

## ROLE OF ECONOMICS AND OTHER SOCIAL SCIENCES IN BIOTECHNOLOGY RESEARCH

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Biotechnology research promises to have a greater impact on agriculture and society as a whole than any other technological development in agriculture in the past (such as hybrid corn) or any in the foreseeable future. Biotechnology research potentially encompasses a multitude of technological developments that are likely to impact all aspects of agriculture from agricultural production to food processing to food consumption and possibly even to waste and residuals management, pollution control and water quality. These technological developments provide challenging research and educational opportunities for agricultural economists, economists, rural sociologists, sociologists, and other social scientists. In this paper, two dimensions of the role of economics and other social sciences in biotechnology research are emphasized. First, some research and education program opportunities provided by biotechnology research are briefly highlighted. Kalter and Tauer, Hueth and Just, and Stallman and Schmid provide comprehensive information about potential impacts, policy issues, and property rights issues evolving from biotechnology research. These papers evolved from a general session on "The Economics of Agricultural Biotechnology" held at the Allied Social Science Associations meeting in New Orleans in 1986. The second dimension addressed is the performance to date of economics and other social sciences in biotechnology research and some factors affecting that performance. Casual observation and scrutiny of the literature would suggest that performance of economics and other social sciences has not been what most would consider spectacular.

### OPPORTUNITIES FOR ECONOMICS AND OTHER SOCIAL SCIENCES

Economists, sociologists, and other social scientists have played an important role in assessing the economic and social impacts of new technological

developments (Griliches; Schmitz and Seckler; Martin and Havlicek). These assessments have provided us with a better understanding of changes induced by technological developments, the effects of such changes, and the responses of markets and participants in markets to such changes. This information has been useful for decision making and policy formulation (White and Havlicek).

Biotechnology research has the potential of impacting all aspects of agriculture. The animal and plant biotechnology developments that are emerging impact directly on the costs and outputs at the production level. These impacts entail changes in the quality of inputs, levels of input use, and substitution among inputs. The substitution among inputs ranges from substitution of synthetically produced hormones for those produced naturally in plants and animals to the substitution of plant and animal characteristics produced by biotechnology for various chemical inputs. These biotechnology developments alter costs, returns, competitive positions, and the spatial location of production. Potentially large increases in supplies of agricultural products will have large depressing effects on output prices. Consumption patterns of consumers may be altered substantially because there are differences in consumers' tastes and preferences with respect to food products either produced or manufactured using hormones, bacteria, or other biological materials produced by biotechnology research. Some consumers will not eat meat or other foods produced using hormones or other biotechnology materials, whereas other consumers may prefer these food products over those produced using chemical inputs.

Farm structure is likely not to be insulated from the impacts of biotechnology research (Tweeten and Welsh). Biotechnology innovations permeate the agricultural supply industry and will also affect processing, distribution, and retail marketing of food and agricultural products. Biotechnology develop-

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ments have the potential of dramatically impacting export markets, international trade and competition, and economic growth and development in developing countries. There is a great potential for biotechnology developments to increase food and agricultural production in developing countries. Adoption of cost-reducing biotechnology in developed countries will allow them to be more competitive in international markets.

Economists and other social scientists have a vital role in assessing the economic and social impacts of the adoption of new biotechnology. It is important that the magnitude and distribution of benefits and costs associated with the adoption of a new biotechnology development are understood, that resulting market distortions are recognized, and that good scientific information be provided for formulation of policies concerned with the release and adoption of these new innovations. Economists and other social scientists could potentially play an important role in the marketing and public acceptance of new biotechnology innovations. Social scientists have the expertise to analyze the consequences, *ex ante*, of adoptions of new technologies evolving from biotechnology research.

#### **SOME FEATURES OF BIOTECHNOLOGY IMPACT ASSESSMENT**

Some features of biotechnology research and developments produced by that research make assessment of impacts of biotechnology developments different from impact assessments of other technological developments. All aspects of agriculture are likely to be affected, and the potential impacts on society could be greater than anything we have experienced in the past. Potentially there are large supply effects that could rapidly disrupt input and output markets, change farm structure, alter interregional competition, and result in rapid and large regional shifts in agricultural production. To date the large and rapid disruptive changes have not occurred; however, the potential is ever present.

Traditionally many of the technological innovations in agriculture evolved from the public sector and mainly from the USDA and land-grant universities. The entities developing the new technologies were not developing them for a profit to themselves. Of course, biotechnology research is also being conducted by the public sector in Federal agencies and at major universities; however, there is considerable biotechnology research being conducted in the private sector supported by large infusions of private capital (Fishel 1985; Kenney). This research in the private sector is being conducted for the purpose of earning a profit for the developer in either domestic

or foreign markets, and many foreign markets are generally less restrictive about the release of substances evolving from biotechnology research. The data being generated in the private sector are proprietary, and firms are reluctant to make data pertaining to their specific biotechnology innovation available to social scientists for analysis and public disclosure.

Economists and other social scientists engaged in research on assessing the impacts of biotechnology developments are confronted with data availability problems. Secondary data are nonexistent; therefore, primary data have to be relied upon, and hence economists and other social scientists need to work closely with the biotechnology researcher (Fishel, 1987). Developing these relationships is not an easy task, and only a few economists and other social scientists have been able to develop such relationships. It is difficult to come up with good reasons why private firms would want to make their data available for impact assessment or other analyses to be done by economists or other social scientists. The lack of data is a factor that affects the types of quantitative tools that can be used in assessing the impacts of biotechnology developments. Time series analysis tools and methods based on the linear regression model have limited usefulness in assessment analyses when neither time series nor cross-sectional data are available. Many critical questions about the impacts of biotechnology innovations require *ex ante* analyses, with available data being very limited.

#### **PERFORMANCE TO DATE**

The performance of economists and other social scientists in impact assessments and other analyses concerning biotechnology developments is in a state of infancy and provides ample opportunities for improvement. There are a few examples of economic and other social science research that have generated some useful and sometimes controversial results. Examples are the 1986 OTA predictions of productivity gains for crops and livestock to the year 2000, Kalter's work at Cornell on the impacts of bovine somatotropin (BST), and the Lemieux and Wohlgenant's *ex ante* evaluation of the economic impacts of porcine somatotropin (PST). There are other social scientists who had interest in this area of research, but they were not able to establish a working relationship with appropriate biological scientists and were unable to develop a successful research program.

Social science research on the economic and social impacts of biotechnology developments may be in the fourth of six phases that many research projects and efforts experience. The author is unknown but

the phases are: (1) Enthusiasm, (2) Disillusionment, (3) Panic, (4) Search for the Guilty, (5) Punishment of the Innocent, and (6) Praise and Honor for the Nonparticipants. Probably little would be gained by "pointing the finger" at guilty parties, but some insight might be gained from exploring the major factors affecting the performance of economists and other social scientists in biotechnology research. Numerous factors could be identified, but the two most critical ones are: (1) the lack of resources and other incentives for economists and social scientists to be involved in biotechnology research, and (2) the tremendous gap in research focus and communication between the biotechnologist engaged in basic research and the social scientists concerned with the consequences of the adoption of biotechnology developments. Different scientific disciplinary paradigms, controlled experiments used by biological scientists versus the inferential insights social scientists gain from observing uncontrolled social interaction in markets, and the extension of small-scale laboratory findings linearly without taking into consideration elasticities and parameters of behavioral relations all contribute to the communication gap. The two critical factors above implicate three groups of participants: (1) allocators of funds and resources for biotechnology research, (2) physical scientists engaged in biotechnology research, and (3) economists and other social scientists. The implicated parties are guilty not by design but by pursuing independent courses of action, which in retrospect have resulted in a situation where the involvement of social scientists in biotechnology research offers opportunities for improvement.

At all levels of funding for biotechnology research there has been a lack of incentives for economists and other social scientists to be involved in the research endeavor. At the Federal level there has been the disincentive of social scientists being clearly ineligible to compete for competitive grants in the biotechnology area, which sent very strong signals about the perceived contributions of social scientists. A similar situation exists in most states and at most of our universities and experiment stations. The focus and emphasis are on basic biological research, and very substantial resources have been allocated to support these research efforts, with few incentives for biological and social scientists to interact and work with each other from the initial stages of the research activity. One of the dilemmas social scientists face is limited resources to contribute to the research, and at times it appears they are trying to "siphon off" some of the resources allocated for the basic biological thrusts. Economists and other social scientists are especially good at

assessing the marginal returns to their own personal research efforts, and they rather quickly direct their research efforts to other important economic and social problems. Research support is needed to attract social scientists to engage in analyses of biotechnology research, and funding and resource incentives that will foster biological and social scientists working together could enhance the output and contributions of social scientists to biotechnology research.

The wide gap in research methods and focus between the biological scientist and the social scientist, amplified by communication difficulties, has adversely impacted the performance of economists and other social scientists in biotechnology research. The biological researchers are concerned with basic research aimed at expanding knowledge about fundamental biological phenomena by manipulating genes, and altering basic biological materials, or developing new biological materials. They have little concern about the potential impacts that adoption of biotechnology innovations evolving from this research might have on various components of society. Economists and other social scientists have research interests in the economic and social consequences of the development and adoption of new technologies evolving from biotechnology research and how the impacts work themselves through the economic and social systems. Biological researchers have difficulty seeing any benefit of social science research to their own research activities, and social scientists have difficulty assessing the economic and social impacts of biotechnology research that are intermediate outputs to be used as inputs into additional biotechnology research.

In addition, the paucity of good data and the *ex ante* nature of the needed analyses may have made participation by economists and other social scientists in biotechnology research less attractive. Also, at universities there is some skepticism by social scientists about whether the reward system will reward multidisciplinary research participation. This is especially true in biotechnology research, where the social scientist is likely to be in the background and last author on publications, most of which will not be in the social scientist's disciplinary journal.

## CONCLUDING REMARKS

Biotechnology research offers substantial research opportunities for economists and other social scientists, but they will have to work harder at making these research endeavors successful. As more technologies developed from biotechnology research reach adoption stages, the need and opportunities for economic and other social science research

will increase. Ideally, social scientists should be involved from the initial stages of the research, but realistically some of the social science research will occur as an after thought when questions are raised about the economic and social impacts of a new biological innovation. Even these situations offer opportunities for some social scientists.

A dire need exists for resources and funding that will first foster social science research in biotechnology and second provide incentives for multidisciplinary biotechnology research between biological and social scientists. Without such support and incentives, there will continue to be a hesitancy of econ-

omists and other social scientists to get involved in biotechnology research.

Finally, economists and other social scientists must recognize that the lack of good reliable data for addressing economic and social issues of biotechnology research will continue to be a problem. Also, *ex ante* analyses about impacts and consequences of new biotechnology developments tend to generate the type of information that answers questions that many people have about the consequence of these new innovations. The development and use of conceptual and analytical frameworks that have modest data requirements and are suitable for *ex ante* analyses provide challenges for all social scientists.

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