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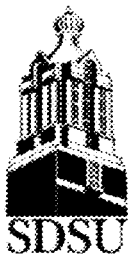
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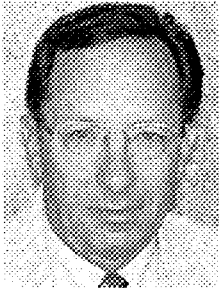


ECONOMICS COMMENTATOR

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Biotechnology— An Application of the 'Precautionary Principle'

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A recent *Commentator* issue (No. 423) authored by Evert Van der Sluis described the current status of biotechnology, including some of its potential costs and benefits. Consumer concerns and some principles for analyzing biotechnology were addressed. In this *Commentator* issue, I describe how the 'Precautionary Principle' is beginning to be used in some parts of the world, particularly in Europe, to address some of the concerns identified by Van der Sluis. The kind of 'biotechnology' I refer to here is genetic engineering that involves the transfer of functional genes from one organism to another—creating, in effect, 'transgenic' plants or animals. Therefore, I will use the terms 'biotechnology', 'genetic engineering', and 'transgenic technology' interchangeably.

There is a tendency among some groups and individuals to suggest that current controversies about genetic engineering technology in agriculture are due largely to an uninformed public and distortions in the media. That simplistic view ignores three central facts. First, new technologies inherently carry many unknown consequences, and that is especially true for a technology with such profoundly new and different elements as transgenic technology. Second, most new technologies positively impact some individuals and groups while negatively impacting others. One need only consider the history of the Industrial Revolution for that to be abundantly apparent. And finally, different individuals and cultures vary in their 'values', especially as they weigh the importance of

potential *benefits* of a new technology in relation to that technology's perceived *costs* and *risks*.

These facts must all be taken into account in the development of public policies for biotechnologies in democratic societies. That can only be done by taking a *systems perspective*. A systems perspective allows one to view the various ways in which different stakeholders in society are affected by biotechnologies. It also facilitates drawing upon the insights of various academic disciplines. Disciplines that are especially valuable for gaining policy insights about biotechnologies in a systems context are ecology, economics, and sociology. Contrary to a common belief among some non-economists, economics deals with much more than private, monetary benefits and costs. Economics is really about the implications of alternative resource allocation decisions. This includes both direct and indirect effects. It includes both effects that are measurable in monetary terms and effects for which monetary measures are not readily available. Examples of effects that are highly relevant to systems oriented economic analyses but which cannot always be measured monetarily include various environmental or ecological impacts, as well as some kinds of social impacts.

The nature of potential benefits, costs, and risks

Transgenic technology research and development (R&D) in agriculture is most commonly intended to produce 'benefits' in one or more of the following areas:

- Increased or less variable output (yield) per unit of land
- Increased productivity relative to non-land inputs (e.g., output per unit of fossil fuel energy inputs or per unit of chemical pesticide inputs)

- Decreased costs of production (e.g., dollars per bushel of corn produced)
- New or enhanced 'quality' characteristics (e.g., protein composition)

Therefore, attempts to assess economic consequences of particular transgenic technologies are best begun by specifying which one or more of these 'benefits' the R&D is intended to produce.

New or higher costs associated with particular biotechnologies may accrue to adopters, to others in the farm and food system, and to other individuals and groups. For example, herbicide tolerant transgenic plants involve higher seed costs and sometimes may result in lower per acre yields. Those costs must be weighed against potentially lower labor, machinery, and chemical pesticide costs in determining the net impact on farm profitability. Some agri-businesses involved in grain handling are likely to experience increased costs for segregating transgenic and non-transgenic grains if resistance to transgenic products continues in major foreign markets. Those costs may or may not be offset by premiums that handlers can capture or charges they are able to assess.

Another kind of costs is described by economists as 'externality costs'. An externality is any action that affects the welfare of, or opportunities available to, an individual or group without direct payment or compensation, and may be positive or negative. Economists involved in systems analyses of biotechnology applications are concerned with 'technological' (or physical) externalities, rather than with 'pecuniary' (or price effect) externalities. An example of a technological external cost would be pollen drift from a transgenic crop that 'contaminates' a neighbor's organic crop. (This is a 'technological' externality because there is a 'physical' alteration in the neighbor's crop.) Crops grown from transgenic seed stock are not supposed to qualify for organic certification, and therefore, organic price premiums. Consequently, contamination can have severely adverse economic ramifications for organic farmers, who are unwilling recipients of the impacts of adoption by others of transgenic technology.

'Risks' in systems analyses of biotechnologies generally are those potential costs that, at best, we can only estimate in rough, probabilistic terms. Often included here are health and environmental risks. For example, StarLink™ corn was not approved for human consumption yet found its way into the human food system in spite of regulations prohibiting that. The Centers for Disease Control has subsequently issued a statement that StarLink™ poses no risk to human health; however, a response from a scientific panel questioned the reliability of the test that was used.

The 'precautionary principle'

How can democratic governments decide which transgenic technologies should be approved for commercial application—given the potential benefits, costs, and risks for different segments of society? US policies are based primarily on a 'science-based' approach, in which approval for commercial application is ultimately given if there is *no compelling proof of harm*. This approach is based on the American philosophy that tends to view science as progress; this philosophy contrasts with a somewhat more skeptical view of science in Europe.

The 'precautionary principle' is based on the premise that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not yet fully established scientifically" (Barrett and Flora, 2000, p. 6). Whereas the US approach tends to place the burden of proof on those who fear potential harm, the precautionary principle places the burden of proof primarily on proponents of transgenic technology to demonstrate that there is, in fact, little or no risk of serious harm. Core elements of the precautionary principle include the following:

- A primary goal of society is to protect both the environment and public health.
- Proactive measures should be taken toward this goal—even in the face of scientific uncertainty.

The first section of the report discusses the current state of the economy and the impact of the recession. It highlights the challenges faced by businesses and consumers alike, and the need for government intervention to stabilize the market. The report also examines the role of the Federal Reserve in managing the money supply and interest rates to combat inflation and unemployment.

The second section of the report focuses on the impact of the recession on the labor market. It analyzes the causes of job loss and the factors that contribute to long-term unemployment. The report also discusses the importance of job training and education in preparing workers for the future workforce. It suggests that the government should invest in these areas to help workers regain their skills and find new employment opportunities.

The third section of the report examines the impact of the recession on the financial system. It discusses the risks posed by subprime mortgages and other high-risk investments, and the need for stronger regulatory oversight. The report also examines the role of the government in providing financial aid to struggling households and businesses. It suggests that the government should continue to support these efforts to ensure the stability of the financial system.

The fourth section of the report discusses the impact of the recession on the social safety net. It examines the effectiveness of unemployment benefits and other social programs in providing relief to those in need. The report also discusses the importance of maintaining these programs during times of economic crisis. It suggests that the government should continue to support these programs to ensure that those who are most vulnerable are protected.

The fifth section of the report examines the impact of the recession on the housing market. It discusses the causes of the housing bubble and the resulting crisis in subprime mortgages. The report also examines the impact of the crisis on the broader housing market and the need for government intervention to address the crisis. It suggests that the government should continue to support these efforts to ensure the stability of the housing market.

The sixth section of the report discusses the impact of the recession on the global economy. It examines the effects of the recession on other major economies and the potential for a global recovery. The report also discusses the role of international trade and cooperation in promoting economic growth. It suggests that the United States should continue to support these efforts to ensure a strong and stable global economy.

- The burden of demonstrating the safety of a potentially harmful technology falls on its developers, rather than on the public or government.
- Alternatives must be considered.
- Open, informed, and democratic processes must be used to make decisions about the acceptability of technology, its demonstrated safety, alternatives, research, and policy goals as well as the process to achieve these goals. (Barrett and Flora, p. 7)
- Is the biotechnology process fully contained (i.e., does the technology involve no release to the environment of transgenic organisms)?
- If the transgenic crops are released to the environment, will they affect only the target organisms as predicted?
- Is the likelihood of food toxicity or antibiotic resistance effects in transgenic foods as low or lower than other foodstuffs?
- Is the transgenic product fundamentally for the public good? Will it be distributed through public extension systems?
- Are claims for environmental benefits arising from biotechnology use on the farm supported by practice?

The European Union (EU) emphasizes the precautionary principle in its regulatory approach to biotechnology. This approach has been characterized as “guilty until proven innocent,” while the US approach is “innocent until proven guilty” (Ervin, et al., 2000, p. 37). Of course, there is a wide range of views about how to approach risk both within the US and within Europe. There are many in the US who advocate the precautionary principle here, while there are sizeable numbers in Europe—particularly within the ‘scientific community’—who feel that the precautionary principle is too restrictive. What we are talking about here is differences in **values**, both among cultures and among individuals within given cultures and societies. Science cannot tell us which ‘values’ are correct. Consequently, though scientists may have their own, varying, opinions about an appropriate regulatory approach, they are in no position to dictate a philosophy of risk avoidance to the rest of society.

As a variation of the ‘precautionary principle’ approach, Pretty (1999) has suggested a biotechnology regulatory approach based on six questions. When the answer to any of these questions appears to be ‘no’, then there is great need for caution and more research. If the answer appears to be ‘yes’, then society is able to proceed with less caution. Pretty’s six questions are the following:

- Does the biotechnology process only involve gene transfers within the same or related species?

These six questions, based substantially on the ‘precautionary principle’, facilitate systematic thinking about the benefits and risks of biotechnologies. The framework helps to clarify that all biotechnologies are not the same, but that they vary by types and magnitudes of potential benefits, costs, and risks offered. Consequently, policy and regulatory bodies that address these questions about research and commercialization of various transgenic applications need to work on a case-by-case basis.

For Further Reading:

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