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Abstract

Agricultural biotechnology has been advancing very rapidly, and while it presents many promises, it also poses as many questions. Many dimensions to agricultural biotechnology need to be considered to adequately inform public policy. Policy is made more difficult by the fact that agricultural biotechnology encompasses many policy issues addressed in very different ways. We have identified several key areas—agricultural research policy, industry structure, production and marketing, consumer issues, and future world food demand—where agricultural biotechnology is dramatically affecting the public policy agenda. This report focuses on the economic aspects of these issues and addresses some current and timely issues as well as longer term issues.

Keywords: Biotechnology, economics, adoption, patents, research policy, markets, market segregation, and identity preservation.

Note: The use of commercial or trade names does not imply approval by USDA or ERS.

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Summary

The issues associated with agricultural biotechnology are complex and varied. Biotechnology poses many outstanding possibilities for agriculture and other important areas like medicine, the environment, and biodiversity. While biotechnology could greatly expand our frontiers of knowledge and production potential, many issues must be addressed as we move forward. The array of issues includes the legal, the ethical, and the economic. This report addresses some of the economic issues confronting agriculture.

The complexity of issues stems from the creation and management of the science, the ownership in intellectual property, the economic nature of the industry undertaking the research, the interaction between public and private research, and the marketing of products. Adding to the complexity are concerns about the implications of biotechnology for new agricultural products, markets, and contractual arrangements between producers, processors, and marketers. The acceptance of the technology depends critically on the perceptions and attitudes of consumers, both domestic and foreign, and on the expected impacts on food safety, health, and the environment. The degree of foreign acceptance can significantly affect international trade and may create the need to segregate and identify genetically engineered (GE) products.

The science and its manifestation in new products and markets has been evolving very rapidly, so it is difficult to provide a current and timely exposition of the issues. Nonetheless, this document is an attempt to present and explore the relevant issues to date.

Much of the current interest in biotechnology stems from two recent phenomena: the extremely rapid diffusion in North America and other exporting countries, like Argentina, of GE crops, such as cotton, soybeans, corn, and canola; and the different consumer response in Europe, as compared with the United States, to products derived from genetically modified crops. U.S. producers and policymakers are concerned about policies being developed by trading partners, potential loss of markets, and the additional marketing costs that might result from segregated or identity-preserved marketing. These phenomena, in turn, might reduce incentives for the development of new agricultural biotechnology products.

Research Policy Issues

In one form or another, however, agricultural biotechnology is here to stay, despite the changes that will be determined by demand-side factors. Supply-side factors will also affect the direction and pace of biotechnology innovation in the long run. Intellectual property rights (IPR) and market concentration in the agricultural input industries are intertwined areas that are shaped by public policy. The ways in which IPR and market concentration influence innovation are not well understood. In general, public policy affecting agricultural biotechnology is less well developed than it is for information technology. Open but informed debate on these issues is necessary to assess barriers to entry at key points in the flow of new technology and to devise appropriate public policy responses.

The response of public-sector agricultural research to increased private-sector research investment is somewhat better understood, although also subject to debate. Public-sector agricultural research increasingly targets basic science and applied science with a public good component. Good examples include natural resource research and research on food safety. Even in areas increasingly dominated by the private sector, such as plant breeding, there are appropriate topics for public-sector research to pursue—for example, fundamental issues concerning gene interaction, regulation, and expression.

A critical role for public research is in the conservation, management, and characterization/evaluation of genetic material. An estimated 50 percent of yield gains in major cereal crops since the 1930's have come from genetic improvements through conventional breeding techniques. Also, it has been estimated that biological improvements contributed to 50 percent of the yield growth in corn, 85 percent for soybeans, 75 percent for wheat, and 25 percent for cotton.

Future crop yield growth will also depend on biological improvements that will largely come from genetic material that is either in the wild or in gene banks. The U.S. National Germplasm System is one of the world's largest collectors and distributors of germplasm; yet, according to the General Accounting Office, it does not have sufficient funding for evaluation and documentation or to perform necessary regeneration of seed

accessions. Advances in biotechnology offer new possibilities to more rapidly evaluate and characterize germplasm as well as to transfer and regulate it in seeds. Biotechnology may increase the demand for public genetic resource management by increasing the potential uses of genetic material and enhancing the ability to learn more about the characteristics of the genetic resource.

Production and Marketing Issues

Vertical integration of chemical companies into the seed and biotechnology industries has led to increasing concentration within the U.S. seed industry. Acquisition and joint ventures and massive investments made by leading chemical companies in biotechnology research allow these firms to maintain a competitive position and to capture profits from biotechnology innovations. The large biotechnology firms have also merged with or acquired seed companies to obtain sources of germplasm for further development of genetically modified seed varieties and to have an outlet for delivery of the new technology, usually as seed.

The increasing dominance of a few major players and biotechnology and chemical patent restrictions on what competitors can do raise questions about the potential for too much market power in parts of the seed and chemical industries. Several antitrust cases in seed and chemical markets raise concern about the potential adverse impact on market competition resulting from the removal of competitors from already concentrated seed markets. The use of licensing agreements and strategic alliances by leading biotechnology firms might also bar entry of potential competitors to the herbicide market. In addition, grower agreements signed by producers and seed companies impose planting restrictions on producers, raising fear that farmers might become “hired hands” for biotechnology companies.

Increased value from output-enhanced crops will lead to further coordination within the market. The technology provider creates the original value of this crop and will want to control this value and share it according to each market participant’s bargaining position, assumed risk, or additional costs relative to the traditional commodity system. The type of coordination mechanism used will depend on the product’s value, volume, and competitive market characteristics and on the firm’s desired control, capital resources, costs, and asset specificity. An array of coordinating mechanisms will likely be used, depending on the specific situation. Open markets, licensing agreements, contracts, strategic alliances, cooperatives, and full vertical integration are all likely candidates in conjunction with a segregated or identity-preserved (IP) handling system. There are concerns about the transparency of the price discovery process and potential negative impact on market efficiency.

Variety approval processes, labeling requirements, and expressed market demand for non-GE crops could fundamentally alter the structure of the current marketing system. Demand for nonbiotech crops could lead to segregated marketing. Segregation is also needed to preserve end-use characteristics for value-enhanced crops (including non-GE’s). At the core of the concerns about segregation are questions such as: How much will segregation add to total costs of marketing? Who will bear the cost? How much premium will the market prescribe for non-GE crops? While segregation or IP marketing is nothing new, the viability of segregated or IP marketing would critically depend on the speed, accuracy, and costs of testing for the presence of GE’s.

The costs of segregation vary significantly among grain elevators and by the method of segregation. Also, a considerable degree of uncertainty is associated with any cost estimates at present. Major factors that affect the distribution of segregation costs include (1) demand price elasticity, (2) competitive structure of the food industry, (3) the proportion of ingredient in the value of the final product, and (4) alternative sourcing of supply by foreign buyers.

If consumer resistance to GE’s persists in a segment of U.S. export markets (such as the European Union) while producers continue to rapidly adopt input-trait GE’s and a string of value-enhanced new products emerges, can the current grain grades and standards continue to function effectively without change? If not, what changes would be needed to facilitate marketing and trade? In the near- to mid-term, increasing sophistication and detail will be added to contract specifications as well as to the grading system. Labeling regulations and/or market segmentation might require contracts to be amended to ensure that the level of GE’s does not exceed what those demanding nonbiotech products will tolerate, which is occurring now. It is conceivable that a specialty grade of high-oil corn, similar to the case of waxy corn, eventually could be included in the grading system if the demand for the specific output trait becomes more common. Thus, U.S. grain grades and standards, by and large, are likely to remain intact in the near- to mid-term as long as output-trait GE's remain as niche markets.

In the longer run, if specialty grades become so widespread (including many stacked output and input traits) and if these specialty crops become widespread, then the grain grades and standards could begin to cease their basic functions and may require complete revamping. At that point, grain grades and standards dominated by physical characteristics and dominance of specialty grades in foreign buyers' imports might become irreconcilable. At a certain point, if the rate of change and multitude of specialty products accelerate—particularly with stacked traits—IP marketing could become the only way to market these value-enhanced products.

Consumer Issues

The response from U.S. consumers to the increasing prevalence of foods containing biotech products has been generally small, and the U.S. public appears to have confidence in the regulatory system to ensure an abundant and safe food supply. When the first biotech food product was released in the United States, a tomato engineered for longer shelf life, it was accompanied by information in the media and at the markets that increased familiarity and reduced fear of this new technology. However, commodity crops, such as corn and soybeans with altered agronomic traits, have subsequently been released without much public notice. While it is generally agreed that consumers have little cause to be concerned about the safety of biotech products in food and feed, some consumers object to consuming food produced with any new technology that lacks a long established history of use. In addition, food labeling has become an issue of consumers' "right to know."

Biotechnology and Future Agricultural Demands

Agricultural biotechnology has also been hailed as a key strategy to raising world food supplies. World food demand, driven by growth in both population and incomes, is projected to rise 35-45 percent in volume over the next 20 years. The increase will mostly come from developing countries. Increased production must come from a land base that will not expand very much, and it is desirable that these production gains not come at increasing environmental costs. Biotechnology clearly holds promise as a solution to some developing-country production problems, and to solving them in an environmentally friendly manner. Several factors, however, both technical and institutional, must be resolved if biotechnology is to fulfill that promise.

On the technical side, crop improvement, of which biotechnology is a part, must be complemented by innovative crop management research if supplies are to keep pace with demand. As for crop improvement itself, the application of biotechnology at present is most likely to reduce yield variability but not to increase maximum yields. More fundamental scientific breakthroughs are necessary if yields are to increase.

On the institutional side, policies on intellectual property rights, market concentration, and agricultural research are likely to take on even greater importance worldwide than they have now in industrialized countries. In most developing countries, the legal and public policy systems are less prepared to deal with the challenges of the biotechnology revolution than they are in industrialized nations. Furthermore, public-sector agricultural research in many developing countries is severely underfunded, and human capital development may not be adequate for the successful deployment of useful agricultural biotechnology. The appropriate international framework for bringing advanced research from developed countries, whether it is from private multinational corporations or from public research institutes, to bear on total world food supply has only begun to be addressed. Furthermore, this research stands a much greater chance of success if it is not performed in top-down fashion but in collaboration with talented scientists from developing countries and with real understanding of the constraints.