
Sharing the Benefits of Biodiversity: Access regimes and intellectual property rights

Graham Dutfield

WGTRR, OCEES, Mansfield College, University of Oxford, Oxford OX1 3TF, UK

Tele/Fax: 44-(0)1865-282904
Wgtrr.ocees@mansfield.ox.ac.uk

Abstract: Two types of legal regime have emerged to regulate the allocative aspects of the trade in biogenetic resources and products derived from them. These are access and benefit sharing laws and intellectual property rights (IPRs). This paper describes both, but IPRs are emphasised because: (1) the acquisition by firms of patent and plant variety right portfolios appears to influence the unequal allocations of benefits obtained from industrial use of biogenetic resources; (2) the number of countries allowing strong IPR protection for life-science products and technologies is increasing rapidly. The effect may be to reinforce this asymmetry of benefit allocations; (3) patents and plant breeders' rights have been accused of encouraging biodiversity-erosive breeding and cultivation practices; and (4) just as inappropriate IPRs may harm the interests of developing countries, well-designed IPR systems could conceivably be highly beneficial, helping such countries to add value to their biogenetic wealth. Unfortunately, the global IPR system has become increasingly inflexible in recent years, reducing such opportunities for developing countries.

Keywords: biodiversity; bioprospecting; genetic resources; intellectual property rights; Convention on Biological Diversity; TRIPS Agreement.

Reference to this paper should be made as follows: Dutfield, G. (1999). Sharing the Benefits of Biodiversity: Access Regimes and Intellectual Property Rights. Science, Technology and Development Discussion Paper No. 6, Center for International Development and Belfer Center for Science and International Affairs, Harvard University, Cambridge, MA, USA.

Biographical notes: Graham Dutfield is a doctoral student at Oxford University who has written extensively on intellectual property rights, traditional knowledge and biodiversity policy. He authored a book called "Intellectual property rights, trade and biodiversity: seeds and plant varieties" (Earthscan Publications) and is currently preparing a book to be titled "Intellectual property rights and the life science industries: a twentieth century history"..

1 Bioprospecting

To help biodiversity-rich developing countries to capture a greater proportion of the benefits from the industrial use of their resources while creating incentives for conservation, some conservationists, economists and policy makers have in recent years been promoting 'bioprospecting' programmes throughout the world, especially in the Tropics. Bioprospecting is the collection and screening of biogenetic resources for commercial purposes.

The bioprospecting concept is based on the legal fact that nation states have sovereign rights over their resources. As *de jure* gatekeepers of biological resources, it is thought that governments are in a strong position to negotiate favourable benefit sharing arrangements with foreign private and public sector natural product research institutions.

There are three drawbacks with bioprospecting as it is often understood and sometimes practised.

First, there is a tendency to suppose that with an access regime in place, the bargaining position of genetic resource exporters vis-à-vis the industrial users is quite strong. In fact, the economic benefits developing countries could capture by asserting their property rights and negotiating monetary or other benefits in exchange for biological samples for, say pharmaceutical screening, are unlikely ever to be very great. One of the main reasons is that a tiny fraction at most of collected samples will ever provide a lead for a new product and many such samples may exist also in other countries. Consequently, insufficient attention tends to be paid to local value addition and the production of less high-technology-intensive natural products for domestic as well as international markets [1].

Second, some bioprospecting advocates overlook the fact that even apparently 'wild' genetic resources may not be 'gifts of nature' at all. Rather, the useful characteristics of plants and animals expressed by genes identifiable only in laboratories may be well known to local and indigenous communities who may have legitimate claims over access to and use of these resources and the information they possess about them.

Third, in comparison with historical 'gene hunting' [2] nowadays much bioprospecting can be carried out without even visiting the places from where resources were originally collected. Botanic gardens and agricultural research institutions, such as the member institutions of the Consultative Group on International Agricultural Research (CGIAR), hold large *ex situ* collections of plant genetic resources. Many scientific institutions throughout the world hold substantial collections of microbial genetic resources (culture collections), animal genetic resources [3], and even human genetic resources. Neither does traditional knowledge have to be acquired directly from traditional communities. A great deal can be gleaned from literature searches carried out from a computer terminal located almost anywhere in the world. This situation is of course highly beneficial for scientific research institutions and corporations.

These reservations notwithstanding, the bioprospecting literature which proliferated during the 1990s served the useful purpose of linking the trade in genetic resources to conservation incentives and has led to some valuable and worthwhile initiatives. What is now necessary is to identify the political and institutional obstacles which: (a) prevent biodiversity-rich developing countries from enhancing the value of their resource so that they are no longer just exporters of low value raw materials; and (b) discourage them from adopting or continuing practices

compatible with conservation and sustainable use rather than environmentally damaging alternatives.

2 Regulatory regimes for allocating the benefits of biodiversity

Two types of regulatory regime have emerged which determine how benefits from the trade in biogenetic resources and products derived from them are allocated. These are access and benefit sharing laws and intellectual property rights (IPRs).

2.1 Access and benefit sharing regimes

The Convention on Biological Diversity (CBD) encourages countries to enact access and benefit sharing (ABS) regimes. Article 15.1 states that: “Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.” ABS regimes base their provisions upon such nation state sovereign rights. By exercising such rights it is intended that these countries will be better able to capture the benefits from industrial use of their biogenetic resources while conserving and sustainably utilising biodiversity. Can ABS regimes achieve these goals? Economic property rights theory can be used to support the view that creating legal rights in this way can achieve such positive effects, but there are ample grounds for scepticism.

2.1.1 Economic property rights theory

In theory creating property rights over biogenetic resources would lead to their more efficient utilisation. It would do this by strengthening the bargaining position of developing country suppliers enabling them to capture greater benefits. Consequently there would be stronger incentives to conserve and sustainably exploit the resource base since the enhanced benefits would help meet the opportunity costs of conserving species and biodiverse ecosystems while securing long-term benefits from their industrial application.

Such an outcome is consistent with the view of Demsetz [4], who argued that property rights are created when, as a result of changes in relative prices or technology, the benefits of establishing and enforcing them become greater than the costs of continuing without them [5]. The assertion of national sovereignty over genetic resources may well be a case in point since the CBD’s rejection of the “common heritage of mankind” doctrine [6] – which *inter alia* had resulted in the amassing of large collections of genetic resources held outside the country of origin whose accessions can be acquired freely – coincided with increases in the value of genetic resources driven by biotechnological advances in industrialised countries. According to the theoretical approach of Demsetz, the international community’s agreement to create national sovereignty rights could be interpreted as a predictable response to this increased value *and* recognition of the threat to the resource base.

According to Coase [7] the internalisation of negative externalities such as environmental damage is most efficiently achieved by private bargaining among affected parties over the allocation of rights. Frequently such bargaining is either impossible or too costly because of the absence of markets to trade such rights and/or clearly defined property rights. Where transactions costs are too high to make private bargaining feasible, the most economically rational solution may be to assign property rights and to create markets to trade rights. For example, to reduce air pollution caused by industrial emissions, factory owners could be required either to purchase rights to pollute or be compensated for efforts to reduce pollution. Tradable right-to-pollute permits are a classic coasian solution. Sedjo and Simpson [8] and Lerch [9] regard bioprospecting contracts

likewise as coasian solutions that need not entail high transaction costs; neither need they require the creation of new property rights.

In practice achieving such favourable outcomes in the biodiversity context would be very difficult to achieve. In particular due to the likely availability of the same resources in more than one country, potential rents that might accrue to an individual country are quite low. Since negative externalities in the form of biodiversity loss ensue from a whole range of activities, even quite high rents might do little to reverse the general global trend towards biologically-uniform development paths.

Moreover, emphasising property rights at the nation state-level may even encourage counter-productive conservation and sustainability policies including mercantilist and overly-centralised approaches that may be both inefficient and undemocratic. It is true that governments are in a far stronger position to bargain with transnational corporations than domestic non-governmental institutions and local communities, yet a statist approach that assigns the gatekeeper role exclusively to government entities may not be the most efficient way to monitor the erosion of the country's biological diversity, especially in areas inhabited by indigenous and local communities. It might well also lead to infringements of the legitimate entitlements of these communities.

It is very important that ABS regimes embody a decentralised approach that empowers democratic local-level institutions with at least some rights to control access and that encourages their participation. Channelling the benefits from the biotrade to encourage environmentally-friendly practices through such institutions is much more likely to result in favourable outcomes than the more top-down conservation approaches that are still prevalent in many countries.

2.1.2 The tragedy of the commons

According to the theory of the tragedy of the commons [10] – which might more accurately be called “the tragedy of open access” [11] [12] – the absence of property rights or access regulations over resources will lead to their depletion. This is because while individuals accrue benefits as they exploit resources, the costs of everybody exploiting resources at unsustainable levels will have to be met by the community as a whole. In economic terms, resource depletion is a negative externality resulting from the absence of property rights. A good example of such a tragedy is overexploitation of high seas fishing stocks. How far does this theory apply to bioprospecting and biodiversity erosion?

First, we must remember that a great deal of biodiversity loss is caused not by overexploitation of species or degradation of biodiverse ecosystems but the conversion of such ecosystems to more uniform ones. Second, local-level property rights systems and regulations often *do* exist and the real problem is that these are not recognised by the wider society. Biodiverse lands are nationalised or privatised so that the owners become the state or non-local private interests and the local people are disenfranchised and even forcibly removed from their traditional territories. Indeed, the enclosure of the commons is a global phenomenon that has resulted in the loss of local control over lands, resources and knowledge systems. Ironically, this process has often been stimulated by policies that were intended to benefit the local people. Time after time, though, the result is deepening poverty, decreased self-sufficiency and further environmental degradation.

This blindness towards non-western regimes is nothing new [13]. During the European colonial period, sparsely populated “wildernesses” were regarded as being to all legal intents and purposes vacant prior to colonisation. Settler societies, such as in Australia, built up legal systems based upon the *terra nullius* (the land of nobody) doctrine. Even today, traditional forest communities in

some countries (e.g. Latin America) can more easily acquire legal title to their lands if they “improve” them by removing the trees so that they are no longer “virgin forests” [14].

Neither is this situation limited to territories. There are close similarities between seizing territories and displacing their traditional inhabitants, purportedly “for the good of the biosphere”, and taking traditional knowledge in the public domain and patenting “inventions” based upon this knowledge “for the benefit of humankind”. In each case, territories, ecosystems, plant varieties (whether domesticated or not), and traditional knowledge, are treated as if they are *res nullius* (the property of nobody) before their “discovery” by explorers, scientists, governments, corporations, and conservation organisations [15].

Curiously, this refusal to accept the existence of non-western proprietary systems is shared by many pro-Third World activists [16] who assume that the regulatory regimes prevailing in westernised and traditional societies are polar opposites with individualism, privatisation and enclosure the norm in the former, and open access in the latter societies, in which resources and information are shared freely among community members and others.

2.1.3 *Cartels*

Given the weak bargaining position of biodiversity-rich countries acting alone, an economically rational option is either for neighbouring countries to develop common ABS regimes as the Andean Community countries have done, or for countries to unite by forming genetic resource supply cartels.

The Andean Community’s *Common System on Access to Genetic Resources* establishes common regulations concerning access for all five member states. This makes it harder for foreign corporations to seek cross-boundary resources in member states charging the lowest prices. However, it does not make a price war impossible since neighbouring non-member states like Brazil, Chile and Guyana will certainly share many of the same resources.

Following the same economic logic, two economists, Joseph Vogel and Timothy Swanson, propose the creation of cartels (although Swanson does not use the word ‘cartel’). Vogel [17] advocates cartels that would include *all* countries that possess an identical resource. There would be a fixed royalty rate of 13% of sales of products derived from the resources that would be shared among the countries concerned. An additional small percentage (Vogel suggests 2%) would go to the actual supplier country. Although the royalty rate seems high, Vogel believes that such countries have little to lose given the paucity of benefits he believes they currently receive from bilateral bioprospecting contracts. In any case the cartels would not be prevented from lowering royalty rates in the future. There is of course a danger that cartels might have so many members that the benefits going to each one, even at such a high royalty rate, would be very low. One way to improve Vogel’s proposal might be to include a mechanism for distributing the benefits in proportion to the efforts individual countries make to conserve and sustainably use biodiversity. It does not seem fair that countries which are the most environmentally destructive should receive an equal share to more responsible countries.

Swanson [18] believes that cartelisation should be linked to a certification system so that only those countries that invest sufficiently in conservation and sustainable harvesting to be designated certified suppliers would be allowed to trade their resources. The idea is that biodiversity-rich countries would have a greater incentive to invest in environmentally friendly practices.

It remains to be seen whether such cartels are feasible on scientific or political grounds. For one thing many species are widely distributed, existing not just in adjacent countries but in different continents too.

2.2 *Intellectual property rights*

The negotiating power of developing countries over their genetic resources is weak, at least if they act alone, and may not improve much if they seek to form cartels. In contrast, transnational corporations generally enjoy a much stronger bargaining position vis-à-vis most developing countries over access to their proprietary (i.e. intellectual property right-protected) technologies and products. This imbalance is especially marked when comparing the bargaining strength of high technology knowledge-intensive industrial sectors which depend in part or entirely upon inputs of biogenetic material, such as pharmaceuticals, crop breeding and biotechnology with the countries supplying this material. Most probably this asymmetry is widening.

Arguably the main weapons in the armoury [19] of such corporations with which developing countries must contend are intellectual property rights (IPRs) such as patents, plant variety rights, and trade secrets. How sharp or blunt these 'weapons' are depends upon how widely these monopoly rights are available *and* enforceable. This is why these industries made such efforts to ensure that the Uruguay Round of the General Agreement on Tariffs and Trade resulted *inter alia* in an intellectual property rights agreement that establishes universal minimum standards of intellectual property protection and enforcement. In this sense, then, IPR law is an emerging regulatory mechanism insofar as it relates to biogenetic resources, since it is only recently that the products of plant breeding, fermentation and the new biotechnologies have been protectable in more than a handful of countries.

Certain features of IPRs and the emerging international regime appear to create barriers to equitable benefit sharing, and may even be threatening to biodiversity.

First, ownership of life science technologies and products is becoming ever more concentrated as large corporations in the life science/biotechnology industrial sectors increasingly access rival companies' IPR-protected technologies through cross-licensing, or by purchasing or merging with these companies. Such life science giants as Monsanto and Novartis, which dominate more than one industrial field, are the result of mergers and acquisitions involving companies in such sectors as chemicals, seeds, biotech and pharmaceuticals [20]. Thus, there has been a concentration of high-value IPR protected technologies and products in the hands of a small number of conglomerates with annual turnovers higher than the GNPs of several developing countries. Given the economic power of these companies it may be more difficult than ever for developing countries to negotiate favourable terms for technology acquisition. According to Drahos [21]:

If it turns out that the global market in scientific and technological information becomes concentrated in terms of the ownership of that information it might also be true that the developmental paths of individual states become more and more dependent upon the permission of those intellectual property owners who together own most of the important scientific and technological knowledge.

Second, many critics of IPRs allege that there may be a negative link between enhanced intellectual property rights over biological material, and the state of the world's biological diversity. It is often suggested that there may be linkages between the availability of IPR protection for plant varieties and the replacement of complex, diverse agro-ecosystems, with

monocultures of single ‘improved’ varieties. The genetic uniformity of large monocultures leads to vulnerability to crop diseases that can devastate large areas. Increasingly, the new varieties have been genetically engineered to be resistant to a herbicide being marketed by the same company [22]. Both the herbicide and the seed for which it is ‘designed’ are likely to be IPR-protected. Excessive use of the herbicide is likely to result in other plant varieties and species growing nearby being killed [23].

Third, while the IPR system is able to protect the “collective innovations” of companies, protection of the collective knowledge, innovations and practices of indigenous peoples and local communities relevant to conservation and use of biogenetic resources have not been considered necessary or even a proper function of IPR law.

3 Intellectual property rights in science and technology capacity building: a help or a hindrance?

It may be concluded so far that biodiversity rich developing countries have little to gain from exporting biological samples and extracts, and that existing institutional mechanisms regulating such transactions are severely limited in how far they can improve this situation. For these reasons, the following alternative (or additional) approaches for developing countries should be considered:

1. domestic vertical integration of production through the enhancement of applied life science and biotechnology capacities; and
2. the identification, development and marketing of high value primary and semi-processed products.

The key questions which then arise are:

- (a) are these strategies more viable? and
- (b) are they likely to result in more sustainable use of biogenetic resources and improved conservation of biodiversity-rich ecosystems?

A static understanding of the principle of comparative advantage would lead us to believe that while option 2 might be feasible, most biodiversity-rich developing countries need not consider attempting alternative approach 1, and have little alternative but simply to export raw biological material. One must be cognisant of the very real obstacles to following strategy 1, especially the huge investments in training, education, and advanced R&D facilities that would be required. It is noteworthy that two preconditions for the establishment and growth of the United States biotechnology industry were said to be: (1) the considerable amount of basic research that had already been conducted by the universities and the government; and (2) the large quantities of venture capital funds made available partly by the deregulation of pension funds in the 1970s [24].

The task for developing countries is to follow successful former developing countries like Japan and South Korea by transforming their comparative advantage from exporting low-value commodities to high value goods and services. In the context of the biotrade, the challenge for them is to exploit their *de jure* control of genetic resources by:

1. identifying specific fields of technology or industrial or market sectors where they may be able to compete internationally;
2. acquiring and/or channelling the necessary investments to develop and market high value

- products; *and*
3. putting in place the institutional reforms needed to ensure that efforts to conserve biodiversity and utilise biological resources do not conflict but are mutually supportive.

Enhancing the scientific and technological base of developing countries requires financial investments and laws and policies which provide well-targeted rewards and incentives for innovation, investment, conservation and sustainable practices. Bioprospecting partnerships between developing country institutions such as government agencies, companies and local communities and developed company high technology firms, as well as the outsourcing policies of pharmaceutical transnational corporations can provide financial input and expertise but cannot really overcome the basic problems presented above.

How far do IPRs help or hinder such aims? In my view IPRs may be a help or a hindrance. Patents, trade secrets, trademarks and geographical indications could be useful tools in the service of developing countries seeking to enhance their scientific and technological capacities and market new high-value products. The problem facing many of these countries is that their options for developing appropriate IPR laws have become much more limited.

Broadly speaking, the twentieth century history of IPRs in the industrialised world has been characterised by a strengthening and broadening of existing rights, and the creation of new rights, especially since the 1960s. Developing countries, on the other hand, have tended not to conform to this trend, preferring to continue with relatively weak IPR regimes. But one of the outcomes of the Uruguay Round of the General Agreement on Tariffs and Trade was an agreement to establish a global IPR system that requires all member countries to adopt such changes in their national laws (i.e. the Agreement on Trade Related Aspects of Intellectual Property Rights ['The TRIPS Agreement']).

Until recently, one could have argued that the nature and extent of IPRs has always depended on the state's willingness to define and protect these rights in pursuit of such objectives as economic development or cultural advancement. This assumption is becoming less reliable. Developing countries are now being pressured to enact IPR laws and to invest resources in enforcing them not necessarily because such countries agree that these laws are necessary for economic development, but merely because the World Trade Organization's rules require them to provide such rights.

This matters, first because this is unfair and contrary to the behaviour of many developed countries when they were becoming industrialised, and second, because quite a number of studies have recently been conducted which *inter alia* question whether IPRs fulfil the national development objectives of developing countries [25]. Empirical studies on the links between stronger IPRs, investment flows, R&D and technology transfers provide conflicting results and overall are inconclusive. Maskus [26] claimed some evidence of a positive correlation, while conceding that IPRs are one of several factors that may enhance technology transfers, and also that strengthening IPRs can involve costs as well as benefits for developing countries [27]. A World Bank study was even more cautious and recommended further research before firm conclusions could be made [28]. Evidence from Turkey [29] found that the banning of pharmaceutical patents appeared to have no significant effects on levels of direct foreign investment, technology transfers or domestic innovation. Similarly, Kondo [30], taking manufacturing industry as a whole, found no evidence to support the notion that foreign direct investment levels in Brazil are greatly affected by patent protection.

IPRs can be questioned at a more fundamental level. Every assertion one can make to justify their existence, scope and duration is contestable. In some areas of creative or inventive

endeavour, it can be argued that some rights have become overly generous. In others legal rights are inadequate or even absent so that claimants have no legal recourse, at least within the IPR system. Innovation and creativity flourish in many parts of the world without any (western) IPR laws. At the same time, allegations are increasingly made that too much IPR protection of basic research is stifling innovation.

Arguably, these problems and contradictions are most evident in the case of the extension of patenting to include life-forms [31]. In fact, the emergence of the ‘patenting life’ issue has stimulated a growth of critical literature which focuses on a number of aspects such as:

- The moral significance of assigning property rights over life-forms [32].
- The way that these patents challenge such fundamental considerations as description, disclosure, repeatability and exhaustion of rights, and appear in some cases to render the invention/discovery distinction meaningless [33]. In these ways, they may even be subverting the patent system from within.
- The possibility that such patents may sometimes harm research when overly broad ‘species-wide’ patent claims are allowed [34], and biotechnology research tools such as gene sequences [35] are protected.
- That allowing ‘life-form’ patents supports the practice of ‘biopiracy’ [36]
- That patents on plants infringe the basic right of farmers to save and exchange harvested seed [37].

Other aspects of the international IPR regime have been subjected to critical examination and found to be inadequate. Some of these critiques highlight the inherently protectionist motivation for setting minimum IPR standards at a high level as compared to the majority of countries [38]. Others, often inspired by the Convention on Biological Diversity, are motivated by concern for the environment [39], the rights of indigenous peoples [40], the general interests of the developing countries [41], food security and/or rights and interests of farmers [42], and sometimes some or all of these [43].

4 Knowledge gaps

At a time when the developed countries have achieved an international IPR regime in which minimum standards of protection are mandatory so their own firms can protect their ‘information value-added’ more and more widely, what are the implications for developing countries seeking ways to develop and/or acquire scientific and technological information that can add value to their biological resources? Should they simply imitate the national IPR regimes of developed countries as some of the latter nations and transnational corporations are pressuring them to do?

In considering these questions, we need to address four major gaps in the state of our knowledge. These are as follows:

1. The relationship between IPRs and the transfer of technologies supportive of conservation and sustainable use of biodiversity is unclear, as is the extent to which such technologies are currently IPR-protected or are in the public domain [44].
2. The role of IPRs in the erosion of agro-biodiversity has been the subject of some polemical debates. We still do not know how far biodiversity is affected by IPRs for seeds, plant varieties and/or agrochemicals. But it can be argued that we cannot afford to wait for conclusive proof one way or another before making decisions on the design of environmentally-sound IPRs. It is vital

to consider whether and how the precautionary principle may be applied in the IPR context to minimise the risks without (a) being construed as an illegal barrier to trade or (b) foreclosing opportunities for developing countries to use IPR law to enhance their life science and technology capacities [45].

3. It is generally accepted that the application of traditional knowledge and technologies can add value to genetic resources. While patents are clearly unsuitable mechanisms to protect the rights of traditional knowledge holders, the use of other IPRs like trade secrets, plant variety rights and geographical indications may in some circumstances be feasible [46]. However, this is an under-researched subject and very few experiments in applying IPRs to traditional knowledge and the products based up traditional knowledge are taking place.
4. For at least 60 years, economists have attempted to evaluate the economic efficiency of patent rights. Approaches adopted include estimating the optimal breadth of the rights granted [47]; their duration [48]; the extent to which patents induce increased R&D expenditure [49]; and the welfare losses caused by the temporary monopolies provided [50]. None of these assessments provide a trustworthy guide to the level of IPR protection that would be the most economically efficient or socially optimal for any legal jurisdiction, even less the world as a whole [51]. According to Vaver [52], “[i]t seems impossible to argue that the current laws encourage just the right amount of research, creativity and financing, and just in the right areas”. This is important to bear in mind when pressure is placed on developing countries to introduce protection as strong as that of the developed countries.

Addressing such knowledge gaps and uncertainties requires us to confront some quite fundamental questions about IPRs, none of which have such self-evident answers as corporate advocates of universal IPRs would have us accept: Why do IPRs such as patents, copyrights and trademarks exist at all? Is the system we have the best possible system? Can we assume that an IPR system that suits the United States is necessarily the most beneficial one for India or Kenya? Is an IPR system that satisfies the needs of Glaxo-Wellcome an equally attractive one for a start-up biotech firm in Britain? What is a ‘level playing field’ in the terms of access to and availability of legal protection of intellectual property rights?

In view of such fundamental uncertainties about the sustainable development impacts of the global IPR regime, I would argue that developed countries at the very least should desist from attempts to amend TRIPS by further raising the minimum standards such as by deleting exceptions from patentability or increasing protection terms.

References and notes

- 1 This is not always the case though. The bioprospecting projects funded by the US government’s International Cooperative Biodiversity Groups programme, for example, generally address these concerns.
- 2 See Joyce, C. (1994) *Earthly Goods: Medicine-Hunting in the Rainforest*, Boston and Toronto, Little, Brown & Company; Juma, C. (1989) *The Gene Hunters: Biotechnology and the Scramble for Seeds*, Princeton, Princeton University Press.
- 3 Heywood, V.H. (ed.) (1995). *Global Biodiversity Assessment*, Cambridge, UNEP and Cambridge University Press.
- 4 Demsetz, H. (1967) ‘Toward a Theory of Property Rights’ in *American Economic Review*

57, pp.347-359.

- 5 “Property rights develop to internalize externalities when the gains of internalization become larger than the costs of internalization”.
- 6 The CBD breaks little new ground in international law by asserting national sovereign rights over genetic resources. This was merely a restatement of an established norm which in a sense undermines nation state rights since they are now required to provide access. What is innovative is that the CBD departs from the tendency of countries in the case of crop germplasm not to exercise their sovereignty rights.
- 7 Coase, R. (1960) ‘The problem of social cost’ in *Journal of Law and Economics*, 4, pp.1-44.
- 8 Sedjo, R.A. and Simpson, R.D. (1995) ‘Property rights, externalities and biodiversity’ in Swanson, T.M. (ed.): *The Economics and Ecology of Biodiversity Decline: the Forces Driving Global Change*, Cambridge, Cambridge University Press, pp.79-88.
- 9 Lerch, A. (1998) ‘Property rights and biodiversity’ in *European Journal of Law and Economics* 6, pp. 285-304.
- 10 Hardin, G. (1968) ‘The tragedy of the commons’ in *Science*, 162, pp.1243-48.
- 11 Lerch *op cit.*; Monbiot, G. (1999) ‘The tragedy of enclosure’ in Posey, D.A. (ed.): *Cultural and Spiritual Values of Biodiversity*, London, UNEP and Intermediate technology.
- 12 In a 1998 article in *Science* (Vol. 280:682), Hardin acknowledged his error in failing to distinguish between managed and unmanaged commons: “To judge from the critical literature, the weightiest mistake in my synthesizing paper was the omission of the modifying adjective ‘unmanaged.’ In correcting this omission, one can generalize the practical conclusion in this way: ‘A *managed commons* describes either socialism or the privatism of free enterprise. Either one may work; either one may fail: *The devil is in the details*. But with an unmanaged commons, you can forget about the devil: As overuse of resources reduces carrying capacity, ruin is inevitable.’ With this modification firmly in place, ‘The Tragedy of the Commons’ is well tailored for further interdisciplinary syntheses.”
- 13 For example, John Locke considered America to be in a state of nature (“In the beginning all the world was America”) in which indigenous modes of governance did not constitute political society, and customary land use was not a legitimate form of property rights. Tully provides evidence that some British colonists found Locke’s ideas convenient in justifying the dispossession of indigenous peoples from their lands. Interestingly, if Locke had recognised (as a few British colonists of the time did) that indigenous peoples regarded themselves as self-governing nations, his theory of government could have been used to legitimise their violent rebellion against the British. Tully, J. (1993) *An Approach to Political Philosophy: Locke in Contexts*, Cambridge, Cambridge University Press.
- 14 As Tully (*ibid.*) notes, Emeric de Vattel’s highly influential *The Law of Nations* of 1758 was consistent with Locke’s view in stipulating agricultural improvement and the existence of political society as preconditions “for the recognition of sovereignty and nationhood in international law”.

- 15 Dutfield, G. (1999) 'Rights, resources and responses' in Posey, D.A. (ed.): *Cultural and Spiritual Values of Biodiversity*, London, UNEP and Intermediate technology.
- 16 See for example Biothai and Genetic Resources Action International (1998) *Road Maps to a Peoples' Sui Generis Rights Plan of Action*, Bangkok, Biothai; Nijar, G.S. (1996) *In Defence of Indigenous Knowledge and Biodiversity: A Conceptual Framework and Essential Elements of a Rights Regime*, Penang, Third World Network; Shiva (1995) *Captive Minds, Captive Lives: Ethics, Ecology and Patents on Life*, Dehra Dun, Research Foundation for Science, Technology and Natural Resource Policy.
- 17 Vogel, J.H. (1998) 'An economic analysis of the Convention on Biological Diversity: the rationale for a cartel'. Revised paper presented at the UNEP-Mexico IV Foro del Ajusco on *Biodiversidad, Globalización y Sustentabilidad en América Latina y el Caribe: de quién es la naturaleza*. November 1997.
- 18 Swanson, T. (1997) *Global Action for Biodiversity: an International Framework for Implementing the Convention on Biological Diversity*, London, Earthscan.
- 19 Such military language is used by US Trade Representative Charlene Barshevsky: "The progress we have achieved as a direct result of this year's Special 301 annual review underscores the fact that Special 301 is one of the most effective instruments in our trade policy arsenal" (USTR 1998) [emphasis added]. (The "Special 301" provisions of the Trade Act of 1974, as amended, require the USTR to determine whether the acts, policies and practices of foreign countries deny adequate and effective protection of intellectual property rights or fair and equitable market access for U.S. persons who rely on intellectual property protection.
- 20 See Kloppenburg, J., Jr. 1988 *First the Seed: The Political Economy of Plant Biotechnology*, Cambridge, Cambridge University Press; Sehgal, S. (1996) 'IPR driven restructuring of the seed industry' in *Biotechnology and Development Monitor*, 29, pp.18-21; Suppan, S. (1998) 'Biotechnology's takeover of the seed industry' (Information about Intellectual Property Rights, Biotechnology and Biodiversity, No. 23). Minneapolis, Institute for Agriculture and Trade Policy.
- 21 Drahos, P. (1997) 'States and intellectual property: the past, the present and the future' in Saunders, D. and Sherman, B. (eds.): *From Berne to Geneva: Recent Developments in Copyright and Neighbouring Rights*, Brisbane, Australian Key Centre for Cultural and Media Policy and Impart Corporation.
- 22 See Bell, J. (1996) 'Genetic engineering and biotechnology in industry' in Baumann, M., Bell, J., Koechlin, F. and Pimbert, M. (eds.): *The Life Industry: Biodiversity, People and Profits*, London, Intermediate Technology, pp.31-52; Kloppenburg *op cit*.
- 23 Bell *op cit*.
- 24 Harrison, B. (1997) *Lean and Mean: The Changing Landscape of Corporate Power in the Age of Flexibility*, New York and London, Guilford Press.
- 25 Oddi, A.S. (1987) 'The international patent system and Third World development: reality or myth?' in *Duke Law Journal*, pp. 831-878.

- 26 Maskus, K. (1998) 'The role of intellectual property rights in encouraging foreign direct investment and technology transfer' in *Duke Journal of Comparative and International Law*, 9(1), pp.109-161.
- 27 See also Rapp, R.T. and Rozek, R.P. (1990) 'Benefits and costs of intellectual property protection in developing countries' in *Journal of World Trade*, 24(5), pp.75-102; UNCTAD (1996) *The TRIPS Agreement and Developing Countries*, Geneva, UNCTAD.
- 28 Primo Braga, C.A. and Fink, C. (1999, in press) 'International transactions in intellectual property and developing countries' in *International Journal of Technology Management*.
- 29 Kirim, A.S. (1985) 'Reconsidering patents and economic development: a case study of the Turkish pharmaceutical industry' in *World Development*, 13(2), pp.219-236.
- 30 Kondo, E.K. (1995) 'The effect of patent protection on foreign direct investment' in *Journal of World Trade*, 29(6), pp. 97-122.
- 31 That is to say whole plants and animals, micro-organisms, and functional or structural components of life-forms such as gene sequences, proteins and cells.
- 32 See Overwalle, G. van (ed.) (1998) *Octrooirecht, Ethiek en Biotechnologie/Patent Law, Ethics and Biotechnology/Droit des Brevets, Ethique et Biotechnologie*, Brussels, Bruylant; Sterckx, S. (ed.) (1997) *Biotechnology, Morality and Patents*, Aldershot, Ashgate.
- 33 Winter, G. (1992) 'Patent law in biotechnology' in *Journal of Environmental Law*, 4(2), pp.167-187.
- 34 See Crespi, R.S. (1995) 'Biotechnology, broad claims and the EPC' in *European Intellectual Property Review*, 6, pp. 267-268. (In all other respects Crespi is an enthusiastic advocate of 'patenting life').
- 35 Eisenberg, R. (1994) 'Technology transfer and the genome project: problems with patenting research tools' in *Risk: Health, Safety and Environment*, 5(2), pp.163-175; Heller, M.A. and Eisenberg, R.S. (1998) 'Can patents deter innovation? The anticommons in biomedical research' in *Science*, 280, pp. 698-701.
- 36 See Baumann, M., Bell, J., Koechlin, F. and Pimbert, M. (eds.): *The Life Industry: Biodiversity, People and Profits*, London, Intermediate Technology; Kothari, A. (1998) 'Biopiracy unlimited' in *Frontline*, April 17, pp.66-69.
- 37 See Lehmann, V. (1998) 'Patent on seed sterility threatens seed saving' in *Biotechnology and Development Monitor*, 35, pp.6-8; Verma, S.K. (1995) 'TRIPs and plant variety protection in developing countries' in *European Intellectual Property Review*, 6, pp. 281-289.
- 38 See Almeida, P.R. de (1995) 'The political economy of intellectual property protection: technological protectionism and the transfer of revenue among nations' in *International Journal of Technology Management*, 10(2/3), pp.214-29; Bhagwati, J. (1995) 'The poverty of protectionism' (interview with F. Smoler. *Audacity*, 3, pp.16-26.
- 39 See Cameron, J. and Makuch, Z. (1995) *The UN Biodiversity Convention and the WTO*

TRIPS Agreement: Recommendations to Avoid Conflict and Promote Sustainable Development, Gland, World Wide Fund for Nature; Downes, D. (1995) 'The Convention on Biological Diversity and the GATT' in Goldberg, D., Housman, R., Van Dyke, B. and Zaelke, D. *The Use of Trade Measures in Select Multilateral Environment Agreements*. Environment and Trade Series No. 10, Geneva, United Nations Environment Programme; Tarasofsky, R. (1997) 'The relationship between the TRIPs Agreement and the Convention on Biological Diversity: towards a pragmatic approach' in *Review of European Community and International Environmental Law*, 6(2), pp.148-156; Yamin, F. (1995) *The Biodiversity Convention and Intellectual Property Rights*, Gland, World Wide Fund for Nature.

- 40 See Brush, S.B., and Stabinsky, D. (eds.) (1996) *Valuing Local Knowledge: Indigenous Peoples and Intellectual Property Rights*, Covelo, Island Press; Dutfield (1999) *op cit.*; Greaves, T. (ed.) (1994) *Intellectual Property Rights for Indigenous Peoples: A Sourcebook*. Oklahoma City, Society for Applied Anthropology; Nijar *op cit.*; Posey, D.A. and Dutfield, G. (1996) *Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local Communities*, Ottawa, International Development Research Centre.
- 41 See Raghavan, C. (1990) 'Recolonization: GATT in its historical context' in *The Ecologist*, 20(6), pp.205-207.
- 42 See Hamilton, N.D. (1994) 'Why own the farm if you can own the farmer (and the crop)?: contract production and intellectual property protection of grain crops' in *Nebraska Law Review*, 73, pp.48-103; Jaffé, W. and van Wijk, J. (1995) *The Impact of Plant Breeders' Rights in Developing Countries: Debate and Experience in Argentina, Chile, Colombia, Mexico and Uruguay*. The Hague, Directorate General International Cooperation, Ministry of Foreign Affairs; Leskien, D. and Flitner, M. (1997) *Intellectual Property Rights and Plant Genetic Resources*. Issues in Genetic Resources No. 6. Rome, International Plant Genetic Resources Institute; Sharma, D. (1995) *GATT to WTO: Seeds of Despair*. New Delhi, Konark; Shiva, V. (1996) *Globalisation of Agriculture and the Growth of Food Insecurity*. New Delhi, RFSTNRP.
- 43 See Cosbey, A. (1996) *The Sustainable Development Effects of the WTO TRIPS Agreement: A Focus on Developing Countries*. Winnipeg, IISD; Crucible Group (1994) *People, Plants and Patents: The Impact of Intellectual Property on Trade, Plant Biodiversity, and Rural Society*. Ottawa, International Development Research Centre; Dutfield, G. (2000) *Intellectual Property Rights, Trade and Biodiversity: Seeds and Plant Varieties*. London, Earthscan; United Nations Development Programme (1994) *Conserving Indigenous Knowledge: Integrating Two Systems of Innovation. An Independent Study by the Rural Advancement Foundation International*, New York, UNDP; Mooney, P.R. (1996) 'The parts of life: agricultural biodiversity, indigenous knowledge, and the role of the third system'. *Development Dialogue* (Special issue), 1-2.
- 44 Dutfield 2000 *op cit.*
- 45 *ibid.*
- 46 Posey and Dutfield *op cit.*
- 47 See Merges, R.P. and Nelson, R.R. (1990) 'Market structure and technical advance: the role of patent scope decisions', *CCC Working Papers*, 90-100, Berkeley, University of California; Scotchmer, S. (1991) 'Standing on the shoulders of giants: cumulative research

and the patent law' in *Journal of Economic Perspectives*, 5(1), pp.29-4; Scotchmer, S. and Green, J. (1990) 'Novelty and disclosure in patent law' in *RAND Journal of Economics*, 21(1), pp.131-146.

- 48** See Nordhaus, W.D. (1969) *Invention, Growth and Welfare: A Theoretic Treatment of Technological Change*, Cambridge, MIT Press; Scherer, F.M. (1972) 'Nordhaus' theory of optimal patent life: a geometric interpretation' in *American Economic Review*, 62, pp.422-427.
- 49** See Taylor, C.T. and Silberman, Z.A. (1973) *The Economic Impact of the Patent System: The British Experience*, Cambridge, Cambridge University Press.
- 50** See Plant, A. (1934) 'The economic theory concerning patents for invention' in *Economics*, 1, pp.167-195.
- 51** With respect to patent duration, the eminent economist Jagdish Bhagwati remarked at an NGO roundtable meeting in Geneva in November 1998 that the 20 year minimum term of protection required by TRIPS "had no basis in economics" (*Bridges*, 1(6), p.1). The conclusion of Fritz Machlup in his classic 1958 paper on the patent system remains valid today: "[n]o economist, on the basis of present knowledge, could possibly state with certainty that the patent system, as it now operates, confers a net benefit or a net loss upon society. The best he can do is state assumptions and make guesses about the extent to which reality corresponds to these assumptions". Machlup, F. (1958) 'An economic review of the patent system: study of the Subcommittee on Patents, Trademarks and Copyrights of the Committee on the Judiciary, United States Eighty-fifth Congress, Second Senate. Washington DC, United States Senate.
- 52** Vaver, D. (1991) 'Some agnostic observations on intellectual property' in *Intellectual Property Journal*, 6, pp. 125-153.