# INCENTIVIZING ECOLOGICAL DESTRUCTION? THE GLOBAL JOINT REGULATION OF THE CONSERVATION AND USE OF GENETIC RESOURCES

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## I. THE INTERNATIONAL MANAGEMENT OF BIOLOGICAL INFORMATION

For the last ten thousand years, the global exchange of biological information is perhaps one of the most significant processes underlying the development of humanity.[1] Through trade and migration, animals and plants have been introduced into new habitats, selected, and bred for desirable, productive traits. Microbes and biochemical compounds that proved successful at one location have been applied in novel settings to aid a myriad of production processes, from fermentation to providing cures. Most palpable is the effect of global biological information sharing in agriculture and medicine. Modern agriculture would be unthinkable without this purposeful sharing of genetic information across initially tribal and subsequently national boundaries.[2] Countries around the world share biotechnological innovations that enhance productivity and quality of agricultural production. Likewise, the great variety of pharmaceuticals available to modern man has only been possible through a screening process that examined plants and other organisms for medically useful compounds. While the original life forms may only exist in a specific location, the pharmaceutical mechanism to which it gives rise can be applied, and hence provide benefits, at a global scale.

Many observers have noted that there are two salient characteristics of the global exchange of biological information. One is that it involves two very distinct regions of the world, often referred to as "North" and "South."[3] On the one hand, there are developing countries in the South that export "raw" biological information, based on an abundant stock of biodiversity. This "raw" information is usually referred to as "genetic resources" and forms a major

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1. *See, e.g.*, ALFRED W. CROSBY, ECOLOGICAL IMPERIALISM: THE BIOLOGICAL EXPANSION OF EUROPE, 900-1900 (1986); JARED M. DIAMOND, GUNS, GERMS AND STEEL: THE FATES OF HUMAN SOCIETIES (1997); L.T. EVANS, CROP EVOLUTION, ADAPTATION AND YIELD (1993).

2. *See, e.g.*, EVANS, *supra* note 1; JOHN HOLDEN ET AL., GENES, CROPS, AND THE ENVIRONMENT (1993).

3. *See, e.g.*, Paul E. Chambers et al., *Debt-for-nature Swaps as Noncooperative Outcomes*, 19 ECOLOGICAL ECON. 135 (1996); Timothy Swanson, *The Reliance of Northern Economics on Southern Biodiversity: Biodiversity as Information*, 17 ECOLOGICAL ECON. 1 (1996).

contribution of the South to global innovation processes.[4] The North, on the other hand, consists of industrialized countries that import these genetic resources, use them as a production factor and then export "processed" biological information in the form of biotechnological innovations. This way of looking at the global exchange of biological information suggests seeing it as a bilateral trade between a North and a South, trading in different forms of biological information.[5] The second important observation is that despite the essential importance of the modern development process for the continued generation of new biotechnological innovations, the supply of "raw" biological information (in the form of biodiversity) is under threat in many of those developing countries that harbor the majority of biological diversity left on this planet. Together, these two observations make it clear that the erosion of the stock of "raw" biological information is a problem of economically significant global interdependencies in informational inputs and outputs between North and South. Managing this problem optimally therefore requires ensuring that decisions taken in the North and South are responsive to the global costs and benefits they create.

In recognition of the nature of this problem, the international community has created a set of institutions that are aimed at regulating both the conservation of the genetic inputs and the rules governing the use of biotechnological outputs. These institutions and their contribution to conservation, trade, and development are at the center of our analysis in this paper. We begin with a short presentation of the international management problem relating to biological information that these institutions are designed to address. We then discuss the institutional responses of the international community to this problem and report on the results of a game theoretic analysis of the current institutions carried out in some of our recent work.[6] This analysis raises the possibility that one of the reasons why these institutional solutions have so far failed to induce an appropriate level of conservation effort is that the current institutional design contains a critical flaw. The institutions themselves may provide strategic incentives for ecological destruction to continue.

Understanding the nature of the international bargaining process over biological information has important ramifications for learning lessons about how to build institutions that manage global public goods. There is currently a wider debate about the need for a unified international environmental framework such as a World Environment Organization.[7] Some of the results presented here

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4. Swanson, *supra* note 3.

5. Suzanne Droege & Birgit Soete, *Trade-Related Intellectual Property Rights, North-South Trade and Biological Diversity*, 19 ENVTL. & RESOURCE ECON. 149 (2001); Timothy Swanson & Timo Goeschl, *Property Rights Issues Involving Plant Genetic Resources: Implications of Ownership for Economic Efficiency*, 32 ECOLOGICAL ECON. 75 (2000).

6. RUPERT GATTI ET AL., THE BIODIVERSITY BARGAINING PROBLEM (Cambridge Working Papers in Economics, No. 0447, Sept. 2004).

7. *See, e.g.*, Frank Biermann, *The Case for a World Environment Organization*, 42 ENV'T 22 (2000); John Whalley & Ben Zissimos, *What Could a World Environmental Organization Do?*, 1 GLOBAL ENVTL. POL. 29 (2001).

have relevance to this debate, the debate about how to reconcile developmental and environmental goals in the best possible fashion.

## II. The Nature of the Problem

The need for global cooperation in the field of biodiversity conservation has been recognized for some time.[8] This global cooperation is usually thought of as requiring two regional parties: a technology-rich and biodiversity-poor North that depends on the South for the supply of biodiverse habitats and for the supply of genetic inputs into the biotechnological Research and Development (R&D) process; and a biodiversity-rich and technology-poor South that depends on the North for highly productive biological technologies.[9] These differences in natural and technological endowments therefore create significant interdependencies between people living in different parts of the world. From a welfare-theoretic point of view, land-use decisions and the degree of access to biotechnological inputs and outputs should take into account the global nature of the benefits inherent in this sector. This sector of biotechnological exchange, in inputs and outputs, is the center of our focus in this paper.

There are, of course, many areas where such interdependencies exist. North and South are interdependent not only in the areas of biodiversity, but also many other natural resources such as oil and gas and minerals. The natural response to the presence of such interdependencies is for countries to engage in mutually beneficial exchange of these goods, in other words to realize the mutual gains from trade. The problem in the case of the biotechnology sector is that the goods to be exchanged have a very peculiar property, namely that they are mainly informational in character. Both on the input and the output side, the economic interest focuses on the knowledge of the ecological function and genetic composition of a plant or animal. In other words, the benefits are derived from the knowledge of which gene, and at which location in the genetic make-up of the organism delivers productive benefits. This knowledge can exist in various forms, such as the history of crosses that generated a high-yielding cultivar or the precise genetic markers of the crop or, at its most sophisticated level, in the actual genome of the plant. But, the common feature is that it is information, rather than a physically tangible good, that generates the benefits.

One central finding in microeconomics is that information is a very difficult good for markets to allocate efficiently. The non-excludable (and non-rival) nature of informational goods challenges both the practicability (and desirability) of using a market allocation process. Absent some remedial measures, countries seeking access to these informational goods will not do so under what would usually be described as "trade" or voluntary exchange since it would be impossible for the country of origin to prevent another country from

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8. Scott Barrett, *The Biodiversity Supergame*, 4 Envtl. & Resource Econ. 111 (1994); Swanson, *supra* note 3.

9. Naturally, some countries such as India or China are increasingly challenging these categories through the nascent biotechnological capacities.

appropriating those goods. Unless the costs of appropriating informational goods are prohibitively high, the country of origin would not enjoy "seller's privilege," i.e., the possibility to decide who can benefit from the good. In the case of biological information, the absence of seller's privilege would be problematic for both North and South. While the South would be incapable of preventing the appropriation by the Northern innovators of knowledge about desirable crop traits (agriculture) and bioactive compounds (pharmaceuticals), the North could not prevent the imitation and unlicensed use of biotechnological innovations in the South.

The internationally sensitive nature of this not always voluntary exchange of biological information explains the emergence of discussions about new forms of "piracy" committed by North and South. On the one hand, some commentators have pointed to the theft of biological information by the North from the South in the form of plants, animals, and seeds or of traditional knowledge, hence the term of "biopiracy"[10] has entered the political debate. On the other hand, there has been significant debate about "product piracy," i.e., the illegitimate theft of intellectual property of Northern R&D and quality investment by the South. The scale of these debates points to the economic significance of the global interdependencies in informational inputs and outputs of the biotechnology industry.

## III. RESPONSES

The problem of enabling rents from the provision of informational goods to be appropriated efficiently exists at different levels of spatial aggregation. However, the capacity of policymakers to address the problem differs markedly depending on whether the informational spillovers are of a local nature, or arise at higher spatial orders. For problems of informational goods, domestic policymakers have access to a wide range of instruments to address the specific challenges posed by informational goods. They range from public provision, to contractual arrangements, to the creation of property rights in informational goods. At the domestic level, these instruments can be implemented with relative ease. In the case of biological resources, typical domestic instruments used to solve the problem are national agricultural research centers, publicly sponsored university research and information dissemination, private contracts between germplasm providers and plant breeders, and intellectual property rights in biological information through patents or particular *sui generis* forms of Intellectual Property Rights (IPRs) such as plant breeders' rights.

While the policy instruments described above provide effective institutional solutions at the domestic level, it is the international level at which the exchange of biological information generates the most significant benefits. Note that the domestic solutions rely extensively on a fiscal and legal infrastructure for their functioning: resources to support public information production and dissemination require a domestic tax base and funding mechanism. Intellectual

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10. VANDANA SHIVA, BIOPIRACY: THE PLUNDER OF NATURE AND KNOWLEDGE (1997).

property rights and contracts have to be enforceable through a judicial system. Since the institutional solutions to the challenges of informational goods cross jurisdictional boundaries, there is no fiscal and legal infrastructure at the international level that is developed to the same degree as that available to domestic policymakers. An internalization of the informational externalities at the international spatial scale is therefore much more difficult and requires cooperative efforts among countries in order to generate a comparable structure of rights and enforcement capabilities.

Despite the obstacles involved in setting up institutional solutions at the international level, a number of negotiations among countries throughout the 1980s and early 1990s led to a set of rights and rules that mimic the domestic policy solutions at the international level. As far as biodiversity inputs and biotechnological outputs are concerned, these international rights and rules are enshrined in two separate and distinct agreements, namely the Convention on Biological Diversity and the Agreement on Trade-Related International Property Rights, which will be discussed in detail below. Both conventions explicitly refer to the problem of genetic resources and biodiversity management and state their intention to incentivize their production, maintenance, and international exchange by coordinating the choices in the North and South. The rules and rights that were agreed in these international agreements and have been governing the biological information problem for the last ten years are supposed to capture the externalities inherent in biodiversity inputs and biotechnological outputs.

### *A. The Convention on Biological Diversity*

The Convention on Biological Diversity (CBD),[11] in existence since 1992 (and in force since 1993), has created a legal framework that binds the 175 contracting parties to undertake measures to safeguard and enhance existing biological diversity to allow for the conservation and sustainable use of this resource. Central to the CBD are rules about access to genetic resources, as well as agreement about the mechanisms for benefit sharing, funding, and technology transfer. The CBD upholds the established principles of countries enjoying sovereignty over their natural resources and leaves domestic access and benefits sharing rules in the hands of national governments. This principle of informed consent in the use of biological information in itself, however, does not generate any financial flow for conservation. Therefore, in addition, the agreement allows the CBD to distribute funds paid by the North to the South on a project basis through the so-called Global Environment Facility (GEF). Thus, the costs to developing countries of carrying out conservation measures can be financially covered by the mechanism of the GEF. This combination of the accordance of property rights in biological information to national governments and a funding mechanism is intended to address both sovereignty and equity considerations at once.

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11. See http://www.biodiv.org/doc/legal/cbd-en.pdf for the text of the Convention.

### *B. Trade-Related Intellectual Property Rights*

The second institution created to coordinate the management of biological information is the agreement on Trade-Related Intellectual Property Rights (TRIPS)[12] that arose out of the World Trade Organization (WTO) agreements in 1994. TRIPS specifies that any product or process innovation that fulfills the criteria of novelty, usefulness, and non-obviousness emanating from a signatory country can be subject to patent protection in any other signatory country. This agreement covers plant varieties and animals. To gain access to the benefits of WTO membership, countries without a TRIPS-conforming domestic IPR system have to commit to a short-to-medium development of such a system. TRIPS enshrines three trends characteristic of the modern global IPR system: the broadening of existing rights, specifically for living organisms; the creation of *sui generis* systems to extend IPR principles into new domains; and the increasing standardization of IPR principles.[13]

### *C. The Joint Regulatory Framework*

Despite their separate and distinct origins, both institutions make explicit reference to each other. The CBD refers in detail to the "adequate and effective" protection of intellectual property within the framework of the Convention (Article 16.1). With this, the parties chose to explicitly link the convention to TRIPS, which uses identical language.[14] It also binds parties to seek cooperation on the IPR issue, thus pointing to TRIPS as the emerging standard of IPR protection. There is explicit reference to the role of biotechnological innovations as a vehicle for technology transfer between countries subject to the provisions of adequate IPR protection (Article 17). Therefore, the CBD consciously subordinates itself to TRIPS as far as its provisions relate to the nature of property rights that can be assigned to immaterial goods. Similarly, the TRIPS agreement defers to the CBD insofar as the objectives of genetic resource conservation and the specific form of IPR protection for plants and animals are concerned.

Jointly then, the CBD and TRIPS constitute a coherent institutional framework governing the international management of biological information in terms of inputs (genetic resources) and outputs (new crops and pharmaceuticals). This framework enshrines, through TRIPS, the assignment of property rights in this information and commits countries to enforcing these property rights domestically. At the same time, the institutional framework creates, by virtue of the CBD, a mechanism of technology transfer and financial payments through the GEF. As a result, the international community has institutions in place that should increase investment in biotechnological R&D in the North by providing global protection of the outputs of the innovation process, while at the same time

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12. See http://www.wto.org/english/docs_e/legal_e/27-trips.pdf for the full text.

13. GRAHAM DUTFIELD, INTELLECTUAL PROPERTY RIGHTS, TRADE AND BIODIVERSITY: SEEDS AND PLANT VARIETIES (2000).

14. *Id.*

the framework should enhance the conservation of genetic resources in the South through financial support mediated through the GEF. With the successful creation of these two institutions and implementation of their operation, the difficulty of managing the conservation and use of biological information appears to be solved.

## IV. PROBLEMS

The CBD and TRIPS have now been in existence for a decade and have been widely adopted. In many ways, therefore, these institutions have been a considerable success in terms of demonstrating the capacity of countries to generate solutions to problems of global scale. Countries have drawn up national legislation to supplement the international agreements in the areas of IPR law, in particular *sui generis* systems of plant variety protection.[15] They have also designed and implemented policies targeted at the conservation of biodiversity in general, and genetic resources in particular in, for example, Costa Rica, Ecuador, and the Philippines.[16]

However, despite their success as institutions, several observers have noted that while there has been considerable progress in the global adoption of intellectual property rights, on the environmental side there is, so far, little evidence that these international agreements have had discernable positive effects on efforts to halt the degradation of genetic resources in the South. Considerable interest exists in the question why conservation efforts are lacking, despite the presence of a global institutional regime. Various explanations for this failure have been advanced that can be divided into three broad themes. The first theme emphasizes the issue of government failure in various forms. Typical examples are perverse subsidies that are competing with conservation measures and hamper their effectiveness.[17] Other examples are the persistence of dysfunctional property rights,[18] and the lack of complementary rights for farmers or landowners on which biologically valuable resources exist.[19] Other authors have emphasized the insufficient pass-through of funds received under the payment mechanisms of the CBD from national governments to those individuals that actually make the day-to-day conservation decisions.[20] The two other recurrent

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15. *See* BIODIVERSITY AND TRADITIONAL KNOWLEDGE: EQUITABLE PARTNERSHIPS IN PRACTICE (Sarah A. Laird ed., 2002); GRAHAM DUTFIELD, INTELLECTUAL PROPERTY RIGHTS AND THE LIFE SCIENCE INDUSTRIES: A TWENTIETH CENTURY HISTORY (2003).

16. *See* DUTFIELD, *supra* note 11.

17. SERGIO MARGULIS, CAUSES OF DEFORESTATION OF THE BRAZILIAN AMAZON (World Bank, Working Paper No. 22, 2003).

18. Douglas Dewitt Southgate, Jr. et al., *Markets, Institutions, and Forestry: The Consequences of Timber Trade Liberalization in Ecuador*, 28 WORLD DEV. 2005 (2000).

19. Droege & Soete, *supra* note 5.

20. *See, e.g.*, Kelly Day-Rubinstein & George B. Frisvold, *Genetic Prospecting and Biodiversity Development Agreements*, 18 LAND USE POL'Y 205 (2001).

themes are that land speculation destroys incentives for conservation[21] and that widespread corruption prevents any significant funds from reaching local decision makers.[22] An almost universal trait of this literature is, therefore, a scepticism that the incentives created by the CBD are substantial enough to reverse or neutralize existing governance problems.

One possibility that has not been considered explicitly so far in the debate is whether, perhaps, it is the very institutions designed to stimulate conservation that create the actual incentives for biodiverse land to be degraded by developing countries. In other words, the reason for the failure of the institutional solution to induce greater conservation efforts may lie in the design choices enshrined in the CBD and TRIPS as well as external factors. This is the focus of the following section.

## V. Bio-Bargaining and the Use of Rational Threats

The basic insight underlying the negotiations over a set of international institutions to govern the management of biological information is that there are gains from cooperation available to the parties involved in the bargaining process. What are the gains available to North and South from bargaining over how to jointly manage global biological information? The North's primary benefits arise out of a more productive biotechnological R&D sector. A greater provision of biological resource stocks in the South enhances this productivity, and hence generates gains to the North. The South, on the other hand, benefits from higher productivity in the sectors that use biotechnological products as an input, such as agriculture and health. For these productivity gains to be realized and the South to benefit, the North has to supply biotechnological innovations. Since these biotechnological innovations are the outcome of the R&D process that benefits from a greater supply of biodiversity in the South, there are mutual gains available to North and South from agreeing on how to govern the use of biological information.

Bargaining theory is a branch of game theory that allows one to analyze and predict outcomes of bargaining processes such as the international negotiations over biological information. The foundations of this theory go back to seminal work of John Nash.[23] Two of Nash's fundamental insights into the bargaining process are of importance in the context of trying to understand the North-South bargaining problem. The first central insight is that the precise outcome of the cooperative bargaining process is indeterminate unless something is known about the bargaining power of the parties involved. What can be predicted is that all outcomes should belong to the so-called "bargaining frontier," i.e., the set of outcomes on which the bargaining parties cannot Pareto-improve that are Pareto-optimal in the sense that it is impossible to make one of the bargaining parties better off without making at least one other party worse off. Nash demonstrates

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21. Margulis, *supra* note 15.

22. *See* R.J. Smith et al., *Governance and the Loss of Biodiversity*, 426 Nature 67 (2003).

23. John Nash, *Two-Person Cooperative Games*, 21 Econometrica 128 (1953).

how knowledge about the bargaining power can be used to resolve the indeterminacy of the predicted outcome. The second critical insight of Nash is that bargaining power alone may not be the only determinant of the final bargaining outcome.[24] Depending on the particular situation and the fulfillment of some conditions, parties may be able to use threats in order to improve on the bargaining outcome that would have predicted on the basis of bargaining power only. A typical case for the applicability of so-called "rational threats" is where a party can increase the value of cooperation to the other player without adversely affecting the value of her own outside option, but the actual requirements for threats to be rational (and credible) are less stringent than this.[25]

In a recent paper, Gatti and his co-authors pursue the question whether, in line with Nash's argument, the failure of the South to increase conservation effort can perhaps be explained as the use of a rational threat in an ongoing negotiation process over how to share the gains from cooperation in the management of biological information.[26] If it is in the interest of the South not to halt the continuing degradation of biological information for strategic reasons, the current institutional solutions are not robust against rational threats. This would point to fundamental flaws in the very institutions created to solve the international problem of conserving and using biological information. The authors provide a formal model that analyzes the bargaining process over biological information in the context of the externalities present on the input and output side.[27] Here, we summarize and discuss these results in an informal way while referring the reader to the technical paper for more detail.

Figure 1 presents the structure of the North-South bargaining problem that focuses, without loss of generality, on the agricultural aspects of the problem. Both North and South possess land endowments $L_n$ and $L_s$. In the North, the land endowments are divided between a traditional extensive sector and an intensive biotechnology sector. In the South, there is an additional sector of highly biodiverse "reserve" lands. Trade between North and South takes place in the form of an export of "raw" biological information out of the reserve sector in the South that is absorbed by the intensive biotech sector in the North. The latter, for its part, combines these informational inputs with skilled labor and, as a result, exports high yielding crops to the South. The global problem then consists of determining the optimal size of reserves that enhance the productivity of the biotechnological R&D sector in the North and the optimal size of technology transfer into the intensive sector in the South. Three questions arise: first, whether an optimal allocation can be reached through a bargaining process; second, how the gains from cooperation are distributed between the bargaining parties; and third, whether this distribution of gains is robust against the use of rational threats by one of the parties.

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24. *Id.*
25. *Id.*
26. Gatti et al., *supra* note 6.
27. *Id.*

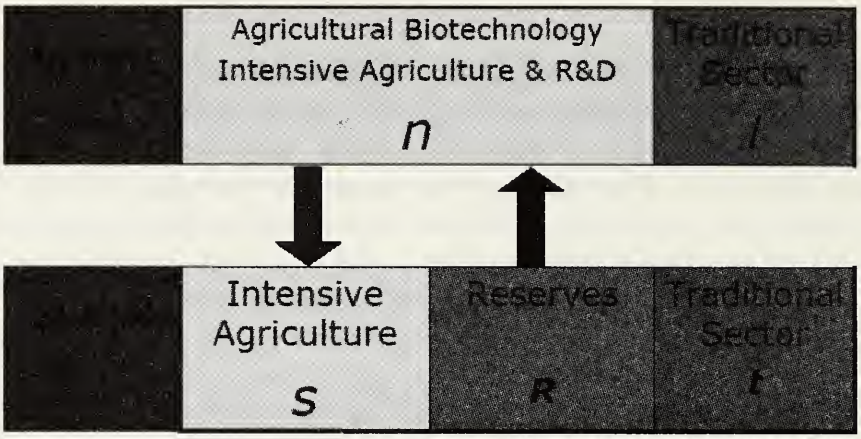


**Figure 1: Schematic Structure of the Model**

In order to answer the first question, it is necessary to define three important benchmarks, which are illustrated in Figure 2. The first benchmark is the welfare position the parties would reach in the absence of cooperation. This is the putative reference point for the bargaining process relative to which the gains from cooperation can be defined. In the literature, this is usually referred to as the "conflict" payoff. The analytical model determines the conflict payoff as the welfare positions both parties arrive at in the position of autarky, i.e., where no trade and no transfers are taking place. Under fairly general conditions, it can be shown that the autarky point is an interior solution, i.e., the South will conserve some small, but positive amount of reserves that will generate positive externalities for the North's R&D sector. The South, on the other hand, does not receive either technology transfer embodied in biotechnological products exported from the North or financial compensation for the conservation efforts carried out. These characteristics of the "conflict" payoff are important since they define what gains can be made by cooperating on the provision of more reserves in the South (thus improving the productivity of R&D in the North) and on the provision of biotechnological product by the North (thus improving agricultural productivity in the South). The "conflict" payoff or "autarky point" is denoted with "A" in Figure 2 with associated welfare levels $\left(U_N^a, U_S^a\right)$ for the North and South, respectively.

The second benchmark is the so-called "bargaining frontier," i.e., the point of cooperative bargaining outcomes that are Pareto-efficient. This frontier consists of the set of points "U*" at which no bargaining party can be made better off without reducing the welfare of the other party. This bargaining frontier is denoted by "U*" in Figure 2. Together with the autarky point "A," the "bargaining frontier" defines a triangle that depicts the social and individual net gains from cooperation. They also define jointly the scope for strategic threats for the bargaining parties. Note that if the autarky point is an interior solution, the South will provide a positive amount of reserves from which the North benefits. If the North's welfare is increasing in the size of reserves and if the net cost of land degradation bears a low net cost (conversion costs minus gains from conversion, such as timber extracted, etc.), the South can use the size of reserves as a strategic variable.

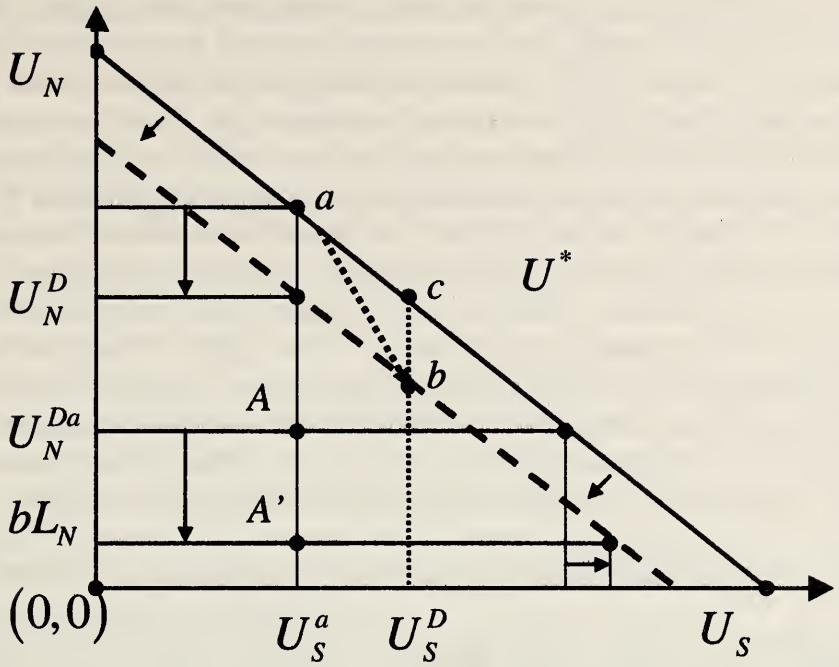


**Figure 2: Strategic Destruction as a Bargaining Ploy**

If land degradation is a bargaining instrument, the South can use it to vary the size of the bargaining pie, namely by threatening to reduce the social gains available from bargaining. This creates a new benchmark for the North, namely the threat point, which is denoted by "A" in Figure 2. As the figure illustrates, if the South can credibly threaten a payoff combination of $\left(U_N^{Da}, U_S^a\right)$, this increases the relative gains to the North from cooperating with the South.

This existence of these three benchmark points means that in the process of bargaining over rents from optimal land uses, conditions exist in which the South can use the threat of strategic destruction to improve its payoff. It does so by increasing the value of cooperation to the North, in which its payoff is increasing, despite the fact that carrying out this threat would reduce the value of social welfare due to the irreversible loss of valuable reserves. In terms of Figure 2, if the Nash bargaining solution based on bargaining power is represented by point "a" on "U*," and if the threat is carried out, the solution would move to a point to the southeast such as "b." This new point is on a bargaining frontier that is everywhere to the left of the original frontier on account of the loss of reserves. It is important to note that the use of destruction as a bargaining tool is virtually independent of the distribution of bargaining power.

In Gatti and his co-authors' study, this analysis derives two requirements that any bargaining process over how to share the benefits from biological information has to fulfill in order to be robust against the use of rational threats.[28] The first is that under the agreement, the South has to achieve a welfare level that

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28. *Id.* at 11.

is at least as high as the welfare level it would achieve when it carried out the threat. In other words, the bargaining solution cannot leave the South at a welfare level below "$U_S^D$." Points depicting bargaining outcomes with a welfare level to the left of "$U_S^D$" therefore do not pass the robustness test. The second prerequisite is that the compensation must be conditioned on the stock of reserves held by the South in order to ensure that the bargaining frontier "U*" is reached. If these conditions are not fulfilled, the South will have an incentive to degrade biodiverse lands in order to improve on the existing arrangements. This strategy will have two effects. On the one hand, the North will find it worthwhile to reconsider the existing agreements in the light of the declining positive externalities generated by the South. On the other, it will permanently reduce the global gains from cooperation available to the bargaining parties. The obvious next step is to examine whether the current institutional solutions meet both requirements derived in the context of the bio-bargaining game.

## VI. Investigating the Current Institutional Solutions

As mentioned in Part III, there are two central institutions that have emerged in response to the biodiversity bargaining problem, the CBD and TRIPS. In this section we discuss these two institutions in light of the requirement that they should be robust against the use of rational threats by the bargaining parties. Of particular interest are the contracts implied by the financial mechanism of the CBD, the Global Environment Facility (GEF). The GEF is the financial mechanism that has emerged as the main coercive instrument for biodiversity conservation for signatories of the CBD. The way in which the GEF allocates and dispenses funding provides the first application of the conclusions of the theoretical bargaining model. The second application is the analysis of the TRIPS agreement with the associated instruments of intellectual property rights such as Plant Breeders Rights (PBRs) and patents. In both cases, we are interested in the extent to which such institutions pass the test for robustness against the South using strategic destruction as a rational threat. The central result from Gatti and his co-authors is that in both cases, current institutions appear to initially place the bargaining power in the North, and yet strategic destruction is a viable option for the South.[29]

### *A. The CBD*

The CBD represents the major international institution that has emerged in response to what we have called the biodiversity bargaining problem. The CBD recognizes that there are considerable gains to be made from cooperation in this regard. In short, it recognizes the bargaining frontier. However, Article 20 of the CBD states explicitly that the implementation of commitments under the convention will depend upon the extent of financial transfers from the developed country signatories. This is implemented by means of the "agreed incremental cost" concept of the GEF under which the North compensates the South for the

29. *Id.* at 21-22.

costs it incurs in relation to the commitments contained in the CBD, e.g., the opportunity cost of foregone land uses.

Applying the incremental cost approach to the case in hand, the indicated contract is one in which the North receives the cooperative gains from innovations/intensive production and compensates the South for the welfare loss associated with the alternative use of land that occurs as the South moves away from the Autarky allocation. Thus, the South ends up at its conflict payoff, represented by point A in Figure 2. In the language of bargaining theory, the South is presented with an extreme point contract. More precisely, this extreme point contract very much reflects the idea of "net incremental" cost: the minimum compensation required to ensure participation, which maintains the South at its pre-contract welfare level.[30] Cervigni discusses the extent to which the compensation should reflect the gross or net incremental costs, where net incremental cost is net of any additional benefits that the recipient country alone obtains from the presence of an unconverted or preserved environment.[31] In this way, net incremental cost is that minimum compensation required to maintain the recipient at pre-agreement welfare levels.

Ultimately, the optimal contract between the North and South is indeterminate in the absence of some previously agreed resolution of the bargaining problem and there is no basis in principle for preferring any one over the others. The incremental cost approach merely defines one of an entire family of contracts that could facilitate the optimal outcome. The choice of an extreme point contract does not represent a complete solution to the bargaining problem for two reasons. First, it implicitly assumes zero bargaining power for the South, and second, it ignores the capacity of the South to engage in strategic bargaining, i.e., strategic destruction.

In reality, bargaining power is not so unevenly allocated between regions and such bargaining strategies have been observed in practice. For example, incremental cost contracts offered by the GEF and World Bank to farmers in Latin America to encourage both changes in agricultural practices to agro-forestry and conservation of remaining forests were met with the response "Bueno, corto todo" (OK, I'll cut the lot!) when compensation for the existing forests was excluded from the offered contract.[32] This brings to light the fact that dissatisfaction with the share of the surplus can lead the South not only to reject the initial contract, but also to exert bargaining power in the hope of securing higher welfare upon renegotiation. The South can and does bargain with destruction as predicted by the theory outlined above. Indeed the analysis suggests that, in order to eradicate the incentives for strategic destruction, the optimal North-South contract should not only compensate the South for the incremental cost of biodiversity conservation, but compensation should also be

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30. Raffaello Cervigni, *Incremental Cost in the Convention on Biological Diversity*, 11 ENVTL. & RESOURCE ECON. 217 (1998).

31. *Id.*

32. STEFANO PAGIOLA ET AL., PAYING FOR BIODIVERSITY CONSERVATION SERVICES IN AGRICULTURAL LANDSCAPES (World Bank Env't Dep't, Paper No. 96, 2004).

conditioned upon the stocks of reserves. This recommendation is intuitive and similar to previous work on international transfers.[33]

### *B. TRIPS*

The discussion above shows that resource ownership is an important determinant of the bargaining outcome. In the case at hand, the outcome turns upon the ownership of innovations and reserves. Therefore, it is critical to investigate the nature of property rights that currently prevail in this sector and the impact they have on the solution to the biodiversity bargaining problem. In this section we present the results of a model of what we call the Prevailing Property Rights structure (PPR) and comment on their implications for understanding North-South bargaining.

Intellectual Property Rights (IPR) protection of innovations has long been an important institution for R&D and the focus of much investigation in the North-South context [34] where Plant Breeders Rights (PBRs) and patents are pertinent examples in plant breeding and biotechnology. Indeed, the potential for conflict in enforcement of IPRs across countries led to calls for international harmonization. This culminated in TRIPS under the auspices of the WTO.

TRIPS explicitly allows property rights in genetic resources. However, most states require that they be "improved" or "products of human intervention" rather than simple selections or discoveries of diverse genetic resources. This allows property rights to be taken in genetic resources by those states with the human capital and technological capacity to develop natural genetic resources. It should also be recognized that, in the context of the plant breeding sector, the discussion about IPRs over high yielding varieties (HYVs) reflects the other side of marginal land use decisions to the CBD. That is, since modern agriculture is one of the major causes of deforestation and loss of traditional landraces,[35] the extent to which there is transfer of HYVs to the South represents another important determinant of the extensive margin, and hence the level of reserves.

The model developed reflects this property rights structure, that is, the PPR scenario is characterized by IPRs for innovations in the North and very little in the way of intellectual property in the South. The model allows an analysis of the impact of this property rights structure on the choice of contract by our stylized North (endowed with technology) and South (endowed with biological resources). To reflect this apparent imbalance in the strength and implementation of IPRs for innovations in biotechnology, and the absence of specific property rights for genetic traits found in the South, we assume that IPRs only exist for seed innovations emanating from the North. Distinct property rights (intellectual, cultural, historical, etc.) are assumed to be non-existent for

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33. Daan van Soest & Robert Lensink, *Foreign Transfers and Tropical Deforestation: What Terms of Conditionality?*, 82 AM. J. AGRIC. ECON. 389 (2000).

34. *See, e.g.*, Elhanan Helpman, *Innovation, Imitation, and Intellectual Property Rights*, 61 ECONOMETRICA 1247 (1993).

35. Swanson, *supra* note 3.

the stock of information accumulated in situ genetic resources supplied by the South.

Ultimately, in the PPR model it is the North-South market for seeds that facilitates the solution to the biodiversity bargaining problem, with the solution being determined by the underlying property rights structure. The enforcement and location of IPRs gives the North some considerable advantage in determining the outcome. The PPR model places the North in the position of monopolist in the export to the South of seeds embodying technology and gives the North free access to the resources important for generating the innovations (the reserves).

The importance of the location of property rights as a means to ensure efficient incentives at each layer of a vertical industry have also been highlighted in the literature.[36] Goeschl and Swanson provide a discussion relating specifically to the biotechnology industry.[37]

In short, discoveries of genetic information contained in reserves are treated as a global public good. Both of these characteristics of the North reflect to a large extent the current property rights with regard to innovations and access to genetic material.[38] Given this, the North is able to capture the marginal rental value of both human and fixed capital inputs to R&D (from the North) and the rents associated with the genetic diversity (from the South).

Characterized in this way, it seems that there are two reasons why the prevailing property rights are unlikely to be a sufficient mechanism to guarantee the supply of biodiversity from the South. First, IPRs contain no provisions for the South to be directly remunerated for its contribution to the R&D process. Second, the emergence of an intensive agricultural sector in the South has the potential to lead to greater conversion of reserve land through expansion at the extensive margin. However, there remains an important countervailing force in the PPR model, the impact of technology transfer. The North can internalize the value of biodiversity to the South through the export of seeds which embody innovations. Assuming perfect information, the South will understand that the productivity of intensive agriculture is dependent upon the presence of reserves. Although such technology transfers can be globally suboptimal, they cause the South to share the North's interest in biodiversity conservation (supply), and represent an important mechanism when contracting directly on reserves is not possible.

A thorough analysis of the bargaining process under the prevailing set of property rights shows that the prevailing IPRs are likely to provide an inadequate mechanism to harness the global value of biodiversity and that this leads to an

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36. *See, e.g.*, Sanford J. Grossman & Oliver D. Hart, *The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration*, 94 J. POL. ECON. 691 (1986).

37. Timo Goeschl & Timothy Swanson, *Pests, Plagues, and Patents*, 1 J. EUR. ECON. ASS'N 561 (2003); Swanson & Goeschl, *supra* note 5; TIMOTHY SWANSON & TIMO GOESCHL, ON BIOLOGY AND TECHNOLOGY: THE ECONOMICS OF MANAGING BIOTECHNOLOGIES (Fondazione Eni Enrico Mattei (FEEM) Note di Lavoro No. 42.2003, 2003).

38. Timo Goeschl & Timothy Swanson, *The Social Value of Biodiversity for R&D*, 22 ENVTL. & RESOURCE ECON. 477 (2002).

inefficient solution to the biodiversity bargaining problem. The inefficiencies arise not only due to the absence of direct remuneration for reserves and the presence of monopolistic behavior which can increase the conversion of reserves, but also due to the scope for strategic destruction that this bargaining solution can introduce.

## CONCLUSION

The global exchange of biological information has been an important source of significant economic development in the past and has great potential for delivering global benefits in the future. What complicates this mutual interdependence between North and South in the exchange of this information is that market prices, and therefore simply trade, cannot be relied upon to sufficiently coordinate the activities of the parties involved. The nature of biological information, specifically its non-excludability, poses great challenges to harnessing the capacity of market-based systems to optimally coordinate choices of the maintenance, production, and exchange of biological information in the North and South. A different set of institutions than market-based exchange is required to allow the potential gains from cooperation to be realized.

It is a considerable success of international cooperation that alternative institutions have been created in the form of the CBD and TRIPS that are intended to resolve the problems of managing the conservation and use of biological information. However, while successful as institutions, there is little evidence that these institutions have done much to address the problem of land degradation in developing countries which continues to threaten the existing stock of biological information on this planet. While there are a number of explanations for this failure that demonstrate why, despite the presence of the current institutions, conservation efforts are lacking, our analysis points to potential problems in the very design of these institutional solutions. This design tends to acknowledge the relatively overwhelming bargaining power of the North in these negotiations by enshrining rules that are of significant benefit to Northern interests: an extensive interpretation of the rights of IPR owners of biotechnological innovation, a restrictive interpretation of the rights of traditional knowledge owners, and a incremental cost mechanism for conservation efforts in the South. What the design of both institutions fails to acknowledge is the fact that the South can improve on the bargaining outcome by carrying out rational threats of land degradation. The implementation of these threats has two consequences: it raises the relative benefit to the North from agreeing to renegotiate the current agreements, and it permanently reduces global welfare by destroying irreversible stocks of biological information.

If the currently agreed international governance of biological information is not robust against the use of rational threats by the South, there is the danger of substantial global cost of institutional failure. These costs are avoidable in principle through the careful design of the institutions to be created. Recently, much more comprehensive and encompassing institutional solutions to global environmental problems have been discussed in the context of a possible World Environment Organization to match issues such as trade and health on a similar

footing. Some proposals have very concrete ideas about how to empower such a body to initiate monetary transfers in return for environmental efforts in developing and industrialized countries. As our discussion about biodiversity conservation and use in this paper shows, any such attempt needs to pay close attention to the lessons that can be learned from more specific agreements.