

INTEGRATING BIOTECHNOLOGY IN AGRICULTURE

INCENTIVES, CONSTRAINTS
AND COUNTRY EXPERIENCES

BY
CARLIENE BRENNER



DEVELOPMENT CENTRE STUDIES

INTEGRATING BIOTECHNOLOGY IN AGRICULTURE

Incentives, Constraints and Country Experiences

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Foreword

This study was produced under the OECD Development Centre's 1993-95 Research Programme on the theme "Sustainable Development: Environment, Resource Use, Trade and Technology".

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Acronyms

ABSP	Agricultural Biotechnology for Sustainable Productivity
ARC	Agricultural Research Council
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
Biocide-S	<i>Bacillus sphaericus</i>
biocide-T	<i>Bacillus thuringiensis</i>
B.t.	<i>Bacillus thuringiensis</i>
CIAT	Centre of Tropical Agriculture
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
CGIAR	Co-ordinating Group on International Agricultural Research
CICY	Scientific Research Center of Yucatán
CINVETAV	Research Centre for Advanced Studies
CIT	Centre for Innovation and Technology (Mexico)
COLCIENCAS	National Science and Technology Council (Colombia)
CONACYT	National Programme for Technological and Scientific Development (Mexico)
CORPOBIOT	Colombian Corporation for the Industrial Development of Biotechnology
CORPOICA	Colombian Corporation for Agricultural Research
DBT	Department of Biotechnology (Ministry of Science and Technology – India)
DGIS	Special Programme on Biotechnology and Development Co-operation (Netherlands)
GMOs	genetically modified organisms
IARCs	International Agricultural Research Centres
IARI	Indian Agricultural Research Institute

IBS	Intermediary Biotechnology Service
ICAR	Indian Council for Agricultural Research
IDRC	International Development Research Centre (Canada)
IICA	Inter-American Institute for Cooperation in Agriculture
INIFAP	National Agricultural Research Institute (Mexico)
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
IPR	Intellectual Property Rights
IRRI	International Rice Research Institute
KARI	Kenya Agricultural Research Institute
MOSTE	Ministry of Science, Technology and Energy (Thailand)
NACBAA	National Advisory Committee on Biotechnology Advances and Applications (Kenya)
NARs	National Agricultural Research Systems
NCGEB	National Center for Genetic Engineering and Biotechnology (Thailand)
NSI	National System of Innovation
NSTDA	National Science and Technology Development Agency (Thailand)
PBR	Plant Breeder's Rights
PCR	polymerase chain reaction
PRONDETYC	National Programme for Technological and Scientific Development (Mexico)
PRV	papaya ringspot virus
PSTC	Programme in Science and Technology Cooperation
RAPD	randomly amplified polymorphic DNA
R&D	research and development
RCZ	Research Council of Zimbabwe
RFLP	restriction fragment length polymorphism
SACCAR	South African Centre for Co-operation in Agricultural Research
SADC	Southern African Development Community
STDB	Science and Technology Development Board
TRB	Tobacco Research Board
TRIPs	Trade-related Intellectual Property Rights
TTDI	Thai Tapioca Development Institute
UNAM	National Autonomous University of Mexico
UPOV	Union pour la protection des obtentions végétales

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The Development Centre also acknowledges with gratitude the generous financial contribution of the Governments of Finland and Switzerland.

Preface

The study entitled “Integrating Biotechnology in Agriculture: Incentives, Constraints and Country Experiences” was undertaken in the context of the Development Centre’s 1993-95 research theme, Sustainable Development: Environment, Resource Use, Technology and Trade. It draws and builds on earlier Development Centre research on the institutional aspects of technological change in developing country agriculture.

Despite the extravagant claims made in the mass media in recent years that biotechnology would revolutionise agriculture and food production, the first wave of genetically-engineered biotechnology crop products is only now beginning to reach the market. Their long-term impacts, in terms of competitive advantage, productivity or sustainability are therefore still unclear.

A growing number of developing countries are investing in biotechnology research, in a national and international environment very different from that which inspired the development and diffusion of the earlier “Green Revolution” high-yielding crop varieties. While philanthropic foundations, national agricultural research institutions and, in particular, the international agricultural research centres (IARCs) played a key role in the transfer of Green Revolution technologies, developments in biotechnology have been spearheaded by commercial companies.

Comparing the situations in Colombia and Mexico in Latin America, India and Thailand in Asia, and Kenya and Zimbabwe in Africa, the study has examined the nature and scope of biotechnology research. In addition, it has examined the mechanisms and structures in place which would impede or facilitate the transition “from the laboratory to the farmer’s field”.

The study finds that, to a large extent, biotechnology research has not been closely integrated with the problems and constraints confronting the agriculture sector, nor with the obstacles in the way of widespread diffusion of new technology, particularly to low-income farmers. Given the potential of biotechnology to contribute

to more sustainable methods of plant production and protection, it is important to create the conditions which would enable developing countries to take full advantage of that potential.

In conclusion, the study draws a number of policy implications and options as they concern national policies and the role of aid. It also suggests the need for reflection, on the part of developing countries, relevant NGOs, the donor community and the IARCs on innovative public/private mechanisms for the transfer and diffusion of “public good” biotechnologies in developing-country agriculture.

Jean Bonvin
President
OECD Development Centre

May 1996

Executive Summary

A growing number of developing countries are investing in agricultural biotechnology research and some have created special biotechnology research institutes. However, biotechnology has often been embarked upon in isolation from the overall national context in which it is being developed, from the problems confronting agriculture and from the obstacles in the way of technology development and diffusion. This can lead to unrealistic expectations with respect to the pace and extent of biotechnology development and applications in developing country situations. Given the potential of biotechnology to contribute to more sustainable methods of plant production and protection, it is important to create the conditions which would enable developing countries to take full advantage of that potential.

This research, which draws and builds on earlier Development Centre research in this field, was motivated by the following concerns: first, that the potential contribution of biotechnology to developing-country agriculture, at least in the short term, has been overstated; second, that the current economic, political and environmental context, which differs significantly from that which inspired the widespread diffusion of the earlier Green Revolution technologies, may be less conducive to the transfer of biotechnologies from developed to developing countries; third, that the enhanced role of private-sector interests, together with the strengthening of intellectual property rights in agricultural biotechnology is likely to weaken the earlier "public good" aspect of agricultural technology; finally, that the factors which in the past have inhibited the widespread diffusion of new technologies in developing-country agriculture are not only poorly understood, but have generally been overlooked in expectations for biotechnology.

Against this background, the Development Centre has undertaken the present project, which has sought to review developments with respect to biotechnology for plant production and protection in selected countries. Not only have the nature and scope of the research effort been examined, but also the policies, practices and mechanisms in place which would facilitate or impede the development of

biotechnology-based products and their diffusion in the farmer's field. An effort is also made to determine the kinds of institutional arrangements and policies which would enable developing countries to take full advantage of the potential of biotechnology to contribute to more environmentally friendly approaches to crop production and protection.

The project has a number of different components, including an analysis of publicly funded international initiatives to facilitate the introduction of biotechnology in developing-country agriculture. It also includes comparative analysis of the situation in six countries — India and Thailand in Asia; Colombia and Mexico in Latin America; and Kenya and Zimbabwe in Africa — which have focused on biotechnology for plant production and protection. A feature of these studies is that they have not only examined the “state of the art” with respect to biotechnology research, but also provide information on the different phases in the whole process from basic research to the marketing and widespread diffusion of a biotechnology product.

Lessons from Country Studies

The potential of plant biotechnology to contribute to enhanced productivity, quality, or to resistance to pests, disease or stress acts as a powerful incentive to “get into the act”. (This has happened even though few genetically engineered agricultural products have reached the market even in industrialised countries and that their success, in market terms, is not yet assured.) Despite these incentives, however, a number of major constraints need to be overcome to ensure that successful research effort eventually leads to the widespread diffusion of a biotechnology product.

In general, the biotechnology research reported on in the country studies suffers from a lack of clear priorities and focus and has not been firmly integrated with the priorities and problems confronting agriculture. Countries cite both financial and human resources as major constraints in research. However, in the absence of clear objectives and priorities, it is difficult to determine with any accuracy what would be an appropriate level of resources to be diverted to biotechnology rather than to other, perhaps equally or more important, problems.

The crucial area of “development” — midway between the laboratory and the field — emerges as a major obstacle in most country studies. Contributing factors are: weak or inexistent linkages and feedback among the different public and private actors and institutions concerned with the development of biotechnology; lack of effective demand for the biotechnology product(s) under development; and inadequate provision — or lack of provision — in research budgets for product development, large-scale testing and up-scaling.

With structural adjustment and liberalisation policies under way, there are strong pressures in most countries to reduce public expenditure — including the financing of agricultural research — and to give greater rein to market forces. Although private-

sector organisations, such as producer groups, play a significant role in some countries for specific crops, in most countries R&D investment in biotechnology by commercial firms is very limited. It will therefore be necessary to provide incentives to local firms to encourage participation in biotechnology research, or in public/private sector research collaboration. The alternative would require greater effort on the part of public research institutes towards “finished” products, closer to potential commercialisation.

In most countries, efforts are now being initiated to encourage private-sector participation in the development and diffusion of biotechnology. These include different forms of tax incentive to companies and soft loans. They also include innovative institutional arrangements, such as the university institutions set up specifically to explore commercial possibilities and partnerships, or public/private corporations created specifically to strengthen links between research centres and industry in biotechnology product development and the up-scaling of related bio-processing, or to provide advisory services and training to companies interested in developing biotechnology innovations.

Another possible constraint to the development and diffusion of biotechnologies is that of inadequate national capacity in the complementary or underpinning technologies and capacities which are necessary to ensure the transition from laboratory to the end user. For example, growing demand for biopesticides would require more efficient, large-scale bio-processing capacity. Similarly, strong plant-breeding capacity and a seeds industry which incorporates not only production but also quality control and certification are needed for the diffusion of biotechnologies embedded in seed. In the countries included in the study, while the seeds industry is well-developed for the major commercial crops, with private local and foreign firms supplying and selling seed, for other crops — and in particular for food crops grown by low-income farmers — the seeds sector is less developed. Indeed, for some crops, seed is not commercially produced but is mainly reproduced, saved and exchanged among farmers.

When it comes to the ultimate phase in the research, technology development and diffusion cycle, again there are major constraints to be addressed. Most of the biotechnology products which are already being commercialised are the products of tissue culture and micropropagation. Disease-free planting material is now available for a growing number of crops and is supplied by a growing number of local firms. Other biotechnology products, such as biopesticides, have met with less commercial success at a time when public extension services which, in the past, have facilitated the diffusion of new technology at the farm level, have fewer resources or are being privatised.

This raises the problem of “public good” technologies which governments may wish to promote for reasons of equity, as a measure in favour of poor farmers, or as a means of alleviating environmental pollution. These may be situations where there is a perceived **need** for the technology, but where **demand** in an economic sense is not strong and where the socio-economic and/or environmental benefits of the technologies would be realised only in the long term. This raises difficult issues of devising ways