Understanding the Impacts of Biotechnology

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Biology is engaged in the pursuit of knowledge of immense significance. The scientific understanding of life processes is inspiring and awesome in its contributions to our knowledge of life systems and its application to solving real-world problems. As biologists, we are not only responsible for generating, redefining, and enlarging this knowledge base, but we must also share hugely in its interpretation and its extension into use.

With increasingly refined research tools and techniques, we find ourselves with a truly incredible mass of well-organized knowledge about biological systems. The use of this knowledge, as well as that from the physical sciences, has wrought much change for our civilization. Now, in the last third of this century, with the startling genetic transformations by Stanley Cohen and Herbert Boyer building upon the discoveries of DNA by James Watson and Francis Crick, the whole matter of the human intervention into living systems has been opened. This drama is literally being rehearsed in a major new undertaking referred to collectively as biotechnology.

During the decade of the 1980s, emerging research results reinforced earlier predictions of the potential of biotechnology to have an impact on the food, feed, and natural fiber production of this nation. Biotechnology does not simply contribute a new set of tools to the tasks of biologists; it brings to them new concepts and a whole new capacity for intellectual pursuits involving life processes. The question before us is not simply how to grow a plant, animal, or microbe, but to elucidate why they grow at all. By knowing some of the answers to these questions, we can design biological systems to meet humankind's needs more predictably and, at the same time, substantially reduce the consumption of valuable resources. Through biotechnology, we can hope to aggressively contribute to the protection and preservation of natural resources and provide new industrial potentials for biologically based systems. It is no longer a matter of providing new answers to old problems, but of providing entirely new potentials for biological systems.

As biotechnology got under way, it was widely appreciated by the scientific community that certain concerns for the safety of the research needed to be met. If those concerns were not met in a timely manner, the research could be delayed or perhaps even prevented. Even worse was the prospect of proceeding without proper concern for potential adverse consequences, thereby encouraging a climate of reckless development. These concerns apply most directly to agricultural biotechnology because of our need to conduct investigations outside specialized contained laboratories. Without considerable field testing, the research process in agriculture cannot proceed normally, and the applications of biotechnology will not come forth.

There are those who would argue that too little information is available to allow anything but the most safe experiments. I disagree. In the past half century, irrespective of biotechnology, our agricultural research systems have deliberately released genetically altered biologics (plants, animals, and microbes) on a regular basis. This has been done on an almost unbelievable scale: 4 trillion animals in fifty years, 193 trillion corn plants each year, 25,000 species of fungi each year, 3,000 species of nematodes each year, 600 species of bacteria each year, and 80 "species" of viruses each year.

These releases are performed not only as part of the agricultural production system but as an integral part of the research process looking for improvements in the agricultural production system. Our natural food, feed, and fiber production systems have, at times, involved the use of 653,636,400 ha that must constantly be served with improvements and observed for problems.

The core research system that currently serves the need for environmental testing is a network of some 3,000 research sites constituting over 1.3 million ha distributed in every state and territory of the nation. Collectively, this network addresses an infinite range of biota subject to all manner of climatic and edaphic factors. Also impressive is the realization that many of these sites were established over a century ago and most have been established for at least 25 years. Thus, much baseline information for these sites is readily available.

This network of sites plus those of industry and other public and private institutions provides an impressive network of research stations in which investigations can be conducted under the oversight of a science-based review process.

There is, then, a national system poised and in place, ready to address the challenges of biotechnology research in agriculture. In the following series of papers the authors point out the research approaches that could be used to address the real and perceived problems of field testing genetically modified organisms.

The first paper, by F. W. Nutter, Jr., addresses the methodologies for assessing the risks and benefits associated with the planned introductions. This is then followed by D. A. Kluepfel, et al, describing a biological monitoring system for microbes. The third paper, by P. S. Teng, looks at the potential for using modeling and nonmodeling approaches in the environment. A fourth paper by M. A. Martin examines the socioeconomic impact of agricultural biotechnology and the prospects for addressing these issues. The final paper, by D. R. MacKenzie, describes a national program established by the U.S. Department of Agriculture to facilitate safe field testing of genetically modified organisms. These papers were presented by the authors at a symposium sponsored by the American Phytopathological Society Plant Disease Losses Committee held during the 1988 APS Annual Meeting in San Diego, CA.

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