ECONOMIC ASSESSMENT OF AGRICULTURAL BIOTECHNOLOGY

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In predicting the impacts of biotechnology on agriculture, the future is seen through a glass so dark that only the most striking features of the economic landscape are visible, and these features themselves are changing. Any economic assessment of agricultural biotechnology, then, must take account of these changes, whose nature can now be fairly well discerned.

To date, much of the analysis of biotechnology has focused on what is called the "microeconomics" of farm and food markets. The focus has been on the individual unit of production, seeking to determine the response of the atomistic farmer or firm presented with the opportunity (perhaps the imperative) to adopt a new technology. Neoclassical economic theory allows analysts to make some fairly robust predictions about the adoption decisions of these individual units, *given no other changes in the economic environment*.

As the decade of the 1980s passed, however, the assumption of constancy in what can be considered the "macroeconomics" of agricultural markets has become less tenable. In fact, today the outlines of major change in public policy can be seen that will profoundly affect the widespread adoption and effects of agricultural biotechnology. The anticipated successful conclusion of the multilateral trade talks and the coming reworking of the laws governing pollution of the nation's waters will combine to work distinct changes on the incentives and constraints on the farm economy.

Evolving attitudes about nutrition and health as well as life-styles will further affect the use of biotechnology, particularly in food processing. In the years ahead, the most welcome contribution biotechnology could make would be in allaying (not stimulating) consumers' concerns about food safety.

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The present analysis puts this important aspect of the economic assessment of biotechnology aside, however, and concentrates instead on an assessment of the environment faced by production agriculture.

SOURCES OF MACROECONOMIC CHANGE

A new international farm trade regime and domestic environmental policy focused on farming will profoundly change the environment in which new products and processes are adopted. In this respect, biotechnology will not be the tail that wags the dog, although an exclusive focus on the microeconomics of the adoption process may have contributed to such a perception. For a farmer, the choice of biotechnologies is but one in a set of input decisions that are conditioned by the prices of his output and other inputs. The trade and environmental changes in the 1990s will affect both market prices and the implicit price of use of the natural environment.

Farm Support Policy — The recent Congressional affirmation of the President's authority and flexibility to negotiate makes quite probable a successful conclusion to the Uruguay round of trade talks. Under the auspices of the General Agreement on Tariffs and Trade (GATT), the U.S. will be pushing a new farm policy regime that does not distort international commodity trade. While direct income subsidies would likely be permitted, the current configuration of supply control and price support for specific commodities would be phased out. At the same time, domestic U.S. budget realities may well require further reductions in the level of support, even though the level of non-distorting subsidy is not subject to GATT discipline.

Taken together, the move away from commodity-specific subsidies based on the level of production and a reduction in the overall level of support returns a large measure of the responsibility for managing the risks of farming to the farmer. Over the past 60 years, the Federal government has assumed an ever-greater share of this risk through, for example, the imposition of supply control and price support, the subsidized provision of crop insurance and disaster assistance, and the stockpiling of surplus crops. By these means, government intervention has both moderated and absorbed much of the instability inherent in agricultural production.

The provisions of the recently-enacted farm bill provide a clue to the future. The reduction in the level of support was imposed by scaling back

the number of acres on which production is eligible for price support. A farmer now has the "flexibility" to plant for market on the acres not receiving subsidies. In many cases, the planting choice will be a crop other than that the subsidy program supports. A move to an income-based subsidy would accelerate this trend away from support based on production of a specific commodity.

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Diversification across crops and perhaps livestock enterprises will be a farmer's most logical response to change and reduction in the domestic policy regime. Federal commodity programs have historically encouraged a farmer to put all his eggs in one basket, but future subsidies will not so favor the production of one set of "basic" commodities over others. By moving away from specialization and toward reliance on multiple outputs, the farmer will hedge his bets with nature and the commodity markets. His input choices will be conditioned not only by prices but by the input's effect on the stability of his outputs. The farmer is now managing his farm enterprise as he would a portfolio of stocks, considering both risk and return.

Environmental Policy —The Clean Water Act is due for reauthorization during this session of the Congress. The revision of the law protecting the nation's waters will focus on the contribution of farming to surface water quality degradation. Over the years, other "point" sources of water pollution, such as factory waste pipes, have been brought under control. Agriculture, as the major "nonpoint" source, has gone unregulated largely because of the difficulty of identifying individual sources of pollution. However, the Congress is now apparently feeling up to the challenge.

At present, the means for controlling farm pollution of water are under scrutiny. The Administration has supported a course of pollution prevention. The President's Water Quality Initiative has endorsed the subsidy of the development of environmentally "benign" farming techniques and promoted their transfer to farmers. And, the Administration's proposal for the 1990 farm bill gave farmers total flexibility in planting on program acres, thereby promoting crop rotation as a straightforward means of minimizing jeopardy to the environment posed by monoculture. Farmers tend to prefer an approach under which they receive incentive payments to adopt certain practices, but budget constraints make this an unlikely outcome. Another alternative would mandate (through regulation) prac-

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tices expected to be less harmful to water quality. Trading of the right to pollute, as with provisions of the Clean Air Act, might be another avenue to pollution Control.

Even without being able to describe the outcome of the Clean Water debate in detail, a prediction of the impact on farmers can be made. The price of the using the natural environment in farm production will increase. One way or another the pollution of water will become more expensive to farmers, who may find their production costs raised by the prohibition against the use of certain techniques, nutrients, and/or chemicals. Historically, the environment has been valued at zero in farm production; however it does so, the Clean Water Act will change that.

All input and output choices are likely to be affected when the price of using the environment as an input increases. A recent article in the *New York Times* business section underscored this point in promoting the stocks of biotechnology companies working on biopesticides. Preventing water pollution by either nutrients or chemical pesticides may also push farming away from specialization, just as changes in the subsidy regime can be expected to do. Then, new crop inputs may have to function in new rotations, and new animal inputs may no longer be used in today's large confinement systems but in integrated crop/livestock production systems.

AGRICULTURAL BIOTECHNOLOGIES IN A NEW CONTEXT

In the next decade, anticipated changes in domestic farm support and environmental policies will have profound effect on the macroeconomics of agriculture. Two major implications for the use of biotechnologies emerge: first, the need to anticipate the demand for inputs that help farmers manage risk and second, the need to prevent environmental pollution.

Current signs point to the re-emergence of diversified farming as the hallmark of American agriculture. While a return to the small scale farms of the 1930s is unlikely, more diversified and regionally concentrated farm production may well be in the future. As examples, for both economic and environmental reasons, extensive cropping of the Northern Plains and concentrated livestock production throughout the country may become impractical. In looking to the future, analysts should consider predictions about the outcome of the GATT negotiations as a starting point. And, by considering the tenants of sustainable agriculture, the virtues of integrated systems in a new context may become clearer.

To this point, economic assessment of biotechnology has concentrated on the current context of farm production. But, as time passes and biotechnologies begin to come on line, the policies that condition farmers' responses will become very different from those in evidence today. In particular, the farmer's need to manage more of the risk of farming than ever before adds another dimension to his decision-making. The contribution of input choice to output stability becomes at least as important as the effect on the level of output. The theoretical framework for analysis of production choices under risk is fairly well-developed; it now needs to be applied to the consideration of individual biotechnologies.

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At the same time, modifications to environmental laws will make farming more expensive, most likely through restriction of input choices and techniques. Already, there is a general awareness of the contribution biotechnologies can make to solving pollution problems. Public support of research for biotechnology might well find its biggest payoff by making environmental sensitivity a high priority. To the extent that plants' needs for added nutrients and pest protection can be moderated, the environment could be better protected.

CONCLUSIONS

Facing the future with biotechnology requires recognition that the times are changing and agriculture with it. To the extent that American agriculture will look and act differently, its willingness and ability to adopt biotechnology maybe affected. Economic assessment must consider the effects of changes in the overall "macro" environment in making predictions based on the "micro" unit. These remarks have offered a rough guide to the formulation of that analysis of the future.

Would acknowledgment of the changes in store affect the development of biotechnologies underway today? It is hard to say, but one can say with some confidence that that knowledge will certainly determine the successful marketing of products tomorrow. The prediction of future change is put forth together with the hypothesis that it does matter to the form and function of future agricultural biotechnologies. How it may matter and to what extent, is left to those with more extensive understanding and experience.

No look toward the future would be complete, however, if it focused exclusively on the economic variables because they themselves reflect society's values and concerns. To that end, if biotechnology can be shown to make a positive contribution to the process of change in agriculture, its future will be assured. But to the extent that adoption of biotechnology is promoted as an end in itself (as an application of frontier technology) or simply as a problematic successor to conventional technology, society may raise barriers to its adoption regardless of it is other merits. Looking outward, the largely scientific community that understands biotechnology must describe its potential to help in terms the rest of society understands.