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The Cartagena Protocol and Biological Diversity; Biosafe or Bio-sorry

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The Cartagena Protocol and Biological Diversity: Biosafe or Bio-Sorry?

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I. INTRODUCTION

In February 1999, delegates from some 170 nations were summoned to Cartagena, Columbia to finalize an international protocol on the regulation of biotechnology. Under the auspices of the United Nations Convention on Biological Diversity (CBD),[1] national representatives and members of non-governmental organizations met to hammer out the details of a new regulatory regime for genetically modified organisms. "We need a widely accepted protocol that protects the environment, strengthens the capacity of developing countries to ensure biosafety, complements existing national regulations, and promotes public confidence in biotechnology and the benefits it can offer," proclaimed Klaus Toepfer, executive director of the United Nations Environment Programme.[2] It was not to be. While delegates from the European Union and many developing countries sought a protocol that would allow for stringent regulation, the United States and other major agricultural exporters feared such a deal would place too many limits on global trade.[3] Nine days of talks produced little headway. Yet

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1. U.N. Conference on Environment and Development: Convention on Biological Diversity, June 5, 1992, U.N. Doc. UNEP/Bio.Div/N7-INC.S/4, *reprinted in* 31 I.L.M. 818 [hereinafter CBD].

2. UNEP, *Governments to Finalize and Adopt Biosafety Protocol* (visited Jan. 28, 2000) <http://www.biodiv.org/press/pr1-99-BSWG6.html>.

3. *See* Andrew Pollack, *Biotechnology Treaty Stalls as U.S. and Developing Nations Quarrel*, N.Y. TIMES, Feb. 23, 1999, at A9; *see also* Christopher S. Zalewski & Paul F. McQuade, *A Stalemate on Biosafety Pact*, NAT'L L.J., May 24, 1999, at C1.

protocol proponents were undaunted. "Biotechnology can contribute enormously to human well-being, but it poses potential risks," Toepfer commented. "For this reason, the global community will continue to work on establishing a legally binding biosafety regime."[4]

When the formal negotiations resumed eleven months later in Montreal, an Indian agricultural scientist who teaches in the United States released a petition of scientists endorsing "the use of recombinant DNA [rDNA] as a potent tool for the achievement of a productive and sustainable agricultural system."[5] Echoing a wealth of scientific literature on the likely benefits of agricultural biotechnology,[6] the proclamation declared that rDNA techniques are a "powerful and safe means for the modification of organisms" that "can contribute substantially in enhancing quality of life by improving agriculture, health care and the environment."[7] Just one week earlier, *Science* published research documenting the successful creation of vitamin A-enhanced rice.[8] This so-called "golden rice" was immediately hailed as a "major advance in global nutrition" because vitamin A deficiency, which can cause blindness and other ills, affects up to 250 million children worldwide.[9]

The broad scientific support for expanded use of rDNA techniques to engineer more productive, nutritious, and environmentally benign crops seemed to have little effect on the course of the protocol negotiations. While the scientific community generally supports advances in biotechnology, environmental activists charge that the spread of genetically modified organisms (GMOs) could pose untold threats to human health or the environment. During the January 2000 Protocol negotiations in Montreal, activists erected a six-meter-high monster

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4. UNEP, *Governments Postpone Adoption of Biosafety Treaty* (visited Jan. 28, 2000) <http://www.biodiv.org/press/pr2-99-BSWG6.html>.

5. AgBioWorld, *Scientists in Support of Agricultural Biotechnology* (visited Mar. 3, 2000) <http://www.agbioworld.org/petition.html>. The petition was opened for signatures on January 18 and released to the public at a press conference on January 22, 2000.

6. *See, e.g.*, NATIONAL INSTITUTES OF HEALTH, 1992 NATIONAL BIOTECHNOLOGY POLICY BOARD REPORT 2 (1992); NATIONAL RESEARCH COUNCIL, FIELD TESTING GENETICALLY MODIFIED ORGANISMS: FRAMEWORK FOR DECISIONS (1989); COMMITTEE ON THE INTRODUCTION OF GENETICALLY ENGINEERED ORGANISMS INTO THE ENVIRONMENT, INTRODUCTION OF RECOMBINANT DNA-ENGINEERED ORGANISMS INTO THE ENVIRONMENT: KEY ISSUES (1987). These reports and other aspects of the near-scientific consensus on agricultural biotechnology are summarized in HENRY I. MILLER, POLICY CONTROVERSY IN BIOTECHNOLOGY: AN INSIDER'S VIEW (1997). *See also* COMMITTEE ON GENETICALLY MODIFIED PEST-PROTECTED PLANTS, BOARD ON AGRICULTURAL AND NATURAL RESOURCES, NATIONAL RESEARCH COUNCIL, GENETICALLY MODIFIED PEST-PROTECTED PLANTS (2000).

7. AgBioWorld, *Scientists in Support of Agricultural Biotechnology* (visited Mar. 3, 2000) <http://www.agbioworld.org/petition.html>. As of March 3, 2000, over 1,300 scientists had endorsed the petition. Signatories of the petition include Nobel winners James Watson and Norman Borlaug, World Food Prize recipient Gurdev Khush, and 1998 National Medal of Science recipient Bruce Ames. *See Nobel Prize Winners Endorse Agricultural Biotechnology* (visited Mar. 3, 2000) <http://www.agbioworld.org/watson.html>.

8. *See* Xudong Ye et al., *Engineering the Provitamin A (B-Carotene) Biosynthetic Pathway into (Carteniod-Free) Rice Endosperm*, 287 SCIENCE 303 (Jan. 14, 2000).

9. *See* Guy Gugliotta, *New Vitamin A-Rich Rice Strain Termed Nutrition Breakthrough*, WASH. POST, Jan. 14, 2000, at A6.

corn cob to protest "genetic pollution"[10] and marched through the streets chanting "Life before profits!"[11]

When negotiators finally reached an agreement in the wee-morning hours of January 29, environmental activists applauded the "historic" agreement because "international law is recognizing that G.M.O.'s are distinct and have to be regulated separately."[12] A spokesman for Greenpeace crowed that "we won almost all the points we were pushing for."[13] In particular, environmental activists were pleased that the final Protocol language explicitly provided for the use of precautionary regulation in the face of scientific uncertainty.[14] The Cartagena Protocol on Biosafety (Biosafety Protocol) marks the first time the precautionary principle was enshrined in an international treaty's operative provisions.[15]

The stated purpose of the Biosafety Protocol is to establish safeguards against potential "adverse effects on the conservation and sustainable use of biological diversity."[16] The preamble cites "growing public concern" over biotechnology's "potential adverse effects on biological diversity" as part of the need for international regulation.[17] The Biosafety Protocol is an agreement under the CBD.[18] The CBD declares biodiversity "of critical importance for meeting the food, health and other needs of the growing world population."[19] The sad irony of the Biosafety Protocol is that it may well retard, rather than advance, the

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10. Lynn Moore & Pauline Tam, *An Earful on Biosafety: Talks Open Optimistically*, MONTREAL GAZETTE, Jan. 25, 2000.

11. Daniel Sanger, *Protesters March Through Montreal*, ASSOC. PRESS, Jan. 22, 2000.

12. Andrew Pollack, *130 Nations Agree on Safety Rules for Biotech Food*, N.Y. TIMES, Jan. 30, 2000, at 6 (quoting Chee Yoke Ling of the Third World Network). *See also* Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Feb. 23, 2000, art. 1, *available at* (visited Apr. 5, 2000) <http://www.biodiv.org/biosafe/BIOSAFETY-PROTOCOL.htm> [hereinafter Biosafety Protocol].

13. Maggie Farley, *Deal Struck to Regulate Genetically Altered Food*, L.A. TIMES, Jan. 30, 2000.

14. For an overview and critique of the precautionary principle as applied to biotechnology, see Jonathan H. Adler, *More Sorry than Safe: Assessing the Precautionary Principle and the Proposed International Biosafety Protocol*, 35 TEX. INTL. L.J. 173, 194-204 (2000).

15. Prior international environmental treaties make reference to precautionary approaches to environmental protection, but only in a hortatory fashion. *See id.* at 194-95 (summarizing the precautionary language contained in the Rio Declaration, Vienna Convention, and other international environmental agreements).

16. Biosafety Protocol, *supra* note 12, art. 1. Other purposes, such as protecting human health, are explicitly subsidiary under Article 1 of the Protocol.

17. *Id.* pmbl.

18. CBD, *supra* note 1. The CBD's stated objectives are (1) "the conservation of biological diversity;" (2) "the sustainable use of its components;" and 3) "the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." *Id.* art. 1.

19. Biosafety Protocol, *supra* note 12, pmbl. Biodiversity, as defined by the Convention on Biological Diversity, is "[t]he variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems." CBD, *supra* note 1, art. 2. It should be noted, however, that as of 1999, the Conference of Parties of the CBD had yet to agree on a system for the classification or quantification of biodiversity. *See* Rowan Martin, *Biological Diversity*, *in* EARTH REPORT 2000, at 212-13 (Ronald Bailey ed., 1999).

protection of biodiversity. Under the guise of adopting "precautionary" measures to protect the environment, the Protocol could restrict one of the most important tools for biodiversity conservation — agricultural biotechnology. Negotiators gave hypothetical risks posed by genetically engineered crops and foodstuffs greater consideration than the demonstrated need to improve agricultural productivity and reduce modern agriculture's stress on the natural environment. Government representatives of developing countries claimed that concern for environmental protection justified restrictions on the transboundary movement of genetically engineered crops, but "paid little attention to the rural devastation currently caused by expanding acreage under low-yielding, pest vulnerable [non-genetically engineered] crops."[20] Even if one's sole focus is environmental protection, it is quite possible that the Biosafety Protocol could do more harm than good.

In order to evaluate whether the Biosafety Protocol advances environmental protection, it is important to understand the nature of the environmental problems it is supposed to address. With this in mind, Part II of this article briefly surveys current threats to biological diversity. Part III summarizes the key provisions of the Biosafety Protocol, and how they seek to address the loss of biodiversity. Building on these two sections, Part IV assesses the congruence, or lack thereof, between the biodiversity problem and the Biosafety Protocol. This section further explains why the Biosafety Protocol may do more to hinder, rather than help, the conservation of biodiversity, especially in those regions of the world in which the threats to biodiversity are the most severe. The article concludes with lessons that can be drawn from the Protocol's embrace of precautionary regulation and an assessment of the utility of such approaches in international environmental law.

II. THE THREAT TO BIODIVERSITY

The loss of biological diversity[21] is a serious environmental concern. "We — the human species — have been dependent on other species since the beginning of our time," notes Stephen Edwards of IUCN (International Union for the Conservation of Nature and Natural Resources).[22] Other species provide sources of food, clothing, and shelter, not to mention pleasure. While estimates of species loss vary greatly, there is general agreement that human activities contribute directly and indirectly to biodiversity loss and species extinction,[23] and that the

20. Robert Paarlberg, *Promise or Peril? Genetically Modified Crops in Developing Countries*, ENVIRONMENT Jan./Feb. 2000, at 26.

21. In this paper, the terms "biological diversity" and "biodiversity" are used interchangeably.

22. Stephen R. Edwards, *Conserving Biodiversity: Resources for Our Future, in* THE TRUE STATE OF THE PLANET 213 (Ronald Bailey ed., 1995).

23. The loss of biological diversity and species extinction, while interrelated, should not be confused with one another. Biological diversity consists of both the diversity of different species, but also the genetic diversity within given species and populations. Thus, for example, the loss of species from given habitats can reduce biodiversity even if those species do not go extinct.

current rate of species loss is substantially higher today than at any time in human history.

There are an estimated 5 to 15 million species on the planet.[24] These estimates are quite speculative, however, and the actual number could be anywhere from 3 to 111 million species.[25] As many as 15,000 new species are identified and described each year,[26] yet fewer than 2 million plant and animal species have been recorded to date.[27] It is generally accepted that a substantial percentage of birds, mammals, and plants have been identified. This is not the case with other orders of species, however, such as insects, nematodes, and bacteria.[28] Overall, efforts to determine the precise number of plant and animal species on the earth have been "surprisingly fruitless."[29]

While there is little hard data to indicate which species are threatened, conservationists estimate that approximately 11% of mammals and birds are threatened with extinction around the world, and presume that a similar percentage of other types of species may be threatened as well.[30] A commonly cited estimate is that "terrestrial species are vanishing one hundred times faster than before the arrival of humans."[31] Recent studies estimate that between 10% and less than 1% of all species disappear each decade.[32] These estimates are quite speculative and remain controversial.[33] Nonetheless, given the available evidence, "even the most optimistic person would agree that common sense calls for caution."[34]

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24. *See* Nigel E. Stork, *Measuring Global Biodiversity and Its Decline*, *in* BIODIVERSITY II: UNDERSTANDING AND PROTECTING OUR BIOLOGICAL RESOURCES 65 (Marjorie L. Reaka-Kudla et al. eds., 1997).

25. *See* WORLD RESOURCES INSTITUTE, WORLD RESOURCES 1996-97, at 247 (1996).

26. *See* Stork, *supra* note 24, at 44.

27. *See* WORLD RESOURCES, *supra* note 25, at 247. There is even uncertainty about the actual number of species identified, and estimates range from 1.4 to 1.8 million. *See* Rowan B. Martin, *Biological Diversity*, *in* EARTH REPORT 2000, *supra* note 19. Estimates vary because there is no single agreed-upon list of identified species, and many species may be known by more than one name.

28. *See* WORLD RESOURCES, *supra* note 25, at 248 tbl.11.1.

29. Stork, *supra* note 24, at 41.

30. *See id.* at 46-47.

31. Edward O. Wilson, *Biodiversity: Wildlife in Trouble*, *in* THE BIODIVERSITY CRISIS 9 (M. Novacek ed., 1000).

32. *See* Stork, *supra* note 24, at 62-63 tbls.5-6. Some activist groups, however, place the estimates of species oss much higher. *See, e.g.*, John C. Ryan, *Conserving Biological Diversity*, *in* STATE OF THE WORLD 1992, at 9 L. Brown ed., 1992) (citing loss estimates of over 50,000 species per year).

33. *See, e.g.*, WILFRED BECKERMAN, THROUGH GREEN-COLORED GLASSES 80-84 (1996). *See also* Edwards *upra* note 22, at 217-21.

Despite the high estimates, there are only approximately 1,000 recorded extinctions in the last four centuries. *ee* Stork, *supra* note 24, at 45. The small number of recorded extinctions could well be the result of poor nowledge about the number and distribution of species around the globe. Data from the International Union for ie Conservation of Nature and Natural Resources (IUCN) indicates that the rate of documented extinctions creased rapidly from the year 1600 until the middle of the 20th century. *See* Edwards, *supra* note 22, at 218. ontrary to estimates of species extinction rates, however, the rate of documented extinctions appears to have owed since the 1930s. *See id.* at 219 fig.7-2.

34. Edwards, *supra* note 22, at 217. "Caution," however, does not necessarily mean precautionary gulation, as such efforts may do more harm than good. *See infra* Part III.

Whether or not conventional extinction estimates are accurate, there is a general consensus that human activity threatens many species around the globe. Over one-third of documented animal extinctions were due to habitat destruction,[35] and most biodiversity experts believe that continuing loss of habitat could claim up to half of the species alive today.[36] Thus, saving biodiversity requires protecting plant and animal species in their native habitat.[37] Other leading causes of extinction are the introduction of exotic species and hunting.[38] Nevertheless, conserving species habitat is the key to the preservation of biological diversity.

Most habitat loss is caused by human conversion of land to other uses.[39] "In particular, conversion of land to agriculture is the single greatest agent of habitat conversion, and associated displacement of species and increasing stress on biological diversity."[40] Since 1980, net agricultural land worldwide increased by over 4% or 200 million hectares.[41] Low crop yields and increasing human populations create substantial pressure to clear land for crops. In sub-Saharan Africa, for example, the use of land for agriculture and livestock poses a substantial threat to biodiversity.[42] In much of the continent "[p]overty is so intense that all land with agricultural potential will be exploited and even that with very little potential will be put to use — even if that use is unsustainable."[43]

While forest cover in many developed countries is stable or increasing, deforestation of tropical forests, particularly in developing nations, is substantial and appears to be on the rise.[44] Between 1980 and 1995, net forest cover declined by 180 million hectares worldwide and by 200 million hectares in developing nations.[45] Most of the loss of forest cover in developing nations is driven by the need to clear land for agriculture, and is exacerbated by poor land tenure regimes and government subsidies.[46] Tropical deforestation is expected to have a substantial

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35. *See id.* at 222.

36. *See, e.g.*, Paul O. Ehrlich & Edward O. Wilson, *Biodiversity Studies: Science and Policy*, 253 SCIENCE 758 (1991). According to one recent assessment, "[l]and-use change is the most severe driver of changes in biodiversity." Osvaldo E. Sala et al., *Global Biodiversity Scenarios for the Year 2100*, 287 SCIENCE 1770, 1771 (2000).

37. *See* Wilson, *supra* note 31, at 11.

38. *See* Edwards *supra* note 22, at 222.

39. *See, e.g.*, P.M. Vitousek et al., *Human Domination of Earth's Ecosystems*, 277 SCIENCE 494 (1997).

40. Indur Goklany, *Meeting Global Food Needs: The Environmental Trade-Offs Between Increasing Land Conversion and Land Productivity*, 6 TECHNOLOGY 107, 108 (1999). *See also* Sala et al., *supra* note 36, at 1771.

41. *See* Indur M. Goklany, *Richer Is More Resilient: Dealing with Climate Changes and More Urgent Environmental Problems*, *in* EARTH REPORT 2000; *supra* note 19, at 155, 164.

42. *See* Martin, *supra* note 27, at 230.

43. *Id.* at 231.

44. *See* Roger A. Sedjo, *Forests: Conflicting Signals*, *in* THE TRUE STATE OF THE PLANET 178, 198-201 (Ronald Bailey ed., 1995).

45. *See* UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION, STATE OF THE WORLD'S FORESTS 1999, at 1 (1999). The FAO reports that net forest cover actually *increased* in developed nations by approximately 20 million hectares from 1980 to 1995. *See id.*

46. *See id.* While some blame commercial timber harvesting for deforestation, Roger A. Sedjo of Resources

impact on species survival rates as forest habitat houses an estimated 60% of the world's terrestrial biodiversity.[47]

An additional threat to biodiversity comes from habitat modification due to the introduction of exotic species. While the introduction of species from one part of the world to another as crops or livestock can bring tremendous benefits, the occasional introduction of biologically invasive species has had substantial adverse consequences for many species. Habitat invasion by exotic species is generally considered the second leading threat to endangered species behind habitat loss.[48] By some estimates, up to 20% of endangered vertebrate species are threatened by exotic species.[49]

While other threats to biodiversity will remain important, habitat loss is likely to be the greatest threat in coming decades. Global population hit an estimated six billion in 1999.[50] At present, global population increases by one billion people every twelve to thirteen years. While many expect this rate of increase to slow, most analysts believe that there could be approximately ten billion people on the planet by 2050.[51] Increased population will mean more mouths to feed, and that will require increased agricultural production. Increased wealth in the developing world will also spur demand for greater caloric and nutritional intake, pushing up agricultural demand further still.[52] According to estimates by the International Food Policy Research Institute, global demand for basic agricultural commodities, such as wheat, maize, and rice, will increase by 40% by 2020, or 1.3% per year.[53]

Over the past several decades, global food availability has kept pace with the increase in agricultural demand.[54] Yet the explosion in agricultural productivity unleashed by the "green revolution" may be reaching its limits as annual increases in agricultural productivity appear to have been slipping; cereal yields per hectare rose 2.2% per year in the late 1960s and 1970s, but only rose 1.5% per

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for the Future, notes that "forestlands that are commercially harvested typically remain as forestlands." Sedjo, *supra* note 44, at 188.

47. *See* William J. Snape III, *International Protection: Beyond Human Boundaries*, *in* BIODIVERSITY AND THE LAW 81, 85 (W. Snape ed., 1996). The FAO reports that "[n]atural forests are arguably the single most important repository of terrestrial biological diversity." FAO, *supra* note 45, at 8.

48. *See* WORLD RESOURCES INSTITUTE, WORLD RESOURCES 1998-99, at 197 (1998).

49. *See id.*

50. *See* Nicholas Eberstadt, *World Population Prospects for the Twenty-First Century: The Specter of "Depopulation?"* *in* EARTH REPORT 2000, *supra* note 19, at 63, 64-65.

51. *See* Paul Georgia et al., *Benchmarks: The Global Trends that Are Shaping Our World*, *in* EARTH REPORT 2000, *supra* note 19, at 237, 242-43 (indicating that the "medium projection" of the United Nations is for a global population just under 10 billion in 2050). It is worth noting, however, that some analysts expect population increases to slow more rapidly and top out at approximately 8 billion in 2040. *See id.* at 242; *see also* Eberstadt, *supra* note 50.

52. An estimated one-in-five people in developing nations suffer from chronic undernourishment. *See* Paarlberg, *supra* note 20, at 21.

53. *See* Charles C. Mann, *Crop Scientists Seek a New Revolution*, 283 SCIENCE 310, 310 (1999).

54. *See* Georgia et al., *supra* note 51, at 256-57, 260-61 (indicating the continuous rise in per capita agricultural production and food production over the past four decades).

year in the 1980s and early 1990s, and may drop even further.[55] Unless agricultural productivity increases substantially, this will mean putting thousands, if not millions, of additional hectares under plow — and consequently losing thousands, if not millions, of hectares of species habitat. Thus, a failure to enhance per-acre agricultural productivity will have severe consequences for global and regional biological diversity.

III. THE CARTAGENA PROTOCOL ON BIOSAFETY

The Cartagena Protocol on Biosafety is part of the broader regulatory and institutional structure created by the Convention on Biological Diversity (CBD) to conserve biodiversity. The CBD was originally agreed to at the United Nations Earth Summit in Rio de Janeiro in 1992 and has been adopted by 176 countries as of January 2000, not including the United States.[56] President William J. Clinton signed the CBD in June 1993, but the U.S. Senate has not yet ratified the Convention. Despite not being a party to the CBD, the United States was an influential participant in the biosafety protocol negotiations in Cartagena and Montreal as the world's largest agricultural producer and participant in global markets.

The CBD contains a range of provisions that are intended to promote the conservation of biological diversity and limit the environmental impacts of human development.[57] In particular, the CBD specifically contemplates the regulation of genetically modified organisms (GMOs). Parties to the Convention must:

> establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which *are likely* to have adverse environmental impacts that *could affect* the conservation and sustainable use of biological diversity, taking also into account the risks to human health.[58]

This language from Article 8(g) is sufficiently broad and tentative to justify

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55. *See* Mann, *supra* note 53, at 310; *see also* Gordon Conway, *Food for All in the 21st Century*, ENVIRONMENT, Jan./Feb. 2000, at 11, 13.

56. *See Report of the Resumed Session of the Extraordinary Meeting of the Conference of the Parties for the Adoption of the Protocol on Biosafety to the Convention on Biological Diversity: 24-28 January 2000*, EARTH NEGOTIATIONS BULL., Jan. 31, 2000, at 4-5 [hereinafter *Report of Resumed Session*].

57. Parties to the CBD are obligated to develop "national strategies, plans or programs" for the conservation of biodiversity, which shall include, among other things: (a) "a system of protected areas," such as parks or reserves, that include protective buffer zones and are to be managed to ensure "conservation and sustainable use;" (b) "measures for the recovery and rehabilitation of threatened species," including the reintroduction of species into their native range; and (c) measures to "facilitate access to genetic resources for environmentally sound uses" and the transfer of advanced technologies to other nations. *See* CBD, *supra* note 1, arts. 6, 8, 9, 15, 16. The CBD further requires parties to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species." *Id.* art. 8(h).

58. *Id.* art. 8(g) (emphasis added).

almost any level of GMO regulation by individual countries. The Convention further provides for the negotiation and adoption of an international biosafety protocol. Under Article 19, the parties to the CBD are to "consider the need for and modalities of a protocol" regulating "the safe transfer, handling and use of any living modified organism resulting from biotechnology that may have an adverse effect" on biological diversity.[59]

Pursuant to the CBD, negotiations on a potential biosafety protocol began in 1994 and continued for over five years. When the negotiations started there already was a broad scientific consensus that there was no reason for regulating genetically engineered organisms as such.[60] A scientific panel convened by the United Nations Environment Programme (UNEP) in 1993 to consider issues relating to a protocol concluded that "a protocol would, for no clear purpose: (1) divert scientific and administrative resources from higher priority needs; and (2) delay the diffusion of techniques beneficial to biological diversity, and essential to the progress of human health and sustainable agriculture."[61] Nonetheless, negotiators from 130 countries proceeded in their efforts to draft just such an international agreement.

Over the course of the negotiations, there was a broad consensus on the need for information exchange, greater risk assessment of GMOs, and the development of procedures to facilitate advance informed agreement on trans-boundary shipments of living modified organisms (LMOs).[62] Nonetheless, the negotiations were quite contentious.[63] The European Union and some developing nations[64] wanted the Protocol to include liability provisions for accidental

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59. *Id.* art. 19(3). Note that the Protocol focuses on "living modified organisms" or "LMOs," a subset of GMOs capable of replicating or transferring their genetic material. "Living modified organism" is defined by the Biosafety Protocol as "any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology." Biosafety Protocol, *supra* note 12, art. 3(g). "Living Organism" is defined as "any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses, and viroids." *Id.* art. 3(h). "Modern biotechnology" is defined to include the use of rDNA methods and other forms of genetic engineering "that are not techniques used in traditional breeding and selection." *Id.* art. 3(i).

60. See *supra* note 6 and sources cited therein. As the British journal *Nature* would later editorialize as the negotiations neared their completion, "[t]here is as yet no substantial evidence that GM [genetically modified] foods are inherently more dangerous than conventional foods just because they have been produced using novel techniques." *GM Foods Debate Needs a Recipe for Restoring Trust*, 398 NATURE 639, 639 (1999).

61. UNEP, *Report of Panel IV: Consideration of the Need for Modalities of Protocol Setting out Appropriate Procedures Including, in Particular, Advance Informed Agreements in the Field of the Safe Transfer, Handling and Use of Any Living Modified Organism Resulting from Biotechnology Diversity*, UNEP Arguments for a Protocol Pursuant to Article 19.3 of the Convention ¶ 42(ii), at 11, U.N. Doc. UNEP/Bio.Div/Panels/Int.4 (1993), *quoted in* Thomas P. Redick et al., *Private Legal Mechanisms for Regulating the Risks of Genetically Modified Organisms: An Alternative Path within the Biosafety Protocol*, 4 ENVTL. LAW. 1, 37 (1997).

62. For the definition of LMOs and under the Biosafety Protocol, see *supra* note 59.

63. These negotiations are summarized in *Report of Resumed Session*, *supra* note 56, at 1-2, and Adler, *More Sorry than Safe*, *supra* note 14, at 189-94.

64. It is worth noting that the positions adopted by delegates from developing country governments may be at odds with the interests of citizens of those nations. Indeed, some of the calls for more stringent regulation came from countries with the most to lose from restrictions on the spread of agricultural biotechnology. *See,*

releases, incorporate the precautionary principle, and trump international trade rules, such as those enforced by the World Trade Organization. These proposals were opposed by the United States and many Latin American nations out of fear that such provisions would become a pretense for protectionism.[65]

The final Protocol language agreed upon in late January 29, 2000 in Montreal establishes an international framework for the regulation of all LMOs "that may have adverse effects on the conservation and sustainable use of biodiversity, taking also into account risks to human health."[66] While not as stringent as some environmental activists and negotiators wanted, the Protocol text creates mechanisms whereby national governments will be able to restrict, or even prohibit, the importation of LMOs, such as genetically engineered crops. The Protocol's terms may allow government authorities to restrict the import of foodstuffs as well.[67] The Protocol also requires the labeling of bulk shipments of LMOs intended to be used for food, feed, or processing.[68] These provisions could have a substantial impact on the diffusion of agricultural biotechnology, particularly in developing nations.

The primary mechanism for limiting the importation of genetically modified crops are the advance informed agreement provisions in Article 7.[69] This provision makes the first shipment of any LMO intended to be planted as a crop or otherwise released into the environment conditional upon the approval of the importing country.[70] Technically, once the importing nation is notified of the intended shipment, it is supposed to respond within 90 days, acknowledging the notification, and provide an answer within 270 days, indicating whether or not it approves of the import.[71] Yet there is no provision of the Protocol to enforce this

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e.g., Paarlberg, *supra* note 20, at 26 (noting the role of African governments in denying opportunities to African farmers).

65. Given the U.S.-E.U. conflict over beef hormones, this concern was clearly justified. The United States challenged the E.U. ban on the sale of beef produced using bovine growth hormones. The European Union claimed that the restriction was a valid public health measure despite the lack of any credible scientific evidence indicating that the use of the hormones in beef production posed any threat to human health. In 1997, a World Trade Organization (WTO) dispute resolution panel sided with the United States, ruling that the import ban was a protectionist measure and not a neutral regulation intended to protect the environment or public health. The European Union appealed, but to no avail, as the WTO panel again sided with the United States. Nonetheless, the European Union is resisting compliance with the WTO ruling. *See* Julie Wolf, *EU Moves to Keep Ban on Hormone-Treated Beef*, WALL ST. J., May 5, 1999, at A2.

66. Biosafety Protocol, *supra* note 12, art. 4. Pharmaceuticals intended for human use are exempted from the protocol. *See id.* art. 5.

67. Whether these provisions of the Protocol authorize a member nation to violate WTO rules was not settled in the final text. *See id.* pmbl. ("*emphasizing*" that the protocol does not "imply[ ] a change in the rights and obligations of a Party under any existing international agreements").

68. Such shipments must bear a label that says they "may contain" LMOs. *See id.* art. 18(2)(a).

69. *See id.* art. 7.

70. *See id.*

71. *See id.* arts. 8-10. Under these provisions, the importing nation is to acknowledge receipt of the notification and whether the shipment may proceed, or whether more information is necessary in order to make a determination, or whether the time period for a response "is extended by a defined period of time." *Id.* art. 10(3)(d).

time limitation, and an importing nation's failure to respond does "not imply . . . consent" to the shipment.[72] "Cooperative procedures and institutional mechanisms to promote compliance" are to be agreed upon at a later date.[73]

The advance informed agreement provisions of the Protocol embrace the precautionary principle advocated by environmental activists. They provide that "lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects" of an LMO "shall not prevent" the importing nation from limiting transboundary shipments.[74] These provisions are reinforced by the statement in the preamble "reaffirming the precautionary approach" to environmental regulation "contained in Principle 15 of the Rio Declaration on Environment and Development."[75] The importing nation may also take into account "socio-economic considerations arising from the impact of living modified organisms" in making its determination.[76] In other words, parties to the Protocol can effectively bar the importation of genetically modified crops irrespective of whether there is *any* scientific basis for the refusal.

The resulting Protocol could inhibit the spread of genetically engineered crops, particularly to those nations that need agricultural biotechnology to increase agricultural productivity. Parties to the Protocol will be able to bar importation of modified crop varieties for valid scientific reasons, questionable economic reasons, or no reason at all. As two commentators noted:

> Rather than creating a uniform, predictable, and scientifically sound framework for effectively managing legitimate risks, the biosafety protocol establishes an ill-defined global regulatory process that permits overly risk-averse regulators to hide behind the precautionary principle in delaying or deferring approvals.[77]

In addition, the Protocol could expand opportunities for economic interest groups to erect trade barriers to competing agricultural products under the guise of environmental protection.[78]

While a Protocol text was agreed to in Montreal, a few issues remain unresolved. The most important of these are any potential liability for harm

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72. *Id.* art. 9.

73. *Id.* art. 34.

74. *Id.* art. 10(6).

75. *Id.* pmbl. The Rio Declaration provides that "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" and "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities." Rio Declaration on Environment and Development, U.N. Conference on Environment and Development, U.N. Doc. A/CONF.151/5/Rev.1 (1992), *reprinted in* 31 I.L.M. 374 (1992).

76. Biosafety Protocol, *supra* note 12, art. 26.

77. Henry I. Miller & Gregory Conko, *The Protocol's Illusionary Principle*, 18 NATURE BIOTECHNOLOGY 360 (2000).

78. *See* Adler, *supra* note 14, at 202-04.

caused by the introduction of LMOs into the environment and the relationship between the trade-restrictive measures of the Protocol and the trade rules of the World Trade Organization. These issues, and any potential compliance mechanisms, will be settled at a later date. In the meantime, the Protocol is open for signature beginning in May 2000. After it is ratified by fifty nations, it will go into force.[79] Parties to the Protocol may not make any reservations to the Protocol once it is ratified,[80] and all transboundary shipments of LMOs between parties and non-parties must be made in accordance with the Protocol's terms.[81]

IV. BIOSAFETY VERSUS BIODIVERSITY

There is a mismatch between existing threats to biological diversity and the Cartagena Protocol on Biosafety. Habitat loss is the greatest cause of biodiversity loss and species extinction. Yet the Protocol's operative provisions will do little, if anything, to promote or enhance habitat conservation. Worse, the net effect of the Protocol could actually be to *increase* risks to biodiversity by making it more difficult for farmers to feed a growing global population without clearing more species habitat.

Population growth and economic development are rapidly increasing the demand for food in much of the developing world.[82] As a result, there is a trade-off between increasing agricultural productivity and reducing the threat to biodiversity from land conversion. Meeting global food needs can be achieved either by clearing more land for agriculture or enhancing the productivity of existing agricultural lands. Increasing agricultural productivity a scant 1.4% per year from 1993 to 2050, which may be necessary to meet global food needs, would produce an overall increase in agricultural output of 121%.[83] To achieve this same increase through the use of more cropland alone would probably require increasing the amount of cropland by *more than* 121%, or over 1,700 million hectares.[84] Thus, if gains in agricultural productivity do not outpace the rising demand for agricultural production, biodiversity will suffer as forests are cleared and grasslands are plowed to make room for crops. As environmental analyst Indur Goklany explains, the difference between an average annual increase in agricultural productivity of 1 percent and 1.5 percent between 1993 and 2050 is "the difference between converting 368 Mha [million hectares] of habitat (globally) to new cropland or reducing cropland by 77 Mha."[85] By

79. *See* Biosafety Protocol, *supra* note 12, art. 37.

80. *See id.* art. 38.

81. *See id.* art. 24.

82. *See supra* notes 39-47, 50-55 and accompanying text.

83. *See* Goklany, *Meeting Global Food Needs*, *supra* note 40, at 120.

84. *See id.* This is a conservative estimate, as it does not fully account for the diminishing marginal returns that are likely as less productive lands are converted to agricultural use. It also does not include the conversion of land to other agricultural uses, such as pasture.

85. *See id.* at 126.

Goklany's estimates, to protect biodiversity from the encroachment of agriculture, annual increases in agricultural productivity worldwide must exceed 1.4%.[86]

Genetically engineered crops are likely to play an integral role in increasing the productivity of existing croplands and thereby reducing pressures on species habitat — if their use is not stifled by an overly burdensome regulatory regime. A scientific panel convened by the World Bank and Consultative Group on International Agricultural Research (CGIAR) concluded that genetic engineering could increase agricultural yields by as much as 25%.[87] Even delaying ripening in fruits and vegetables could substantially enhance food supplies, as post-harvest and end-use losses are estimated to be as high as 47% in some countries.[88]

Some of the first transgenic crops to be introduced were modified to contain a gene from the *Bacillus thuringiensis* (Bt) bacterium to protect it from insect pests. Bt occurs in nature and is often cultivated and used as a "natural pesticide." Inserting a Bt gene enables crops to produce a defensive protein, protecting them from insect pests and reducing crop damage (as well as reducing the need to apply additional Bt or other pesticides).[89] The result, among other things, is increased productivity. In 1997, for instance, the per-acre yields of corn modified to produce Bt were 7% higher than unmodified corn.[90] Bt cotton yields reported in 1996 were even further above conventional crops — 15% to 17% higher than yields of unmodified cotton treated with conventional pesticides.[91] Early transgenic harvests in the developing world are showing similar results, such as a modified rice variety with increased yields of 5% to 15%.[92]

The negative impacts of a protocol on habitat conservation will be felt most in sub-Saharan Africa. "The African continent, more than any other, urgently needs agricultural biotechnology, including transgenic crops, to improve food production."[93] Indeed, the agricultural biotechnology revolution is potentially even more valuable for some developing countries than the original "green revolution" because the use of transgenic crops will not require the same costly inputs

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86. These estimates may even be a bit optimistic. In some parts of the world, such as sub-Saharan Africa, it may be necessary to achieve an annual productivity increase of 1.8% to 3% to avoid clearing habitat for cropland. *See* C.J.M. Musters et al., *Can Protected Areas Be Expanded in Africa?*, 287 SCIENCE 1759, 1760 (2000).

87. *See* World Back Press Release, *Bioengineering of Crops Could Help Feed the World; Crop Increases of 20-25 Percent Possible* (Oct. 9, 1997) *available at* <http://www.worldbank.org/html/cgiar/press/biopress.html>.

88. *See* Goklany, *Meeting Global Food Needs*, *supra* note 40, at 120.

89. Early studies show that the use of pest-resistant crops typically results in substantially lower pesticide use. *See, e.g.*, Paarlberg, *supra* note 20, at 23.

90. *See* Anne Simon Moffat, *Toting Up the Early Harvest of Transgenic Plants*, 282 SCIENCE 2176, 2177 (1998).

91. *See* Judy Stringer, *Monsanto Poised to Reap Biotech Harvest*, CHEM. WEEK, Nov. 6, 1996, at 51.

92. *See* Conway, *supra* note 55, at 14.

93. Florence Wambugu, *Why Africa Needs Agricultural Biotech*, 400 NATURE 15 (1999). *See also* Musters, *supra* note 86.

that many "green revolution" techniques do.[94] Without the contribution of new generations of GMOs, it will be immensely difficult to meet the rising food demands of the world's peoples and still preserve large areas of undeveloped habitat. Even if the use of genetically engineered crops allows for the further intensification of agricultural production, which has environmental impacts of its own, these impacts pose a lesser threat to biodiversity than the unabated loss of native habitat throughout the world; "the environmental costs of expanding the area tilled are enormously greater than those of increasing yield."[95] Thus, adoption of a precautionary biosafety protocol could well counteract other efforts under the CBD to protect biological diversity.

While the Biosafety Protocol will, if anything, retard efforts to protect habitat from the encroachment of agriculture, some hope that the advance informed agreement procedures, combined with the information sharing provisions, will help to reduce other ecological risks from the introduction of LMOs. One prominent concern is that the introduction of LMOs into the broader environment could disrupt local ecosystems. The introduction of non-indigenous animal and plant species, ranging from the brown tree snake in Pacific regions to Zebra mussels in North America to feral cats in New Zealand, has had a significant impact on biodiversity and is a substantial contributor to species extinction.[96]

The introduction of exotic species into new environments is a legitimate concern. The Biosafety Protocol, however, is ill-equipped to address it. There is no basis for presuming that GMOs pose a distinct threat of ecosystem invasion. The National Academy of Sciences noted that "a mutation made by traditional techniques may be accompanied by many unknown mutations."[97] The additional precision offered by rDNA techniques utilized in GMOs, however, makes the introduction of a new "pest" species less likely, as it reduces the chances of inadvertently transferring unwanted genetic traits from one species to another. Moreover, most scientists believe that those genes introduced to transgenic crops "in fact decrease their fitness in the wild."[98] In other words, good crops make bad weeds. Existing regulatory measures may well be insufficient to prevent the

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94. *See* Paarlberg, *supra* note 20, at 22.

95. John H. Barton, *Biotechnology, the Environment, and International Agricultural Trade*, 9 GEO. INT'L ENVTL. L. REV. 95, 99 (1996).

96. Examples from Chris Bright, *Understanding the Threat of Bioinvasions*, *in* STATE OF THE WORLD 1996, at 97-98 (1996). *See also* Edwards, *supra* note 22, at 222.

97. INTRODUCTION OF RECOMBINANT DNA ORGANISMS INTO THE ENVIRONMENT, *supra* note 6, at 11. The 1992 report of the National Biotechnology Policy Board reached the same conclusion that "biotechnology processes tend to reduce risk because they are more predictable." NBPB, *supra* note 6, at 2. *See* Declan Butler & Tony Reichhardt, *Long-term Effect of GM Crops Serves Up Food for Thought*, 398 NATURE 651, 653 (1999) (noting that "in addition to introducing a desired trait into a crop from a wild relative, [conventional] breeders have no idea what other changes they may have introduced through the integration of large chunks of the donor genome").

98. Brian Johnson, *Genetically Modified Crops and Other Organisms: Implications for Agricultural Sustainability and Biodiversity*, *in* AGRICULTURAL BIOTECHNOLOGY AND THE POOR 133 (G.J. Persley & M. M. Lantin eds., 2000).

introduction of invasive exotic species, yet a protocol focusing on biotechnology does little to remedy this concern. Indeed, by focusing on GMOs it may divert resources and attention from greater ecological threats.

A related concern is that transgenic crops will "pollute" regional ecosystems by releasing new genetic combinations into the environment through pollination.[99] "Genetic pollution is considerably more dangerous than oil spills. You can't just go out there and put a boom around it and put it back in," according to Kristin Dawkins of the Institute for Agriculture and Trade Policy.[100] Not only does this concern wrongly presume that transgenic crops pose unique risks of such pollution, but it overstates the risks of rogue genes transforming natural ecosystems. Those traits that are genetically transferred to crops, such as resistance to a particular chemical or pest, are unlikely to confer any competitive advantage over wild plants that would lead to a substantial invasion.[101] Indeed, pathogenicity and "weediness" are functions of multiple genetic traits, so the transfer of one or two through rDNA techniques is unlikely to transform a relatively innocuous crop into an invasive or disruptive species.[102] In addition, some believe that the same rDNA techniques used to enhance crop productivity could be used to introduce safety-enhancing traits, "such as pollen incompatibility, to prevent gene flow."[103]

Concerns about "genetic pollution" are reasonable, even if they are not truly addressed by the Protocol. It is nonetheless instructive that there is as yet no evidence that transgenic crops pose any greater risk of such "pollution" than their traditionally crossbred cousins. Consider that in 1998, 27.8 million hectares were planted with genetically modified crops around the world, albeit focused in a handful of countries.[104] One year later, such crops covered 39.9 million hectares.[105] Yet despite the millions of acres planted, most in plots with extensive oversight systems, there is scant evidence that transgenic crops are having any adverse environmental effect.[106] There similarly has yet to be any indication of

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99. *See* Paarlberg, *supra* note 20, at 24.

100. Rick Weiss & Justin Gillis, *U.S. 'Observers' Lobby Against Trade Curbs on Biotechnology*, WASH. POST, Feb. 13, 1999, at A4 (quoting Kristin Dawkins).

101. *See* Declan Butler et al., *Assessing the Threat to Biodiversity on the Farm*, 398 NATURE 654, 655 (1999).

102. *See* Henry I. Miller, *Regulation, in* THE GENETIC REVOLUTION: PROSPECTS AND PUBLIC PERCEPTIONS 207-08 (Bernard D. Davis ed., 1991).

103. Johnson, *supra* note 98, at 133.

104. *See* Paarlberg, *supra* note 20, at 20. In 1999, the United States accounted for 72% of the area planted with transgenic crops, Argentina 17% and Canada 10%. *See id.* The remaining 1% was planted across nine other countries — China, Australia, South Africa, Mexico, Spain, France, Portugal, Romania, and Ukraine. *See id.*

105. *See id.*

106. According to R. James Cook of Washington State University:

> This remarkable record of safety for crop plants would indicate that either (1) the risks to the environment are low; (2) the extensive field testing prior to commercial use and the institutional assessments and decisions on which plants or varieties to grow as crops have been sound; and/or (3) the management practices in place have been adequate to mitigate any risks inherent with plants.

any health risk from any genetically engineered food product commercially available in the United States.[107]

While the Biosafety Protocol is unlikely to increase the protection of rural environments in developing countries, it could well retard the use and development of genetically engineered crops. The more uncertain and costly the regulatory structure becomes, the more research and investment will steer clear of biotechnology.[108] According to former Food and Drug Administration official Henry Miller, "[u]nnecessary governmental scrutiny in the form of case-by-case reviews will cause delays in the testing of biotechnological products, increase the potential for corruption and markedly inhibit the diffusion of this useful technology to the developing world."[109] An overemphasis on the potential risks of using agricultural biotechnology ignores the equal, if not far greater, risks of doing without such advances. "For the world's developing countries, one of the greatest risks of genetic engineering is not being able to use this technology at all."[110]

James Cook, *Science-Based Risk Assessment for the Approval and Use of Plants in Agricultural and Other Environments*, *in* AGRICULTURAL BIOTECHNOLOGY AND THE POOR, *supra* note 98, at 123. Any of these conclusions would suggest that a biosafety protocol is unnecessary.

A May 1999 study of the potential impact of Bt-modified crops raised environmental concerns about the impact of transgenic crops. *See* John E. Losey et al., *Transgenic Pollen Harms Monarch Larvae*, 399 NATURE 214 (1999). A preliminary study found that Monarch butterfly larvae raised on a diet of leaves dusted with pollen from Bt-engineered corn fared worse than those fed leaves with unmodified corn pollen or undusted leaves. *See id.* The study generated headlines and prompted calls for the prohibition of "killer corn," despite its unclear implications. Friends of the Earth, for example, issued a letter to President Clinton calling for the cancellation of Bt crop registrations and new regulations on genetically modified crops. *See* Friends of the Earth, *Letter to President Clinton* (visited Jan. 28, 2000) <http://www.foe.org/safefood/lettertoclinton.html>. Researchers at the National Biological Impact Assessment Program at Virginia Tech University noted that "experts predict little impact on monarch larvae beyond the edges of Bt corn fields," in large part because the exposure to Bt pollen in the study were far greater than what could ever be expected in the wild. *See* Ruth Irwin, *Butterfly Brouhaha*, ISB NEWS REP., July 1999, at 2. Indeed, the lead author of the Monarch butterfly study himself commented that the "study was conducted in the laboratory, and . . . it would be inappropriate to draw any conclusions about the risk to Monarch populations in the field based solely on these initial results." Michael Fumento, *The World Is Still Safe for Butterflies*, WALL ST. J., June 25, 1999, at A18 (quoting John Losey of Cornell University).

107. *See* C.S. Prakash, *Feeding a World of Six Billion*, AGBIOFORUM, Summer/Fall 1999 (quoting David Aaron of the U.S Commerce Department); *see also* COMMITTEE ON GENETICALLY MODIFIED PEST-PROTECTED PLANTS, BOARD ON AGRICULTURAL AND NATURAL RESOURCES, NATIONAL RESEARCH COUNCIL, GENETICALLY MODIFIED PEST-PROTECTED PLANTS (2000) (finding that genetically engineered crops are safe and that they do not pose any greater health or environmental risk than plants produced through traditional breeding practices); Paarlberg, *supra* note 20, at 21 ("There is no credible evidence of a food safety risk linked to any GM food currently on the market in Europe."); Tim Beardsley, *Rules of the Game*, SCI. AMER., Apr. 2000, at 42 (noting that "no harm from a GMO crop has ever been demonstrated").

108. *See* Henry I. Miller & Gregory Conko, FIN. TIMES (US Edition), Mar. 7, 2000, at 12 (stating that "[u]nnecessary and unpredictable regulation invariably discourages use of a technology . . .").

109. Henry I. Miller, *UN-based Biotechnology Regulation: Scientific and Economic Havoc for the 21st Century*, TRENDS IN BIOTECHNOLOGY, May 1999, at 189.

110. Laura Tangley, *Engineering the Harvest*, U.S. NEWS & WORLD REP., Mar. 13, 2000, at 46 (quoting Calestous Juma, a Kenyan advisor to the Harvard University Center for International Development and former executive secretary of the CBD).

V. CONCLUSION

The Cartagena Protocol on Biosafety adopts a "precautionary" approach to the regulation of biotechnology. Under this view, it is prudent to delay the introduction and use of new technologies until one can be sure that there are few, if any, potential adverse effects. Advocates of a stringent regulatory regime for biotechnology claim that such an approach is prudent — a precautionary approach to the dangers of new inventions. Anti-biotechnology activist Jeremy Rifkin warns that "there's no science that proves they're safe."[111] Yet such proof — proof that no adverse effects are possible — is beyond even the most able scientist's grasp, as one cannot prove a negative proposition. As a result, the precautionary principle is an excuse for interminable delays in the introduction of new technologies, and those delays can have negative consequences of their own.[112]

One can readily see the failings of the precautionary principle if one considers the consequences of foregoing technologies that the world now takes for granted. "If our technologies had remained stuck in the past and if somehow the world's population had nevertheless been able to grow to its current level, the impact of humanity on the natural environment would have been calamitous."[113] Had agricultural productivity in 1993 remained what it had been in 1961, existing levels of food production would have required increasing agricultural land by 80% or more over 1961 levels.[114] In other words, an additional 3,550 million hectares — over one-quarter of the earth's land area excluding Antarctica — would have had to be converted to agricultural uses.[115]

Habitat loss around the world poses a real threat to biodiversity. Absent advances in agricultural production, the world's burgeoning population, and the consequent increased demand for food production, will accelerate this trend. If the parties to the Convention on Biological Diversity want to arrest this trend, their efforts would be better spent building institutional capacities for habitat conservation.[116] A global regulatory regime for biotechnology will not do much to stem the loss of biological diversity. If anything it could make this real problem worse.

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111. Margaret Kriz, *Global Food Fight*, NAT'L J., Mar. 4, 2000, at 692 (quoting Jeremy Rifkin).

112. For an extension of the argument against precautionary regulation of biotechnology, see Adler, *More Sorry than Safe*, *supra* note 14, at 197-204. More generally, see Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851, 873 (1996).

113. Ronald Bailey, *The Progress Explosion: Permanently Escaping the Malthusian Trap*, *in* EARTH REPORT 2000, *supra* note 19, at 1, 13.

114. *See* Indur M. Goklany, *Saving Habitat and Conserving Biodiversity on a Crowded Planet*, 48 BIOSCIENCE 941, 941 (1998). This figure includes both cropland and permanent pasture.

115. *See id.*

116. *See generally* Edwards, *supra* note 22; Martin, *supra* note 27.