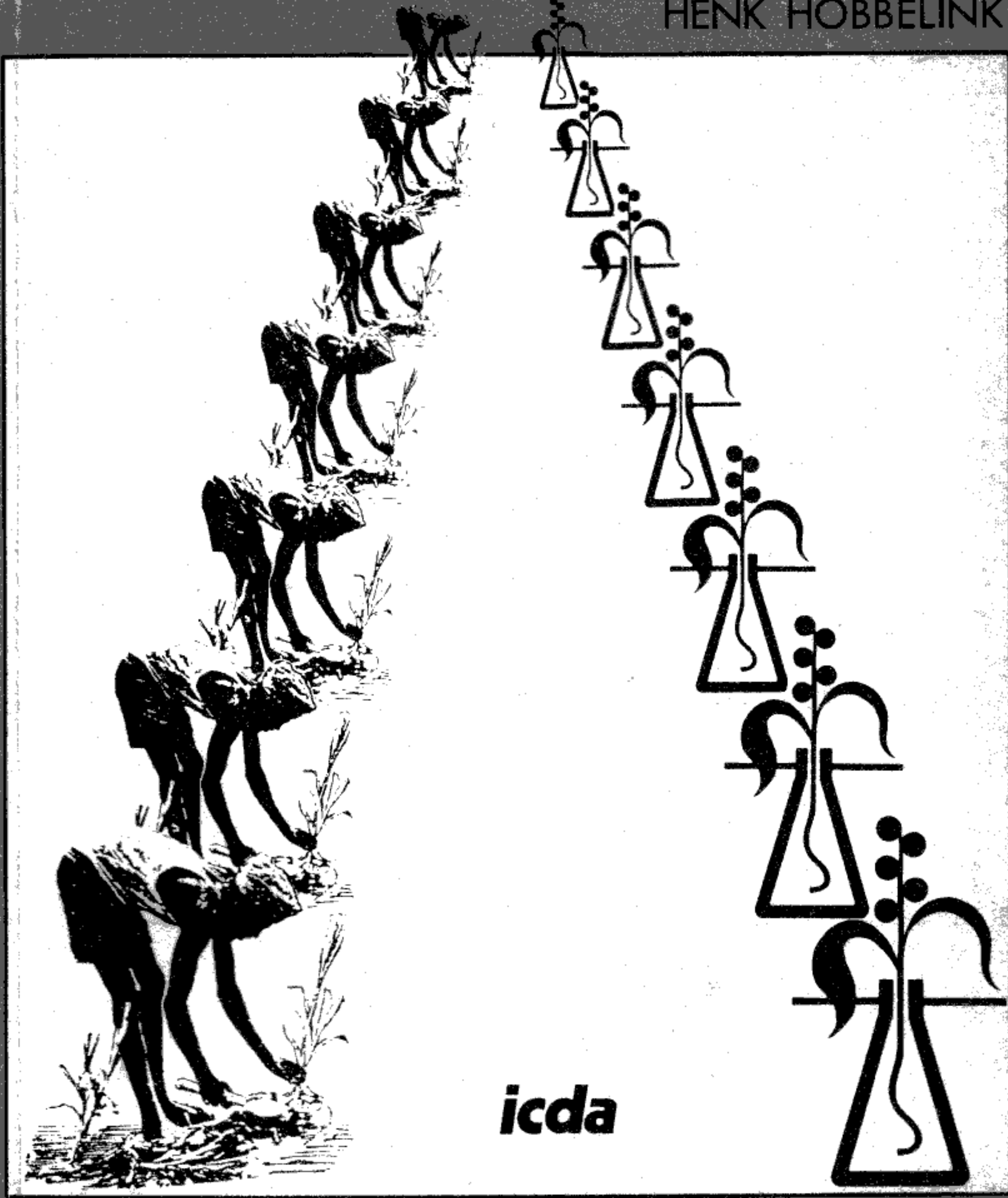
NEW HOPE OR FALSE PROMISE?

BIOTECHNOLOGY AND THIRD WORLD AGRICULTURE

HENK HOBBELINK



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ABOUT ICDA IBC

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Henk Hobbelink
ICDA Seeds Campaign Coordinator
Barcelona, February 1987

1 INTRODUCTION:
About Hope and Promise

One can hardly open a popular scientific magazine these days without finding exciting articles on the potential blessings of the newly emerging biotechnologies for agricultural production. Some of these articles stress the potential of yield increases through genetic engineering. Others tell us about super-plants that could produce their own nitrogen-fertilizer and pesticides, thus reducing the need for costly and harmful agro-chemicals, or about plants that could be grown on poor soils on which agriculture is difficult if not impossible. Yet others point to the huge possibilities of engineering micro-organisms which attack their relatives that cause damage to crops. The list of possibilities seems endless and promises great advantages, especially for agriculture in developing countries which so desperately need to produce more food and import less agro-chemicals.

The excitement of the possibilities of the bio-revolution, reminds us of the mood when the first results of another revolution started to reach the fields of the farmers in Third World: the so-called "Green Revolution". Developed at the International Agricultural Research Centres, the "miracle seeds" of the Green Revolution also raised hopes and offered the promise of reaching one of the most important goals of developing countries, namely, the ability to feed themselves. Now, a few decades and a few thousands of reports on the impact of the Green Revolution later, the proponents and opponents are still debating the consequences. The proponents point to the substantial increases in food production which resulted, turning countries like India and Indonesia from food importers to food exporters. Opponents stress that socio-economic patterns have also been affected by the Green Revolution, resulting in an increased gap between agricultural production and food consumption at the local level. The gap between the rich and the poor in the Third World was thus exacerbated and small farmers and landless wage-workers marginalised. While proponents draw our attention to the statistics on increased wheat production in India, others point out that a quarter of India's population still suffers famine and show how this increased production took place at the cost of crops traditionally used by the poor. They also point to the cost of growing dependence on the northern chemical industries for the increasing supply of agro-inputs.

Probably both camps are right. The Green Revolution did increase food production substantially in some developing countries. But it did so at a considerable cost: the position of the poor in those countries and the dependence on expensive inputs from outside. Perhaps the most important lesson to be learned from the Green Revolution is that technology as such is not a solution, but a tool — a very special tool with a degree of built-in direction towards a certain type of development. Its success depends only in part on its scientific quality; it also depends on the way it is created and the circumstances in which it is developed and used, the interests of those who introduce it and the circumstances of those to whom it is directed.

"New Hope or False Promise?", then, describes some of the possibilities and pitfalls for Third World agriculture arising from the introduction of biotechnology. We first thought of calling the publication "Biotechnology: Myth or Reality?", but then realized that this is not the right question. Although some of the possibilities of biotechnology might be very much exaggerated, the development of a new bio-revolution is more real than ever. Billions of dollars are currently being poured into research and development in order to realize it. A biotechnology race is taking place among the main industrialized blocs. Although the Third World is largely an outsider in this race, it certainly will not be an outsider when it comes to the impact. As with the Green Revolution, the question is not **whether** biotechnology will reach the poor, but **how** and **with what consequences**.

For almost a decade now, ICDA has been drawing attention to the dangerous narrowing of our food base and the impact of the increasingly monopolistic control of genetic resources in the hands of a few transnational corporations. Genetic resources are the very building blocks of agricultural production, but they are also the basic ingredients for genetic engineering. Biotechnology could be a powerful force for change in agricultural production. But it could also be the means by which monopolistic control over agriculture is increased. General awareness of the impact of the Green Revolution came a decade after it was felt. There may be still time to raise some crucial questions concerning the bio-revolution — questions relevant in relation to the development and introduction of any new technology — namely, **how** should it be developed, **by whom** and **for whose benefit**? This book is intended to stimulate this debate and to be a contribution to a better understanding of the likely impact of a technology which still has to be moved from the laboratory to the farmers' fields.

2 THE TECHNOLOGY, ITS APPLICATIONS AND MARKET

"Why trouble to make compounds yourself when a bug will do it for you?"
Biologist J.B.S. Haldane, 1929, when asked his views on chemists[1]

Biotechnology as such is nothing new. It has existed for millennia, ever since people started making wine, brewing beer, making cheese or baking bread. The Egyptians used biotechnology in their beer brewing 2000 years before Christ was born. The principle of all these activities is the same: you expose a specific raw material to micro-organisms which do the job of transforming the original material (grapes, barley, milk, wheat) into the desired product (wine, beer, cheese, bread). The new biotechnologies are often based on the same principle. The difference between then and now, is the extent to which the processes can be influenced and directed. The fundamental bases of modern agricultural biotechnology are two different techniques that have been developed and improved by science in recent decades: tissue culture and recombinant-DNA (r-DNA) techniques.

Tissue culture techniques create the capacity to isolate tissues and individual cells and grow each of them out to whole plants. A tissue culture of no more than one cubic centimeter in size, may contain a million almost identical cells, each carrying the potential to become an entire new plant. Tissue culture gives the plant breeder the opportunity for speeding up breeding work enormously. Using traditional techniques of crossing and back-crossing different varieties, it can take a breeder a decade and a half to produce a new variety. In the case of crops like oil-palm which mature slowly, the time is even longer. Tissue culture has reduced the time necessary to develop oil palm varieties by a factor of 30![2] Tissue culture also enables the evaluation of germplasm to be performed on a growing mass of cells in a petrie dish rather than having to wait until the actual plant has grown out. This presents enormous possibilities for the selection and isolation of new strains with potentially useful characteristics. In this way tissue culture affects the breeding work not only by speeding up the process, but also by qualitatively improving plant breeding.

While the possibilities of tissue culture are very promising, and in fact have already proven their commercial value for several crops, the range of possibilities resulting from recombinant-DNA techniques are even more far-reaching. Recombinant-DNA (generally referred to as genetic engineering) enables the breeder to isolate desired genetic characteristics from one cell and incorporate them into another. The vectors used for the transfer of the genes are often micro-organisms, or parts of them which are capable of accepting foreign genes introduced into their structure and then grafting them into the genetic code of the plant cell they naturally infest. This technique offers, at least in principle, almost unlimited possibilities for changing the genetic characteristics of living matter. In agricultural breeding practice, it means that the improvement of plants can be carried out at a cellular level and in a way which is much more directed toward a desired result. It allows breeders to overcome natural biological barriers which would otherwise impede crossing of different species. However, up to the present time no genetically engineered plants or animals have been marketed. But developments in this field are now proceeding very rapidly and the first biotechnologically engineered plants are expected to be in the marketplace before the end of this decade.

Finally we should mention here a few other important techniques. A further aspect of biotechnology is enzyme technology. This technology consists of using enzymes to catalyze biological processes, in such a way that a desired product is obtained. Instead of using entire micro-organisms to produce certain products, there are now possibilities to build or isolate specific enzymes and let them do the job. The possibility of using enzymes in food production and many other areas has led to the creation of a complete new industry which produces enzymes on a commercial scale.

A related technology is the fermentation process. The principle is, again, nothing new but the technology has been improved to such an extent that now bacteria or enzymes, for example, can be put to work in huge fermentation tanks to produce substances which in earlier times could not be produced, or could only be extracted from plants.

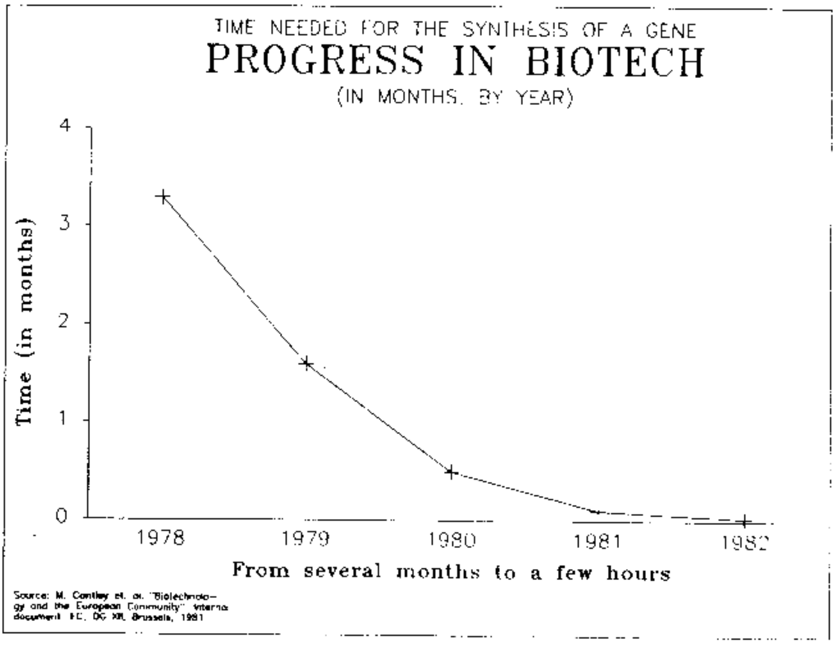
It is the **integrated** use of all these technologies that makes biotechnology so powerful and commercially interesting.

The applications

The initial focus of biotechnology was on human and animal health, using modified micro-organisms to produce medicines. The focus was also on industrial applications especially in the food processing industry, using improved enzyme technologies. Insulin, for example, was one of the first biotechnological products on the market. Formerly, insulin had to be extracted from the pancreas of cows and pigs, but now a genetically modified bacterium can produce human insulin. Other examples are the production of interferon and growth hormones. The list of possibilities is endless. In the field of energy, microbes could be put to work on petrol to produce edible substances. Or the other way round: crops that are now used for food production could be turned into sources of energy. Marine oil spills could be fought by modified bacteria and genetically engineered microbes might have a good meal on industrial wastes.

However, biotechnology is expected to have its most profound impact on agriculture, both in the input sector (seeds, fertilizer, pesticides) and in the post-harvest technologies (food processing). Genetically engineered plants and animals have yet to reach the market, basically because higher organisms have a far more complex structure than micro-organisms. But it is important to stress that many of the promised applications are not just dreams. Significant progress has already been made in changing the genetic code of higher plants and animals. An example of how fast the technique is developing is shown in **Graph 1**. The graph shows how quickly and how easily a researcher can carry out the synthesis of a gene, for the period 1978-1982.

GRAPH 1

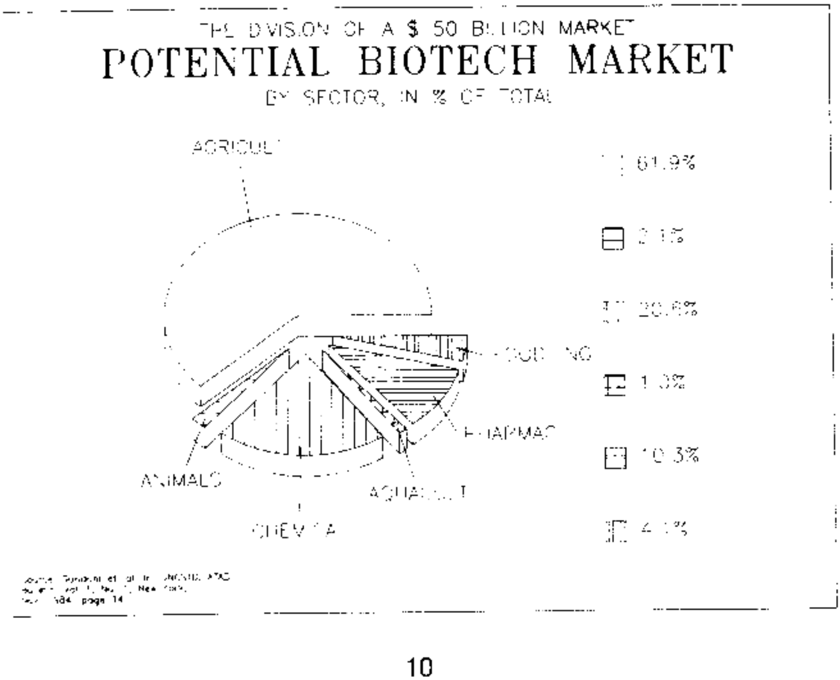


Research is being carried out on a broad range of different agricultural applications. Great efforts are being made toward improving tissue culture techniques. Tissue culture not only speeds up plant breeding, but can also produce useful compounds in the laboratory which otherwise would have to be extracted from agricultural crops. Moreover, the technique can induce novel genetic variation. Through genetic engineering it would be possible to transfer the genes responsible for pest resistance or those responsible for nutritional values, into major crops. Research is also being carried out to adapt crops to a wider range of environments by making them more drought resistant and salinity tolerant. Finally it is important to mention the work on nitrogen-fixation. Crops could be developed which could produce their own nitrogen fertilizer or engineered micro-organisms would do it for them. The complexity of the genetic definition of required characteristics will determine the speed at which these improvements will finally reach the market. Herbicide resistance (see chapter 7) will probably be the first characteristic to be incorporated biotechnologically into commercial varieties as it is often determined by a single gene.

The market at stake

The important role of agricultural biotechnology in the future is reflected in **Graph 2**. A potential market for biotechnology of about US$ 50 billion

GRAPH 2



is a conservative estimate. Of this total potential market, agriculture alone takes up US$ 30 billion. A market forecast made in Britain in 1983 estimated that worldwide biotechnology in agriculture and food and beverage industries alone, will be worth US$ 6.2 billion by 1985 and $US 103 billion by 1995.[3] In agriculture, the delivery system of the new genetics is largely seed. A study prepared by L. William Teweles and Company, an international consulting company for the seeds and biotechnology industry, predicts that the total retail value of all seeds, incorporating improvement from the new plant genetics, will increase from US$ 8 million in 1985 to US$ 6.8 billion by the year 2000.[4]

Many more such projections have been made. The estimates vary considerably, often depending on the interest of the group or company that makes them. Diverse as these estimates might be, the general conclusion is clear: the potential of the technology is enormous, likewise the commercial market at stake, especially for agriculture. There is no doubt that the process which has been set in motion during the past decade will continue, probably at a dazzling pace. There is also no doubt that the commercial market will increase enormously. The question is whether the potential of biotechnology to solve some of our most pressing problems especially in the Third World, will be realized. To address this question, it is necessary to analyse the development of the technology in its international socio-economic context and to have a closer look at the main actors involved.

---

[1] Quoted in Susan George, "Biobusiness: Life for Sale", a paper prepared for the Institute for Policy Studies' Conference: "Meeting the Corporate Challenge", June 6-10, 1984.

[2] Kloppenburg, Jack and Martin Kenney: "Biotechnology, Seeds, and the Restructuring of Agriculture". In: *The Insurgent Sociologist*, Vol. 12, no. 3. Summer 1984

[3] Vannon, J.H., "Britain's Biotech Thrust into Agrochemicals", In: *Chemical Marketing Reporter*. 4 April, 1983. Quoted by Sondahl et. al. in: UNCSTD, ATAS Bulletin, Vol 1., No 1. New York, November 1984

[4] Kidd, George H., (L. William Teweles & Co), "The New Plant Genetics: Restructuring the Global Seed Industry", in "Biotech 85", the proceedings of a major biotechnology conference, held in Geneva, May 1985.

3 THE BIO-INDUSTRY

> *"Present day biotechnology is the result of the work of thousands of people who patiently built the foundations, the walls and raised the roofbeams of an enormous edifice.Now that these labours are over, corporations new and old are crowding and jostling each other on the building site to put the final slates on the roof and call the whole place theirs"*
> Susan George[1]

The new biotechnologies were born in the laboratories of universities and other public research institutions. Before anyone even knew the word, scientists in those places were removing step by step the secrets of nature, moving steadily ahead in the fields of molecular biology, biochemistry and genetics. The United States' Office of Technology Assessment (OTA) credits publicly funded research efforts for launching biotechnology, stating that *"the recent spectacular advances in molecular biology in the United States have arisen from basic research, most of which is federally funded and carried out in university laboratories"*[2] Commercial interest grew when the integration of all these different research areas seemed to offer worthwhile commercial opportunities. It started on a small scale. For example university professors built their own small companies, often on the same campus and drawing heavily on university research. This was especially the case in the USA.

Although small biotechnology companies that started up during the past decade still achieve most of the publicity, it is now the giant agrochemical and pharmaceutical transnational companies (TNCs) that dominate the research and the market. They are the real newcomers on the "building site". Although some of the TNC's already began investing in biotechnology at the end of the 1970's, most of them did not become active in this field until 1981. Despite their brief involvement they already exert substantial control on biotechnology research. This is shown very clearly in the latest statistics on owners of patents of biotechnology related products in the USA. Universities, government agencies and individuals obtained only 21% of the 1078 biotechnology related patents that were issued in 1985. The lion's share (79%) went to corporations, a share that is increasing each year. Yet more significant is the fact that, of 32 firms receiving five or more patents, only four were small biotechnology companies.[3]

But patent control does not give us the whole picture at this early stage of biotechnological development. A look at research and development (R&D) budgets of some of the companies involved gives us an even better idea of the degree of TNC control in biotechnology. Transnationals like Hofmann-La Roche, Schering-Ploegh, and Eli Lilly each spend over US$ 60 million a year on biotechnology R&D, while the chemical giants Monsanto and Du Pont each spend a staggering US$ 190 million and US$ 200 million a year respectively. This in contrast with the new biotechnology start-up firms like Genex, Biogen and Hybritech which spend between US$ 5 and 9 million a year on biotechnology R&D.[4] The R&D budgets of some leading biotechnology start-up firms in the field of crop agriculture are given in **Table 1**.

TABLE 1.

TNC involvement in some of the main new crop agriculture biotechnology firms

New Firm	Founded	Capital invested by	Share (%)	Contractual Agreements with	mill. US$	R&D budget
Advanced Genetic Sciences Inc. (AGS)	1979	Volvo (Via Hilleshög) Rohm & Haas	15% 15%	Volvo (via Hilleshög) Rohm & Haas PGS (Hilleshög)	0.3 5 8.5	n.k.
Calgene	1980	Allied Corp Continental Grain Hambrecat Quist	20% 3% n.k.	Allied Corp Kemira Oy Rhone Poulenc Campbell Soup Nestle Dekalb-Pfizer		n.k.
Cetus Madison	1981	W.R. Grace Cetus Corp	51% 49%	—		
DMA Plant Technology	1981	Cempbell Soup Corp. Koppers	24.1% 8.4%	Campbell (1982) Campbell (1983) Brown-Wilarson General Foods Corp Koppers Hershey Foods Corp	0.65 0.70 1 2 0.2	2.3M. US$
Internat. Plant Research Institute (IPRI)	1978	Bio Rad Laboratories Eli Lilly (US$ 5 mill.)	70%	Arco Eli Lilly Mr. Laughun Gormley Lafarge Coppee General Foods		5M. US$
Molecular Genetics	1979	American Cyanamid Martin Marietta Moorman MFG	8.6% 16.8% 6.1%	American Cyamid Boehinger-Inglemein	3	3M. US$
Plant Genetics Inc.	1981	INCO Standard Oil of Ohio		Volvo (via Cardo)		2.5M. US$
Sungene.	1981	Mitsubishi Lubrizol Hambrecht Quist	< 5% 28%	4 contracts on barley and sunflower		2.5M. US$

Source: Centre Francais du Commerce Exterieur, Université des Sciences Sociales de Toulouse.: *"Semences et Biotechnologies: Les Grandes Groupes Etrangers"* Paris/Toulouse, March 1985. Adapted by ICDA.

Ways the TNCs get involved

Although most agriculture-related biotechnology is still in its infancy, patterns of market and research control are beginning to become very clear. There are three different ways in which TNC's are gaining control of the potentially profitable new technology.

The first way is by building up in-house research on biotechnology and integrating it with the company's interests in other fields. Huge sums are now being invested in upgrading biotechnology programmes and building completely new biotech centres. DuPont, one of the world leaders in pesticides manufacture, is now building an US$ 85 million "Life Science Centre" in the USA with a heavy focus on biotechnology. Eli Lilly is building a US$ 50 million Biomedical Research Centre with emphasis on rDNA technology. G.D. Searle, recently taken over by Monsanto, is spending US$ 15 million on a new biotech centre. The German pesticides and drugs giant Bayer has just opened a US$ 23 million biotechnology centre in Ludwigshaven.

The second way the TNCs are becoming involved is through acquisition of, equity investment in, and collaborative ventures with, new biotech companies. These relatively small companies are very attractive targets for TNC's, as they have excellent skills in specific areas of biotechnology, but lack the marketing structure that TNC's have with their established seed, pesticides and drug interests. An example of this type of investment is the case of the chemical giant Lubrizol, which

The large pesticides and drugs companies such as Bayer are now becoming heavily involved in biotechnology.

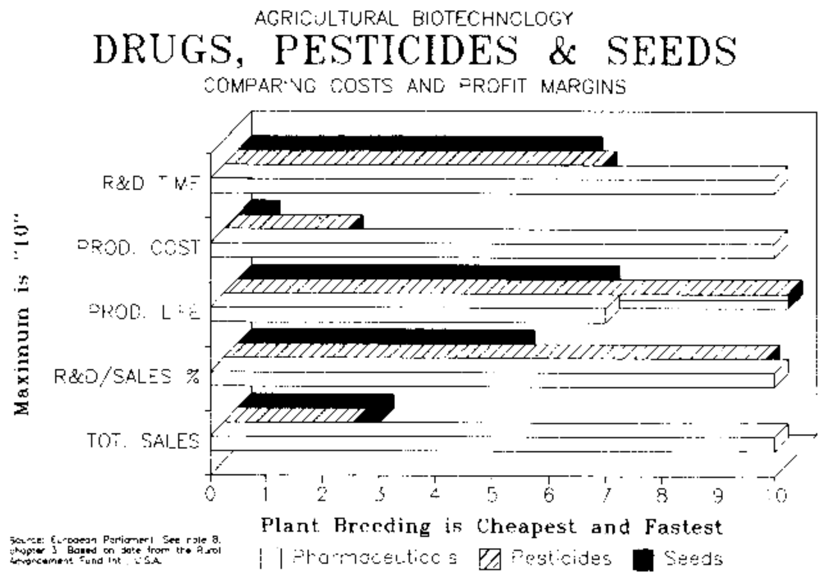
already owns 16 American companies in seed or seed related businesses, investing in biotechnology companies like Genentech (US$ 25 million, 25% control) and Sungene (US$ 4 million, 28% control).[5] Lubrizol also bought Agrigenetics in 1984 for US$ 110 million. Involvement of TNCs in some crop agriculture biotechnology start-up firms is given in **Table 1**. The OTA study quoted above, lists over 60 take-overs or equity investments between 1980 and 1983 in the USA alone and takes three long pages to list *some* of the contractual links between TNC's and small biotechnology companies.

Finally, a very attractive and profitable way to gain more control over biotechnology is to make contracts with universities and other public research institutions. Both in Europe and the USA many such contracts have been signed in which the TNC makes the funds available and the university carries out the research. Monsanto "donated" US$ 23.5 million to Washington University for biotech research; Bayer is contributing to the Max Planck Institute in Koln for the same purpose; and Hoechst built an entire US$ 70 million biotech research laboratory for the Massachusetts General Hospital where research on crop genetics is also carried out. Lubrizol has more than US$ 20 million tied up in research contracts at 18 universities and other public institutions.[6] These industry – university contracts have caused much controversy for obvious reasons: *"You don't need to know algebra to figure out how that committee works"* says American congressman Albert Gore, talking about the committee that governs the Monsanto / Washington University deal, *"no research can be done unless the company gives permission"*. Zimmerman, from the biotech company Cetus says of the Hoechst grant for a biotech laboratory: *"Essentially everyone in that lab is an indenture servant to Hoechst"*.[7] In most contracts the TNC has the right to the first look at the results and can delay publication of them until patent possibilities are investigated. It is beyond the scope of this publication to discuss the consequences of the increasing corporate influence on university research, but many people are concerned that it causes substantial erosion of academic freedom and democratically set priorities for research and therefore of the proper development of science.

Taking a closer look at the current actors in biotechnology, the first conclusion will not come as a surprise for those who have been monitoring the restructuring of the global agro-chemical industry. Exactly the same TNC's that already control the pesticide and pharmaceutical market, and have taken major control over the seeds sector during the past decade, are now the most active in the field of biotechnology. **Table 2** gives an overview of the different activities of the world's leading pesticide producers, which are in many cases also the major pharmaceutical producers and often also lead in plant breeding. *All* of these TNC's are now heavily invested in biotechnology.

Graph 3 gives some indication of the reason for the move of major pesticide and pharmaceutical producers into plant breeding and from

GRAPH 3



there into agricultural biotechnology. The graph is based on data collected by the Rural Advancement Fund International (RAFI) and published in a draft report of the European Parliament.[8] It compares different factors that influence the costs and profitability of the production of pharmaceuticals, pesticides and seeds. For purposes of comparing time periods and dollar costs, the five factors were placed in a scale of one to ten, where the sector with the "greatest" always equals "10" and the others are scaled in relation to the first. While pharmaceuticals have the largest market (Total Sales), they are also most expensive to produce, take more research and development (R&D) time and require a large proportion of the total sales for R&D. Pesticides have a longer product life on the market, and take less time and money to develop than drugs. But cheapest and fastest of all is the development of new seeds. This partially explains why pesticides and drugs TNCs have moved massively into the seeds sector during the past decade. But it also makes the next step logical: the focus of the same corporations on agricultural biotechnology. Seeds are in many ways the delivery mechanism of much of the new plant genetics, and biotechnology links them increasingly to the other sectors.

Biotechnology in the Agro-Industrial Production Chain

In order to understand the role that biotechnology will play in the restructuring of agriculture and the impact of this restructuring on developing countries, it is important to analyze the situation in its global

TABLE 2

The chemical connection enhanced: biotechnology further increases control over food production

Company	Pestic. ranking	Pestic. sales	Pharma sales	Seeds sales	Total sales	General info. on company's in food and agriculture	Biotechnology related activities
Bayer (FRG)	1	2344	2267	<20	15600	Largest chemical company in FRG. sells pesticides and fertilizer. Also leading in drugs	Made contracts with Genentech and Genetic Systems, also working with Max Planck Institute
Ciba Geigy (CH)	2	2070	2278	208	7416	Leading in pestic. and pharmaceuticals; vast interests in the seeds sector as well. Controls some 30 seed houses worldwide.	Owns ALZA 80%, build $7.5 million biotech lab. working on soybean resistance to herbicides. Also involved in university contracts.
Rhone Poulenc (F)	3	1272	1307	12	6244	Major in pesticides and pharmaceutic. worldwide also expanding substantially in seeds. Took over agro-chemical div. of Union Carbide in 1986	Research contract with Calgene to develop sunflowers resistant to RP's herbicides, also much contract research with several universities.
Monsanto (USA)	4	1152	262	30	6747	4th largest US chem. comp., leading herbicides worldwide. heavily involved in seeds and drugs (through acq. of Searle)	Heavily involved in crop & livestock genetics. Invested in at least 4 biotech comp. $190 million R&D budget for biotech.
Hoechst (FRG)	5	1022	2396	x	14511	Number one in phamac. worldwide, also big in livestock vaccines. Ranks high in pesticides and recently got involved in seeds (10% in KWS, + one Dutch comp)	Since 1970 in animal biotech. Heavily into research contracts with universities. Also involved in biotech research on cotton and other field crops.
Du Pont (USA)	6	1000	—	—	29483	Largest US chem. comp. produces and sells pesticides in more than 100 countries. Over $200 million R&D budget for life sciences	Opened $85 million Life Sciences research complex, and also invested in other biotech comp. Research on herbicide resist. nitrogen fixation and fixation and growth regulators.
ICI (UK)	7	850	1231	90	13903	Largest comp. in UK, in 1987 bought Stauffer Chemicals (US), thus almost doubling its pesticide turnover.	Joint venture with Carlo (S) on gen. engineering in agricult., applies biotech to produce new pesticides.

						Growing spectacularly in seeds (after SES acq. In 1987: 170 mill. $ seed sales). Committed to become largest seed comp. in the world by 1999.	One of the potential buyers of PBU/NSDO (UK) in 1987
Shell (UK/NL)	xx	450	—	200	83956	World's 2nd largest comp. leading in pesticides and seeds. Also heavily into fertilizer. Recently sold off Shell Chemical (US). Main interest is in oil.	Contracts with Celltech and Cetus. Opened $9 million biotech lab. Working on herbicide resistance and hybrid cereals.
Eli Lilley (USA)	xx	408	1836	—	3271	Major in drugs and pesticides, also important in animal health products. Eli Lilly pesticides are used on more than 50 crops. 60 $ million biotech R&D budget.	Invested $5 million in IPRI, and is working with several other biotech comp. Involved in crop & livestock genetics, herbicides res. & plant growth regulators
American Cyanamid (USA)	xx	360	1167	—	3536	Major in pesticides and animal health products. Also sells plant growth regulators and fertilizers.	Invested $ 5.5 mill. in Molecular Genetics, MG isolated resistant gene to AC's new herbicides. AC has now contract with Pioneer Hybrid to breed the gene into its corn varieties. Also working on animal hormones.
Rohm & Haas (USA)	xx	340	—	<20	2051	Major US chemical comp. Produces pestic. worldwide. Recently sold off its seed interests that focussed on hybrid wheat soybeans and oats.	Invested $12 million in Advanced Genetic Sciences, and also finances research at Plant Genetic Systems in Belgium. Biotech used for breeding and herbicide resist,
Sandoz (CH)	xx	245	1592	290	3441	Major in drugs and pesticides worldwide. Invested heavily in the seeds sector and now controlling over 30 seeds companies. Took over Stauffer Seeds in 1987.	Acquired Zoecon Group working on biological pesticides. Genetic research focusses on soybeans & vegetable crops. Has also research contracts with universities.

All sales in million $ US
(1985 figures, 1986 structures)
— = not active in this field
x = involved in this field
xx = heavily involved in this field

SOURCES: Compiled by ICDA from different sources:
—Annual reports and other industry reports
—Pierre Benoit Joly, "An Analytical Framework of the Economic Impact of Industrial Strategies in Biotechnology". Paper presented to the "Bogeve Conference", organized by the Dag Hammarskjold Foundation, Bogeve, March 7-12, 1987. (for figures)
—Jack Doyle "Altered Harvest", Viking Press, 1985. (for comments)

context and to describe the technology in terms of strategic importance and monopoly control. The first and most important characteristic of the changing pattern in world food production is the increasing integration of the different phases in the production. The food production system can roughly be divided in four phases:

1. The production and use of agricultural inputs (seeds, pesticides, fertilizers and machinery).
2. The agricultural production itself (the crops in the field).
3. The industrial processing of agricultural products into food.
4. The international distribution from the producer to the consumer.

This four-stage process has come to be known as the agro-industrial production chain. Within all the four phases, a strong concentration has taken place during the past decades. Even more important, concentration has also occurred between the phases. In the input sector, 10 TNC's control 50% of the pesticides market. A significant part of the international seeds sector is now controlled by some 15 TNC's, most of which are also major pesticide producers. In the farming sector itself, concentration processes also took place, both in the North and the South where small farmers are increasingly forced out of the market. Likewise the international food processing sector is in the hands of a few TNC's, as is grain distribution. In the different phases we often encounter the same corporations. Unilever for example, an Anglo-Dutch oil and fat giant, not only controls a major part of that sector but also owns thousands of hectares of oilseed crop plantations in the Third World, develops new oil seed varieties and regulates a large part of the product distribution. Biotechnology will have an impact on all the different sectors in which the company is involved. It provides the means of integrating the different phases and of enhancing its control over the global agricultural production system. It is in the context of the agro-industrial production chain, that biotechnology is being developed and introduced, and the research priorities set. Any promises to eradicate hunger through biotechnology or develop products for human welfare must be viewed against this background.

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[1] George, Susan. "Biobusiness: Life for Sale", see note 1) chapter
[2] 2 U.S. Office of Technology Assessment (OTA), "Commercial Biotechnology, An International Analysis". Washington D.C., January 1984. page 411.
[3] Chemical & Engineering News, Washington, Febr. 24, 1986. page 17
[4] Data from OTA, 1984, op. cit., page 74. Monsanto and Du Pont budgets from Jack Doyle *Altered Harvest*, Viking Press, New York, 1985.
[5] Doyle, Jack. op. cit., page 92-93
[6] OTA, ibid, page 574-577. See also Jack Doyle, 1985, op. cit.
[7] Both quotes from Doyle, op. cit., page 359.
[8] European Parliament, Committee on Agriculture, Fisheries and Food. "Draft Report on the Effects of the Use of Biotechnology", Rapporteur Mr. Graefe zu Baringdorf, Part B, doc.nr. PE 107.429/rev. Sept. 1986
[9] Important work on the relation biotechnology — agro-industrial production chain has been carried out by Guido Ruivenkamp at the University of Amsterdam.
See for example Guido Ruivenkamp: "Biotechnology: the Production of New Relations Within the Agro-Industrial Chain of Production". Paper for World Food Assembly Conference., Rome, 12-15 Nov, 1984.
See also research of Gonzalo Arroyo (France/Mexico) and Augusto Perelli (Italy)

4 SUBSTITUTION AND INTERCHANGEABILITY:
The Third World on the Losing End Again

"The consequences of the application of biotechnology on developing countries are in the first instance consequences of its application in the industrialized countries, which can lead to the substitution of important imports from developing countries. (...) In the medium term the application of biotechnology threatens thus to worsen the situation of developing countries."

Kees v/d Doel, and Gert Junne. Researchers at the University of Amsterdam.[1]

The international division of labour between the North and the South has changed considerably over the past decades. In colonial times, the Third World simply served as a source of cheap agricultural products for further processing and use in the industrialized countries. Spices, tea, coffee and rubber were, and still are, some of those products. In the 1960's and 1970's, the labour intensive industrial activities such as textile and clothing, assembling of TV sets, moved to the South because of cheap labour. Technical developments, especially in micro-electronics, have given rise to a reverse in this process as labour costs in specific production processes decreased. Increased possibilities of automation and other labour-replacement techniques introduced in the North, devalue the role of the least developed countries as producers of raw materials. With developments in biotechnology even this weak role of the poor nations in international trade is being undermined. Using biotechnology, industrial nations are now working to transfer some important resources that were traditionally produced in the South to factories in their own countries. In addition, biotechnology results in an increasing interchangeability of raw materials for industrial use, thus diminishing still further the possibilities for developing countries to set conditions for trade.[2]

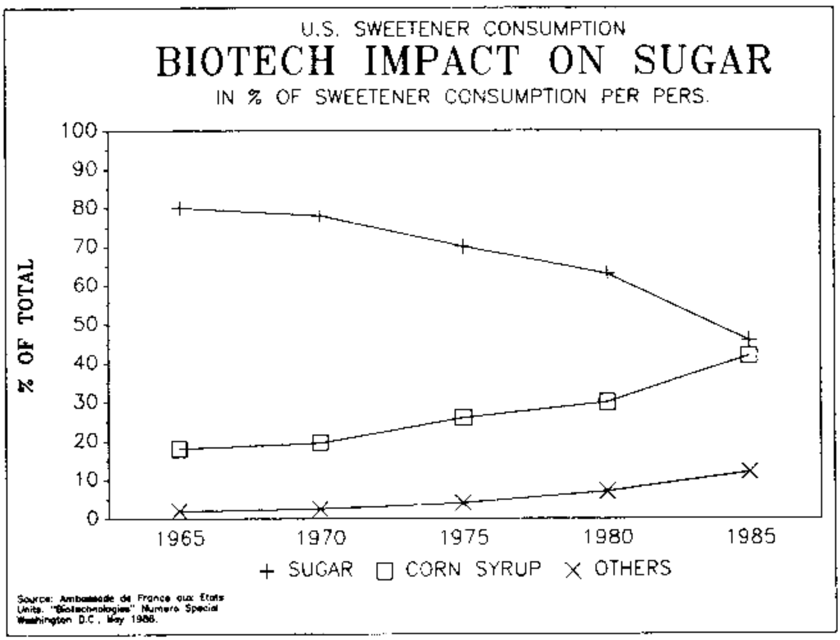
Replacing sugar

The sugar sector illustrates the type of developments described above very clearly.[3] The first shock for sugar cane producing countries in the South was the tremendous increase in production of sugar beet in the

North, especially in Europe. The EEC turned from sugar importer to exporter in the mid 1970's. Overproduction of sugar on the world market generally has depressed world prices considerably. Now biotechnology is promising to triple yields of sugarcane per hectare, which might seem beneficial for developing countries but will result in a further depression of prices on the world market. But another parallel development in biotechnology is having far greater consequences for developing nations that produce sugar. Sweeteners can be extracted from other crops or produced entirely in the factory by improved enzyme techniques. According to an American study, sugar is confronted by competition from over 20 other substances.[4]

One of the most important of these substances is High Fructose Corn Syrup (HFCS). HFCS is extracted from corn by new enzyme techniques and modified in such a way that it is interchangeable with sugar. Since 1978, HFCS has started to replace sugar in the two most important export markets: the USA and Japan. Up to the present more than 30 different soft drink corporations in the USA (such as Coca Cola, Pepsi Cola, 7-Up, Sunkist,) have switched from sugar to HFCS. The consumption of sugar in the USA dropped considerably as a result of which their sugar imports dropped form 4.6 to 2.5 million tons between 1978 and 1985[5]. In **Graph 4**, the evolution of sugar consumption per

GRAPH 4



person in the USA, is shown. The use of HFCS is expected to increase even more in the coming decade[6]. In Japan similar developments have taken place. In the EEC this substitution process has been limited because of a quota system on the production of HFCS to protect domestic sugarbeet production. It is likely, however, that this quota system will come under increased pressure.

But it is not only extraction from other crops that threatens the sugar market. Other sweeteners, biotechnologically produced in the factory without one single hectare of land, are also in the running. Aspertame, 200 times sweeter than sugar, produced by Searle (recently taken over by Monsanto) already has a market of over US$ 1 billion[7]. Hoechst produces Acefulsame-k, 130 times sweeter than sugar; the British sugar giant Tate & Lyle and Anglo-Dutch Unilever are working on factory production of thaumatin, 250 times sweeter than sugar. The thaumatin case is illustrative of what is likely to happen with many Third World crops. Tate & Lyle established plantations of the African bush that produces thaumatin in Liberia, Ghana and Malaysia in the 1970's. But the same corporation is also carrying out research to produce the component back home in the factory. In this scenario, the plantation system in the Third World might function only as a transition phase until the corporation is able to produce the raw material at home through tissue culture.[8]

What all these developments will mean for over 50 million workers in sugar production and processing, most of them in the Third World, we can only fear. It is clear that developing nations are losing a very important export market with especially dramatic consequences for the nations which are largely dependent on sugar exports. Income from sugar exports to the U.S. from the Carribean, for example, shrank from $ 686 million in 1981 to $ 250 million in 1985.

Developments in the Philippines provide a typical example of what the global sugar crisis can mean for millions of small farmers and plantation workers. The Philippines saw their sugar export earnings drop from US$ 624 million in 1980 to US$ 246 million in 1984. Marketing problems forced the government to reduce production from 2.4 to 1.6 million tons annually. Large sugar plantations are now massively changing to other crops that are often less labour intensive, resulting in half a million farm workers losing their jobs. This switch can hardly be made by the small sugarcane farmers due to the investments required. The result is a neglect of land and further impoverishment. The standard of living in the Philippines, where a large part of the population derives its income from agriculture, has gone down about one fifth in the last four years.[9]

Moving agriculture to the factory

Although the sugar/sweetener example is important in terms of the size of the market and because the impact is already being felt, it is by no means the only sector which will be affected by the replacement of raw material production from South to North. In **Table 3** some of the possible candidates for moving to factories in the North are listed. The early candidates are expensive products for the pesticides and pharmaceutical industries. The most important limitation on further transfer is that the relevant techniques are still too expensive to be economically competitive. But the technology is being developed very rapidly. Products like natural pyrethins and cocoa could be produced in the North soon. Natural pyrethrin is an insecticide extracted from a plant called pyrethrum, cultivated in East Africa and Ecuador, providing for a US$ 20 million market in the USA alone. It is now being researched for factory production by the University of Minnesota with funds from McLaughlin Gormely King, one of the main pyrethrin importers. Cocoa is being researched for factory production by Hershey, Nestlé and Unilever, and has a US$ 3 billion market which is vitally important for some poor African countries.

TABLE 3.

Moving agricultural production in the south to factories in the north: current research on plant tissue culture

Plant cultured	Plant product to be cultured	Exporting country	Research organization	Market size (US$ million)
Lithospermum	Shikonin	Korea, China	Mitsui Petrochemical (Jap.)	
Pyrethrum	Pyrethrins	Tanzania, Ecuador, India	Univ. of Minnesota Biotec (Belgium)	110 (world)
Papaver	Codeine Opium	Turkey	Plant Science Ltd. (U.K.)	50 (US alone)
Catharanthus	Vincristine		Eli Lilly	18 – 20 (US)
Digitalis	Digitoxin-digoxin		Univ. Tubingen, Boehringer – Man.	20 – 55 (US)
Chinchona	Quinine	Indonesia	Plant Science Ltd. (U.K.)	
Cocoa	Cocoa butter	Brazil, Ghana	Cornell Univ. Hershey, Nestle	<2500 (world)
Thaumatop coccus	Thaumatin		Liberia, Ghana Malaysia	
Tobacco	Tobacco	many	Japanese Salt & Tobacco Monop.	>4000 (world)

Sources: M. Kenney, F. Buttel: "Biotechnology: Prospects for Third World Development" In: *Development and Change*. SAGE, Vol 16, 1985, pag 74. And: H. Hobbelink, G Ruivenkamp: "Biotechnologie en de Derde Wereld" In: "*Derde Wereld*", Adapted by ICDA.

The export crops mentioned above do not necessarily bring the solutions so desperately needed by the poor in the Third World. Many NGO's have rightly criticized the disastrous impact that emphasis on export crops in developing countries has on national and local food production and supply. The situation of plantation workers who are under-paid and suffer bad working conditions is also widely known. But product displacement from one region to another has always affected the poor at the very beginning of the production chain such as small farmers, landless wage-workers on plantations and in the factory. The disastrous situation for the workers in indigo production in Asia after indigo production was replaced by aniline dyes made in Germany at the end of last century, is one example of how product displacement affected the poor. Another striking example of the disastrous impact of product displacement on national and regional economies occurred in whole regions of South America after rubber production was transferred first to Asia and later to synthetic rubber produced in the North.

There is no evidence that product displacement caused by biotechnology will have a less dramatic impact. The disastrous consequences of substitution of sugar by other sweeteners are already being felt by small sugar cane farmers and plantation workers in countries like the Phillipines. There is a very big difference between a national Third World government trying to set priorities away from cash crop production in favor of local food production on the one hand, and the disappearance of whole export markets caused by changing market patterns and technological advances in the North, on the other hand.

Interchanging products, markets and producers

The negative impact of product dislocation is increased by another feature of biotechnology as it is currently being developed. Biotechnology increases the interchangeability of the raw materials used for the end products. We have already seen how biotechnologically modified products from different plants can result in more or less the same end product. A product like HFCS which is already competing with sugar is not only derived from corn, but in principle also from wheat, potatoes or manioc, for example. A similar situation exists for protein production. The production of protein for cattle feed on the base of soybeans is already being threatened by the so-called Single Cell Protein (SCP) production. SCP technology simply sets modified micro-organisms to work to make proteins in huge fermentation tanks. Hoechst, ICI and the Soviet Union are currently investing huge amounts of money in the further development of this process. The Soviet Union claims it will be self-sufficient in cattle feed by 1990, which would restructure the entire world protein market. But also fish meal exports from developing countries, and tapioca production in Thailand are in danger of being replaced. The EEC imposed on Thailand a reduction in its tapioca exports for cattle feed to Europe. At the risk of a "grain war"with the USA, the EEC would be reluctant to impose reduction of exports of corn derivatives to Europe from the USA, yet with a country with no bargaining power such as Thailand, imposing an export reduction is very easy. Finally, as will be seen in Chapter 5, similar processes are taking place in the international vegetable and fat sector.

All these different sources of protein, starch and oil are increasingly becoming interchangeable. Biotechnology makes food production more and more like an assembly industry. Crops as such are not the raw materials anymore, but rather the compounds in them: starch, proteins, oils and fats. The fishermen in Peru, the soybean producers in Brazil and the factories of ICI and Hoechst are now competing for the same protein market. Similarly the sugar cane workers in Cuba, potato producers in the Netherlands, the synthetic sweetener factories in the North, tapioca farmers in Thailand and corn producers all over the world are all competing for the same sweetener market.

Interchangeability of products also means interchangeability of producers. The users of the raw materials can choose from a variety of sources depending on world market prices, technological progress in their own country and political stability in the region from which the resources are obtained. Overall, this results in a further decrease in world market prices for agricultural raw materials and in a weakening of the position of the raw materials' suppliers, often the developing countries.[10]

One of the consequences of that weakened position of the raw materials' suppliers is the virtual collapse of international agreements on agricultural raw materials. While such agreements have always been difficult to reach, not least due to the different interests and stages of development within the Third World, biotechnology now threatens to make a bad situation worse. The new technologies make it impossible to predict what is going to happen on the world market and price guarantees to the Third World are out of the question in this context. Different developing countries take different positions depending to what extent they can make use of the new technologies. More often than not, the Group of 77 can no longer reach a joint position which results in decreasing power of the Group as a negotiating bloc.[11]

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[1] Doel, K. v/d and G. Junne. "De gevolgen van de toepassing van biotechnologie voor de internationale betrekkingen". University of Amsterdam, March 1985. page 5.
[2] ibidem. page 56-57.
[3] See for example: Guido Ruivenkamp: "The Impact of Biotechnology on International Development: Competition between sugar and the new sweeteners". In: *Vierteljahresberichte*, no. 103, March 1986

[4] Barnett, Malvern. "More sweeteners win government approval", in: Food, May 1982
[5] Bijmman, v/d Doel, Junne,: "The Impact of Biotechnology on Living and Working Conditions in Western Europe and the Third World". University of Amsterdam, April 1986. (Doc. No. 85-1.3.5-3030-16)
[6] Kloppenburg & Kenney, "Biotechnology, Seeds and the Restructuring of Agriculture". In: *The Insurgent Sociologist*, Vol. 12, Nr. 3. Summer 1984
[7] Business Week, 15 October 1984, p. 26
[8] Kenney et. al. "Impact of Industrial Applications", in: UNCSTD , ATAS Bulletin, Vol. 1, Nr. 1, New York, November 1984. p. 50.
[9] This section on the Philippines was derived from: Bijman et. al., op. cit. page 45/46
[10] See for example: Guido Ruivenkamp: "Biotechnology is een revolutie van bovenaf". In: *NIO Kroniek*, No. 37, Amsterdam, April/May 1985
[11] A good analysis of the consequences of increasing interchangeability of raw materials for the Third World can be found in v/d Doel & Junne, 1985, ibid. page 67-69

5 INCREASING YIELDS, REDUCING HUNGER?

"A policy using biotechnology to increase developed country food output, would make a bad situation worse"
Peter Carlson, Vice President, Crop Genetics Int'l N.V. (A U.S. biotech Company)[1]

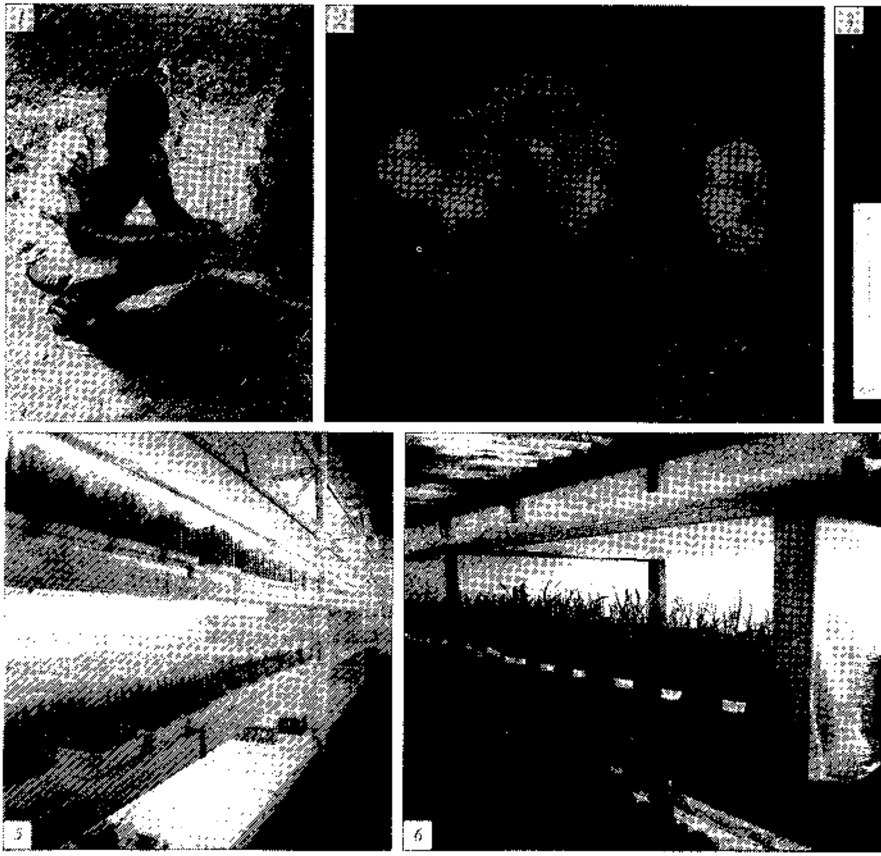
"Under OTA's most likely conditions, milk production per cow (in the USA) is expected to increase from the 12000 pounds in 1982 to at least 24000 pounds by (the year)2000."
Office of Technology Assessment, U.S. Congress.[2]

"A surplus of 58 million tons of cereals in the EEC is forecast for the year 2000 providing present trends prevail. (...) Through genetic and plant husbandry improvements and by introducing quotas in animal production an even larger surplus can be expected"
F. Rexen and L.Munck in a report prepared for the European Commission.[3]

The Vegetable oil story

Unilever, an Aglo-Dutch TNC involved in oil and fat production and processing, has some 90,000 hectares of plantations in six developing countries, two-thirds of which are planted with oil-palm. The company controls about one third of the world market for vegetable oils and fats. Unilever is planning to increase its plantation interests enormously, and is aiming at having some 160,000 hectares by the year 2000.[4] The basic reason for this expansion is that the company has developed a technique to clone oil-palms and can now propagate exact copies of the best plants in test tubes. The company now produces over one million plantlets of oil palms a year for planting on plantations in developing countries. The technique, tissue culture, enables individual cells and tissues to be grown into whole plants. Unilever has obtained a patent on tissue culture technique for oil-palm and thus has a complete monopoly.[5]

The company estimates that oil-palms produced by this method yield about 30% more than other oil-palms. Tissue culture is a very powerful



CLONING THE OIL PALM

1. Samples of root are taken from a high-yielding oil palm

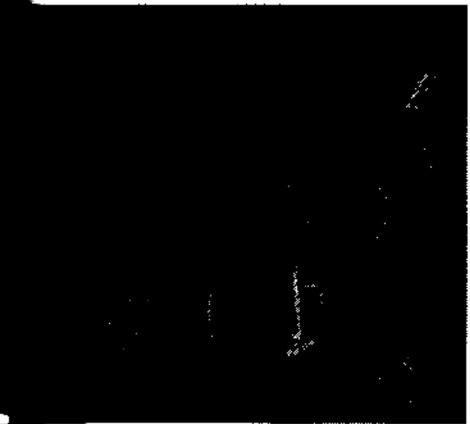
2. Placed in a special nutrient medium, the cells of the ro... to multiply, forming a mass known as a callus

5. The young plants are kept in controlled environments while still in test tubes

6. Once out of the test tubes, the plants are still carefully ... on the plantations until established

way of speeding up plant breeding and raising yields, especially for tree crops. Oil-palm breeding by traditional means is very time-consuming as it takes many years between planting and harvesting. Some estimate that tissue culture speeds up the breeding and selection work by a factor of 30 ![6] Oil-palms currently yield about 2 to 5 tons per hectare. Biotechnology is well on the way to raising that figure to some 10 to 12 tons.[7]

Is this good news for the farmers in developing countries? Under the circumstances in which the technology is being introduced now,



[illegible] tiny oil palm plantlets begin to grow

[illegible] are transferred to polybags in the Malaysian [illegible]

4. The plants are transferred to different culture media at various stages of growth, in order to provide the nutrients they need

8. Regularity is a noticeable feature of the young clonal palms in the Colombian plantation

(Unilever)

probably not. As we have seen, palm-oil production is expected to increase dramatically as a result of biotechnology. When the flood of palm-oil comes onto the market, vegetable oil prices will drop considerably with dramatic consequences for farmers producing other vegetable oils. For countries that depend on the exports of these other oils, like Senegal (groundnut) and the Philippines (coconut), the consequences are obvious.

Let us examine a country like the Philippines as an example. It is estimated that about 25% of the total population of the country is wholly or mainly dependent on the coconut palm — its cultivation, processing, transport and marketing. Oil-palm is a typical large estate crop, but coconut is not. Most of the 700,000 Philippine coconut farmers are small and not able to replant more productive varieties when prices are low. In the past the exports of coconut products brought in between 15% and 20% of the country's total export earnings. Because of declining productivity and decreasing prices, the export earnings dropped from US$ 1 billion in 1979 to US$ 555 million in 1984. In 1985 this figure had further dropped to US$ 353 million. The position of the millions of Filippinos depending on this sector is in danger and the lack of alternative employment is leading to enormous increases in poverty.[8] And the real "oil-palm boom" still has to come. We must remember also that the Philippines also lost 60% of their export value of sugar between 1980 and 1984 due to another feature of biotechnology (see chapter 4).

Even for a major palm oil producing country like Malaysia the impact is not necessarily entirely positive. Malaysia depends to a large extent on two agricultural commodities: oil-palm and rubber. Growing oil-palm has become more attractive than growing rubber because of the increased yields of oil-palm. This will result in a massive switch from rubber to oil-palm. Rubber plantations, however, are more labour intensive than oil-palm. Accordingly, the switch will reduce the demand for labour, threatening the employment of hundreds of thousands plantation workers on the rubber estates. This loss seems to be compensated by a spectacular expansion of cocoa plantations.[9] But cocoa is also threatened by substitution by factory production in the North as we explained in chapter 4.

While it is true that unrefined palm oil is often an important source of food in areas where the tree is cultivated, it remains to be seen whether biotechnology will help to improve the nutritional value of this traditional food source. The potential is there, but Unilever's efforts seem to point to another direction that brings in more money: "An important long-term goal is to modify the fatty acid composition of oil-bearing seeds to make them ideally suited to manufacturing purposes". Not nutritional value but "obviating the need for costly chemical or enzyme processing" is Unilever's main goal in using biotechnology to change the components in the oil palm seeds.[10]

It is important to stress again that, biotechnology as such, is not necessarily a bad technology for farmers in the Third World. The availability of the technology and the socio-economic context in which it is introduced will determine the outcome. With Unilever monopolizing the oil-palm technology the impact will be mainly negative for many people: not for the company for which large quantities of cheap vegetable oils are clearly beneficial; not for the industrialized countries, which are mainly importers of vegetable oils. The negative impact will be felt by such diverse groups as the groundnut farmers in Senegal, the coconut farmers in the Philippines and the workers on the rubber plantations in Malaysia.

Increasing food production

Plantation crops are probably the most extreme example of the impact that biotechnology will have on crop yields in the near future. Biotechnology, however, is also expected to boost yields of major food crops, but probably to a lesser extent. It is very likely that the growth of food production as a result of biotechnology will be concentrated in the industrialized world, as virtually all biotechnology research is being carried out in the North and is integrated with the production conditions of the industrialized countries. The focus of the research is heavily biased towards productivity increases in highly sophisticated agricultural systems. Whether developing countries will also benefit from the opportunities that biotechnology offers, depends on the extent to which they are able to appropriate the technology and develop it to their needs. It will also depend on the role that the international research institutions will be able to play in countering the type of technology that is now being developed in the North.

It should be mentioned here that it is increasingly difficult to talk about "the Third World" as one bloc. Developing countries often have different levels of industrialization, research capacity and scientific infrastructure. This is already resulting in different levels of adaptation to the technology. It is evident however, that if developing countries are to benefit from biotechnology they will do so later than the industrialized world. This means that in any case they will first feel the negative impact resulting from biotechnology being introduced in the North.

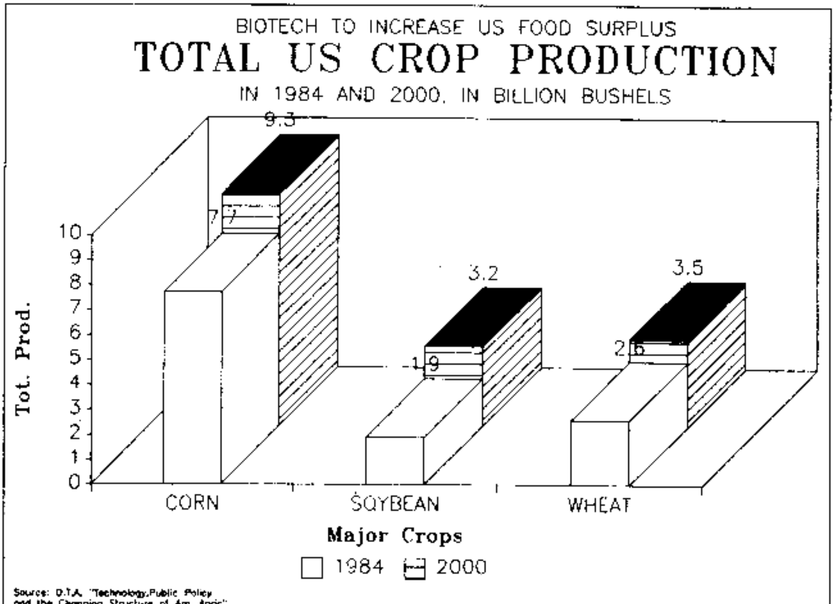
The most immediate effect of biotechnology in the North, however, will not be on crop production, but in the dairy sector. In the near future milk production per cow is expected to rise by 30 to 50%, mainly because of the use of bovine growth hormones.[11,12] The growth hormones, produced by engineered bacteria, are currently awaiting approval by the USA Food and Drug Administration and could reach the market by 1988. Similar developments are expected in beef production. Together with developments in the crop sector, this will force a complete restructuring upon the USA and European farming sector. The USA Office of Technology Assessment (OTA) predicts that half of all American farmers will disappear from the scene before the year 2000.[13] European farmers are likely to face the same situation.

Whether the increased milk production will result in an increase of the already huge dairy surplusses, depends on farm policies. The EEC has, since 1984, a stringent quota system for milk which does not allow further increase in total production. It is possible, however, that the level of these quotas will come under pressure with dairy productivity substantially increased due to biotechnology applications. The surplus could also increase when milk proteins are substituted for vegetable proteins in the food sector leading to substantial reduction of the demand for milk components.

While the immediate impact on the dairy sector is evident, a substantial impact will also be felt in agricultural crop production. **Graph 5** shows that the USA will have increased total production of corn, soybean and wheat by 21%, 68% and 35% respectively by the year 2000. For Europe it is estimated that the EEC, if it does not change its farm policy considerably, will produce a total surplus of 58 million tons of cereals by the year 2000, an amount that is likely to further increase because of the impact of biotechnology.[14]

This increased excess of agricultural production will undoubtedly result in intensified competition on the world export market between Europe and the USA. The increased degree of self-sufficiency likely in the USSR and China in the future, also partly as a result of biotechnology, will further raise the pressure to dump surpluses on Third World markets.

GRAPH 5



Source: O.T.A. "Technology,Public Policy and the Changing Structure of Am. Agric" Summary. Washington, March 1986.

Food exports have already led to conflicts between the USA and the EEC on several occasions. The USA tried, for example, to capture a part of the huge (US$ 1.6 billion in 1984) cereal export market to Egypt, by selling heavily subsidized wheat to that country. Egypt traditionally obtains its wheat from Europe, and the USA manoevre almost led to an open trade war between the two blocs. Although this kind of trade practice might seem beneficial for developing countries, it is widely recognised that in the long run it is disastrous for their national agricultural economies.

By the year 2000, demand for food in developing countries will have doubled, according to FAO. Increased food production is needed in the South, not in the North. Nothing appears to be more logical than to use biotechnology to help increase food production in the Third World. But the problem is that the agro-industrial production chain has its own momentum: as we have seen above, biotechnology will substantially increase productivity in crop agriculture and dairy farming in Europe and the USA. The danger is that this growing production will increasingly be dumped on the markets of developing countries with a weak agricultural sector.

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[1] In a letter to Vic Althouse, M.P., Canada, d.d. August 22, 1985.
[2] OTA, *Technology, Public Policy and the Changing Structure of American Agriculture* Summary, Washington, March 1986.
[3] Rexen,F. and L. Munck, "Cereal crops for industrial use in Europe". Report prepared for the Commission of the European Communities, EUR 9671 EN, Copenhagen, 1984.
[4] Hobbelink, Henk and Jolke Oppenwal, "Biotechnologie en Honger". In: *Intermediair*, Amsterdam, August 9, 1985.
[5] Mooney, Pat. "Impact on the farm". In: *ATAS Bulletin*, UNCSTD, Vol. 1, No. 1, New York 1984
[6] Kloppenburg et al.:"Biotechnology, seeds and the Restructuring of Agriculture". In: *The Insurgent Sociologist*, vol. 12, no. 3,1984, page 12
[7] Sondahl et al. In *ATAS Bulletin*, op. cit. page 15
[8] Bijlman, v/d Doel, Junne: "The impact of biotechnology on living and working conditions in Western Europe and the Third World". University of Amsterdam, Amsterdam, April 1986. (Doc. no. 85-1.3.5-3030-16)
[9] ibidem.
[10] Quotes from: Unilever N.V., Unilever PLC.: "In Search of Progress: Science, Technology and Unilever". Weert, the Netherlands, 1985. page 25 and 28.
[11] OTA, "Technology, Public Policy and the Changing Structure of American Agriculture". Summary. Congress of the U.S., March 1986
[12] Kalter, R.J. "The New Biotech Agriculture: Unforeseen Economic Consequences". In: *Issues in Science and Technology*, Fall 1985, p.127
[13] OTA, op. cit.
[14] Rexen,F. and L. Munck, "Cereal crops for industrial use in Europe". Report prepared for the Commission of the European Communities, EUR 9671 EN, Copenhagen, 1984.

6 BIOTECHNOLOGY TO REDUCE THE NEED FOR CHEMICAL INPUTS?

"In two decades, we won't be spraying crap on plants anymore"
Sam Dryden, President of Agrigenetics, a major biotechnology company in the U.S.[1]

It should be kept in mind, however, that much of the agricultural research effort is being made by the agricultural chemical industry, and this industry may see the early opportunity of developing pesticide-resistant plants rather than undertaking the longer term effort of developing pest-resistant plants.
Congress of the United States, Office of Technology Assessment.[2]

"Screening of cultivars for genetic resistance to new, highly potent herbicides, is becoming as important as screening the same cultivars for genetic resistance to prevalent disease and insect pests"
Don Duvick, corn breeder at Pioneer Hi-Bred, a major seed and biotechnology company in the U.S.[3]

Perhaps one of the most exciting and promising possibilities of agricultural biotechnology is to decrease the need for chemical inputs in crop production. Virtually every article on this issue starts off by saying that biotechnology has unlimited possibilities in this direction. "Newsweek" promises its audience that biotechnology will produce plants that *"can destroy plant and insect attackers with little or no help from people."*[4] Howard Schneiderman, R&D Director of Monsanto, also paints a bright future: *"I believe (...) that with the new biotechnology almost anything that can be thought of can ultimately be achieved".* He specifically refers to *"new treatments for disease, new ways of controlling pests, crops which produce their own pesticides."*[5]

This euphoria on the possible impact of biotechnology on agriculture is easy to understand. Biotechnology, at least in theory, *can* provide the tools for increased pest resistance in crops and for the reduction of dependence on chemical nitrogen fertilizers. Although the work is not as easy as it might seem, it is possible to transfer the genes responsible for pest resistance to crop plants, or develop biological pesticides.

(FAO)

In theory, biotechnology could *be the means of reducing pesticide dependence with all its attendant dangers. But what will happen in practice?*

The breeding of pest resistance into crops has always been a painstaking and expensive job and certainly has not received the attention that it deserves. The US Office of Technology assessment (OTA) stated that in the past decades less resistance-breeding was done because of the availability of cheap pesticides.[6] The main focus of plant breeding has always been to increase yields. Private breeding programmes especially lack emphasis on pest resistance breeding, according to OTA.[7] In many ways, chemical pesticides were used to compensate for the lack of genetic resistance that might have been bred into crops. Increased emphasis on monocropping, based on a few very vulnerable varieties, has likewise served to encourage an agricultural system that needs enormous amounts of pesticides (worth about US$ 13 billion in 1983) but still loses 20 to 50% of the harvest to pests.[8]

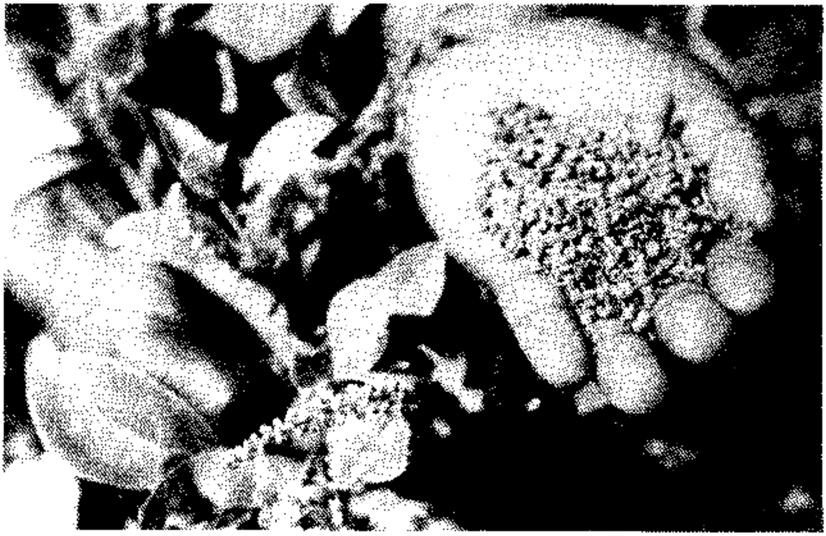
Will biotechnology reverse this trend toward increased crop vulnerability and associated increased pesticide use? It might and it might not. It simply depends on who sets the priorities for research. Biotechnology provides some very powerful tools to increase pest resistance in agricultural crops, but it certainly does not automatically cause a major shift to resistance-breeding. Geneticists still face major problems in this field. The resistance that biotechnology might breed into crops in the near future will be based on one, or a few, genes. The manipulation of entire gene complexes is still far too difficult to handle. This "one-gene/one-pest" resistance is rather easy to overcome by pests, which are continuously adapting themselves to new situations. Just as pests can develop resistance to pesticides, they are also able to find a way around pest resistance in crops, especially when this resistance is provided by only one gene. We are still a long way from the perfect superplants that dispose of all pests.

But apart from these technical limitations, another feature of biotechnology threatens to increase the vulnerability of crops. As we saw in chapter 5, tissue culture techniques are likely to be widely used in many different crops. Through tissue culture, mass production of genetically identical plants is possible. Such cloned plants are, genetically, exact copies of each other, and the wide use of them in a certain crop, would seriously increase the vulnerability of that crop. Some experts estimate that clonally propagated crops are six times more vulnerable to pests than their seed bred counterparts.[9] The wide use of cloned crops will undoubedly lead to the increased use of pesticides.

The central question remains, however, whether enough attention will be paid to pest resistance breeding at all. As already pointed out in chapter 3, biotechnology research is heavily dominated by the private industry: *"the very same industries that made it so easy for plant breeders and entomologists to avoid the more difficult but smarter biological and genetic options"* as Jack Doyle points out.[10] In this context, the optimistic expectations of Howard Schneiderman (quoted earlier) should be viewed with some scepticism. Schneiderman's company is the third largest pesticide producer in the world.

The main focus: herbicide resistance

The discrepancy between potential and actual developments in biotechnology, nowhere becomes clearer than with respect to weed-killers or herbicides. Over the years the use of herbicides has grown dramatically, as a result of changing agricultural techniques: monocropping, mechanization and non-tillage farming. World sales of herbicides amount to almost US$ 5 billion, representing some 40% of total pesticides sales in the world.[11] Although the industry often claims that the newly developed herbicides do not harm the environment, recent research has detected several cases of carcinogenicity due to herbicides and herbicide residues in groundwater. In general, very little is known about the long-term effects of herbicides in the environment.



(Louise Gubb/UNDP)

Seeds of the Endod or African soap-berry plant — a safe, cheap and versatile alterantive to chemical pesticides and molluscides.

The better understanding of basic plant science that is possible with biotechnology could help in designing herbicide-free weed control strategies. These could include better crop rotation techniques, mixed crop systems repressing the growth of weeds, and the use of allelopathic crops that produce natural herbicides.[12] Especially for developing countries in tropical regions, where weeds are a very serious problem, such weed control strategies could be of tremendous help. In many developing countries agricultural practices are already based on mixed cropping and subtle rotation techniques. Any programme to develop these techniques further in accordance with local resources, would be a significant contribution to helping the rural poor.

But let us take a look at what really happens. It is striking to note that biotechnology at the moment is mainly used to make an increase in herbicide use possible. One problem that limits the use of herbicides is the fact that many herbicides not only attack the weeds that they are supposed to kill, but also harm the crop that they are supposed to protect. This limits the farmer in the amount of herbicide he can use. Some herbicides are designed not to harm specific crops, but then the problem arises that the herbicide may linger too long in the soil and damage the crop that is planted the next season.

The first efforts to reduce the damage that herbicides can cause to crops, were undertaken by Ciba-Geigy. Ciba, which had already bought up several seed companies in the 1970s, developed a chemical "coat" for seeds to protect them against the herbicides produced by the same company. This "herbishield" was wrapped around Ciba-Geigy seeds, thus providing the company with a double profit: the farmer buys the Ciba-Geigy seeds packaged with the Ciba-Geigy herbicides. After successfully introducing the package in industrialized countries, Ciba is now trying to penetrate the market in the South. With the help of biotechnology this process is now being further sophisticated. Research is being done to genetically alter crops in order to resist higher doses of herbicides. Again, the seeds and herbicides are linked by the company that produces them. Ciba-Geigy tries to get Ciba-Geigy seeds tolerant to Ciba-Geigy herbicides, atrazine among others. Rhone-Poulenc tries to produce sunflower seeds resistant to its herbicide bromoxinyl, and so on.

In **Table 4** some of the current research activities on herbicide resistance are listed. In a RAFI/ICDA document[13] no less that 41 such research programmes are listed, and even this list is far from complete. In fact, virtually all large pesticide producers have major research programmes on herbicide resistance.[14] The research is either being carried out in-house, or through contracts with small biotechnology companies. Herbicide-resistant crops are expected to be massively marketed by the end of the decade. The total annual value of those varieties is estimated to rise to US$ 2.1 billion by the year 2000.[15]

TABLE 4.
Developing crop resistance to herbicides.

Herbicide producer	Contracted biotech. comp.	Crop	Resistance for
American Cyanamid	Phyto-Dynamics	Maize	Prowl
American Cyanamid	Molecular Genetics Inc. (contract finished)	Maize	Imidazolines
American Cyanamid	Pioneer Hi-Bred	Maize	Several
Eli-Lilly	Phyto-Dynamics	Maize	Treflan
Monsanto	Phyto-Dynamics	Maize	Roundup
Monsanto	in-house program	several	Roundup
—	Calgene	several	Roundup
Kemira Oy	Calgene	Turnip-rape	several Kemira herbicides
Kemira Oy	Phytogen	Cotton, Soy bean, tobacco & potato	several Kemira herbicides
Rhone-Poulenc	Calgene and in-house program	Sunflower	Bromoxinyl
Ciba-Giegy	In-house program	several	Atrazine
Shell	in-house program	Maize	Cinch
Shell	in-house program	several	Roundup
Dekalb-Pfitzer	Calgene	Maize	not specified
Lubrizol	Phyto-Dynamics	Oil-seeds	not specified

Source: Compiled by ICDA from dif. sources: "Genetic Technology News" April '84//"1986 Seeds Campaign" (see note 13)//Henk Hobbelink, Guido Ruivenkamp: "Biotechnologie en de Derde Wereld", in: *Derde Wereld* no. 86/2. Nijmegen 1986.//Pierre Benoit Joly, personal communication.

From the TNC perspective, it is not hard to understand this heavy research emphasis on herbicide resistance. The use of herbicide resistant crops will substantially increase the total global herbicide market, and thus the total revenues of the TNCs involved. But there is yet another reason, which emerges when the costs of developing seeds and pesticides are compared. Let us look again at graph 3 in chapter 3. It shows that it is simply cheaper to adapt a crop to a herbicide than develop a new herbicide. A draft report recently issued by the European Parliament, puts it this way: *"From the point of view of the industry, herbicide-resistant varieties are, above all, developed for economic reasons, since the development costs of a new herbicide are up to 20 times higher than those for a new variety."*[16] With both sectors often in the hands of the same TNC, the company can choose. And the choice does not seem to be difficult.

From a socio-economic perspective, however, it is difficult to understand why scarce human resources and finance are devoted to make crops resistant to pesticides rather than to pests. Especially for developing countries that so desperately need low-input and locally-adapted technologies for their farmers, the way biotechnology is used as described above does not make much sense. As with Ciba-Geigy's "herbishield", herbicide resistant varieties will also find their way to the Third World through the extensive distribution infrastructure that TNCs have built up. This Northern technology will, as with the Green Revolution varieties, primarily be adopted by the large farmers, resulting in a further dependence of the Third World on the North for chemical inputs. It will further marginalize the rural poor who need a very different type of technology.

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[1] Quoted by Jack Doyle in Altered Harvest, Viking Press, New York 1985, page 90
[2] Office of Technology Assessment. *Commercial Biotechnology: an International Analysis*. Washington, 1984. Page 177
[3] Quoted by Jack Doyle in GeneWatch, Vol 2, no. 4-6, page 19. Boston, 1985.
[4] Schulman et. al. in: Newsweek, Febr. 18th, 1985.
[5] Jack Doyle. *Altered Harvest*, op. cit. page 109-110
[6] OTA, *Pest Management Strategies in Crop Protection*. Vol. 1, Washinton 1979.
[7] OTA, quoted in Jack Doyle, *Altered Harvest*, op. cit. page 190.
[8] FAO, quoted in F. Wengemayer: "Biotechnik fur die Landwirtschaft aus der sicht der Industrie". In: *Entwicklung + Landlicher Raum*, Vol 20, No. 5/85.
[9] Conway, Gordon. ed. "Pesticide resistance and World Food Production", cited by Pat Mooney: "Impact on the Farm" in: UNCSTD, ATASBulletin, Vol. 1, No. 1, New York, Nov. 1984, page 46.
[10] Doyle, Jack. Altered Harvest, op. cit. page 197.
[11] Wood Mackenzie & Co. "Agrochemical Overview, 1983"
[12] Doyle, Jack. *GeneWatch* op. cit. page 1.
[13] RAFI/ICDA "1986 Seeds Campaign, Joint Programme RAFI/ICDA", 1986, unpublished.
[14] For example: out of the 10 largest pesticide producers (listed in table 2), at least 7 have a research programme or contract on herbicide resistance. (See also Jack Doyle in *GeneWatch* op. cit. p. 18)
[15] Estimate from L. Teweless & Co, cited in RAFI/ICDA 1986, op. cit.
[16] European Parliament, Commission on Agriculture, Fisheries and Food,: "Draft Report on the effects of the use of biotechnology", Brussels, September 1986. (Doc. PE 107.429/rev.)

7 INCREASING CONTROL: Patents in Biotechnology

"One unpleasant consequence could be that the multinational chemical companies would take control of all plant breeding and plant production"
Mr. H. Skov, Danish representative to a 1984 UPOV meeting on the impact of seed-patents in plant breeding[1]

As soon as a new technology moves from the laboratories to the market place, the question of who owns the technology and the products resulting from it, becomes important. Intellectual property and patent discussions have always accompanied progress in science. But the debate has never been so heated in the past as it has become recently over the question of whether and how to protect property of living matter. And the possible consequences of living matter as intellectual property have never been so threatening and far-reaching as at this very moment when biotechnology is likely to multiply the impact of almost every scientific development.

The question of intellectual property is not new. Way back in history, many examples can be found of how societies tried to honour the inventor of a product on the one hand and, at the same time guarantee access by society to technological progress on the other. The first examples of patent protection can be found with the ancient Greeks. But examples of opposition to this type of exclusive monopoly control also date from the same period. Matters seemed to be settled in a definite way in 1883 when the industrial powers of that time signed the International Patent Convention in Paris. Inventors were assigned exclusive property rights on their products, which is the basis on which industrial production still rests today.

A special system for plant breeding

The debate on intellectual property was given a new and massive impulse when the bio-sciences developed to a stage where, through systematic research, life forms could be changed and brought to the market place. After the work of Georg Mendel and the rediscovery of his heredity laws in 1900, systematic plant breeding started to take off.

Vegetable breeding in Botswana using simple equipment. *(Roel Burgler)*

When plant breeding matured and developed into an industrial activity, pressure to protect the ownership of the resulting products also grew. The first to react were the Americans, by adopting the Plant Protection Act in 1930. But "life" never fitted comfortably into the industrial patent schemes. The American Plant Protection Act was limited to asexually-reproduced plants, as seeds were considered to be too unstable to be described completely. Seeds change, mutate and reproduce — all too difficult for patent systems which had been based on industrial products.

Pressure from the newly-emerging seeds industry grew steadily and resulted in a special property protection system for plants, outside the industrial patent system: the Plant Breeders Rights system (PBR). In 1961 the Union for the Protection of New Varieties (UPOV) was formed, and the UPOV Convention was signed by a number of (mainly European) industrialized states. PBR gives, for a certain period of time, exclusive monopoly control on the reproduction of plant varieties for commercial purposes, marketing and sale for the breeder that developed them. In the 1970s several more industrialized countries joined UPOV (including the USA), but the growth of UPOV came to a halt by the end of the 1970s when several industrial states did not ratify the convention and efforts to persuade the developing countries to join the club were unsuccessful.

The reason for this setback was increased recognition of the negative impact of PBR for plant breeding. Evidence began to appear that because of PBR, TNCs started to gain increasing control of the breeding sector. It was also increasingly acknowledged that PBR, because of its requirements for uniformity, increases genetic uniformity and that it hardly contributes to the development of new, qualitatively distinct, varieties.[2] Developing countries recognized that PBR would not contribute to the build up of viable national agricultural systems. On the contrary, PBR would jeopardize efforts to build an independent national breeding sector. The UPOV convention attracted up to now only 17 member state signatories and it does not seem that this number will increase much in the future.

Tightening the grip: the push for industrial patents

With the debate about PBR still going on, the multinational seeds industry, now massively involved in biotechnology, is pushing already for a much stronger form of protection. Advances in biotechnology result in an increasing value of the genetic resources themselves, and techniques to manipulate them also assume a strategic importance. Increased pressure is being exercised to bring varietal property protection under the general industrial patent system in order to achieve more far-reaching monopoly control.

Despite the profoundly negative impact that PBR had — and still continues to have — on plant breeding, the scope of the PBR protection itself is relatively limited compared to the industrial patent system that is now being sought. PBR does not protect the germplasm in the seed, it "only" gives a monopoly right for the selling and marketing of a certain variety. The property rights of industrial patents go much further. To have a clear understanding of the implications of industrial patenting in the field of plant breeding and biotechnology, we should distinguish first the two different types of patents: process patents and product patents.

Process patents protect the property of a certain technological method, for example the method by which a new gene is inserted into a micro-organism. PBR does not protect this kind of process, which means that breeders can use each other's technologies to improve varieties. With patented processes, this type of technology-exchange between research institutions would be seriously limited, thus hampering technological progress. To use a patented process, the breeder must obtain a license from the patentee, and pay royalties for it. Extensive use of process patenting will make plant breeding more expensive and thus facilitate further concentration within the industry.

The impact of *product patents* goes still further. The industry is very actively seeking product patents on genes and on seeds. The patentee of a gene can, at least in theory, control all varieties in which his gene is incorporated. Or even worse: he can prevent anyone else using the gene and incorporate it exclusively in his own varieties. However, the degree of protection of a patented gene is not well defined at present. Decisions in patent offices and law suits in the coming years will have to clarify these matters. The chemical giants are pressing hard for the option that gene-patents should be extended to all subsequent varieties in which the patented gene is incorporated, thus giving them a much more comprehensive control over the whole breeding sector. But many plant breeders oppose this concept as it would virtually mean the end of their business. *"The artificial gene which science is today able to construct should be protectable by patents, but as soon as this gene is incorporated into a plant and starts functioning, it should no longer be allowed patent protection"*, says a Dutch breeder.[3] His opinion is supported by the Dutch Ministry of Agriculture which has recently supported the claim that PBR should be given precedence over patents.

Patenting varieties: the consequences

The industry is not only pushing for strong patent-protection on individual genes, but also wants to establish the possibility to patent new varieties. As a product patent on a variety gives complete property control over the germplasm in that variety (contrary to PBR protection), seed patents would have two dramatic consequences.

First, the patenting of varieties would make it impossible for breeders to freely use finished varieties patented by someone else as a source for further breeding. Using existing varieties for crop improvement is in fact the very basis of all contemporary plant breeding. Abolishing this practice by the introduction of industrial seed patent systems, would mean quite simply the destruction of what is left of the independent seeds industry. It would be the means by which the chemical industry could further integrate the seeds sector in their main areas of interest and at the same time dispose of competition from traditional breeders. It would also jeopardize progress in crop improvement as the gene-pool that could be used as the basic source for breeding would be severely limited. Finally, it would make current efforts to guarantee free exchange of genetic resources, such as that undertaken by FAO, completely worthless.

Secondly, patented varieties would make it illegal for farmers to use part of their harvest for next year's sowing, as the germplasm in the seeds would continue to be owned by the patentee. The farmer would have to return to the market each year to purchase seed, as is now the case with hybrid crops. It would also be illegal for a farmer to pass on harvested seed to his neighbours or sell it on a limited scale. This would virtually eliminate a widespread farming practice, not only in developing countries but also in the North. It is estimated that only 63% of all planted seeds worldwide are supplied commercially by companies and public organizations. The other 37% is the result of the farmers practices mentioned above.[4] In **Table 5**, the use of home-grown seed by US farmers is given, by crop. While use of such seed in the USA is substantial, especially for non-hybrid crops, the use of home grown seeds in developing countries is much greater.

TABLE 5.

The use of "home grown" seeds in the USA: A practice to disappear?

Crop	%
Corn	5
Grain Sorghum	5
Alfalfa	5
Tobacco	10
Vegetables	15
Rye	25
Rice	30
Peanuts	30
Barley	50
Soybeans	65
Wheat	65
Oats	70

Source: Jack Kloppenburg Jr.L The Social Impact of Biogenetic Technology in Agriculture. In: G. Berardi and C. Geisler (eds.): *The Social Consequences of New Agricultural Technologies. Westview Press, Boulder, Colorado.*

The result of the extended property protection described above would be to increase greatly the farming community's dependence on the plant breeding and biotechnology industry. It would also mean the total loss of the genetic diversity that is maintained in the field by farmers through the selection and use of their own seed. Lesser, Associate Professor of Agricultural Economics at Cornell University, estimates that a complete prohibition of farmer-saved seeds would cost the USA farmers half a billion US$ annually. However, his message is simple: *"Farmers, though, must overcome a psychological resistance to having the uses of their crop dictated by the legal system"*[5]

In one of its documents[6], UPOV adds two more dangers arising from the patenting of varieties. One is that it might be possible, by defining the claims carefully, to extend the exclusive right of the patent on a variety to the final product of that variety thus controlling not only the seed but also its post-harvest products. The second is the danger arising from patents being defined very broadly. On the basis of just a few characteristics, a patent could cover a whole range of existing — or even still to be produced — varieties: for example a patent on all blue or thornless roses. UPOV has several times pointed out its resistance to industrial patents on varieties. The reason for it is not so difficult to understand: *"If it were possible to protect plant varieties by means of a product patent, the further development of the specialized legislation of the UPOV countries (....) would be jeopardized"*.[7] The very existence of UPOV is threatened by industrial patents.

The way the lobby works

Debate in the international community on the industrial patenting of plants, genes and processes, has only just begun. Pressure for patenting comes, of course, from the major corporations that are now investing in biotechnology. The problem for the proponents is that important legal conventions have to be changed to make their wishes possible. This is especially true in Europe. The European Patent Act, signed by 11 European countries, specifically excludes *"plant or animal varieties or essentially biological processes for the production of plants and animals"* from patentability. Further, the UPOV legislation itself forbids a "double protection". When a variety is protectable under PBR, it cannot be patented by another system. This makes, at least in the European context, patents on plant and animal varieties impossible for the time being. The question of process patents under the European Patent Act is more complex. It depends on how "biological processes" are interpreted. The biotechnology industry bluntly defines all their activities as essentially technical, or chemical, and thus patentable.

Not having signed the European Patent Act, the situation in the USA is more flexible. In the past, the USA patent office did not grant patent protection to crop varieties that are protectable under the UPOV-like PBR legislation that falls under the USA Plant Variety Protection Act. But after two important decisions, one of the U.S. Supreme Court in the Chakrabarty case (1980) and one of the USA Board of Patent Appeals in the Hibberd case (1985), industrial patent protection can now be granted to plant varieties. It is expected that a major shift will now take place in the USA from PBR to industrial patents.[8]

But despite the socio-economic impact, legal problems and existing conventions, the lobby for patents is moving steadily ahead. At the international level, the position of the agro-chemical multinationals is voiced especially by the World Intellectual Property Organization (WIPO). WIPO is a United Nations body, based in Geneva, dealing with patent policy. Mr. Baeumer, director of WIPO's Industrial Property division, is very clear about his mission. *"Our task in this field is to stimulate better patent protection for the biotechnology sector."*[9] WIPO established a special Committee of Experts on Biotechnological Inventions and Industrial Property, which met for the second time in February 1986. Twenty-nine states were represented at this meeting, of which only seven were developing countries. Representatives of these seven countries participated very little in the discussions.

More interesting still was the massive participation of industry representatives as NGO-observers. The WIPO secretariat prepared a background document for this meeting, which clearly outlines the WIPO position. The document notes that certain national laws exclude plants, animals and biological processes from patent protection and states that *"such an exclusion is no longer justified. All biotechnological inventions should be eligible for patent protection."*[10] Most government representatives were more guarded than the WIPO secretariat might have wished, stating that the time is not yet ripe for patenting plants and animals. The secretariat managed nevertheless to keep the initiative and was asked to prepare a further study on the issue for the next session in 1987. The industry will be asked to put their views on paper for that meeting, undoubtedly to build up more pressure and so speed up the decision making process.

WIPO is not alone in the push for patents. The Organization for Economic Co-operation and Development (OECD) published a report in 1985, recommending that the industry should have the choice between PBR and patents.[11] The European Commission has also been dealing with the question.

As stated earlier, the debate has just begun and important groundwork to strengthen patent protection is being carried out. Regardless of the outcome of the controversy, the dispute really amounts to a confrontation between traditional plant breeders and the chemical companies.

Where is the Third World in this debate? Hardly anywhere. Although developing countries are represented in bodies like WIPO, this complex issue is completely dominated by the industrialized world: not surprisingly, since the whole international patent system is completely dominated by and benefits the North. But increased patent control and the resulting dominance of the chemical industry, will be especially disastrous for the South. There is an urgent need for developing countries to talk to each other and involve themselves more actively in the debate. The concern expressed by Mr. Skov on the socio-economic impact of industrial patents, quoted at the beginning of this chapter, is too often expressed by just a few individuals. In UPOV and WIPO meetings they are often minuted as a dissident opinion. It is of crucial importance that the concerns about the socio-economic impact of industrial patents in biosciences are thoroughly assessed and voiced in the appropriate decision making bodies.

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[1] H. Skov, Chief of Administration of the Danish State Plant Production Office. In: "Industrial Patents and Plant Breeders' Rights". Records of a Symposium. UPOV publication no. 342 (E), page 66.

[2] See, for example, Pat Mooney "The Law of the Seed", in: *Development Dialogue*, No. 1-2, Uppsala, 1983.

[3] Quoted in: David Dickson, "Chemical Giants Push for Patents on Plants", Science, vol 228, 14 June 1985

[4] Kent, James W. "The Driving Force Behind the Restructuring of the Global Seeds Industry". In: *Seed World*, Vol. 124 No. 7. June 1986

[5] Lesser, W. "Patenting Seeds: What to expect", Dept. of Agricultural Economics, Cornell University, U.S.A., January 1986.

[6] op. cit. UPOV document no. 342 (E), page 80

[7] de Lange, Peter. Head of the Legal Department of KWS (German seed company) at a UPOV conference on patents. op.cit. UPOV document no. 342 (E), page 37

[8] op. cit. Lesser, 1986

[9] *ICDA Seedling*. Barcelona, July 1986.

[10] WIPO document "Biot/CE/II/2, "Industrial Property Protection of Biotechnological Inventions". Geneva, 1985.

[11] Beier, F.K. et. al. *Biotechnology and Patent Protection*. OECD, Paris 1985

8 APPROPRIATING BIOTECHNOLOGY BY THE THIRD WORLD:

Possibilities and Problems

In the previous chapters we tried to show that the biorevolution will have a profound impact on global agriculture, both in developed and underdeveloped countries. It will affect the position of the Third World as exporter of agricultural commodities, and also as importer of agro-inputs. It will also affect Third World capability of producing its own food, and in general the dependence on agro-industry. We have stressed several times that biotechnology as it is being developed now, will have mainly a negative impact on developing countries. But we have also pointed out that the technology could , at least in theory, make a significant contribution towards resolving some of the pressing problems that currently face developing nations.

Central to the whole question of the impact of biotechnology is the context in which it is now being developed. At the moment, the technology is being heavily privatized, mainly by large TNCs, and the direction of the research is strongly biased towards a 'high-tech' type of agriculture and towards the interests of industrialized nations. The implementation of biotechnology under present conditions, is likely to result in a new international division of labour, a decreased value of raw agricultural materials traditionally produced by the South, and an enhanced dependence of the Third World on the industrialized nations.

The developing countries will feel the negative impact of biotechnological developments most keenly if they are unable to take action. Their capacity to appropriate and adapt biotechnology to their special needs will determine the extent to which the technology will contribute to the solution of their problems. The contribution of biotechnology will also be determined by the capacity of these countries to minimize the negative effects of the type of technology and the type of restructuring described in the previous paragraph which is currently benefitting the North. Simultaneous strategies will need to be defined to both counter these negative effects and, on the positive side, to strengthen indigenous biotechnological capacity. Some suggestions for elements of such strategies are given below, together with a discussion on the main obstacles to implementation.

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A. POSITIVE STEPS: STRENGTHENING INDIGENOUS CAPACITY

1. Guaranteed access to the building blocks

Of crucial importance in any attempt to appropriate biotechnology for Third World needs is access to genetic resources, the very building blocks of this technology. Most of the diversity of genetic resources originates in developing countries. Over the past decade a massive "gene-drain" took place from the farmers' fields in the South to the genebanks in the North. It is estimated that over 90% of all germplasm collected by the International Board for Plant Genetic Resources (IBPGR), an international body responsible for collecting and conserving plant genetic resources came from the Third World. Some 40% of that germplasm ended up in the genebanks of Europe and North America, while another 40% went into the storage facilities of the International Agricultural Research Centres (IARCs). Only 15% was stored directly in the genebanks of the developing nations.[1] With plant breeding and biotechnology growing into major commercial activities, the strategic importance of genetic resources is growing likewise. A heated debate is currently taking place in the Food and Agriculture Organization of the UN (FAO) on access to and ownership of, those genetic resources. Efforts now underway in FAO to guarantee free access to these resources, taking control of stored germplasm away from individual states and bringing it under a truly international system, should be enthusiastically supported.

It is also important that FAO proposals to set up an international fund for plant genetic resources are successful. This fund is meant to support germplasm storage and utilization in developing countries. At a recent FAO meeting it was stressed that contributions to this fund should be supplementary to IBPGR contributions and the question of including payments from Plant Breeders' Rights in this fund was also raised.[2]

Although these initiatives are not aimed directly at biotechnology research, they are in fact of utmost importance for any biotechnology programme in developing countries. Without free access to genetic resources and without substantial funding for germplasm storage and utilization in the South, the current leaders in the "biotechnology-race" are likely to continue to create the conditions for development of biotechnology in their own interest. The developing countries are doing nothing more nor less than requesting equal rights over a resource,

(UN/IPBGR)

Over 90% of all germplasm collected by IPBGR comes from the third world but only 15% is stored in genebanks of those countries.

originating largely within their own boundaries, which has up to now been used freely by industrialized countries.

2. The role of the International Agricultural Research Centres (IARCs)

In the past decade the IARCs, having led the Green Revolution, have been heavily criticized for their role in Third World agricultural development and for the negative impact that the Green Revolution has had on the rural poor. Rightly so, as we pointed out in Chapter 1. But with the heavily privatized, Northern-based biotechnology threatening developing nations, use of the IARC system might yet prove to be one of the few mechanisms that could reverse the privatization of biotechnology and challenge the direction of current research. But even that is an open question. While the Green Revolution was firmly in the hands of the IARCs, biotechnology is almost completely dominated by TNCs. In the case of the Green Revolution, the TNCs acted "merely" as suppliers of the inputs for seeds that the IARCs had developed; for the bio-revolution, the TNCs are direct competitors of the IARCs in bringing the technology to the farmers' fields. This applies especially to those crops with large market potential such as maize and wheat, the speciality crops of the IARCs.

The competition between IARCs and the TNCs will focus mainly on access to the technology. As the IARCs will probably continue to emphasise applied research, they will require access to fundamental biotechnological information externally developed. A research team at Cornell University in the USA, identified four possible sources for this kind of information: small biotechnology start-up firms in the North, public research institutions in the North, the ICGEB (see below) and the national research programmes of developing countries.[3]

If the IARCs are going to have any role at all in developing biotechnology for the needs of the rural poor, access to this type of information must be guaranteed. Apart from strategies to gain access, by far the most important question is how the biotechnology research objectives are developed. If anything is to be learned from the Green Revolution, it is that peasant smallholders in the Third World are not well served by a general type of high-input technology. In principle, biotechnology affords the opportunity to develop an appropriate type of agricultural technology, specifically directed towards the rural poor. It is clear enough that TNCs will not develop this technology. The real challenge for the IARCs in responding to the bio-revolution is to put into practice the lessons of the Green Revolution by appropriating biotechnology and gearing the research towards the specific problems of the rural poor.

3. International biotechnology centres: ICGEB and MIRCENs

UNIDO has made what appears to be the most ambitious and promising attempt to create an institutional mechanism for the transfer and adaptation of biotechnology to the needs of developing countries. But the creation of the International Centre for Genetic Engineering and Biotechnology (ICGEB) has proved to be very difficult, partly due to resistance from the USA and Japan, the two countries with the largest biotechnology interests. These countries are very reluctant to share their technology internationally, as it might affect their dominant position.[4] Another difficulty in setting up the Centre was choice of location. Some argued to establish it in the North, while the developing countries argued for a site in the South. A compromise was reached by establishing it in two places: India (New Delhi) and Italy (Trieste). Each Centre has a different mandate. ICGEBs activities will focus both on research and training and will also facilitate a networking function for national research programmes in the South.

Although the Centre is still in its infancy, and its initial budget is very limited, ICGEB could make a vital contribution toward the development of biotechnology in the interests of developing countries. It could play a very important role in North-South and South-South information exchange and provide an important input to the work of the IARCs. Finally, its role in training scientists from developing countries could be crucial. A dangerous weakness of ICGEB is the lack of support from the industrialized countries. By mid-1985, only 33 states had signed the statutes of the Centre and were participating in the Preparatory Committee. Only three out of the 33 states are from the North (Spain, Italy and Greece).[5] To really make the Centre work, industrialized states should be pressed to join ICGEB and support the creation of independent biotechnology research capacity in the South aimed at developing appropriate agricultural technology. Substantial funding should be made available to the ICGEB.

Another initiative, at a more advanced stage than ICGEB, under the cooperative auspices of Unesco and UNEP (the United Nations Environment Programme) is the creation of the so-called "Microbiological Research Centres" or MIRCENs. Up to now eight such centres have been assigned, all of them located in developing countries. The objectives of the MIRCENs initiative are to strengthen the research and training capacity of the regionally situated centres and contribute to policy formulation at the national and international level. Currently supplementary training is provided for nearly 300 biotechnology researchers.[6]

4. National biotechnology programmes in developing countries

International structures to facilitate the creation of indigenous research capacity in the Third World and to counteract the current direction that biotechnology is taking are of the utmost importance. But the crucial question remains as to whether developing countries will be able and committed enough to develop indigenous national research programmes directed towards the need of the rural and urban poor. Several developing countries, among them Argentina, India, Cuba, Brazil, China and the Philippines, have already taken steps in this direction, some of them with remarkable success. The research programmes vary, according to the different needs of each country. However, in most countries the biotechnology programmes still face serious technical, economic and political obstacles.

The most important technical obstacles are the lack of trained personel and the absence of a basic scientific infrastructure — a feature of many developing countries, especially the poorest ones. This is in fact a general problem in setting up any applied agricultural research programme. Additionally, long term financial commitment to biotechnology research is difficult for many of the developing countries at a time of widespread austerity programmes related to debt servicing.

The basic requirement for the success of such programmes is that research priorities are very carefully defined according to the specific needs of the majority of the population. It would be inappropriate for developing countries to try to join the 'high-tech' biotechnology race that is taking place now among the industrialized countries. Biotechnology has already provided some low-tech, low-cost techniques which could be of considerable benefit for the Third World. Focussing on this type of technology may seem to be an obvious choice, but there is a danger here. Martin Kenney, having visited biotechnology programmes in Brazil and Mexico, puts it in this way: *"Yet, technically simple projects such as these are not well supported. It is scientists with extensive credentials, following the U.S. model, who impress politicians and continue to extract considerable funding, while accomplishing little that is applicable to the needs of the vast majority of the citizens."*[7]

This is in fact one of the crucial points in counteracting biotechnology as it is now being developed in the interest of the industrialized nations. Programmes can only succeed if there is a clear understanding of the problems faced by the rural and urban poor and the political will exists to solve them. This in addition to knowledge of the realistic possibilities offered by biotechnology to solve these problems. In many cases this also means that appropriate research programmes will only be effective if accompanied by broader socio-economic reforms aimed at improving the position of the rural poor. Priorities could be set in consultation with grass-roots organizations and other NGOs, which often have considerable knowledge and experience of the local situation.

B. CONTROLLING THE NEGATIVE IMPACTS

Whether or not developing countries will manage to appropriate biotechnology and develop it in accordance with their specific needs, they will have to cope with the negative impact that is imposed on them by the development of biotechnology in the North. Some of those negative consequences have been discussed in the previous chapters. To reduce this impact and protect the interest of their people, developing countries themselves will, of course, need to develop their own policies and joint strategies. But others can also contribute to this process and so we list below some possible actions that could be undertaken by governments, NGOs and intergovernmental organizations.

5. The need for Early Warning Systems on the impact of emerging biotechnologies

To be able to react in time to expected developments and adjust policies, developing countries need timely and adequate information. Until now gathering and disseminating such information on has been quite sporadic and fragmentary. Elements of this type of information could be:

— technological information: development of new techniques and possibilities.

— commercial information: developments within the biotechnology industry; identification of TNCs controling the market; research priorities of TNCs and the extent to which they are moving into Third World markets.

— socio-economic information: the impact of Northern developed biotechnology on crop displacement in the Third World; displacement of labour; impact on prices;
the impact of increased food crop production in the North; monitoring and assessment of dumping surpluses on Third World markets.

Development NGOs in both industrialized and developing countries could play a crucial role in gathering and disseminating information on the developments mentioned above. Several UN agencies could also have a vital role here and could upgrade their activities in the area. Several NGOs and UN bodies are already involved but much more needs to be done. As shown in Chapter 4. developing countries are too often faced with the negative impact of new technologies after the event.

6. The need for adequate regulations in the South

Technology regulation has always been a difficult issue for developing countries. Often due to pressing economic problems in Third World countries, foreign technology and TNC investment has been welcomed without sufficient attention to possible dangers for the environment and the population. Recent tragedies such as Bhopal and the gas explosion in Mexico City have demonstrated that adequate safety standards are often not met. The debate on dangers inherent in genetically-engineered organisms currently taking place in most industrialized countries has also brought the regulation issue under scrutiny. There is already speculation that TNCs might relocate part of their biotechnology research in developing countries in order to circumvent domestic safety regulations. Legal regulatory schemes are also important for the development of national biotechnology programmes in the Third World. Again, ICGEB could play an important role in drafting legal guidelines and in providing a forum for developing countries to discuss this complex issue. Building capacity in the Third World, one of ICGEBs main tasks, should also include the promotion of effective legal instruments to control the technology and protect people and the environment from harmful effects.[8]

7. The need to reject patent systems

Perhaps the most powerful instrument in increasing the privatization of biotechnology and establishing monopoly control, are patent systems. While in theory patents are meant to facilitate the availability of information, in practice the opposite happens. Experience has shown that the major beneficiaries of patent protection are the industrialized nations, and more specifically the large TNCs in those nations. Patents basically act as a concentration and market-control instrument. As indicated in Chapter 7, the Third World will come under increasing pressure to adopt patent-like legislation for biotechnology products. For developing countries, patent legislation on biotechnology inventions, including plant and animal varieties, would mean simply handing over the development of biotechnology to foreign companies. It would also mean jeopardizing public research programmes. For these reasons, pressure to adopt patent-like legislations should be resisted by developing countries. WIPO (see Chapter 7) is a forum where such resistance could be expressed.

Until now, the Third World has been generally reluctant to adopt both Plant Breeders Rights legislation and patent legislation for biotechnology-related products. They were right in doing so. However, it might be in the interest of developing countries to establish other types of legislation in order to reward inventors and stimulate indigenous research efforts. The property rights question is not without options. Developing countries might choose to use inventors certificates, reward concepts, or taxation measures, for example. Specific licensing agreements might also prove to be very useful in the stimulation of research and transfer of technology.[9] Exploration of such alternatives is needed.

8. Negotiating a way out: building on experience

The role of the Third World in the FAO debate on genetic resources, is a positive example of collective action on the part of developing countries resulting in concrete progress. Five years ago genetic resources was a "non-issue" in the whole UN system. Now the Third World is in a position to negotiate with the industrialized countries on this issue. For example, concrete agreements on ownership, exchange and conservation of germplasm and on financial support for setting up breeding and conservation programmes in the Third World are now being discussed in FAO. Increasing awareness that genetic resources originate mainly in the South and are often used for the benefit of the North, helped to build a strong joint position on the part of developing countries.

The building blocks of biotechnology are these same genetic resources; the development of biotechnology is also directed mainly for the benefit of the North. Based on their FAO experience, developing countries could ensure that biotechnology is placed on the agenda of all relevant bodies where negotiations take place, including UN organizations. On the basis of solid information, carefully gathered as described above, developing countries could put forward concrete proposals to limit the negative impact that Northern based biotechnology will have on the South. Such a position could also gain substantial political and financial support for creating indigenous biotechnology programmes. The best way to achieve some success in this effort is by developing joint positions on the main items — not an easy objective. In its present mode of development, biotechnology itself induces conflicting interests within the Third World block (see Chapter 4). Efforts could nevertheless be made to develop joint positions by embarking on the debate within the South. Joint positions on issues like patenting, regulation, product and labour displacement and TNC involvement, is a fundamental prerequisite for reshaping biotechnology in a way which will help solve some of the developing countries' problems.

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[1] Mooney, Pat. "The Law of the Seed Rivisited" In: *Development Dialogue* No. 1985/1, Uppsala, Sweden. pages 141-142.
[2] FAO: "Report of the Working group of the FAO Commission on Plant Genetic Resources". First Meeting. Rome, 2-3 June 1986. page 6.

[3] Buttel et. al. "The IARCs and the Development and Application of Biotechnologies in Developing Countries". In: Biotechnology in International Agricultural Research. IRRI, Manila, 1985.
[4] See Kenney at. al. "Biotechnology, Prospects and Dilemmas for Third World Development" In: Development and Change. SAGE publications, London/Beverly Hills/New Delhi, Vol 16 (1985), 61-91.
[5] UNIDO, Genetic Engineering and BiotechnologyMonitor. Issue no. 12 Vienna, June/July, 1985.
[6] See: UNCTSD, ATASBulletin, Vol 1, No. 1, New York, Nov. 1984. p. 59-60
[7] Kenney,Martin. "Reflections on a Visit to Latin American Biotechnology Research Institutes". In: *GeneWatch*, Vol. 2, No. 3. Sept/Oct 1985.
[8] See for a detailed discussion on regulation: Dembo et. al. : "Biotechnology and the Third World" In: *Rutgers Computer and Technology Law Journal*, Vol. 11, No. 2, 1985.
[9] See for a more detailed discussion on such alternatives note 8) and: UNCSTD, 1984, op. cit. p. 73-74.

9 THE ROLE OF NGOs

In the past decade, several networks have been set up to coordinate and facilitate the work of NGOs on several specific issues related to agriculture, health and the environment. The International Baby Food Action Network (IBFAN), Health Action International (HAI), Pesticides Action Network (PAN) and the Seeds Action Network (SAN) have all been actively involved in and have achieved considerable success in raising public awareness, pressing for better international regulatory procedures and challenging the more extreme marketing practices of some of the companies involved. International NGOs such as IOCU (International Organization of Consumers' Unions) and ELC (Environmental Liaison Centre) and ICDA have played an important role in the initiation of the networks.

As biotechnology will have a substantial impact on agriculture, health and the environment, the work of the NGO networks will need to take these developments into account. Biotechnological developments lead to a closer integration of these sectors. For example, naturally produced medicines, often based on developing country agriculture will increasingly be replaced by industrially-produced pharmaceuticals. Seeds will be programmed, through genetic engineering, to resist higher doses of pesticides. Screening of new pesticides will be accelerated by tissue culture techniques. Milk production will increase and could result once again in baby food dumping in developing countries. Moreover, it is often the same corporation that produces and markets the pharmaceuticals, the pesticides and the seeds. Dealing with the future impact of biotechnology will therefore provide the stimulus to closer collaboration between the existing issue networks. Recently, several new NGO networks, focusing specifically on socio-economic and environmental aspects of biotechnology, have been set up. In the USA, groups such as "The Committee for Responsible Genetics" and the "International Network on the Social Impacts of Biotechnology" have already embarked on sensitizing public opinion. In Europe, the German-based "Genetisches Netzwerk" is now being created.

For all of us, biotechnology is still something new. There is an urgent need for increased NGO network interaction. A first step is being undertaken by the Dag Hammarskjöld Foundation and RAFI in collaboration with ICDA, IOCU and NGLS. A conference is being organized which will bring together the main actors to discuss the impact of biotechnology and the possibility of increasing cooperation.

Below we list some areas where we feel that NGOs can play a role in influencing the course of biotechnology and its socio-economic impacts.

1. Monitoring the industry

NGOs participating in the different networks, often focus their attention on the same corporations and a considerable body of information has been built up by NGOs. These companies are often the ones which are now investing heavily in biotechnology. NGOs can contribute substantially to understanding the impact of biotechnology by monitoring ways in which the industry is being restructured and research priorities set. Information on the companies which are dominating the market, their trade and marketing practices, can be usefully collected and shared.

2. Monitoring and forecasting the impact

A common feature of all the issue networks is an active participation of NGOs from both industrialized and developing countries. These north-south links can be very important in monitoring the global impact of biotechnology and assessing its future impact in certain areas. It is important to link this type of activity with university-based research which is also contributing substantially to understanding of the biotechnological impacts.

3. Informing and mobilizing public opinion

An important part of the activities of the different networks and NGOs involved in them, has been to inform the public and mobilize public opinion against dangerous and harmful practices. Apart from the possible dangers to the environment of genetically-engineered micro-organisms, the public view of biotechnology is that it will be tremendously beneficial to mankind, not least because the press mainly focuses on the positive side of the story. There is an urgent need to publish information on the possible negative socio-economic aspects of the new biotechnologies and to stimulate public debate on these aspects.

4. Influencing research priorities

In many industrialized countries commissions have been set up by governments to promote biotechnology research and development, install national biotechnology programmes, and to facilitate cooperation between the public and private sector. Governments in most of these countries see biotechnology as an important strategic sector, and give high priority to their leadership role in the "biotechnology race". Generous subsidies are made, often indiscriminately, to attain this goal, sometimes without sufficient attention to other aspects such as the impact on specific groups in the society, on the quality of food and agriculture and on the developing countries. At present, the views of trade unions, environmentalists, consumers and development organizations are poorly represented in these national biotechnology bodies. At the international level important decisions are being taken on biotechnology programmes. A recent example is the "Eureka" project of the European Community that contains substantial funding for biotechnology research. There is an urgent need for wider and more democratic participation in the decision-making process on the applications of biotechnology, especially with regard to definition of research priorities.

5. Helping the Third World in raising concerns

This is also an area where many NGOs have considerable experience. PAN and SAN have been working with developing country delegates in FAO in raising those countries' concerns on pesticides and seeds. HAI and IBFAN have worked within WHO on pharmaceuticals and baby food in a similar way.

NGOs could play a supportive role by stimulating discussion on patents in WIPO, and encouraging developing country representatives to make their views known in that discussion. The same is true for discussions on changing trade relations arising from biotechnology in bodies like UNCTAD and GATT, and on labour aspects in ILO. The impact of biotechnology on health and the environment should be raised within WHO and UNEP and the impact on agricultural production in FAO. In many of these bodies, discussions are heavily dominated by the North because of lack of information, resources and expertise on the part of the developing countries. NGOs have often played a crucial role in bridging this gap by providing concrete and timely information to Third World delegates and by discussing strategies with them. Positions of Northern delegations can be influenced by mobilizing the public opinion in industrialized countries and through direct contacts with national governments.

While work in all these different fora is very important, a detailed discussion among concerned NGOs within the networks is needed to set priorities for action. NGOs have the commitment, shared concern experience and expertise, network structure and contacts. These valuable assets can be used to tackle the biotechnology issue if information is shared and priorities are set realistically.

ANNEX 1

THE USE OF TISSUE CULTURE IN AGRICULTURE TEN POINTS TO PONDER

Positive considerations	Negative considerations
1. GENETIC DIVERSITY	
Tissue culture techniques offer a safe and quick means of germplasm transfer from one region to another. An increase in such transfers could substantially broaden the breeding base available to agronomists from which to develop new cultivars. Particularly in areas of new production (for oil palm, rubber, coffee, etc.) this could have the effect of widening the genetic base of the crop and reducing the risk of losses.	Tissue culture techniques permit the mass production of genetically identical plants over vast areas. While it is possible to expand the breeding base of plantation crops in this way, the highly-centralised nature of the technology (for example Unilever in oil palm) is more likely to increase the uniformity and vulnerability of the crop. In addition, replantings are now taking place in the absence of a conservation strategy and are already accelerating the pace of genetic erosion.
2. GERMPLASM IDENTIFICATION	
It can now take as long as ten years to identify the usefulness of characteristics in a tree crop from seed (such as coconut or oil palm for example). Clonal propagation could almost eliminate this risk of undesirable characteristics and enormously increase the pace of new cultivar development.	While this application has undeniable advantages, the key question is "who" will decide "what" characteristics are beneficial and for "whose" purpose. Recent commercial breeding for developing country markets has focused on broad adaptability often at the expense of resistance to local pests or in ignorance of those local conditions for which breeders should seek advantage.
3. CULTIVAR DISSEMINATION	
The low seed-bearing rate of some plants, combined with their long germination period, means that the multiplication of a new cultivar is slow and expensive. New technologies can produce hundreds of thousands of plantlets a year and make the total replanting of a crop feasible within a growing season.	The employment of this new technique has indisputable advantages for the dissemination of improved cultivars, as long as it is preceded by an equally thorough orientation/training programme upgrading husbandry skills etc., to match the innovation. The mass dissemination of uniform cultivars however, could destroy or severely handicap the crop's longer term biotech capacity. A full collection/conservation strategy is a first priority.

4. PRODUCTION INCREASES

Whereas 20 percent of the trees often produce 80 percent of the yield, the development of uniform new cultivars could bring plantation harvests up to the level of the most productive trees. The new technologies can also be employed to significantly increase the yield of even the best trees. Depending on the crop, plantation harvests could easily increase anywhere from three to twelve-fold within a few decades.

Little attention has been given to the breeding of plantation crops, in general, and it is likely that even an increase in orthodox breeding would lead to major yield improvements. Higher-yields could prove a significant benefit to some developing countries unable to grow their domestic requirements. There is reason to be concerned, however, that a sharp increase in production in major exporting states could mean overproduction leading to further market instability and reduced export prices. In such a case, the only beneficiaries may be those marketing the technology and/or those importing the product. In some cases (i.e. Unilever for vegetable oils or Firestone for rubber) the technology source and the importer are the same enterprise.

5. PEST PROBLEMS

Rapid tissue culture techniques may be the fastest way to combat pest epidemics (such as now afflicting bananas). The speed of character identification and multiplication are often essential to the survival of many vulnerable tree crops.

Such techniques may well be the saviour of banana in the short-term but banana's major problem arises from its genetic uniformity resulting from its clonal propagation. The long term security of such crops depends upon increasing genetic variability of the crop. Further, seed crops which may soon be propagated by clones (such as coconut and oil palm) can be expected to suffer six times the pest losses of outbred crops, meaning a major increase in the cost of chemicals.

6. MACHINE UNIFORMITY

Beyond the development of higher-yielding and more disease resistant varieties, cell and tissue culture will make it possible to develop more uniform plants amenable to harvest machinery and/or processing and other market requirements.

The market requirements being met may reduce the value of the crop for alternative domestic and export use (bananas for cooking or coconut for fuel or mats). The net benefit to the economy might be substantially reduced or eliminated. The obvious social risks of unemployment due to mechanical harvesting etc. (for example, date palm) may make the socio-economic gain even more dubious.

7. GERMPLASM STORAGE

Cell and tissue culture may prove to be the only viable means of achieving the long term storage of large-seeded and clonally-propagated crops. Living collections (now often the only means of conservation) take up enormous land areas and are very costly in labour and money.

The present international proposal for a tissue culture base collection would locate the centre in Australia and further the concentration of such collections in industrialized countries (i.e. Japan, France, U.K., U.S.A.), increasing the political problems currently associated with access to economically important germplasm. Further, while tissue culture storage should not be overlooked, the technology is new and living museums cannot safely be abandoned.

8. LAND USE

In some countries, it may be possible to dramatically reduce the area devoted to a tree crop and make this land available for other national purposes including domestic food production and redistribution to peasant farmers.

This could prove to be a very wonderful advantage. It is, however, more likely that global overproduction will force a reduction in land area in the context of a depressed economy unable to take advantage of the potential social benefits.

9. SMALLHODERS

More productive plants could do much to strengthen the viability of small holdings and allow the redirection of production towards family estates and away from traditional plantations.

While this would be a constructive result, large estates will have the technological access, husbandry skills, financial resources, market experience and economies of scale, needed to utilize the technology first. In all likelihood, small holders will be seriously disadvantaged or eliminated.

10. AGRICULTURAL DEVELOPMENTS

More stable and higher levels of production of a better quality crop should strengthen market conditions and reduce the risk of losses to synthetics or alternative crops.

The history of industrial country-originated technology since the Second World War would suggest that developing countries have not benefitted equally from these changes (for example, synthetic textiles vs cotton; synthetic latex vs. natural rubber; polypropylene vs. natural cordage, etc.). Early experiences in biotechnology (maize replacing sugarcane; guayule challenging rubber; laboratory production of flavours and fragrances, etc.) argue that this trend will continue and could lead to factory farming of many plantation crops in the decades to come.

Source: Reprinted from: Pat Mooney "Impact on the Farm". In: UNCSTD, *ATAS Bulletin*, Vol. 1, No. 1, New York, Nov. 1984.

ANNEX 2
COMPARING TWO REVOLUTIONS

CHARACTERISTICS	GREEN REVOLUTION	BIOREVOLUTION
Crops affected	Wheat, Rice, Maize	Potentially all crops, including vegetables, fruits agro-export crops (e.g. oil palms, cocoa, etc.) and speciality crops (spices, etc.)
Other products affected	None	Pesticides, animal products, pharmaceuticals, processed food products, energy.
Areas affected	Some developing countries	All areas; all nations; all locations, including marginal lands(characterized by drought salinity, Al. toxity, etc.)
Development of technology and dissemination	Largely public or quasi-public sector	Largely private sector, especially transnational corporations
Proprietary considerations	PBR and patents generally not relevant	Process and products patentable and protectable
Capital costs of research	Relatively low	Relatively high for some techniques, relatively low for others.
Access to information	Relatively easy, due to policy of IARCs	Restricted, due to privatization and proprietary considerations.
Research skills required	Conventional plant breeding and parallel agricultural sciences	Molecular and cell biology expertise plus conventional plant breeding skills
Crop vulnerability	Seed bred High Yielding Varieties, relatively uniform, thus increasing genetic vulnerability.	Crop propagation through tissue culture produces genetically exact copies and increases vulnerability even more.

Source: Martin Kenney, Frederick Buttel, "Biotechnology: Prospects and Dilemmas for Third World Development". In: *Development and Change*. SAGE, London/Beverly Hills/ New Delhi, Vol. 16 (1985), p. 70. Adapted by ICDA.

ANNEX 3

ABBREVIATIONS

ATAS	Advance Technology Alert System (of UNCSTD)
EEC	European Economic Community
ELC	Environment Liaison Centre
FAO	Food and Agriculture Organization (UN)
HAI	Health Action International
HFCS	High Fructose Corn Syrop
IARC	International Agricultural Research Centre
IBFAN	International Baby Food Action Network
ICDA	International Coalition for Development Action
ICGEB	International Centre of Genetic Engineering and Biotechnology
ILO	International Labour Office (UN)
IOCU	International Organization of Consumer Unions
MIRCEN	Microbiological Research Centre (UN)
OECD	Organization for Economic Co-operation and Development
OTA	Office of Technology Assessment (USA Congress)
PAN	Pesticide Action Network
PBR	Plant Breeders Rights
RAFI	Rural Advancement Fund International
SAN	Seeds Action Network
SCP	Single Cell Protein
TNC	Transnational Corporation
UNCSTD	UN Centre for Science and Technology for Development
UNCTAD	UN Conference on Trade and Development
UNEP	UN Environment Programme
UNIDO	UN Industrial Development Organization
UPOV	Union for the Protection of New Varieties of Plants
WHO	World Health Organization (UN)
WIPO	World Intellectual Property Organization (UN)

ANNEX 4

USEFUL PUBLICATIONS AND RESOURCES

PUBLICATIONS

I. *Selected Books and Reports*

UNCSTD, *ATAS Bulletin*. "Tissue Culture Technology and Development". Vol 1, No. 1. New York, Nov. 1984. 93 pp. (ATAS/UNCSTD, United Nations, New York, NY 10017, USA)

OTA, *Commercial Biotechnology, an International Analysis* U.S. Congress, Washington D.C., January 1984. 612 pp. (U.S. Congress, OTA, Washington D.C. 20510, U.S.A.)

OTA, *Technology, Public Policy and the Changing Structure of American Agriculture* Summary, U.S. Congress, Washington D.C., March 1986.
F.K. Beier et. al. *Biotechnology and patent protection*. OECD, Paris, 1985

Jack Doyle, *Altered Harvest*, Viking Press, New York, 1985, 502 pp. (ISBN 0-670-11524-X).

Edward Yoxen, *The Gene Business*. Pan Books in conjunction with Channel Four Television Company Limited. London 1983, ISBN 0-330-28112-7, 264 pp.

"Biotech 85: The World Biotech Report 1985." Proceedings of Biotech 85 Europe, Geneva, May 1985. Online Publications, Pinner, U.K. 1985.

John Elkington. *Double Dividend? US Biotechnology and Third World Development*. World Resources Institute Papers, no. 2. Washington, DC, USA. November 1986

Social Impacts of Agricultural Biotechnology Study Group, Department of Rural Sociology, Cornell University. Ithaca, NY 14853, USA. This group has produced several very interesting publications, some of which are:

> Jack Kloppenburg, Martin Kenny: "Biotechnology, seeds and the restructuring of agriculture". In: *The Insurgent Sociologist*, Vol 12, No. 3, Summer 1984.
>
> Martin Kenny, Frederick Buttel: "Biotechnology: Prospects and Dilemmas for Third World Development". In: *Development and Change*, Vol 16, 61-91, London 1985.

For a more complete list, write to the address above.

The biotechnology research team of the University of Amsterdam produces very useful materials, some of which are:

> Guido Ruivenkamp: "Biotechnology: the production of new relations within the agro-industrial chain of production". Paper presented at the Conference of the World Food Assembly. Rome, 12-15 November 1984
>
> Bijlman, v/d Doel, Junne: "The impact of biotechnology on living and working conditions in Western Europe and the Third World" University of Amsterdam, April 1986.

For a more complete list, write to: University of Amsterdam, Vakgroep Internationale Betrekkingen, Research Team on Biotechnology, Herengracht 510, 1017 CC Amsterdam, the Netherlands.

David Dembo, Clarence Dias, Ward Morehouse, "Biotechnology and the Third World: Some social, economic, political and legal impacts and concerns" In: *Rutgers Computer and Technology Law Journal*, Vol 11, No. 2. 1985.

II. *Selected Journals*

A) NGO and UN newsletters.

Seedling, bi-monthly bulletin of ICDA's seed campaign. General information on the seeds issue, including information on biotechnology. (for address of ICDA Seeds Campaign see "Resources" section)
IGRP Report, Quarterly newsletter of Rural Advancement Fund Int'l (RAFI). Information on Genetic Resources and related issues. (for address RAFI see "Resources" section.)

Bio/Communique is also published by RAFI on specific topics related to biotechnology and the Third World

GeneWatch, bi-monthly bulletin of the Committee for Responsible Genetics. Background information on several aspects of biotechnology, updates, activities, etc. (for address, see "Resources")

Genetic Engineering and Biotechnology Monitor, quarterly bulletin of UNIDO, free of charge. General information, news from the UN (especially ICGEB), country and company news, applications, etc. UNIDO, Industrial information section, PO Box 300, 1400 Vienna, Austria.

B) Some Commercial Magazines.

Agricultural Biotechnology News. Academic/Research News, Company News, Conferences, Governmental News, New Products. (PO Box 7, Cedar Falls IA 50615, USA)

Agricultural Genetics Report. Academic/Research News, Company News, Conferences, New Publications, Technical News. (Mary Ann Leibert Inc., 157 East Street, New York, NY 10028, USA)

Applied Genetics News. Company News, Governmental News, New Products, Patents, Technical News. (Business Communications Co. Inc., PO Box 2070C, Stamford, CT 06906, USA).

Biofutur (French). Background Articles, Company News, Conferences, Governmental News, New Products, New Publications, Patents, Technical News. (56, rue de l'Universite, 75007 Paris, France.)

Bio/Technology. Academic/Research News, Background Articles, Company News, Conferences, Governmental News, New Products & Publications. (Nature Publishing Co.. 15, East 26th Street, New York, NY 10010, USA)

European Biotechnology Newsletter. Academic/Research News, Company News & Surveys, Conferences, Governmental News, New Products Technical News. (Biofutur, 29 rue Buffon, 75005 Paris, France)

Genetic Engineering News. Background Articles, Company News, Conferences, Governmental News, New Products, New Publications, Technical News. (Mary Ann Leibert Inc. 157 East 86th Street, New York, NY 10028, USA)

These are just a few journals on biotechnology from the many that appear on the market. For a more complete list, write to: The European Biotechnology Information Project (EBIP), The British Library, 9 Kean Street, London WC2B 4AT, UK. EBIP also issue *EBIP News*, with useful information in the different fields of biotechnology.

RESOURCES: NGO NETWORKS ON BIOTECHNOLOGY AND RELATED ISSUES

Committee for Responsible Genetics (CRG).
CRG wants to "create a forum for discussing, evaluating and distributing information about the social impacts of genetic engineering". A useful newsletter is published bi-monthly by CRG ("GeneWatch", see section on periodicals).
Address: CRG, 186A South Street, Boston, MA 02111, USA. Tel: (617) 4230650.

International Network on the Social Impacts of Biotechnology (INSIB).
INSIB, also US based, wants to improve communication between concerned individuals and groups. They issue, and update, a useful resource guide with names, addresses, publications, etc.
Address: INSIB, Sheldon Krimsky (Network Coordinator), Department of Urban and Environmental Policy, Tufts University, Medford, Massachusetts 02155 USA

Foundation on Economic Trends
Focusses especially on legislative action on the release of genetically altered organisms.
Address: 1346, Connecut Av., Nw. Suite 1010, Washington DC 20036, U.S.A.

Genetischen Netzwork
German based, recently launched. Wants to facilitate information exchange and networking on biotechnology among interested groups.
Address: Potsdamerstr. 96, 1000 Berlin 30. Tel: 30-2618500

Seeds Action Network (SAN)
Launched in 1985, active on genetic resources and related issues, monitoring the seeds industry, also interested in biotechnology. Contact points:

Europe/Australia/Nw Zealand:
ICDA seeds campaign
Apartado 23398
08080 Barcelona, Spain
Tel: (3) 2158949

North America:
Rural Advancement Fund
PO Box 1029, Pittsboro
NC 27312, U.S.A.
Tel: (919) 5425292

Africa:
ELC
PO Box 72461
Nairobi, Kenya
Tel: (254) 24770
or: PAFATU
B.P. 7130
Togo, Lome
Tel: 216259

Asia:
Sahabat Alam Malaysia
37, Lorong Birch
Penang, Malaysia
Tel: (04) 376930

Pesticide Action Network (PAN)
Active on the use, regulation and export of pesticides, monitoring TNC that operate in this field, also interested in biotechnology. Contact points:

Europe:
PAN-Europe
22, rue des Bollandistes
1040 Brussels, Belgium
Tel: (2) 7352431

North America:
Pesticides Education and Action Project
P.O.Box 610
San Francisco, CA 94101, USA
Tel: (415) 4337373

Latin America:
Fundacion Natura
Casilla 243
Quito, Equador
Tel: 239177

Asia/Pacific:
IOCU
PO Box 1045
Penang, Malaysia
Tel: (04) 20391

Africa:
ELC (see under SAN)

Health Action International (HAI)
HAI is working to further the safe, rational and economic use of pharmaceuticals worldwide. Contactpoints:

IOCU
PO Box 1045
Penang, Malaysia
Tel: (04) 20391

HAI European Coordinator
c/o Emmastraat 9
2595 EG The Hague
The Netherlands

International Baby Food Action Network (IBFAN)
Contact: Case 157, 1211 Geneva 19, Switzerland.

ABOUT ICDA

ICDA is a network of over 500 development oriented groups and agencies in 21 industrialized countries. The network is committed to building a more just and equitable international order. ICDA provides the framework for development groups working at national level, to:

* undertake joint campaigns to raise public awareness of development issues and their underlying causes
* exchange ideas and experiences on action models and campaign strategies
* create channels of communication between development groups in the North and their counterparts in the South, and hence to develop understanding of the particular problems faced by Third World groups
* initiate and maintain active links between development groups and other important people's movements such as trade union's, women's organizations, the peace movement and environmental action groups
* be informed on a regular basis about issues and events affecting the relations between industrized countries and the Third World.

ICDA SEEDS CAMPAIGN.

ICDA Seeds Campaign started 8 years ago with the main campaigning focus on preventing national monopolistic control on plant genetic resources and pressing for the adoption of an international convention to regulate the exchange and conservation of genetic resources by the United Nations. Emphasis is also placed on the development educational aspect of the seeds issue in order to raise awareness and stimulate public participation in the Seeds Campaign.

ICDA considers the seeds campaign as a fundamental part of the struggle for sustainable agriculture in both developed and developing countries insofar as erosion of genetic diversity and increasing monopolistic control over genetic resources by a few multinational corporations, threaten the very basis of sustainable agriculture.
The work of ICDA's seeds campaign includes or has included:

* Publication of information on genetic resources in ICDA News, the monthly newsletter of ICDA
* Publication of SEEDLING, the bi-monthly newsletter of the seeds campaign. SEEDLING reports on new developments in the seeds issue, news from the different national seed groups, lobby preparations and results, meetings, etc.
* Publication of a study on the European Seeds Industry, analysing multinational involvement in the seeds sector in Europe and reviewing the current monitoring and research activities of NGO's in this field
* Preparation of a slide-show kit (over 300 slides) on seeds for use and adaptation by national seed groups. This already resulted in the production of slide-shows in 6 different European languages
* Support for the work of national seed groups by providing information and research
* Organization of regular Seeds Campaign Meetings, where organizations active in the Seeds Campaign come together, report on their work and discuss future activities

For further information contact:

ICDA Seeds Campaign, Apartado 23398, 08080 Barcelona, Spain.
Telephone (34) (3) 215 8949.

NEW HOPE OR FALSE PROMISE ?

BIOTECHNOLOGY
AND
THIRD WORLD AGRICULTURE

Few technologies have raised such expectations as the newly emerging biotechnologies. Hopes have been expressed that finally a technology is being developed which will contribute to the elimination of malnutrition, hunger and starvation. These hopes are based on the potential agricultural applications of biotechnology especially in the Third World. Drawing on the experience of the Green Revolution, NEW HOPE OR FALSE PROMISE? analyzes this potential and describes the context in which this new technology is being developed. The main actors in developing biotechnology are the same transnational corporations which already control the agro-chemical and pharmaceutical market, and during the past decade have taken control over a major part of the seeds sector. For them biotechnology also has powerful potential - potential to further integrate global agricultural production into their main fields of interest.

In this context, biotechnology is likely to result in a new international division of labour, decreased value of agricultural raw materials traditionally produced by the South, and enhanced dependence of the Third World on externally produced inputs and on the industrialized nations in general. Whether biotechnology will be a "new hope" for the poor in developing countries, depends largely on whether this monopolistic control of the new technology can be challenged.

The message is that it is not too late. While general awareness of the impact of the Green Revolution came a decade after the "miracle seeds" started to reach the farmers' fields, there may still be time to raise some crucial questions about the bio-revolution, namely, **how** should it be developed, **by whom** and **for whose benefit**. NEW HOPE OR FALSE PROMISE? concludes with a discussion on the possibilities and problems related to the appropriation of biotechnology by the Third World for its own legitimate needs and on the role that NGOs can play in that process.

This booklet is intended to be a contribution to a better understanding of the likely impact of biotechnology. It also aims to stimulate the debate on whether and in which ways, the technology should be developed, used and controlled.

icda

International Coalition for Development Action
22 Rue des Bollandistes, 1040 Brussels, Belgium

Price: $US 5.00, plus postage and packing, US$2.50 from ICDA