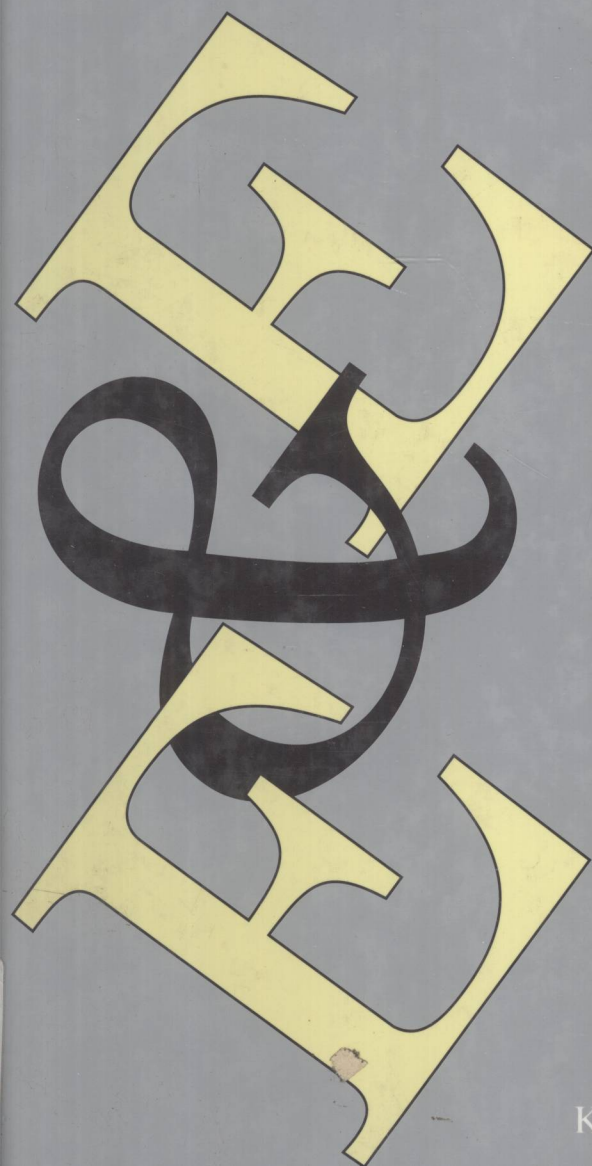


The Economics of Managing Biotechnologies

Edited by Timothy Swanson



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Edited by

Timothy Swanson

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The Economics of Managing Biotechnologies

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VOLUME 22

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Preface

Why do biotechnologies raise new problems of economic interest? Are there legitimate policy concerns to be voiced about problems concerning the rate or direction of technological change? Why do biological contexts raise distinct forms of management problems? How should policy makers respond to these problems?

This volume is the result of a workshop on Environmental Policy, Agriculture and Biotechnology held in Rome, Italy in May 2000 that focused on these general questions in the context of recent agricultural biotechnology changes. This workshop was attended by a large group of economists interested in the issues that exist at the interface between the biological, industrial and technological worlds. It also attracted the interest and involvement of a number of scholars and policy-makers expert in these individual fields. There were presentations that covered the basics of the biotechnologies currently appearing in agriculture, and presentations on the essence of the policy discussions about these biotechnologies. Then there were sessions where the economists discussed their various approaches to thinking about the problems that lie at the interface between the biological and industrial worlds.

The first part (Part A) of this volume includes a number of survey papers devised to 'set the scene' concerning the problem of agricultural biotechnologies and their management implications. The first paper by Charles Spillane and Yvonne Pinto covers a lot of the agricultural grounding for this issue. It lists the range and forms of biotechnological changes occurring in that field, and the various types of benefits that might be anticipated to result. After indicating the range of benefits, it then catalogues the various types of risks and limitations inherent within the technologies. Finally the paper then moves into the policy realm, indicating the wide variety of regulatory forums and regimes that are currently dealing with these problems. Thus the paper provides a very broad and general introduction to the benefits, risks and policies applicable to these technologies.

The second paper in the volume is by a pioneer in the field of biological management, Uri Regev. It was Professor Regev and his co-authors who first identified and discussed the economic nature of the problem of resistance nearly thirty years ago. This problem concerns the management of the capability of biological organisms to adapt to prevailing technologies by reason of natural selection. Thus any new pest management technology that is extremely (but not absolutely) effective sows the seeds of its own demise by reason of the enhanced reproductive success of those pests naturally resistant to the technology. His early work on the intertem-

poral externalities inherent within pest management technologies is here extended to the case of biotechnological innovations. That work had demonstrated that the biological context introduced an intertemporal externality amongst joint pest managers (e.g. farmers) of the nature of a common pool problem. Each pest manager would share in the future benefits from reduced selection pressure, and hence the trait of resistance is like that of a common pool resource. It will be subject to overexploitation if there are a large number of managers sharing the resource.

The third paper of the volume is a neat economic survey of the new biotechnologies, analogous to the first chapter, but applied to the case of forestry. Roger Sedjo places the benefits, risks and policy issues applicable to biotechnologies in terms that economists understand by assessing the costs and benefits of their introduction into forestry plantations.

Together the papers of Part A are intended to introduce the problems, principles and policies inherent within the new agricultural biotechnologies. This first part makes clear that the problems of biotechnologies within agriculture are well-known and much-discussed. There are many different venues that have considered these problems for many years, on account of the on-going international discussions over agriculture and the long-standing problems with pest management.

However, as indicated above, there are several relatively new lines of economic enquiry raised by the questions of biotechnological advance. While Part A raises surveys the issues within a very specific context, it is also possible to abstract from this particular context and to consider the general problems involving technological changes introduced within biological systems. This is what we do in the ensuing parts of the volume.

The first general issue raised by biotechnology concerns the question of directing technological change down specific avenues through appropriate incentive systems. Part B contains three papers considering the direction of technological change within the biological context. Chapter 4 is a survey of the literature on the problem of pest resistance and a consideration of the capacity for a decentralised industry to address it. As the evolutionary model in Goeschl and Swanson make clear, the nature of the resistance problem is the directed evolution of pests in response to the application of the technology – evolution ensures that the pests reproducing best in the presence of the technology are precisely those which predominate within future populations. This introduces the common pool problem earlier noted by Regev, but it also introduces a problem at the level of the technological innovator. Since innovations must be rewarded through their use across time horizons during which they are marketed, the in-built depreciation through use reduces the incentives for innovation. A decentralised industry, rewarded through use of its innovations over time, has little incentive to solve such problems.

Chapter 5 is a specific application regarding the problem of directing technology to a desirable outcome. Here the problem being considered by O'Shea and Ulph concerns the externality inherent in the use of an innovative technology by

reason of its extreme novelty within the biological environment. Biotechnologies represent the capacity to bridge across vast distances within the genetic pool, and this implies new biological innovations of an extreme nature. Such innovations, when introduced within a biological world, may not fit in well with already-existing organisms. This implies the possibility of pest management, but also has the unintended effect of removing other layers of the trophic pyramid. Hence, severe impacts on wide varieties of insects might translate into losses of bird life as well. O'Shea and Ulph examine this problem and analyse the policies required to internalise the externality inherent in such forms of technological change.

Chapter 6 is a paper on the economics of risk management in the context of uncertainty and irreversibility. Wesseler examines the problem of technological management when there is extreme uncertainty about the possible effects from introducing the innovation. Biotechnologies involve such uncertainties precisely because they involve the generation of organisms across greater distances than nature has attempted, and because the existing system of organisms will respond in unpredictable ways to such innovations. Under standard theories of option pricing, he assesses the 'hurdle rate' for biotechnologies, i.e. the additional benefits required of these technologies to compensate for their inherent uncertainties.

Thus, Part B of the volume assesses the general problem of managing technological change for its environmental/biological consequences. The three forms of analysis consider various aspects of the problem of managing biotechnologies: resistance; unintended effects; and, irreversible uncertainties. This part of the volume demonstrates that an unregulated market may not generate the direction of technological change that society desires.

Part C of the volume considers the management of biotechnological change from a different perspective: how should drastic technological change be introduced within the context of biological resources? The specific policy issue of concern is the optimal size and extent of refugia retained to dampen the effects of dramatic technical change. The paper by Laxminarayan and Simpson in Chapter 7 analyses this issue from the economic perspective. It assesses the costs of retaining reserves and balances them against the benefits of reduced resistance. Reserves are a buffer against enhanced resistance effects because they retard the rate at which successful pests are able to diffuse across space (the epidemiological benefit) and because they provide a source of diverse pests and pathogens (the selection benefit). Of course these benefits come at the cost of both reduced production and increased pestilence, and the analysis by Laxminarayan and Simpson assesses the economically optimal level of reserves given these trade-offs.

Chapter 8 by Hurley et al. considers the same issues but looks at them solely from the agricultural perspective, i.e. what is the optimal level of reserves for containing the development of resistance? This is an important policy question because laws already exist that specify minimum reserve requirements for the introduction of biotechnological products. This paper analyses whether those policies

are correct, when assessed solely against their own objective, i.e. the avoidance of enhanced resistance effects.

Together the papers demonstrate that the management of dramatic technological change must involve the managed introduction of the products of those technologies. When the adverse effects are known and expected, then the phased introduction of the technology may enable the dampening of those impacts. In a biological setting, phased introduction accords with managed introduction across both time and across space.

Part D of the volume turns to the industrial, as contrasted with the environmental, impacts of new technologies. New technologies or rapid rates of technological change often have distributive as well as efficiency effects. This is because such technologies often imply highly concentrated industries. The reasons for this vary. Sometimes it is attributable to the complex of patents and other restrictions that develop around the new technologies. Sometimes it is because the capital structures or development capacities of certain parts of the world render them incapable of assimilating or applying the new technologies. In either event, fields of rapid technological change frequently display the characteristics of heavily concentrated industries. Chapter 9 by Munro assesses the industrial economics of the biotechnology industries, determining the conditions under which these new technologies might result in greater industrial concentration. One of the more straightforward routes by which this is occurring in the field of biotechnology is through the advance of new use restriction technologies. These are technologies that inhibit the reproduction of products sold previously, e.g. the development of sterile seed technologies. Such technologies enable the enhanced appropriation of the rents from innovation, by disallowing any unlicensed transfers or uses.

Chapter 10 by Goeschl and Swanson assesses the distributive impacts of such use restriction technologies. The efficiency effects should be straightforward: greater appropriation of the benefits of innovation should result in greater investment in innovations, wherever they might be applied. However, the distribution of the benefits from innovation will depend in part on: (a) the investment by the innovator in technologies applicable in all parts of the world; and (b) the diffusion of the information embedded in technologies across all parts of the world by the innovator. In theory the innovator should have incentives to pursue both activities to distribute benefits, but in practice Chapter 10 demonstrates that this has not always occurred. For this reason the benefits of rapidly advancing technologies are often concentrated near that technological frontier.

Part E of the volume comprises two papers with some policy reflections and conclusions. Chapter 11 by Dale states the obvious benefits from biotechnologies and the clear-cut risks associated with them. The chapter lists the elements of the necessary risk assessment that must be conducted before new biotechnologies are introduced. This is one of the clear messages from the analysis contained within this volume: new technologies imply new management obligations.

Chapter 12 by Crompton and Tzotzos gives a less obvious but equally important set of conclusions. New technologies also imply new needs for international cooperation. This is because the implications of the technologies vary significantly for different parts of the world, and these varying needs must be taken into account when managing safety implications and when managing technological diffusion and distribution.

In sum, the volume sets forth a range of issues concerning technological change, its impacts (environmental and industrial) and its management implications. The papers have been selected to provide a survey of the issues concerned rather than in-depth analysis of a single topic. The volume is best read in its entirety in order to take the message from the Rome Workshop.

Acknowledgements

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I also would like to thank all of the participants at the Rome Workshop for their excellent contributions and enthusiastic involvement. The quality of this volume is primarily attributable to their efforts.

Finally I would like to thank the editorial staff at Kluwer for their advice and assistance in completing the volume.

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PART A

SURVEYING THE ISSUES: TECHNOLOGIES, BIOLOGY AND ECONOMICS

