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## *Public Perceptions of the Benefits and Risks of Biotechnology*

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During the next decade, biotechnology is expected to have major impacts on food production and processing. Supporters predict significant economic, social and environmental benefits. Opponents raise serious concerns about risks and ethics of biotechnology. Biotechnology has become an important and controversial public policy issue that is drawing the attention of the media and the public. Social science research can provide industry, government, universities and others with valuable insights into public perceptions of biotechnology and related public policies. This paper presents an overview of the role of social science research and examines selected results of a recently completed project.

Most experts recognize that public knowledge and perceptions of biotechnology must be systematically evaluated. Stenholm and Waggoner (1992) explain how consumers will be the ultimate judge of emerging technologies. They will appraise the merits of a particular product and determine its success or failure. The Office of Technology Assessment (1992) points out that while many new technologies will soon be commercially viable, they will not automatically be put to use. The public increasingly questions whether technological change is good or needed. People are voicing new concerns about food safety, the environment and the changing structure of agriculture. Lack of public acceptance could prevent some technologies from being used even if they are approved by regulatory agencies.

Social science research can help design effective educational programs and public policies. Political, industrial and educational leaders need more information about potential public reaction to biotechnology. Consumers will make the ultimate decisions about the acceptability of food products developed through biotechnology through their market behavior. However, it is also useful to anticipate consumer reaction to the products of biotechnology before there has been a significant investment in research and development. Cross (1992) argues that government, academia and private industry must not wait until the questions are asked before information is provided to the public. It is necessary to identify different audiences and know how to reach them.

*Public participation will promote more effective and acceptable biotechnology policies.*

Industry, government and universities must understand and respond to public opinion. Social science research helps make that possible.

Social science research also serves to broaden the debate to include more diverse perspectives. Much of the controversy surrounding biotechnology is not simply a matter of scientific facts and expert opinion. Some of the key issues revolve around the public's confidence in and ability to influence public and private decisions about the future of biotechnology. The Office of Technology Assessment (1992) notes that biotechnology is not so different from previous agricultural technologies as to raise novel scientific issues concerning the safety of foods. What is substantially different, however, is the climate in which this new class of technologies is being introduced. Society is increasingly skeptical of how new technologies are developed and regulated.

Social science research can serve as a valid and reliable mechanism for public participation. Public participation will promote more effective and acceptable biotechnology policies. Stiles (1989) argues that without adequate participation in decisions about biotechnology, the public will react as it has to other technologies. He explains how a technology must fit into society to maximize benefits and minimize social and political disruption. Public participation in society's decisions cannot be avoided. It either occurs in a planned and orderly fashion or in a reactive and disruptive fashion.

Social science research can also provide guidance to improve the design and implementation of educational programs. Public attitudes and knowledge must be researched, understood and considered before developing educational programs and communication efforts. Such research must illuminate the diverse types of information that are important to the public. Even after the issues have been identified, communication will not be easy or effective without systematic evaluation. Foreman (1990) explains the problems with assuming that communication will resolve public concerns about biotechnology. Differences over this issue may represent not a failure to commu-

nicate, but a conflict in values. Conflict also occurs if the risks and benefits of biotechnology do not accrue to the same individuals or groups. Social science research can help identify and evaluate the effectiveness of conflict management efforts.

Social science research helps better define the social and political context in which biotechnology is developing. The use of biotechnology in agriculture and food production could elicit food safety and environmental concerns similar to those expressed about agricultural chemicals. Other dimensions of biotechnology also draw public attention (e.g., socioeconomic impacts and ethical concerns). Senator Al Gore (1991) explains that what is needed to balance our technological prowess is a renewed engagement in the debate over biotechnology policy—not just the ethics of genetic engineering, but the entire relationship between biotechnology and our future. He concludes that it is important to not lose sight of the larger policy questions that will determine whether our ability to manipulate the basic process of life will benefit the world community.

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Social science research can enhance the debate by providing a systematic and credible mechanism for incorporating societal values and preferences into public and private decisions. Social science provides useful insights for the important policy debates and educational programs that are needed. However, social science often tries to reach a moving target. Public perceptions are complex and dynamic. It is important to recognize that many factors will ultimately affect consumer acceptance of foods developed through biotechnology. Public awareness and attitudes will change as more information and actual food products become available. In that sense, any research project serves as a baseline for future work.

#### PROJECT METHODOLOGY

The purpose of the project was to determine what consumers think and want to know about the use of biotechnology in food production and processing. Results should prove useful in several ways. One outcome will be to provide guidelines for development and implementation of educational programs. Another outcome will be to enlighten the formulation and evaluation of public policies by providing a valid means of citizen input. Third, the results will recommend appropriate and acceptable types of biotechnology research and product development activities.

This project involved several complementary research methodologies. All work was conducted in a collaborative manner using established social

science methods. Full details on project methodology can be found in the technical reports which are available from the authors (Hoban and Kendall, 1992; Kendall and Hoban, 1993). An extensive literature review assessed existing studies on public attitudes about biotechnology, as well as surveys on similar topics. From this review, conceptual models were developed that guided survey development.

Several organizational structures were developed to carry out this project in a consultative and interdisciplinary manner. At North Carolina State University and Colorado State University, interdisciplinary project teams were established. In addition, a national advisory committee consisting of university and government experts was established. The campus teams and national committee assisted with development and review of the telephone survey and focus group instruments, as well as the technical reports.

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Development of the telephone survey instrument involved several related tasks. At the outset, a series of open-ended individual and small group interviews were conducted in Washington, DC with public and private sector leaders in the area of biotechnology. Results of the interviews were summarized to inform development of the telephone survey. To further inform survey development and test the face validity of potential questions, personal interviews were conducted with about 40 consumers in North Carolina and focus groups were conducted with 67 consumers in Colorado, Ohio, New York, Pennsylvania and Nebraska. Results of these interviews and focus groups led to further refinement of the telephone survey instrument. Additional telephone pretests were then conducted to finalize question wording.

The sampling frame for the telephone survey was the entire population of households in the United States with telephones. The random sample of telephone numbers was purchased from Survey Sampling Incorporated (SSI). Their samples are systematically drawn using random digit dialing. Both listed and unlisted numbers are included in the sample. All telephone interviews were conducted by the Applied Research Group at North Carolina State University during February and March of 1992. A total of 1,228 interviews were completed. The final telephone interviews averaged about 26 minutes in length. At least ten attempts were made at various times to reach each telephone number selected before a number was eliminated from the sample. The response rate for the survey was just over 60 percent. The sample population appears quite representative of the country as a whole on most major background characteristics. Full demographic profiles of respondents are included in the project technical report (Hoban and Kendall, 1992).

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After the telephone survey, focus groups were conducted during October of 1992 to assess reactions to specific food products, obtain more detailed opinions about biotechnology, and have consumers generate ideas about educational needs. Subjects were randomly selected from city telephone directories in Denver and Raleigh. Eight focus group sessions were held: four in Colorado and four in North Carolina. A total of 46 people participated in the eight groups. The focus-group lasted approximately two hours. Discussion focused on eight topics: general knowledge of biotechnology; reaction to specific products; information needs and sources; labeling issues; environmental issues; economic issues; moral and ethical issues; and the role of citizens. In general, focus groups results supported many of the phone survey results and added additional qualitative insights. Full details can be found in the Focus Group Technical Report which is available from the authors (Kendall and Floban, 1993).

#### SELECTED SURVEY RESULTS

This paper focuses on selected results of the telephone interviews. In keeping with the NABC 5 theme, we mainly discuss findings related to public perceptions of the benefits and risks of biotechnology. Some key relationships between a selected set of background characteristics and general reaction to biotechnology will be analyzed. Due to limits on length, we cannot present information on all the background variables. Full information, including the wording for all questions and detailed analysis results, are included in the Telephone Survey technical report (Hoban and Kendall, 1992).

#### General Attitudes about Biotechnology

Respondents were read several statements about the general benefits and risks of biotechnology and asked the extent to which they agreed or disagreed. Almost three quarters agreed that "Biotechnology will personally benefit people like me in the next five years." On a related statement, over two-thirds agreed that "Government should fund more biotechnology research because of the potential benefits." Concerns about risk are evident by the fact that nearly half of the respondents agreed that "Biotechnology should not be used because of potential risks to the environment."

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As we designed the survey, it became evident that most people did not know enough about biotechnology to provide a detailed assessment of potential benefits or risks. One set of questions did measure respondents' general expectations concerning the potential impacts of biotechnology. Overall, respondents anticipated generally positive effects of biotechnology in

most areas. Almost three quarters of the respondents saw the effects as positive for farmers' economic conditions, as well as for food quality and nutrition. Nearly two-thirds felt the effects of biotechnology would be positive for environmental quality. Between one-half and two-thirds of the respondents saw positive effects of biotechnology on farmers' use of chemicals and fish and wildlife. In all cases, between five and ten percent of all respondents did not have an opinion about whether the effects would be positive or negative.

One pair of questions assessed whether respondents would have moral objections to the use of biotechnology in either animal or plant applications. The first question asked: "Do you believe the use of biotechnology to change plants is morally wrong or not?" In this case, almost one quarter of the respondents felt that it would be morally wrong. Respondents had stronger views concerning the moral aspects of animal biotechnology. When asked "Do you believe the use of biotechnology to change animals is morally wrong or not?" over half said that it was. This turns out to be one of the most important and unique issues associated with the use of biotechnology in agriculture and food production.

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### Acceptance of Biotechnology

The interview attempted to address a fairly complex and controversial area involving consumer acceptance of food products that involved clearly transgenic characteristics. Such issues have received considerable attention from the media, consumer groups and industry. Examples were used that either reflected actual applications or were representative of possible future uses. These questions were sequenced to move from the least dramatic to most dramatic examples. This set of questions was introduced with the following statement: "Genes from most types of organisms are interchangeable." Respondents were first asked "Would potatoes made more nutritious through biotechnology be acceptable or unacceptable to you if genes were added from another type of plant, such as corn?" Two-thirds of all respondents said they would find such plant-to-plant gene transfer acceptable. Respondents were next asked "Would such potatoes be acceptable or unacceptable to you if the new genes came from an animal?" In this case, only one quarter of all respondents indicated they would find such animal-to-plant gene transfer acceptable.

Two examples were used to determine reaction to animal-related gene transfers. First, respondents were asked: "Would chicken made less fatty

through biotechnology be acceptable or unacceptable if genes were added to the chicken from another type of animal?" In this case, just under 40 percent of the respondents said they would find such a gene transfer acceptable. As a final, relatively dramatic (but technically feasible) application, respondents were asked: "Would such chicken be acceptable or unacceptable if the genes came from a human?" Only 10 percent of all respondents indicated that such human-animal gene transfer would be acceptable.

### Public Policy and Citizen Participation

One set of questions examined the area of government credibility. Respondents were asked if they would have a lot, some, or no confidence in the U.S. Department of Agriculture (USDA), Food and Drug Administration (FDA), Environmental Protection Agency (EPA), and state agencies to effectively regulate biotechnology. In all cases, about two-thirds of the respondents reported "some" confidence. Of the remaining respondents, the percent reporting "no confidence" exceeded the percent reporting "a lot" of confidence.

*There seems to be considerable interest in biotechnology.*

Differences among the levels of confidence in each of the agencies were quite small.

Two statements measured respondents' opinions about the role of citizens in biotechnology decisions. Over three quarters agreed that "Citizens have too little say in decisions about whether or not to use biotechnology." On a related point, almost all respondents agreed that: "Government should pay more attention to what people like me think about biotechnology." This likely reflects more general feelings that people have about government responsiveness and effectiveness.

### Interest in Biotechnology

There seems to be considerable interest in biotechnology. This suggests that biotechnology will be a major public policy issue. One in five respondents said they had a lot of interest in learning more about biotechnology. Almost half reported some interest. One in five had only a little interest and the remaining 14 percent said they had no interest in learning more about biotechnology.

Those respondents who reported at least "a little" interest in learning more about biotechnology were then asked how important they felt it would be for them to receive each of six different types of information regarding biotechnology. This indicates the relative level of importance people attach to each of the major issue areas. Over two-thirds felt it would be "very important" for them to have information about the potential risks or negative effects of biotechnology. Most of the rest said such information would be somewhat important. Just under two-thirds said it would be very important

to have information about new uses of biotechnology in human health care. About half indicated that it would be very important to have more information about the potential benefits or positive effects of biotechnology. Under half felt information about new uses of biotechnology in food production would be very important. Almost as many felt that information about how government regulates biotechnology would be very important. The information considered least important involved the basic science behind biotechnology. However, even in this case over one-third said this information would be very important and over half said it would be somewhat important.

### Overall Reaction to Biotechnology

It seemed important to obtain a general assessment of respondents' bottom-line reaction to biotechnology. This was done by asking: "Overall, would you say you support or oppose the use of biotechnology in agriculture and food production?" Almost two-thirds of all respondents said they supported the use of biotechnology in agriculture and food production. Just over a quarter opposed its use. Almost 10 percent did not have an opinion on the question.

Some additional analysis reveals the types of respondents who were likely to support the use of biotechnology in agriculture and food production. In terms of demographic and background characteristics, men were more likely to support the use of biotechnology than were women. Respondents with higher educational and/or income levels also expressed greater support for biotechnology. People who considered religion to be more important in their daily lives tended to express greater opposition to the use of biotechnology. Interest in new scientific and technological developments was positively correlated with support for the use of biotechnology.

Other attitudes about and awareness of biotechnology were also significantly related to support for the use of biotechnology in agriculture and food production. Those who had read or heard more about biotechnology, as well as respondents with a greater interest in learning about biotechnology, expressed greater support. Respondents who felt biotechnology was morally wrong were much more likely to oppose its use. High levels of confidence in government, as well as trust in information, had a significant positive relationship with support for biotechnology.

### Reasons for Supporting Biotechnology

About two-thirds of all respondents answered positively when asked whether they supported or opposed the use of biotechnology in agriculture and food



production. A wide range of answers were given in response to the follow-up question: "Can you describe why you support the use of biotechnology?" Seven major categories were developed that describe the reasons. Open-ended questions like this are useful for gaining deeper insights into peoples' perceptions.

The most common reason for support of biotechnology (represented by 22 percent of all responses) was that people believed it will enhance the quality of food products. Many of these respondents indicated that by using biotechnology the nutritional value, taste or other desirable qualities of food could be improved. Some suggested that biotechnology could be used to reduce fat, cholesterol, pesticide residues or other undesirable aspects of food products. Others indicated that biotechnology would make food safer.

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Of those who supported biotechnology, about one in five believed it would help increase the quantity of food produced. Many of those in this group expressed the opinion that food production needs to keep up with population growth. Some respondents viewed biotechnology as a means of reducing hunger. Biotechnology was considered by some to be an important method for producing more food at lower cost, with the use of less and/or other resources.

Approximately 14 percent of supporters felt biotechnology will benefit society by providing environmental or economic benefits.

Some respondents in this category indicated that biotechnology will be beneficial to American industry and reduce the cost of production. Other individuals indicated that biotechnology may help reduce pollution, including agriculture's dependency on chemicals. Some respondents specifically suggested that farmers would benefit from the development of biotechnology.

*Respondents... basically felt new developments in science and technology were necessary and desirable.*

Another group of respondents (14 percent) suggested that scientific and technological advances benefit society, in general. Respondents viewed biotechnology as important for maintaining such leadership in the future. Respondents in this category basically felt that new developments in science and technology were necessary and desirable. Approximately 12 percent provided statements which suggested biotechnology will improve the overall quality of life. More specifically, some respondents in this category hoped it would improve health care, including finding cures for medical problems. Ten percent of the responses involved nonspecific

statements of support for biotechnology. These responses simply implied a belief that biotechnology is good or beneficial without being able to provide specific reasons.

Nine percent of the respondents who supported biotechnology gave statements that reflected some apprehension. Some indicated there may be problems with biotechnology. Other respondents said they worried whether the experts would consider citizens' best interests. Some responses indicated a willingness to support some applications (e.g., with plants) but not others (e.g., with animals). Overall, individuals in this final category indicated their support for biotechnology was conditional.

### Reasons for Opposing Biotechnology

Just over one-third of all respondents who took a position on this question opposed the use of biotechnology. They were then asked: "Can you describe why you oppose the use of biotechnology?" Responses were again coded into several main categories. The most common reason for opposition to biotechnology (given by over one-third of all respondents who opposed biotechnology) involved concerns that it could threaten the balance of nature. Some respondents worried that biotechnology would lead to serious impacts on the natural environment. They felt such tampering with nature was wrong. Other respondents in this category opposed biotechnology because it was "not natural." Some mentioned concerns about loss of genetic diversity or the creation of harmful mutations.

*The most common reason for opposition to biotechnology ...involved concerns that it could threaten the balance of nature.*

Around thirty percent of those who opposed biotechnology said they were concerned about its unknown effects or long-term risks. Some respondents in this category mentioned lack of trust in scientists or government to adequately control biotechnology. Others felt it could be used in an inappropriate manner. Some felt that not enough testing would be done regarding the possible side effects. Such reasons seemed to revolve around the general notion of perceived risk.

The third most common reason (about 13 percent) for opposition involved concerns over the application of biotechnology with either humans or animals. Respondents also worried about possible impacts on human population growth. About eight percent of the respondents who opposed the use of biotechnology had concerns that it would promote the increased use of chemicals in farming or food processing. Some worried that food safety or quality would be negatively affected through the use of biotechnology, resulting in possible harm to those who eat the food products.

Another eight percent of the comments from those opposing biotechnology indicated that respondents opposed the use of biotechnology because they believed it was somehow against God's will or contrary to their religious beliefs. This reason also included a general sense of moral objection, as well as objection to trying to improve on "God's creation." Four percent of those who opposed biotechnology did so because of concern about impacts on the economy. Individuals mentioned potential social or economic impacts that biotechnology could have for small businesses or family farms. Two percent of the statements involved concerns over other impacts.

*A significant commitment to unbiased and ongoing education is needed*

## CONCLUSION AND IMPLICATIONS

This research project has a variety of implications for the development and implementation of educational efforts and public policies. In this final section, we describe some of the main implications in these areas. This section will conclude with a discussion of future social science research needs, including the limitations of such work.

### Implications for Education and Policy

Results of this work document the need for expanded education and information efforts. Given relatively low levels of awareness and considerable interest in biotechnology, a significant commitment to education is needed. Outreach programs need to be developed and implemented to provide people with information they need to better understand the issues related to biotechnology. The goal should be to help consumers make their own informed decisions about this new technology. This should involve a broad-based approach aimed at school children, organizations, opinion leaders and consumers. A wide range of groups and organizations can contribute to educational programs. Land-grant universities, such as those represented by NABC, are in a credible and influential position to play an important leadership role in such education.

*The goal should be to help consumers make their own informed decisions about this new technology.*

This project indicates that consumer knowledge and attitudes about food produced through biotechnology will be influenced by general information obtained from the media. Education efforts must recognize the limitations and opportunities for media-based information. Education needs to be unbiased, ongoing and proactive. Adequate time, money and expertise must be devoted to education to ensure that opinion leaders and consumers are able to receive the information they want and deserve in a timely and credible

manner. The future of biotechnology in food production is by no means assured without a much more proactive and open dialogue among all interested parties.

Our results indicate that one of the most important factors influencing public perception of biotechnology will be the perceived credibility of public policies and regulations. Consumers want government to play an active role in establishing policies that ensure environmental protection and food safety.

*...public confidence in government agencies to effectively regulate biotechnology could be significantly improved.*

They also want government to expand the debate over the most appropriate uses of this powerful set of technologies. The federal government should pursue a proactive and credible approach to biotechnology policy that empowers citizens to make informed decisions, while facilitating development of appropriate products.

This project indicates that public confidence in government agencies to effectively regulate biotechnology could be significantly improved. Few people understand the nature of government policies and regulations in this or other areas. Low confidence is, in part, a reflection of a more general erosion of public confidence and trust in government. Attempts during the past decade to reduce regulation have been responsible, in part, for decreased public confidence in government. Most respondents felt that government should pay more attention to what citizens think about biotechnology. People want more say in decisions that affect their lives. This is not unique to biotechnology, but includes other policy areas. Consumers expect public policies to be developed in an open manner with ample opportunities for involvement of all interested stakeholders.

### Future Research Needs

Biotechnology is a complex and dynamic public policy area. This project may have raised as many questions as it has answered about public perception of biotechnology. Because the telephone survey was done before the May, 1992 FDA announcement of regulations for food produced using biotechnology, it represents a baseline for future surveys using the same questions. This final section will offer some general observations about the utility and limitations of social science research.

Public attitude surveys, such as this one, are useful for identifying issues, interests, concerns, educational needs and public policy implications. Our work provides insights into these areas. For example, this work shows different levels of consumer acceptance for different products. It also highlights important ethical and environmental issues. Our results also suggest appropriate education and information efforts.

However, telephone surveys are not good for evaluating specific products or probing deeply into people's basic beliefs. Other methodologies will be more appropriate and useful for testing consumer response to new food products. Focus groups and taste tests will provide guidance for marketing of specific products. Market-basket studies and computer simulation models will help evaluate and predict actual consumer behavior. Once people are actually able to taste a new food product, they will form much more definite opinions about its desirability.

Survey research is as much an art as a science. It is important to start with a clear set of objectives and a testable conceptual model. Research must be based on past research and theory as well as clear plans for analysis. Social science research is most useful when it goes beyond simple description into the realm of explanation and prediction. It is necessary to analyze why people feel the way they do. The population must be segmented into different groups and compared on key questions. Our analysis along these lines is just beginning. Further results will be published in professional journals.

Realize that survey research is only one piece of the puzzle. Regulations must still be based on the best available science. Public policy will always include economic and political considerations. Surveys, however, do provide a cost-effective and systematic mechanism to incorporate public beliefs and values in decisions. If done right, surveys can reflect the views of a diverse cross section of citizens.

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