and transitions on many fronts, most notably agriculture
- understanding environmental, societal, policy, and economic impacts
- opposition to new technology and products derived from that technology.

Many other questions were raised and challenges made. Among these were questions on intellectual property and its concentration in limited hands; on the impact of consolidation in industry and agriculture; on research funding and support; on the responsibility for demonstrating that technology is safe, advantageous or value-creating; and on the responsibility for educating the public and ensuring science-based decision-making.

In creating biobased products and a biobased economy, it is important to keep in mind the role that industry and market dynamics will play. Companies likely will evaluate biobased technologies that yield cost-effective, competitive, and successful products. Business sustainability is an important long-term issue, but companies are under many short-term pressures to create returns on their investments.

Only a few, although prominent, companies such as Dow Chemical and DuPont are viewing the combination of chemistry and biology as an opportunity for growth and new products in mature businesses. However, these companies tend to be exceptions and greater industrial “buy-in” and participation will most likely be needed.

Moving beyond niche markets with major product successes will do much to validate the acceptance of biobased technologies among current industrial players. Product commercialization milestones may also serve to convince shareholders and Wall Street of the viability of “biobased-business plans.” On the horizon are Dow’s commercialization of polylactic acid and DuPont’s new polyester, 3GT. Polylactic acid is produced from corn-based starting materials, and one of the 3GT intermediates, 1,3-propanediol, can be produced via biocatalysis.

Industrial-scale production of biobased materials still faces many challenges in increasing yields and reducing costs. There are cost-related issues associated with raw-material production, transportation, processing, and operations. Many of these must still be addressed to gain and maintain industrial interest and long-term investments.

Pressures from Wall Street and shareholders can be serious constraints to a corporation’s ability to maintain a long-term vision. Government is often no better. Currently, the federal government is backing biobased initiatives, which may change at any time for political, economic, or other reasons. Several speakers addressed this point with the message, “We’ve been here before.” In addition, this is an election year with new initiatives being set, often for political reasons, and a new administration on the horizon with its own agenda.

Universities may be best suited to maintain the long-term vision and create the basic knowledge needed for technological progress. But visions need to be periodically reviewed in light of marketplace, political, and other realities.

In order for biobased products to succeed in the marketplace, there is much to be said for market-pull driving their creation, rather than technology pushing unwanted products on consumers. For example, Dow emphasizes the functionality of polylactic acid, at least as much as the polymer’s biodegradability. Several years ago, a push to create biodegradable polymers was met with limited enthusiasm from the marketplace. Dow’s development of polylactic acid strives to address potential customer needs rather than just have a biological origin.

Although at least one speaker suggested that technology has gotten ahead of the science, arguments can be made also that technology is ahead of the marketplace. Some argue that the initial products of agricultural biotechnology were designed only to leverage and perpetuate existing businesses. Whether this is true or not, companies do admit to a myopic view of their initial customers — namely, the farmers — and grossly underestimated consumer reaction and its impact on the agricultural value chain. Assumptions, if any, made about consumer reaction and acceptance of the first genetically engineered insect-resistant and herbicide-tolerant crops may have contributed to major miscalculations in marketing strategy.

Biotechnology has been more readily accepted where there was clear benefit to consumers — for example, in biopharmaceuticals. In the agricultural arena, producers now are working to develop “second-generation” products that many hope will alter consumer sentiment, including food and agricultural products with improved nutritional or health profiles. Consumer acceptance may be an important factor in the development of products that, although not containing genetically modified components, are produced through genetic engineering. There already is anecdotal evidence of protests against fibers from genetically engineered cotton, and questions are being raised about recombinant industrial enzymes.

To achieve the goal of creating a biobased economy, at least four major groups will be involved, each of which has its own role and array of contributions. The groups and their areas of impact and expertise, as envisioned by the participants, are listed below.

- Government: policy and regulation, create goals and road maps, economic and risk assessment, build on existing networks, technology creation, and funding and support.
- Academia: basic research, education, and integration and partnerships.
- Industry: product development, investment, commercialization, and marketing.
- Farmers: raw-material supply, creation of new business opportunities and partnerships.

In summary, the NABC represents a high level of enthusiasm for a vision of a biobased economy that promises the following:

- great potential and opportunities for expansion beyond food, feed, and fiber to include industrial products and energy production
- the future for agriculture
- cooperative interaction of government, academia, industry, and the public
- integrated approach through R&D and business partnerships
- improved quality of life, environment, health, security, and economics.