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Economic Aspects of Biopesticides[*2]

During the conference a lot was heard about the problems with conventional pesticides, the potential of biopesticides, and the promise of sustainable agriculture. But, consider for a moment:

What if, through public or private research, a set of “ethically appropriate", “socially rational”, and environmentally beneficial, biological pest control products are developed,.. . .and nobody wants them?

It has happened before. In fact, the pest control toolbox is filled with effective techniques that either have not been commercialized or, while currently available, are not widely used because they cost too much or present other disadvantages to their potential users.

I will briefly review the current economic situation with regard to pest control, indicate the basic economic criteria for success of biopesticides, and derive a few policy implications.

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[1]When this speech was prepared and presented, Dr. Reichelderfer was with the U.S. Department of Agriculture as Associate Director of the Resources and Technology Division, Economic Research Service.

[2]The term “biopesticides,” is used broadly in these remarks to refer to: biological control alternatives relying upon the use of natural pest predators, parasites, and pathogens; bioengineered pest parasite, predator, or pathogen species; and bioengineered plant varieties possessing resistance to pests or pesticides.

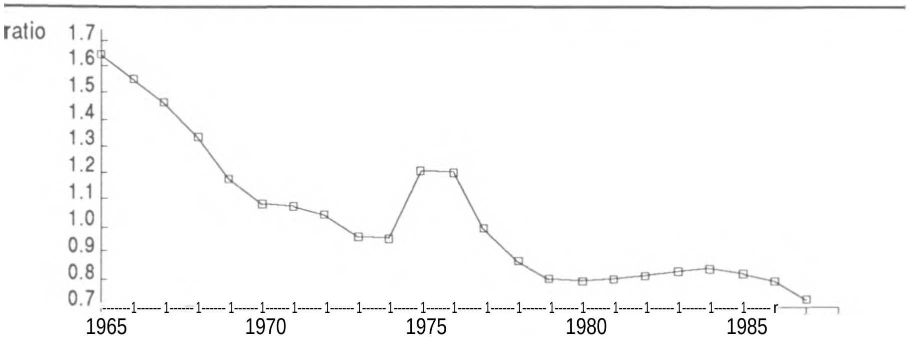
FACTORS INFLUENCING PESTICIDE USE

Why do farmers, as a group, depend so heavily on chemical pesticides, and appear often to use more than is necessary[1]?- There are several reasons.

First, chemical pesticides are ever-cheaper substitutes for other increasingly high-cost agricultural inputs (Daberkow and Reichelderfer, 1988). Pesticide prices have risen over the last 40 years. But, they have risen at a far slower rate than have agricultural wage rates and land values (Fig. 1 and Fig. 2). The result is that, relative to land-extensive pest control techniques such as crop rotation, or techniques that

Figure 1—Agricultural wage rates

Figure 2—Land values



require a lot of labor or time, pesticides have become cheaper over time. In fact, the economic theory of induced innovation would suggest that current land and laborsaving pest control technology was developed in direct response to farmers' needs and market demands as wage rates and land values skyrocketed (Hayami and Ruttan, 1985).

Second, farming has always been a risky venture, with volatile markets and unpredictable weather events like drought and hail. Anything that can help reduce the uncertainty associated with farming is viewed as desirable. Much of what we consider an overuse of pesticides, is, from the perspective of the farmer, completely rational. If there is an unknown chance that a pest may be present, and a cheap, prophylactic application of a pesticide will take care of the problem, should it arise, it makes some economic sense to use it even if you don't know with certainty that there will be a need for it. Thus the appeal of Du Pont's 1988 advertisement for Preview® herbicide, which states that, "Until farming becomes more predictable, there's Preview®".

Pest control techniques that save time and effort have also become more valuable as management time has become more precious to the farmer. New techniques for managing soil fertility, soil conservation, livestock feed rations, and commodity marketing strategies are a few of the many things that compete with pest control for scarce management time. The time allocation problem is even greater under low input, sustainable agriculture (LISA) systems, which are more sophisticated and complex than conventional production systems. Couple this with the trend towards off-farm work as a way to cope with the income uncertainty of farming, and time can quickly become a limiting factor. This explains the appeal of Dow Chemical Company's 1988 ad for Tandem® herbicide: "Tandem® puts time on your side".

Third, there is the influence of farm policy. Current commodity programs provide farm income support which is tied to the level of production of particular commodities and depends upon acreage reduction schemes to control commodity surpluses. The commodities receiving government support include, quite by coincidence, crops which are among the more chemically dependent of agricultural land uses. The use of annual acreage reduction programs for supply control has further reinforced the trend towards development and use of land-saving agricultural inputs, such as pesticides. The base acreage system, the accounting mechanism used for our elaborate farm income support process, discourages the diversification of farming activities that is essential for adoption of LISA systems (Fleming, 1987).

Fourth, we need to recognize that farmers, in order to sustain their way of life, must respond to market signals provided through prices. Prices for export crops are now going up, meaning that each unit of additional yield is worth more. A problem with the market for agricultural commodities is that it does not recognize the environmental costs of how we produce the commodities.

FACTORS AFFECTING THE ECONOMIC FEASIBILITY OF BIOPESTICIDES

The current situation as described above provides clear signals regarding the factors that need to be considered to make biopesticides in a sustainable system competitive with conventional agricultural protection and production practices. The following summary highlights some of the more important factors in determining the economic feasibility of biopesticide development and utilization. (See also: Carlson, 1988; Reichelderfer, 1985; and Reichelderfer, 1981.)

The "bottom line" for farmers is that the net returns accruing to the use of biopesticides must be equivalent to or greater than those gained through the use of conventional pesticides. Otherwise, there is little incentive for change. Some determinants of a pesticide's potential benefits are obvious; others less so.

Efficacy of the biopesticide. Unless the biopesticide is available at lower cost than the chemical pesticide it would replace, its technical effectiveness must be at least the same as that of its alternative. As efficacy increases and all else is constant, the probability that a biological pest control technique is economically feasible improves.

Pest spectrum. Simultaneous occurrence of several pests of the same general type has a negative impact on economic feasibility of species-specific biopesticides. If chemical methods can control all coexisting pests of a certain type, and if the available biopesticide is specific to only one of these species, use of the biological alternative, all else constant, will likely result in little or no relative benefit. Control action would still have to be taken against the coexisting pests. If that action, like the use of a broad-spectrum herbicide, is both necessary and effective against all coexisting pests, any cost of using a species-specific biopesticide would appear unjustified. Biopesticides with broad- spectrum activity would be more desirable and also have greater commercial feasibility.

Crop price. The benefit of any pest control action is directly related to the price of the crop on which control is to take place. The higher the unit price of the crop needing protection, the greater the per-unit value of reducing the pest population and the greater the premium placed upon rapid, dependable, and efficacious pesticidal action.

Market price of the biopesticide. Obviously, the price one pays for a new pesticide alternative weighs heavily on the users' determination of the technique's economic feasibility. All else equal, the lower this price to the user, the greater the economic feasibility of the technique. However, if the biopesticide presents a special advantage, such as low human toxicity or reduced leaching potential, and is sufficiently efficacious, users may be willing to pay a premium (a higher price).

Variability in effect on pests. Risk and uncertainty are important features of economic feasibility. The more variable or otherwise risky a technique is viewed, the lower its economic feasibility from the perspective of its potential users. Risk-averse users, especially, prefer consistency over the possibility of a periodically outstanding effect. They will actually pay a premium (a higher cost) for a technique that has consistent results. The risk associated with using a highly variable biopesticide adds a user cost that adversely affects its economic feasibility.

User costs of implementing biological pest control. While the market price of some biopesticide materials may be less than or equivalent to chemical pesticide alternatives, use of the biopesticide may require acute management skills or additional time or effort, whether in the field or at the desk. It is important to keep in mind, as the farmer does, that time, management, and labor are not free. The costs of using a biopesticide can be as important in determining its economic feasibility as is the cost of purchasing it.

Personal, family, farm worker, or livestock health risk is a special form of user cost of some chemical pesticides that is receiving increased attention by farmers. Abbot Labs capitalizes on the safety advantages of biological alternatives through its 1989 advertisements for Dipel®, which stress the reduced, potential health-related user costs of that material.

Additional factors come into play to determine the commercial availability of biopesticides. Commercial feasibility is influenced by a range of considerations, including the following:

Distribution and frequency of target pest problems. If a pest problem occurs only in a limited area/or infrequently, the expected profits from commercialization of a biopesticide targeted to that problem would be unlikely to cover the costs of research, development, and registration of the material. Thus, commercial feasibility is greatest for biopesticides against widespread, frequently occurring or multiple pest species.

Proprietary rights to the biopesticide. If the rights to manufacture and sell a biopesticide cannot be protected for a sufficient period to cover its research, development, and registration costs, it is not likely to be commercialized.

Registration costs. As requirements for materials' use registration increase, the probability of investment in research and development (R&D) declines for materials with uncertain profit potential. Public concern about the potential environmental effects of biotechnological experimentation could result in increased registration costs for some biopesticide materials.

BIOPESTICIDE RESEARCH

If 1 were in charge of a commercial firm, I would be gearing biopesticide research towards materials that are highly efficacious and certain in their effect against a consistently occurring, light or moderately damaging, single major pest on a high valued crop. Of course, I would make sure that the biopesticide could be sold at a competitive price and would not require large amounts of time, management, or labor to use. And I would have to be guaranteed that a patent could be obtained and that the material's registration costs were not prohibitive.

Products that meet these criteria will be commercially feasible. But, they don't provide products for use in small markets or one-shot markets. I find it difficult to blame seed, pesticide, and other input industries for not investing the significant amounts of capital required to develop products for markets that are too small or unprofitable to cover costs.

But here is where the public sector has a role to play. Public sector R&D can fill the gaps by concentrating its own increasingly scarce resources on:

—The development of environmentally beneficial pest control methods and products for specialty crops, forestry, and other limited markets;

—Conducting high risk, long term research on techniques that may, eventually, be patentable; and

—Funding R&D on techniques that are inherently unpatentable.

THE ROLE OF PUBLIC POLICY

Because agricultural commodity markets fail to incorporate the environmental costs of agricultural production, and, given the expressed social goals of reducing environmental costs and developing a truly sustainable agriculture, the debate needs to focus on how alternative public policy instruments can be used to resolve conflicts.

Directing public research is one policy tool, but it is not a panacea. As the preceding discussion illustrates, merely making new, "rational" technologies available through public research does not guarantee that those technologies will be adopted. Economic incentives, a favorable market, and a supportive agricultural policy environment must also be in place.

Modification of farm policies to assure their compatibility with environmental goals comprises another set of policy options. Among the suggestions made as debate over the 1990 farm bill has developed are various alternatives for: 1 changing the base acreage system, the accounting mechanism currently used to determine commodity program payment levels; 2 decoupling farm income payments from production levels; 3 eliminating commodity price supports that influence farmers' agricultural chemical use rates; and 4 using environmental criteria to target acreage reduction programs—any or all of which could to some degree reduce the aggregate level or adverse environmental consequences of chemical pesticide use (Fleming, 1987). Such proposed actions could also affect farm incomes, feed prices, the U.S. agricultural trade balance, and the structure of our agricultural input industries (Reichelderfer, 1989).

Environmental regulation, feed, fines, and taxes are direct policy interventions. Many state governments are taking the regulatory or input taxation approach. For example, California's Proposition 65 would make it unlawful for some agricultural producers to use certain registered pesticide materials. Connecticut's Potable Drinking Water law makes farmers whose pesticide use results in water contamination liable for the costs of cleaning up the water or supplying alternative drinking water sources. Iowa has imposed a tax on fertilizer sales to fund groundwater monitoring programs. (See Batie & Diebel, 1989 for a comprehensive review of state policies, most of which have been enacted within the last five years). One effect of accelerating environmental regulation is that it provides a market incentive for private R&D on environmentally benign substitutes for current agricultural chemicals. If regulation or taxation increases the user cost of chemical pesticides, then it is more likely that biopesticides can effectively compete for market share. At the same time, however, some farmers' incomes are decreased by regulatory action (though others' may increase because commodity prices may rise as the cost of production goes up), and consumers bear a large share of the costs imposed by environmental regulation or input taxation.

CONCLUSIONS

The economic and social implications of biopesticide research and development, like those for other areas of biotechnology, are very uncertain. Highly variable market conditions strongly affect farmers' management decisions. But, to the extent that farm and environmental programs modify those decisions, and research provides new options for consideration in the decision making process, economic and policy factors will be the principal guides for the direction of both private and public pest control research.

I remain very optimistic about the future potential for increasing the compatibility between agricultural production and environmental quality.

REFERENCES

Batie, Sandra and Penelope Diebel, 1989. "Managing Agricultural Contamination of Ground Water: State Strategies," Working Paper, Department of Agricultural Economics, Virginia Polytechnic Institute and State University.

Carlson, Gerald A, 1988. "Economics of Biological Control of Pests," American Journal of Alternative Agriculture, 3 (2-3): 110-116.

Daberkow, Stan G. and Katherine H. Reichelderfer, 1988. "Low Input Agriculture: Trends, Goals, and Prospects for Input Use.", American Journal of Agricultural Economics, 70 (5): 1159-1166.

Fleming, Malcolm H., 1987. "Agricultural Chemicals in Ground Water: Preventing Contamination by Removing Barriers Against Low-Input Farm Management," American Journal of Alternative Agriculture, 2 (3): 124-130.

Reichelderfer, Katherine H., 1981. "Economic Feasibility of Biological Control of Crop Pests," in (G. Papavizas, editor) Biological Control in Crop Protection, Totowa, NJ: Allanheld, Osmun Publishers, pp. 403-417.

-----, 1985. "Factors Affecting the Economic Feasibility of the Biological Control of Weeds," (E.S. Delfosse, editor) Proc. VI International Symposium on the Biological Control of Weeds, Agriculture Canada, pp. 135-144.

-----, 1989. "Environmental Protection and Agricultural Support: Are Trade-offs Necessary?" National Center for Food and Agricultural Policy, Discussion Paper FAP89-03. Washington, DC.: Resources for the Future.