Genetically manipulated organisms: international policy-making and implications

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The fast-moving field of recombinant DNA technology will lead to large-scale releases of genetically manipulated organisms into the environment. Abby Munson argues that allowing such releases to proceed in the threadbare international policy infrastructure, resulting from the United Nations Conference on Environment and Development (UNCED) process, involves potentially serious implications for both national and global security.

A scientific revolution which began in the 1970s has been steadily gaining momentum. *In vitro* recombinant technology was then successfully achieved by accurately splicing and then rejoining (recombining) pieces of DNA. This new variant of biotechnology—referred to as genetic engineering, genetic manipulation, or genetic modification—enables scientists to move genes between organisms or to mass produce inserted genes.

Professor William Stewart, the UK government's chief scientific adviser, has said that genetic manipulation of organisms 'will have as important an impact over the next forty years as splitting the atom has had over the past forty years'.[1] Allan Bromley, former President Bush's science adviser, believes that while physics and chemistry have dominated world economies since the Second World War, in the future that role will belong to biotechnology.[2] These two chief scientists are not alone in holding these views. The prospect has emerged of a whole new generation of genetically manipulated products, with profound implications for the existing food, pharmaceutical, chemical and agro-chemical industries. Furthermore, because of the potential for innovative biological weapons, there are also potential implications for military security.

In March 1992 *Business Week* quoted industry forecasts of $50 billion worth of biotech products being on sale world-wide by the year 2000. A significant proportion of this business will be based on genetic manipulation of organisms

[1] W. Stewart, in 'Biotechnology 8, genetic engineering and the environment: a marker from the Royal Commission', Environmental Data Services, Jul. 1989, no. 174, p. 11.

[2] Cover story, J. O'C Hamilton, E. T. Smith, L. Armstrong, G. Smith, 'Biotech: America's dream machine', *Business Week*, 2 Mar. 1992, pp. 66–94.

for release to the environment. It is widely acknowledged that the first large-scale commercial releases of genetically manipulated organisms (GMOs) are not far off.[3]

The United States Vice President, Al Gore, is among a growing number of politicians who perceive a missmatch between technical progress in the field of genetic manipulation and the pace of regulation. 'The speed of current developments in biotechnology,' he said in 1991, 'contrasts sharply with the lethargy in the policy debate... we cannot lose sight of the larger policy questions that will determine whether our ability to manipulate the basic processes of life will benefit the world community'.[4] Gore's view is in step with the conclusions of a number of expert groups, who in recent years have recommended the need for stronger international control of GMOs.[5] In the run-up to the United Nations Conference on Environment and Development in June 1992, many governments recognized the need for international discussion on the subject. Biotechnology was placed on the UNCED agenda at an early stage, both within the negotiations for a Biodiversity Convention, and within UNCED's 'programme of action', *Agenda 21*.

This article first surveys the political process leading to the provisions agreed for GMO technology at the Earth Summit a year ago, and the extent of those provisions. It then goes on to examine in detail the ability of Brazil, a key developing country, to regulate the release of GMOs. Brazil is pivotal in the international policy debate because it is outstandingly rich in natural genetic resources: it has its own nascent biotechnology industry, it is host to multinational biotechnology interests, but as yet it has not set up formal regulations. Finally, a survey of the UNCED framework and the case history of Brazil provides the basis for an analysis of the wider implications of emerging GMO policy-making for the international community.

Recent international policy-making on genetic manipulation

In 1990, two years before the Earth Summit, multilateral negotiations began with the aim of creating a Convention on Biological Diversity, and a programme of action, *Agenda 21*, whose purpose was to provide governments with a guide to achieve sustainable development. The biodiversity talks involved five Inter-governmental Negotiating Committee (INC) meetings. The *Agenda 21* talks required four Preparatory Committee (PrepCom) meetings, both of which addressed the role of GMO technology in sustainable development.

[3] RCEP, 13th Report, 'The release of genetically engineered organisms to the environment', (London: HMSO, Jul. 1989), p. 2.

[4] Al Gore, 'Planning a new biotechnology policy', *Harvard Journal of Law & Technology*, Fall 1991, vol. 5, pp. 19–30.

[5] UNIDO/UNEP/WHO/FAO Working Group on Biosafety, 'Voluntary international code of conduct for the release of organisms into the environment', Jul. 1991; WRI, IUCN, UNEP, 'The global biodiversity strategy,' May 1992, p. 47; RCEP 13th report, p. 89; J. M. Tiedje, *et al.*, Ecological Society of America (ESA), 'The planned release of genetically engineered organisms: ecological considerations and recommendations', *Ecology*, vol. 70. Apr. 1989, no. 2, pp. 298–315.

Two factors made the *Agenda 21* negotiations particularly complex: first, in a structural sense, biotechnology and biodiversity were negotiated separately, despite being interrelated. In the INC negotiations, they were pooled from the start. Second, from the legal perspective, there was a tendency for progress in the *Agenda 21* negotiations to be contingent on progress in the INC sessions, because the Biodiversity Convention was a binding instrument of international law, whereas the *Agenda 21* document was not. In both fora, prolonged discussions took place on two particularly controversial issues: the first on suitable safety precautions on biotechnology, and the second on the exchange of biological resources in return for access to biotechnology. These issues are now considered.

I Biosafety

Laissez-faire versus regulation

The framework for international biosafety policy was a matter of controversy because some nations, such as Sweden and Malaysia, believed international legally binding biosafety regulations essential, whereas the United States opposed a legally binding convention and a voluntary code of conduct on biotechnology, preferring to leave the issue for domestic policy-making.

At PrepCom meetings, the US delegation insisted that every reference on safety should be removed from the working documents. At PreCom 3, for example, they wanted the phrase 'monitoring and evaluating the effectiveness and safety' of biotechnology changed to 'evaluating the success' thereof. 'Whether an organism has been manipulated or not does not bear on risk to the environment', a US delegate stated. 'To treat GMO's as inherently dangerous because of the way they have been produced is to put ourselves in an uncomfortable and wholly unnecessary regulatory straight jacket.'[6] The Japanese were vocal in support of the US on this point.[7]

The US administration's position at UNCED was an inevitable outcome of former Vice President Dan Quayle's Competitiveness Council, which promoted new biotechnology as a potential multi-billion dollar industry, capable, in principle, of leading the United States out of recession. Quayle's Council launched a 'Scope' policy document which argued that GMOs posed no greater threat to the environment than non-genetically engineered organisms; that products resulting from genetic manipulation technologies should be regulated the same way as any other product; and that any new regulation would endanger the potential economic returns from the industry, so prejudicing the United States' competitive edge over the Japanese and the Germans.

The United States' position on biosafety, however, was at odds with many of the views of American ecologists. The US Ecological Society (ESA) contested,

[6] US intervention in WG1, PrepCom 3, Geneva, 22 Aug. 1991.
[7] Interview with Japanese delegate, Masato Fukeshima, PrepCom 3, Geneva, 22 Aug. 1991.

in a 1989 report, a number of the sanguine assertions commonly made by biotechnology practitioners about the inherent safety of GMOs.[8] Quayle's advocacy of deregulation also contrasted strongly with statements on environmental regulation in two EC directives, on the contained use and the deliberate release of GMOs, that recognize the unique character of GMO products and processes and therefore regulate them accordingly, separately from non-genetically manipulated products and processes.

In the United Kingdom, for example, parliament, in enacting the directives, accepted that 'separate provision for the protection of the environment is necessary, particularly in view of the fact that the proposals to release GMOs to the environment are likely to increase significantly'.[9] This position had been influenced by UK-based threat assessments. In 1989, for example, the 13th Report of the UK's Royal Commission on Environmental Pollution (RCEP) had warned of the potential dangers accompanying genetic engineering. The Commission concluded that while the risk resulting from the use of the technology was low, should such hazards occur their consequences would be serious. 'At the most extreme,' the Royal Commission concluded, 'new organisms could conceivably affect major environmental processes such as weather patterns, the nitrogen cycle or other regenerative soil processes'.[10]

The German delegation argued in PrepCom 3 that 'biotechnology is not an environmentally friendly technology "as such"—its use may also involve damage.' The Swedish delegation from the start of the PrepCom process argued that there is a fundamental difference between the 'new' recombinant DNA biotechnology and other biotechnologies. 'We don't agree with the US', the Swedish delegation stated. 'You cannot play down the risk because it does matter if it has been genetically manipulated.'[11]

All member states of the European Community were in agreement with the conclusions of the 'Global Biodiversity Strategy', a report by the World Resources Institute (WRI), the United Nations Environment Programme (UNEP), and the World Conservation Union (IUCN), which stated that an International Code of Conduct on biotechnology should be developed 'to regulate biotechnology at all levels'.[12] According to the Portuguese Secretary of State for Foreign Affairs and Cooperation, speaking on behalf of the EC and its members states, the framework on biosafety agreed in *Agenda 21* should 'be regarded as a basis for the preparation of an international legal instrument (on biosafety)'.[13]

Many developing countries were in agreement with the EC, pointing to the need for a voluntary international code of conduct and prior informed consent for GMO releases, but certain developing countries wished to go further. A

[8] Tiedje, *et al.*, 'The planned release of genetically engineered organisms.'
[9] Health and Safety Commission consultation paper, 'Genetically modified organisms: proposed new regulations', Oct. 1991, p. A3.
[10] RCEP, 13th report, p. 18.
[11] Swedish intervention in WG1, PrepCom 3, Geneva, 22 Aug. 1991.
[12] WRI, IUCN, UNEP, 'The global biodiversity strategy', p. 47.
[13] Statement made by the Portuguese Secretary of State for Foreign Affairs and Cooperation on behalf of the EC and its member states, PrepCom 4, New York, 20 Mar. 1992.

Philippine's delegate, proposing a mandatory code, professed that 'there are also a lot of negative elements of biotechnology'.[14] The Malaysians warned of the dangers of legislation potentially legitimizing uncontrolled experiments.[15] They shared the view, expressed by a UNEP official, that 'if TNCs follow a Code of Conduct and something goes wrong no-one will blame them'.[16] Malaysia, accordingly, proposed that any legislation must include strict liability and compensation.

At the time of PrepCom 3, the draft of *Agenda 21* referred in a bracketed text to the need to 'consider the possibility of developing an international Code of Conduct'.[17] Governments negotiated the final wording of *Agenda 21* behind the doors of a biotechnology contact group in Rio. On 8 June, delegates of Sweden, Malaysia, the Philippines and Costa Rica went so far as to state they could 'without any problems' sign the Citizen's Commitment on Biotechnology, a document drawn up by non-governmental organizations during the UNCED process, calling for an international binding agreement on biosafety regulations, and emphasizing the precautionary principle and the principle of 'strict financial liability for any damages or consequences' resulting from any of the new biotechnologies.[18]

The UNCED compromise

The compromise package ultimately reached for biosafety issues during the UNCED process was as follows: Article 19 of the Biodiversity Convention, negotiated in the final INC in Nairobi during May 1992, obliges contracting parties to 'consider the need for and modalities of a protocol setting out... the safe transfer, handling and use of any living modified organism resulting from biotechnology'. Chapter 16 of *Agenda 21*, on the 'Environmentally Sound Management of Biotechnology', requires governments to 'consider the need for and feasibility of internationally agreed guidelines on safety in biotechnology releases.'

The Swedish and British governments decided not to push for tougher language in *Agenda 21*, but to wait for the first meeting of the Conference of the Parties. They believed that by leaving open the possibility of a protocol on biosafety, the Convention would invoke the prospect of a legal entity far more substantive than international guidelines.

Although the US delegation had played a full part in negotiating the final compromise language on biosafety, at the Earth Summit itself President Bush was alone among OECD countries in not signing the Convention on Biological Diversity. Late attempts by Environmental Protection Agency administrator William Reilly to revise the compromise wording failed to change Bush's

[14] Interview with Philippine delegate, PrepCom 3, Geneva, 20 Aug. 1991.
[15] Document submitted by Malaysia to UNCED, 'Notes on biotechnology for submission to the National Steering Committee on UNCED', 1991.
[16] Interview with UNEP Official, PrepCom 3, Geneva, 21 Aug. 1991.
[17] UNCED Secretariat, Document PC42, Add. 5, Para. 22.c.
[18] 'Citizen's commitment on biodiversity ready for signature', NGO press release, Rio de Janeiro, 9 Jun. 1992.

position.[19] The reason Bush gave was that 'US economic interests must take priority over "extreme" environmental concerns'. He further argued that the competitiveness of the US biotechnology industry would be impaired, and American jobs would be threatened by the intellectual property and financial considerations in the Convention.[20] Protecting the US biotechnology industry in this way, Bush declared, 'will benefit Brazil and every other country; because it is our science, our technology that helps the world the most... in this instance, not signing is the best for the rest of the world'.[21]

Even under the terms of the Convention they had negotiated, but failed to sign, the Bush administration envisaged that any discussions on biosafety by the Conference of Parties would only cover guidelines.[22] But the Clinton administration, which announced in April 1993 that the United States would be signing the Biodiversity Convention, now has the option of revising many of the US views advanced during the INC negotiations. However, by the end of May 1993, the Clinton administration was circulating an interpretive statement the terms of which are reportedly causing concern in European governments. A common behind-the-scenes view from European diplomats in Rio was that the contracting parties would use the Biodiversity Convention to establish a Code of Conduct, and even move on to a biosafety convention, with or without the Americans.

II The politics of germplasm

The development issue

The second of the two major discussion points in the UNCED process involved the exchange of biological resources in return for access to biotechnology.[23] The background to the biodiversity debate is well known. A common estimate for the number of animal and plant species on the Earth is 30 million, of which only about one and a half million have ever been described. The best estimates suggest that about one-quarter of the Earth's species are at risk of extinction within the next 30 years.[24] Biodiversity and the genetic resources it harbours, quite apart from other considerations, are valuable. Trade in agricultural products amounted to $3 trillion in 1989,[25] and medicines from plants are now worth $40 billion a year.[26] If genetically manipulated genetic resources become patentable there would be a huge global increase in patent royalty charges.

[19] A. Munson, 'The United Nations Convention on Biological Diversity,' in, *The Earth Summit agreements: a guide and assessment* (London: Energy and Environment Programme, Royal Institute of International Affairs, Apr. 1993).

[20] D. Pitt, 'European envoys come to US aid', *Earth Summit Times*, Rio de Janeiro, 6 Jun. 1992.

[21] T. Braga, '"I'm not president of the world" says Bush', *Journal do Brasil*, Rio de Janeiro, 14 Jun. 1992.

[22] Interview with UK delegate, Rio de Janeiro, Jun. 1992.

[23] Biological resources include genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity. Germplasm includes genetic material, especially its specific molecular and chemical construction, that comprises the physical basis of the inherited qualities of an organism.

[24] Cover story, 'The state of the global environment', *Our Planet*, (Nairobi: UNEP, 1992), vol. 4, no. 2, p. 7.

[25] 'The global biodiversity strategy', p. 3.

[26] Cover story, 'The state of the global environment', *Our Planet*, pp. 4–8.

A primary consideration for those industrialized countries at UNCED was guaranteeing access to, and protection of, biological resources in the developing countries, where most biodiversity is to be found; developed countries hope to make large profits by patenting manipulated genetic material. The United States and the European Patent Offices have granted patents covering both plants and animals, and the EC Commission, despite considerable public protest against animal patenting, has proposed a directive to allow for the patenting of life. The developing countries, for their part, sought sovereign rights over the biological resources from their territories. They also insisted that they should have access—on concessional terms—to benefits resulting from the use of such resources in biotechnology.

The Convention issue

All OECD countries, except for the United States, felt able to accept the wording in the Biodiversity Convention on the need for concessional and preferential exchange of biotechnology with other countries. The final agreement on this exchange was as follows: Article 16 of the convention states that access to and transfer of biotechnology 'shall be provided and/or facilitated under fair and most favourable terms, including on concessional and preferential terms'. In addition, Article 19 requires 'priority access on a fair and equitable basis by Contracting Parties, especially developing countries, to the results and benefits arising from biotechnologies based upon resources provided by those Contracting Parties'. Such access is qualified as being 'on mutually agreed terms.'

Chapter 34 of *Agenda 21* proposes the following objectives: 'to promote, facilitate, and finance, as appropriate, the access to and the transfer of environmentally sound technologies and corresponding know-how, in particular to developing countries, on favourable terms, including on concessional and preferential terms as mutually agreed, taking into account the need to protect intellectual property rights as well as the special needs of developing countries for the implementation of *Agenda 21*.'

The degree to which technology will be transferred on 'concessional' and 'preferential' terms in practice will depend on legal and political interpretation, and will without doubt become a dominating discussion at the Conference of Parties of the Biodiversity Convention.

President Bush believed the final wording in the Convention compromised existing US patent standards, and would constrain the growth of dynamic research communities developing biotechnology in the United States, so threatening US jobs. Only months before the Earth Summit, he had launched a Presidential Biotechnology Initiative in the United States, a plan to increase federal support for basic biotechnology research to more than $4 billion per annum.

Most governments and observers, however, judge that the Convention does not in fact pose a significant threat to business, partly because the ambiguous

wording of parts of the Convention allows permissive legal interpretation. For example, the language covering the terms for transfer of biotechnology—'fair and most favourable'—have not themselves been defined. In addition, any agreement on technology must recognize 'effective protection' of intellectual property rights. Yet such 'effective protection' is left open for national interpretation.

The Convention on Biological Diversity reaffirmed that states have sovereign rights over their own biological resources. The issue of how and who to reward for the contribution of genetic resources was also discussed in the negotiations. Almost all governments acknowledged that countries rich in germplasm should be compensated for their contributions to future technologies. However, which states were to be rewarded remained an issue. Mexico, for example, said that the country of the germplasm's original provenance should receive the rewards. India, however, disagreed, arguing that as well as the country of origin, countries supplying non-native germplasm should also be entitled to rewards. Not one country was in favour of the Ethiopian proposal to make rewards retrospective. That would have made compensation payable on past germplasm collections gathered from the South and now stored in gene banks in the North. Both *Agenda 21* and the Convention on Biological Diversity omit nation-states' sovereign rights to the germplasm collected and stored in such a way. The great proportion of such germplasm will, therefore, remain under the charge of the Consultative Group on International Agricultural Research (CGIAR), a body controlled by is donors—mainly from the North.

Implications of the policies agreed during the UNCED process

The collage of compromises agreed during the negotiation of the Biodiversity Convention and *Agenda 21* has, therefore, resulted in something of an international policy vacuum. Meanwhile, the rapid pace of development in genetic engineering technology means this situation and its implications need further investigation.

The Preamble to the Earth Summit's Rio Declaration recognizes that the international community and national communities are dependent on each other for their common security—environmental, agricultural or otherwise.[27] With respect to GMOs, this interdependence is axiomatic, given the innate irrelevance of national boundaries once GMOs have been released into the environment, plus the impossibility of recalling a GMO once it has been released.

Principle 6 of the Rio Declaration commits the governments of developed countries to 'address the needs and interests of developing countries.' With regard to GMO technology a number of expert studies have described the

[27] The Rio Declaration was one of the five agreements to emerge from the Earth Summit. It is a declaration of principles to underpin government action on environment and development issues.

unique difficulties developing countries face.[28] The UNCED compromise on biosafety nonetheless leaves developing countries to set up their own national GMO policies in a vacuum. Meanwhile, the first large-scale commercial releases draw ever closer.

A case-study of the state of GMO policy-making in a developing country is, therefore, germane to the wider analysis of where the UNCED agreements on GMO technology leave the international community.

Brazil: a case history

Background

Brazil's problems with regard to policy-making on biosafety are similar to those many developing countries are experiencing today, or are likely to experience in the future. Brazil has not yet set up regulations on release, but it already has genetically manipulated products on sale commercially and it is developing biotechnology within it's own public institutions, university laboratories, and private industry. It is host to a number of transnational corporations with interests in biotechnology and it has the added attraction of a rich abundance of germplasm within its rainforests, available, in principle, to non-national interests in return for access to biotechnology.

Attitudes, practice and plans on deliberate release

As far as biosafety is concerned in Brazil, no federal law, regulation, guidelines, or effective safety measures currently cover the release of GMOs to the environment. Professor José Goldemburg, ex-Minister for Science and Technology, speaks for many in the Brazilian government when he claims that the risks of GMO hazards have been 'grossly exaggerated'.[29] A proposal for a new law on biosafety was introduced into the Brazilian Congress in the late 1980s. Both the Brazilian Biotechnology Association (ABRABI), and the Secretariat for Science and Technology recommended amendments reflecting their belief that the bill was too concerned with the potential hazards associated with the technology.

The following account dates from the Summer of 1992, when I conducted more than 50 interviews with officials, scientists, politicians, and industrialists in Brazil, before and after the Earth Summit. At that time, apart from those in ABRABI and the Secretariat for Science and Technology, few government officials, business people or academics in the relevant fields, were aware of the proposed biosafety law, or its contents.

No one within the Brazilian Ministry of the Environment appeared to be

[28] 'The global biodiversity strategy', p. 60; InterAmerican Institute for Cooperation on Agriculture, 'Guidelines for the release into the environment of genetically modified organisms', p. 9, Costa Rica, Jun. 1991; RCEP, p. 89; Report of the Informal UNIDO/WHO/UNEP Working Group on Biotechnology Safety, 4th Meeting (UNIDO, IPCT.113), p. 7, Vienna, Austria, 18–19 Dec. 1989.

[29] Telephone interview with José Goldemburg, Brasilia, Jul. 1992.

responsible for input into biotechnology policy-making, or for the analysis of the ecological consequences of releases.[30] The Ministry of Agriculture and the Ministry of Health were also taking a back seat in the activities, leaving the major responsibility for biosafety to the Science and Technology Secretariat, which is also the Secretariat responsible for the promotion of biotechnology. The Ministry of Health's National Institute of Quality Control for Health (INCQS)—the institute responsible for analysing the safety of drugs, cosmetics, and some foods—had no internal capacity for policy-making, no future plans, or knowledge of anyone else in the Ministry of Health who could analyse genetically manipulated products.[31]

Officials have suggested São Paulo's state environmental pollution control agency (CETESB), and the State of Rio de Janeiro's Foundation of Environmental Engineering (FEEMA)[32], as possible monitoring and enforcement agencies. However, neither FEEMA nor CETESB have the facilities, staff, or expertise to control or monitor GMO releases to the environment.[33]

Meanwhile, in the absence of government guidelines, Brazilian scientists are clearly preparing to release GMOs. For example, one academic in the Department of Genetics at the Federal University of Rio de Janeiro, professed himself willing to test on the campus, where the department had cultivated land.[34] Dr Maria José Sampio, Chief Technical and Research Director at the Brazilian National Centre for Research in Biotechnology (CENARGEN, the main biotechnology agency within the Ministry of Agriculture) believes such unregulated field tests will become a fact of life in Brazil. Furthermore, the government has not kept track of existing proposals for GMO releases to the environment. For example, the research branch of the Ministry of Agriculture (EMBRAPA) were approached by the transnational corporation Monsanto, which requested land on which to test a transgenic cotton. Dr Sampio says that EMBRAPA were not aware of the potential hazards associated with the test, and were about to allow Monsanto to test the crop in the middle of the cotton producing region. She was only able to postpone this experiment because she found out about it by chance.

It is unlikely, moreover, that effective scrutiny of GMO products, or products which have used GMO techniques in their manufacture, will be possible before they reach the market. An example is Monsanto's product, 'lactotropin', a genetically manipulated bovine-somatotropin hormone (BST). BST is a natural hormone which regulates the production of milk in cows. If genetically manipulated, and injected into cows, it is said to increase the milk

[30] Interviews with the Director of Department of Planning and Coordination of Environmental Policy, Ministry of the Environment, and an interview with an official of the Department of Research and Control (IBAMA), also within the Ministry of the Environment, Brasilia, Jul. 1992.

[31] Interview with an official at the INCQS, Rio de Janeiro, Jun. 1992.

[32] Interview with the Programme Director, Secretariat of Science and Technology, and an interview with an official at IBAMA, Brasilia, Jun. 1992.

[33] Interview with an ex-Director of Pollution Control Department, FEEMA, May 1992, Rio de Janeiro, and with officials at CETESB, São Paulo, Jun. 1992.

[34] Interview with academics at the Department of Genetics, Federal University of Rio de Janeiro, May 1992.

yield. Transnational corporations have spent a total of over $100 million internationally on the development and promotion of BST. The United States government and the European Commission have not yet approved the product because the risks associated with its use are still believed to be improperly understood.

In 1986, Monsanto argued that due to the high level of administration needed to farm and market genetically engineered BST-treated cows and their milk, the technology was not appropriate for developing countries. But subsequently and after failing to win approval of the product in the United States and Europe—as a result of which Monsanto lost $42 million in 1989 promoting and defending the product—their marketing efforts turned to the developing world.[35]

Monsanto's Manager of Manufacturing in Brazil claimed lactotropin had been approved by the Ministry of Agriculture. However, the Chief Technical and Research Director within CENARGEN, as well as other relevant agencies, had no knowledge that lactotropin was being sold in Brazil, and disagreed about which Ministry should have examined the product before it went on sale.[36]

Guaranteeing the safe development of biotechnology in Brazil would also depend on whether the domestic biotechnology industry would comply with biosafety regulations. The Brazilian company Vallee, for example, has projects to develop vaccines against salmonellosis and coli baculosis using genetic manipulation, but a director of technology in the company has said that research on safe field trials 'is something very far from our ideology, to be honest'.

Patenting

The absence of a coherent international programme on the ownership of life has meant policy dilemmas for many developing countries which are of profound relevance to the issue of deliberate GMO releases into the environment. Brazil's situation in this regard is highly instructive. It was the first developing country to raise objections in the UN General Assembly to patenting.[37] However, President Collor's government soon fell into line with the emerging international norms, and proposed a domestic patent law. This policy reversal was not only in part due to a desire to attract advanced technology from abroad, and to remain part of the international market, but it was also in response to international pressure.[38]

[35] Rural Advancement Fund International (RAFI) communiqué, 'Third World marketing and promotion of biosynthetic milk hormone', *Information Release*, Oct. 1990, p. 2.

[36] Interviews with the Programme Director at the Secretariat for Science and Technology, the Director of Department of Planning and Coordination of Environmental Policy, Ministry of the Environment; the Chief Technical and Research Director within CENARGEN, Brasilia, Jul. 1992.

[37] 'Progress at the UN and the great reversal', *GATT Briefing* (Lyon: European Network on Agriculture and Development, RONGEAD, 2 Jul. 1990), no. 2, p. 2.

[38] Interview with Head of Department of Coordination for Technical Cooperation (INPI), Rio de Janeiro, 15 May 1992.

In 1988, Washington heard complaints from the US business community that Brazilian industry was 'pirating' (copying free) their patented inventions. This argument was contested by many in the Brazilian government, but using Section 301 of the 1988 US Omnibus Trade and Competitiveness Act, in October 1988 the United States imposed punitive retaliatory tariffs on Brazilian pharmaceutical and consumer electrical goods imported to the United States, of approximately US$39 million.[39] Two days after this President Collor proposed the new Intellectual Property Rights (IPR) revisions. The US trade sanctions against Brazil were lifted, but the United States continues to apply pressure, and Brazil is still on the US 'Priority Watch List'.[40]

Such unilateral action does little to quell the growing hostility felt by the developing countries on the issue of access by developed countries to biodiversity in the South in return for access by them to biotechnology in the North. Many in the Brazilian biotechnology community now identify with the sentiments of Dr Sampio, who, having once been a supporter of the patenting of biotechnology, changed her mind in the aftermath of US failure to support the Biodiversity Convention.

In 1991, proposals were put forward to update Brazil's existing 1971 Industrial Property Code that would include patents for chemical products, foods, chemical pharmaceuticals, and drugs—genetically manipulated or otherwise—which had until that time been excluded. Patenting for animals and plant 'varieties', however, were still excluded.[41] Until June 1992, there had been more than 600 amendments to the projected patent law, which still arouses much controvery among Brazilian deputies, not least because the definition of a micro-organism itself remains unclear.

Despite the number of amendments proposed in the Congress, there has been neither a proper debate about the potential consequences for Brazilian society of the proposed patent law, nor consideration of alternative property rights. A study commissioned by the Dutch Ministry of Foreign Affairs warned that the adoption of patents by developing countries is 'unlikely' to promote domestic private research.[42] Of the deposits of patents in the National Institute of Industrial Property (INPI), 90 per cent are by foreign companies, of which one US company, Genentech, has more than 55.7 per cent.[43] Most foreign patents granted in Latin American countries are never put to use there, but are held by companies to protect their imports.[44] With the US investing $6 billion dollars in the biotechnology field, compard to Brazil's $100 million, it is no wonder

[39] 'Brazil says US Sanctions breach standstill deal', London: *Financial Times*, 17 Oct. 1989, in 'Behind the TRIPs: the pressure from the north', *GATT Briefing*, (Lyon: RONGEAD, 2 Jul. 1990), no. 2, p. 2.

[40] 'Brazil to recognise biotechnology patents', *Biotechnology and Development Monitor* (The Hague: Directorate General International Cooperation of the Ministry of Foreign Affaris, and University of Amsterdam, Sept. 1991), no. 8, p. 18.

[41] Law No. 5772 (1971); Project of Law, no. PL824 (1991).

[42] 'The impact of intellectual property protection in biotechnology and plant breeding on developing countries', Report Commission by the Ministry of Foreign Affairs (performed by Study Committee on Biotechnology), The Hague, Jan. 1991, p. 34.

[43] Interview with official at FIOCRUZ.

[44] Report by Inter-American Development Bank, 1988, in H. Hobbelink, *Biotechnology and the future of world agriculture* (London: Zed Books, 1991), p. 100.

that some biotechnology businesses are not in favour of adopting patenting of living organisms in Brazil.[45]

One issue close to the hearts of many policy-makers in Brazil is compulsory licensing. A proposal in Congress for a law on industrial property includes compulsory licensing, which grants the government authority to force a patent holder to surrender exclusive monopoly over a patent and allow third parties to develop and commercialize the patented product in the interests of public health or national security. In this it follows the World Intellectual Property Organisation developing country Model Law and the Paris Convention. For a developing country such as Brazil, this is an obvious anti-trust measure. A good example of the kind of problem arising from this issue involves a technique used in genetic manipulation, polymerase chain reaction (PCR), which is being used at the Ministry of Health's Oswaldo Cruz Foundation (FIOCRUZ) in work on Chagas disease, a type of sleeping sickness. Without compulsory licensing, this research may suffer, because patents will award exclusivity of PCR to the existing patent owner, who, provided they use PCR somewhere else in the country, do not have to grant FIOCRUZ permission to use it.[46]

The costs of filing for a patent—as well as the cost of any subsequent legal battles—make it almost impossible for most of those involved in research and development in Brazil either to obtain, or maintain, a patent. For example, in 1987 Monoclonal Antibodies had to pay US$2.25 million, not including royalty fees, to Hybritech in a biotechnology patent law suit.[47]

If Brazil adopts stricter patent laws on biotechnology products there are strong indications that health treatment so vital for Brazil's needs could become more expensive. FIOCRUZ, for example, is studying a very powerful component produced by *Quebra pedra*, a plant which grows in most Brazilian gardens. Dr Sampio has claimed that the dried leaves of this plant can cure Hepatitis B—a major disease in developing countries. Yet a US company has already patented the whole plant. As a result, FIOCRUZ, and other laboratories outside Brazil working with this plant, would not have a chance to continue these studies, if IPR were adopted, without permission.

Implications of Brazil's policy-making

Both biosafety and patenting in Brazil are clearly in a state of considerable confusion and flux. This is a situation which has profound implications both nationally and—as argued in the next section—internationally. As it stands the biosafety regime in Brazil cannot be of satisfaction to anyone except the most diehard advocate of unconstrained GMO releases. If piecemeal, unregulated, GMO releases go ahead—as seems almost certain under the current impasse—the extent of the implications for environmental security cannot be predicted, but they would certainly be profound. The temptation offered to

[45] Interview with official at FIOCRUZ, Rio de Janeiro, May 1992.
[46] Interview with official at FIOCRUZ.
[47] 'From cabbages to kings? Patents, politics and the poor', *Development Dialogue*, (Uppsala, Sweden: Dag Hammarskjöld Foundation, 1988), pp. 237–54.

Brazil-based transnationals to pursue 'biotechnological tourism', of the kind that would never be permitted in the developed countries, only compounds this problem.

As far as patenting is concerned, the current regime—imposed in large part as it has been by overseas pressure—presents real risks for a range of Brazilian security concerns. Among these, patents stand to benefit overseas interests rather than domestic interests. The cost to domestic companies and domestic health care may be considerable.

All this is not going unnoticed in Brazil. On the patenting issue, there are whiffs of retaliation in the corridors of government. EMBRAPA, the Ministry of Foreign Affairs, the Secretary of Science and Technology, and the Secretariat of the Environment (SEMA), in particular, are discussing a code of ethics. There is also increasing resistance to opening up the country for the collection of biological material for export to and research in the developed world, and talk of screening all genetic collections and punitive sanctions against those unwilling to comply with inspections. In the final analysis, Brazil holds a crucial ace: a huge proportion of the world's terrestrial germplasm lies within its borders, and as such it carries a flag for other germplasm-rich developing countries.

International implications

Biosafety and environmental security

Once released to the environment, GMOs reproduce, possibly mutate, spread, and transfer the manipulated genes to other organisms, and in so doing have the potential to upset natural ecosystems. They may, in the worst-case—as the UK Royal Commission on Environment and Pollution concluded—cause catastrophic damage to the global environment. The RCEP warned that 'some releases may alter the diversity of species in the environment, including changing the composition of existing communities. Such effects could produce noticeable changes in the countryside, locally or more widely.'[48]

Protagonists of the technology claim that transferred genes are highly specific, and that risks of disturbing ecosystem stability are extremely small. The Ecological Society of America's (ESA) objections to this view have been discussed above, but one of them involves the fact that a gene is often responsible for more than one phenotypic trait, which may not be detectable at field trials. Once released to the larger environment, the gene, engineered into the plant or micro-organism, may work in an unforeseen manner, perhaps imbuing GMOs with added strengths or advantages in nature, and causing them to upset other species by occupying a parallel role, or by destroying habitats or food supplies of other species. This possibility has caused GMOs to be likened by some ecologists to exotic, non-native species, which, when introduced to new habitats, have commonly caused widespread unexpected

[48] RCEP, p. 18.

damage to ecosystems. A recent example involves the cane road (*Bufo marinus*), originally introduced to Australia from Hawaii to control an insect that was destroying sugar cane, but which is now becoming a serious pest. The Global Biodiversity Strategy pointed to the serious damage exotics can cause to ecosystems, particularly to island ecosystems.[49]

Those who claim that genetic manipulation has an inate safety mechanism point to the decreased viability of GMOs, relative to the natural organism, because of the additional energy required to carry and express additional genes. The RCEP however, believes 'there is no general support' for this hypothesis, and believes the fitness of a GMO could facilitate its transformation into a weed.[50] The ESA reported that natural 'selection after the release of the transgenic organism will tend to increase fitness, not decrease it.'[51]

In certain cases gene transfer may occur between genetically manipulated and non-manipulated plants, through hybridization or pollination. Norman Ellstrand, of the University of California, found that gene transfer occurred between a particular cultivated radish, Round Whites, and the wild radish, *Raphanus sativus*. Wild radishes containing the gene from the cultivated variety were found up to a kilometre away.[52] Gene transfer may have serious consequences for agriculture if, for example, a gene carrying the properties for herbicide tolerance transfers into a weedy wild relative of a crop, making that weed very difficult subsequently to control. In developing countries, where many of the wild relatives of the major food crops are found, this could, in principle, be a very serious problem. The potential for damage is obvious in Africa, where the sorghum cereal fields are often infested with wild relatives of the sorghum plant. The crop has been known to hybridize with the weed to produce a serious pest called 'shattercane'.[53]

Another example of the potential hazards associated with GMO technology is in the field of genetically manipulating micro-organisms. The exchange of genes within the microbiological community is common, yet we still know very little about micro-organisms, or their movements in the environment. In 1989 scientists found that one teaspoon of water from Lake Plussee in Germany contained more than 1 billion distinct viruses, a concentration ten million times greater than previously recorded.[54] The ESA observed that 'lateral transfer among micro-organisms in nature is neither so rare that we can ignore its occurrence, nor so common that we can assume that barriers crossed by modern biotechnology are comparable to those constantly crossed in nature'.[55]

Furthermore, there may be no way of knowing the outcome of a large-scale release by using the results from a small-scale field test. Professor William Stewart, introducing the RCEP report, concluded that 'there is therefore a risk that once released it will become impossible to control them... they may

[49] 'The global biodiversity strategy', p. 45. [50] RCEP, p. 30. [51] Tiedje, *et al.*

[52] A. Coghlan, 'Will altered crop genes run wild in the country?' *New Scientist*, 21 Mar. 1992.

[53] P. Hatchwell, 'Opening Pandora's Box: the risks of releasing GEOs', *The Ecologist*, Apr. 1989, vol. 19, no. 4, pp. 130–35.

[54] S. Witt, 'Biotechnology Microbes and the Environment', Briefbook, Center for Science Information, California, 1990, p. 104. [55] Tiedje, *et al.*, p. 304.

function in an unknown way if transferred in the environment to a new organism.'[56] Government departments may assert that they are using a precautionary approach towards conducting field trials prior to release on a large scale, but the reality seems to be that GMO releases may involve more of a 'trial and error' approach. As the RCEP concluded, 'there is a need for a substantially enhanced research base in the basic sciences underlying the release of genetically engineered organisms to the environment.'[57] The Global Biodiversity Strategy echoed these sentiments when it urged that 'the dangers of releasing genetically modified organisms should be more carefully assessed, especially where genetic diversity is high'.[58]

The UNCED negotiations showed that among governments there is substantial, but far from unanimous, political will for a comprehensive dialogue on biosafety, and appropriate international accords. That this will has failed, as yet, to find meaningful expression in policy-making is clearly not in the interests of environmental security. The case-study of Brazil suggests very strongly that, even if developed governments succeed in managing risk, so as to experience no serious ecological disturbances as a consequence of their own domestic licencing of GMO releases, the same may not be true of other countries, or of the activities of their own business community in other countries.

The concentration of control over food security and GMO releases

The biotechnology industry is becoming increasingly monopolized by transnational corporations whose activities involve one quarter of the world's most productive assets, and 70 per cent of products in world trade.[59] Where biotechnology is concerned, for example, one transnational, Bayer, may soon spend more money on biotechnology research than the whole of Latin America.[60]

The top ten transnational corporations already command more than 12 per cent of the global market in seeds. These companies include agrochemical and pesticide companies which are often buying seeds with the intent to manipulate them genetically to be tolerant of the pesticides they themselves sell. By the year 2000, just ten companies may effectively control the entire commercial seed market.[61] The now effectively disbanded United Nations Centre on Transnational Corporations found that the percentage of patents owned by transnationals is increasing rapidly in the biotechnology field at the expense of small industry.[62] Until April 1989, of the 147 applications for plant-related patents to the European Patent Office, one-third had come from just three transnationals (Lubrizol, Monsanto and Ciba Geigy).[63] Al Gore has said

[56] RCEP, pp. 83–4. [57] RCEP, p. 99. [58] 'The global biodiversity strategy', p. 47.
[59] 'Ongoing and future research: transnational corporations and issues relating to the environment', report by the United Nations Commission on Transnational Corporations (UNCTC), 5–14 Apr. 1989, p. 5. [60] *Biotechnology and Development Monitor*, Sept. 1990, p. 1.
[61] G. Kidd, in D. Goodman, M. Redclift, *Refashioning nature* (London: Routledge, 1991), p. 172.
[62] 'Benchmark corporate environmental survey,' UNCTC. ST/CT/SER.C/1 (New York: UN, 1991), p. 25.
[63] H. Hobbelink, *Biotechnology and the future of world agriculture* (London: Zed Books, 1991), p. 115.

that growing economic concentration in the field of biotechnology represents 'selling the tree of knowledge to Wall Street'.[64] To allow this degree of potential control over world food supplies to fall into the hands of a small number of transnationals raises security questions which go beyond just environmental considerations. But the potential for the concentration of GMOs in such a narrow sector of the business community has not yet been taken seriously by the policy-making community.

Expert groups have commented that existing systems of IPR may tend to reinforce the trend towards decreased genetic diversity.[65] But superimposed on a general tendency in agriculture towards uniformity in crops, whether transgenic or otherwise, this serves to compound the vulnerability. Some have called for the international oversight of transnationals' activities.[66] The Global Biodiversity Strategy pointed out that 'few developing countries possess the resources and capacities needed to control TNC operations within their own borders, let alone to police the transfer of profits offshore. Thus international action is also needed to improve TNCs environmental behaviour.'[67]

Before the Earth Summit, Al Gore recommended that governments should adopt a series of anti-trust laws to scrutinize business activities for potentially harmful environmental actions. Gore points to the example of chemical companies producing pesticides and fertilisers which then buy up seed companies, giving themselves the scope to select and breed seeds that maximize the use of their own chemical products, while neglecting other varieties that might feature a greater degree of natural resistance to pests. He recommended that in such cases, 'there ought to be a requirement to consider the potential for harmful consequences to the environment and, if necessary, the right to prevent such mergers'.[68]

UNCED ultimately failed to promote oversight of large corporations, wiping all references to prospective regulation of transnationals from *Agenda 21*. The only direct reference to business in *Agenda 21* is a section entitled 'strengthening the role of business and industry', located in a section on enhancing the rights of women, youth, and indigenous people. Business interests, represented by the Business Council for Sustainable Development and the International Chamber of Commerce, and including major investors in biotechnology, promoted the concept of self-regulation throughout the UNCED process and successfully deflected, using a sizeable lobby, moves towards external regulation. Combining this outcome with the effective dismantling of the United Nations Centre on Transnational Corporations early in 1992, the scope for international monitoring or control of transnationals involved in GMO technology today seems slim.

[64] Cited in V. Shiva, 'Biotechnology: environmental, health and economic implications for the Third World', briefing paper, UNCED, Third World Network, Malaysia, Aug. 1991.

[65] Keystone international dialogue series on plant genetic resources, conference in Madras, India, Feb. 1990.

[66] UNCTC negotiations for a Code of Conduct on TNCs (ECOSOC DOC: E/1990/94); UNIDO/UNEP/WHO/FAO Working Group on Biosafety, p. 60.

[67] 'The global biodiversity strategy', p. 60.

[68] Al Gore, *Earth in the balance* (Boston, MA: Houghton Mifflin, 1992), p. 343.

UNCED's failure to deal with the property issue

UNCED failed to address the historical inequities in the exchange of genetic resources and technology. The North has accumulated heavy rewards over the years from taking biological resources freely from the South and shipping them out as raw materials. The US Agency for International Development calculated that developing countries contribute approximately $176 million a year to the value of US rice, $1.8 billion to US wheat, and estimates the future contribution of southern maize farmers to US maize at $6 billion.[69] Yet for many years now, developing countries have had to pay heavy sums to buy back the freely given derivatives. For example, in 1983 Mexico imported US seed costing $46,323,000. $13 million of this was spent on hybrid maize, and $8.8 million on vegetable seed, mostly tomatoes.[70]

A whole new dimension to this unequal exchange emerges with the introduction of patenting by developed countries for genetically manipulated products and processes based on genetic material from the developing countries.[71] As long ago as the 1970s, the OECD and the UN General Assembly both warned that development in developing countries might suffer if those countries were forced to set up patent systems similar to the ones in the developed world.[72] Although *Agenda 21* and the Biodiversity Convention grant developing countries 'preferential and concessional' access to patents, they do not sufficiently define what terms such as 'fair and most favourable' or 'preferential and concessional' mean, leaving access to and transfer of the technology open to individual national interpretation.

The past distribution of patents in general attests to the unequal playing field likely to be created by the patenting of GMOs. Of the 3.5 million patents existing in the 1970s, developing countries only granted approximately 200,000. Of these, 84 per cent were owned by foreigners, and less than 5 per cent of these foreign-owned patents were used in production in the South.[73]

Recognizing both the profits the developed world makes from those biological and genetic resources collected from the South, as well as the future prospects for increasing those profits using patents and genetic manipulation technology, developing countries are beginning to close the door to free access of their germplasm. Private bilateral deals of exchange are already being struck. For example, Costa Rica's National Biodiversity Institute (INBio) has made an agreement with the US pharmaceutical company Merck and Co., allowing the company access to national forests to prospect for useful plant chemicals and genes in return for $1 million, and a share of any royalties accruing to Merck.[74]

[69] H. Hobbelink, R. Vellve, 'The new owners of life', *Foodmatters*, Norwich: Farmers' Link, Norwich Education for Action and Development, Farmers World Network, 1990, p. 5.

[70] 'The origins of the genetic supply industry', *Internazionale, IDOC*, Rome, Feb. 1985, Anno XVI, vol. 17, pp. 29–31.

[71] C. Juma, *The gene traders*, (Princeton, NJ: Princeton University Press, 1989), p. 1.

[72] H. Hobbelink, *Biotechnology and the future of world agriculture*, p. 102.

[73] UNCTAD/WIPO, 'The role of the patent system in the transfer of technology to developing countries' (New York: UN, 1975).

[74] L. Roberts, 'Chemical prospecting: hope for vanishing ecosystems?' *Science*, 22 May, vol. 256, pp. 1,142–3.

Critics of this deal in Costa Rica have pointed out that a private organization like INBio is selling off the country's public resources, and too cheaply at that.

While national inequities remain unaddressed, so too do local ones. The Convention on Biological Diversity fails to establish a vehicle for compensating the centuries of traditional knowledge and inventions of indigenous peoples and rural communities. It requires contracting parties merely to 'encourage' the equitable sharing of the benefits arising from the utilization of such knowledge, and qualifies this as 'subject to its national legislation', and agreed 'as far as possible and as appropriate'.

With the onset of the patenting of genetically manipulated crops, farmers may have to pay royalties on the seeds they buy, and lose the ability to save harvested seed to replant for next year's crop—the Farmers' Privilege. Industrial analysts report that over one-third of all seeds planted in the world are saved from the previous season.[75] Over 85 per cent of the seed used for sowing in the majority of developing countries is grown on the farms themselves and is freely available between farmers.[76] Losing the right to save seed will undoubtedly be a problem for many small-scale farmers and their agricultural practices which in general promote biodiversity. Failing to recognize the interdependency of culture and biodiversity, therefore, involves risk of further losses of ecosystem diversity.[77] Such losses would only serve to enhance perceptions of reliance on genetically manipulated crops.

Biological warfare capabilities

The recent 'scientific revolution' in the field of biotechnology heralds the prospect of a whole new generation of biological weapons. The proliferation of countries and companies with advanced biotechnological capabilities has meant the potential availability of a whole new category of relatively cheap weapons of mass destruction for states and organizations which hitherto had no access to such weapons. There is, therefore, a strong case for expanding the scope of the 1972 Biological Weapons Convention (BWC). Transparency in arms control verification has recently been improved in other fora such as the chemical weapons convention, favouring in principle the prospect of an expanded BWC.[78] But with regulatory regimes for deliberate releases of GMOs as slack as they are, internationally and nationally, it is difficult to imagine how the BWC can easily be strengthened.

The BWC allows research, development and possession of biological agents for 'prophylactic, protective and other peaceful purposes'. But as with all such agreements, allowing research makes defensive capability difficult to distinguish

[75] H. Hobbelink, *Biotechnology and the future of world agriculture*, p. 113.

[76] 'Patent legislation: plant breeders' rights and farmers' rights', paper by NOVIB for Conference on Biotechnology and farmers rights: opportunities and threats for small-scale farmers in developing countries, Free University of Amsterdam, 8–9 Apr. 1991, p. 22.

[77] 'The global biodiversity strategy', p. 11.

[78] Convention on the prohibition of the development, production, and stockpiling of bacteriological (biological) and toxin weapons and on their destruction. Entered into force, 26 Mar. 1975.

from offensive. Defence against a GMO engineered for potential offensive use is in any case difficult in the extreme. Defence planners would have to know what disease was going to be used, and the alterations made to that disease. They would then have to have the time, ability and resources to discover, develop and mass produce an effective vaccine, presumably for their entire population, without the adversary knowing.

The US Department of Defense awarded a three-year $1,762,000 contract to Molecular Genetics, an international animal health care and agricultural biotechnology company, to work on Rift Valley fever virus, a disease affecting cattle and people in the Middle East and Africa.[79] This type of development has the potential to appear as a threat to developing countries, and could encourage them to become involved in investigating the potential uses of GMOs in weaponry. British intelligence suspect that as many as eleven countries are preparing for biological warfare.[80] GMOs developed for biological weapons invoke the spectre of a specifically targetable disease, one that could be used for a particular situation, on a particular population, or even, in principle, against a specific ethnicity. GMO-based weapons would be easy to hide, to mass produce, and would obviate stockpiling. It is possible to proliferate in days a huge amount of pathogen from a tiny culture.[81]

Biological weapons also offer the possibility to create economic warfare through the targeting, not of humans, but of agriculture. Alexis Shelikoff, a virologist with the Salk Institute, the largest contractor with the US Army Fort Detricks biowarfare programme, noted that 'a desirable weapon is one that affects, say, livestock, and may affect people but not kill them'. The first crude efforts at such warfare may have, therefore, already entered the casebook. Armenian helicopters dropped packages containing bacteriological material and insects on to territory of the Kelbadzharsky and Lachinsky Rayons of Azerbaijan in March 1992. Preliminary analysis showed the contents to be 'harmful to the environment'.[82]

Many low intensity wars are fought in the poorest areas of the world where outright military victory is very expensive (if the war drags on), or simply not possible. It is relatively easy to imagine the circumstances under which temptations might arise to use a GMO-based weapon. The prevalence of monoculture crops in developing countries would only serve to increase the temptation. Who could tell if an epidemic striking a particular crop was the result of a chance disease or a deliberate release of GMOs? Short of use in warfare, risk to the environment through potential accidental release or terrorist theft increases with every new country, and indeed new laboratory, which becomes involved in this type of research. Damage to the environment has already occurred from the effects of 'natural' biological weapons: for example, from the anthrax bombs tested on the Scottish island of Gruinard,

[79] 'Regulating the supernatural', *Development Dialogue*, p. 213.
[80] D. Fairhall, The *Guardian*, 5 Sept. 1991.
[81] S. Freeman, 'Disease as a weapon of war', *Pacific Research*, Feb. 1990, vol. 3, no. 1, pp. 3–7.
[82] *Arms Control Reporter* (Cambridge, MA, May 1992), 701.B.90, IDDS.

which remains uninhabitable to this day. The harm caused from a similar test using GMOs could in principle be much worse.

The Third Review Conference of the BWC, held in September 1991, set up an ad hoc group of governmental experts to look at verification measures, but the BWC is still very weak on verification and complaints procedures. It has a long history of suspicions and unresolved allegations, such as those over Sverdlovsk.[83] The verification regime of the BWC clearly needs to go further.

In principle, given the degree of transparency achieved in the verification of treaties covering conventional weapons, strategic arms, INF, and chemical weapons, an international agreement on scientific inspection of biological laboratories is no longer inconceivable. A system of verification with snap inspection of undeclared sites, similar to the verification regime being implemented in the process of nuclear arms control in the START talks, could be set up, and other forms of constraint can be envisaged, such as bans on specific types of research. But while the regulatory regime for GMO technology remains as slack as it does today, such an eventuality remains to all practical purposes impossible. The threat of biological weapons proliferation simply adds to the already long list of problems arising from the advent of genetically manipulated organisms and their release—in a world of diminishing food security—into an imperfectly understood environment.

[83] *Arms Control Reporter*, Jan. 1991, p. 701.A.3.