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**Review Article**

# The Early Years of Agricultural Biotechnology at the United States Department of Agriculture, 1986-1996

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**Abstract**

For ten years, 1986-1996, the United States Department of Agriculture's Office of Agricultural Biotechnology was assigned the primary responsibility for implementing and coordinating the Department's policies and procedures pertaining to all facets of agricultural biotechnology. The office supported mechanisms for biotechnology policy, coordination, and provided a focus for research and biosafety advice, public outreach, and international coordination. To ensure the successful transfer and public support of organisms and products developed through biotechnology, USDA established a science and educational pathway, and a regulatory pathway. The Animal and Plant Health Inspection Service took the lead responsibility for ensuring regulatory compliance involving field tests. The Office of Agricultural Biotechnology with the support of the Agricultural Biotechnology Research Advisory Committee developed and promoted science, practices, and procedures to aid researchers in assessing the safe conduct for the planned introduction into the environment of genetically modified organisms. Following ten years of successfully advancing the research, promoting the adoption of biotechnology, and working closely with the public, universities and the industries, a decision was made to close the Office of Agricultural Biotechnology and its many programs and activities. The responsibilities for the public's acceptance of the products of agricultural biotechnology were transferred to private industry, with government providing regulatory oversight. This action resulted in the products of agricultural biotechnology becoming the target of protests over public concerns for the environment and public health. Perhaps if USDA had continued its numerous programs beyond those first ten years, the future of agricultural biotechnology may have been different.

**Keywords:** Agricultural Biotechnology; GMO Field Tests; Department of Agriculture; Biosafety; Public Acceptance of Biotechnology; Agricultural Research Service; Animal & Plant Health Inspection Service; Agricultural Biotechnology Research Advisory Committee

## Abbreviations

ABRAC: Agricultural Biotechnology Research Advisory Committee; APHIS: Animal and Plant Health Inspection Service; ARS: Agricultural Research Service; BBEP: Biotechnology, Biologic, and Environmental Protection Unit; CSREES: Cooperative State Research, Education, and Extension Service; EPA: Environmental Protection Agency; ERS: Economic Research Service; FDA: Food and Drug Administration; FS: Forest Service; FSIS: Food Safety Inspection Service; GE: Genetically Engineered; GM: Genetically Modified; GMO: Genetically Modified Organism; NBIAP: National Biological Impact Assessment Program; NEPA: National Environmental Protection Act; NGO: Non-Governmental Organizations; OSTP: Office of Science and Technology Policy; USDA: United States Department of Agriculture.

## Introduction

In March 2018, CAST (Council for Agricultural Science and Technology), issued a paper describing the "Regulatory Barriers to the Development of Innovative Agricultural Biotechnology by Small Businesses and Universities" [1]. The Issue Paper noted that American taxpayers have invested heavily in government, university, and small business developers of crops and foods improved by using biotechnology; however, the returns of new, improved Genetically Engineered (GE) crops was disappointedly thin [1]. Moreover, despite the United States Department of Agriculture (USDA), universities and small businesses having developed dozens of GE crops, almost all have been denied commercial release because of public concerns of the risks, resulting in United States of regulatory obstacles that disproportionately penalize public, academic, and smaller private breeding programs [1].

In October 2018, Carzoli et al. in discussing both those risks and opportunities of GM (genetically modified) crops, noted that despite commercialized GM crops on more than 190 million hectares globally: "The fear of CM crops has led to substantial opposition from non-governmental organizations and politically-motivated groups, who have the ability to influence policies around the establishment of biosafety frameworks in developing countries" [2]. While many plants have been field-tested, many have been approved for food and feed use in the United States. However, to date the global trade in biotech-improved crops have involved primarily only four plants:




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soybeans, cotton, corn (maize) and canola. The improvements have been primarily insect resistance and herbicide tolerance [3].

Observations of a rising tide of discontent, suspicion, and opposition to the adoption of GMOs have been observed for more than 20 years. Roger Beachy, the President of the Donald Danforth Plant Science Center in St. Louis, Missouri, noted in 1999: "A growing number of editorials and articles in the popular press, first in Europe, and more recently in the United States, described in exaggerated language the dangers and unknown effects of adoption of the new crop varieties and foods derived from biotechnology" [4]. At the same time, Jacobs, the Editor-in-Chief of Chemical & Engineering News concluded that the problem was a lack of informed debate about genetically modified foods. She noted that there were too many questions that needed to be answered in the poorly handled debate about the safety of GMOs. She blamed the chemical and life science companies who moved aggressively into the field without first understanding the public concerns, the media for distorting scientific studies and reports to attract audiences, and the failure of many scientists for failing to get involved [5].

What is most disturbing, is that at the time the technology was being challenged, the scientific community was making rapid advances. By all accounts, the adoption of the technology should have occurred, so what went wrong? Since the late 1990, there has been seen the rising tide of discontent, suspicion, and opposition to the adoption of Genetically Modified Organisms, a technology that was intended to be a win-win situation for everyone? The following narrative describes the efforts of the USDA to ensure that agricultural biotechnology would be successfully adopted, and the products of the technology would be welcomed by the producer and the consumer. The anticipation that the responsibility for ensuring its adoption would be left to the private sector where the arguments would be "to regulate or not to regulate." Nor were the heated debates anticipated regarding whether GM crops would help alleviate food in-security or be limitedly adopted due to risk perceptions and fears spread by anti-biotech lobbing groups.

## The Establishment of Agricultural Biotechnology at USDA

The process of genetic improvement has always been the backbone of agriculture and the foundation of a society's ability to feed and clothe a growing population. In the early 1970s with the advent of molecular biology at the National Institution of Health, the United States Department of Agriculture quickly recognized that the tools of this new biology had many applications throughout plant and animal sciences. An investment in the long-term research required to capitalized on these opportunities by USDA began in 1984 with a $14 million commitment to "agricultural biotechnology research" [6]. As noted, agricultural innovations through modern biotechnology have delivered limited economic, environmental, health and consumer benefits throughout the world. This "limited benefit" has occurred despite a tremendous effort undertaken in the early years of biotechnology at USDA that were responsible for providing the scientific advances and regulatory mechanisms that ensured that this new technology would be safe for agricultural production systems, human health, and the environment. The acceptance of biotechnology by the public was crucial if the products of agricultural biotechnology were to be safe and effective for their intended use.

To ensure the successful transfer and public support of agricultural biotechnology, USDA established a science and educational pathway and a regulatory pathway. The Animal and Plant Health Inspection Service (APHIS) took the lead responsibility for ensuring regulatory compliance. This required APHIS to coordinate with the White House Office of Science and Technology Policy (OSTP), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA) on all laboratory evaluations and subsequent field testing [7]. The Office of Agricultural Biotechnology (OAB) was established in 1986 and reported initially to the Office of the Secretary of Agriculture. The OAB took on the coordinating tasks of evaluating and promoting the science agenda, assisting in developing public outreach and education programs, and being responsible for the Agricultural Biotechnology Research Advisory Committee (ABRAC) [7]. It was intended that the goals of these two pathways for USDA would ensure that biotechnology was a balanced, efficient, well-managed, and environmentally responsible agricultural system that would use the best of technology and science [7].

### The budgetary process

Eleven agencies or offices within USDA played roles in biotechnology research, regulation, education, commercialization, and international activities. Each of these agencies had their own constituencies, legal responsibilities, and budgets. However, the budgetary process was overseen and determined by not only the Secretary of Agriculture, but also the Office of Budget and Management (Executive Office of the President), and the Agricultural Committees of the Congress of the United States. Although this was a very cumbersome process, its strengths were that it involved all constituencies dependent on American agriculture.

Key roles in this process were the National Association of State Universities and Land-Grant Colleges and the Board of Agriculture of the National Research Council [8]. With the advent of biotechnology, it was recognized that the business of agriculture was changing. Agriculture was increasingly challenged to compete in the international marketplace. Consumer preferences were becoming dynamic and were having growing impacts on decisions about food from production to consumption. The public's environmental concerns continued to place new demands on the food and fiber industry. Thus, the budgetary process now involved inputs from both the consumers of agricultural products and the producers of agricultural products, a system that provided almost 20% of the jobs in the United States [8]. Moreover, having strategic plans for action on agriculture and national resources were crucial to the final budgets approved and provided to the Agencies each year. As noted, in 1984, $14 million was appropriated to initiate research in areas of biotechnology. By late 1995, USDA's funding for biotechnology was approximately $300 million as an annual investment. Biotechnology was now integrated into all the research programs of the Department of Agriculture, to include support for the Land-Grant Universities (the Cooperative State Research, Education, and Extension Service, CSREES), and the Federal Laboratories of the Agricultural Research Service (ARS) and the Forest Service [7]. It should be noted that in 2008, the CSREES research budget exceeded $4.1 billion, and the ARS budget exceeded $1.1 billion [data from the Secretary of Agricultures Annual Report for 2008].

## Coordination of agricultural biotechnology initiatives

For ten years, 1986-1996, by order of the Secretary of Agriculture, the Office of Agricultural Biotechnology (OAB) was assigned the primary responsibility for "implementing and coordinating the Department's policies and procedures pertaining to all facets of agricultural biotechnology." The OAB had a small permanent staff and added detailees as necessary to address specific issues. The Office utilized and supported mechanisms for biotechnology policy coordination, and provided a focus for research and biosafety advice, public outreach, and international coordination. The Committee on Biotechnology in Agriculture, from 1986 to 1992 consisted of sub-cabinet officers and provided policy-level coordination. The Biotechnology Council, a consortium of senior-level employees from eight agencies who met monthly to discuss and make recommendations on issues having an impact on departmental biotechnology programs. A Biotechnology Information Group was also formed. This body was comprised of public information officers who met regularly to discuss public outreach activities. The latter was instrumental in helping OAB produce the publication, "Biotechnology at USDA", a directory of agency activities and contacts.

## Presidential initiative on biotechnology research

From 1991 to 1996, OAB served as the USDA action office in a US Government-wide effort to track and analyze Federal investment and to identify research opportunity in biotechnology research. This effort involved OSTP and a dozen Federal agencies with biotechnology research interests. In FY 93, the Report on "Presidential Initiatives on Biotechnology Research" was published, and in FY 94, the White House publication "Biotechnology for the 21st Century: New Horizons" was published.

## Public participation and media initiative

Biotechnology was of great interest to the agricultural research community, farm groups, teachers, students, businesses, and the average consumer. The Office of Agricultural Biotechnology worked vigorously with the media and public to dispel common myths about biotechnology, to educate and inform consumers about the potential benefits of biotechnology as well as its limits, and to encourage participation in the decision-making process. OAB sought to provide these groups and others with information about biotechnology that was free of scientific or regulatory jargon. An effective tool for establishing a mechanism of communication was Biotechnology Notes, a free monthly news publication meant to inform and educate USDA's clientele about public policy issues, research, education, regulation, technology transfer, and educational activities taking place around the world. For nine years (1988-1996), Biotechnology Notes was published monthly and distributed widely within the University System, Federal and State Agencies and Laboratories, private companies, individuals, NGOs, and to 26 different countries [total issues: 80; Distribution: 500,000, mostly *via* electronic means). Importantly, national, state, and local contacts for biotechnology education were established in all 50 states, and guides were provided to assist in development of agricultural biotechnology information programs.

The OAB professional staff were encouraged to accept speaking engagements, participate in workshops and conferences, and to publish in professional journals. From November 1987 through December 1995, 217 presentations were given to approximately 16,000 people. Fifty-four presentations were given locally (in Washington DC and the immediate area) to professional groups, agricultural commodity groups, public interest groups, high schools, and colleges. Nationally, 128 presentations were given, while internationally 35 presentations were made, including conferences in Sweden, Ireland, Egypt, Japan, Italy, and the Netherlands. The Director of OAB served as USDA's representative to the Biotechnology Research Subcommittee, Committee on Fundamental Science, National Science and Technology Council to the United States-European Union Task Force. The Following Publications were released: Biotechnology and Genetic Resources, October 21-22, 1992, Airlie, Virginia, USA; and Methods of Communicating Biotechnology with the Public, March 22-25, 1992, Dublin, Ireland.

From FY 1988 through FY 1995, 47 grants or agreements were provided to support 38 symposia, workshops, or conferences, and 5 special projects. The 38 symposia, workshops or conferences sponsored or co-sponsored by OAB encompassed the spectrum of interests in agricultural biotechnology by USDA. The following were examples of important conferences:

- Scientific Evaluation of the Potential for Pest Resistance to the Bacillus thuringiensis (Bt) Delta-endotoxins. A Conference to Explore Resistance Management Strategies, January 21-23, 1992, Washington, DC,
- Symbol, Substance, Science: The Society Issues of Food Biotechnology, June 28-29, 1993, the North Carolina Biotechnology Center, Research Triangle Park, NC,
- The International Workshop on Animal Biotechnology Issues, April 1994, University of California, Davis, CA,
- Mapping Biotech Strategies with Genetic Maps, June 23, 1995, University of Minnesota Food Animal Biotechnology Center, St Paul, MN, and,
- Symposium: Consumer Issues in Biotechnology: Genetically Engineered Foods, April 10, 1995, Experimental Biology '95' Meeting, Atlanta, GA.

## The Agricultural Biotechnology Research Advisory Committee (ABRAC)

The USDA Agricultural Biotechnology Research Advisory Committee (ABRAC) was established on October 23, 1987 and re-chartered three times thereafter. The purpose of ABRAC was to provide advice to the Secretary of Agriculture on policies, programs, operations, and activities associated with the conduct of biotechnology research. The ABRAC was cited for consultation by the Secretary in the 1990 Farm Bill. The ABRAC consisted of 15 doctoral-level experts with knowledge in one or more of the following areas: recombinant-DNA research in plants, animal, and microbes; food science; ecology/epidemiology/environmental science; agricultural production practices; biological containment and biological field release; applicable laws and regulations; standards or professional conduct and practice; public attitudes; public health; occupational health and ethics; human medicine; fisheries science; and socioeconomic impacts. The OAB provided executive and secretarial staff support for ABRAC. The membership of ABRAC was by two-year appointments from 1988 through closure in 1996.

On March 5, 1992, the ABRAC released "Guidelines for Research Involving Planned Introduction into the Environment of Genetically Modified Organisms, dated December 3-4, 1991. This was a three-year effort involving hundreds of hours of discussions between some of the most outstanding agricultural-related scientists in the United States. Prior to finalizing the Guidelines, public meetings were held in Sacramento, CA; St. Louis, MO; Raleigh, NC; and Washington, DC.

"These Guidelines recommend practices and procedures for the safe conduct of research involving the planned introduction into the environment of certain genetically modified organisms. The Guidelines establish principles for assessing the safety of research with specific organisms and designing confinement to promote safety. They are intended to aid researchers and institutions in the design of safe experiments conducted outside contained facilities."

In his letter of transmission of the Guidelines to the Acting Assistant Secretary for Science and Education, the Chair of the ABRAC, Bennie I. Osburn, DVM, PhD stated:

"I think I speak for all the members of the ABRAC in stressing how important it is for the Department to provide guidance to the agricultural research community of the safe performance of research utilizing the newer techniques of biotechnology. This research is important not only for the orderly pursuit of agricultural biotechnology research, but also for the long-term health of the US economy and its international trading activities."

The Guidelines are available on the Internet. The use of the Guidelines was intended to fulfill requirements of the National Environmental Policy Act (NEPA) concerning biotechnology research.

On August 2, 1995, ABRAC released "Performance Standards for Safely Conducting Research with Genetically Modified Fish and Shellfish." These voluntary Performance Standards were intended to aid researchers and institutions in assessing genetically modified fish, crustaceans, or molluscs. Where the need was identified, they were also intended to aid researchers in developing appropriate risk management measures so that the research could be conducted without adverse effects on natural aquatic ecosystems. The Performance Standards are available on the Internet.

## Agricultural Biotechnology Research

The Plant Genome Mapping Program was created in 1989 with three major goals: to map and sequence plant genomes, including technology and development; to establish and manage databases, information, and resources; and, to identify, characterize, and express genes of agricultural importance. The Plant Genome Research Program was ranked as one of the most important research areas in USDA. Achievement of the program's goals were expected to have significant, long-term impacts on improving the quality productivity, and other characteristics of plants and their products [9]. Indeed, by 1993, genome research was being conducted on agronomic traits in more than 40 crop and tree species. USDA allocated a budget of $14.7 million in FY 1991, with commitments of $15 million annually through FY 1995 [9]. The Plant Genome Research Program was authorized for only 5 years of support. Expectation was that a larger "national genome program" would continue USDA's efforts. However, it soon became apparent that controversy involving genes, patents, and product development would hinder genome related product development [9,10].

The National Biological Impact Assessment Program (NBIAP) was initiated by the Cooperative State Research, Education and Extension Service (CSREES) and was chiefly concerned with biosafety monitoring and obtaining knowledge for predicting potential impact of biotechnology products in field tests or commercial development. In 1993, MacKenzie, the first Director of NBIAP, noted that a proper balance was needed between the restraint to assure safety and the freedom to allow discovery. How this balance would be maintained for biotechnology research in agriculture was not yet clear [11]. There was a need for the scientific community to accept the growing public expectation for biosafety assurances. The scientific community must be provided with assistance to facilitate that compliance; hence, the purpose of NBIAP [11]. Accordingly, NBIAP established a computerized source of information on agricultural and environmental biotechnology at the Virginia Polytechnic Institute and State University. This computerized system combined news on recent developments with direct access to more than 14 databases. Topics ranged from complete texts of Federal regulations to sources of all available information on specific organisms. NBIAP began the first discussions on the labeling of food-plant biotechnology products.

To promote agricultural biotechnology research, The Cooperative State Research Education and Extension Service (CSREES) began investing considerable resources into the Land-Grant Universities for direct institutional support, special research grants for specific research projects and competitive research grants. The CSREES partnership funding to the university-based agricultural research system was through the congressionally mandated funds, including Hatch Act, McIntire-Stennis Cooperative Forestry Act, Evans-Allen Act, and the Animal Health and Disease Research Act. As noted earlier, by 1995, USDA funding for biotechnology was approximately $300 million as an annual investment, and by 2008, $4.1 billion. The Cooperative Extension System combined the expertise and resources of federal, state, and local governments. The partners in this unique system included extension professionals at the 52 1862 land-grant universities and at the 16 1890 land-grant universities and Tuskegee University, as well as extension professionals in nearly all 3,150 counties of the Nation.

In 1984, the Agricultural Research Service (ARS) opened its new Plant Gene Expression Center at the Western Research Center in Albany, CA. Numerous projects were initiated to identifying genes that controlled specific desirable traits such as plant resistance to disease or insects, cold hardiness, and drought tolerance. Their efforts to use genetic engineering to make crop products more nutritious and of higher quality were intended to help trim the farmer's production costs. The ARS 1995 budget included an estimated $106.9 million for research in biotechnology. At least 185 ARS scientists were working on 165 projects at their laboratories throughout the United States, many affiliated with land-grant Universities. In 1989, a new Plant Molecular Biology Laboratory was opened at the Beltsville Center in Maryland. Subsequently, ARS published a book, "Solving Agricultural Problems with Biotechnology", which described ongoing research programs and accomplishments.

The technology responsibilities of the Economic Research Service (ERS) involved analysis of the potential for new technologies to affect agricultural policies, commodity production, and trade; financial impacts on the farm sector and rural economies; and, agricultural resource utilization. These responsibilities also included analysis of the economic aspects of policies that developed, regulated, and encouraged the adoption of biotechnology, and the impact of these policies on agricultural productivity. ERS conducted a significant amount of research investigating the impacts of animal growth hormones, e.g., Bovine somatotropin (BST), and the effects on the dairy industry [12].

USDA's Forest Service (FS) developed and tested basic techniques to employ biotechnology for accelerating tree growth and improving the quality of trees. Biotechnology in forestry fell into three areas: the use of vegetative reproduction methods; the use of genetic markers; and the production of transgenic trees. However, it was quickly recognized that the benefits of biotechnology in forestry would go beyond economic advantages to include such environmental benefits as helping to preserve biodiversity and mitigate global warming. There were early concerns about biosafety and the effects of transgenic trees on the resistance of pathogens and on the natural ecosystem, particularly the question of genetic exchange between domestic and wild populations. The December 1991 ABRAC Guidelines included the example of Pinus taeda, loblolly pine. A determination of the level of safety concerns included the potential to establish transgenic plants; the impact of pest/pathogen status; the potential for inducing genetic change in natural or managed populations; and the design of safety protocols and confinement principles.

## The Regulatory Oversite of Agricultural Biotechnology

Established as a formal policy in 1986, the Coordinated Framework for Regulation of Biotechnology described the Federal system for evaluating products developed through the modern biotechnology [13]. The Coordinated Framework was based upon existing laws designed to protect public health and the environment. However, the Agencies responsible for regulatory oversight of biotechnology-derived products prepared additional regulations, policies, and guidance. The US Government agencies responsible for oversight of the products of agricultural biotechnology were APHIS, EPA, and FDA. Depending on its characteristics, a product could be subject to the jurisdiction of one or more of these agencies [13].

During the years from 1986 to 1996, the agricultural research community continued to define the risks, and hence could lessen the scope of organisms that should receive regulatory oversight. The goals of regulating biotechnology were to: 1) to avoid singling out recombinant -DNA technology as representing any more risk than traditional procedures used to modify an organism; 2) to refrain from unduly hindering research with burdensome and unnecessary overregulation; and 3) to provide assurance to the public that there was careful scientific review prior to the release of modified organisms if there was any question as to how they would affect the environment or human health [6].

USDA's Animal and Plant Health Inspection Service (APHIS) was responsible for protecting agriculture from pests and disease. Under the Plant Protection Act, APHIS has regulatory oversight of the products of modern biotechnology that could pose such a risk. Accordingly, APHIS regulated organisms and products that were known or suspected to be plant pests or to pose a plant pest risk, including those that have been altered or produced through genetic engineering. By combining existing staffs, APHIS established the Biotechnology, Biologic, and Environmental Protection Unit (BBEP) in October 1988, to coordinate USDA biotechnology regulation; to regulate veterinary biologics; and, to assure that all product reviews and program activities conformed with legislation designed to protect the environment. APHIS began issuing permits for biotech products in July 1987. Within two years APHIS had issued more than 500 permits, and each of the applications for a permit was reviewed with the mandatory deadlines spelled out in the regulations. By July 1989, more than 100 people were employed by APHIS, including biotechnologists, molecular geneticists, environmental ecologist, and animal and plant physiologists. In April 1993, APHIS streamlined its regulatory requirements by establishing a notification system in lieu of requiring permits for field tests of six major crop species. By 1996, APHIS had issued more than 1,140 permits of notification for field tests of genetically transformed plants, and the momentum of field testing was growing at that time [7].

The Food Safety and Inspection Service (FSIS) was the agency responsible for assuring the safety, wholesomeness, and truthful labeling of meat and poultry products for the United States. In 1996, FSIS inspectors were stationed in nearly 7,000 plants throughout the US. The Agency annually inspected approximately 120 million head of livestock, 5.6 billion birds, and 150 billion pounds of processed products such as sausage and ham. Biotechnology provided new mechanisms for production of animals that were disease resistant, leaner, or possessing other desirable characteristics [14].

On December 27, 1991, FSIS published a notice in the Federal Register titled: "Livestock and Poultry Connected with Biotechnology Research." In January 1993, FSIS petitioned ABRAC to address the scientific questions associated with human food safety of products prepared from transgenic animals. In response, ABRAC formed a transgenic animal working group comprised of specialists in the field of animal biotechnology from the industry, academic, and government which held public meetings to address these questions [15]. Based on ABRAC recommendations, on March 17, 1994, FSIS informed the public of the document: "Points to Consider in the Food Safety Evaluation of Transgenic Animals from Transgenic Animal Research". For consumers, this document provided assurances that the regulatory oversight in ensuring food safety of meat and poultry derived from transgenic research was adequate [15]. As of 1996, FSIS had not approved any transgenic livestock for slaughter, but FSIS was working on a policy for the slaughter of commercial transgenic animals.

## Addressing the Issues of Concern for Agricultural Biotechnology

- In March 1992, the United States and the Commission of the European Communities held a workshop on "Methods of Communicating Biotechnology with the Public" in Dublin, Ireland [15]. The Workshop examined the Role of the Media, Role of Scientists, the Role of the Public and Public Interest Groups, the Role of Government Institutions, and the Role of Educators in communicating biotechnology with the Public [16]. The conclusions:

- In democratic societies, the public has an obligation and a right to shape the developments of technology. The media is key to providing information on biotechnology to the public. The relationship between the media, the scientist, and the biotechnology community in general will determine both the quality and quantity of information that is provided to the public,

- Scientists show the least incentive to communicate with the public, a problem that relates to the scientists' education and training,

- The public at large, and public interest groups are seeking more active participation in the decision-making process related to science policy. Decision makers must provide hearings for the citizens groups and individuals to assure that democratic processes are followed,

- Governments must play a role as broker between different stakeholders in the biotechnology debate. Importantly, government should provide an unbiased assessment of the technology, and,

- Educators play a crucial role in laying the foundation for a society that is expected to make important decisions related to science and technology. Increased education in biotechnology should not support further specialization but an interdisciplinary approach to teaching scientific and social issues.

In the four years following the Dublin Workshop, USDA personnel participated in hundreds of public meetings, provided interviews with the media, and organized conferences with universities and industries on consumer attitudes about food biotechnology, food safety, technology transfer, bioethical issues related to plant and animal biotechnology, animal welfare, biodiversity and food security, food labeling, patents and intellectual property rights, functional foods, nutrition, ecology of transgenic crops, and industrial products. A special effort was made to introduce biotechnology into the curriculum of "Ag in Classroom", an educational program of USDA's Extension Service.

## Issues Hindering Public Acceptance

The success of the overall program within USDA in advancing the research, promoting the adoption of biotechnology, and providing a positive track for public acceptance of the technology by producers and consumers of agricultural products was the justification for the Department of Agricultural to abolish the Office of Agricultural Biotechnology in 1996. With the closure of OAB, the ABRAC, and the coordination of biotechnology programs within USDA, the attitude of the leadership of USDA, FDA, and EPA, and the Clinton Administration was that it was now time for the Biotechnology Industry to assume the responsibilities of communicating, promoting, and developing biotechnology. The Government's role was now relegated to providing regulatory oversight of the technology [6,7].

In the years following the changes in direction by USDA and other Government Agencies, the potential products of agricultural biotechnology became the targets of public concerns both national and internationally. Thayer noted in 2000: "Discussions, protests, and reports about Agricultural Biotechnology have become a stream of new stories…Demonstrations by environmental and other activist groups have surfaced at all the international trade and scientific meetings" [17]. Thayer concluded that the industry was gambling on an information campaign, continued farmer acceptance, and the promises for the future [17]. Benson et al. in the magazine Mother Jones concluded: "It's scary. We're so caught up in the pyrotechnics of biotechnology that we tend to forget that we are altering the genetic codes of living things" [18].

The conclusions by Jacobs, the Editor-in-Chief of Chemical and Engineering News in 1999 proved to be true [5]. Namely, that the problems of adoption of biotechnology was a lack of informed debate about genetically modified foods and the safety of GMOs. She blamed the chemical and life science companies who moved aggressively into the field without first understanding the public concerns, the media for distorting scientific studies and reports to attract audiences, and the failure of many scientists for failing to get involved [5]. Perhaps if USDA had continued its numerous programs and activities beyond those first ten years (1986-1996), the future of Agricultural biotechnology may have been different.

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