Overview

Major fundamental advances in molecular and cellular understanding of biology, particularly since the 1960s, have generated a new technology referred to as biotechnology. However, biotechnology—the use of an organism or its product(s) as a product or a process—is a centuries' old technology. Humans have selected, improved, and used organisms and their products for decades: yeasts for bread, wine and cheese making, domesticated animals and crops for agriculture and food, antibiotics, insulin and other natural therapeutics for health care; and microorganisms for waste treatment and mining. The above examples may be referred to as the old, established or traditional biotechnology in which we have a great deal of familiarity and much favorable experience. In these traditional examples, genetic selection or modification was performed, for the most part, at the organismal level, e.g., plant and animal breeding.

In contrast, the "new" biotechnology of the 1960s and later provides the tools for the use of molecular and cellular, in addition to organismal approaches. Commercial examples from this expanded biotechnology are most developed in the human health care where molecular modification of microorganisms is used to produce useful quantities of natural therapeutics, e.g., human insulin for diabetes, human growth hormone for genetic dwarfs, erythropoietin for kidney dialysis patients, and "pure" vaccines to eliminate the dangerous side effects of impurities in traditional vaccines. Also, specific and highly sensitive diagnostics for disease organisms or conditions have been developed.

Several potential products of this molecular and cellular biotechnology for agriculture, food, and feed uses are at the research and development stage with commercialization expected in the early 1990s. Examples are microbially produced animal growth promotants for increased efficiency of meat and milk production and for improved quality of meat, genetically modified microorganisms for use as biopesticides and growth promotants, and genetically modified crops that are self-protected against insect pests and diseases tolerant to synthetic chemicals such as herbicides or improved in nutritional value.

This report and the NABC will focus on new biotechnology as an extension of established biotechnology. New biotechnology is expected to have a major impact on many human activities, including agriculture and food. Most developed countries perceive the new biotechnology as providing the next basis for international commercial competitiveness. This perception is strongly held in the United States, in the European Economic Community, and in Japan; and actions are being taken to strengthen national and regional competitive positions. Developing countries are also anxious to access biotechnology produced for their own needs, while at the same time there is concern that food products and substitutes will be using biotechnology to replace agricultural export products, often their main source of cash income, grown in the Third World.

This new biotechnology is perceived differently by various groups and differently by individuals within a group. Some see it as a major new opportunity, others as a threat, and others are merely confused. These divergent views were noted by President Gordon P. Eaton of Iowa State University in his welcoming comments at the First Annual NABC Meeting.

> "Those of you who are biotechnologists are dedicated to pushing back the frontiers of your science. You are motivated and driven by your quest for understanding the fundamental processes that control living organisms. You are seeking ways to use that knowledge to modify living organisms in ways that have never before been possible. The potential of your success is viewed by some in our society as enormously exciting and holding ultimately great benefit for society.

At the same time, it is viewed by others as not only threatening, but even frightening. As your knowledge of the living organism expands, our traditional approaches to agriculture are being dramatically changed. I think, at this point, we frankly aren't sure, sometimes, how we are going to deal with your success, and I suggest that that may be true for a very long time to come."

Bovine somatotropin (BST), one of the first commercial agricultural products, is an example of technical success we do not know how to deal with. Its use in the dairy area has received unprecedented visibility and debate. The use of BST will improve efficiency of milk production—the major emphasis of dairy research for the past several decades. More milk from fewer cows may have a modest positive environmental impact in terms of reduced production of methane (a greenhouse gas pollutant) and nitrate (a water pollutant) from manure. However, some farmers and others are concerned about a treatment that will increase milk production substantially when the milk market already has excess production capability with the resultant inability of some dairy farmers to stay in business. Some consumer groups are concerned about the safety and wholesomeness of this milk and suggest that it be labeled as milk produced by cows supplemented with injected BST.

In other food areas, there is consumer desire for foods produced with decreased or no synthetic chemical pesticides, concomitantly there is increased emphasis on biological control of pests. Animal rights activists voice concern about animal treatment, representing another concern for the agricultural producer. These and other agricultural concerns, especially the economic disaster in crop agriculture in the early 1980s and its destructive impact on rural Midwestern communities, has prompted increased interest in agricultural ethics, rural communities and structure and is bringing new voices to the dialogue on agricultural biotechnology. These interest groups now include agribusiness, farm producers, technologists, lawyers, ecologists, economists, environmentalists, molecular biologists, human health professionals, social scientists, philosophers, public interest groups, consumers, and politicians.

THE NABC RESPONDS TO A NEED

In response to the need for a neutral forum for dialogue among these diverse interest groups on agricultural biotechnology and its use, Robert B. Nicholas of McDermott, Will & Emery and Ralph W.F. Hardy of Boyce Thompson Institute for Plant Research conceived the National Agricultural Biotechnology Council (NABC) in February 1987. A university/institute council was formed, representing leading national, not-for-profit research and educational institutions with a national geographic distribution. The National Agricultural Biotechnology Council members and their institutions now include Vice Chancellor Charles J. Arntzen, The Texas A&M University System; Senior Provost Robert Barker, Cornell University; President Gordon P. Eaton, Iowa State University; President Ralph W.F. Hardy, Boyce Thompson Institute for Plant Research; Chancellor Theodore L. Hullar, University of California at Davis; and Robert B. Nicholas, Partner, McDermott, Will & Emery a Washington, DC law Firm. The Council members provide guidance to the NABC including identification of the focus of the annual meeting. Initial funds to support the NABC were obtained from The Joyce Foundation and the U.S. Department of Agriculture.

An earlier council for agricultural technology, the Council for Agricultural Sciences and Technology (CAST), was formed in the 1950s. It combined agricultural, commercial, and professional society interests to address issues of agricultural science and technology. Many useful reports have been produced, and CAST, headquartered at Iowa State University, has had a significant beneficial impact on agricultural issues. We hope that the NABC will prove to be as useful for agricultural biotechnology as CAST was for agricultural technology. In contrast to CAST, NABC has expanded the participants in its dialogues to include many additional groups beyond agribusiness and professional societies that must be involved in any dialogue on agricultural biotechnology issues. We hope that this expanded constituency will give a 1990s creditability and relativity to the NABC.

The general objective of the NABC is to bring together economic, environmental, health, social and ethical viewpoints on an agricultural biotechnology topic of current importance. Through presentations, workshops, and workshop reports, we hope to increase communica-

tion and understanding and generate policy options as appropriate for the safe and efficacious development of biotechnology for benefit to the farmer/producer, agribusiness, food processor and distributor, consumer, society, and our nation.

THE FIRST NABC MEETING

Iowa State University proposed that the 1989 meeting focus on biotechnology and sustainable agriculture, an area of major interest to both the university and the state. This proposal was accepted. The Council recognized that there had been many meetings on sustainable agriculture or variants thereof, but there were no meetings discussing the relationship of biotechnology to sustainable agriculture. Under the local leadership of Dr. Walter R. Fehr, Biotechnology Coordinator at Iowa State, and with the involvement of the Bioethics Committee and Leopold Center for Sustainable Agriculture, the meeting was planned.

Four timely subject areas of agricultural biotechnology that were relevant to sustainable agriculture were selected: biopesticides, herbicide-tolerance in plants, disease control in animals, and animal growth promotants. Biopesticides include natural or genetically modified pest predators, parasites, and pathogens or their products, as well as plants modified to resist pests or disease. The most advanced biotechnological biopesticides include the Bacillus thuringiensis toxins for insect pest control and the coat proteins of viruses to protect plants against viral diseases. Herbicide tolerance refers to crop plants that have been selected or genetically modified for increased tolerance to selective as well as non-selective herbicides. Herbicidal resistance, which had earlier included the concept of tolerance is now used to refer to weeds that have developed resistance to herbicides. This distinction of tolerance and resistance was not always made clear in the presentations or discussions on this topic. Biotechnological products for problems and control of animal disease are less developed but could include diagnostics, vaccines, and therapeutics, resulting in a focus on the general area of animal welfare, not on specific products. Animal growth promotants include BST and porcine somatotropin (PST) with BST the most debated of any agricultural biotechnology product. Animal growth promotants and herbicide-tolerance have entered the political arena where at least one state's 1990 governorship election now has agricultural biotechnology as a key issue.

SUSTAINABLE AGRICULTURE

Sustainable agriculture is difficult to define because there is no established definition. The vision of sustainable agriculture varies from a major emphasis on the non use of synthetic chemicals as fertilizers and pesticides to a major emphasis on maintenance of family farms to the attendant agricultural practices that provide regeneration or no long-term loss to natural resources. Most agree that sustainable agriculture involves environmental equilibrium with a longer-term view than has been characteristic of traditional agriculture with its dominant emphasis on short-term economics. This longer-term view must balance the real needs of farmers, consumers, society, the environment, the nation, and even the world. It must be sensitive to the preservation of resources such as germ plasma, soil, water, fossil fuels, and even technologies and social structures. Sustainable agriculture must seek to make agriculture more environmentally and farmer friendly. Sustainable agriculture must also include the dominant role of the consumer who is the ultimate purchaser of agricultural products. President Eaton made some perceptive comments on sustainable agriculture:

> "Sustainable agriculture also has a unique culture. Persons involved with this activity are seeking ways to reduce the inputs, particularly the chemical inputs, to agricultural production. As these inputs are reduced, as surely they must be, there will be a greater reliance on labor and perhaps even a loss in total productivity, although not necessarily, and hopefully not, a reduction in profitability Although few would question the appropriateness of reducing inputs agricultural production in order to preserve the quality of our environment, there is concern as to whether or not the traditional family farmer will be willing or able to adapt to a system that may reduce productivity and will require additional labor. There is also, I think, in some quarters concern about the possibility of the United States continuing to serve as a major world supplier of food if productivity of its agricultural systems is actually reduced by lowering inputs of fertilizers and other products."

MEETING FORMAT

The meeting format included two keynote presentations—one by a leading spokesperson for sustainable agriculture from the Center for Rural Affairs, Charles Hassebrook, and the other by an agricultural bio-

technologist from a development-stage agricultural biotechnology company, Robert M. Goodman. Hassebrook emphasized that "agricultural research is really a form of social planning" and "the aim should be to develop a set of research goals by which the public research agenda reflects and addresses the needs of society." Goodman, on the other hand, emphasized the role of biotechnology. "Genetic manipulation is a proven technology that can be used to address whatever the future agenda is for agriculture" and "genetic manipulation is the proven environmentally safe way to address production challenges—both economical and environmental." These agenda-setting talks are in section three of this report.

Each of the four subject areas—biopesticides, herbicide tolerance, animal disease, and animal growth promotants—was addressed by proponents for technological, economic, environmental, sociological, and ethical viewpoints. These presentations are grouped under each of the four subject areas and may be found in section four. In most cases the authors had strong position statements to make, bringing divergent viewpoints to a common forum. Several of the authors' position statements reveal an order of magnitude of differences. Possibly the greatest difference was between the extremely pro- herbicide technology paper and the extremely anti-herbicide social and ethical paper on herbicide tolerance. This lack of heretofore direct communication and understanding of alternate perspectives underscored the need for this NABC meeting.

These often provocative presentations were used as input for the workshops where the major outcome of the meeting was developed. Each subject area had a workshop, co-chaired by individuals from different disciplines and viewpoints to facilitate balanced discussions. There was also some effort to assure a broad mix of viewpoints among the participants in each workshop.

The workshops chairs were asked to promote dialogue between disciplines and viewpoints so that understanding could develop. Such dialogue occurred, but the distances in positions were so great that the participants agreed that they could not progress beyond disagreement on some issues during the limited period of the exchange. One such example, the labeling of biotechnologically-produced foods resulted in an agreement to disagree. There was agreement, however, that participants departed from the meeting with a much broadened base of information on biotechnology and sustainable agriculture and awareness of

differences within and among various groups. The workshops were encouraged to require documentation for statements and, if such could not be provided, to note that such statements were only hypotheses at this stage. Some progress was made in this area although acceptable documentation may vary between disciplines.

Following two days of intense discussions, each workshop identified several major issues and key topics requiring additional research. Policy alternatives were also generated. The workshop reports are presented in the next section of this report and represent the major contribution of the NABC meeting. There was more consensus generated than expected from this diverse group of over 200 participants, although most discussion was at a general, rather than a specific level. This First Annual NABC Meeting represents an important initial step.

CONCLUSIONS

Some general conclusions can be drawn from this enlightening and provocative meeting on biotechnology and sustainable agriculture.

Learning Experience—The presentation-workshop format involving a diverse mix of disciplines and viewpoints provided a broad-range learning experience for all participants.

Continuing Technological Steps—Agricultural biotechnology products were not seen as major revolutionary steps, but rather as continuing technological steps in agriculture with varying impacts from modest to, in a few cases, dramatic.

Product rather than the Process—There needs to be an evaluation of the impact of a technological product on sustainable agriculture, irrespective of the process.

Needs Driven—Agricultural biotechnology is driven, for the most part, by needs of the customer, i.e., consumer, farmer, rather than the potential of the technology.

Public Input to Decision Making—There is a need for more meaningful public input into decisions on public sector agricultural research in general and agricultural biotechnology specifically.

Products for Family Farms—Biotechnology products need to be applicable and affordable to low input small family farms.

Information Need—There is a lack of information on different biotechnology products and alternatives, especially for farmers, consumers and the public. There is inadequate information available and a lack of understanding of sustainable agriculture. Scientists/technologists need to better understand and respond to the public.

Creative Information Dissemination—More creative information dissemination and education must be developed for farmers, consumers, and society. Negative public response often results from lack of information. Real versus perceived risks need to be discussed much more thoroughly and responded to more seriously.

Multidisciplinary Dialogue—True multidisciplinary dialogue is needed where the opportunity for productive reasoning can occur in a non-threatening, respectful environment without the need to protect vested interests.

RECOMMENDATIONS

After two and a half days of dialogue and disagreement, several specific policy suggestions or recommendations on biotechnology and sustainable agriculture reported out of the various workshops are listed below. Many similarities as well as some differences will be seen.

Biopesticides

—Encourage more public input into decisions concerning biopesticides and sustainable agriculture utilizing research advisory groups, public hearings for regulatory decisions, and an ombudsperson as a liaison with the public.

—Redirect public research to promote sustainable agriculture through establishing a system of competitive grants for sustainable agriculture.

—Modify environmental and agricultural policies to be consistent with sustainable agriculture.

10 —Integrate use of biopesticides with other techniques of sustainable agriculture.

Herbicide Tolerance

—Provide public sector funding for research on the environmental, economic, and social impacts of current and alternative systems of weed control including herbicide-tolerant crop/herbicide combinations.

—Initiate major public and private research efforts on the environmental, economic, and social impacts of agricultural systems.

—Determine how farm policy affects the adoption of different weed control techniques.

—Provide public funds to foster innovation at the producer level for use of alternative methods that are environmentally, socially, and economically superior to conventional methods.

Animal Disease Control

—Help assure the food safety of animal products utilizing biotechnology.

—Optimize environmental and management practices and systems for production of healthy livestock and assurance of well being and freedom from disease utilizing biotechnology.

—Establish trusting relationship's between livestock producers and health service providers with the products of biotechnology reaching all types and sizes of producers.

—Increase level of support to disseminate delivery systems to foster animal health products for a sustainable agriculture.

—Provide products of biotechnology that complement good husbandry practices for disease control.

Animal Growth Promotants

—Broaden public input into determining public biotechnology research programs.

—Establish public education programs regarding products of

biotechnol**ogy**

—Develop special competitive grants programs innovative information delivery systems for farmers who may be disadvantaged by biotechnology products.

—Produce societal impact statements on forthcoming technological innovations.

Expansion of the above recommendations as well as additional information on each topic is found in the workshop reports and the papers. This report is unique in providing the diverse viewpoints and discussion that is an integral part of the debate on biotechnology and sustainable agriculture. As President Eaton said, "We will make our best contribution.. .by soliciting what we know to be highly diverse points of view and attempting to find convergent and constructive solutions to what are very complex problems."

NABC Report 1 makes a major contribution to the initiation of this process. Continuing dialogue and education will be needed to extend the process. The process must be continued if we are to safely and efficaciously utilize the power of biotechnology to evolve a more sustainable agricultural system.